



वार्षिक प्रतिवेदन
ANNUAL REPORT
2019



Since 1923

Fulfilling Nation's Dairy Dreams

भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान

(मानद् विश्वविद्यालय) करनाल - 132 001 भारत

ICAR-NATIONAL DAIRY RESEARCH INSTITUTE

(Deemed University) Karnal - 132 001 India

VISION

Ensure availability of quality milk and milk products at affordable cost, livelihood security to the producer and profitability to the dairy sector through adoption of appropriate technologies and human resource development.

GOAL

Provide R&D support towards generation and dissemination of knowledge towards improved national milch herd for milk production enhancement, greater productivity of dairy industry and management aspects of the dairy profession leading to the social, economic and environmental benefits to the Nation as well as contributing towards manpower development programmes.

MISSION

To serve the cause of dairying by developing quality human resource and suitable technologies related to the production, processing and marketing of milk and milk products, and their dissemination for the benefit of dairy industry, farming community and the Nation.

MANDATE

- Research in the Areas of Dairy Production, Processing and Marketing.
- Human Resource Development in Dairy Sector.
- Dissemination of Innovative Dairy Technologies.



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Preservation and multiplication of germplasm of Gir Breed

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CONTENTS

<i>Preface</i>	i
<i>Executive Summary</i>	iii
कार्यकारी सारांश	xiii
1. Introduction	1
2. Organisational Setup	3
3. New Initiatives in Research, Teaching and Extension	5
4. Research Achievements	6
<i>Biotechnological Interventions for Higher Productivity</i>	6
<i>Genetic Improvement of Dairy Animals</i>	14
<i>Animal Fertility, Reproduction and Diagnostics</i>	21
<i>Feed, Fodder and Productivity</i>	34
<i>Innovative Approaches in Management of Dairy Animals</i>	46
<i>Novel Approaches in Value Addition and Functional Foods</i>	60
<i>Development and Validation of Health Promoting Dairy Foods</i>	71
<i>Mechanisation and Process Engineering</i>	83
<i>Risk Assessment and New Generation Methods to Assess The Quality and Safety of Milk and Milk Products</i>	87
<i>Dairy Development: Policy Analysis, Strengthening Database and Impact Assessment</i>	96
<i>Extension Approaches for Socio-Economic Upliftment Through Dairying</i>	103
5. Research Prioritization, Monitoring and Evaluation (PME)	108
6. Extra-Mural Funding and Collaborations	116
7. Intellectual Property Management	121
8. Entrepreneurship Development and Business Incubation Activities and Consultancy Services	124
9. Dairy Education	128
10. Technology Dissemination and Extension Programmes	131
11. Women Empowerment and Mainstreaming of Gender Issues	142
12. Honours and Awards	144
13. Publications	156
14. Training and Capacity Building	176
15. Major Events	186
16. Distinguished Visitors	188
17. Personnel	189
18. Main Campus, ICAR-NDRI, Karnal	199
19. Regional Campuses	216
20. Budget and Expenditure	228
21. राजभाषा कार्यकलाप	230
22. Swachhh Bharat Abhiyan: Clean & Green NDRI	233
23. Mera Gaon Mera Gaurav (MGMG)	235

MILESTONES

1923	Established in Bangalore as Imperial Institute of Animal Husbandry and Dairying.		1923	Sahiwal Calf "Holi" through Ovum Pick up (OPU-IVF) technique born on 7 th March, 2012.	
1936	Renamed "Imperial Dairy Institute".			NRC on Milk Quality and Safety established at NDRI, Karnal.	
1955	National Dairy Research Institute came into existence at Karnal, at the former Central Cattle Breeding Farm. Bangalore facilities became Southern Regional Station of the Institute.	1998	A Modern Cafeteria with a seating capacity of 150 constructed in front of the Institute Hostels.	Business Planning and Development (BPD) Unit established at NDRI, Karnal.	
1957	B.Sc. Dairying commenced at NDRI, Karnal.	1999	Total no. of 9 NATP Projects with financial outlay of 266.25 lakhs initiated.	2013	First female calf named 'Mahima' was born to a cloned buffalo on 25 th January 2013. A male cloned buffalo calf named 'Swarn' was born on 18 th March 2013. Donor somatic cell used was isolated from the seminal plasma of an elite bull.
1961	B.Sc. Dairying bifurcated into two branches, namely B.Sc. (Dairy Technology) and B.Sc. (Dairy Husbandry); M.Sc. Dairying courses commenced at Karnal.	2000	A Guest House with two suites named as "Kamdhenu" was constructed at SRS, Bangalore. Web-site of NDRI was created and launched by the Hon'ble Union Minister for Agriculture on 23 rd December 2000.	2013	A Diploma in Dairy Technology started at Southern Regional Station, Bangalore.
1962	Western Regional Station established at Bombay.	2001	Foundation stone of the Agricultural Technology Information Centre laid on 1 st August, 2001 under NATP project at NDRI, Karnal.	2014	NDRI bagged the Sardar Patel Outstanding ICAR Institution Award presented by Hon'ble Prime Minister of India, Sh. Narendra Modi ji. NDRI produced a clone of endangered wild buffalo of Chhattisgarh named "Deepasha" on 12 th December, 2014. A new extension education approach "Farmers' Farm School" was started at NDRI, Karnal.
1964	Eastern Regional Station established at Kalyani (W.B.).	2002	International Students' Hostel equipped with modern facilities and amenities constructed at NDRI, Karnal. Feed Quality Control Lab. set up to help keep-strict quality check on feeds being fed to bovine livestock.		NDRI got ISO 9001: 2008 certification. NDRI implemented MIS/FMS to carryout administrative and financial activity of the Institute.
1966	Institute brought under the aegis of ICAR.	2003	State-of-the-art milking parlour system introduced in cattle section.	2016	Two service centres established at Lalukheri, Muzzafarnagar (UP) and Piprakothi East Champaran (Bihar).
1975	Operational Research Project initiated.	2004	First IVF goat kid born at NDRI. ATIC centre made functional at NDRI.	2017	Additional KVK established at Eastern Campus, Kalyani. One month Foundation Course for newly admitted students of 2017-18 batch introduced. Automation of the 'Academic Management System' implemented
1976	Department of Human Nutrition and Dietetics established at NDRI, Karnal.	2006	New Animal Biotechnology Centre commissioned.	2018	A mega world-bank funded Institutional Development Plan (IDP) of National Agricultural Higher Education Project initiated. National Referral Center for Milk Quality and Safety (NRCMQS) granted accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL). Atal Incubation Centre set up at Southern Campus of ICAR-NDRI, Bengaluru.
1979	M.Sc., Ph.D. Programme in Dairy Engineering commenced at Karnal.	2007	Creation of Video Conferencing Lab and Mini Auditorium.		
1983	IDD (DH) started at Bangalore.	2009	World First Cloned Buffalo Calf and second cloned calf "Garima" produced by hand-guided cloning technique at NDRI. DST supported Technology Business Incubator (TBI) facility made functional. New Course Curricula for B.Tech in Dairy Technology and Masters and Doctoral Programmes introduced. Reforms in examination system, grading system and introduction of comprehensive exam. for Ph.D. programme introduced. A new extension programme "Dairy Education at Farmers' Door" started.		
1985	"Farm Advisory Bureau" and "Industrial Consultancy Cell" set up. The Institute recognised as Centre of Excellence in Animal Biotechnology.	2010	8 th Convocation of NDRI, Deemed University held in presence of Dr. A. P. J. Abdul Kalam, Former President of India.		
1987	Embryo Biotechnology Centre established.	2011	M.Sc. in Forage Production introduced at NDRI, Karnal. NDRI recognized as Centre of Advanced Faculty Training (CAFT) in the Disciplines of Dairy Production and Dairy Processing.	2019	Three cloned calves produced using donor cells of an elite bulls. ICAR-NDRI ranked first consecutively third-time among all Agricultural Universities and four Deemed Universities of ICAR in the year 2018-19).
1989	The Institute granted "Deemed to be University" status. M.Sc. in Biotechnology started.				
1990	Birth of Pratham, first IVF buffalo calf of the world.				
1991	20 bedded Hospital Complex set up and made functional.				
1994	The Institute got recognition as Centre of Advanced Studies in Dairy Technology and Dairy Cattle Breeding.				
1996	A two-year National Dairy Diploma (NDD) course introduced at Southern Regional Station of NDRI at Bangalore. The ICAR award (1993-94) for outstanding KVK conferred on the KVK located at NDRI.				
1997	A state-of-the-art Auditorium having seating capacity of 950 and 2 conference rooms and 2 meeting rooms made functional. A commercial Model Dairy Plant with a capacity of 60,000 lit./ day				

PREFACE



ICAR-NDRI Annual Report 2019 is being presented as an all-inclusive account of the most significant achievements of the Institute in the areas of Research, Education and Extension, and related activities undertaken to strengthen these programmes during the last one year. The information has been so arranged that it provides a complete panoramic view of this premier dairy Institute of the country and its functioning.

ICAR-NDRI made hat trick by securing **FIRST RANK** consecutively for the third time amongst Agricultural Universities. The Institute was privileged to receive this honor on ICAR Foundation Day, July 16, 2019 at NASC Complex, Pusa, New Delhi. The research and development activities of ICAR-NDRI got further impetus through its mandate oriented and well-structured research programmes comprising 69 in-house and 80 externally funded research projects, which also included four International collaborative research projects.

In the area of cloning, the Institute has already made a mark by producing many cloned calves one after the other. During 2019, three cloned calves were produced using donor cells of an elite bull. A pregnancy-associated glycoproteins-based diagnostic assay was developed for early detection of pregnancy in bovine. An aptamer-based method was developed for detection of β -casomorphin-7 in urine and blood.

In the area of dairy processing, a method was developed for preparation of spray dried milk protein-vitamin A/ vitamin D complexes for fortification in various food products. Plasmin activity and its relation with physico-chemical, bio-functional and sensory attributes of Gouda cheese were evaluated. Manufacturing protocols were developed for products such as Ricotta cheese from cow milk, milk protein concentrate 80 from buffalo milk; omega-3 rich table spread, processed mozzarella cheese and fortified sweetened milk Kefir.

Antioxidant active packaging was developed for *burfi*, using electrospun structures. Vitamin B₁₂ bio-fortified soy-curd developed under specific optimized conditions has scope for commercial adaptation in food industry. A protocol was developed for the fortification of dahi and biscuits using whey protein concentrate-iron complex. A protocol was standardized for extraction of Metagenomic DNA from 'Dahi' samples. Whey based medium was tailored to improve the growth of Lactic Acid Bacteria (LAB) equivalent to the standard culture medium. The fermented product panchamrit optimized having dahi, milk, honey, sugar and ghee had storage stability of 3-4 weeks at refrigeration temperature.

PANI-PEC based paper strip assay for detection of *E. coli* in milk products was developed. The developed assay for rapid detection of β -lactam group in milk was transformed on paper based pillar array device in collaboration with UK partners. Studies also showed that *in situ* EPS producing NCDC400 could be used to develop hypo-cholesterolemic fermented dairy products.

A mechanized whey dewatering system was developed for chhana production. The developed time saving equipment would be suitable for small-entrepreneurs for hygienic production of chakka.. A low cost mechanized stretching and portioning unit was developed for Mozzarella cheese production at small scale. Automatic Endo-exo Thermal unit was developed for fermented milk products. The experimental setup of farm milk cooler having 40-80 liters capacity was designed and fabricated. Transmission based colour measurement system was designed and developed. A mechanical unit was custom designed and developed for the dry-crystallization process to prepare convenience

mix for *Palada Payasam*, a traditional dairy product of Kerala. Studies were also carried out on spatio-temporal analysis of bovine population dynamics, milk production trends and economic contribution of dairy sector in India.

In the area of Dairy Education, UG students were provided mentor support for development of technological packages for value added dairy products under Student Ready Programme as per the suggestion of 5th Dean Committee with the aim to inculcate the research based developmental activities and business acumen among them. Six teams of students developed the technology and also business canvas model for chhana based Muffins, Goat milk cheese, Malt ice cream/Kulfi, Fruit barfi and Ghee residue based chocolate Barfi.

ICAR-NDRI, a deemed university, is all set to bring in new reforms to keep its activities aligned to the trends in global institutions of higher learning. Various initiatives were taken for strengthening academic programmes, leveraging alumni network, nurturing soft skills of the students, and equity action plan plus green campus under Institutional Development Plan (IDP). A total of 16 faculty members were selected for international training and out of which 7 faculty were deputed for availing advance training at 6 different universities located in USA and Netherlands. A total 24 students completed their overseas internship at 11 different universities in 4 different countries. A Foundation course was organized for fresher students to nurture their innate talents during which sessions on literary activities, communication skills, leadership skills, theatre art, cultural dance, music, physical and sports activities including yoga, values, ethics and social awareness were conducted.

Six workshops on women empowerment, leadership and social entrepreneurship, sensory evaluation techniques, mammalian genome editing, advances in starter culture technology, textural analysis of dairy & food products and computer vision applications in dairying were organized for the benefit of the faculty and students. Subject experts including four overseas professors from USA, UK and Ireland were invited to deliver the lectures during these workshops. A skill development programme on microbiological quality and safety analysis of dairy products and a certificate course on starter culture and fermented milk products were also organized. A skill development programme N_Reach sponsored by Nestle India Pvt. Ltd. was conducted for B.Tech final year students to improve their communication/soft skills.

Furthermore, linkages were established with different industries and academic institutions. A MoU was signed with Institute of Rural Management Anand (IRMA), Anand, India for initiation of Post Graduate Diploma in Dairy Management Course to cater to the needs of dairy industry. Alumni data base was updated to strengthen global alumni network. Eleven entrepreneurial development programmes for prospective entrepreneurs including one innovative idea contest and an experiential learning programme for UG students were conducted to nurture business ideas amongst undergraduate students. As a part of outreach activity, a total of 61 MOOCs were developed in the field of dairy production and processing with the support of ICAR-NAARM, Hyderabad

A total number of seven patents were granted during the year 2019. Seven technologies developed at the Institute were transferred to five commercial houses through seven different license agreements and 17 technologies were approved for commercialization. Training programmes were conducted for varying periods for the benefit of milk producers, prospective entrepreneurs and farmers by Business Planning & Development Unit, Dairy Extension Division, Krishi Vegan Kendras and both the Regional Campuses of the Institute. KVK of ICAR-NDRI organized 215 off campus and on campus skill based vocational training programmes for 7589 dairy stake holders. BPD Unit of the Institute conducted 12 Entrepreneurship Development Programmes in the area of commercial dairy farming and milk processing & value addition. Two International training programmes were organized for farmers and marketing personnel from African Nations. Under Tribal Sub Plan (TSP) 6 camps were organized in different parts of Eastern and North- Eastern India and 4 on-campus training programmes were organized. Five North Eastern states of India namely, Meghalaya, Tripura, Sikkim, Nagaland and Mizoram were covered under the North Eastern Hill (NEH) project during 2019 and livestock and different inputs were distributed among farmers.

Another landmark has been the creation of a new Livestock Research Centre building, which was opened for use on December 9, 2019 at Southern Campus of ICAR-NDRI, Bengaluru. Extension of Krishna Wing of Hostel was completed and a Skywalk from Guest House and Hostel Complex to main Campus was built at Southern Campus of ICAR-NDRI, Bengaluru. All this could be achieved by the Institute with the dedication, hard work and cooperation of all the Scientists and staff of the ICAR-NDRI fraternity. The Institute is committed to become a world-class model campus for promoting dairy research, education and outreach as dairying is emerging as a major game changer for transforming socio-economic lives of millions of farmers.

I sincerely hope that ICAR-NDRI Annual Report 2019 would serve as a valuable source of information to the professionals of the other Institutions of Higher Learning and Dairy Development Organizations in the country.

(M. S. Chauhan)

Director, ICAR-NDRI

EXECUTIVE SUMMARY

ICAR-National Dairy Research Institute is a premier research organization of the nation dedicated to provide Research and Development (R&D) and Human Resource Development (HRD) support towards dairy development programmes in the country. Established in 1923 at Bangalore, the headquarters of the Institute were moved to the present location at Karnal in 1955. It has two regional stations, one at Bengaluru and the other at Kalyani for providing region-specific support suited to their agro-climatic conditions. ICAR-NDRI has the distinction of being a Deemed University for implementing its academic programmes since 1989. The Institute has been ranked first among all Agricultural Universities of India including 4 Deemed Universities consecutively for the third time in the year 2018-19.

ORGANISATIONAL STRUCTURE

In consonance with the administrative pattern of the Deemed University System of the ICAR, the Institute is managed through various policy/decision making bodies, viz. Board of Management, Research Advisory Committee, Academic Council, Executive Council and Extension Council. The Director is the Chief Executive Officer assisted by the Joint Directors for managing research, academic and extension functions. The Institute has three major areas of R & D activities viz. i) Dairy Production, ii) Dairy Processing and iii) Dairy Extension/Management. All the R & D activities are managed through thirteen Research Divisions/Sections, namely, Animal Genetic & Breeding, Livestock Production and Management, Animal Nutrition, Forage Research and Management, Animal Physiology, Animal Biochemistry, Animal Biotechnology, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, Dairy Extension and Dairy Economics, Statistics and Management. The Institute also has an Agricultural Technology Information Centre (ATIC), Krishi Vigyan Kendra and Dairy Training Centre, Artificial Breeding Research Centre, Krishi and Dairy Vikas Kendra at KVK, Piprakothi, East Champaran, Motihari, Bihar and Model Dairy Centre at Lalukheri in Muzzafarnagar, U.P. The Institute has infrastructure consisting of central facilities such as Livestock Research Centre, Forage Research and Management Centre, Animal Health Complex, Model Dairy Plant, Technology Business Incubator, Business Planning and Development Unit, National Referral Laboratory for Milk Quality and Safety, Experimental Dairy Plant, Consultancy Unit, Library and National Bio-informatic Centre, Computer Centre, Estate Section and Maintenance Engineering Section. The administrative functions viz. purchase, stores and security are under the administrative control of the Joint Director (Admn.) and Registrar, whereas finance division is under the administrative control of Comptroller (Finance). The Institute presently has strength of 159 scientists, 186 technicians, 128 administrative staff and 345 skilled supporting staff.

BUDGET OUTLAY

The financial outlay of the Institute in terms of actual expenditure during the year 2019-20 was Rs. 21374.70 lakhs and budget sanctioned for the year 2019-20 was Rs. 21491.03 lakhs. These figures also include the financial outlays for the strengthening of Regional Campuses. The revenue receipts of the Institute including regional campuses were Rs. 914.30 lakhs during 2019-20.

RESEARCH

- Three cloned calves were produced using donor cells of an elite bull.
- Treatment of cloned buffalo embryos with Dickkopf-1, an inhibitor of canonical Wnt signaling pathway, was shown to increase the blastocyst, conception and live birth rate, and improves their quality.
- Unique differential glycan profile, which can help in preselection of spermatozoa for their fertilizing ability, was elucidated for high and low fertile buffalo spermatozoa.
- Novel proteins involved in lactogenesis were revealed using quantitative proteomic analysis of proliferating and differentiated buffalo mammary epithelial cells.
- A pregnancy-associated glycoproteins-based diagnostic assay was developed for early detection of pregnancy in bovine.
- An aptamer-based method was developed for detection of β -casomorphin-7 in urine and blood.
- Recombinant buffalo sperm lysozyme-like protein 5 (SPACA5) was produced using *Pichia pastoris* expression system.
- The semen proteome of Karan Fries bulls was analyzed for elucidating the markers for semen freezing potential.

- Antibiotic resistance pattern of mastitis-causing bacteria in Karnal district revealed that these were least resistant to Gentamicin and highly resistant to Cephalosporins and Penicillin.
- Seven new α 2 (S2) casein variants were identified from Marwari, Jakhrana, Bakarwali and Osmanabadi goat breeds.
- The peak yield of elite Sahiwal cow (SW- 2233) was 23.5 kg with 305day milk yield and total milk yield as 3854 kg and 4220 kg, respectively.
- Best 305DMY for Gir cow (G-21) was 2232 kg.
- Best 305DMY for Tharparkar cow (TP-1274) was 2656 kg.
- Best milk yield for Murrah buffalo (MU- 6630) was 4024 kg. The average of best lactation milk yield of elite Murrah buffaloes was 3067 kg.
- GG genotype of SNP locus C6521978T and AA genotype of A6547390G SNPs of ANKRD31 gene in Karan Fries cattle and TT genotype of SNP locus T5634584G of SFXN1 gene in Sahiwal cattle could be used as an aid to selection for higher milk production with desired udder conformation after validation in a larger population.
- Based on functional gene-assay, Milk Fat Globule-EGF Factor 8 (MFGE-8) and Protein Di-Sulfide Isomerase-3 (PDIA3) genes were found to be significantly up-regulated in the high yielding KF cattle, which could be served as potential biomarkers for higher milk production in Karan Fries cattle.
- GG genotype of Exon-40 region of FASN gene and TT genotype of Exon-2 region of MTNR1A gene depicted typical type of lactation curves for milk yield and its constituent traits in Murrah buffalo, which could serve as additional genetic criteria in selection of buffaloes.
- A total of 258,231 genome-wide SNPs were identified in Sahiwal cattle using ddRAD approach with reference to *Bos indicus* genome, of which 150,231 were novel SNPs. Among the high-confidence SNPs identified, 91.86% and 27.30% were genotyped in 50% and 100% of the samples. Mapping of the identified SNPs revealed 525 SNPs in candidate genes related to production traits while 333 SNPs were mapped to candidate genes related to reproduction traits.
- Using ddRAD approach, a total of 87,047 SNPs, 8,465 INDELS and 2571 SSRs were identified in Tharparkar cattle, of which, 496 SNPs from 69 genes for fertility traits, 334 SNPs from 47 genes for immune response traits, 243 SNPs from 61 genes for adaptability traits, 1042 SNPs from 109 genes for milk production traits and 756 SNPs from 97 genes for carcass traits were annotated.
- Breed-specific preputial wash volume and frequency of preputial cleaning were standardized to reduce bacterial contamination in the ejaculate.
- After vaccination of bull, semen functional quality is compromised for up to 6th week after vaccination and only after the restoration of all functional characteristics of sperm, higher dilution of the semen could be recommended for preservation.
- Murrah buffalo males could grow fast, attain early puberty and AFE with better semen quality when provided with improved feeding and seasonal shelter management.
- Studies suggested that calves are social animals and should be kept in group housing for better social interaction, which can potentially be a better option in optimizing their performance and welfare in modern calf management practice.
- Protein source of concentrate mixture could be replaced upto 30% with improvement in growth rate compared to control of growing Sahiwal calves, which could reduce the cost of concentrate feeding to dairy animals.
- Feeding of vitamin D₃ @ 20,000IU/day in early lactating buffaloes (day 30) increased milk production by 1.99 kg/day due to improved circulatory vitamin D3 levels without influencing milk composition.
- Tharparkar cows showed more heat tolerance due to higher plasma aldosterone, milk urea and sodium content, which makes them more climate resilient than the Sahiwal and Gir cows. It was observed that least changes in rectal temperature in Tharparkar cows during hot-dry and hot humid season further contributed to thermal resistance.
- The Sahiwal cows with a lactation length between 250-305 days showed higher persistency of lactation than cows with short lactation. The regression of persistency on age at first calving was also found to be significant ($P < 0.05$).
- Sahiwal cows with TT genotype of bGH-*Msp1* gene showed better lactation yield, persistency of lactation and longer lactation length; therefore, a breeding strategy could be made to use these genotypes to improve persistency of lactation.
- *Chlorophytum borivilianum* (80 mg/d) ameliorated thermal stress by augmenting the immunity and lowering the physiological responses and stress hormones in crossbred KF cows.

- Tharparkar cows showed low cortisol, values of respiration rate, rectal temperature, pulse rate and higher aldosterone levels than the crossbred Karan Fries cows.
- In crossbred cows, the average daily milk yield declined by 41 gram in the heat stress zone while there was a decline of 10 gram milk per unit increase in THI.
- Milk plasminogen activator, plasminogen, plasmin (PA, PG, PL) levels could be used as biomarkers of synthetic capacity of the mammary gland.
- SIN-1 addition at refrigerated temperature reduced the sperm quality in a dose and time dependent manner.
- Topical application of *Terminalia bellerica*, *Piper betel*, *Boswellia serrata*, *Bergenia ciliata* to the udder and teats of subclinical mastitis Karan Fries cows significantly ($P < 0.05$) reduced milk SCC without influencing composition.
- The season and period of calving significantly impacted ($P < 0.01$) persistency measures in Sahiwal cows.
- Sahiwal cows with TT genotype of bGH-*Msp1* gene showed better lactation yield, persistency of lactation and longer lactation length than other bGH genotype.
- SIN-1 addition at refrigerated temperature reduced the sperm quality (Sperm motility, viability, membrane integrity as well as acrosome integrity) in dose and time dependent manner. Prolonged exposure of spermatozoa to high peroxy nitrite concentrations was detrimental for semen quality.
- As compared to the ICAR (2013) recommendations for growing cattle in general, MP requirement for growing Sahiwal heifers could be reduced by 15%, while the ME content could be increased by 15%. These breed specific requirements would be beneficial in achieving optimum growth performance of this valuable indigenous germplasm.
- Additional benefits of this increment in ME increased plasma concentration of IGF-1, insulin, leptin and immunoglobulins and lower concentrations of GH and Cortisol. Better antioxidant and immune status of the animals were also observed during both the seasons.
- Animals growth performance and hormonal, antioxidant and immune status were found better during winter as compared to the summer season. The requirements of both the seasons' metabolizable energy and protein requirements were higher during the summer season.
- Boron supplementation 200 and 400 ppm (though no additional benefit of higher dose) was found to be helpful in maintaining higher antioxidant status and plasma Ca levels especially during transition period. Milk persistency was also improved by supplementation of boron.
- Dietary Cation Anion Difference + 300mEq/kgDM was effective in improving production performance of buffaloes yielding an average of 10 kg milk per day.
- Antioxidant activity and immune responses of pre and post ruminant calves was improved on hydroxy Zn supplementation as evident from increased SOD, GPx, and catalase activity; TAC, IgG and TIg concentration with concomitant decreased TBARS values.
- Calcium, P, Mg, Fe, Cu, Zn content in *M.oleifera* leaf were 1.85%, 0.15%, 4.81%, 330ppm, 9.21ppm and 26.72ppm, respectively. Tannin, saponin, total phenolic content and total flavonoids content in *M.oleifera* leaves were 2.02%, 1.01%, 4.28% and 3.61%, respectively.
- Growth performance and feed conversion efficiency of kids were better in 60:40 and 70:30 roughage to concentrate ratio with 10% and 20% replacement, respectively, with *Moringa oleifera* leaves as compared to 70:30 roughage to concentrate ratio.
- *In vivo* results suggested that incorporation of depotash vinasse (a light dark coloured waste product of alcohol distilleries) in the pellet @8 % didn't affect digestibility and intake of any nutrients, blood bio-chemicals and hepatic enzymes in lactating Murrah buffaloes.
- Milk yield and FCM yield of the buffaloes were also similar with all its composition and it was concluded that depotash vinasse could be used as pellet binder @8% and subsequently feeding to lactating buffaloes without any adverse effect to the animals
- Supplementation of aloe vera extract can enhance milk nutraceutical properties through manipulation of rumen fermentation.
- The three best probiotics isolates were recognised as *Lactobacillus reuteri* SW26, *Lactobacillus reuteri* SW27, and *Enterococcus faecium* SW28.
- Milk replacers were formulated for kids of black bengal goat.
- Eastern Himalayan forest tree leaves were evaluated as herbal feed additives to manipulate rumen fermentation for improving animal productivity.

- Studies revealed that quality fodder production with high profit generation from forage based cropping system, higher qualitative biomass yield (187 t/ha) was obtained with cropping sequence NBH + Cowpea/- Berseem (2 cutting) with B:C ratio 4.20. However lowest was produced by Baby corn-cowpea-chinese cabbage(s) i.e (63 t/ha).
- It was observed that that in cereal based cropping system application of PGPR with RDF gave highest yields (Grain/straw/green fodder) compared to recommended dose of chemical fertilizers, RDF+Cow urine spray and 75% RDF+CU+PGPR. Moreover, application of 75% RDF+CU+PGPR recorded almost equal yield as compared to RDF and RDF+CU under Maize -cowpea-wheat cropping system. In terms of economics it was recorded that rice-berseem cropping system gave maximum returns followed by rice-wheat and maize-wheat-cowpea.
- Different oats varieties under varying fertility levels and seed rates were evaluated. Amongst the oats varieties JHO-851 with 125% of RDF recorded highest growth and yield attributes followed by HJ-08. At seed rate of 105 kg/ha, highest grain and fodder yield was recorded.
- Six new genotypes of Napier hybrid, guinea grass and Multicut sorghum were collected from Karnataka and Tamilnadu and planted at Agronomy Research Farm of ICAR-NDRI for further multiplication and testing the local area adaptability.
- Production of Sugargraze with 25 kg K₂O as basal + KSB seed treatment + 2% KNO₃ foliar spray (at 25DAS) of potassium management was observed better agronomic practice for higher fodder productivity in terms of growth, yield, quality as well as economics during *kharif* season of Karnal based ecological condition.
- Tissue heterogeneity of mitochondrial DNA content and mitochondrial genes expression was observed in buffalo.
- There is a haplotype-specific variation in mitochondrial DNA copy number in buffalo.
- Loop-mediated isothermal amplification (LAMP) reaction was developed to detect *Ureaplasma diversum* in the cervico-vaginal swabs of Murrah buffaloes.
- miR-326 regulated estradiol-17b production and proinflammatory cytokines by targeting CYP19A1 and TLR-4 in buffalo granulosa cells.
- The model dioxin, TCDD, in the milk in a range of 0.02-20 pg/mL concentration were found to be not much hepatotoxic on the basis of 3D cultured buffalo hepatocyte model system.
- Body condition score, parity, shelter cleanliness and male proximity were identified as highly associated non-genetic factors with post-partum anestrus in Murrah buffalo in field conditions.
- Three (P2, P4 and P8) potential peptide inhibitors were identified against Cysteine Synthase protein of the *Haemonchus contortus*.
- Camel milk showed a protective effect in combating type-1 diabetes by reducing blood glucose, glycosylated hemoglobin levels and by improving insulin and GLP-1 secretion.
- The camel milk whey hydrolysates prepared using pepsin exhibited the maximum insulinotropic effect.
- The osteoanabolic activity of β casein-derived heptapeptide augmented using structure activity relationship.
- The influence of probiotics lactobacilli (*L.fermentum* and *L.rhamnosus*) in the presence of inflammatory agents on the NF-k β pathway as the master inflammatory regulator was monitored.
- Probiotic fermented milk (*Lactobacillus rhamnosus* and *Lactobacillus fermentum*) and associated prebiotic tested, fructooligosaccharides synergistically improved the viability parameters in mice model fed with obesogenic diet.
- The symbiotic combination of the established probiotic (*Lactobacillus rhamnosus* and *Lactobacillus fermentum*) with prebiotic significantly ameliorated testicular histopathophysiology of mice exposed to high fat diet.
- Heat stress is one of the most important abiotic factors which affect the growth, milk yield and reproductive health of the dairy animals and identified 387 conserved and 77 novel miRNAs from Tharparkar and Karan Fries cattle under stressed condition. Family distribution analysis further showed the identified miRNAs belong to more than 15 different families in which miR-2284 was the most abundant.
- In both, Tharparkar and Karan Fries differential gene expression showed more than 344 miRNAs changed their expression significantly between control and stressed condition. Heat map was generated for the top 20 most up and down regulated miRNAs. miRNAs were validated using qRT-PCR to be heat-responsive based on read count value and differential gene expression. These novel miRNAs are indeed a new addition to the miRNA database of cattle.
- High throughput omics was found to be helpful to decipher the global effect of the NPs at the molecular level and this provided potential nano-safety clues for the final assessment of the nano-particles.

- NPs were found to be able to perturbate number of pathways related to cellular stress even at the low dose exposure and cells maintained the homeostasis against external insults thus indicating Nanosafety levels.
- Casein hydrolysates (P, T, C, PT, PC, CT and PTC) exhibited significant DPP-IV inhibitory activity as compared to casein protein. Whey protein hydrolysates (P, PT, PC, CT and PTC) exhibited significant DPP-IV inhibitory activity as compared to whey proteins.
- Below 3 kDa fraction of casein protein PC hydrolysate and whey protein PTC hydrolysates exhibited significant DPP-IV inhibitory activity as compared to casein PC and whey protein PTC hydrolysate respectively. Below 3 kDa fraction of whey PTC hydrolysate was more effective in DPP-IV inhibition than below 3 kDa fraction of casein protein PC hydrolysate.
- CRISPR/CAS9 guided functional analysis of genes regulating early embryonic survival in buffalo was initiated.
- Uterine fluid proteins marker(s) were identified for detection of subclinical uterine infection in dairy cattle.
- Identified that abundant proteolysis by ubiquitination and down regulation of WNT signaling, cell proliferation, differentiation and steroid-genesis could be a reason for higher incidence of poor semen quality and/or sub-fertility/infertility in crossbred males
- Studies proved that the proportion of cryo-capacitated spermatozoa in cryo-preserved semen was negatively related to bull fertility.
- Fertility associated proteins in spermatozoa were identified for buffalo bull fertility prediction.
- Heat killed probiotic preparation of *L. fermentum* MTCC 5689 and LGG exhibited anti-inflammatory effect in colitis mouse model.
- Peptidoglycan of both *L. fermentum* MTCC 5689 and LGG showed the potential to exhibit anti-inflammatory potential.
- Two indigenous probiotic strains viz. LbS4 and Lf1 and their surface proteins displayed strong decolonization efficacy against robust ESBL *E. coli* strains 9/234, 23/208 besides improving gut barrier permeability.
- Vitamin B₁₂ bio-fortified soy-curd developed under specific optimized conditions has scope for commercial adaptation in food industry.
- The antifungal mix from Lactic Acid Bacterial isolates viz. *W. cibaria* P6 and *L. plantarum* P10 was prepared that exhibited strong antifungal activity against test fungi indicators as well as spoilage fungal isolates.
- *In situ* EPS producing NCDC400 could be used to develop hypocholesterolemic fermented dairy products.
- High up-regulation of the histidine kinase could provide the strong foundation for bile tolerance process in *Lactobacillus helveticus* MTCC5463. Besides, GMP synthase, ABC transporter permease, Holiday junction, Multidrug resistance, family of transcriptional regulators and histidine kinase were found to be highly important during bile tolerance process in MTCC5463.
- Protocol for extraction of Metagenomic DNA from 'Dahi' samples was standardized.
- Whey based medium was tailored to improve the growth of Lactic Acid Bacteria (LAB) equivalent to the standard culture medium.
- The fermented product panchamrit optimized had dahi and milk (2:1), and 5% honey, 3% sugar and 5% ghee. The product had storage stability of 3-4 weeks at refrigeration temperature.
- Panchamrit formulations had high antimicrobial activity and Immuno-modulatory activity in HT-29 cell line. *In vitro* immuno-modulatory activity showed the induction of IL-10 cytokines with pre (six hours and 24hours) and post-treatments against HT -29 cell line. Change in the induction of IL-10 was 511.553 ± 2.635 pg/mL for six hours pre-treatment
- PANI-PEC based paper strip assay for detection of *E. coli* in milk products was developed with a detection sensitivity of 0.52 ± 0.17 log cfu/mL *E. coli* at 37°C within $10:21 \pm 0:10$ h.
- The PANi-Pec strips used for the detection of total microbial load in milk using optimized medium in raw milk showed a detection sensitivity of 4 ½ hrs at 7 log cfu/ml.
- Magnetic molecularly imprinted polymer- enzyme inhibition based microtiter assay was developed for recovery of Captan pesticides at a level of 88.61 ± 0.22 , 83.97 ± 1.15 and $72.8 \pm 2.11\%$ of captan in water, skim milk and pasteurized milk, respectively and met their MRL.
- Prevalence of antibiotic resistant zoonotic pathogens in dairy supply chain was conducted in milk samples collected from both organized and unorganized sector for *E. coli*, *Staphylococcus aureus* and *Enterococcus* species and resistance towards extended spectrum β -lactams, oxacillin and vancomycin antibiotics was observed in 6 *E. coli* and one each of *S. aureus* and *Enterococcus* strains.

- Seven hundred and two (702) samples of raw and pasteurized milk procured from Rajasthan and Haryana were screened and 4.68% samples were found contaminated with antibiotic residues with the presence of β -lactam, chloramphenicol, sulfa drugs, enrofloxacin. Samples were also tested for pesticides residues with presence of 3.55% in raw milk and 0.59% pasteurized milk.
- Baseline data on prevalence of mastitis in dairy animals was generated by taking 376 raw milk samples from organized dairy farms in Haryana. Prevalence of clinical mastitis in 14.36 %, sub clinical mastitis in 17.81 %, *E. coli* in 13.82% and *S. aureus* in 31.64% was detected.
- Strip based test employing β -galactosidase enzyme from *B. licheniformis* ATCC 12759 was developed with LODs of Pb 20 ppb, Cd 100 ppb, As 250 ppm and Hg 5 ppb giving results within 25 min in buffer system.
- Proof of concept on paper strip based analytical device was developed for rapid detection of β -lactam group in milk. The developed assay was transformed on paper based pillar array device in collaboration with UK partners.
- Relevance of ISO standard of milk fat purity in case of cow and buffalo ghee was evaluated for detection of adulteration in ghee.
- Triglyceride profile of cow and buffalo as affected by season and processing conditions was evaluated with a view to develop method for detection of adulteration in ghee.
- About 14% of the samples of whey protein based health supplements available in the market deviated from the claimed values for protein and fat content on the label.
- A nanotechnology based analytical method was developed for the rapid detection of organophosphorus pesticide residues in milk.
- A protocol was developed for the fortification of dahi and biscuits using whey protein concentrate-iron complex.
- A method was developed for the preparation of spray dried milk protein-vitamin A/vitamin D complexes for fortification of various food products.
- A methodology was developed for analysis of the panchgavya components.
- ATR-FTIR studies indicated that low density polyethylene (LDPE) and octene/butene based linear low density polyethylene (LLDPE) are the polymeric layers widely used as food contact materials in multilayer co-extruded packaging material used for milk and *ghee*.
- Plasmin activity and its relation with physico-chemical, bio-functional and sensory attributes of Gouda cheese was evaluated.
- The effect of intact casein content (an indirect measure of the composition of the natural cheese blend in the raw material) on selected properties of processed cheese was assessed.
- Manufacturing protocols were developed for products such as Ricotta cheese from cow milk, milk protein concentrate 80 from buffalo milk, omega-3 rich table spread, etc.
- Antioxidant active packaging was developed for *burfi*, using electrospun structures.
- A mechanized whey dewatering system was developed for chhana production. The developed equipment would be suitable for small-entrepreneurs for the production of chakka and fulfils the requirement of time saving and hygienic production.
- A low cost mechanized stretching and portioning unit was developed for Mozzarella cheese production at small scale.
- Automatic Endo-exo Thermal unit was developed for fermented milk products.
- The experimental setup of farm milk cooler having 40-80 liters capacity was designed and fabricated.
- Transmission based colour measurement system was designed and developed.
- Catechin loaded niosomes were prepared using food-grade surfactants and different stabilizers by thin film hydration technique and high shear homogenization. The developed niosomes could serve as promising delivery vehicles for improved bioavailability and functionality of catechins.
- Process was optimized for the development of functional processed mozzarella cheese.
- Technology was developed for the development of Fortified Sweetened Milk Kefir.
- Resveratrol and catechin-loaded niosomes and nanoparticles as delivery vehicles for fortification of milk and milk products were standardized.
- A mechanical unit was custom designed and developed for the dry-crystallization process to prepare convenience mix for *Palada Payasam*, a traditional dairy product of Kerala.

- The liquid milk value chains mapped by applying simulation model Vensim PLE x32 package, revealed that the profit earned by integrated production and processing units (Model-II) i.e., Rs. 7.21 per litre was over and above the assumed model profit of Rs 2.5 per liter.
- A study in Odisha observed that the repeat breeding was affecting the crossbred (CB) cows much more than the local cows, with household loss amounting to Rs. 20,000 and Rs. 6,400 for CB and local cows, respectively. Among diseases, mastitis was found to be the greatest contributor to household losses among all the diseases at about 40% share followed by Foot and Mouth Disease (FMD) and blood protozoan disease.
- About 77% per cent of the farms in coastal Odisha were found vulnerable to risk and uncertainty. The extent of vulnerability was high among landless (87.51%) and lower farm size categories, e.g., marginal farmers (82.24%) and small (51.89%).
- Among peri-urban dairy farms in coastal plains of Odisha, the overall gross maintenance cost for milch crossbred cow was worked out to be Rs.269.53/day, which varied from Rs.272.88 for small category to Rs.250.25 for large category. The overall gross maintenance cost for milch buffalo was worked out to be Rs.276.63/day, which varied from Rs.247.16 for small category to Rs.300.58 for large category.
- The mean profit efficiency of dairy farmers was 54% in coastal plains of Odisha. It was the highest in case of large farms (76%) followed by medium (64%) and small farms (60%). Wage and concentrate application were the factors significantly affecting the profit efficiency in an overall situation.
- The milk supply elasticity in Eastern Region of India was estimated to be inelastic (0.7154%) with respect to own price. On large farms, the milk supply elasticity was elastic (1.6746) as the large farms were capable of increasing the milk supply in response to increase in its price.
- In the Eastern Region of India, the factor demand elasticities with respect to milk prices were inelastic for all the factors, except dry fodder where it was elastic (1.1763) showing that demand for dry fodder increases more than the proportionate increase in milk price. On large farms, these were found to be elastic for all factors except veterinary services.
- In economic valuation of Sahiwal breed, the high disease resistance was the most positive attribute whereas low milk yield was the most important negative attribute. Farmers in Sri Ganganagar and Fazilka assigned more value to the Sahiwal breed. For encouraging the crossbred rearing farmers to rear Sahiwal an additional expenditure of Rs. 19,075 per animal per year is required.
- The profit margin over cost was found to be highest in Butter Milk (38.04%) and it was lowest (1.75%) in case of SMP. Likewise, the margin of safety over the Break Even Point (BEP) was found to be the highest in Curd (86.95%) and the lowest in SMP (32.90%).
- A comparison of dairy farming income in Gujarat and Haryana, observed that the marginal farming households were earning 30% less than the state average of Rs.2400 per month in Haryana. On the other hand, in Gujarat, real monthly income increased from Rs.1000 per month to Rs.2500 per month for marginal; and from Rs.1100 per month to Rs.3600 per month for small farming households.
- The machine learning (ML) algorithms exhibited relatively better predictive potential as compared to that of the conventional regression models in predicting all output parameters of textural properties of *paneer* except hardness.
- Spatio-temporal analysis of bovine population dynamics, milk production trends and economic contribution of dairy sector in India was carried out.
- Seven patents were granted during the year 2019.

EXTENSION

- KVK of ICAR-NDRI organized 215 off campus and on campus skill based vocational training programmes for dairy stake holders. KVK, Nadia carried out four front line demonstrations and two on farm testing at field level. A total of 299 extension activities including exposure visits were organized by KVK Nadia. A total of 12,520 farmers were benefitted through training programmes and extension activities organised by KVK at NDRI and KVK, Nadia.
- KVK celebrated Mahila Kisan divas on January 23, 2019 wherein 108 farmwomen participated.
- Live webcast was arranged for about 400 farmers on the launch of Prime Minister-Kisan Scheme (Pradhan Mantri Samman Nidhi) on February 24, 2019.
- KVK organized exposure visit for 44 farmers at IARI Pusa New Delhi during Krishi Unnati Mela to expose the farmers to the latest developments in agriculture and allied fields on March 6, 2019.

- KVK arranged direct telecast of PM on International women's day (March 8, 2019) followed by the interaction of PM with the women. About 70 farm women participated in the event.
- A workshop was organized with Petroleum Conservation Research Association (PCRA), Ministry of Petroleum on March 14, 2019 to sensitize 100 farmers on reducing the cost of production in agriculture by adopting the method for conservation of petrol and oil.
- A three day programme on "Youth Leadership and Community Development" was organized for 39 participants from March 18-20, 2019 along with Nehru Yuva Kendra, Karnal. .
- KVK celebrated "World No Tobacco Day" on May 31, 2019 to educate the participants on ill effect of tobacco.
- KVK organized world breast feeding week at Daha Jageer village on Aug. 1, 2019 in which about 33 women participated.
- KVK organized "Soil Health Day" December 5, 2019 for 90 farmers and farmwomen to create awareness on the importance of soil health in crop production.
- KVK organized a Kisan Mela and awareness programme for 200 farmers and youth from Karnal and nearby districts on Jal Sanrakshan on July 19, August 9, 2019, respectively.
- KVK organized an awareness programme on "Water Conservation" for 140 farmers and farmwomen and youth on July10, September 2, 2019..
- KVK organized an awareness programme on water conservation at Sultanpur and Jalmana villages of Karnal district on September 3, October 18, 2019 for 160 school students and 79 farmers.
- KVK organized sowing of wheat with the help of happy seeder and zero tillage seed drill in 144.0 acre and 237.0 acre area, respectively at Bhaini Khurd and Sultanpur villages of Karnal District.
- KVK organized 22 visits by subject matter specialists to monitor the progress of wheat crop and clear the doubts of farmers and 347 farmers were benefitted.
- KVK organized 32 awareness programmes and kisan goshties to sensitize farmers against burning of crop residue in the fields and use of machines for In-situ management of crop residue. A Total of 1356 farmers participated in these programmes.
- KVK Organized stake holders meet on In-situ crop residue mangement programme on 26th March 26, 2019 along with ICAR-ATARI, Jodhpur. The event was attended by more than 100 farmers and SMS of various KVK in state of Haryana.
- Four training programmes were organised on "Milk Processing and Value Addition" for prospective entrepreneurs during April 1-10, July 1-10, September 2-11 and December 16-25, 2019, respectively.
- One International training program organised on "Milk and Milk Products Processing" for farmers from Uganda during March 4-18, 2019.
- One International training programme was organised on 'Novel and Value Added Dairy Products' for farmers and marketing personnel from African nations during November 5-14, 2019.
- Two international training programs were conducted for farmers and dairy personnel from African countries.
- BPD Unit of the Institute conducted 12 Entrepreneurship Development Programmes in the area of commercial dairy farming and milk processing & value addition attended by 194 participants across the country. For promotion of entrepreneurship, 10 days specialized training programme on "Practical Training on Commercial Dairy Farming and Milk Processing" was organized for 16 serving and retired personnel of Indian Army with the aim to impart the theoretical and practical knowledge about the rearing of dairy animals and effective management practices for running it as enterprise.
- Animal Biotechnology Centre of the Institute organized a one month "Summer Training on Biotechnological Techniques" for 15 students selected for Internship from 10 different universities of the country during June1-30, 2019. Students were imparted practical training on various techniques including PCR, RT-PCR.
- A one month training programme was organized on "Training Programme on Food Processing Technologies" by the Dairy Technology Division of the institute for 21 students from 13 universities and colleges during June 1 to 30, 2019.
- During the period, a specialized training programme on "Advanced Feed Technologies" was organized by Animal Nutrition Division of the Institute for 15 employees of M/S Kemin Industries South Asia Pvt., Ltd.,Chennai.
- A total of 52 students from other universities and educational organization were imparted training from 1 to 6 months duration in various Divisions and Sections of the Institute during the period.

- Through contract services, the Institute served 85 organizations, individuals and industries by offering the services of analysis, supply of testing kits, cultures and custom hiring of equipment.
- During the year 2019, ATIC of the Institute rendered extension services (3132) in the area of agricultural technology and technology products for the 5445 stakeholders.
- A total number of seven technologies developed at the Institute were transferred to five commercial houses through seven different license agreements and earned Rs. 20.60 Lakhs (excluding Service Tax) for the Institute through technology transfer fee and 17 technologies were approved for Commercialization.
- Under Tribal Sub Plan (TSP) 6 camps were organized in different parts of Eastern and North- Eastern India and 4 on campus training programmes were organized.
- Five North Eastern states of India namely, Meghalaya, Tripura, Sikkim, Nagaland and Mizoram were covered under the North Eastern Hill (NEH) project during 2019 and livestock and different inputs were distributed among farmers.
- Artificial insemination and veterinary first aid facility was provided through the 'Dairy Vikas Kendra and six vaccination & veterinary health camps were organized by the centre.
- Training programmes on scientific dairy farming, artificial insemination and veterinary first aid, and scientific goat farming were organized.
- Seventeen major visiting teams comprising of 942 visitors has visited the institute.
- Subject Matter Specialists of Eastern Campus visited 22 villages and provided solutions of their day to day problems at their door step under 'Mera Gaon Mera Gourav'- programme.

EDUCATION

- UG students were provided mentor support (Faculty & Staff of MDP) for development of technological packages for value added dairy products under Student Ready Programme as per the suggestion of 5th Dean Committee. Six teams (comprising 8 students each) were asked to develop a business model for new range of innovative dairy products under the mentorship of expert faculty. The students developed the technology and also business canvas model for chhana based Muffins, Goat milk cheese, Malt ice cream/Kulfi, Fruit barfi and Ghee residue based chocolate Barfi. The students conducted consumer acceptance studies and based on the feedback formulation and processing parameters were also modified. The aim of the training was to inculcate the research based developmental activities and business acumen among the student fraternity.
- Dairy Economics, Statistics & Management Division, ICAR-NDRI, Karnal organized 3-Day National Training Programme on "Market Strategies for Promotion of Dairy Products" for 30 participants in collaboration with the CCS National Institute of Agricultural Management, Jaipur, during July 24-26, 2019.
- Various initiatives were taken for strengthening academic programmes, leveraging alumni network, nurturing soft skills of the students, and equity action plan plus green campus under Institutional Development Plan (IDP). A total of 16 faculty members were selected for international training and out of which 7 faculty were deputed for availing advance training at 6 different universities located in USA and Netherlands.
- A total 24 students completed their overseas internship at 11 different universities in 4 different countries.
- Foundation course was organized for fresher students to nurture their innate talents during which sessions on literary activities, communication skills, leadership skills, theatre art, cultural dance, music, physical and sports activities including yoga, values, ethics and social awareness were conducted.
- A skill development programme i.e. N_Reach was conducted by Nestle India Pvt. Ltd. for B.Tech final year students to improve their communication/soft skills during November 27-28, 2019.
- Six workshops on various topics viz. women empowerment, leadership and social entrepreneurship, sensory evaluation techniques, mammalian genome editing, advances in starter culture technology, textural analysis of dairy & food products and computer vision applications in dairying were organized for the benefit of the faculty and students. Subject experts including four overseas professors from USA, UK and Ireland were invited to deliver the lectures in these workshops. A skill development programme on microbiological quality and safety analysis of dairy products and a certificate course on starter culture and fermented milk products were also organized.
- Linkages were established with different industries and academic institutions. A MoU was signed with Institute of Rural Management Anand (IRMA), Anand, India for initiation of Post Graduate Diploma in Dairy Management Course to cater the needs of dairy industry for human resource having administrative capabilities.

- Alumni database was updated to strengthen global alumni network. Eleven entrepreneurial development programmes for prospective entrepreneurs, one innovative idea contest and an experiential learning programme for UG students were conducted to nurture business ideas of undergraduate students.
- As a part of outreach activity, a total of 61 MOOCs were developed in the field of dairy production and processing with the help of ICAR-NAARM, Hyderabad.
- B. Tech. (Dairy Technology) students visited surrounding villages to create awareness about the environment and cleanliness among the students and common masses.
- Twenty meritorious students from sister Dairy Science Colleges across the country were imparted internship (live research projects) for two months duration in laboratories and other facilities at ICAR-NDRI.
- As a part of social equity and environmental sustainability initiative, female students were given self-defense training and remedial classes were conducted for academically weak students.
- Incinerator for biohazard waste was procured to treat biological waste, kitchen automation equipment, CCTV cameras were installed and lawn mowers procured to strengthen the student hostel amenities.
- Three of our recently passed-out (2018-19 pass-out) B.Tech students (beneficiaries in our IDP) proceeded to pursue Masters at three different universities in USA.
- Dr. Charles Long, Texas A&M University, USA delivered a talk on “Mammalian Genome Editing by CRISPR Technique” on November 15, 2019 at ICAR-NDRI, Karnal.
- Dr. Olivia McAuliffe, Teagasc, Food Research Centre, Ireland delivered a talk on “Advances in Starter Culture Technology” on December 12, 2019 at ICAR-NDRI, Karnal.
- Dr. Aditya Nigam, Associate professor, IIT, Mandi delivered a talk in a workshop on “Computer vision applications in dairying” organized during January 20-24, 2020 at ICAR-NDRI, Karnal.

INFRASTRUCTURE

- Renovation of new Biomarker Lab at Animal Biotechnology Centre, ICAR-NDRI, Karnal
- Fabrication of 03 no. Metabolic Cages at ICAR-NDRI, Karnal.
- Fabrication and Erection of a shed at KVK, ICAR-NDRI, Karnal.
- Repair of flooring (Bitumen Mastic flooring) work with material and Artificial Breeding Research Centre, ICAR-NDRI, Karnal.
- Installation of Unipole Hording at ICAR-NDRI, Karnal.
- Renovation and maintenance of elite animals (Bull Mother) at Livestock Research Centre, ICAR-NDRI Karnal.
- Repair & renovation of flooring of all type B & D types of quarters at ICAR-NDRI, Karnal.
- Repair & Renovation of G.I pipe railing at Livestock Research Centre, ICAR-NDRI Karnal.
- Electric wiring of newly installed AC points at Library Building, ICAR-NDRI, Karnal.
- Repair of Floor-tiles of the Milk Parlour at ICAR-NDRI, Karnal.
- Repair & renovation of Flooring etc. of metabolic sheds of Animal Nutrition Division at ICAR-NDRI, Karnal.
- Repair of Damaged Parking Shed at Animal Biotechnology Centre, ICAR-NDRI, Karnal.
- New Livestock Research Centre building was constructed and opened for use on December 9, 2019 at Southern Campus of NDRI, Bengaluru.
- Extension of Krishna Wing of Hostel completed at Southern Campus of ICAR-NDRI, Bengaluru.
- A Skywalk from Guest House and Hostel Complex to main Campus was built by BBMP on PPP mode at Southern Campus of ICAR-NDRI, Bengaluru.



कार्यकारी सारांश

कार्यकारी सारांश

भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित संगठन है जो देश में डेरी विकास कार्यक्रमों के लिए अनुसंधान विकास तथा मानव संसाधन विकास में सहयोग के लिए पूर्ण रूप से समर्पित रहा है। वर्ष 1923 में बंगलौर में संस्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में इसके मौजूदा स्थान करनाल में स्थानान्तरित किया गया था। इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो बंगलौर तथा कल्याणी में स्थित हैं। दक्षिण एवं पूर्वी क्षेत्रीय केन्द्र स्थानीय क्षेत्र में कृषि वातावरण के अनुरूप डेरी विकास के लिए अनुसंधान एवं सहयोग प्रदान करने में लगे हुए हैं। भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान को वर्ष 1989 से शैक्षणिक कार्यक्रमों के संचालन हेतु मानद विश्वविद्यालय का दर्जा प्राप्त हुआ है। संस्थान को वर्ष 2018-19 के लिए भारतवर्ष के सभी कृषि विश्वविद्यालयों जिनमें चार मानद विश्वविद्यालय भी शामिल हैं, में लगातार तीसरी बार प्रथम स्थान प्राप्त हुआ है।

संगठनात्मक स्वरूप

संस्थान की प्रबंध प्रणाली भारतीय कृषि अनुसंधान परिषद के मानद विश्वविद्यालय की प्रशासनिक पद्धति के अनुरूप ही है। संस्थान के अनुसंधान, शिक्षण, प्रशिक्षण, विस्तार, शिक्षा तथा प्रशासनिक कार्यकलाप के क्षेत्र में नीति निर्धारण और निर्णय का दायित्व प्रबंध मंडल, अनुसंधान सलाहकार परिषद, शिक्षा परिषद, कार्यकारिणी परिषद तथा प्रसार परिषद समितियों को सौंपा गया है। संस्थान के निदेशक इसके मुख्य कार्यकारी अधिकारी हैं तथा प्रबंधन, अनुसंधान, शैक्षणिक तथा प्रसार कार्यकलापों के लिए संयुक्त निदेशक उनकी सहायता करते हैं। संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र (i) डेरी उत्पादन (ii) डेरी प्रसंस्करण तथा (iii) डेरी विस्तार/प्रबंधन हैं। सभी अनुसंधान विस्तार कार्यकलाप तेरह अनुसंधान प्रभागों/अनुभागों-पशु आनुवांशिकी एवं प्रजनन, पशुधन उत्पादन एवं प्रबंधन, पशुपोषण, चारा अनुसंधान एवं प्रबंधन, पशु शरीर क्रिया, पशु जीव रसायन, पशु जैवप्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी अभियांत्रिकी, डेरी रसायन, डेरी सूक्ष्म जीवविज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र, सांख्यिकी एवं प्रबंधन प्रभाग के अन्तर्गत संपन्न होते हैं। संस्थान में एक कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक) कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण केन्द्र, कृत्रिम प्रजनन अनुसंधान केन्द्र, हैं। पीपराकोठी, पूर्वी चम्पारन, मोतीहारी, बिहार में कृषि विज्ञान केन्द्र के अन्तर्गत कृषि तथा डेरी विकास केन्द्र तथा मुज्जफरनगर (उ.प्र.) में लालूखेड़ी में मॉडल डेरी केन्द्र भी संस्थान के कार्यक्षेत्र में आते हैं। संस्थान में पशुधन अनुसंधान केन्द्र, चारा अनुसंधान एवं प्रबंधन केन्द्र, पशु स्वास्थ्य परिसर, माडल डेरी संयंत्र, टैक्नोलॉजी बिजनेस इनक्यूबेटर व्यवसाय नियोजन एवं विकास एकक, दुग्ध गुणवत्ता एवं सुरक्षा के लिए नैशनल रैफरल प्रयोगशाला, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय तथा राष्ट्रीय जैव सूचना केन्द्र, कंप्यूटर केन्द्र, संपदा अनुभाग, राजभाषा एकक एवं अनुरक्षण अभियांत्रिकी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे क्रय, भंडार एवं सुरक्षा अनुभाग आदि संयुक्त निदेशक(प्रशासन)/कुलसचिव के नियंत्रण में हैं जबकि वित्त विभाग नियंत्रक (वित्तीय) के प्रशासनिक नियंत्रण में हैं। संस्थान में इस समय 159 वैज्ञानिक, 186 तकनीशियन, 128 प्रशासनिक एवं 345 निपुण सहायक कर्मचारी हैं।

बजट परिव्यय

संस्थान का वर्ष 2019-20 के लिए वास्तविक व्यय बजट रु. 21374.70 लाख रूपए था तथा वर्ष 2019-20 के लिए स्वीकृत बजट रु. 21491.03 लाख रूपए था। इन आंकड़ों में क्षेत्रीय केन्द्रों के सृद्धीकरण का बजट परिव्यय भी शामिल है। संस्थान का क्षेत्रीय केन्द्रों सहित वर्ष 2019-2020 का राजस्व अर्जन रु 914.30 लाख था।

अनुसंधान

- एक उत्कृष्ट सांड की डोनर कोशिकाओं का प्रयोग करके तीन क्लोनड कटड़े उत्पन्न किए गए।
- डिकोफ-1, शंक्वाकार विन्टसिम्लिंग पाथे के एक अवरोधक के साथ क्लोनड भैंस के भ्रूण के उपचार से ब्लास्टोसिस्ट में वृद्धि, गर्भाधान एवं जीवित जन्म दर दिखाई गई तथा उनकी गुणवत्ता में सुधार किया।
- अद्वितीय विशेष गलाइकेन प्रोफाइल जो कि शुक्राणुओं की उनके जनन क्षमता के लिए पूर्व चयन में सहायक हो सकती है, का उच्च एवं निम्न प्रजनन क्षमता भैंस के शुक्राणुओं के लिए स्पष्ट की गई।
- लेक्टोजेनेसिस में सलग्न नवीन प्रोटीन प्रोलिफेरेंटिंग तथा विशेष भैंस के स्तनीय एपिथिलियल कोशिकाओं के मात्रात्मक प्रोटीओमिक विश्लेषण प्रयोग से प्रकट हुए।
- गोपशुओं में गर्भाधान के शीघ्र पहचान के लिए एक गर्भाधान संबंधी ग्लाइकोप्रोटीनस आधारित नैदानिक परीक्षण विकसित किया गया।

- मूत्र एवं रक्त में बी-केसोमार्फिन की जांच के लिए एक एप्टामर आधारित विधि विकसित की गई।
- पुनः संयोजक भैंस शुक्राणु लाइसोजाइम-जैसे प्रोटीन 5 (एस पी ए सी ए5)पिचिआ पेस्टोरिस अभिव्यंजना प्रणाली का प्रयोग कर विकसित किए गए।
- करन फ्रीज सांडो के वीर्य प्रषीतन मार्कर की संभाव्यता जानने के लिए वीर्य का प्रोटीओमिक विप्लेशन किया गया।
- करनाल जिले में थनैला रोग उत्पन्न करने वाले जीवाणुओं के एंटीबायोटिक प्रतिरोधी पैटर्न प्रकट करते हैं कि ये सिफेलोसपोरिनस तथा पेनसिलीन के लिए अधिक प्रतिरोधी तथा जेन्तामाइसिन के लिए कम प्रतिरोधी थे।
- मारवाड़ी, जखराना, बाकरवली तथा ओसमानाबादी बकरियों की नसलों से सात नई एस 2(952)केसीन प्रकारों की पहचान की गई।
- श्रेष्ठ साहीवाल गाय (एस.डब्ल्यू. 2233) का अधिकतम उत्पादन 23.5 कि.ग्रा. तथा 305 दिन तक दुग्ध उत्पादन (एम.वाई) तथा कुल दुग्ध उत्पादन (टी.एम.वाई.) क्रमशः रु 3854 कि.ग्रा. तथा 4220 कि.ग्रा. था।
- गीर गाय (जी.21) का 305 दिन का श्रेष्ठ उत्पादन 2232 कि.ग्रा. था।
- थारपारकर गाय (टी.पी.1274) का 305 दिन का श्रेष्ठ दुग्ध उत्पादन 2656 कि.ग्रा. था।
- मुराह भैंस (एम.यू.-6630) का श्रेष्ठ दुग्ध उत्पादन 4024 कि.ग्रा. था। श्रेष्ठ मुराह भैंसों का श्रेष्ठ ब्याँत दुग्ध उत्पादन(एल.एम.वाई.) का औसत 3067 कि.ग्रा. था।
- एस.एन.पी. लोकस सी. 6521978 टी के जी.जी. जीनोटाइप तथा करनफ्रीज गोपशुओं में ए.एन.के.आर.डी31 के ए.6547390 जी. एस.एन.पी. के ए.ए.जीनोटाइप तथा साहीवाल गोपशुओं में एस.एफ.एक्स एन1 जीन के एस.एन.पी. लोकस टी 5634584 जी.के.टी. टी.जीनोटाइप का एक विशाल जनसंख्या में मानकीकरण के बाद वांछित अयन बनावट के साथ अधिकतम दुग्ध उत्पादन के लिए चयन की सहायक के रूप में प्रयोग किया जा सकता है।
- क्रियाशील जीन परीक्षण पर आधारित, दुग्ध-वसा गोल-ई.जी.एफ. फैंक्टर8 (एम.एफ.जीई.8) तथा प्रोटीन डाई-सल्फाइड आइसोमिरेज-3(पी.डी.आई ए3) जीनस करनफ्रीज गोपशुओं उच्च उत्पादन वाले में महत्वपूर्ण रूप से अप-रेगुलेटिड (विनियमित) पाए गए जो कि उच्च दुग्ध उत्पादन वाली करनफ्रीज गायों में सम्भावित बायोमार्करों के रूप में प्रयोग की जा सकती है।
- एफ ए एस एन जीन के एक्सान-40 रीजन के जी.जी.जीनोटाइप तथा एमएनटीआरआईए जीन के एक्सान-2 रीजन के टी.टी. जीनोटाइप ने दुग्ध उत्पादन के लिए ब्याँत कर्व तथा मुराह भैंसों में इसके संघटक लक्षणों को विशेष प्रकार से दर्शाया है, जो कि भैंसों के चयन में अतिरिक्त आनुवांशिक मापदण्डों के रूप में कार्य कर सकते हैं।
- बास इंडिकस जीनोम के संबंध में ddRAD दृष्टिकोण का प्रयोग करके साहीवाल गोपशुओं में कुल 258, 231 जीनोम-वाइड एस.एन.पी की पहचान की गई, जिनमें से 150 231 नवीन एसएनपी थे। उच्च आत्मविश्वास के बीच पहचाने गए एस.एन.पी. 91.86% तथा 27.30% नमूनों के 50% तथा 100% में जीनोटाइपड थे। पहचाने गए एस.एन.पी के मैपिंग उत्पादन लक्षणों से संबंधित कैंडिडेट जीनस में 525 एस.एन.पी प्रकट करते हैं जबकि 333 एस.एन.पी. प्रजनन लक्षणों से संबंधित कैंडिडेट जीनस को मैपड करते हैं।
- डी.डी.आर.ए.डी एप्रोच का प्रयोग करके थारपारकर गोपशुओं में कुल 87.047 एस.एन.पी, 8.465, इनडेल तथा 2571 एस.एस.आर की पहचान की गई, जिसमें से जननक्षमता लक्षणों के लिए 69 जीनस में से 496 एस.एन.पी इम्यून रिसपॉस लक्षणों के लिए 47 जीनस में से 334 एस.एन.पी., अनुकूलन क्षमता के लिए 61 जीनस से 243 एसएनपी, दुग्ध उत्पादन लक्षणों के लिए 109 जीनस से 1042 एसएनपी. तथा करकास लक्षणों के लिए 97 जीनस से 756 एस.एन.पी पर टिप्पणी की गई।
- नस्ल विशेष प्रीपयुशियल वाश वाल्यूम तथा प्रीपयुशियल सफाई की आवृत्ति वीर्यपात में जीवाण्विक संदूषण को कम करने के लिए मानकीकृत किए गए।
- सांड को टीका लगाने के बाद, वीर्य के काम करने की गुणवत्ता का टीकाकरण के छठे सप्ताह तक समाधान किया गया तथा शुक्राणु की सभी क्रियात्मक विशेषताओं के रिस्टॉरेशन के बाद, वीर्य के उच्चतर विलयन की परिरक्षण के लिए संस्तुति की जा सकती है।
- मुराह नर भैंसे (झोटे) तीव्रता से बढ़ सकते हैं जल्दी यौवन अवस्था तथा श्रेष्ठ वीर्य गुणवत्ता के साथ ए.एफई प्राप्त करते हैं। जब संशोधित आहार तथा मौसमी आवास प्रबंधन प्रदान किया जाता है।
- अध्ययन सुझाते हैं कि बछड़े/बछड़ियों सामाजिक पशु है तथा अच्छे सामाजिक पारस्परिक समन्वय के लिए उन्हें सामूहिक आवास में रखा जाना चाहिए, जो कि उनके प्रदर्शन को सुधारने के लिए तथा आधुनिक बछड़ा प्रबंधन प्रक्रिया के कल्याण के संभवतः एक अच्छा विकल्प हो सकता है।

- सान्द्रण मिश्रण का प्रोटीन स्रोत बढ़ते साहीवाल बछड़ों के नियंत्रण की तुलना में वृद्धि दर में सुधार के साथ 30% तक प्रतिस्थापित किया जा सकता है, जिससे कि डेरी पशुओं को दिए जाने वाले सान्द्रित आहार की लागत कम हो सकती है।
- शीघ्र स्तनपान कराने भैंसों (30 दिन) में विटामिन डी3 20.000IU/ प्रतिदिन की दर से खिलाने से दुग्ध उत्पादन जो कि दुग्ध संरचना को प्रभावित किए बिना संशोधित संचार संबंधी विटामिन डी 3 स्तरों के कारण दुग्ध उत्पादन में 1.99 कि.ग्रा./दिन वृद्धि होती है।
- थारपारकर गायें उच्चतर प्लाज्मा एल्डोस्टेरोन, दुग्ध यूरिया तथा सोडियम की मात्रा के कारण अधिक ऊष्मा सहिष्णुता प्रदर्शित करती है जो कि उन्हें साहीवाल तथा गिर गायों की अपेक्षा जलवायु परिवर्तन आदि में संभलने में अधिक समर्थ बनाती है। यह देखा गया कि गर्म-शुष्क तथा गर्म आर्द्र ऋतु के दौरान थारपारकर गायों में मलाशयी तापमान में कम से कम परिवर्तन होते हैं।
- साहीवाल गायों ने 250–305 दिनों के दुग्धस्त्रवण काल की अवधि के साथ दुग्धस्त्रवण की अधिक दृढ़ता प्रदर्शित छोटे दुग्ध स्त्रवणकाल वाली गायों की अपेक्षा/प्रथम ब्याँत के समय आयु पर दृढ़ता की रिग्रेशन महत्वपूर्ण (पी<0.05) पाई गई।
- बीजीएच–एम.एसपी। जीन के टी.टी.जीनोटाइप के साथ साहीवाल गायों ने श्रेष्ठ दुग्धस्त्रवण उत्पादन परसिटै।सी आफ लेक्टेशन तथा लम्बा दुग्ध स्त्रवणकाल प्रदर्शित किया। अतः दुग्धस्त्रवण की परसिस्टेंसी में सुधार के लिए इन जीनोटाइपों का प्रयोग करने के लिए प्रजनन रणनीति तैयार की जा सकती है।
- संकर करनफ्रीज गायों में शारीरिक प्रतिक्रियाओं तथा तनाव हार्मोनस को कम करने के लिए तथा रोग प्रतिरोधक शक्ति को बढ़ाने के लिए कलोरोफाइटम बोरिविलिएनम (80एमजी/डी) द्वारा तापीय तनाव में सुधार किया जा सकता है।
- करनफ्रीज संकर गायों की अपेक्षा थारपारकर गायों अल्प कोर्टिसोल, श्वसन दर के मान मलाशयी तापमान, स्पंदन दर तथा उच्चतर एल्डोस्टेरोन स्तर प्रदर्शित किए।
- संकर गायों में ऊष्मा तनाव क्षेत्र में औसत दैनिक दुग्ध उत्पादन 41 ग्राम कम हो गया जबकि टी.एच.आई. में प्रति यूनिट वृद्धि से 10 ग्राम दूध कम हुआ।
- दुग्ध प्लासमिनोजेन एक्टिवेटर, प्लासमिनोजेन, प्लासमिन (पी.ए, पी.जी, पी.एल) स्तरों को स्तनीय ग्रन्थियों के सिंथैटिक क्षमता के जैवमार्करों के रूप में प्रयोग किया जा सकता है।
- रेफरीजरेटिड तापमान पर एस.आई.एन-1 मिलाने से एक डोज में शुक्राणुओं की गुणवत्ता तथा समय डिपेंडेंट प्रणाली में कमी आती है।
- उपनैदानिक थनैला वाली करन फ्रीज गायों के अयन तथा स्तानाग्रों के टर्मिनलिया बलेरिका, पाइपर बीटल, बोसबलिया सेराटा, बर्जिनिया सिलिकाटा के सामयिक अनुप्रयोग संरचना को प्रभावित किए बिना दुग्ध एससीसी को महत्वपूर्ण रूप से (पी<0.05) कम किया।
- ब्याने का काल एवं अवधि का साहीवाल गायों में परसिटैसी मापदण्डों पर महत्वपूर्ण प्रभाव (पी<0.01) पड़ा।
- बी.जीएच जीनोटाइप की अपेक्षा बीजीएच–एमएसपी1 के जी.टी. जीनोटाइप वाली साहीवाल गायों ने श्रेष्ठ दुग्धस्त्रवण उत्पादन, दुग्धस्त्रवण की परसिस्टेंसी तथा लम्बे दुग्धस्त्रवण अवधि प्रदर्शित की
- रेफरीजरेटिड तापमान पर एसआईएन1 मिलाने से डोज में शुक्राणु की गुणवत्ता (शुक्राणु की मर्त्यता, जीवक्षमता, मेम्ब्रेन अखण्डता तथा एक्रोसोम अखण्डता) तथा समय निर्भरता प्रणाली कम होती है। शुक्राणुओं का उच्च परआक्सीनाइड्रेट सान्द्रणों में दीर्घकालीन पहुंच वीर्य गुणवत्ता के लिए हानिकारक थी।
- सामान्य रूप में बढ़ते हुए गोपशुओं के लिए भारतीय कृषि अनुसंधान परिषद (2013) की संस्तुतियों की तुलना में बढ़ते हुए साहीवाल ओसरों के लिए एम.पी. की मांग 15% तक कम की जा सकती है जबकि एम.एफ का अंश 15% तक बढ़ाया जा सकता है। ये नस्ल विशेष मांग इस बहुमूल्य स्वदेशी जननद्रव्य के अनुकूलतम विकास प्रदर्शन को प्राप्त करने में लाभप्रदा होगी।
- एम.ई. में इस वृद्धि के अतिरिक्त लाभों ने आई.जी.एफ-1, इनसुलिन, लेप्टिन तथा इम्यूनो-गलोब्युलिनस के प्लाज्मा सान्द्रण में वृद्धि की तथा जी.एच. एवं कार्टिसोल के सान्द्रणों में कमी की श्रेष्ठ प्रतिआक्सीकारक तथा पशुओं का प्रतिरक्षा स्तर दोनों ऋतुओं के दौरान भी देखे गए।
- ग्रीष्म ऋतु की अपेक्षा शीत ऋतु के दौरान पशु विकास प्रदर्शन तथा हार्मोनल, प्रतिआक्सीकर एवं प्रतिरक्षा स्तर श्रेष्ठ पाया गया। दोनों ऋतुओं की चयापचयात्मक ऊर्जा की मांग तथा प्रोटीन की मांग ग्रीष्म ऋतु के दौरान अधिक थी।
- बोरोन सम्पूरण 200 तथा 400 पी.पी.एम (यद्यपि उच्चतर खुराक के कोई अतिरिक्त लाभ नहीं) उच्चतर प्रतिआक्सीकारक स्तर तथा प्लाज्मा सी.ए.स्तरों विशेषकर संक्रमण अवधि के दौरान के अनुरक्षण में सहायक पाई गई बोरोन संपूरण के द्वारा दुग्ध परसिस्टेंसी में भी सुधार आया है।

- आहारीय कीटान एनायन अन् + 300 एमई.क्यू./कि.ग्रा.डी.एम.औसत 10 कि.ग्रा दूध प्रतिदिन देने वाली भैंसों की उत्पादन प्रदर्शन में सुधार में प्रभावी था।
- जुगाली करने वाले बछड़ों के पूर्व तथा बाद के प्रतिआक्सीकर गतिविधि तथा प्रतिरक्षा प्रतिक्रियाओं हाइड्रोजन Zn संपूरण पर संशोधित था जो कि कम होते सहगामी टीबीएआर एस मूल्यों के साथ बढ़ते हुए एस.ओ.डी, जी.पी.एक्स तथा केटालेज़ प्रतिक्रिया; टी.ए.सी, आई जी जी तथा टी 1जी कन्सनट्रेशन से प्रत्यक्ष थे।
- एम.ओलिफेरा लीफ में कैल्सियम, पी.एम.जी, एफई, सी4 जेड एन अंश क्रमशः 1.85%, 0.15% देने 4.81%, 330पीपीएम, 9.21 पीपीएम तथा 26.72 पीपीएम थे। एम.ओलिफेरा लीवस में टैनिन, सपोनिन, कुल फेनोलिक अंश एवं कुल फलेवोनायडस अंश क्रमशः 2.02%, 1.01%, 4.28%, तथा 3.61% थे।
- मेमनों की विकास प्रदर्शन एवं आहार परिवर्तन क्षमता 60:40 तथा 70:30 के अनुपात में बेहतर थी तथा क्रमशः 10% तथा 20% प्रतिस्थापन के साथ कनसनट्रेंट अनुपात की तुलना में मोरिंगा पत्तियों के साथ 70:30 था।
- इन विवो परिणाम सुझाव देते हैं कि गोलियों में 8% की दर से (अल्कोहल भट्टियों का एक हल्के गहरे रंग का व्यर्थ पदार्थ) का समावेश किसी पोषक तत्वों के अन्तर्ग्रहण तथा पाच्यता, रक्त जीव-रासायनों तथा स्तनपान कराने वाली मुराह भैंसों में जिगर संबंधी किण्वकों को प्रभावित नहीं करता।
- भैंसों का दुग्ध उत्पादन तथा एफ.सी.एम. उत्पादन इसकी सभी संरचना के साथ भी समान था तथा यह निष्कर्ष निकाला गया कि डैपोटैश विनैस 8% की दर से गोलियों को बाइंडर के रूप में प्रयोग किया जा सकता है तथा इसके बाद में पशुओं को किसी प्रतिकूल प्रभाव के बिना स्तनपान कराने वाले भैंसों को आहार खिलाया जाता है।
- एलोवीरा सत्व का संपूरण रुमेन किण्वन के हेर फेर के द्वारा दुग्ध न्यूट्रासियुटिकल गुणों में वृद्धि कर सकता है।
- तीन श्रेष्ठ प्रोबायोटिक वियोजक लेक्टोसिलस रियूट्री एस.डब्ल्यू 26, लेक्टोबेसिलस रियूट्री एस.डब्ल्यू 27 तथा एंट्रोकोकस फेसियम एस.डब्ल्यू 28 के रूप में पहचाने गए।
- ब्लैक बंगाल बकरी के मेमनों के लिए दुग्ध प्रतिस्थापकों का सूत्रीकरण किया गया।
- पूर्वी हिमालयी जंगलों के पेड़ों के पत्तों को पशु उत्पादकता में सुधार के लिए रुमेन किण्वन को हेरफेर करने के लिए हर्बल आहार संयोजकों के रूप में मूल्यांकित किया गया।
- अध्ययन प्रकट करते हैं कि चारा आधारित फसल प्रणाली से उच्च लाभ सृजन के साथ गुणवत्ता वाले चारा उत्पादन, उच्च गुणात्मक बायोमास उत्पादन (187टी/हैक्टेयर) को क्रापिंग अनुक्रम एन.बी.एच + लोबिया-बरसीम (दो कटाई) बी : सी. अनुपात 4.20 के साथ प्राप्त किया गया था। हालांकि सबसे कम बेबीकार्न-लोबिया-चाइनिज कैबेज अर्थात् (63टी/हैक्टेयर) द्वारा उत्पादित किया गया था।
- यह पाया गया कि आर.डी.एफ. के साथ पी.जी.पी.आर.के अनाज आधारित फसल प्रणाली में रासायनिक उर्वरकों, आर.डी.एफ.+ गोमूत्र स्प्रे. तथा 75% आर.डी.एफ./सी.यू + पी.जी.पी.आर की संस्तुत खुराक की तुलना में उच्चतम उत्पादन (अनाज/पुआल/हारा चारा) दिया गया। इसके अतिरिक्त मक्का-लोबिया+गेहूँ फसल प्रणाली के अन्तर्गत आर.डी.एफ तथा आर.डी.एफ + सी.यू + पी.जी.पी.आर के प्रयोग की तुलना में लगभग समान उपज रिकार्ड की गई। अर्थशास्त्र के संबंध में यह दर्ज किया गया था कि चावल-बरसीम फसल प्रणाली ने चावल-गेहूँ और मक्का गेहूँ-लोबिया के बाद अधिकतम लाभ दिया था।
- विभिन्न उर्वरता स्तरों तथा बीज दरों के अन्तर्गत जई की विभिन्न किस्मों का मूल्यांकन किया गया। जई की किस्मों के बीच आर.डी.एफ के 125% के साथ जे.एच.ओ-851 अधिकतम वृद्धि एवं उत्पादन गुणों वाली रिकार्ड की गई तथा इसके पश्चात् एच.जे.-08 किस्म का स्थान रहा। 105 कि.ग्रा./हैक्टेयर की बीज दर पर उच्चतम अनाज एवं चारा उपज रिकार्ड की गई।
- कर्नाटक तथा तमिलनाडु नेपियर संकर, गिनी घास तथा बहुकाट वाली सीरगम की छः नई जिनोटाइप एकत्रित की गई तथा आगे बहुगुणन तथा स्थानीय क्षेत्रीय स्वीकार्यता परीक्षण के लिए राष्ट्रीय डेरी अनुसंधान संस्थान के सस्य विज्ञान अनुसंधान फार्म पर रोपित की गई।
- करनाल आधारित पारिस्थितिक स्थिति के खरीफ मौसम के दौरान विकास, उत्पादन गुणवत्ता एवं अर्थशास्त्र के मामले में उच्चतम चारा उत्पादन के लिए श्रेष्ठ कृषि प्रक्रियाओं के लिए 25 कि.ग्रा. के.2ओ बेसल 2% के.एन.ओ₃ में फोलियर स्पे (25DAS पर) पोटाशियम प्रबंधन के लिए अवलोकित किए गए।
- भैंसों में 'माइटोकनोड्रियल डी.एन.ए. अंश तथा माइटोकनोड्रियल जीनस अभिव्यंजना की ऊतक विषमता देखी गई।
- भैंस में माइटोकनोड्रियल डी.एन.ए. प्रतिलिपि संख्या में एक हैप्लोटाइप-विशिष्ट भिन्नता है।

- मुराह भैंसों के गर्भाशय—योनि स्वैब में यूरिया डाइवर्सम की जांच के लिए लूप—मीडिएटिड आइसोथर्मल एम्पलीफिकेशन (एलएएमपी) प्रतिक्रिया विकसित की गई।
- miR-326 ने भैंसों के ग्रेनुलोसा कोशिकाओं में CYP19A1 तथा टीएलआर-4 को लक्षित करके एस्ट्राडियोल 17-बी उत्पादन तथा प्रोइन्फ्लामेटरी साइटोकाइनस विनियमित किया।
- मॉडल डाइआक्सिन, टी.सी.डी.डी, दूध में 0.02–20 पी.जी./एम.एल, सान्द्रण की एक सीमा में पाया गया जो कि 3डी संवर्धित भैंस के हेपेटोसाइट मॉडल प्रणाली के आधार पर बहुत अधिक हेपेटोटाक्सिन नहीं था।
- शरीर की स्थिति का स्कोर, समता, आश्रय स्वच्छता तथा नर निकटता क्षेत्रीय परिस्थितियों में मुराह भैंस में प्रसव पश्चात् मदकाल के साथ गैर आनुवांशिक कारकों के साथ अत्याधिक रूप से जुड़े कारकों के रूप में पहचाने गए।
- हेमोनकस कॉंट्राटस के सिस्टेन सिनथेस प्रोटीन के विरुद्ध तीन (पी2, पी4 तथा पी8) संभावित पेप्टाइड अवरोधकों के रूप में पहचान की गई।
- ऊँटनी के दूध ने रक्त शर्करा, ग्लाइकोसिलेटिड हीमोग्लोबिन के स्तर को कम करके तथा इन्सुलिन एवं जी.एल.पी-1 स्त्राव में सुधार करके टाइप-1 मधुमेह का मुबाबला करने में एक सुरक्षात्मक प्रभाव दिखाया।
- पेप्सिल के प्रयोग द्वारा तैयार ऊँटनी के दूध का ढे हाइड्रोलाइसेटस ने अधिकतम इन्सुलिनोट्रोपिक प्रभाव प्रदर्शित किया।
- संरचनात्मक गतिविधि संबंध का उपयोग करके संवर्धित β केसीन-व्युत्पन्न हेप्टापेप्टाइड की आस्टियोना बोलिक गतिविधि को संवर्धित किया।
- एन.एफ.- κ B पैथवे पर उत्तेजक कारकों की विद्यमानता में प्रोबायोटिक लेक्टोबेसिलि (एल.फरमेंटम तथा एल.रहेमनोसस) को प्रभाव की उत्तेजक नियामक मास्टर के रूप में निगरानी की गई।
- प्रोबायोटिक किण्वित दूध लेक्टोबेसिलिस रहेमनोसस तथा लेक्टोबेसिलिस फरमेंटम) तथा संबंधित प्रोबायोटिक का परीक्षण किया गया, ओबेसोजेनिक आहार के साथ चूहों के मॉडल में जीवनक्षम पैरामीटरों में फ्रूटोलिगो-सेकेराइडस साइनरजिसटिकली सुधार किया।
- प्रोबायोटिक के साथ संस्थापित प्रोबायोटिक (लेक्टोबेसिलिस रहेमनोसस तथा लेक्टोबेसिलिस फरमेंटम) के सहजीवी संयोजन तथा उच्च वसा वाले आहार के संपर्क में आने वाले चूहों के वृषण हिस्टोपैथ फिजियोलॉजी में महत्वपूर्ण रूप से सुधार हुआ।
- ऊष्मा का प्रभाव महत्वपूर्ण अजैविक कारकों में से एक है जो कि डेरी पशुओं के विकास, दुग्ध उत्पादन तथा प्रजनन स्वास्थ्य को प्रभावित करता है तथा प्रभावी परिस्थितियों के अन्तर्गत थारपारकर तथा करन फ्रीज गोपशुओं से 387 संरक्षित तथा 77 नवीन miRN। की पहचान की गई। पारिवारिक वितरण विश्लेषण ने दिखाया कि पहचाने गए miRN। 15 से अधिक विभिन्न परिवारों से संबंधित हैं जिनमें miR-2284 सबसे प्रचुर मात्रा में था।
- थारपारकर तथा करन फ्रीज दोनों में अन्तर जीन अभिव्यंजना ने 344 से अधिक miRNA ने नियंत्रण और तनावग्रस्त स्थिति के बीच अपनी अभिव्यक्ति को काफी बदल दिया। हीट मैप को शीर्ष 20 अप एवं डाऊन विनियमित miRNA के लिए तैयार किया गया था। miRNAs को qRT-PCR का उपयोग करते हुए रीड काउंट वैल्यू तथा विभिन्न जीन अभिव्यंजना के आधार पर हीट-रिस्पॉन्सिव होने के लिए पुष्टि की गई थी। ये नवीन miRNA वास्तव में गोपशुओं के miRNA डेटाबेस के लिए एक नया संयोजन है।
- आण्विक स्तर पर एन.पी के वैश्विक प्रभाव को समझने के लिए उच्च थ्रोपुट ओमिक्स को मददगार पाया गया तथा इससे सूक्ष्म कणों के अंतिम मूल्यांकन के लिए संभावित नैनो सुरक्षा सुराग मिले।
- अल्प खुराक प्रदर्शन पर कोशिकीय तनाव से संबंधित कई पैथवों की उत्तेजित करने में एन.पी.सक्षम पाए गए तथा कोशिका नेनोफसेफटी स्तरों को इंगित करते हुए बाह्य इनसल्टस के विरुद्ध होम्योस्टेसिस का अनुरक्षण करती हैं।
- केसीन प्रोटीन की तुलना में केसीन हाइड्रोलाइसेटस (पी,टी,सी,पीटी, पी.सी, सी.टी तथा पी.टी.सी.) ने महत्वपूर्ण डीपी.पी-IV महत्वपूर्ण निरोधात्मक गतिविधि का प्रदर्शन किया। ढे प्रोटीन की तुलना में ढे प्रोटीन हाइड्रोलाइसेटस (पी.पीटी, पीसी, सीटी तथा पीटीसी) ने महत्वपूर्ण निरोधात्मक गतिविधि प्रदर्शित की।
- केसीन प्रोटीन पीसी हाइड्रोलाइसेट तथा ढे प्रोटीन हाइड्रोलाइसेट के 3kDa प्रोटीन पीटीसी हाइड्रोलाइसेटस की तुलना में महत्वपूर्ण डीपीपी-IV निरोधात्मक गतिविधि प्रदर्शित की। ढे पी.टी.सी. हाइड्रोलाइसेटस के 3kDa अंश के नीचे पीसी हाइड्रोलाइजेट DPP-IV निषेध में अधिक प्रभावी था जो कि केसीन प्रोटीन पीसी हाइड्रोलाइजेट के 3 के डीडे अंश से नीचे।
- भैंस में भ्रूण के प्रारंभिक अस्तित्व को विनियमित करने वाले जीनस के CRISPR/CA59 निर्देशित कार्यात्मक विश्लेषण शुरू किया गया था।

- डेरी गोपशुओं में उपनैदानिक गर्भाशय संक्रमण का पता लगाने के लिए गर्भाशय संबंधी द्रव प्रोटीन मार्करों की पहचान की गई थी।
- यह पहचान की गई थी कि डब्ल्यू.एन.टी.सिग्नलिंग, कोशिकीय वृद्धि, विभेदीकरण तथा स्टीरायड—उत्पत्ति के अबिक्विटीनेशन (ubiquitination) एवं अल्प विनियमन द्वारा प्रचुर मात्रा में प्रोटीओलिसिस संकर नर पशुओं में निम्नकोटि के वीर्य की गुणवत्ता तथा / अथवा उप जननक्षमता / बांझपन की अधिकता का कारण हो सकता है।
- यह अध्ययन प्रमाणित करते हैं कि क्रायो परिरक्षित वीर्य में क्रायो सर्मीथित शुक्राणुओं का अनुपात नकारात्मक रूप से सांड की जननक्षमता से संबंधित था।
- झोटे की जननक्षमता पूर्वानुमान के लिए शुक्राणुओं में जननक्षमता संबंधी प्रोटीनो का पहचान की गई।
- एल.फरमेंटम एम.टी.सी.सी. 5689 तथा एल.जी.जी की ऊष्मा ने प्रोबायोटिक तैयारी ने कोलाइटिस माऊस माडल में विरोधी संदूषक प्रभाव प्रदर्शित किए।
- एल.फरमेंटम एम.टी.सी.सी 5689 तथा एल.जी.जी. दोनों के पेप्टीडोग्लाइकन ने संदूषण विरोधी संभाव्यता प्रदर्शित करने की संभावना दिखाई।
- दो स्वदेशी प्रोबायोटिक जातियां अर्थात् एलबीएस4 तथा एलएफ1 तथा उनकी सतह प्रोटीन आंत अवरोध पारगम्यता में सुधार के अतिरिक्त रोबसट ई.एस.बी.एल ई.कोलि जातियां 9/234, 23/208 के विरुद्ध सुदृढ़ विघटन प्रभावकारिता प्रदर्शित की।
- विशिष्ट अनुकूलित परिस्थितियों में विकसित विटामिन बी₁₂ जैव-पुष्टिकर सोया दही को खाद्य उद्योग में व्यावसायिक रूप से स्वीकार करने की गुंजाइश है।
- लेक्टिक अम्ल जीवाण्विक से एंटीफ्रंगल (फफूंदरोधी) मिश्रण अलग करता है अर्थात् डब्ल्यू सिबेरिया पी.6 तथा एल.प्लांतरम पी10 तैयार किया गया जो कि परीक्षण कवक संकेतकों के साथ खराब फफूंद वियोजकों के विरुद्ध सुदृढ़ फफूंदरोधी गतिविधि का प्रदर्शन करता था।
- हाइपोकोलस्ट्रॉलीमिक किण्वित डेरी उत्पादों को विकसित करने के लिए यथावत ई.पी.एस.उत्पादक एन.सी.डी.सी 400 का प्रयोग किया जा सकता है।
- हाईस्टिडिन काइनेज के उच्च-विनियमन लेक्टोबेसिलस हेलवेटिकस MTcc5463 में पित्त सहिष्णु प्रक्रिया के लिए मजबूत आधार प्रदान कर सकता है। इसके अतिरिक्त एमटीसीसी 5463 में वित्त सहिष्णुता प्रक्रिया के दौरान जी.एम.पी. सिन्थेज़, ए.बी.सी. ट्रांसपोर्टर, हालिडे जंक्शन, मल्टीड्रग प्रतिरोधकता, ट्रांसक्रिप्शनल विनियामको तथा हाईस्टिडिन काइनेज के परिवार को अत्याधिक महत्वपूर्ण पाया गया।
- 'दही' के नमूनों से मेटाजिनोमिक डी.एन.ए. के निष्कर्षण के लिए प्रोटोकॉल मानकीकृत किया गया था।
- मानक संवर्धन माध्यम के बराबर लेक्टिक अम्ल जीवाणुओं (एल.ए.बी.) के विकास में सुधार के लिए व्हे आधारित माध्यम अनुरूप है।
- किण्वित उत्पाद पंचामृत में दही तथा दूध (2:1) के अनुपात तथा 5% शहद, 3% चीनी तथा 5% घी होता है। उत्पाद की भंडारण स्थिरता रेफरीजरेशन तापमान पर 3-4 सप्ताह थी।
- पंचामृत सूत्रों में एच.टी 29 कोशिका लाइन में प्रति सूक्ष्मजैवीय गतिविधि तथा इम्यूनो-मोड्यूलेटरी गतिविधि उच्च थी। इन विट्रो इम्यूनो मोड्यूलेटरी गतिविधि में एच.टी-29 कोशिका रेखा के विरुद्ध पूर्व एवं पश्च (6 घंटे तथा 24 घंटे) उपचारों के साथ आई.एल-10 साइटोकाइनस के अभिप्रेरण प्रदर्शित किए। छह घंटे के पूर्व उपचार के लिए आई.एल-10 के अभिप्रेरण में परिवर्तन 511.553±2.635 pg/mL था।
- दुग्ध उत्पादों में ई.कोलि की जांच के लिए पैन आई-पी.ई.सी आधारित पेपर स्टिप परीक्षण 10:21 ± 0:10 घंटे के भीतर 37°सें. तापमान 0.52 ± 0.17 लाग सीएफयू/एमएल की पहचान संवेदनशीलता के साथ विकसित किया गया था।
- कच्चे दूध में अनुकूलित माध्यम का प्रयोग करके दूध में कुल सूक्ष्मजैवीय भार का पता लगाने के लिए पीएएनआई-पीईसी स्ट्रिपस का प्रयोग किया गया तथा इसने 7 लाग सीएफयू/एम.एल पर 4½ घंटे की संवेदनशीलता का पता चला।
- कैप्टन कीटनाशकों की 88.61 ± 0.22, 83.97 ± 1.15 तथा 72.8 ± 2.11% के स्तर पर पानी, स्किम दूध तथा पास्तुरीकृत दूध के प्रतिपूर्ति के लिए चुंबकीय आण्विक रूप से अंकित पालिमेर-किण्वक अवरोधक आधारित माइक्रोटाइटर परीक्षण किए विकसित किए थे तथा उनके एन.आर.एल. मिले।
- डेरी आपूर्ति श्रृंखला में एंटीबायोटिक प्रतिरोधी ज्यूनोटिक रोगजनकों की व्यापकता ई.कोलि, स्टैफिलोकोकस आरियस तथा एंट्रोकोकस जातियों के लिए संगठित तथा असंगठित दोनों क्षेत्रों से दूध के नमूने एकत्रित करने के लिए आयोजित की गई थी तथा 6 ई.कोलि एवं एस.एरियस एवं एंट्रोकोकस जातियों में विस्तृत स्पेक्ट्रम β लेक्टमस, ओक्सालिसिलिन तथा वेंकोमाइसिन एंटीबायोटिक्स की ओर प्रतिरोध देखा गया।

- राजस्थान तथा हरियाणा से प्राप्त किए गए कच्चे दूध तथा पास्तुरीकृत दूध के सात सौ दो (702) नमूनों की जांच की गई तथा 4.68% नमूने β लेक्टम, क्लोरैम्फेनिकल, सल्फा औषधियों तथा एनप्लोक्सासिन की मौजूदगी के साथ एंटीबायोटिक अवशेषों से दूषित पाए गए। कच्चे दूध में 3.55% तथा पास्तुरीकृत दूध में 0.59% की विद्यमानता के साथ कीटनाशकों के अपशिष्टों के नमूने भी लिए गए।
- हरियाणा में संगठित डेरी फार्मों से कच्चे दूध के 376 नमूने ले कर डेरी पशुओं में थनैला के प्रसार पर आधारभूत डेटा तैयार किया गया था। नैदानिक थनैला की प्रसार में 14.36% उपनैदानिक थनैला में 17.81% ए.ई.कोलि में 13.82% तथा एस.आरियस में 31.64% पाया गया।
- बी.लिकेनफार्मिस ए.टी.सी.सी 12759 से बी-ग्लेटोसिडेज किण्वक को नियोजित करने वाले स्ट्रिप आधारित परीक्षण पीबी 20पीपीबी, सीडी100 पी.पी.बी, के.ए.ओ.डी. के साथ विकसित किया गया जैसा कि 250 पीपीएम तथ एच.जी, 5पीपीबी बफर प्रणाली में 25 मिनट के भीतर परिणाम देने वाले थे।
- दूध में बी.लैक्टम समूह की तीव्र जांच के लिए पेपर स्ट्रिप आधारित विश्लेषणात्मक उपकरण पर अवधारणा का प्रमाण विकसित किया गया। विकसित परीक्षण को यू.के. के भागीदारों के साथ समन्वय से पेपर आधारित पिलर एरै उपकरण पर बदल दिया गया था।
- गाय और भैंस दूध में दूध वसा की शुद्धता के आई.एस.ओ.मानक की प्रासंगिकता का मूल्यांकन घी में मिलावट का पता लगाने के लिए किया गया था।
- मौसम एवं प्रसंस्करण की परिस्थितियों से प्रभावित गाय एवं भैंस के ट्राइग्लिसराइड प्रोफाइल का मूल्यांकन घी में मिलावट का पता लगाने के लिए विधि विकसित करने के लिए किया गया था।
- बाजार में उपलब्ध ढे प्रोटीन आधारित स्वास्थ्य संपूरकों के लगभग 14% नमूनों के लेबल पर प्रोटीन और वसा की मात्रा के दावा किए गए मानों से हट गया है।
- दूध में ओर्गनोफास्फोरस कीटकाशक अवशेषों की तीव्र जांच के लिए एक नेनो प्रौद्योगिकी आधारित विश्लेषणात्मक विधि विकसित की गई थी।
- ढे प्रोटीन सान्द्रण-लौह सम्मिश्रण का प्रयोग करके दही तथा बिस्किटों के पुष्टिकरण के लिए एक विधि विकसित की गई थी।
- विभिन्न खाद्य उत्पादों के पुष्टिकरण के लिए स्प्रे ड्राइड दुग्ध प्रोटीन-विटामिन ए/विटामिन डी सम्मिश्रणों की तैयारी के लिए एक विधि विकसित की गई।
- पंचगव्य संघटकों के विश्लेषण के लिए एक विधि विकसित की गई थी।
- एटीआर-एफटीआई.आर अध्ययन इंगित करते हैं कि कम घनत्व वाली पोलिथिलीन (एल.डी.पी.ई.) तथा आक्टिन/ब्यूटीन आधारित रेखिक कम घनत्व वाली पोलिथिलीन (एलएलडीपीई) पालिमरिक परते हैं जो कि दूध तथा घी के लिए बहुपरतीय-सह-बहिर्वर्धित पैकिंग सामग्री के रूप में व्यापक रूप से उपयोग की जाती हैं।
- प्लासमिन गतिविधि तथा गौडा चीज के भौतिक-रासायनिक, जैव-क्रियात्मक तथा संवेदी गुणों के साथ इसके संबंधों का मूल्यांकन किया गया था।
- प्रसंस्कृत चीज के चयनित गुणों पर पूर्ण केसीन अंश का प्रभाव (कच्चे माल में प्राकृतिक चीज मिश्रण की संरचना का अप्रत्यक्ष मान) मूल्यांकित किया गया।
- गाय के दूध से रिकोटा चीज, भैंस के दूध से दुग्ध प्रोटीन सान्द्रण 80, आमेगा-3 भरपूर टेबल स्प्रेड आदि जैसे उत्पादों के लिए निर्माण प्रोटोकॉल विकसित किए गए।
- इलेक्ट्रोस्पन संरचनाओं का प्रयोग करके बरफी के लिए प्रति आक्सीकर सक्रिय पैकेजिंग विकसित की गई।
- छैना उत्पादन के लिए एक यंत्रिकृत ढे निकालने की प्रणाली विकसित की गई। विकसित उपकरण लघु उद्यमियों के लिए चक्का के उत्पादन के लिए उपयुक्त होगी तथ समय की बचत एवं स्वस्थकर उत्पादन की आवश्यकताओं की पूर्ति करती है।
- लघु स्तर पर मौजरेला चीज उत्पादन के लिए एक अल्प लागत वाली यंत्रिकृत स्ट्रैचिंग एवं पोर्टनिंग यूनिट विकसित किया गया।
- किण्वित दुग्ध उत्पादों के लिए एक स्वचालित एंडो-एक्सो थर्मल यूनिट विकसित किया गया।
- 40 से 80 लीटर की क्षमता वाले फार्म मिल्क कूलर का प्रयोगात्मक सैटअप डिजाइन किया गया तथा निर्मित किया गया।
- प्रसारण आधारित रंग मापन प्रणाली डिजाइन एवं विकसित की गई।
- फूड ग्रेड सरफेक्टेंट्स तथा थिनफिल्म हाइड्रेशन तकनीक तथा हाई शियर होमोजनाइजेशन द्वारा विभिन्न स्थायीकारकों का प्रयोग करके केटेचिन लोडिड नियोसोमस तैयार किए गए। विकसित नियोसोमस केटेचिनस की कार्यात्मकता तथा संशोधित जैवउपलब्धता के लिए आशाजनक वितरण वाहन के रूप में काम कर सकते हैं।

- कार्यात्मक प्रसंस्कृत मौजरेला चीज़ के विकास के लिए प्रक्रिया में सुधार किया गया।
- पुष्टिकर मीठी दुग्ध केफ़ीर के विकास के लिए प्रौद्योगिकी विकसित की गई।
- दूध एवं दुग्ध उत्पादों के पुष्टिकरण के लिए वितरण वाहन के रूप में रिसवर्टरल तथा केटेचिन-लोडिड नियोसोमस तथा नेनोपार्टिकलस मानकित किए गए।
- केरल के एक परम्परागत डेरी उत्पाद, प्लादा पयाज़म के लिए एक सुविधाजनक मिश्रण तैयार करने के लिए शुष्क क्रिस्टलीकरण प्रक्रिया के लिए एक यांत्रिक यूनिट कस्टम डिजाइन एवं विकसित किया गया।
- एप्लाइंग सिम्युलेशन मॉडल वेनसिम पीएलई x 32 पैकेज द्वारा मैप किए गए तरल दुग्ध मूल्य चेन प्रकट करते हैं कि एकीकृत उत्पादन एवं प्रसंस्करण यूनिटों (मॉडल-II) द्वारा अर्जित लाभ अर्थात् रु. 7.21 प्रति लीटर स्वीकृत मॉडल लाभ 2.5 प्रति लीटर से अधिक था।
- उड़ीसा में एक अध्ययन में पाया गया कि आवृत्त प्रजनन स्वदेशी गायों की अपेक्षा संकर गायों में कहीं अधिक प्रभावी था संकर गायों तथा देसी गायों से पारिवारिक क्षति क्रमशः 20,000 रुपये तथा 6400 रुपये थी। रोगों में, थनैला रंग का बाकी सभी रोगों से पारिवारिक क्षति के लिए बड़ा योगदान है इसका लगभग 40% हिस्सा है जबकि इसके बाद खुर एवं मुंह पका रोग तथा रक्त प्रोटोजन रोग का स्थान है।
- तटीय उड़ीसा में लगभग 77% फार्म जोखिम एवं अनिश्चिन्ता की चपेट में पाए गए। चपेट की सीमा भूमिहीन में (87.51%) तथा कम फार्म आकार के वर्गों में सीमान्त कृषकों (82.24%) तथा लघु कृषकों में 51.89% पाई गई।
- उड़ीसा के तटीय मैदानों में पेरी अर्बन डेरी फार्मों में दुधारू संकर गाय की कुल अनुरक्षण लागत रु. 269.53/प्रतिदिन अनुमानित की गई, जो कि छोटे वर्ग के लिए 272.88 रुपये तथा बड़े वर्ग के लिए 250.25 रुपये भिन्न-भिन्न थी। दुधारू भैंसों के लिए कुल अनुरक्षण लागत रुपये 276.63/दिन अनुमानित की गई जो कि छोटे वर्ग के लिए 247.16 रुपये तथा बड़े वर्ग के लिए 300.58 रुपये भिन्न-भिन्न थी।
- उड़ीसा के तटीय मैदानी भागों में डेरी कृषकों की औसत लाभ क्षमता 54% थी। यह बड़े फार्मों में उच्चतम (76%) थी इसके बाद मध्यम (64%) तथा छोटे फार्मों में (60%) थी। मजदूरी तथा सान्द्रण अनुप्रयोग ऐसे घटक थे जो कि लाभ क्षमता को महत्वपूर्ण रूप से प्रभावित करते थे।
- भारत के पूर्वी क्षेत्र में दुग्ध आपूर्ति मूल्य सापेक्षता हमारे अपने मूल्य के संबंध में (0.7154%) मूल्य निरपेक्ष आकलित की गई। बड़े फार्मों पर दुग्ध आपूर्ति मूल्य सापेक्षता लोचदार में (1.6746) थी चूंकि विशाल फार्म इसके मूल्य में वृद्धि के प्रतिक्रिया में दुग्ध आपूर्ति बढ़ाने में सक्षम थे।
- भारत के पूर्वी क्षेत्र में दूध के मूल्यों संबंधी घटक मांग मूल्य सापेक्षता शुष्क चारे को छोड़कर सभी घटकों के लिए मूल्य निरपेक्ष थीं जो कि मूल्य सापेक्ष (1.1763) था जो कि यह दिखाता था कि शुष्क चारे की मांग दुग्ध मूल्य में आनुपातिक वृद्धि की अपेक्षा अधिक वृद्धि हुई। बड़े फार्मों पर, पशुचिकित्सा सेवाओं के अतिरिक्त सभी घटकों के लिए ये मूल्य सापेक्ष पाए गए।
- साहीवाल नस्ल के आर्थिक मूल्यांकन में, उच्च रोग प्रतिरोध अधिक सकारात्मक गुणों वाली थी जबकि अल्प दुग्धउत्पादन अधिक नकारात्मक गुणों वाला था। श्री गंगानगर एवं फाजिलका में किसानों को साहीवाल नस्ल की अधिक मान निर्धारित किए। संकर नस्ल के पशुपालन करने वाले किसानों को साहीवाल पालने के लिए 19,075 रुपये प्रति पशु प्रति वर्ष का अतिरिक्त व्यय अपेक्षित है।
- लागत पर लाभ बटर मिल्क में (38.04%) अधिकतम पाया गया तथा यह एस.एम.पी. में न्यूनतम 1.75) था। इसी प्रकार ब्रेक इवन प्वाइंट पर सुरक्षा लाभ दही में अधिकतम 86.95% तथा एस.एम.पी.में न्यूनतम (32.90%) पाया गया।
- गुजरात तथा हरियाणा में डेरी फार्मिंग आय की एक तुलना में पाया गया कि सीमान्त कृषि परिवार हरियाणा में राज्य औसत 2400 रु प्रति माह की तुलना में 30% कम कमा रहे हैं। जबकि दूसरी ओर गुजरात में सीमान्त किसानों की वास्तविक मासिक आय 1000 रुपये माह से बढ़कर 2500 रुपये प्रति माह तथा लघु कृषि परिवारों की 1100 रुपये प्रति माह से 3600 रुपये प्रति माह हो गई।
- मशीन लर्निंग (एम.एल.) एल्गोरिदम ने कड़ेपन के अतिरिक्त पनीर की संरचनात्मक गुणों के सभी उत्पादन पैरामीटरों को पूर्वानुमानित करने में परम्परागत वापसी मॉडलों की तुलना में अपेक्षाकृत श्रेष्ठ पूर्वानुमानित संभाव्यता प्रदर्शित की।
- गोपशु संख्या गतिकी के स्पेशियों-टेम्परोल विश्लेषण दुग्ध उत्पादन प्रवृत्तियों तथा भारत में डेरी उद्योग के आर्थिक योगदान किया गया।
- वर्ष 2019 के दौरान सात पेटेंट प्रदान किए गए।

विस्तार

- भाकृअनुप-राडेअनुसं के कृषि विज्ञान केन्द्र ने डेयरी हितधारकों के लिए 215 कैंपबाह्य(ऑफ-कैंपस) और कैंप में कौशल आधारित व्यावसायिक प्रशिक्षण कार्यक्रम (कैंपस स्किल बेस्ड वोकेषनल ट्रेनिंग प्रोग्राम) आयोजित किए। कृषि विज्ञान केन्द्र, नादिया ने चार फ्रंट लाइन प्रदर्शनों को अंजाम दिया और दो को फील्ड स्तर पर परीक्षण किया गया। कृषि विज्ञान केन्द्र, नादिया के तहत एक्सपोजर विजिट सहित कुल 299 विस्तार गतिविधियाँ आयोजित की गईं। राडेअनुसं स्थित कृषि विज्ञान केन्द्र एवं कृषि विज्ञान केन्द्र, नादिया के द्वारा प्रशिक्षण कार्यक्रमों और विस्तार गतिविधियों के माध्यम से कुल 12,520 किसानों को लाभान्वित किया गया।
- कृषि विज्ञान केन्द्र ने दिनांक 23 जनवरी 2019 को महिला किसान दिवस मनाया जिसमें 108 ग्रामीण महिलाओं ने भाग लिया।
- प्रधानमंत्री-किसान योजना (प्रधानमंत्री सम्मान निधि) के शुभारंभ पर दिनांक 24 फरवरी, 2019 को लगभग 400 कृषकों के लिए सीधे वैबसाइट की व्यवस्था की गई।
- कृषि विज्ञान केन्द्र ने कृषि उन्नति मेला के दौरान भा.कृ.अनु.सं. पूसा, नई दिल्ली में दिनांक 6 मार्च, 2019 को कृषि तथा संबंधित क्षेत्रों में नवीनतम विकासों से किसानों को अवगत कराने के लिए 44 कृषकों के लिए एक्सपोजर विजिट आयोजित की।
- कृषि विज्ञान केन्द्र ने अन्तर्राष्ट्रीय महिला दिवस (मार्च 8, 2019) पर प्रधानमंत्री के कार्यक्रम के सीधे प्रसारण की व्यवस्था की इसके बाद महिलाओं के साथ प्रधानमंत्री के पारस्परिक विचार विमर्श के प्रसारण की भी व्यवस्था की गई। लगभग 70 ग्रामीण महिलाओं ने इस कार्यक्रम में भाग लिया।
- पेट्रोलियम संरक्षण अनुसंधान संस्था (पी.सी.आर.ए) पेट्रोलियम मंत्रालय के साथ दिनांक 14 मार्च 2019 को पेट्रोल तथा तेल संरक्षण के लिए विधियों को अपना कर कृषि में उत्पादन की लागत को कम करने पर 100 कृषकों को सुग्राही बनाने के लिए एक कार्यशाला आयोजित की गई।
- नेहरू युवा केन्द्र, करनाल के साथ 'युवा नेतृत्व एवं सामुदायिक विकास' पर 18 से 20 मार्च, 2019 के दौरान एक तीन दिन का कार्यक्रम आयोजित किया गया जिसमें 39 प्रतिभागियों ने भाग लिया।
- तम्बाकू के दुष्प्रभावों के बारे में प्रतिभागियों को शिक्षित करने के लिए कृषि विज्ञान केन्द्र ने 31 मई, 2019 को 'विश्व तम्बाकू रहित दिवस' मनाया गया।
- कृषि विज्ञान केन्द्र ने दाहा जागीर गाँव में दिनांक 1 अगस्त, 2019 को 'वर्ल्ड ब्रैस्ट फीडिंग वीक' दिवस मनाया जिसमें 33 महिलाओं ने भाग लिया।
- कृषि विज्ञान केन्द्र ने फसल उत्पादन में मृदा स्वास्थ्य के महत्व पर जागरूकता पैदा करने के लिए दिनांक 5 दिसम्बर, 2019 को 'मृदा स्वास्थ्य दिवस' आयोजित किया जिसमें 90 कृषकों एवं ग्रामीण महिलाओं ने भाग लिया।
- कृषि विज्ञान केन्द्र ने करनाल एवं इसके समीपस्थ जिलों के युवाओं तथा 200 कृषकों के लिए 'जल संरक्षण' पर क्रमशः 19 जुलाई एवं 9 अगस्त, 2019 को किसान मेला एवं जागरूकता कार्यक्रम आयोजित किया।
- कृषि विज्ञान केन्द्र ने 140 कृषकों एवं ग्रामीण महिलाओं तथा युवाओं के लिए दिनांक 10 जुलाई एवं 2 सितम्बर 2019 को 'जल संरक्षण' पर जागरूकता कार्यक्रम आयोजित किया।
- कृषि विज्ञान केन्द्र ने करनाल जिले के सुल्तानपुर तथा जलमाना गाँवों में 160 स्कूली छात्रों तथा 79 कृषकों के लिए दिनांक 3 सितम्बर एवं 18 अक्टूबर 2019 को जल संरक्षण पर एक जागरूकता कार्यक्रम आयोजित किया।
- कृषि विज्ञान केन्द्र ने करनाल के भैनीखुर्द तथा सुल्तानपुर गाँवों में क्रमशः 144.0 एकड़ तथा 237.0 एकड़ क्षेत्र पर हैपी सीडर तथा जीरो टाइलेज सीड ड्रिल की सहायता से गेहूँ की बीजाई कराई।
- कृषि विज्ञान केन्द्र ने गेहूँ की फसल की प्रगति को मानीटर करने के लिए तथा किसानों की शंकाओं को दूर करने के लिए विषय विशेषज्ञों के 22 दौरे आयोजित किए तथा इससे 347 कृषकों ने लाभ उठाया।
- कृषि विज्ञान केन्द्र ने खेतों में फसल अपशिष्टों को जलाने के विरुद्ध तथा फसल अपशिष्ट के इन-सिटू प्रबंधन के लिए मशीनों के प्रयोग के बारे में किसानों को सुग्राही बनाने के लिए 32 जागरूकता कार्यक्रम एवं किसान संगोष्ठियाँ आयोजित की। इनक कार्यक्रमों में कुल 1356 किसान शामिल हुए।
- कृषि विज्ञान केन्द्र ने इन-सिटू फसल अपशिष्ट प्रबंधन कार्यक्रम पर दिनांक 26 मार्च 2019 को भाकृअनुप-ए.टी.ए.आर.आई., जोधपुर के साथ मिलकर पशुपालकों का सम्मेलन आयोजित किया। इस कार्यक्रम में हरियाणा राज्य में विभिन्न कृषि विज्ञान केन्द्रों के विषय विशेषज्ञों (एस.एम.एस.) तथा 100 से भी अधिक किसानों ने भाग लिया।

- दुग्ध प्रसंस्करण तथा मूल्य संवर्धन विषय पर भावी उद्यमियों के लिए क्रमशः 1-10 अप्रैल, 1-10 जुलाई, 2-11 सितम्बर तथा 16-25 दिसम्बर, 2019 को चार प्रशिक्षण कार्यक्रम आयोजित किए गए।
- दुग्ध उत्पाद प्रसंस्करण पर यूगान्डा के कृषकों के लिए दिनांक 4-18 मार्च, 2019 के एक अन्तर्राष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- 'नवीन एवं मूल्य वर्धित डेरी उत्पाद विषय पर अफ्रीकी राष्ट्रों के किसानों एवं विपणन कार्मिकों के लिए 5 से 14 नवम्बर 2019 को एक अन्तर्राष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- अफ्रीकी देशों के किसानों एवं डेरी कार्मिकों के लिए दो अन्तर्राष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किए गए।
- संस्थान के बी.पी.डी. यूनिट के व्यावसायिक डेरी फार्मिंग तथा दुग्ध प्रसंस्करण एवं मूल्य संवर्धन के क्षेत्र में 12 उद्यमशीलता विकास कार्यक्रम आयोजित किए जिसमें देश भर से 194 प्रतिभागियों ने भाग लिया। उद्यमशीलता को प्रोन्नत करने के लिए 'व्यावसायिक डेरी फार्मिंग तथा दुग्ध प्रसंस्करण पर प्रयोगात्मक प्रशिक्षण' पर 10 दिन की विशेष प्रशिक्षण कार्यक्रम आयोजित किया गया जिसमें भारतीय सेवा (आर्मी) के 16 कार्यरत एवं सेवानिवृत्त कार्मिकों ने भाग लिया इस प्रशिक्षण का उद्देश्य अपना उद्यम चलाने के लिए डेरी पशुपालन तथा प्रभावी प्रबंधन प्रक्रियाओं के बारे में सैद्धान्तिक एवं प्रयोगात्मक ज्ञान प्रदान करना था।
- संस्थान के पशु जैव प्रौद्योगिकी केन्द्र ने देश के 10 विभिन्न विश्वविद्यालयों से दिनांक 1 जून से 30 जून, 2019 के दौरान इन्टर्नशिप के लिए चयनित 15 छात्रों के लिए जैवप्रौद्योगिकीय तकनीकियों के लिए समर आयोजित प्रशिक्षण पर एक मास का प्रशिक्षण किया गया। छात्रों को पी.सी.आर, टी-पी.सी.आर सहित विभिन्न तकनीकियों पर प्रयोगात्मक प्रशिक्षण प्रदान किया गया।
- संस्थान के डेरी प्रौद्योगिकी प्रभाग दिनांक 1 से 30 जून, 2019 के दौरान 13 विश्वविद्यालयों एवं महाविद्यालयों के 21 छात्रों के लिए 'खाद्य प्रसंस्करण प्रौद्योगिकियों पर प्रशिक्षण कार्यक्रम' विषय पर एक मास की अवधि का प्रशिक्षण कार्यक्रम आयोजित किया गया।
- इस अवधि के दौरान संस्थान के पशुपोषण प्रभाग द्वारा मैसर्स कैमिन इन्डसट्रीज साऊथ एशिया प्राइवेट लिमि, चेन्नई के 15 कर्मचारियों के लिए 'एडवान्सड फीड टेक्नोलोजी' विषय पर एक विशेष प्रशिक्षण कार्यक्रम आयोजित किया गया।
- इस अवधि के दौरान संस्थान के विभिन्न प्रभागों एवं अनुभागों में 1 से 6 माह की अवधि के प्रशिक्षण अन्य विश्वविद्यालयों एवं शिक्षण संस्थानों के कुल 52 छात्रों को प्रशिक्षण प्रदान किए गए।
- ठेके की सेवाओं के द्वारा संस्थान ने 85 संस्थानों, व्यक्तियों एवं उद्योगों को विश्लेषण सेवाएं, परीक्षण किटों की आपूर्ति, कल्चर (जामन) एवं उपकरणों की कस्टम हायरिंग की सेवाएं प्रदान की।
- वर्ष 2019 के द्वारा संस्थान के एटिक केन्द्र (कृषि प्रौद्योगिकी एवं सूचना केन्द्र) ने 5445 हितधारकों के लिए कृषि प्रौद्योगिकी एवं प्रौद्योगिकी उत्पादों (3132) में प्रसार सेवाएं प्रस्तुत की।
- संस्थान में विकसित कुल सात प्रौद्योगिकियां सात विभिन्न लाइसेंस अनुबंधों के द्वारा पांच व्यावसायिक प्रतिष्ठानों को स्थानान्तरित की गई तथा संस्थान के लिए प्रौद्योगिकी हस्तांतरण शुल्क के द्वारा 20.60 लाख रुपये (सर्विस टैक्स को छोड़कर) अर्जित किए तथा 17 प्रौद्योगिकियां व्यवसायीकरण के लिए अनुमोदित की गई।
- जनजातीय उपयोजना(टी.एस.पी.) के अन्तर्गत पूर्वी एवं उत्तर-पूर्वी भारत के विभिन्न भागों में 6 शिविर आयोजित किए गए तथा कैम्पस के भीतर चार प्रशिक्षण कार्यक्रम आयोजित किए गए।
- भारत के पांच उत्तर-पूर्वी राज्य अर्थात् मेघालय, त्रिपुरा, सिक्किम, नागालैंड तथा मिजोरम वर्ष 2019 के दौरान उत्तर-पूर्वी पहाड़ी (एन.ई.एच) परियोजना के अन्तर्गत सम्मिलित किए गए तथा पशुधन एवं विभिन्न निवेश वस्तुएं कृषकों को वितरित की गई।
- डेरी विकास केन्द्र के द्वारा कृत्रिम गर्भाधान एवं पशुचिकित्सा प्रथमोपचार सुविधा प्रदान की गई तथा केन्द्र द्वारा छः टीकाकरण एवं पशुचिकित्सा स्वास्थ्य शिविर आयोजित किए गए।
- वैज्ञानिक ढंग से डेरी पालन, कृत्रिम गर्भाधान तथा पशुचिकित्सा प्रथमोपचार तथा वैज्ञानिक ढंग से बकरी पालन पर प्रशिक्षण कार्यक्रम आयोजित किए गए।
- 942 आगन्तुकों की सत्रह प्रमुख भ्रमण टीमों ने संस्थान का भ्रमण किया।
- पूर्वी केन्द्र के विषय विशेषज्ञों ने 22 गाँवों का दौरा किया तथा 'मेरा गाँव मेरा गौरव' कार्यक्रम के अन्तर्गत किसानों के द्वार पर उनकी रोजमर्रा की समस्याओं का समाधान किया।

शिक्षण

- पूर्वस्नातक छात्रों को पांचवी डीन समिति के सुझाव अनुसार छात्र रैडी कार्यक्रम के अन्तर्गत मूल्य वर्धित डेरी उत्पादों के लिए

प्रौद्योगिकीय पैकेजों के विकास के लिए परामर्शदाता (मॉडल डेरी प्लांट के संकाय एवं कर्मचारियों के द्वारा) सहायता प्रदान की गई। विशेषज्ञ संकाय की सदस्यता के अन्तर्गत अभिनव डेरी उत्पादों की नवीन श्रेणी के लिए एक बिजनस मॉडल तैयार करने के लिए छः टीमों (प्रत्येक में आठ छात्र) को कहा गया। छात्रों ने प्रौद्योगिकी तथा छैना आधारित मफिनस, बकरी के दूध की चीज़, माल्ट आइस्क्रीम/कुल्फी, फ्रूट बर्फी, घी अपशिष्ट आधारित चाकलेट बर्फी के लिए बिजनस कैनवस मॉडल भी विकसित किया। छात्रों ने उपभोक्ता स्वीकार्यता अध्ययन किए तथा फीडबैक के आधार पर सूत्रीकरण तथा प्रसंस्करण पैरामीटर भी संशोधित किए गए। प्रशिक्षण का उद्देश्य विद्यार्थियों को अनुसंधान आधारित विकासात्मक गतिविधियों तथा व्यवसायिक कुशाग्रता को समझाना था।

- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के डेरी अर्थशास्त्र, सांख्यिकी एवं प्रबंधन प्रभाग ने जुलाई 24-26, 2019 के दौरान सी.सी.एस.राष्ट्रीय कृषि प्रबंधन संस्थान, जयपुर के समन्वय में 'डेरी उत्पादों को बढ़ावा देने के लिए विपणन रणनीतियां विषय पर 30 प्रतिभागियों के लिए एक तीन दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया।
- शैक्षणिक कार्यक्रमों को सुदृढ़ करने, भूतपूर्व छात्र नेटवर्क के लाभ, छात्रों की सॉफ्ट स्किल्स एवं संस्थान विकास योजना (आई.डी.पी.) के अन्तर्गत हरित परिसर योजनाओं को सुदृढ़ करने के लिए विभिन्न पहल की गई। कुल 16 संकाय सदस्य अन्तर्राष्ट्रीय प्रशिक्षण के लिए चुने गए तथा जिनमें से 7 संकाय सदस्य संयुक्त राज्य अमरीका तथा नीदरलैंड में स्थित छः विभिन्न विश्वविद्यालयों में प्रगत प्रशिक्षण प्राप्त करने के लिए मनोनीत किए गए।
- कुल 24 छात्रों ने 4 विभिन्न देशों में 11 विभिन्न विश्वविद्यालयों में अपनी विदेशी इन्टर्नशिप पूरी की।
- नए छात्रों के जन्मजात प्रतिभाओं को निखारने के लिए फाउंडेशन कार्यक्रम आयोजित किए गए जिनके दौरान साहित्यिक गतिविधियां, कम्प्यूनिवेशन स्किलस, नेतृत्व कौशल, थिएटर कला, सांस्कृतिक नृत्य गीत, शारीरिक एवं खेल गतिविधियां जैसा योगा, मूल्य, आधार विचार तथा सामाजिक जागरूकता पर सत्र आयोजित किए गए।
- बी.टैक अन्तिम वर्ष के छात्रों के लिए उनकी संचार/साफ्ट कौशल में सुधार के लिए 27-28 नवम्बर 2019 के दौरान नेस्ले इंडिया प्राइवेट लिमि. द्वारा एक कौशल विकास कार्यक्रम अर्थात् एन रीच कार्यक्रम आयोजित किया गया।
- संकाय एवं छात्रों के लाभ के लिए महिला सशक्तिकरण, नेतृत्व एवं सामाजिक उद्यमशीलता, संवेदी मूल्यांकन तकनीकियां, स्तनधारी जीनोम संपादन, प्रवर्तक जामन प्रौद्योगिकी में प्रजाति, डेरी एवं खाद्य उत्पादों तथा डेयरिंग में कम्प्यूटर विजिन अनुप्रयोगों जैसे विभिन्न विषयों पर छः कार्यशालाएं आयोजित की गईं। संयुक्त राज्य अमरीका, यू.के तथा आयरलैंड से चार विदेशी प्रोफेसरों सहित विषय विशेषज्ञों को इन कार्यशालाओं में व्याख्यान प्रस्तुत करने के लिए आमंत्रित किया गया। सूक्ष्मजैवीय गुणवत्ता एवं डेरी उत्पादों की सुरक्षा विश्लेषण तथा प्रवर्तक जामन एवं किण्वित दुग्ध उत्पादों पर एक प्रमाणपत्र पाठ्यक्रम जैसे एक निपुणता विकास कार्यक्रम भी आयोजित किया गया।
- विभिन्न उद्योगों, शैक्षणिक संस्थाओं के साथ समन्वय स्थापित किए गए। ग्रामीण प्रबंधन संस्थान आनन्द, (आई.आर.एम.ए.) आनन्द, भारत के साथ प्रशासनिक क्षमताओं वाले मानव संसाधन की तलाश के लिए डेरी उद्योग की आवश्यकताओं की पूर्ति के लिए डेरी प्रबंधन कार्यक्रम में स्नातकोत्तर डिप्लोमा को प्रारंभ करने के लिए एक समझौता ज्ञापन(एम.ओ.यू) पर हस्ताक्षर किए गए।
- वैश्विक भूतपूर्व छात्र नेटवर्क को सुदृढ़ करने के लिए भूतपूर्व छात्र डाटा बेस अपडेट किया गया। भावी उद्यमियों के लिए ग्यारह उद्यमी विकास कार्यक्रम तथा एक अभिनव विचार प्रतियोगिता तथा पूर्वस्नातक छात्रों के लिए अनुभवात्मक ज्ञान कार्यक्रम पूर्व स्नातक छात्रों के व्यवसायिक विचारों को परिपोषित करने के लिए आयोजित किए गए।
- सुदूरवर्ती (आउटरीच) गतिविधियों के एक भाग के रूप में भाकृअनुप-एन.ए.ए.आर.एम., हैदराबाद की सहायता से डेरी उत्पादन तथा प्रसंस्करण के क्षेत्र में कुल 61 एम.ओ.ओ.सी. विकसित किए गए।
- बी.टैक(डेरी प्रौद्योगिकी) के छात्रों ने ग्रामीण छात्रों के पढ़ाने के लिए तथा सामान्य जनसाधारण को पर्यावरण एवं स्वच्छता के प्रति जागरूक करने के लिए आस-पास के गाँवों का भ्रमण किया।
- देशभर के सहयोगी डेरी विज्ञान कॉलेजों से बीस प्रतिभावान छात्रों को भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान की प्रयोगशालाओं तथा अन्य सुविधाओं में दो माह की अवधि के लिए इन्टर्नशिप (लाइव अनुसंधान परियोजनाएं) प्रदान की गईं।
- सामाजिक समता तथा पर्यावरणीय स्थिरता पहल के भाग के रूप में छात्राओं को स्वयं सुरक्षा प्रशिक्षण प्रदान किया गया तथा शिक्षा में कमजोर छात्रों के लिए उपचारात्मक कक्षाएं आयोजित की गईं।
- जैविक अपशिष्ट उपचार के लिए बायोहार्ड अपशिष्ट के लिए कचरा-भट्टी प्राप्त की गई, रसोई के स्वचालित उपकरण, सी.सी. टी.वी कैमरे स्थापित किए गए तथा छात्रों के छात्रावासों की सुविधाओं के लिए लॉन मूवर्स खरीदे गए।
- अभी हाल में उत्तीर्ण हुए हमारे तीन (2018-19 में उत्तीर्ण) बी.टैक छात्र (हमारे आई.डी.पी. में लाभार्थी) संयुक्त राज्य अमरीका के तीन विभिन्न विश्वविद्यालयों में मास्टर्स के लिए अग्रसर हुए।

- डा. चार्ल्स लांग, टैक्सास ए एवं एम.विश्वविद्यालय, यू.एस.ए. ने भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान में दिनांक 15 नवम्बर, 2019 को 'सेमेलियन जीनोम एडिटिंग बाय सीआर.आई.एस.पी.आर तकनीक' विषय पर एक व्याख्यान प्रस्तुत किया।
- डा.ओलिविया मेक आलिफ टीगैरक, खाद्य अनुसंधान केन्द्र, आयरलैंड ने भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में दिनांक 12 दिसम्बर, 2019 को 'एडवांसिस इन स्टार्टर कल्चर टैक्नोलोजी' विषय पर एक व्याख्यान प्रस्तुत किया।
- डा. आदित्य निगम, एसोसिएट प्रोफेसर, आई.आई.टी, मंडी ने भाकृअनुप-राष्ट्रीय अनुसंधान संस्थान, करनाल पमें दिनांक 20-24 जनवरी, 2020 को "कम्प्यूटर विज्ञान एप्लीकेशन्स इन डेयरिंग" विषय पर आयोजित एक कार्यशाला में एक व्याख्यान प्रस्तुत किया।

संरचना

- पशु जैव प्रौद्योगिकी केन्द्र, भाकृअनुप-रा.डे.अनु.सं., करनाल में नई बायोमार्कर प्रयोगशाला का नवीकरण।
- भाकृअनुप-रा.डे.अनु.सं., करनाल में 03 मेटाबोलिक पिंजरों का निर्माण।
- कृषि विज्ञान केन्द्र, भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर एक शेड की स्थापना एवं निर्माण।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के कृत्रिम प्रजनन अनुसंधान केन्द्र में सामान सहित फर्श (बिटुमेन मास्टिक फ्लोरिंग) की मरम्मत।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में यूनियोपल होर्डिंग की स्थापना।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुधन अनुसंधान केन्द्र में श्रेष्ठ पशुओं (बुलमदर) के शेड की मरम्मत एवं नवीकरण।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के 'बी' तथा 'डी' टाइप के सभी क्वार्टरों के फर्शों की मरम्मत एवं नवीकरण।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुधन अनुसंधान केन्द्र की जी.आई.पाइप रेलिंग की मरम्मत एवं नवीकरण।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पुस्तकालय भवन में नए लगाए ए.सी.प्लाइंट की इलेक्ट्रिक वायरिंग।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के मिल्क पार्लर की फर्श की टाइलों आदि की मरम्मत।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुपोषण प्रभाग के मेटाबोलिक शैडों के फर्श की मरम्मत एवं नवीकरण।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशु जैव प्रौद्योगिकी केन्द्र में क्षतिग्रस्त पार्किंग शैड की मरम्मत।
- राडेअनुसं के दक्षिणी केन्द्र परिसर, बेंगलुरु में पशुधन अनुसंधान केन्द्र के नए भवन का निर्माण कराया गया तथा दिनांक 9 दिसम्बर, 2019 से प्रयोग के लिए खोल दिया गया।
- राडेअनुसं के दक्षिणी केन्द्र परिसर, बेंगलुरु में छात्रावास के कृष्णा विंग का विस्तार कार्य पूरा किया गया।
- राडेअनुसं के दक्षिणी केन्द्र परिसर, बेंगलुरु में बी.बी.एम.पी. द्वारा पी.पी.पी. मोड पर अतिथि गृह तथा छात्रावास परिसर से मुख्य परिसर तक एक स्काईवॉक का निर्माण।



INTRODUCTION



ICAR-National Dairy Research Institute (NDRI) at Karnal, Haryana is one of the premier Institutes in dairy sector. The Institute has contributed tremendously to the growth of the Indian dairy industry and played a crucial role in India's development in milk production with its continuous research. Over ninety year old, NDRI's lineage goes back to the Imperial Institute for Animal Husbandry & Dairying, which was set up in Bangalore in 1923 as a center for dairy education. It was shifted to its present site in Karnal in 1955 and renamed as National Dairy Research Institute. The infrastructure of Imperial institute was retained as Southern Regional Station of NDRI and later in 1964 Eastern Regional Station was set up at Kalyani in West Bengal. NDRI was brought under Indian Council of Agricultural Research in 1970. The Institute has been granted a Deemed University status for implementing its academic programmes since 1989. NDRI has the unique distinction of having been ranked first among all Agricultural Universities consecutively three times in the years 2016-17, 2017-18 and 2018-19. The Institute has been accredited by National Agricultural Education Accreditation Board, ICAR up to 2021. The Institute also finds a place in the Special Mention Category of Institutions by National Institute Ranking Framework (NIRF), Ministry of Human Resources Development, Ranking (2018). The primary goal of the Institute is to provide R&D support towards generation and dissemination of knowledge for development of national milch herd, milk production enhancement, greater productivity of the dairy industry and upliftment of the dairy profession, leading to socio-economic and environmental benefits to the nation as well as contribution towards manpower development programme. This is a unique campus, which alongside Deemed University and residential buildings, has various well equipped research laboratories as well as green spaces with perennial plants and gardens. Well equipped sports facilities and attractive leisure time opportunities are offered to the students and employees of the Institute.

Southern Campus, Bengaluru

The foundation stone of the edifice of NDRI was laid at Bengaluru on July 1, 1923. It was the forerunner institution in starting dairy education programmes to meet the manpower requirements of the Nation's dairy industry. Upon shifting of the Institute Head Quarters to Karnal in 1955, the establishment at Bengaluru continued as the Southern Regional Station of NDRI. The station has been catering to the research, training and extension needs of the dairy farmers and dairy industry of the southern region of the Nation. This centre was the first to initiate training in artificial insemination in cattle in the country.

Eastern Campus, Kalyani

The Eastern Regional Station of the Institute was established at the Central Dairy in Kolkata in 1964 and was shifted in 1966 to Kalyani (Nadia district), about 50 km north of Kolkata. The main objective of establishing the Eastern Regional Station was to identify the major constraints of dairy production in eastern and north eastern India and to offer solutions through research and extension activities to these problems.

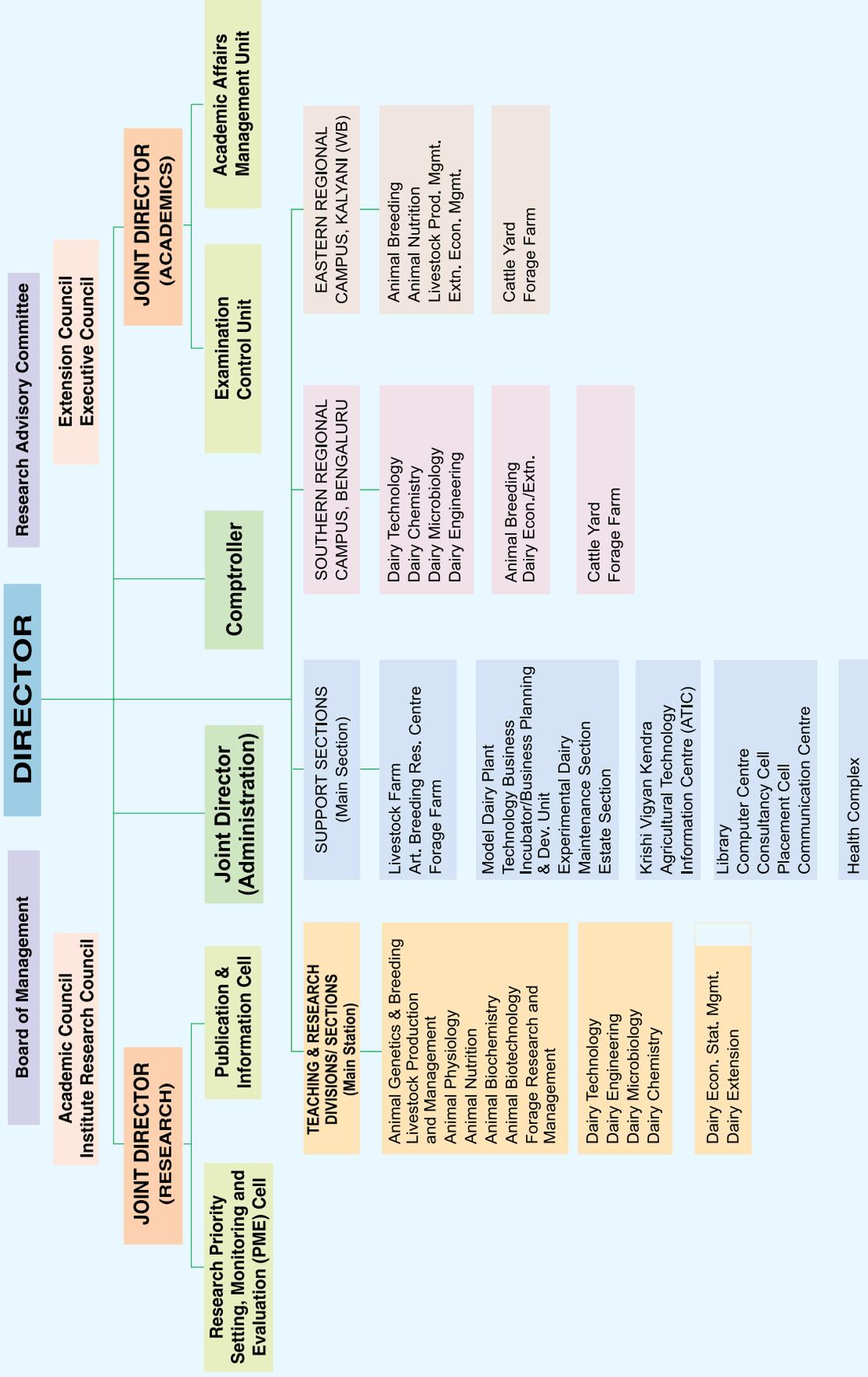
Krishi and Dairy Vikas Kendra, Piprakothi - Motihari

ICAR-NDRI established Krishi and Dairy Vikas Kendra (KDVK) at KVK, Piprakothi, East Charparan (Bihar) in the premises of Dr. Rajendra Prasad Central Agriculture University, Pusa. The Centre was inaugurated by Hon'ble Union Agriculture and Farmers Welfare Minister, Sh. Radha Mohan Singh on July 10, 2016.

Model Dairy Centre, Lalukheri - Muzzafarnagar

The centre was initiated at Lalukheri in Muzzafarnagar, Uttar Pradesh under the project approved by ICAR, New Delhi vide letter No. 2-2/02-ASR-III dated 25.09.2002. The basic facilities have been created for empowering youth and women involved in dairy sector.

Organizational Structure of NDRI



ORGANISATIONAL SETUP

The organizational structure of NDRI follows the Deemed University pattern of the ICAR. The policy making functions pertaining to research, education and extension activities are managed through six main bodies.

- Board of Management
- Research Advisory Committee
- Academic Council
- Institute Research Council
- Extension Council
- Executive Council

The highest policy making body is the Board of Management (BOM). The Director NDRI, is the Chairman of this Board. The Research Advisory Committee (RAC) is responsible for the all-round progress in research at the Institute and its application. The Academic Council is responsible for all issues relating to the education and training. The Academic Council, in turn, is supported by (i) Standing Committees, (ii) the Post Graduate Faculty, and (iii) the Board of Studies in the respective disciplines. The Extension Council is responsible for guiding extension programmes. Institute Research Committee (IRC) is responsible for prioritization, monitoring and evaluation of research conducted in the Institute. The Executive Council is the main task-implementing body on Administrative matters and the powers and the function of this Council shall be those as may be delegated by the BOM. The research, education and extension activities of the Institute are managed by the Director and the Joint Directors through scientific, technical, administrative and supporting staff. The Director is the overall Administrative Head of the Institute and its Regional Stations. The Joint Directors in addition to extending support to the Director in the area of research, academics and administration are responsible to co-ordinate research and educational activities of various Divisions and Regional Stations, respectively. Each of the Regional Stations is administered through the Head located at the station. The scientific and teaching work at the main campus and its regional campuses is conducted in 16 subject-matter disciplines.

BOARD OF MANAGEMENT

Chairman : Director, NDRI Karnal

Member Secretary : Joint Director (Admn. & Registrar)

Members

Joint Director (Research), NDRI

Dr. Raman Seth, PS, DC Division, NDRI, Karnal

Dr. A. K. Singh, PS & Head, DE Division, NDRI, Karnal

Dr. Anjali Aggarwal, PS, AP Division, NDRI, Karnal

Dr. Naresh Kumar, PS, DM Division, NDRI, Karnal

Dr. A. K. Mishra, Vice Chancellor, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand.

Dr. Rameshwar Singh, Vice Chancellor, Bihar Animal Sciences University, Bihar Veterinary College Campus, Patna

Director, IARI, New Delhi

Dr. Suresh S. Honnappagol, Animal Husbandry Commissioner, DAHD&F, Krishi Bhawan, New Delhi

Dr. K. S. Risam, Director of Extension, Shere-e-Kashmir Univ. of Agricultural, Sciences & Technology of Jammu, Jammu-180009 (J&K)

Sh. Rajumor, VPO-Ludana, Distt. Jind, Haryana
Commissioner, Rohtak Division, Rohtak

Joint Director (Academic), NDRI Karnal

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Dr. J. K. Kaushik, PS, ABTC, NDRI, Karnal

Dr. A. K. Mishra, PS, LPM Section, NDRI, Karnal

Dr. A. K. Mohanty, PS, ABTC, NDRI, Karnal

Shri Suresh Chandel, Ex. Member of Parliament, House No. 70/5, Roura Sector-3, District, Bilaspur, Himachal Pradesh

DDG (Animal Sciences), ICAR

Head, Extension Division

Dr. K. K. Baruah, Former Director, ICAR-NRC on Yak, Dirang

Sh. Mukesh Anand, Keshav Gaushala, Anand Ashram, Village New Gothra, Tehsil-Khetri, Distt. Junjhunu, Rajasthan

Director (Finance), DARE

ACADEMIC COUNCIL

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Vice-Chairman : Joint Director (Academic)

Member Secretary : Joint Director, Admn. & Registrar, NDRI Deemed University

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Joint Director (Research)

Dr. N. P. Sahu, Dean (Academics), Principal Scientist & Head, Fish Nutrition, Biochemistry & Physiology Division, Central Institute of Fisheries Education, Andheri West, Mumbai

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DDG (Edn.), ICAR, KAB-II, New Delhi

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Dr. P. Barnwal, Head, DE Division

Dr. A. K. Tyagi, Head, AN Division

Dr. S. M. Deb, Head, AG&B Division

Dr. K. S. Kadian, Head, Dairy Extension Division

Dr. Rakesh Kumar, I/c FRMC

Dr. S. K. Tomar, Academic Coordinator

Dr. Rajesh Kumar, PS, DC Division

Dr. K. P. Ramesha, Head, SRS, Bengaluru

Mr. Sanjay Choudhary, Ph.D. 2nd Year (LPM Section)

Dr. Rashmi Aggarwal, Joint Director (Edu) & Dean, Indian Agricultural Research Institute, Pusa, New Delhi-110012

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Dr. G. Venkateshwarlu, Assistant Director General (EQR), (Agril. Education Division), New Delhi

Dr. Bimlesh Mann, Head DC Division

Dr. Sunita Grover, Head, DM Division

Dr. Dheer Singh, Head, ABC Division

Dr. Mahendra Singh, Head, AP Division

Dr. B. S. Chandel, Head, DES&M Division

Dr. Pawan Singh, I/c Livestock Production & Management

Dr. P. Palta, I/c ABTC

Dr. Jai Kaushik, PS, ABTC

Dr. A. P. Ruhil, PS, Computer & Controller of Examinations

Dr. T. K. Dutta, Head, ERS, Kalyani

Ms. Aditi Agrawal, M.Sc. 2nd year (DES&M Division)

RESEARCH ADVISORY COMMITTEE

Chairman: Dr. S. L. Goswami, Ex-Vice-Chancellor,

Banda University of Agri. & Technology, ZC-590, Chd City, Karnal

Members

Deputy Director General (AS), ICAR, New Delhi

Dr. D. Kathiresan, Ex-Dean, College of Veterinary Science & Animal Husbandry, CVSc & AH, Aizawl

Director, TVCC, Apollo College of Veterinary Medicine, AGRA Road Near Chandmahal Garden Hotel & Poultry Farm, Jaipur

Sh. Rajumor, VPO Ludana, Jind, Haryana

Sh. Mukesh Anand, Keshav Gaushala, Anand Ashram, Vill New Gothra, Khetri, Jhunjhunu, Rajasthan

Director, NDRI, Karnal

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Dr. Seema Bathla, Professor (Agri. Economics), Centre for the Study of Regional Development, School of Social Sciences, Jawaharlal Nehru University, New Delhi

Dr. V.P. Reddy, Dean, Dairy Science, Sri Venkateswara Veterinary University, Administrative Office, Dr. YSR Bhawan, Tirupati, Andhra Pradesh

Member Secretary : Joint Director (Res.)

EXTENSION COUNCIL

Chairman : Director, NDRI, Karnal

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DDG (Extension Education), ICAR, New Delhi or nominee

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Dr. Ashutosh, I/c, Forage Production Section

Dr. A. K. Misra, PS & I/c, ATIC

Dr. A. K. Singh, PS & I/c, BPD Unit, DT

Agriculture Commissioner, Govt. of India, Ministry of Agriculture, Krishi Bhawan, New Delhi

Director (Farm Information), Directorate of Extension, Govt. of India, New Delhi

Joint Director (Res.)

Dr. S. S. Lathwal, I/c, LRC

Dr. B. S. Chandel, PS, DES&M Division

Dr. T. K. Mohanty, PS & I/c, ABRC

Dr. A. K. Tyagi, Head, AN Division

Head, ERS of NDRI, Kalyani

Director General, Department of Animal Husbandry & Dairying Govt. of Haryana, Panchkula or nominee

Member Secretary: Dr. K. S. Kadian, Head, Dairy Extension Division



NEW INITIATIVES IN RESEARCH, TEACHING AND EXTENSION

NDRI is a prestigious Institute that caters to the research and human resource needs of the dairy sector of the country. It is expected that by 2050 the milk production will be increased to the tune of 400 million tonnes/year. The population pressure and emerging global opportunities further necessitate that the efforts for enhancing animal productivity and milk processing are accelerated in the following areas:

- 1** Genetic improvement of dairy animals through genomic semen sexing and strengthening of Institute's bull mother farm.
- 2** Technologies for economic production of nutrient-balanced ration for dairy animals to address the issue of feed and fodder scarcity.
- 3** Development of new generation methods to assess quality and safety of milk and milk products.
- 4** Development and validation of health promoting dairy foods to address nutritional and health security issues.
- 5** Linking rural youth, women and other target groups to markets through skill and entrepreneurship development programmes.
- 6** Strengthening outreach programmes for doubling farmers' income.
- 7** Strengthening HRD programme at the Institute with greater focus on quality and employability together with establishment of stronger international linkages.

RESEARCH ACHIEVEMENTS

BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY

Birth of Cloned Calves



Figure: Three cloned calves produced using donor cells of an elite bull

Treatment of Cloned Embryos with Dickkopf-1 Improved their Developmental Competence, Quality and Live Birth Rate

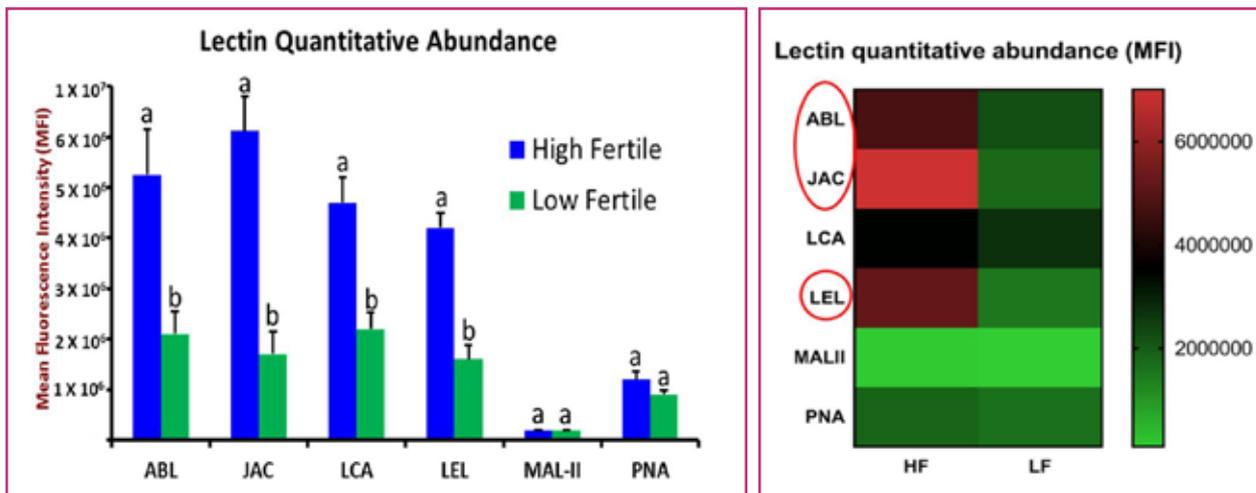
The low live birth rate obtained with cloned embryos limits the application of this technology on a large scale. This study was aimed at improving the developmental competence, quality and live birth rate of cloned buffalo embryos by treating them with Dickkopf 1 (DKK1), an inhibitor of canonical WNT signaling pathway and colony stimulating factor 2 (CSF2), an embryokine. Following supplementation of the *in vitro* culture medium on day 5 with DKK1 (100 ng/ml), CSF2 (10 ng/ml), DKK1+CSF2 and no supplementation (control), the blastocyst rate was higher ($P < 0.05$) with DKK1 and DKK1+CSF2 than with CSF2 or controls. The apoptotic index of the blastocysts was lower ($P < 0.05$) for all the treatment groups compared to controls, and was similar to that in the IVF blastocysts. Although the total cell number was similar for all the treatment groups and the control group, the inner cell mass:trophectoderm cell number ratio of DKK1, CSF2 and DKK1+CSF2 groups was higher ($P < 0.05$) than that of controls and was similar to that of IVF blastocysts. Treatment with DKK1 or CSF2 or both increased ($P < 0.05$) the expression level of *OCT4*, *NANOG*, *SOX2*, *GATA6*, *BCL2*, *PTEN*, *P53*, *FGF4*, *GLUT1* and *IFN- τ* , and decreased that of *C-MYC*, *CDX2*, *CASPASE*, *DNMT3a*, *TCF7* and *LEF1* in blastocysts, compared to controls. Transfer of DKK1-treated embryos to 13 recipients resulted in 4 pregnancies (30.8%, 2 live births and 2 at 7 months of pregnancy) whereas, transfer of DKK1+CSF2-treated embryos to 16 recipients resulted in 4 pregnancies (25.0%, all of which resulted in live birth). No pregnancy was obtained following transfer of control and CSF-treated embryos to 12 and 16 recipients, respectively. These results suggested that DKK1 treatment of NT embryos increased the blastocyst, conception and live birth rate, and improved their quality whereas, CSF2 treatment, did not affect the blastocyst, conception and live birth rate despite improvement in embryo quality.

Production of Pig Embryos by Hand-Made Cloning Technique

Usable quality pig oocytes were *in vitro* matured in IVM medium (TCM-199 + L-Glutamine (0.68 mM) + sodium pyruvate (0.8 mM) + pFSH (2.5 mg/ml) + LH (10 μ g/ml) + estradiol 17- β (1 μ g/ml) + FBS (10%) + EGF (10 ng/ml) + ITS (10 μ l/ml) + gentamicin (50 mg/ml) + 5% follicular fluid for 44 h in a humidified CO₂ incubator (5% CO₂ in air) at 38.5°C. The maturation rate was found to be 72.6 \pm 5.1% on the basis of cumulus expansion and presence of polar body. The matured oocytes were treated with hyaluronidase (0.5 mg/ml) and pronase (2.0 mg/ml) for 3 min and 1 min, respectively. The electrofusion was carried out using 1.6kV/cm for 4 μ s. A total of 257 reconstructs were produced using pig fetal fibroblast cells as donor cells. The activation protocol included treatment with 5 mM calcium ionophore for 20 min followed by 6-DMAP for 4 h. The blastocyst rate on day 8 post activation was found to be 5.62 \pm 1.42%. Further work is being carried out to improve the blastocyst rate.

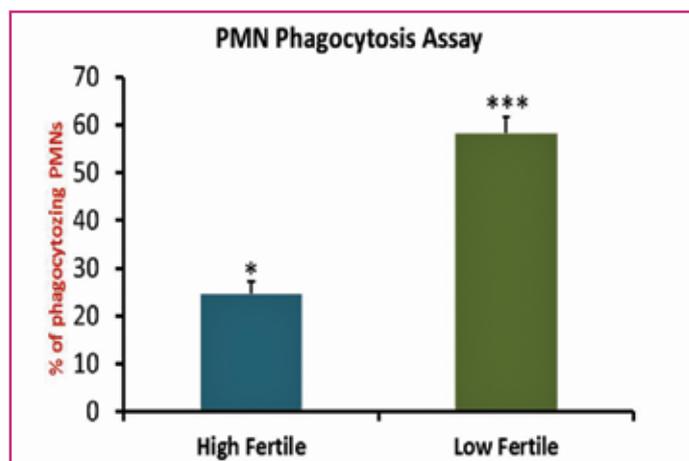
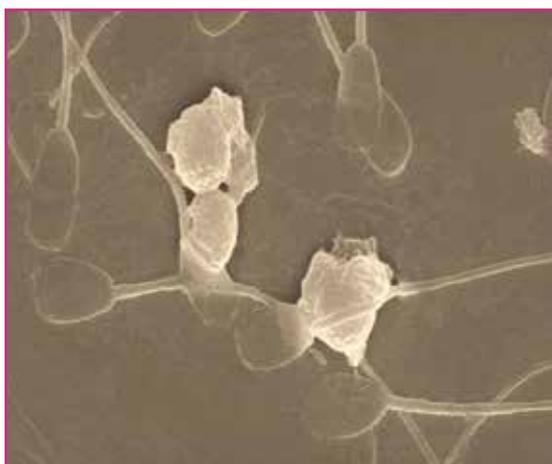
Pre-selection of Buffalo Spermatozoa for their Fertilizing Ability Based on Differential and Spatial Distribution of Glycan Moieties on Sperm Surface

Experiencing a wide variation in the conception rate after use of frozen semen from eligible breeding bulls is common. A strategy to preselect the spermatozoa for their fertilizing ability will help reduce pregnancy losses. Lectins are a group of glycoproteins having strong affinity with glycan moieties on the surface of spermatozoa. Buffalo spermatozoa were assessed for distribution and abundance of surface glycans by utilizing specific lectins. Frozen buffalo semen from high (HF) and low fertile (LF) bulls were utilized to assess the binding and abundance of six lectins viz., ABL, JAC, MAL II, LEL, LCA and PNA using lectin cytochemistry. These lectins were found to display distinct spatial binding pattern on sperm surface. Four lectins namely ABL, JAC, LCA and LEL were differentially abundant among these two groups of sperm populations. Also, after capacitation, the quantitative removal-pattern of two lectins viz. ABL and JAC, differed significantly between HF and LF bulls signifying their role in imparting sperm fertilizing ability. The Mean Fluorescence Index (MFI) for ABL and JAC also reduced significantly after de-glycosylation of sperm surface.



Mean Fluorescence Index (MFI) of six different lectins viz. ABL, JAC, LCA, LEL, MALII & PNA in spermatozoa of high (HF) and low fertile (LF) buffalo bulls

Incidentally, all of these differentiating lectins were found to belong to the O-linked glycan group having strong possibility of providing them immunoprotection in female reproductive tract. An *in vitro* sperm-immune challenge model was developed to assess the differential immunoprotective ability of sperm from HF and LF bulls. The results revealed elevated rate of two destructive phenomena of PMNs viz. phagocytosis and NETosis, for LF bulls as compared to HF during the sperm-PMN challenge assay. In addition, there was a significant increase in these two sperm phagocytosis and netosis phenomena for sperm destruction when the spermatozoa surface was de-glycosylated using O-glycosidase along with neuraminidase (for O-linked glycans). The results also suggested the importance of intact sperm glycocalyx for imparting sperm immunoprotection. The current findings clearly indicated that a major role of O-linked glycans in immune-evasion of sperm in the FRT and differential abundance of glycans by utilizing specific lectins i.e. ABL, JAC could offer an easy tool to assess bull fertility.



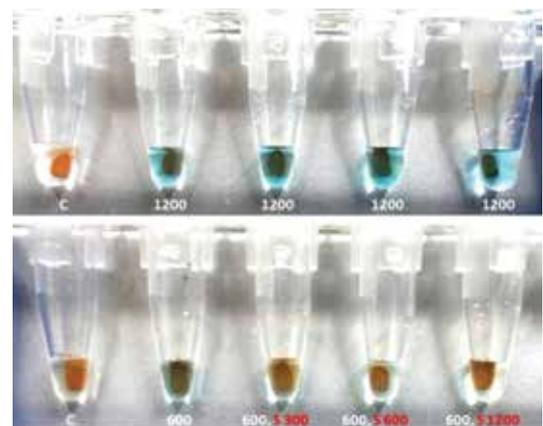
Phagocytosis of sperm by PMN cells & phagocytosis rate (%) for High and Low fertile buffalo bull spermatozoa

Quantitative Proteomic Analysis of Proliferating vs Differentiated Buffalo Mammary Epithelial Cells (BuMEC) Revealed Novel Proteins Involved in Lactogenesis

The lactating mammary gland is comprised of numerous matured alveoli with their lumen surrounded by layers of differentiated luminal mammary epithelial cells (MECs) exclusively involved in milk synthesis and secretion. The number as well as the extent of differentiation in MECs decides the lactation yield of an animal. This study investigated the temporal expression of differentially regulated proteins in BuMEC line (developed previously in our laboratory) at different time points of lactogenic differentiation in vitro using TMT labeling-nano LC approach. TMT-based proteome analysis identified 681 differentially expressed proteins (DEPs) (50 ppm error, 1% FDR) of which, 654 and 28 proteins were up- and down-regulated with a fold change of ≥ 1.5 (1.5 to 88.15 FC) and ≤ 0.6 (0.6 to 0.05), respectively, in at least one of the four time points of treatments. The DEPs showed high heterogeneity in their level of expression at four time points (3, 6, 12 and 15 days) of treatment. Most of the DEPs were in abundance after 12 days of treatment. Bioinformatics analysis suggested that the upregulated DEPs were enriched in metabolic, cell-cell and cell-ECM interactions, cytoskeletal rearrangements, ribosomal and splicing activities, whereas, the downregulated DEPs were associated with the focal adhesions. The study found few overexpressed proteins including ABCA13, IVL, and FABP4 for the first time in BuMECs. Of these, the involvement of IVL in differentiation was established through chemical inhibition assay. These findings advance current understanding of differentiation in BuMECs and correlated their significance in the lactation process.

Development of Pregnancy-associated Glycoprotein (PAG)-based Diagnostic Assay for Early Detection of Pregnancy in Bovine

A simple strip based device which can diagnose pregnancy in cattle and buffalo at the farmer's doorstep is urgently required. PAGs are potential pregnancy biomarkers in farm animals since they are secreted from conceptus and are present in maternal circulation from days 22 to 28 after fertilization. Different isoforms of PAGs were successfully cloned and expressed following recombinant purified proteins and their immunogenic peptides were used for generating antibodies in rat and rabbit models. The polyclonal and monoclonal antibodies produced against PAGs were examined for their suitability as diagnostic markers of early pregnancy. PAG antigen-antibody interaction studies were done by dot blot/western blot and SPR. Best interacting antibodies were further used for development of ELISA and LFA assay. A proof-of-concept was developed for early diagnosis of pregnancy in bovine.



Development of PAG based proof of concept for early detection of bovine pregnancy

Recombinant Buffalo Sperm Lysozyme Like Protein 5 (SPACA5) Expressed in *Pichia Pastoris* Yeast Showed Binding with Oocytes

Lysozyme-like proteins are present on the surface of sperm and are known to help it fuse with the oocyte. Lysozyme-like protein 5 (Lyzl5) was cloned and expressed in yeast expression system. The recombinant Lyzl5 was expressed in a 3L fermenter vessel and purified by affinity chromatography. Lyzl5 showed a molecular weight of 15 kD and two bands, which could be due to differential glycosylation of the protein in the yeast system. The two bands were confirmed to be Lyzl5 by western blotting and mass spectrometry analysis. The purified Lyzl5 showed

strong binding with the zona pellucida of buffalo oocytes. Lyzl5 can be expected to compete with sperm for binding to the oocytes. The work should help in revealing the role of Lyzl5 and discovering the respective receptors on oocyte for regulating animal fertility.

Quantitative Proteomics for Discovery of Proteins Contributing to the Freezing Potential of Semen of Cross-bred Cattle

Semen samples were collected from Karan Fries cattle bulls having high and low semen freezability for investigating its relationship with seminal plasma and sperm proteins. Following extraction of proteins using different methods, label-free quantitation experiments were performed using EASY-nLC 1000 system coupled to Thermo Fisher-QExactive equipped with nanoelectrospray ion source. Analysis of differentially expressed proteins in sperm and seminal plasma of semen between high and low freezability groups provided approximately 200 and 420 significantly upregulated (>2.0 fold) proteins, respectively. Among these, around 25 sperm proteins and 17 seminal plasma proteins were found to be up-regulated with ≥ 2.5 fold change. The upregulated proteins included folate receptor, NADH dehydrogenase, serine-threonine kinase, ATPase, cell cycle control proteins, tissue factor pathway inhibitor, dipetidyl peptidase 4 protein. The differentially expressed proteins were found to be associated with metabolic pathways, lysosomal process, complement pathways, glycolysis, antigen/protein processing and presentation, PI3K-AKT and MAPK signaling pathways etc. Gene ontology classifications showed that the proteins are involved in biological adhesion, regulation, cellular process, localization, immune process, metabolic process and developmental processes. Further analysis should help in discovering proteins responsible for high semen freezability for improving cryoprotection of semen against freezing.

Treatment of Mastitis and Metritis using of Mesenchymal Stem Cells (MSCs) in Cattle

Mastitis and metritis in dairy cattle and buffaloes reduce milk yield and fertility leading to immense economic losses. This study aimed at treating these diseases in cattle by treatment with MSCs. MSCs isolated from the adipose tissue of a cow were characterized by confirming the expression of specific markers viz. alkaline phosphatase, CD73, CD90 and CD105 and absence of CD34, CD45 and CD79a. MSCs were injected through local and intravenous routes. Following treatment of cattle suffering from mastitis MSCs, inflammation and wounds were examined on day 1, 3, 7, 15 and 26. Animals suffering metritis were also examined in a similar manner and uterine fluid was analyzed at above mentioned time intervals. Real time-PCR analysis revealed that in the animals suffering from mastitis, the relative expression of genes for proliferative factors, anti-inflammatory cytokines and antimicrobial peptides was significantly higher in animals given local injection compared to the intravenous and control groups. The somatic cell count was also decreased in both local and intravenous treatment groups than the control group. The expression of these genes in intravenous group of metritis was significantly higher compared to the local treatment group and the control group. The turbidity of cervical fluid and mucus was highly reduced in intravenous, compared to the local group. All the animals were cured completely. This demonstrates the potential of MSCs for treatment of mastitis and metritis in cattle.



Before treatment of mastitis with MSCs



60 days after treatment with MSCs

Antibiotic Resistance Pattern in Mastitis-Causing Bacteria in Karnal District

Antimicrobials are used in cattle and buffalo for prevention and control of mastitis and other bacterial diseases. Antimicrobial resistance (AMR) occurs when microorganisms are able to overcome effects of antimicrobials that were effective otherwise. The prevalence of AMR in mastitis pathogens was investigated in Karnal district of Haryana. A total of 392 milk samples of animals suffering from clinical mastitis were obtained from five veterinary hospitals of Karnal district (Karnal city, Nilokheri, Gharaunda, Assandh and Nissing) for identification and isolation of resistant

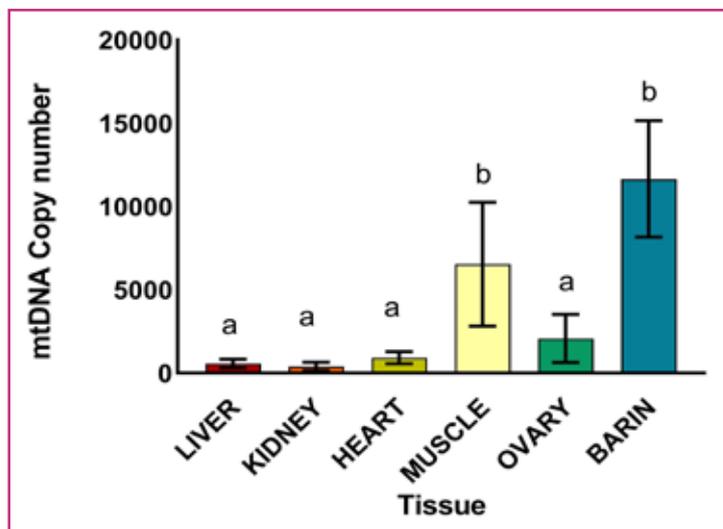
bacterial pathogens using around 30 different antibiotics. The most commonly used injectable antibiotics showed high level of resistance compared to less commonly used ones. Gentamicin showed least resistance whereas, Cephalosporins and Penicillin, showed high resistance. Enrofloxacin showed higher resistance and Tetracycline showed moderate resistance. This information allowed us to identify the prevalence of AMR pathogen in a specific area and their suitable antibiotic therapy accordingly.

Genetic Variation in AS2 Casein (CSN1S2) of Indian Goats

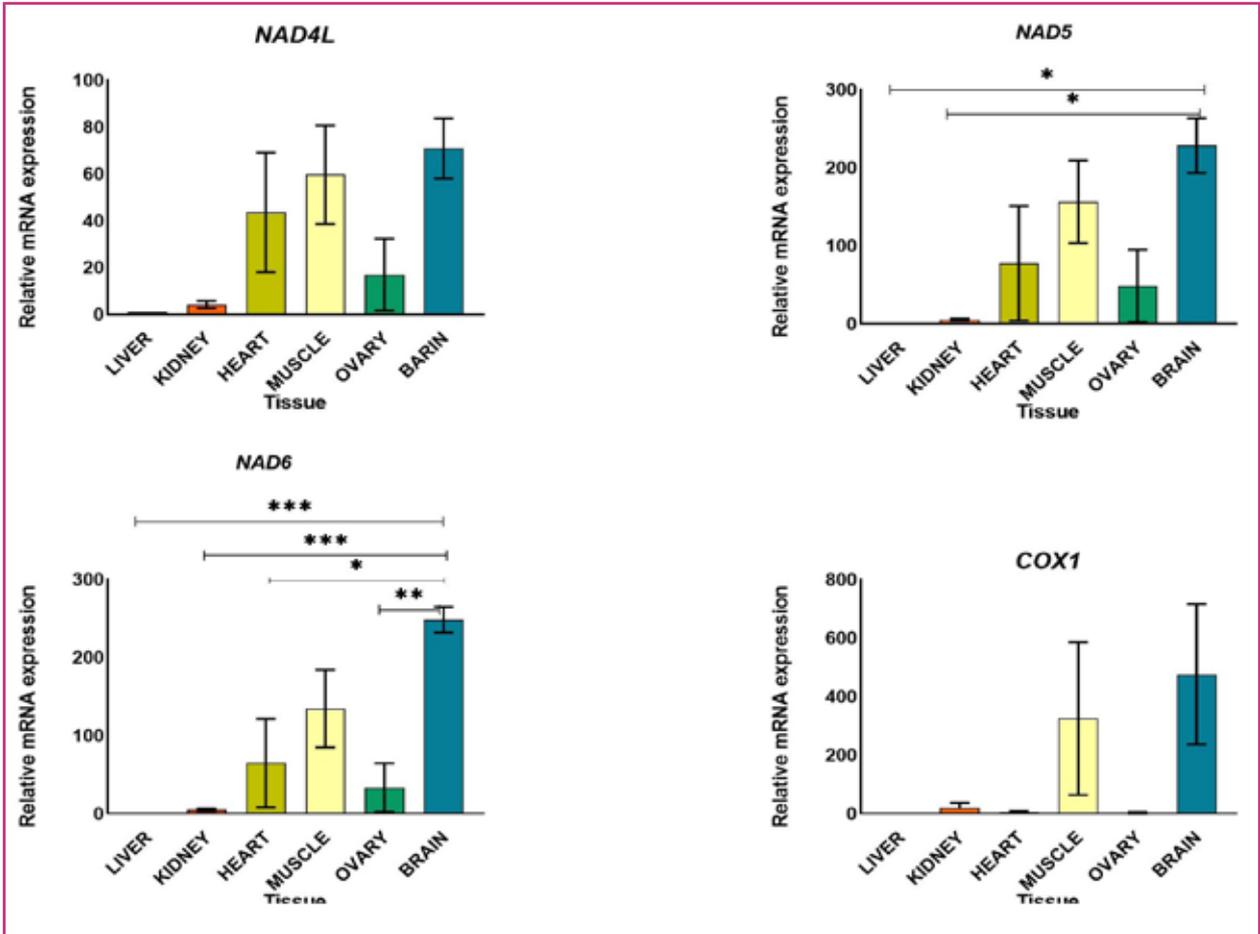
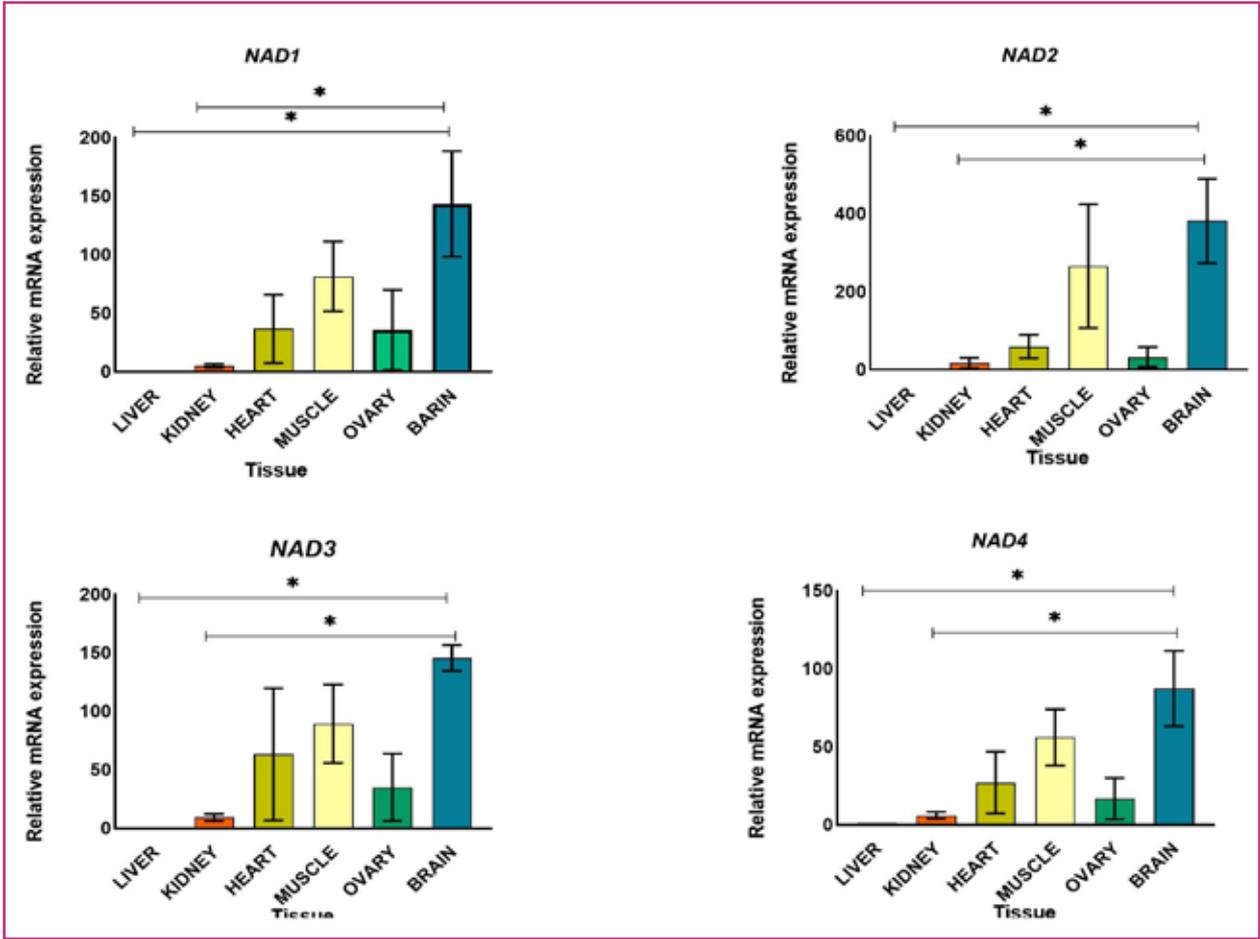
Goat milk is preferred over cattle and buffalo milk for its easy digestibility and unique fatty acid composition. Many unexplored components of goat milk are also attributed to a number of health benefits in human. Thus, to explore the genetic variability of Indian goat milk, the present work was initiated. Milk is having four casein fractions: alpha casein 1 (aS1), alpha casein 2 (aS2), beta and kappa casein. Variations in as2 (*CSN1S2*) gene were detected in six Indian goat breeds namely Bakarwali, Sirohi, Osmanabadi, Marwari, Jakhrana, Chegu and one non-descript goat of Jammu. Three common alleles A, B and C were found present in these breeds of goats which were reported earlier. Altogether seven new as2 variants were identified from Marwari, Jakhrana, Bakarwali and Osmanabadi breeds of goat.

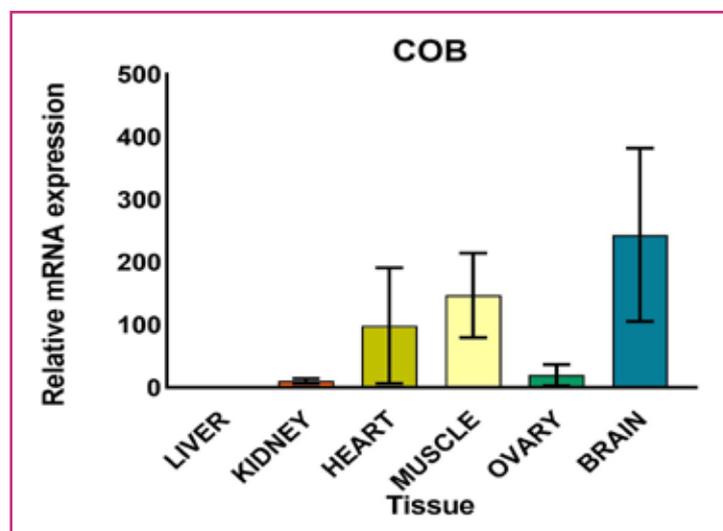
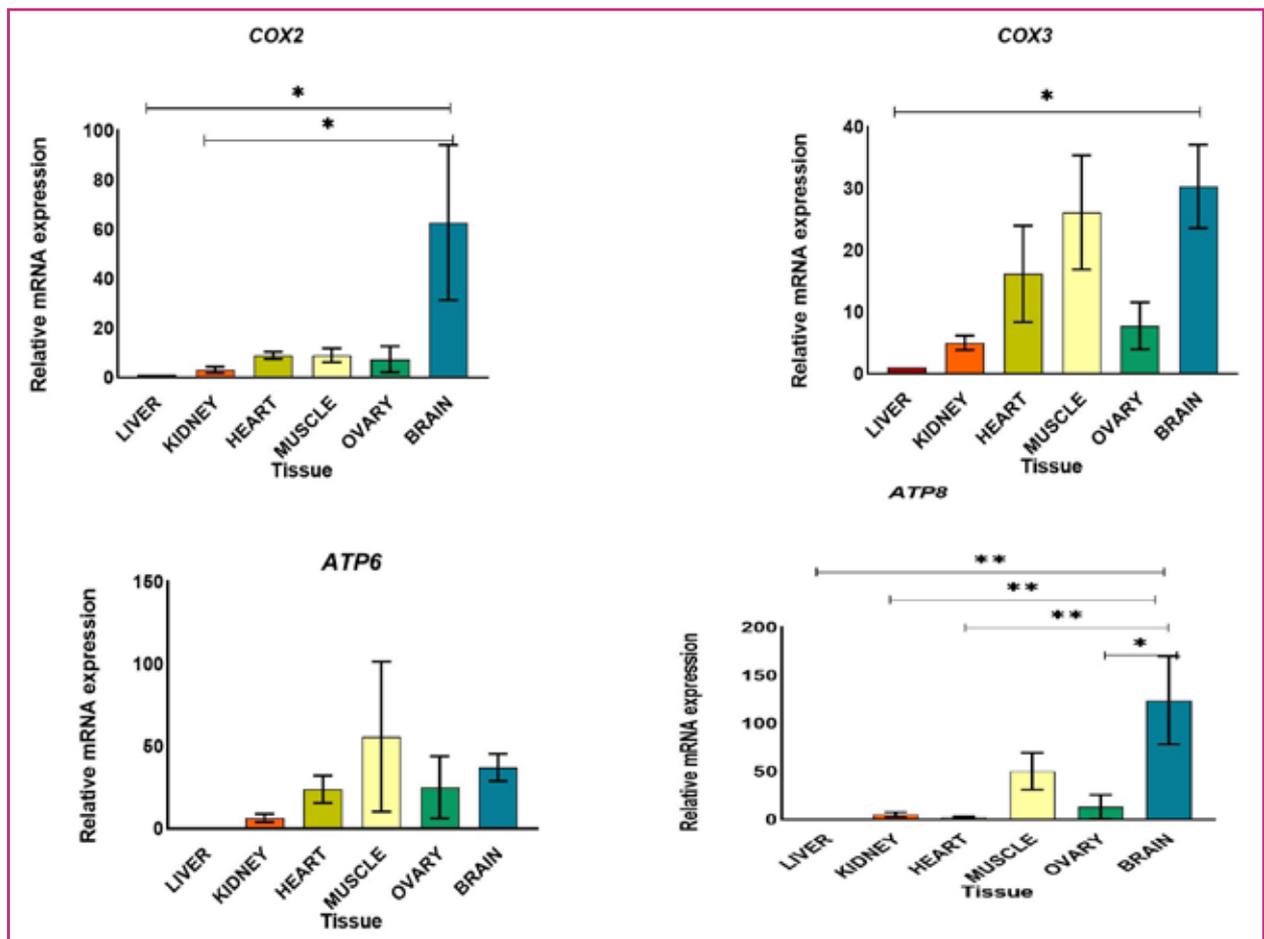
Tissue Heterogeneity of Mitochondrial DNA content and Mitochondrial Genes Expression in Buffalo

It was investigated, whether any tissue-specific difference exists on mitochondrial DNA (mtDNA) copy number and 13 protein-coding mitochondrial encoded gene expression from six different tissues (liver, kidney, heart, muscle, ovary, and brain) of adult buffalo. The liver, kidney, heart, muscle, ovary, and brain of the same slaughtered buffaloes ($n = 4$) were collected according to strictly defined sample collection protocols from the slaughterhouse. The tissue-specific differences in mtDNA copy numbers were measured by qPCR with SYBR detection using primers specific for the mitochondrial *tRNA Leu* (UUR) gene and the single-copy nuclear β -2-microglobulin (β 2M) gene. Expression analysis of 13 protein-coding mitochondrial encoded genes namely *NAD1*, *NAD2*, *NAD3*, *NAD4L*, *NAD4*, *NAD5*, *NAD6*, *COX1*, *COX2*, *COX3*, *ATP8*, *ATP6*, and *COB* was analyzed in six tissues by *qRT-PCR* using gene-specific primers. It was observed that a strict tissue specificity of mtDNA copy number, with muscle and brain tissues showed the highest values ($P < 0.05$). Relative mRNA abundances of *NAD1*, *NAD2*, *NAD3*, *NAD4*, and *NAD5* were significantly higher in the brain as compared to the liver and kidney. Whereas, there were no differences ($P > 0.05$) between heart, muscle, ovary, and brain for *NAD1*, *NAD2*, *NAD3*, *NAD4*, and *NAD5* transcripts. No differences ($P > 0.05$) in relative mRNA abundance of *NAD4L* were observed between tissues. Relative mRNA abundance of *NAD6* in the brain was greater ($P < 0.05$) than that of the liver, kidney, heart, and ovary. No differences ($P > 0.05$) in the relative mRNA abundance of *COX1* were observed between tissues. Although a similar pattern of *COX2* expression was observed between tissues, the transcription level of *COX2* was higher ($P < 0.05$) in the brain as compared to the liver and kidney. Relative mRNA abundance of *COX3* was non-significant among different tissues, except the liver and brain. Relative mRNA abundance of *ATP8* in the brain was greater ($P < 0.05$) than that of the liver, kidney, heart, and ovary. There were no differences ($P > 0.05$) in the relative mRNA abundance of *ATP8* between the brain and muscle. No differences ($P > 0.05$) between the investigated tissues were found in the relative mRNA abundances of *ATP6* and *COB*. It was inferred that there was a tissue-specific pattern of variation in mitochondrial DNA copy number and mitochondrial gene expressions from buffalo.



mtDNA copy number in six tissues of four animals calculated by qPCR. The data are presented as the mean \pm SEM ($n = 4$). Bars with different superscripts were significantly different ($P < 0.05$)





Relative mRNA expression levels of 13 protein-coding mitochondrial encoded genes in six tissues of four animals. Relative mRNA levels were determined with RT-qPCR and results are shown as mean \pm SEM. Asterisks indicate significant differences between tissues ($P < 0.05$).

Mitochondrial DNA Haplotypes, and Haplotype-Specific Variation in Mitochondrial DNA Copy Number in Buffalo

The sequencing of D-loop region of the mitochondrial genome of 106 buffaloes was done to identify the different mitochondrial DNA (mtDNA) haplotype of buffaloes. The sequenced data of 103 samples were deposited in GenBank under the accession numbers MN610371-MN610389; MT073113-MT073196. A total of sixty haplotypes were identified which were nomenclatured from Haplotype 1 to Haplotype 60, respectively. The length of the mtDNA D-loop used for determining the haplotypes ranged from 842 bp to 845 bp. A total of 73 polymorphic sites were identified that distinguished the haplotypes, the number of repeatabilities were highest for haplotype

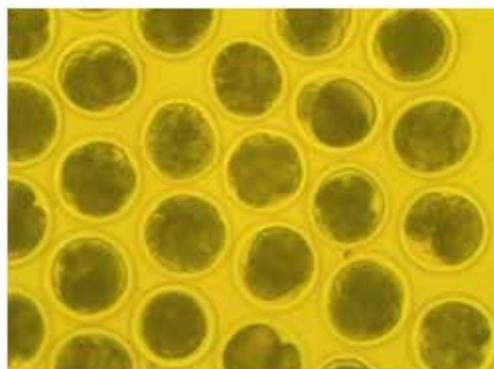
5 and 18 that occurred 7 times followed by haplotype 23 which occurred 6 times. Further, for the quantification of mtDNA haplotype-specific copy number, haplotype-specific eight different ovarian tissues were selected based on the frequency of occurrence (>3 times) observed from our study i.e. Haplotype 2, 5, 18, 23, 25, 35, 44 and 60. A haplotype-specific pattern of variation in mitochondrial DNA copy number was found from buffaloes. There were significant statistical differences amongst haplotypes (range $P < 0.05$ to $P < 0.0004$). Haplotype 5, Haplotype 18, Haplotype 23 and Haplotype 25 possessed significantly more copies of mtDNA (1391.8339 ± 658.8256 ; 2322.4365 ± 127.5941 ; 1886.9987 ± 892.0020 ; 1267.224 ± 212.5198 , respectively) than Haplotypes 2 (190.601 ± 60.8030), Haplotype 35 (326.0422 ± 51.3321), Haplotype 44 (213.0273 ± 28.1577), and Haplotype 60 (349.4036 ± 22.9662). Although there were no significant differences ($P > 0.05$) identified amongst Haplotype 2, Haplotype 35, Haplotype 44 and Haplotype 60, Haplotype 2 and Haplotype 44 recorded the lowest mtDNA copy number. It was found that there is a haplotype-specific pattern of variation in mitochondrial DNA copy number from buffalo.

CRISPR/CAS9 Guided Functional Analysis of Genes Regulating Early Embryonic Survival in Buffalo

Targeted genome editing by CRISPR/CAS9 for Cox2 gene towards unravelling relevant associated pathways governing early embryonic survival in buffalo was attempted. Primers were designed for the buffalo COX2 gene covering the entire coding sequences. Recombinant Taq DNA Polymerase (RT) and Phusion High-Fidelity were used for PCR analysis. Out of ten sets of primers, three primers amplified the expected amplicon sizes. COX2 1 primer amplified the expected amplicon fragment of 880 bp with high-fidelity enzyme. COX2 3 and COX2 4 primers amplified fragments of 449 and 484 bp with both high-fidelity and recombinant DNA polymerases. A 484 bp of COX2 gene fragment was used as an insert to clone in pDrive vector. Colony PCR was performed, three out of ten colonies were positive for colony PCR. Further plasmid DNA was extracted from the colonies and a plasmid PCR was executed; three out of ten colonies were positive for plasmid PCR also. Plasmids were sent for sequencing for the further confirmation of the clone. Simultaneously, a 449 bp of COX2 PCR product was cloned in the pDrive vector. For the backbone cloning construct, (2A-Puro) puromycin resistance gene and Green Fluorescent Protein (GFP) to allow screening or selection of transfected cells. Guide RNA was designed for the COX2 gene based on CRISPR direct, E-CRISP and Chop Chop software and further the gRNA was scrutinized for their OFF-TARGET effects.

In Vitro Embryo Development from Immature Cattle Oocytes Supplementing Media with Platelet Derived Growth Factor

The aim of this study is to improve the production of *in vitro* cattle embryos using platelet derived growth factor as a maturation media supplement. For the present study fresh cattle ovaries and oviducts were collected from local abattoir in saline solution (30-35 °C) supplemented with antibiotics and transported to the laboratory within 2-3 h of animal slaughter. Cumulus oocyte complexes were collected from slaughterhouse ovaries by aspiration method with 19 gauge hypodermic needle, washed 5-6 times and cultured in maturation media for 24 h. in 5% CO₂ incubator at 38.5 °C with maximum humidity. After 24 h of culture, matured oocytes were co-incubated with *in vitro* capacitated sperms for fertilization in Fertilization Bracket Oliphant media at 38.5 °C in 5% CO₂ in air with maximum humidity for 15-18 h for fertilization. After co-incubation, surrounding cumulus cells were stripped off by repeated gentle pipetting by fine pipette, presumptive zygotes were cultured for embryo development. After 40-42 h cleavage was observed and embryos were co-cultured with oviductal cells for 7-9 days in same environmental conditions. Culture media used to replace with fresh media after every 24 h. In this study, platelet derived growth factor was supplemented in maturation media with three different concentrations. In the present study platelet derived growth factor @ 10 ng/ml supplementation with the culture media enhanced cleavage rate as well as blastocyst formation rate for *in vitro* cattle embryo development as compare to control group.



Cattle embryos produced through *in vitro*



GENETIC IMPROVEMENT OF DAIRY ANIMALS

Indigenous Cattle Improvement Programme

Sahiwal Cattle

Sire evaluation and germplasm dissemination under Indigenous Breed Improvement Programme- Sahiwal has been carried out from three set of bulls (total 25 in number) from 2010 onwards. From Feb 2019 fourth set consisting of 10 breeding bulls was inducted. The female herd strength was 442 including 196 breedable females as on 31.12.2019. A total of 37 growing males and breeding bulls were available at the Germplasm Unit. During the year 2019 there were a total of 103 normal calving, out of which 56 males and 47 females were born.

The average age at first calving (1176.55 ± 28.96 days), first lactation milk yield (FLMY) (2210.34 ± 126.50 kg), Total Lactation milk yield (2219.83 ± 90.29 kg), peak yield (10.59 ± 0.54 kg), lactation length (288.0 ± 14.13 days), dry period (140.18 ± 12.39 days) and calving interval (377.42 ± 14.92 days) and service period (128.17 ± 7.62 days) was observed with wet average (7.87 kg) and dry average (3.12 kg). The peak yield of elite Sahiwal cow (SW 2233) was 23.5 kg with 305 days milk yield and total milk yield (TMY) as 3854 kg and 4220 kg, respectively.



Sahiwal Bull at Germplasm Unit-NDRI



Sahiwal Cow SW 2233 Peak Yield 23.5 kg

Males were initially screened on the basis of expected predicted difference (EPD), dam's best 305 days lactation yield, breed characteristics and physical conformity for selection of young male calves for future breeding. A total of 10 males were selected in Bull screening meeting. EPD % of the selected males was 5.18% and average of Dam's best Lactation Yield was 3180.83 kg against herd average of 2210 kg.

Based on Jan, 2019 expected producing ability (EPA), a total of 34 out of 196 Sahiwal females were identified as elite cows (either 305 days-first lactation yield (FLY) equal to or greater than 2500 kg or best 305-day lactation yield (LY) equal to or greater than 3000 kg). The average of Best 305-LY, average LY and EPA were 3137 kg., 3460 kg and 2128 kg against herd average of 2210 kg and average EPA of 2086 kg.

A total of 7680 doses of frozen semen from 6 bulls of Set-III were produced during the period (Jan-Dec, 2019). Semen doses were supplied to DRU units at GADVASU, Ludhiana, GBPUA&T, Pantnagar and LUVAS, Hisar for AI at those centres. During the period (Jan-Dec, 2019), around 251 and 4385 doses of bulls of high genetic merit under set II, III were supplied to farmers/ developmental agencies through sale in addition to supply of semen for Institute extension/ other activities.

Gir Cattle

The herd strength of females of Gir cattle was 133. Performance traits recorded with average of: TMY (kg), 305 day milk yield (kg), lactation length (days), age at first calving (months), calving interval (days), wet average (kg) 1570, 1438, 296, 38.3, 453, 3.24 and average milk Fat%, SNF%, Protein%, Lactose% were 4.49, 8.87, 3.43, 4.65 for

Gir cows. Overall Conception Rate in Gir was achieved as 46.52%. Best 305 day milk yield was recorded as 2232 kg for Gir (G 21) cow.

Germplasm Production and Dissemination of Gir Bulls

Selection of males: A total of 1 male was reserved for breeding based on dam's best lactation yield, EPD, growth and libido. Dam's best lactation milk yield was 2156 kg.

Germplasm production and dissemination: Presently there are 9 breeding bulls being reared at ABRC for imparting training for semen donation or are under regular semen collection. A total of 9840 doses of frozen semen were produced from high pedigree/ genetic merit bulls of Gir cattle. A total of 9401 doses of frozen semen were supplied to farmers/ developmental agencies.

Tharparkar Cattle

The herd strength of Tharparkar cows was 138. Performance traits recorded with average of: total milk yield (kg), 305 day milk yield (kg), lactation length (days), age at first calving (months), calving interval (days), wet average (kg), milk Fat%, SNF%, Protein%, Lactose% were 1553.5, 1548, , 248, 39.25, 462, 4.8, 4.39, 8.87, 3.3, 4.41 for Tharparkar cows. Overall Conception Rate in Tharparkar cattle was achieved as 41.66%. Best 305 day milk yield was recorded as 2656 kg for Tharparkar (TP 1274) cow.

Germplasm Production and Dissemination of Tharparkar Bulls

Selection of males: A total of 3 out of 15 males were reserved for breeding based on dam's best lactation yield, EPD, growth and libido. Dam's best lactation milk yield ranged from 2179 to 2656 kg.

Germplasm production and dissemination: There were 17 breeding bulls being reared at ABRC for imparting training for semen donation or are under regular semen collection. A total of 14210 doses of frozen semen were produced from high pedigree/ genetic merit bulls of TP cattle and supplied to farmers/ developmental agencies for genetic improvement of cattle.

Murrah Buffaloes Improvement:

Network Project on Buffalo improvement-Institute Herd

Murrah herd strength was 479, which comprised 387 females and 91 males. A total of 52.3% Murrah buffaloes were in milk with wet and herd average of 6.7 kg and 3.5 kg, respectively. During the period, average best lactation milk yield of 48 elite Murrah buffaloes was 3067 kg, and dam's best 305 day milk yield of selected bulls ranged from 3,015 to 4024 kg. Average Age at First Calving (AFC), Service Period, Dry Period and Calving Interval recorded were 45.6 months, 135 days, 242 days and 546 days, respectively. The overall conception rate (CR) of 37.45% was recorded during the period in institute buffalo herd; further the conception rates for heifers, first calvers and multiparous animals were recorded as 40.74%, 39.21% and 30.88%, respectively. Four breeding bulls were selected for test mating under Set-XVIII, and three breeding bulls were preliminary selected for 19th Test Mating. A total of 17397 doses of frozen semen were produced from four bulls of 18th set.

Field Progeny Testing Programme for Buffaloes:

Network Project on Buffalo improvement

A total of 4378 AI were performed using semen of Murrah bulls under field conditions and as a result 45.57% conception rate was obtained. As many as 15 breeding bulls belonging to the 18th set were used for AI during the year. Across the villages, the highest conception rate (48.48%) was observed in Shekhpura and lowest (41.93%) was observed in the Rindal village. To find out the seasonal effect, conception rate was observed in each month, which ranged from 42.95% to 52.38% in June & February, respectively. Highest conception rate 52.42% was observed in GADVASU 2689 among all the bulls used during this period. A total of 1421 Murrah buffalo calves (820 males and 601 females) were born in the farmers' herds and performance data on 83 daughters had successfully completed their first lactation recording. The records of daughters under field conditions will



Highest yielder (Buffalo) under Network Project (Field Unit)

be used for the genetic evaluation of Murrah breeding bulls. Highest milk recording in any day of lactation was found to be 16.2 kg in daughter number NWP 626 (Sire H4324 of 15th set) at Kheri Maan Singh village during this period.

Genome-wide Association Studies to Identify SNPs Associated with Persistency and Production in Murrah buffalo

An attempt was made to identify SNPs for milk production and some reproduction traits using a reduced representation (ddRADseq) approach and raw sequence reads were obtained to identify and annotate the genome wide SNPs. A set of double digest RAD-Seq libraries were constructed for each animal, and data of sequence reads was generated in 10 random samples of Murrah buffaloes. The bioinformatics analysis of ddRAD Seq data was done to remove low quality reads and trimming of adaptors. The high quality reads were aligned and mapped. The aligned sequences were used to identify SNPs in persistent and high productive buffaloes based on Test day milk yield, fat and SNF percentages for first lactation.

Association of MFGE-8 and PDIA3 Genes with Peak Milk Production in Karan Fries Cows through Functional Gene-assay

RNA from milk somatic cells was analyzed for the change of expression of six genes, Annexin A1, Moesin, S100 calcium binding protein A8, PDIA 3, MFGE-8 and RAGE, involved in the production of milk in the mammary gland during different stages of lactation, in high vs. low, milk producing Karan Fries cows (KF). Lactating KF cows were grouped as high yielders and low yielders based on their EPA record. Gene expression analysis was done through quantitative PCR technique. Among the studied genes, the fold change in MFGE-8 and Protein Di-Sulfide Isomerase-3 (PDIA3) gene were found to be significant and was up-regulated in the high yielding KF cattle. Based on functional gene-assay, it is envisaged that MFGE-8 and PDIA3 genes can serve as biomarkers for higher milk production in Karan Fries cattle.

Genetic Profile of Lactation Curve Traits in Murrah Buffalo and its Association with SNP changes in Exon-40 of FASN gene and Exon-2 of MTNR1A Gene

A total of 16 different models were evaluated for the identification of best fit of monthly test day milk yield fat and SNF percentage traits in Murrah buffalo. The following functions namely, Linear, Logarithmic, Inverse, Quadratic, Cubic, Power, Compound, S-curve, Logistic, Growth, multiphasic logistic, Wood, Wilmink (with constant k of 0.05, 0.06, and 0.07) and Legendre polynomial function were assessed. Goodness of fit criteria (R^2 value) indicated that Wood function was best fit among all functions used for fixed number of test day records. Best fit lactation curve model was developed and was used to assess the genetic variability of lactation curve. The SNP change were screened for the LOC514211 locus, Exon-40 of FASN, Exon-2 of MTNR1A, Exon-6 of POU1F1 and Exon-10 of ATBF1 genes through PCR-RFLP based technique. Targeted regions of FASN and MTNR1A genes were found to be polymorphic, whereas POU1F1, ATBF1, and LOC514211 were monomorphic. GG genotype of Exon-40 region of FASN gene and TT genotype of Exon-2 region of MTNR1A gene depicted typical type of lactation curves for milk yield and its constituent traits in Murrah buffalo. Thus, genetic profile of standard type of lactation curves can be depicted by using Exon-40 of FASN gene and Exon-2 region of MTNR1A gene, which can serve as an additional genetic criterion in selection of buffaloes.

Genetic Variants in SFXN1, ANKRD31 and WDR41 Genes and their Association with Udder Type Traits, Milk Production and Clinical Mastitis in Karan Fries and Sahiwal Cows

One hundred and thirty three Sahiwal and 123 Karan Fries cows were analysed to explore the genetic polymorphism in SFXN1, ANKRD31 and WDR41 genes and the association of the identified allelic variants with udder type traits, milk production, composition and incidence of clinical mastitis. Total eleven sets of primers were used to amplify targeted regions of each gene. On alignment of the sequenced data with *Bos taurus* reference sequence, a total of 11 SNPs in Karan Fries cows: 4 in SFXN1, 4 in WDR41 gene and 3 in ANKRD31 gene and 9 SNPs in Sahiwal cows: 3 in SFXN1, 4 in WDR41 and 2 in ANKRD31 gene, were identified. PCR-RFLP analysis for genotyping was carried out using *MspI*, *TaqI*, *BspEI*, *HinfI*, *CviQI*, *StuI*, *AfIII* and *HhaI* enzymes. Association of each SNP locus with milk production, composition, udder and teat type traits was analyzed. TT genotype of SNP T5634584G locus recorded maximum Fore udder attachment (FUA), Average test day protein yield (ATDPY) and Average test day Lactose yield (ATDLY) in both the breeds showed significant association with Monthly milk yield (MMY) and Test day milk yield (TDMY) in Sahiwal cows only. Karan Fries cows with CT genotype at SNP C5660904T locus had highest 305MY whereas CC genotype had highest Fore and Rear Teat length (FTL & RTL) and Distance between teats (DFR). The SNP at G8600884A locus revealed that GG genotyped animals had higher 305 MY and GA genotyped animals had higher FUA in Sahiwal cattle, whereas, AA genotyped animals had highest Rear udder width (RUW), Teat diameter (TD) and Average test day Lactose percentage (ATDLP) in KF cattle. CC genotype of SNP C6476252T exhibited higher Rear udder height (RUH) and Central ligament (CL) in Sahiwal cows, whereas highest 305 MY, RUW and udder

depth (UD) in Karan Fries cows. CT genotyped animals recorded maximum shortest distance from front teat ends to floor (SFF) and TT genotyped animals recorded maximum Distance between teats (DLR). AA genotyped animals at SNP locus A6547390G had maximum value of FUA, whereas in Karan Fries cows this genotype had maximum value of TMY, Udder width (UW), FTL, RTL and DFR. KF cows with CT genotype at locus C6521978T had higher Udder circumference (UC), CL, RTL and DFR as compared to CC genotype. GG genotype of SNP locus C6521978T and AA genotype of A6547390G SNPs of ANKRD31 gene in Karan Fries cattle and TT genotype of SNP locus T5634584G of SFXN1 gene in Sahiwal cattle may be used as an aid to selection for higher milk production with desired udder conformation, after validation in a larger population.

Principal Component Analysis (PCA) of Linear Udder Type Traits and their Relation with Milk Yield and Composition in Indigenous Sahiwal Cattle

Principal component analysis for udder type (udder and teat conformation) traits was carried out to identify the components having strongest relationship with milk production traits in Sahiwal cattle. The PCA analysis included 17 linear udder type traits using the correlation matrix between the traits to ensure that all traits are standardized in the analysis. The matrix of partial correlations, Kaiser statistic for sampling adequacy (MSA) using a lower limit of 0.60 and Bartlett's test of sphericity was used to determine the degree of interrelations between variables and adequacy for use in factor analysis. Components were chosen based on auto values greater than one and scree test. Varimax rotation were used for rotation of principal components through the transformation of the components to approximate a simple structure. The relationship of these principal components with milk production traits was analysed using the general linear model.

The means of linear udder type trait measurements varied between -2.21 for Udder balance and 136.35 for Udder circumference. The magnitude of correlation coefficient ranges between -0.677 (Shortest distance from rear teat end to floor and Distance between right and left teat) and 0.958 (Fore teat length and Rear teat length). The general mean value of KMO was obtained as 0.669, indicated the existence of significant correlations between linear type traits and the existence of true factors. Out of 17 principal components, six were extracted using Kaiser Rule criterion. The identified six components could explain 75.777% of the cumulative variance between the linear udder type traits. The communality ranged from 0.476 (rear udder width) to 0.967 (fore teat length) for all these 17 different udder type traits. A relation between first principal component and 305-day milk production was significant with a positive and non-significant effect of 305-day milk-fat yield (305 DF) and 305-day milk-protein yield (305 DP). The results of PCA suggest that the use of orthogonal synthetic variables principal component one (PC1), two (PC2) and three (PC3) provided a means of reduction in the number of linear udder type traits to be recorded in Sahiwal cattle which could be used in explaining the whole udder and teat conformation. The PC1 can be used in selection as a means to explain the mammary system of better milk producing animals to be used in breeding programmes.

Identification of Genome-Wide Genetic Markers and Variants in Candidate Genes for Production and Reproduction Traits in Sahiwal Cattle

Genome-wide genetic markers and variants in candidate genes for production and reproduction traits in Sahiwal cattle were identified using a cost-effective reduced representation sequencing method. A total of 258,231 genome-wide SNPs were identified in Sahiwal cattle with reference to *Bos indicus* genome, of which 150,231 were novel SNPs. Among the high-confidence SNPs identified, 91.86% and 27.30% were genotyped in 50% and 100% of the samples. Mapping of the identified SNPs revealed 525 SNPs in candidate genes related to production traits while 333 SNPs were mapped to candidate genes related to reproduction traits. The breed-specific SNPs will facilitate further insights on tropical adaptation, domestication history and population structure of indigenous cattle and the variants in candidate genes will serve as useful genetic tools, in the quest for phenotype modifying nucleotide change and help in designing appropriate genetic improvement programs.

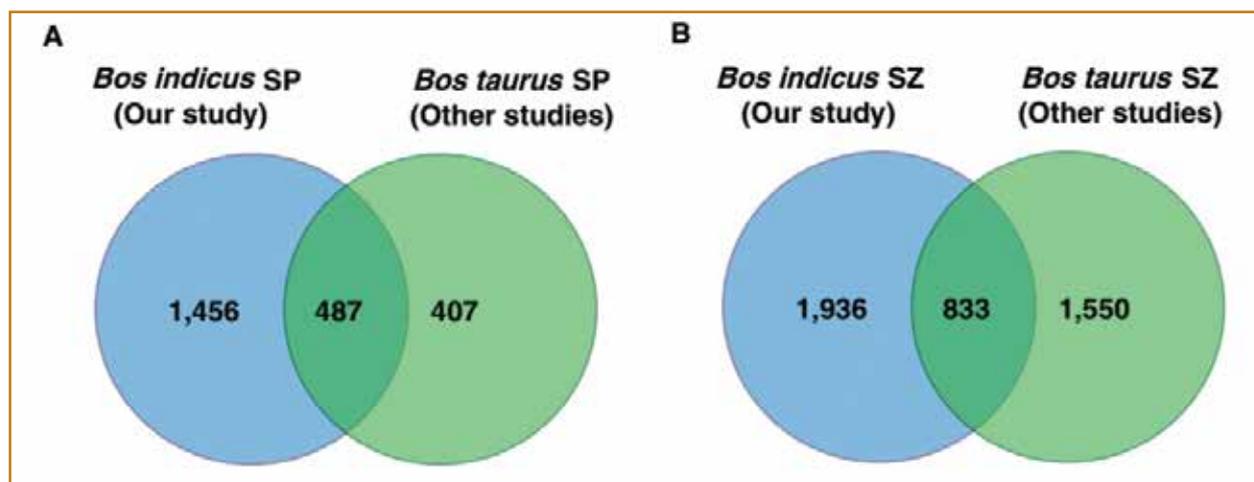
Whole Genome SNPs Identification and Annotation in Tharparkar Cattle

Genome-wide SNPs and SSRs were identified in Tharparkar cattle and annotated to economic traits, using NGS based whole genome reduced representation method ddRAD approach. A total of 12.33 million raw reads with mean base pair length 151bp were obtained from sequencing of genomic DNA from Tharparkar animals. After quality control, 97.05 % of raw reads was retained and these reads were aligned to the reference genomes of *Bos indicus* and *Bos taurus* and got overall average alignment rates of 92.14% and 99.82% with genome coverage 6.52% and 9.65% to their respective genomes. During variant calling, a total of 106,797, 98,383, and 87,047 SNPs and 11,050, 9,850, and 8,465 INDELS to the *Bos indicus* genome at their respective read depths of 2, 5, and 10. Similarly, for *Bos taurus* genome about 183,910, 167,049, and 146,011 SNPs and 11,618, 10,371, and 8,912 INDELS were identified at their respective read depths of 2, 5, and 10, while 2,571 SSRs in 4,326 sequences were obtained. Out of 2,571 SSRs 1219, 1058, 81 196 and 17 were di-nucleotide, tri-nucleotide, tetra-nucleotide, penta-nucleotide

and hexa-nucleotide motifs, respectively, with different threshold level. For annotation, SNPs identified to the reference genome *Bos indicus* at read depth 10 were selected, wherein the prevalence of SNPs in intergenic, intronic and transcript regions was 26.39%, 30.40% and 30.83%, respectively, with Transition and Transversion ratio of about 2.64. Further, from genome wide annotated SNPs, candidate genes for various economic traits such as milk production, fertility, immune response, adaptability and carcass traits were extracted. As a result, 496 SNPs from 69 genes for fertility traits, 334 SNPs from 47 genes for immune response traits, 243 SNPs from 61 genes for adaptability traits, 1042 SNPs from 109 genes for milk production traits and 756 SNPs from 97 genes for carcass traits were annotated.

Deep Proteome Profiling of Semen of Malnad Gidda (*Bos indicus*) Cattle

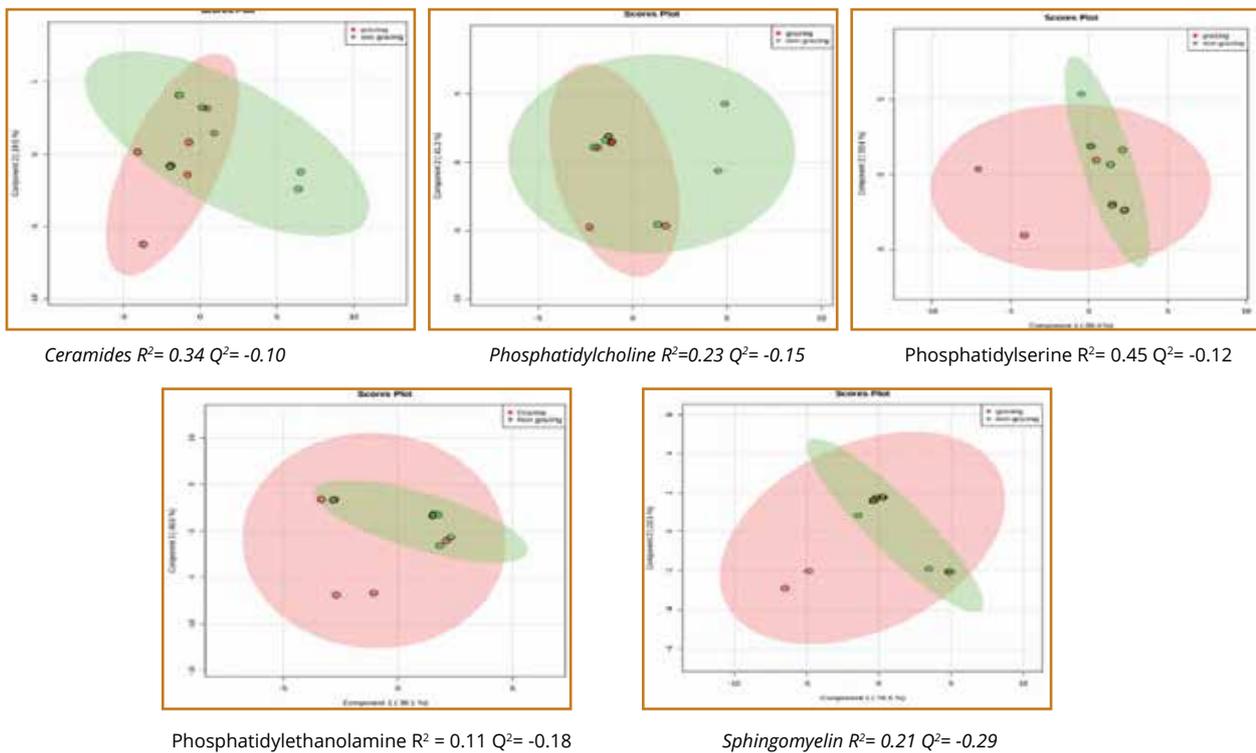
An in-depth proteome profiling of semen (seminal plasma and spermatozoa components) of Malnad Gidda cattle was carried out using a high-resolution mass spectrometry platform and compared with *Bos taurus*. A total of 2,814 proteins were identified from spermatozoa and 1,974 proteins from the seminal plasma of Malnad Gidda. Furthermore, >90% of proteins from each fraction were quantified using the intensity-based absolute quantification. Signal peptides was observed in 33% of seminal plasma proteins, indicating their secretory nature. Gene Ontology analysis revealed their involvement in cytoskeletal assembly associated with sperm head, sperm motility, acrosome reaction, seminal plasma binding, and spermatogenesis associated protein. Literature survey showed that altogether, 2,386 and 894 proteins were reported from spermatozoa and seminal plasma of *Bos taurus* cattle, respectively. The semen proteins of Malnad Gidda (*Bos indicus*) were compared with that of *Bos taurus*. When compared to the proteome of corresponding semen components of *B. taurus*, 1,936 and 1,456 proteins were found to be uniquely identified in the spermatozoa and seminal plasma. The use of multiple strategies in sample preparation maximized protein identification from the semen, which also resulted in a large number of unique proteins when compared to the proteome of semen from *B. taurus*. Most proteins identified in this study were found to be relevant in the context of male fertility. It was observed that semen proteome data of Malnad Gidda, a breed with unique traits in reproduction, would accelerate further research in the context of male fertility.



The Venn diagram showing the comparison of (A) seminal plasma proteins identified in Malnad Gidda (*Bos indicus*) in our study and *Bos taurus* (B) Spermatozoa proteins identified in Malnad Gidda in our study and *Bos taurus* based on literature

Inventory of Milk Metabolomics Data of Malnad Gidda (*Bos indicus*) Cattle and the Effect of Grazing on Milk Metabolites

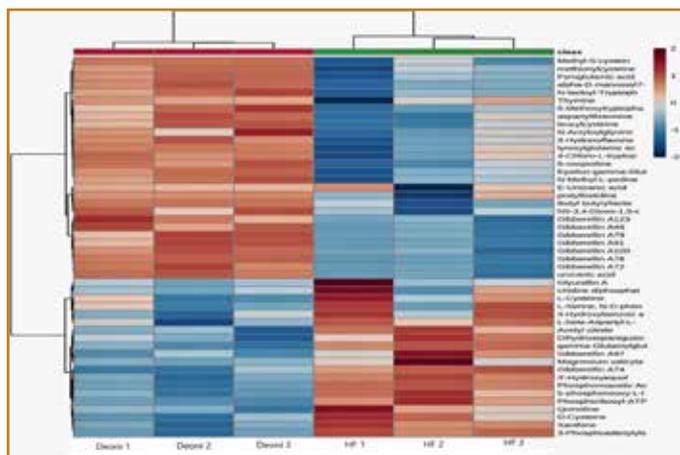
The milk and milk products from cows reared under grazing system have niche market. However, the effect of grazing on milk metabolites specifically lipids has not been fully understood. In this study, various methods were used i.e Acetonitrile precipitation and Methanol: Chloroform methods for extracting the milk metabolites followed by Liquid Chromatography - Mass Spectrometry (LC-MS) run to identify the different metabolites between milk of grazing and non-grazing Malnad Gidda cows in early lactation. Various carbohydrates, amino acids, nucleosides and vitamin derivatives were found to be differentially regulated in grazing cows. A total of 35 metabolites were differentially regulated (fold change above 1.5) between the two groups. Tyrosyl-Threonine, Histidinyl-Cysteine, 1-Methyladenine and Selenocysteine showed fold change above 3 in grazing animals. The lipid profile of milk showed lesser difference between grazing and non-grazing cows as compared to polar metabolites. To the best of our knowledge, this is the first and the largest inventory of milk metabolomics data of an Indian cattle (*Bos indicus*) breed.



Score plot of PLS-DA model of Ceramides, Phosphatidylcholine (PC), Phosphatidylserine (PS), Phosphatidylethanolamine (PE) and sphingomyelin (SM) of grazing and non-grazing cows. PLS-DA, Partial Least Square Dimension Analysis.

Mass Spectrometry based Comparative Metabolome Analysis of Ghee from Curd and Cream of Deoni and Holstein Friesian Cows

In India, there is niche market for ghee from indigenous cow's milk. In Ayurvedic system of medicine indigenous cow ghee is preferred for treatment for many ailments. Traditionally ghee is prepared from fermented milk called 'curd' for household purposes, whereas for large scale production, cream is used for the ghee preparation. In the study, both the methods were used for ghee preparation from the milk of Deoni and Holstein Friesian cows. The metabolites from ghee were extracted using Folch's method and samples were subjected to RPLC and HILIC modes of fractionation, followed by MS/MS mass spectrometry in QTRAP 6500 mass spectrometer. As a result, an upper phase of cream contained a total of 7,673 compounds, among which 3,923 were in positive ion scanning and 2, 257 were in negative ion scanning state. A total of 8,199 compounds were detected in upper phase of curd, among which there were 7,673 positive ions and 1,526 negative ions. The score plots obtained from OPLS-DA (Orthogonal Partial Least Squares Discriminant Analysis) shown the Deoni cow ghee and HF cow ghee were distinguished in both ESI+ and ESI- modes. Results showed that the changes existed between the ghee prepared from the curd and cream in terms of derivative of fat-soluble vitamins, peptides and amino acids and certain fatty acids. By using MetaboAnalyst (Ver 4.0), it was found that 26 metabolites up-regulated in the HF cow ghee obtained from the cream while, only 2 metabolites up-regulated in HF cow ghee obtained from the curd. Differential metabolites were found in ghee made from Deoni and Holstein Friesian cow's milk and they were mostly involved in glycerophospholipid metabolism, valine, leucine and isoleucine biosynthesis, pantothenate and COA biosynthesis, citrate cycle, and pyruvate metabolism.



Genetic Analysis of Lactation Persistency and its Relationship with Economic Traits of Crossbred Cattle

Estimates of heritability for all lactation persistency indices were done by using both paternal half-sib method as well as univariate animal model. The heritability estimates for P_{21} , P_{31} , P_{32} , P_4 and P_5 using paternal half-sib method

were 0.10 ± 0.05 , 0.05 ± 0.06 , 0.07 ± 0.06 , 0.17 ± 0.08 and 0.10 ± 0.05 , respectively in Jersey crossbred cattle. The magnitudes of heritabilities for all persistency indices were low to moderate in nature. The direct heritability estimates obtained from the repeatability model for P_{21} , P_{31} , P_{32} , P_4 and P_5 were 0.02, 0.02, 0.04, 0.01 and 0.01 respectively. The permanent maternal environmental (c^2) effects of different lactation persistency indices accounted for 2-35% of the total phenotypic variance. The presence of permanent environmental effects (c^2) for these traits could be an indication of the large influence of environment on milk production of the animal.

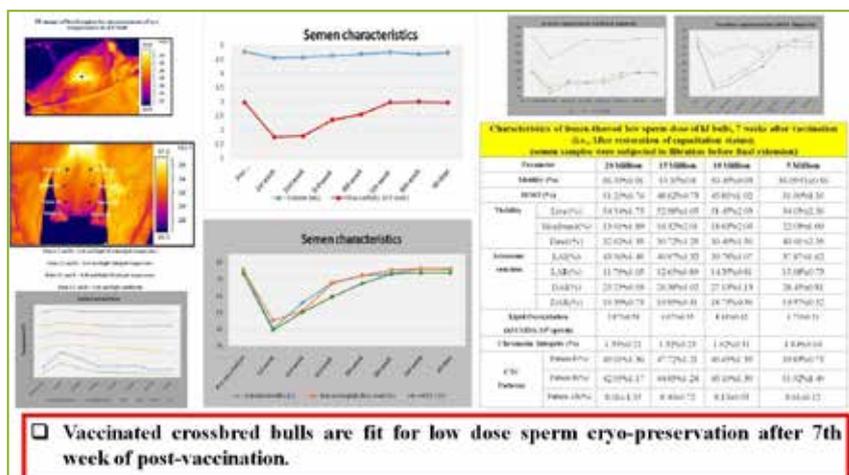
Genetic and phenotypic correlations studies of lactation persistency indices with productive (305-days milk yield and total milk yield) and reproductive traits (viz. calving interval, conception rate and gestation length) of animals revealed that all the genetic correlations between these traits were much stronger than their phenotypic correlations. The phenotypic correlations of persistency indices (viz. P_{21} , P_{31} , P_4 and P_5) with productive traits (305-days milk yield and total milk yield) were found positive and low to medium in magnitude (0.09 to 0.31), whereas the genetic correlations among these traits were low to high (0.11 to 0.82). The maximum positive genetic correlations existed between P_{31} and total milk yield (0.82) and 305 days milk yield (0.74) in the present dataset. The lactation persistency measures i.e., P_4 and P_{21} showed medium relationship with productive traits (0.32 to 0.52) at genetic level. However, the low genetic correlations were found between P_5 and 305-days milk yield (0.19) and total milk yield (0.11). The phenotypic correlations between persistency indices (viz. P_{21} , P_{31} , P_{32} , P_4 and P_5) and reproductive traits (calving interval, gestation Length and conception rate) were found to be low to medium, whereas the genetic correlations among these traits were medium to high. Positive correlations were observed between persistency indices and calving interval with phenotypic and genetic correlation ranging from 0.04 to 0.15 and 0.25 to 0.88 respectively. Persistency indices and conception rate were negatively correlated at phenotypic and genetic level, which ranged between -0.01 to -0.10 and -0.11 to -0.59, respectively. Phenotypic correlations between persistency indices and gestation length were weak and ranged from -0.05 to 0.05 whereas genetic correlations for the same ranged from -0.47 to -0.68.



ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS

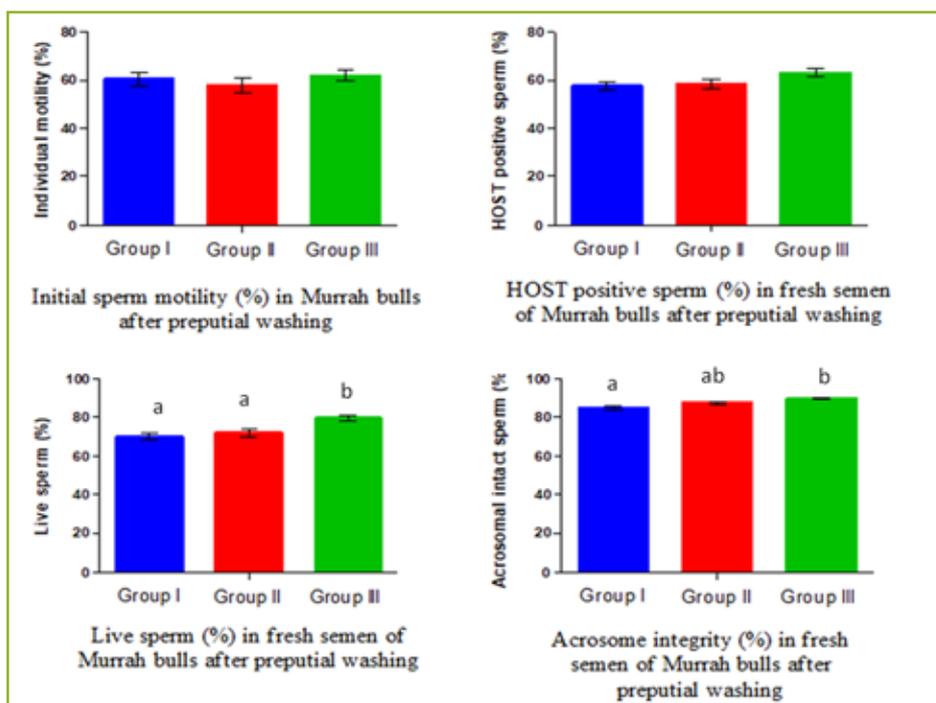
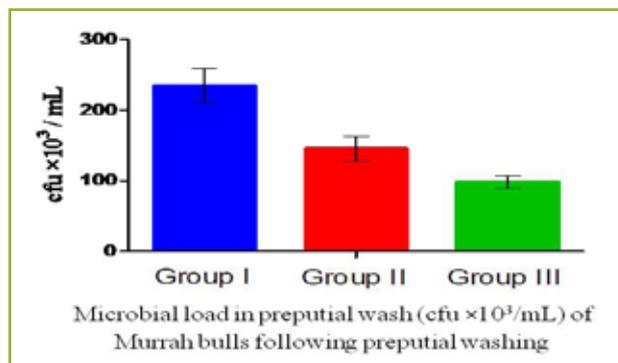
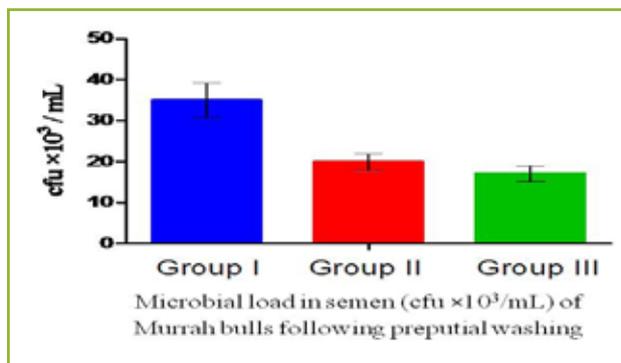
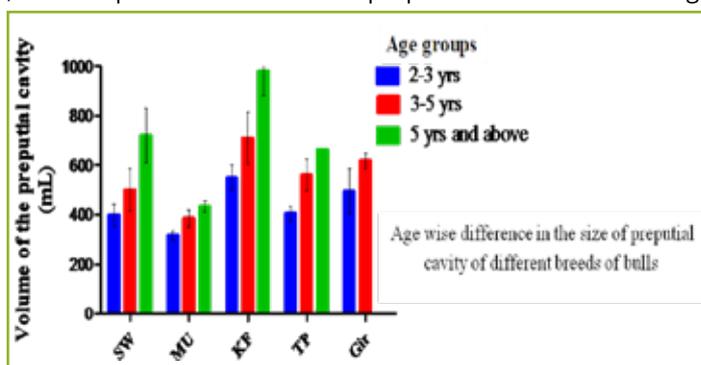
Effect of Semen Filtration on Low Dose Sperm Cryo-Survivability in FMD Vaccinated Crossbred Bulls

Artificial insemination is the most affordably adopted biotechnology to disseminate the superior germplasm. Utilizing high fertile bulls for low sperm doses with acceptable conception rates may be a way to cover a large number of bovines under AI in countries like India. The present study was designed to investigate the effect of semen filtration on low dose sperm cryo-survivability in FMD vaccinated crossbred (KF) bulls. Six ejaculates from each bull were collected from six KF bulls. A part of each ejaculate was evaluated for various seminal attributes such as volume, mass motility, concentration, initial motility, viability, and HOST. The semen was diluted with Tris egg yolk glycerol extender. A portion of extended semen diluted up to 80 million, 60 million, 40 million, and 20 million, sperm / mL; and rest part of diluted semen was filtered before final extension up to 80 million, 60 million, 40 million, and 20 million, sperm / mL; to make sperm dose in French mini straws with 20,15, 10 and 5 million sperm per straws. The semen samples in French mini straws are equilibrated, cryopreserved and evaluated for post-thaw for various sperm functions. The frozen-thawed semen samples were also evaluated for different *in vitro* sperm function tests. Significant ($P<0.05$) improvement was observed in both fresh and frozen-thawed seminal attributes after filtration as compared to non filtered semen. Motility, live and HOST positive sperm were significantly ($P<0.05$) increased after filtration as compared to before filtration in both fresh and frozen-thawed semen. In contrast, LPO, protamine deficient and cryo-capacitated sperm were significantly ($P<0.05$) lower in filtered as compared to non-filtered, frozen-thawed semen. Post-thaw motility, live sperm, acrosome integrity and HOST positive sperm, decreased, while moribund and dead sperm, cryo-capacitated sperm increased with an increase in dilution rate. In another study, the effect of vaccination on sperm functions as well as infrared thermograms on bull testis and the eye was done to assess the scrotal and body thermal profile before and after vaccination. The semen samples were collected two weeks before vaccination and up to restoration of semen quality. After the restoration of semen quality based on the capacitation status semen sample was again filtered and diluted up to 80 million, 60 million, 40 million, and 20 million, sperm / mL and checked for post-thaw sperm function tests. FMD vaccination had a significant effect on body temperature as well as on the seminal parameters of the KF bulls. Individual motility, live and HOST positive sperm were significantly ($P<0.05$) decreased after vaccination up to 5th week as compare to pre-vaccination status. The *in-vitro* capacitation of sperm after 4-hour incubation followed by LPC induced acrosome reaction in capacitating SP-TALP media with heparin was significantly ($P<0.05$) decreased up to 5th week of vaccination and became non-significant after the 6th week. After the restoration of semen quality, semen samples were diluted, filtered and filled in French mini straws, equilibrated, cryopreserved, as per above mentioned concentration/mL and evaluated for various post-thawed sperm function tests. Based on the above findings, it could be concluded that semen quality and freezability improved after filtration. In contrast, semen quality gets reduced in terms of advanced sperm function test with an increase in dilution and this effect was observed at dilution beyond 10 million sperm per dose. After vaccination of bull semen quality is compromised and only after the restoration of all functional characteristics of sperm, higher dilution of the semen can be recommended for preservation.



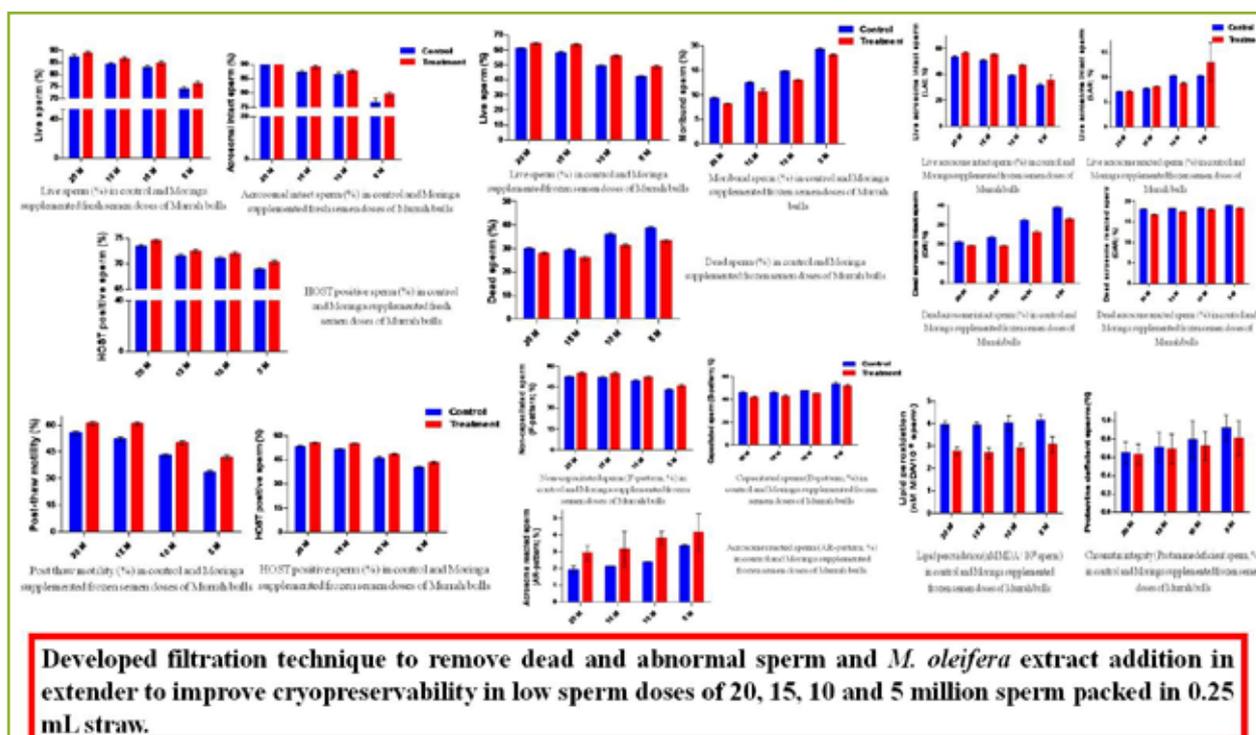
Standardization of Breed-specific Volume of Preputial Wash

The number of bacteria in semen can be decreased by regular rinsing of the preputial cavity. Still, there is a significant variation in the preputial capacity in bovine species, and also, the volume of fluid, which is used regardless of species, is inadequate for preputial washing. Supplementation of *Moringa oleifera* aqueous leaf extract as an additive in flushing fluid and extender has a profound effect due to its antioxidant and antimicrobial properties. The present study was planned with two independent studies; first to optimize the volume of preputial wash in different age groups of various dairy bulls, second to see the effect of optimum preputial wash volume along with *M. oleifera* supplementation on bacterial load in Murrah bulls. The average size of the preputial cavity in Sahiwal, Murrah, Karan-Fries, Tharparkar and Gir bulls were found to be 600 mL, 400 mL, 750 mL, 500 mL and 600 mL respectively. Further, a total of 18 Murrah bulls were divided into three groups. In Group I, 100 mL NS, Group II, average volume i.e., 400 mL NS, while in Group III 400 mL solution of NS and *M. oleifera* leaf extract in the ratio of 10:1 was used for preputial washing. Average microbial load in the preputial cavity of all the 18 experimental bulls before preputial washing was found significantly ($P < 0.05$) higher than all the three groups. Significant ($P < 0.05$) decrease in microbial load, both in the preputial wash as well as semen, was observed in Groups II and III, as compared to Group I. Semen quality was also enhanced in terms of viable sperm and acrosomal intact sperm percentage. Flushing of the preputial cavity with an optimum amount of preputial wash fluid significantly reduced the microbial load both in semen as well as in the preputial cavity. Supplementation of *M. oleifera* aqueous leaf extract in flushing fluid for preputial wash resulted in an improvement in the semen quality of Murrah bulls.



Low Dose Sperm Freezability of Murrah Bulls

Quality semen harvest from high fertile bulls along with optimizing the number of spermatozoa per dose leads to the production of a maximum number of straws with optimum conception rate is one of the ways to cover a large number of bovines under Artificial Insemination (AI). The present study was planned with two independent studies; first to optimize the volume of preputial wash in different age groups of various dairy bulls, second to see the effect of optimum preputial wash volume along with *M. oleifera* supplementation on bacterial load and third to study the cryosurvivability of low sperm numbers in AI doses on post-thaw sperm quality in high fertile Murrah bulls. In the present study, to improve quality of low sperm AI doses, initial diluted semen from the high fertile Murrah bulls was subjected to filtration for removing dead and abnormal sperm and to overcome the dilution effect, low sperm AI doses were supplemented with best effective low concentration of *M. oleifera* aqueous leaf extract, which was decided on the basis of 96 hrs of preservation at 4°C, 40 µg/mL concentration of *M. oleifera* extract showed significantly better motility and viability as compared to its low 5 µg/mL, 10 µg/mL and 20 µg/mL concentration. Motility, viability, acrosomal integrity and HOST were significantly ($P < 0.05$) higher in the treatment group (supplementation of 40 µg/mL *M. oleifera* aqueous leaf extract) as compared to the control group. Post-thaw motility, live, acrosomal intact, HOST positive and non-capacitated sperm, decreased, while moribund, dead, acrosome-reacted and capacitated sperm were significantly increased with the increase in dilution of semen in low sperm doses of 20, 15, 10 and 5 million sperm per 0.25 mL straw. It could be concluded that semen quality reduced in terms of *in-vitro* sperm function parameters with an increase in dilution of sperm doses. Supplementation of *M. oleifera* aqueous leaf extract in semen extender resulted in an improvement in the semen quality of Murrah bulls.



miRNAs Expression Profiling

miRNAs expression profiling was investigated in the blood sample of heat-stressed Tharparkar and Karan Fries cattle to understand the relationship of miRNAs and their target genes in thermotolerance. A total of 387 conserved and 77 novel miRNAs were identified in these two cattle breed under heat stress. The results showed significant enrichment of predicted target genes of differentially expressed miRNAs in several biological processes, including developmental process, cellular process, and biological regulation. Data provided valuable information about the role of miRNAs during heat stress. These new gene resources could be used as miRNAs based biomarkers and to decipher the thermotolerance.

Thermal Stress Zones during Different Seasons

Zones of various levels of heat stress viz. non-heat stress, heat stress and critical heat stress zones were identified as per decline in average daily milk yield of the Sahiwal cattle for a period of 17 years from 2003 to 2019. In Sahiwal, average highest milk yield (7.033 ± 0.046 kg) was found in April and the lowest (5.71 ± 0.039 kg) was in August. It clearly indicated a negative relationship between milk production and THI. Average THI values of observed months ranged between 57.3 and 81.9 suggesting the lack of cold stress, but confirmed the presence of heat stress for

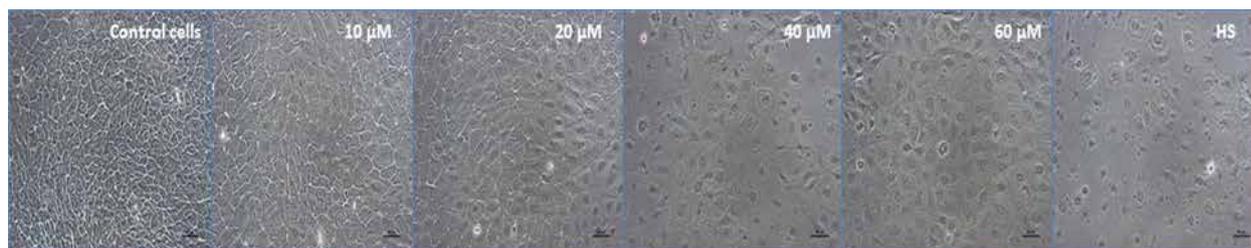
the four months period going from May to August (THI > 80). The average daily milk yield declined by 41 g in the heat stress zone while there was a decline of 10 g per unit increase in THI. There was no decline in the non heat stress zone.

Exploring Heat-Stress Responsive MicroRNAs in Cattle to Decipher the Thermo-tolerance Mechanism

After total RNA isolation the blood samples from control and heat stressed Tharparkar and Karan-Fries cows, a single RNA pool was created for each group and the pooled RNA sample was used for small RNA library construction and NGS sequencing. Illumina single end reads were generated for 4 RNA samples and small RNA analysis carried out against *Bos taurus*. UMD3.1 build genome data. MicroRNA analysis was carried out on an average of 16.6 M data generated. An average of 387 known and 77 novel miRNA were identified. Less than 8% of the reads were known to have the contamination of other ncRNAs. The results showed significant enrichment of predicted target genes of differentially expressed miRNAs in several biological processes, including developmental process, cellular process, and biological regulation. These new gene resources could be used as miRNAs based biomarkers and to decipher the thermo-tolerance.

Assessing the Effect of Curcumin on Heat Stressed Buffalo Mammary Epithelial Cell Morphology and Proliferation

BuMEC cells were treated with different concentrations of curcumin (10 μ M, 20 μ M, 40 μ M & 60 μ M) in 6 wells culture plate and in one well cells were kept without curcumin at 42°C for one hr. followed by recovery period of 24 hr. and images were taken using inverted microscope. Morphological analysis in revealed that control cells were well adhered, showing normal morphology of BuMEC. Cells treated with curcumin (40 μ M and 60 μ M) caused remarkable changes with distorted morphology characteristics of programmed cell death.



Cytotoxic effect of curcumin on BuMEC cells

Cell viability and Proliferation Assay: BuMEC were cultured in 96 wells culture plate and given 1 hr. treatment of heat stress alongwith different concentrations of curcumin followed by recovery of 24 hr. These treated cells were used for MTT and Trypan blue assay analysis. Results showed that curcumin (10 & 20 μ M) increased the cell viability as compared to heat stressed group.

Gene expression study: The treated BuMEC were harvested and used for qRT-PCR analysis. The results of gene expression showed that curcumin up-regulated the expression of anti-oxidants such as CAT, SOD, GST, Nrf2 and heat shock proteins (HSP70 & 90) while genes related to apoptosis were down regulated in treated group compared to heat stressed group.

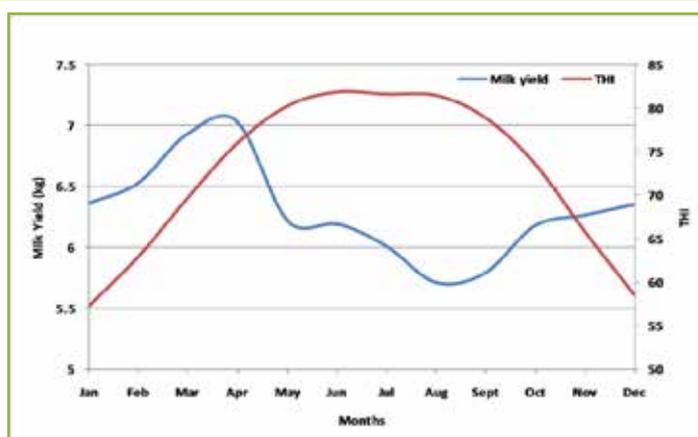
Relationship of THI with Milk Production in Sahiwal Cows

The study was based on the milk records of Sahiwal cows at the Livestock Research Centre, ICAR-National Dairy Research Institute, spanned over 17 years (March 2003- July 2019). Daily THI values were also determined for the experimental period using the equation, $THI = (Tdb + Twb) \times 0.72 + 40.6$, where, Tdb= dry bulb temperature, Twb= wet bulb temperature.

The data on parity and stage of lactation was classified as per the variation(s) observed. On the basis of parity order, animals were divided into five parity groups as code 1, 2, 3, 4 and 5. The lactation data was partitioned as early (0-3 months), mid (3-6 months) and late (9 months and above) stage. The effects of non-genetic factors like parity and stage of lactation on normalized milk yield per day of lactation length was estimated by using least squares analysis for non-orthogonal data. The overall least squares mean for average daily milk yield was 6.556 ± 0.014 kg. The analysis of variance showed significant effect of parity and stage of lactation on average daily milk yield. There was a negative relationship between milk production and THI. Indeed, the increased THI reduced milk yield. The highest THI was found during June indicating higher heat stress on dairy cows during this month followed by July, August and May. The lowest THI was in January, followed by December, November and February. The high THI values indicate that dairy herd was exposed to the negative effects of heat stress.

Table: Corrected daily milk yield and THI during 17 years (2003-2019)

Month	Average MY	Average THI
January	6.364 ± 0.049	57.3
February	6.529 ± 0.053	62.89
March	6.936 ± 0.048	69.63
April	7.033 ± 0.046	75.96
May	6.22 ± 0.047	80.31
June	6.191 ± 0.049	81.9
July	6.01 ± 0.042	81.62
August	5.71 ± 0.039	81.46
September	5.785 ± 0.040	78.96
October	6.179 ± 0.043	73.67
November	6.268 ± 0.045	65.79
December	6.349 ± 0.042	58.42

*Distribution of THI and corrected daily milk yield*

Change in Average Daily Milk Yield with Per Unit Increase in THI

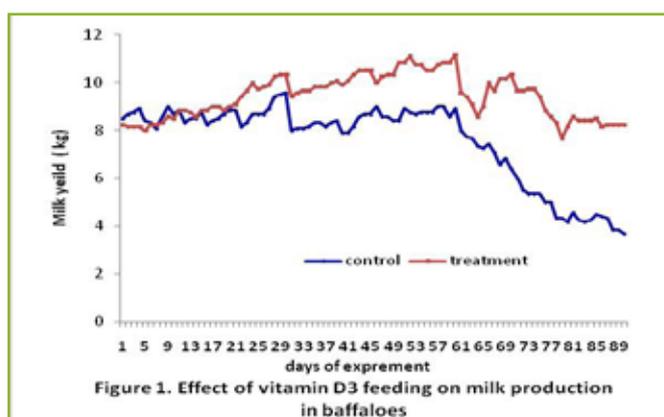
The different heat stress zones viz. non-heat stress, heat stress and critical heat stress zones were identified as per decline in average daily milk yield of the day of the Sahiwal cattle for a period of 17 years from 2003 to 2019.

Table: Changes in average daily milk yield of Sahiwal cows

Name of Zones	Change in daily milk yield (grams)
Non-heat Stress zone	0.0421
Heat Stress zone	-0.0415
All zones	-0.0101

Role of Vitamin D3 in Milk Secretion of Buffaloes

The commercial dairy farms in sub-urban and urban areas are using intensive tools of management in animal sheds which restrict the exposure of lactating buffaloes to solar sun light. Since vitamin D3 is associated with calcium homeostasis in the body, the investigation was carried out to determine the role of Vitamin D3 on milk production, circulatory hormones and plasma minerals in early Murrah buffaloes. The treatment group buffaloes received vitamin D3 dietary supplementation @ 20,000IU/day from 30-120 days of lactation. Milk production was significantly increased by vitamin D3 feeding in the treatment group ($p < 0.01$) as comparison to

**Figure 1. Effect of vitamin D3 feeding on milk production in buffaloes**

control group. Milk yield increased by 1.99 kg/day in vitamin D3 supplemented buffaloes over control group. Plasma vitamin D3 level and Osteocalcin level were higher in the treatment group of buffaloes ($p < 0.01$) in comparison to control group. However, plasma PTH levels decrease ($p < 0.01$). Plasma IgG level were higher ($p < 0.01$) in treatment as compared to control group buffaloes. Milk yield was positively correlated to circulatory vitamin D3 ($p < 0.01$) and osteocalcin levels ($p < 0.05$) and was negatively correlated with PTH ($p < 0.01$). The augmentation of milk production mediated by higher Vitamin D3 revealed that Vit. D3 is essentially required for milk secretion and its higher level improves milk production and persistency of lactation in Murrah buffaloes. Supplementation also impact animal health by improving the immunity of animals.

Association of Milk Yield and PA-PG-PL System in Dairy Cows

Milk yield was significantly ($p < 0.01$) decreased in summer season in all breeds. Milk plasminogen levels were increased significantly ($p < 0.01$) in summer season in KF and Sahiwal Cows. Milk plasmin was increased significantly ($p < 0.05$) in the summer season in all breeds. Milk plasminogen activator was highly increased ($p < 0.01$) in summer season in all breeds. Correlation coefficient revealed significant value of r between the breed, PA and PL with milk yield. PA, PG and PL levels could be used as the biomarkers of biosynthetic capacity of the mammary glands.

Testing of Destress Mixture under Field Conditions

The treated animals were supplemented with destress mixture @30 gm/day/animal with normal daily feeding. The skin surface temperature decreased non-significantly in treated animals whereas the milk yield increased. Antioxidant activity also increased during the experiment. There was a decrease ($p < 0.05$) in catalase activity in treated animals. Destress herbal mixture supplementation improved the physiological status, milk production, its quality and reduced oxidative stress on the animals.

Blood Gases and Acid Base Balance in Crossbred and Indigenous Cows

The blood gas and acid base balance of 6 cows each of Karan Fries and Tharparkar was assessed by ABG blood gas analyzer (NOVA Biomedicals, Waltham, USA). The whole blood pH, pCO_2 , pO_2 , HCO_3 , TCO_2 , SBC, BEb, BEecf, and Hb were analyzed by using stat profile PHOX reagent pack A calibration cartridge-B No. 23937 kit. Blood pO_2 were significantly ($P < 0.05$) lower on 2nd and 4th week of experiment in TP cows as compared to KF cows. pCO_2 , TCO_2 , base excess in extracellular fluid (BEecf), base excess in blood (BEb), were significantly ($P < 0.05$) lower on 4th week of experiment in both breeds. HCO_3 , PCV, Hb were significantly ($P < 0.05$) higher in TP cows as compared to KF cows.

Chlorophytum borivilianum Ameliorates the Thermal Stress in Dairy Cows

A study was conducted to find out the efficacy of herbal Chlorophytum borivilianum (CB) root powder in thermal stress amelioration during hot dry (HD) and hot humid (HH) season on crossbred KF and Tharparkar cows. The cows were supplemented with CB @40 and 80 mg/kg bwt./d in both the seasons. The supplementation did not influence body weight of KF and TP cows during the seasons, however higher dose (80 mg) increased DMI/100 kg bwt; ($p < 0.01$), milk yield (@1.22 kg/d), milk fat, protein, plasminogen level and improved the udder health by lowering the milk SCC in comparison to low doses. The ratio of milk SFAs: UFAs was significantly reduced ($p < 0.01$) in treatment group of cows over the control in both the seasons. The milk of KF cows was found to have higher SFAs and lower UFAs ($p < 0.01$) in comparison to TP cows. Physiological responses like respiration rate, pulse rate and temperatures of rectum, forehead, neck, rear body and udder were significantly decreased ($p < 0.01$) in TP cows in comparison to KF cows. Thermal imaging of skin at various sites revealed elevated skin temperatures ($p < 0.01$) during afternoon interval than in the morning intervals in both the breeds however increases were more in KF in comparison to Tharparkar cows. The lower circulatory glucose and higher NEFA, urea and creatinine levels in control group indicated stress on animals, which were decreased ($p < 0.05$) in the treatment group fed with 80 mg dose/d. The stress hormone (cortisol and prolactin) level was more ($p < 0.01$) in HH than HD season in KF and TP cows which were also reduced to normal level in the treatment groups with 80mg dose ($p < 0.01$), however plasma insulin and aldosterone levels remain unaffected by feeding. The immunity of the cows at higher dose was augmented by higher plasma

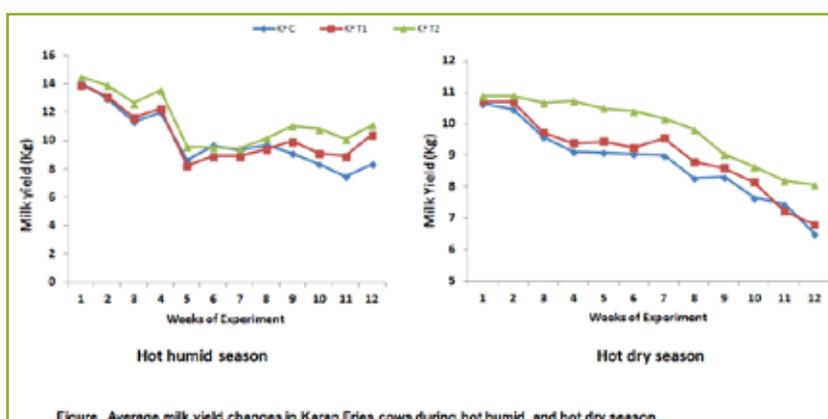


Figure 1. Average milk yield changes in Karan Fries cows during hot humid and hot dry season.

SOD, catalase, TBARS and total antioxidant capacity in KF and TP cows ($p < 0.01$). Further CB supplementation down-regulated ($p < 0.01$) mRNA expression of pro-inflammatory cytokines (TNF alpha and IL1 beta) and anti-inflammatory cytokine (IL10) in both the breeds during HD and HH season. Thus, herbal supplement of *Chlorophytum borivilianum* (@80mg/kg bwt/d) could be used as an effective immune-modulator to mitigate the thermal stress of summer season in dairy cows.

Empowering Farmers through Selective Interventions in Salt Affected Agro-Ecosystems

In the first trial, 24 lactating buffaloes were selected from 5 villages namely Mundri, Geong, Kathwar, Sampli Kheri and Bhaini Majra of Kaithal district and divided into 4 groups viz, group I (control), group II (astaxanthin supplementation @ 0.25 mg/kg body wt/day), group III (prill fat supplementation @ 100g/animal/day) and group IV (combination of astaxanthin + prill fat). Respiration rate was lower ($P \leq 0.05$) in treatment groups than control group. IRT temperature of udder in group IV was higher ($P \leq 0.05$) than the group I and II. Plasma glucose was higher ($P \leq 0.05$) in astaxanthin supplemented group compared to control. Plasma NEFA was lower ($P \leq 0.05$) in treatment groups than control. SOD and Catalase levels were lower ($P \leq 0.05$) in astaxanthin supplemented groups (II and IV) compared to group I and II. The plasma levels of IL-2 was lower ($P \leq 0.05$), whereas IL - 10 was higher ($P \leq 0.05$) in astaxanthin supplemented groups (II and IV) compared to control. The milk yield was increased ($P \leq 0.05$) by 5.38%, 13.82% and 15.62% in group II, III and IV over control, respectively. The combination of astaxanthin and prill fat are having additional benefit over prill fat i.e. improved the health status in addition to milk yield, but prill fat supplementation is better than the combination due to higher cost of astaxanthin. In a second trial, three hundred eight breed-able bovines (Cattle - 49 and buffalo- 259) were inseminated at the time of estrus using the semen from NDRI bulls. These animals were also supplemented with mineral mixture @50-60 g/day/ animal during the study. The overall conception rate was 50.74 %. In third trial, 18 repeat breeding buffaloes supplemented with mineral mixture @50-60 g/day/ animal and fed (roughage + concentrate) as per their requirements. Buffaloes were inseminated with semen from NDRI bulls twice at proper time of estrus, as a result of which 12 buffaloes (66.67%) had conceived.

Causes of Truncated Lactation in Sahiwal Cows

The genetic correlations of persistency of milk yield with first lactation's 305 days milk yield (FL305DMY) were high with positive sign (0.99 ± 0.52). The positive phenotypic correlation between persistency of milk yield and FL305DMY was high (0.55) and highly significant ($P < 0.01$). The highly significant ($P < 0.01$) positive genetic correlations were observed between persistency of milk yield with first lactation total milk yield. Significant association was found between bGH-*Msp1* polymorphism and lactation persistency estimated using test day ratio method. No significant association was found between lactation persistency and bGH-*Alu1* polymorphism. Association of bGH - *Alu1* and *Msp1* polymorphism was found to be significant with FL305DMY, first lactation total milk yield (FLTM) and first lactation length (FLL).

Development of Loop-mediated Isothermal Amplification (LAMP) Reaction has been Developed to Detect *Ureaplasma Diversum* in the Cervico-vaginal Swabs of Murrah Buffaloes

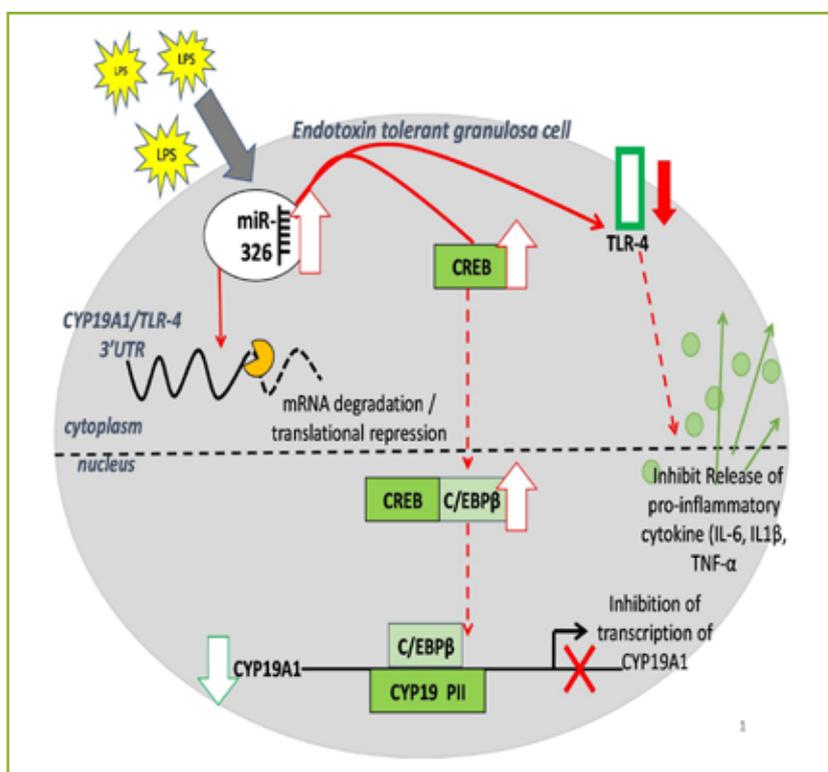
An earlier metagenomics studies from our lab reported that *Ureaplasma diversum* was one of the predominant bacteria in buffalo endometritis samples. In order to identify the prevalence of *U. diversum* in buffaloes, a strain-specific 16S rRNA based PCR was developed using cervico-vaginal samples. However, for rapid evaluation of *U. diversum* in the field conditions, a rapid, robust, and field-applicable loop-mediated isothermal amplification (LAMP) assay was developed in this study. The LAMP assay provided a distinct visible colour change from violet to skyblue colour within 90 min if the sample was positive for *Ureaplasma diversum*. To validate the assay, cervico-vaginal swabs were collected randomly from 50 buffaloes at Livestock Research Centre of NDRI as per the Institute Animal ethics guidelines. Out of 50 cervico-vaginal swab samples, 34 were found positive with LAMP and 16 samples were negative. As the conventional PCR also confirmed these results, the accuracy of the developed LAMP was nearly 100%. However, further study is needed to assess the sensitivity and accuracy of this assay towards the detection of *U. diversum* and its relationship with disease diagnosis. The developed LAMP assay can also be used to screen *U. diversum* infection in cervico-vaginal swabs of other farm animals.



Loop-mediated isothermal amplification (LAMP) reaction for *Ureaplasma diversum* detection in the cervico-vaginal swabs of Murrah buffaloes

miR-326 Regulated Estradiol-17b Production and Proinflammatory Cytokines by Targeting CYP19A1 and TLR-4 in Buffalo Granulosa Cells

Ovarian granulosa cells, known to be endocrine cells, have well active TLR4-/NFkB signalling mediated innate immune capabilities. It was observed that endotoxin (LPS) not only transiently regulated proinflammatory cytokines but also causes the granulosa cells to become endotoxin tolerant by its repeated exposure, which further impaired the granulosa cells functions by downregulating the CYP19A1 and TLR-4 gene expression. To further understand endotoxin tolerance and impaired granulosa cells function, genome-wide transcriptomic profiling had been performed in endotoxin tolerant buffalo granulosa cells (bGCs). This profiling and qPCR validation identified miR-326 as one of the top 5 differentially upregulated miRNAs. Silico analyses showed that miR-326 targeted CYP19A1 and TLR-4 genes. Therefore, in the present study, the role of miR-326 in buffalo granulosa cells (bGCs) was elucidated. The miR-326 mimic was transfected in granulosa cells and analyzed the expression of CYP19A1, CREB & C/EBP- β and genes involved in inflammation (TNF- α , IL-6 and IL-1 β). It was observed that miR-326 upregulated CREB and C/EBP- β , inhibited the transcription of CYP19A1 and decreased estradiol-17b production. Further, transfection of miR-326 in endotoxin treated granulosa cells showed a decreased expression of TLR-4 complex as well as pro-inflammatory cytokines (TNF- α , IL-6 and IL-1 β), whereas an increased expression of anti-inflammatory (IL-10) gene. The study revealed that miR-326 upregulation could create an immunosuppressive state of granulosa cells during repeated endotoxin exposure. It could be inferred that the upregulation of miR-326 in granulosa cells created an endotoxin tolerance state of these cells, but influencing their important function, such as steroidogenesis.



Schematic representation of proposed mechanism of miR-326 upregulation in granulosa cell functions i.e. steroidogenesis and inflammation

Identification of Body Condition Score, Parity, Shelter Cleanliness and Male Proximity as Highly Associated Non-genetic Factors with Post-partum Anestrus in Murrah Buffalo in Field Conditions

Postpartum anestrus (PPA) is a major reproductive issue in buffaloes. Due to 29% of its incidence in buffaloes, it causes a huge economic loss to the farmers. Although genetic and non-genetic factors influence its incidence, identifying the non-genetic factors would be helpful for effective management of this problem in livestock systems. However, no systematic study has been performed to identify the association of non-genetic factors with PPA in buffaloes, especially under field conditions. Therefore, data on 39 parameters representing postpartum anestrus interval (PPAI), health, nutrition, management and environmental status of the animals were collected from 575 buffaloes from 15 villages. The data were analyzed with a general linear model considering PPAI as a dependent variable and the remaining 38 non-genetic parameters as independent variables. The analysis showed that body condition score parameters such as pelvic girdle score ($P < 0.0001$) and girth ($P < 0.05$), parity ($P < 0.0001$), shelter cleanliness ($P < 0.001$), male proximity ($P < 0.005$), amount and frequency of concentrate feeding during early

postpartum ($P < 0.05$), general feeding frequency in a day ($P < 0.05$) and the status of oxytocin injection ($P < 0.05$) were significantly associated with PPAI in Murrah buffaloes. The PPAI residuals plot also indicated the possibility of other unexplained factors, including genetics that could also influence the differences in this trait in Murrah buffaloes. In conclusion, the knowledge of the associated non-genetic factors would help farmers in following proper management practices to maintain efficient reproductive cycles in Murrah buffaloes.

Solid Phase Peptide Synthesis of Identified Ligand Peptides and Testing it for Antagonizing Cysteine Synthase Function

Twenty phages were already identified which were binding to the recombinant cysteine synthase protein. The results of the sequencing of the phagemid DNA were analysed and sequences of the peptides expressed on the surfaces of the phages could be retrieved and analysed for all the phages except the 3rd and the 9th phage. Sequences on phagemid clones 7 and 8 were same. Similarly, the phagemid clones 5, 11 and 18 were also having the same sequence. It showed the stringency of selection process and demonstrated that the peptides could be very specific for locating a region on CS protein.

Out of the 18 selected peptides, 10 were chosen for solid phase peptide synthesis keeping in mind the shared conserved sequences among them and probability of them identifying and binding a common region of cysteine synthase protein.

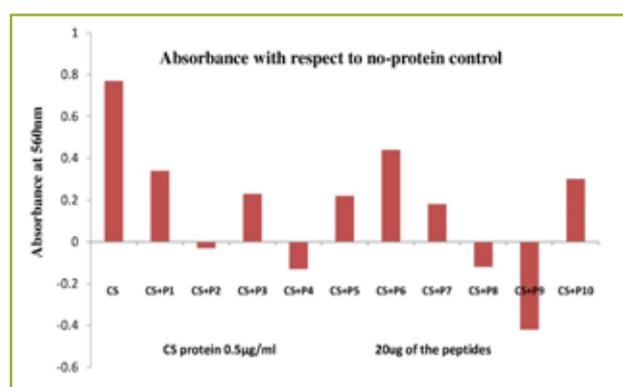
Solid Phase peptide synthesis of 10 identified peptides labelled as P1 to P10 were done commercially with purity of more than 95% and on a 4-mg scale.

S.No	Peptide	Mol wt	pI (Isoelectric point of the peptide)	Expressed on phagemid clones labeled (1-20)
1	P1	1481	11.05	Clone1
2	P2	1382	8.86	Clone 2
3	P3	1338	3.45	Clone 4
4	P4	1363	5.95	Clone 5
5	P5	1281	5.94	Clone 6
6	P6	1281	5.94	Clone 7
7	P7	1342	10.05	Clone 10
8	P8	1543	10.09	Clone 12
9	P9	1331	4.36	Clone 13
10	P10	1315	10.03	Clone 14

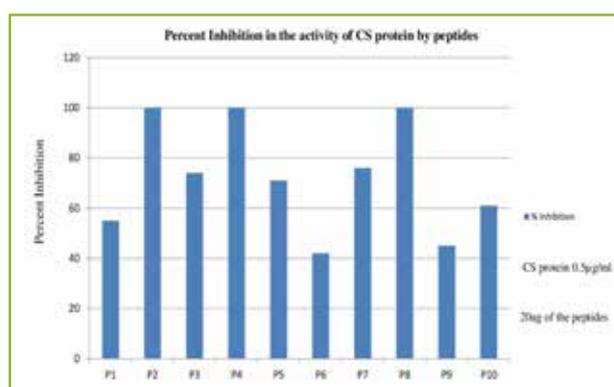
In-vitro testing of peptide ligand for functional enzymatic blockage of cysteine synthesis

In-vitro Evaluation of Inhibitory Activity of the Synthesized Peptides using the CS-Activity Assay Protocol

The protocol was standardized earlier for measuring the cysteine synthesis of the protein following a slight modification of the protocol by Romero et.al, 2014. The peptide 20 µg was included for testing in 500 µl reaction mixture (200 mM potassium phosphate buffer, 100 mM DTT, 0.2 mM PLP, 6.5 mM O-acetyl serine and concentration of CS protein 0.5 µg/ml) with meticulous controls (Peptide control, Protein control and another one without O acetyl serine was prepared). The mixture was incubated at 37°C for 5 minutes. Then, 2 µl of 1M sodium sulfide was added into the reaction mixture and incubated at 37°C for 30 minutes. After that, 50 µl of 20% TCA was added into the



Activity measurement of CS protein in presence of different identified peptide antagonist



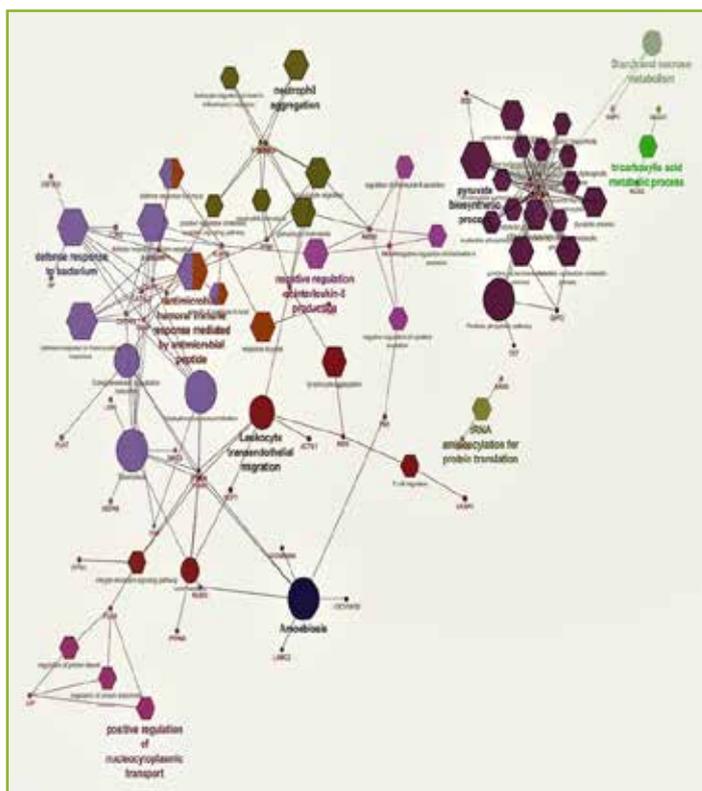
Percent Inhibition in activity of the CS protein in presence of various peptides

tubes to stop the reaction followed by its centrifugation at 12000*g for 5 minutes. Then, 500 µl of supernatant was added in 500 µl of 2.5% ninhydrine solution. The reaction mixture were boiled at 100°C for 10 minutes and cooled on ice before the addition of 500 µl of 95% ethanol. The OD of colour changed was recorded at 560 nm and analyzed with respect to control.

The result demonstrated that peptides (P2, P4 and P8) have the absolute capacity to shut off the enzyme activity. The peptide P3, P5 and P7 are also very effective as they bring about nearly 3/4th inhibition of the CS activity of the protein. The other peptides (P1, P6, P9 and P10) are partially affecting the activity of the protein.

Biomarker Discovery for Subclinical Endometritis in Dairy Cattle through Comparative Proteomics Approach

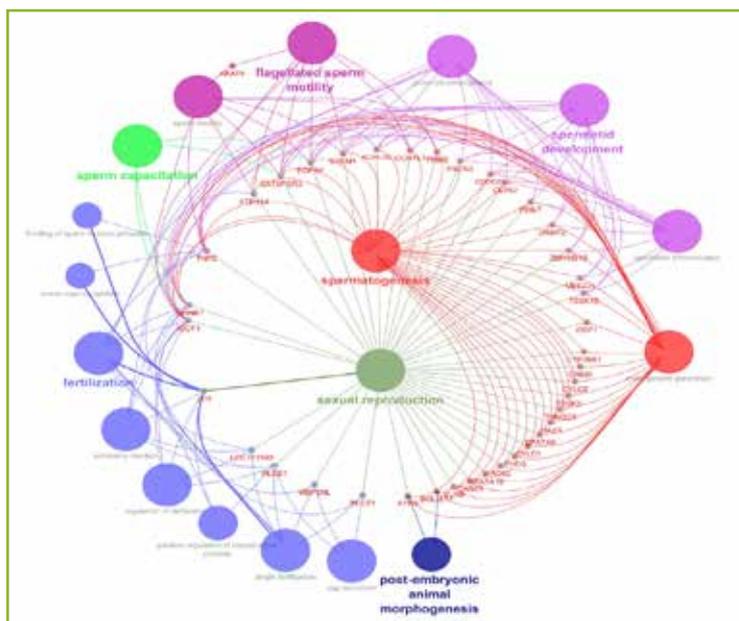
Subclinical endometritis (SCE) is an important postpartum uterine disease of dairy bovine associated with huge financial loss to dairy industry. Few uterine fluid proteins were that could act as potential candidate biomarker(s) for early diagnosis of SCE in dairy cattle identified. Proteomic profiling using tandem mass tags (TMT) coupled with mass spectrometric analysis identified a total of 717 and 148 unique proteins in subclinical endometritis affected Deoni and HF crossbred cows, respectively as compared to normal cows. Among these, 197 proteins were identified to be common to both Deoni and HF crossbred subclinical endometritis affected cows. Gene ontology study revealed that the altered proteins were primarily involved in catalytic activity and cellular components and mainly played a role in metabolic process and binding activity in the cell. Network construction with very high confidence demonstrated that the major crosstalk of proteins and their interactions occurred via lysosomal pathway, pathways related to metabolism and leukocyte trans-endothelial migration pathway. After narrowing down, using different criteria, identified six potential proteins (Protein SCE1 to Protein SCE6) that had strong relationship with SCE, among which two proteins (Protein SCE1 and Protein SCE2) were validated. Western blotting analysis of uterine fluid from experimental cows indicated that the protein SCE1 was expressed more than 3-folds in both Deoni-and HF crossbred cows affected with subclinical endometritis, respectively as compared to normal cows. The protein SCE2 was expressed 5.0 times higher in Deoni cows affected with subclinical endometritis as compared to normal cows. Further validation using a separate set of experimental animals indicated that the proteins SCE1 could be a potential marker for SCE. The expression of protein SCE1 in uterine fluid of subclinical endometritis affected Deoni and crossbred cows was > 2 folds in both LC-MS/MS analysis and Western blotting. Further, the expression of this protein in validation population was also > 2 folds, thus, it could be considered as one of the potential putative markers (or in panel with other markers) for detection of subclinical endometritis in dairy cattle.



Testicular Level Transcriptomic Alterations between Zebu and Crossbred Bulls

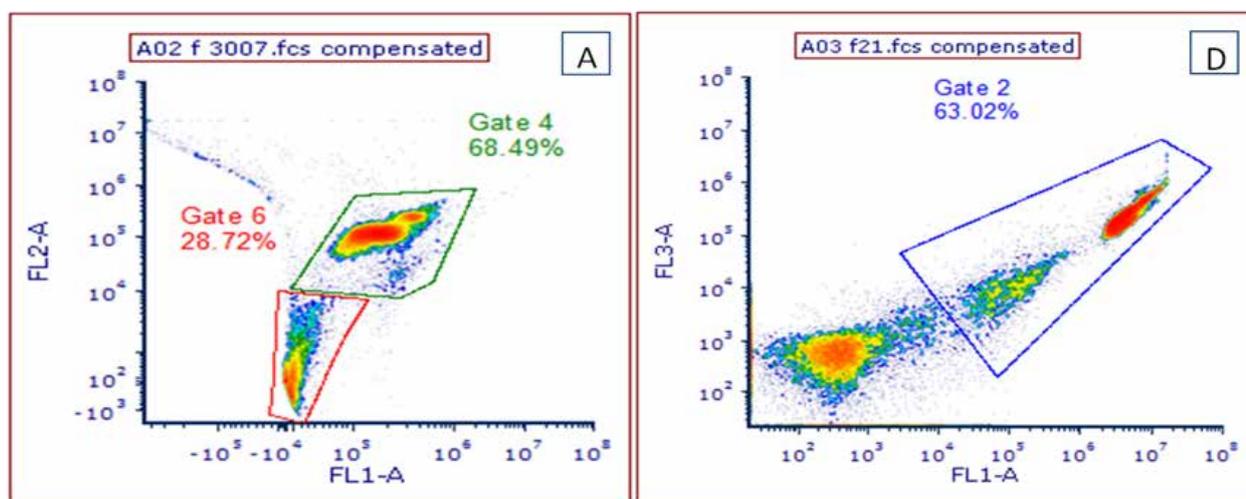
Understanding the testicular level alterations would help us to arrive at identification of possible etiological factors so that remedial measures could be taken up. In this regard, the global transcriptomic profile of testis from crossbred males was analysed and compared with indigenous males. Among the total 14419 transcripts detected in the testis, 1466 were differentially expressed between crossbred and indigenous males; of which 1038 were upregulated and 428 were downregulated in crossbred males. Pathway and gene ontology analysis were carried out to identify altered pathways in crossbred males. Upregulation of 22 genes involved in proteolysis, 11 genes involved in ubiquitin protein ligase activity and 4 genes involved in ubiquitin conjugating enzyme binding and downregulation of genes involved in WNT signaling, which is the regulator of protein integrity are collectively indicated the possibilities of abundant protein degradation in crossbred as compared to indigenous bulls. Down-regulation of genes such as HHEX, DUSP15, NGFR, TFAP2C and TEC (involved in cell proliferation) and MSX1, HOXD4, SETD6, FOXO4 genes (involved in stem

cell differentiation) indicated alterations in spermatogenesis in crossbred males. Down-regulation of CYP17A1, HSD3B1, ADCY9 and HSD17B7 genes indicate derangement in steroidogenesis in crossbred males, which is essential for male gonad development, spermatogenesis and sperm function. Genes related to heparin binding and cAMP metabolism were also downregulated in crossbred bulls indicating possible alterations in capacitation and acrosomal reaction of spermatozoa. Among the 5 genes validated using qPCR, expression of MSMB, PI4KB, SPATA7 and DPY19L2 followed the same trend as observed in microarray, among which SPATA7 (involved in spermatogenesis) was significantly downregulated. It was inferred that abundant proteolysis by ubiquitination and down regulation of WNT signaling, cell proliferation, differentiation and steroidogenesis might be the reason for higher incidence of poor semen quality and/or sub-fertility/infertility in crossbred males as compared to Zebu males.



Dynamics of Mitochondrial Membrane Potential and DNA Damage during Cryopreservation of Cattle and Buffalo Bull Spermatozoa

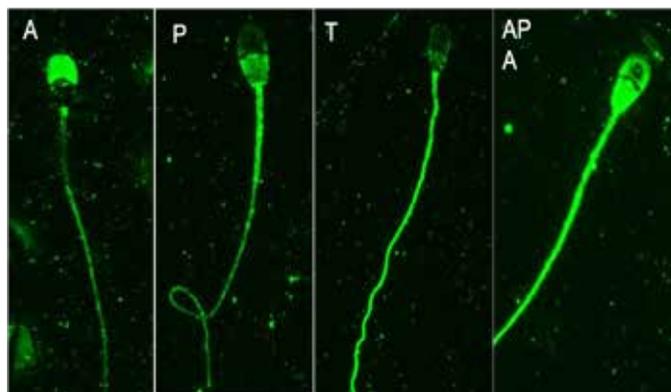
Understanding the changes in the spermatozoa during cryopreservation is indispensable for tailoring and increasing the efficiency of cryopreservation process. However, the dynamics of damages to sperm organelles during different stages of cryopreservation is hitherto underexplored. This study evaluated the mitochondrial membrane potential (MMP) and DNA damage during different stages of cryopreservation viz. immediately after ejaculation, after equilibration and after freeze-thaw in cattle and buffalo spermatozoa using flow cytometry. Proportion of spermatozoa with high MMP decreased significantly ($P < 0.05$) after equilibration. Sperm DNA integrity (%DFI) in Holstein bulls did not differ significantly between fresh and equilibrated samples but a significantly ($P < 0.05$) higher %DFI was observed in frozen-thawed semen samples as compared to both fresh and equilibrated samples. In contrast, %DFI in buffalo spermatozoa did not differ among the three stages of cryopreservation. It was concluded that (i) mitochondrial damaged occur during equilibration while chromatin damaged occur during freeze thawing of cattle bull spermatozoa and (ii) buffalo spermatozoa were lesser susceptible to DNA damage during cryopreservation as compared to cattle spermatozoa.



Sperm Cryo-capacitation and Crossbred Bull Fertility

Identification of subtle differences in the quality of cryopreserved spermatozoa among bulls belonging to different fertility rankings would help to determine the latent fertility of semen before their use at field conditions. In the present study, the status of tyrosine phosphorylation (Indicator of cryo-capacitation), membrane integrity and acrosome reaction of cryopreserved spermatozoa in crossbred bulls ($n=22$) with different levels of field

fertility and their relationship with fertility was assessed. Bulls were categorized into above-average (n=4), average (n=14) and below-average (n=4) based on their different field fertility rates. The progressive sperm motility was significantly ($P<0.05$) higher in above-average fertile bulls compared to either average or below-average fertile bulls whereas sperm membrane integrity and acrosomal reaction status did not differ among the three groups. The proportion of live tyrosine-phosphorylated spermatozoa were significantly ($P<0.05$) higher in below-average and average fertile bulls compared to above-average bulls.

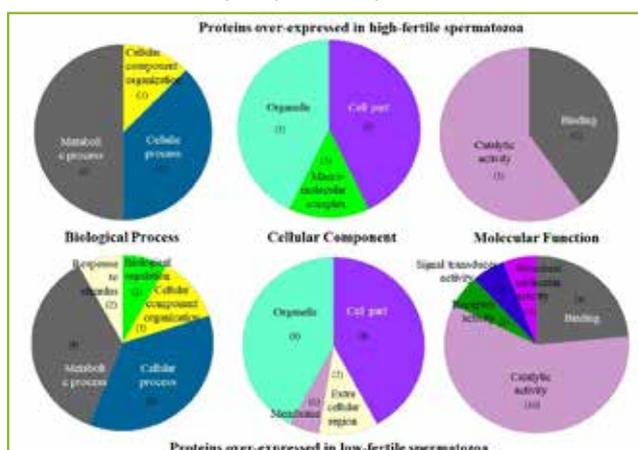


The proportion of spermatozoa showing tyrosine phosphorylation at acrosome and post-acrosomal area (APA) and at acrosome, post-acrosome and tail (APAT) were significantly ($P<0.05$) higher in below-average fertile bulls than other groups. The APA pattern ($r = -0.605$; $P<0.01$) and APAT ($r = 0.507$; $P<0.05$) pattern were significantly and negatively correlated with bull fertility. It was concluded that the proportion of cryo-capacitated spermatozoa in cryopreserved semen was negatively related to bull fertility.

Fertility Associated Proteins in Buffalo Spermatozoa

Some potential proteins were identified in the spermatozoa of buffalo bulls that could be used as an aid in fertility determination through comparative proteomics. The sperm proteome of high-fertile buffalo bulls was compared with that of low-fertile buffalo bulls using 2D-DIGE and the differentially expressed proteins were identified through mass spectrometric method.

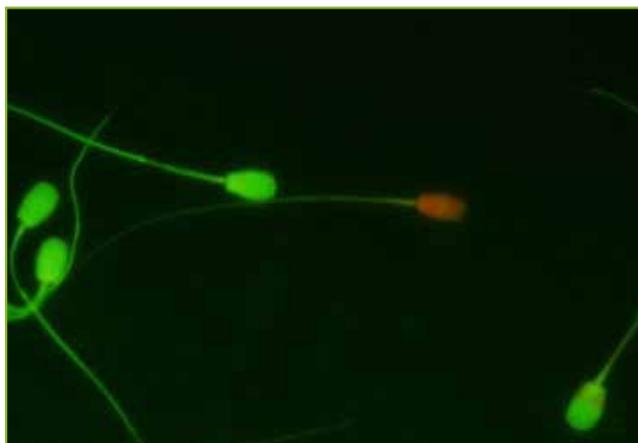
The protein interaction network and the functional bioinformatics analysis of differentially expressed proteins were also carried out. In the spermatozoa of high fertile bulls, 10 proteins were found over-expressed and 15 proteins were under-expressed at the level of two-fold or more ($P\leq 0.05$). The proteins over-expressed in high fertile spermatozoa were PDZD8, GTF2F2, ZNF397, KIZ, LOH12CR1, ACRBP, PRSS37, CYP11B2, F13A1, and SPO11, whereas those over-expressed in low fertile spermatozoa were MT1A, ATP5F1, CS, TCRB, PRODH2, HARS, IDH3A, SRPK3, Uncharacterized protein C9orf9 homolog isoform X4, TUBB2B, GPR4, PMP2, CTS1L1, TPPP2, and EGFL6. The differential expression ranged from 2.0- to 6.1-fold between the two groups, where CYP11B2 was high abundant in high fertile spermatozoa and MT1A was highly abundant in low fertile spermatozoa.



Most of the proteins over-expressed in low fertile spermatozoa were related to energy metabolism and capacitation factors, pointing out the possible role of premature capacitation and cryo-damages in reducing the fertility of cryopreserved buffalo spermatozoa.

Sperm-oviduct Binding Index is Influenced by Season in Murrah Buffaloes

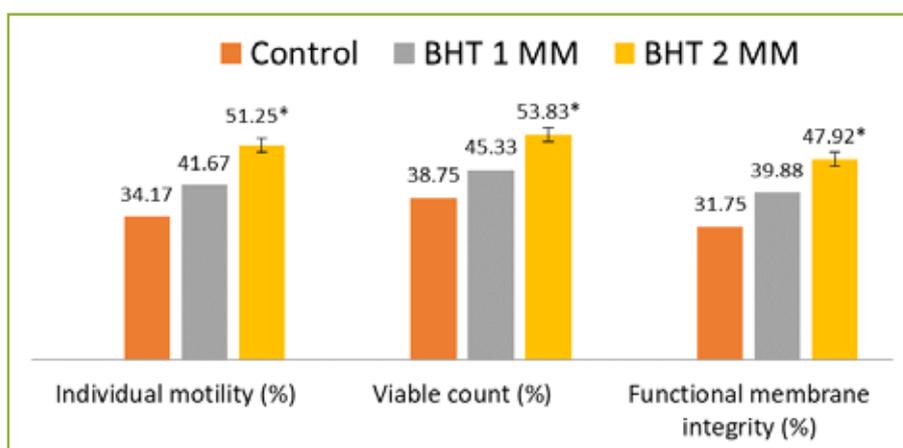
Seasonal fluctuations of climate are considered a major constraint for achieving high reproduction efficiency in buffaloes. The effect of season on fertility associated genes in spermatozoa and sperm-oviduct binding in water buffalo was investigated. Cryopreserved spermatozoa from 6 Murrah buffalo bulls (3 ejaculates/bull/season) were utilized for the present study. Frozen semen straws were thawed at 37°C for 30 seconds and sperm motility, membrane integrity, acrosome reaction and lipid peroxidation status were assessed in winter and summer ejaculates. Oviduct explants were prepared in TCM-199 and washed spermatozoa were added to the oviduct explants and incubated for 1 hour. Then, sperm-oviduct explants were stained with a fluorescent stain (JC-1) and sperm binding index (BI - No. of bound spermatozoa/unit area of oviduct



explants) was assessed. The proportion of motile and membrane intact spermatozoa were significantly higher ($p < 0.05$) in winter as compared to summer ejaculates. The proportion of dead and lipid peroxidised spermatozoa were significantly lower ($p < 0.05$) in ejaculates collected during winter as compared to summer. On the other hand, the expression of fertility associated genes did not differ significantly between the two seasons. However, the BI was significantly lower ($P < 0.01$) when spermatozoa collected from summer season were incubated with oviduct explants as compared to spermatozoa collected from winter season. In conclusion, it was observed that season had an influence on the semen quality and sperm-oviduct binding in the water buffalo bull spermatozoa.

Cryopreservation of Black Bengal Buck Semen – Effect of Antioxidant Additives on Cryo-survivability

To improve the post thaw recovery of Black Bengal buck semen, antioxidant additives such as butylated hydroxytoluene (BHT @ 0, 1, 2 mM) and catalase (@ 0, 50, 100IU) were tested against the standard semen extender Tris-fructose-egg yolk-glycerol (TFYG). Semen ejaculates were collected by artificial vagina and ejaculates were divided into three fractions- control and 2 treatment groups. After extension, the semen samples were equilibrated, cryopreserved in liquid nitrogen and stored. It was observed that supplementation of butylated hydroxytoluene @ 2 mM had significantly ($p < 0.05$) improved the cryo-survivability of sperm cells compared to control group. Semen ejaculates preserved with BHT @ 2 mM had significantly ($p < 0.05$) more post thaw motile sperm cells (51.25 ± 2.26 vs 34.17 ± 2.16); viable cells (53.83 ± 1.97 vs 38.75 ± 1.94) and functional membrane intact cells (47.92 ± 2.12) than the control group. BHT also significantly reduced the production of lipid peroxide compound MDA (0.38 ± 0.02 vs 0.58 ± 0.05 $\mu\text{mol/ml}$) than the control. Similarly catalase @ 50IU/ml had significantly improved the post thaw recovery when compared to control in terms of motile sperm cells (50.50 ± 3.03 vs 41.50 ± 2.33), viable cells (55.75 ± 2.98 vs 46.45 ± 2.33), functional membrane intact cells (46.15 ± 2.77 vs 37.05 ± 2.19). It could be concluded that BHT and catalase could be used as additives to improve the post thaw recovery of Black Bengal buck semen.



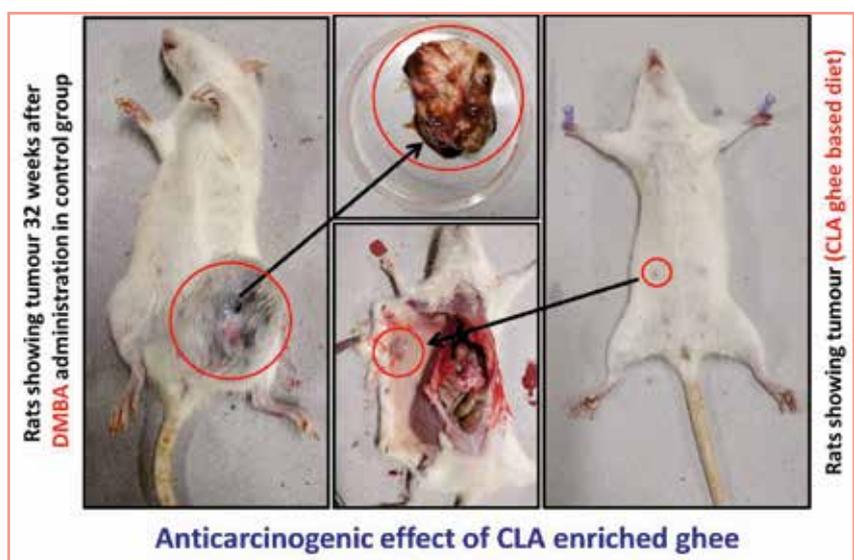
FEED, FODDER AND PRODUCTIVITY

Isolation, Identification and Submission of *Lactobacillus* Strains for Probiotic Attributes Isolated from Calves' Faeces

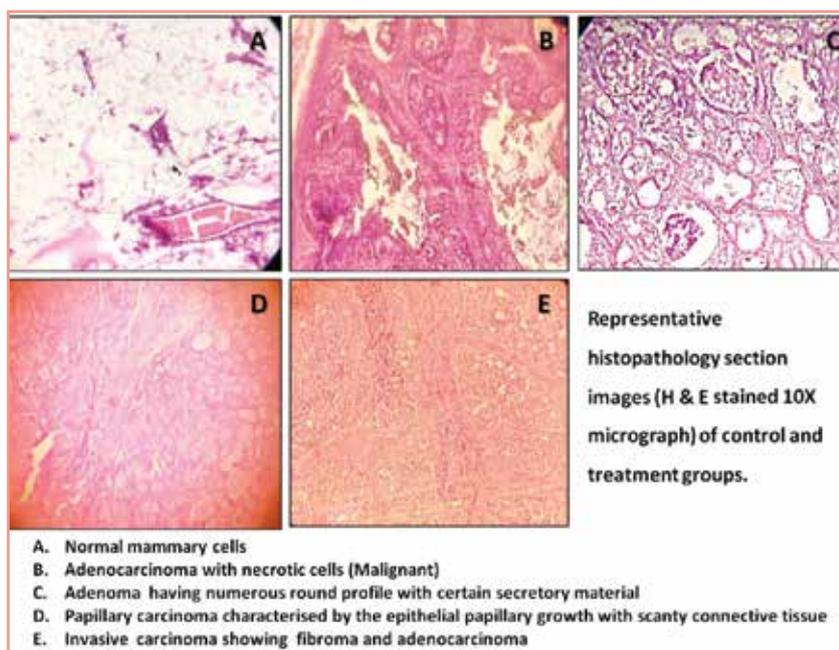
For isolation of *Lactobacillus*, a total of 30 fresh faecal samples were collected aseptically from rectum of different Sahiwal and Tharparkar cattle calves of 5-10 d old and homogenized in phosphate-buffered saline solution. A proven probiotics *L. acidophilus* NCDC15 for comparative evaluation of probiotic attributes was procured from National Collection of Dairy Cultures, ICAR-NDRI, Karnal, Haryana. The colonies on MRS agar were examined based on morphological, microscopic and biochemical tests involving Gram-staining, catalase test, carbohydrate fermentation pattern and genus specific PCR for identification prospective of lactic acid bacteria. Isolates were evaluated for cell surface hydrophobicity and auto-aggregation and selected lactobacilli were identified using 16S rDNA sequencing. The three best probiotics isolates were recognised as *Lactobacillus reuteri* SW26, *Lactobacillus reuteri* SW27, and *Enterococcus faecium* SW28.

Manipulation of Rumen Fermentation using Aloe Vera Extract to Enhance the Nutraceutical Value of Goat Milk

A study was conducted for duration of 90 days, to examine the effects of aloe vera plant extract supplementation on rumen bio-hydrogenation and nutraceutical value of goat milk. Twenty four lactating goats were selected and divided into 3 experimental groups. The control (T1) was fed with basal diet comprising of berseem and concentrate mixture (70:30) without any supplementation. The second (T2) and third (T3) groups were supplemented with aloe vera plant extract @ 2% and 4% of dry matter, respectively, alongwith the basal diet. The aloe vera supplemented group presented a greater amount of unsaturated fatty acids, including gamma linoleic acid in milk than the control fed with basal diet without supplementation. There was reduction in the amount of palmitic acid and stearic acid further leading to decreased total saturated fatty acids and thus, decline in the saturation index. The milk from goats fed with aloe vera containing diet displayed a greater antioxidant capacity than milk from lactating goats fed with control diet. The mRNA expression of Stearoyl CoA Desaturase, Acetyl CoA Carboxylase and Lipoprotein lipase remained unchanged by aloe vera extract supplemented groups, however expression of Fatty acid synthase, showed increasing tendency as compared to control. Overall, the study concluded that supplementation of aloe vera extract can enhance milk nutraceutical properties through manipulation of rumen fermentation. Ghee prepared from the experimental goat milk was evaluated for its anticarcinogenic, properties in lab animal model. The CLA enriched ghee was supplemented in a rat trial conducted for 4 months in 4 different groups (G1-Negative control with no tumour induction, G2-Positive Control with tumour induction, G3-Low CLA ghee with tumour induction, and G4-High CLA ghee with tumour induction). After 4 months of trial it was observed that body weight of positive control group (G2) was observed to be higher as compared to test groups (G3 and G4). Tumor incidence in positive control (G2), low (G3) and high CLA (G4) ghee fed groups was 63.06, 51.00 and 42.11, respectively.

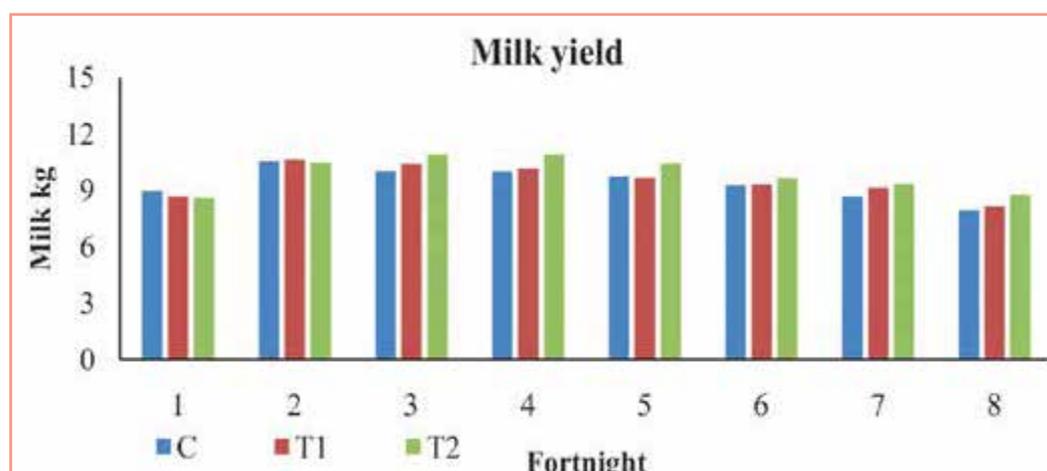


Based on histopathological study the occurrence (%) of fibroma, adenoma and fibroadenoma in G2 rats was higher. Oncogenic gene expression showed that in PPAR-gamma is up-regulated in both test groups by 1.2 and 4.06 fold where as COX-2 and C-MYC gene expression was observed to be down regulated both in G3 and G4 as compared to positive control.



Effect of Depotash Vinasse on Lactation Performance in Murrah Buffaloes

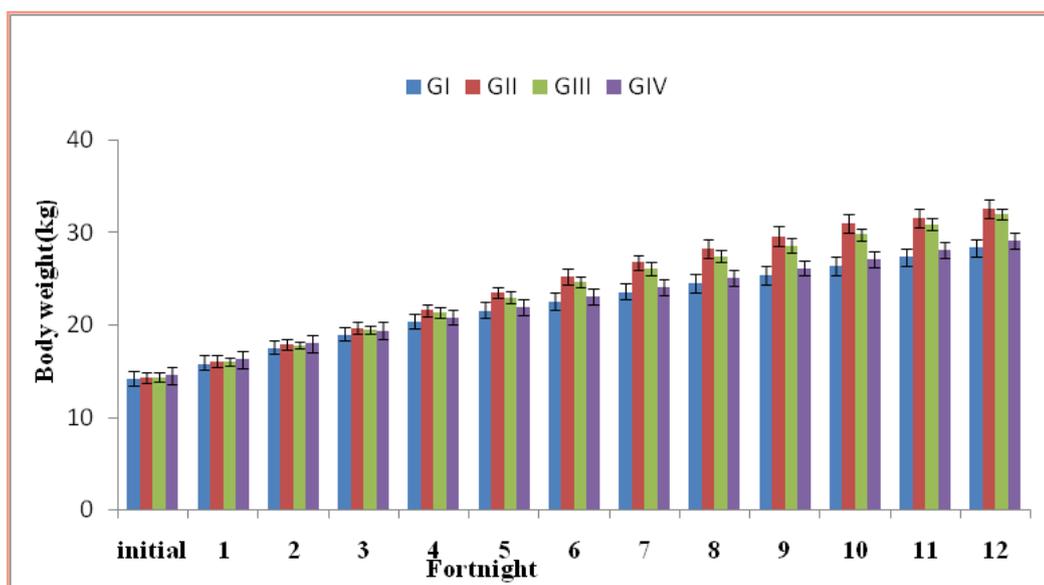
The present study was conducted to investigate the effect of molasses and depotash vinasse (DPV) as pellet binder on nutrient utilization, blood biochemical parameters and production performance in Murrah buffaloes. *In vivo* trial with fifteen early lactating Murrah buffaloes were randomly distributed on the basis of milk yield and days in milk in three groups *viz.*, control, T₁ and T₂. Animals in control group fed basal diet consisting of concentrate mix, oat green and wheat straw; T₁ animals supplemented with molasses pellet with oat green and wheat straw while T₂ animals were fed pellet depotash vinasse with oat green and wheat straw. There was no change in body weight and body condition score due to dietary treatment. Milk yield, FCM yield (kg/d) was not altered and also there was no changes observed in milk composition. There was no effect of dietary treatment on digestibility of any of the nutrients and calculated values of TDN (%) were similar in all the groups. Nitrogen balance as percent of intake and absorbed nitrogen did not vary significantly ($P>0.5$) among the control and treatment groups. The plasma glucose, total protein, albumin, BUN, total cholesterol, AST and ALT level in C, T₁ and T₂ groups were within normal biological range and statistically ($P>0.05$) similar. The mean plasma Ca, Mg, Na, K, Zn, Cu and Fe were not influenced by molasses and depotash vinasse pellets supplementation. It could be concluded that depotash vinasse@ 8% may be utilized for pellet making without any adverse effect on yield and composition of milk, digestibility of nutrients and blood biochemicals to the early lactating buffaloes.



Fortnightly milk yield of Murrah buffaloes in various groups fed concentrate (C), pellet of molasses (T1) and depotash vinasse (T2).

Effect of *Moringa Oleifera* on Growth Performance and Enteric Methane Emission in Kids

Moringa oleifera (sahjan) is known to have many health beneficial effects due to its higher mineral, vitamins, secondary metabolites, antioxidants and other biomolecules and termed as 'miracle tree'. In the present study, effect of *Moringa oleifera* leaf on enteric methane emission and performance of goats was observed. Twenty four goat kids (3-4 months of age) were randomly distributed into 4 groups, 6 animals each in Randomized Block Design (RBD). Group I kids was fed control diet with 70:30 roughage concentrate ratio with berseem and concentrate. Group II, III and IV kids were fed with 60:40, 70:30 and 80:20 roughage concentrate ratio with 10%, 20% and 20% of concentrate were replaced by *M.oleifera* leaf powder, respectively, for 180 days. Body weight gain (kg) was higher ($P<0.05$) in GII (18.18) and GIII (17.48) as compared to GI (14.13) and GIV (14.59). Average daily gain (ADG) g/d was higher in GII (101.01) and GIII (95.68) as compared to GI (79.22) and GIV (81.42). DMI (g/d) was also higher ($P<0.05$) in GII (708.28) and GIII (705.69) compared to GI (655.16) and GIV (669.06). Feed conversion efficiency (weight gain/DMI) was higher ($P<0.05$) in GII (0.14) and GIII (0.14) than GI (0.12) and GIV (0.12). Crude protein intake (g/d) and total digestible nutrient intake (g/d) was also higher ($P<0.05$) in GII (119.54, 471.20) and GIII (115.12, 462.20) than GI (106.28, 429.20) and GIV (105.16, 430.91). Crude protein, ether extract and acid detergent fibre digestibility was not altered by the replacement of concentrate with *M.oleifera* leaf powder. Dry matter, organic matter and neutral detergent fibre digestibility (%DM) was increased ($P<0.05$) in GII (69.70, 71.89 and 54.91) and GIII (70.82, 71.76 and 56.04) as compared to GI (66.84, 69.56 and 52.94) and GIV (67.68, 69.75 and 53.35). Nitrogen balance (g/d) was higher ($P<0.05$) in GII (2.87) and GIII (2.60) compared to GI 2.29 (2.29) and GIV (2.44). Enteric methane emission was similar with replacement of concentrate with *M.oleifera* leaf powder; though methane emission (g/kg DMI) was found to be 7.03%, 7.65% and 6.35% lower in GII, GIII and GIV as compared to GI. The anti-oxidant activity (GPx, Catalase and SOD) was higher ($P<0.05$) in GII (14.80, 54.80 and 93.28), GIII (15.03, 55.03 and 93.40) and GIV (14.68, 54.68 and 93.04) than GI (14.17, 14.68 and 91.69), respectively. There was no effect in the blood mineral profile with the replacement of concentrate with *M.oleifera* leaf powder except Ca (mg/dl), though, it was within biological range Cell mediated immunity and humoral immunity was improved by *M.oleifera* leaf powder replacement groups i.e GII, GIII and GIV than GI.

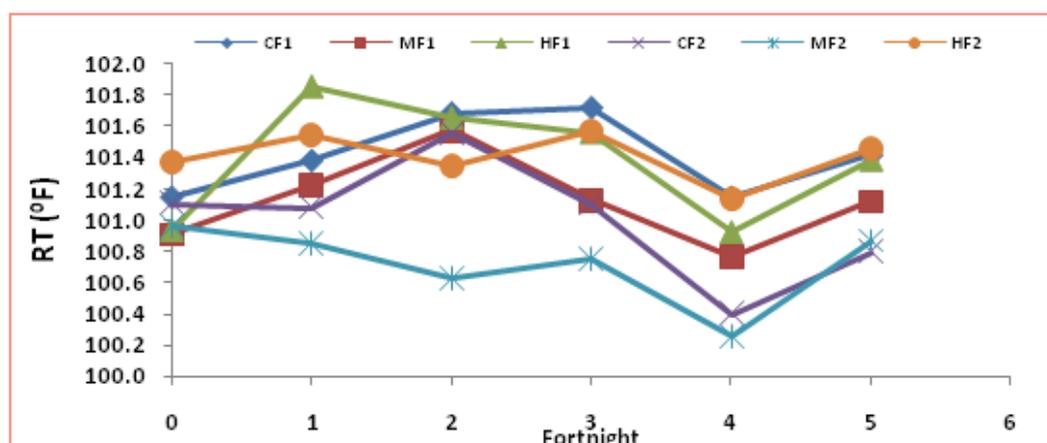


Fortnightly body weight changes (kg) of goats fed with replacement of concentrate with *Moringa oleifera* leaves in different groups

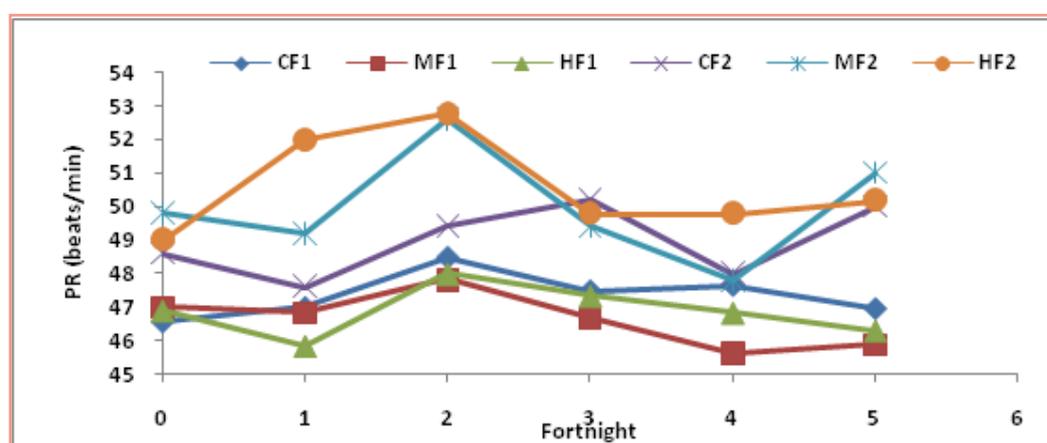
Optimizing Fiber and Protein Levels for Amelioration of Heat Stress in Lactating Murrah Buffalo

Heat stress negatively influences farm animal productivity and thus affecting both, the human food supply chain and the livestock economy. Decrease in feed intake by animals is a way to reduce heat production in warm environments as the heat increment of feeding is an important source of heat production in ruminants. Alteration in dietary fiber and protein which is major portion of ruminant diet has positive effects on physiological status and production performance. The objective of present study was to evaluate the effect of altering dietary neutral detergent fiber (NDF) and protein level on physiological and productive response of lactating Murrah buffaloes under thermal stress. Murrah buffaloes were divided into six treatment groups (n=6). The study groups were separated by diet having different fiber and protein levels. The dietary treatments involved three levels of fiber as 30% NDF followed by 15% and 20% higher NDF respectively and two levels of metabolizable protein as 7.0% (ICAR, 2013) and 8.4% (i.e 20% higher than recommended). Henceforth, the six diet formulated having different combinations of fiber and protein were 30% NDF and 7.0% MP (control; CL1); 34.5% NDF and 7.0% MP (medium;

MF1); 37% NDF and 7.0% MP (high; HF1); 30% NDF and 8.4% MP (control: CF2); 34.5% NDF and 8.4% MP (medium; MF2) and 37% NDF and 8.4% MP (high; HF2). The treatment groups were ultimately fed one of six different diets formulated varying in amount of fiber and protein.



Fortnightly variation in rectal temperature of Murrah buffaloes



Fortnightly variation in pulse rate of Murrah buffaloes

The fortnightly changes recorded show an initial increase in activity which lowers towards the end of feeding trial. Pulse rate did not vary ($P > 0.01$) among groups fed similar protein level. However group fed 37% NDF and 7% MP had maximum PR. Lowest RT ($P < 0.01$) was recorded in Murrah buffaloes fed 34.5% NDF and 8.4% MP. BR was similar and lower in dietary treatments having 8.4% MP. Significantly ($P < 0.01$) high BR was recorded in Murrah buffaloes fed 30% NDF and 7% MP.

Fat content in milk increased significantly ($P < 0.01$) with increasing fibre and protein content of diet. Lower fat content in milk was observed in Murrah buffaloes fed 30% NDF in diet irrespective of protein content. An increase of 12.7% and 9.4% fat content in milk of MF2 and HF2 group respectively was observed when compared to CF1.

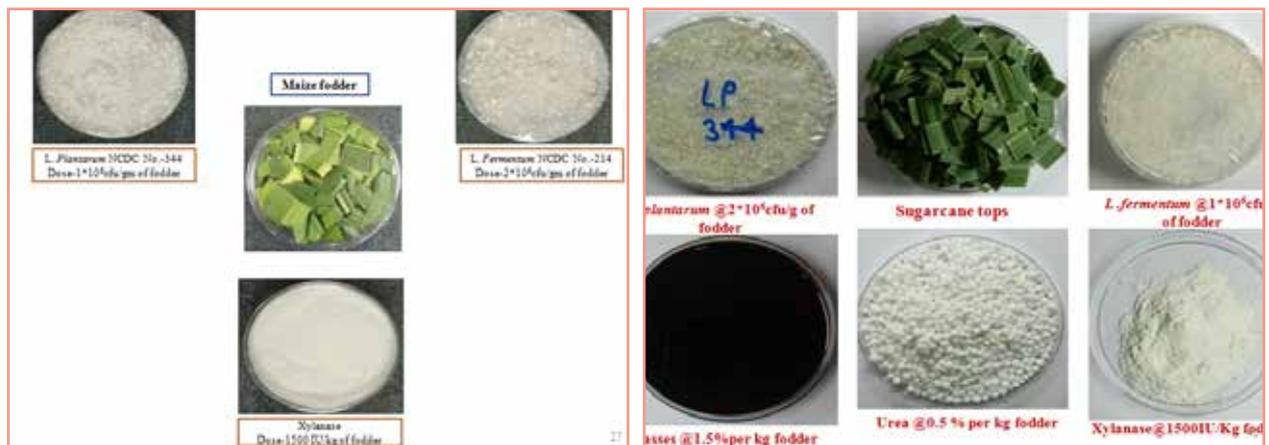
Table: Milk yield, composition and feed efficiencies among experimental lactating Murrah buffaloes

Attributes	CF1	MF1	HF1	CF2	MF2	HF2	SEM	P-value
	7.0%MP			8.4%MP				
Production, kg/d								
Milk	9.87 ^{ab} ± 0.24	10.32 ^{ab} ± 0.30	9.37 ^a ± 0.28	10.13 ^{ab} ± 0.30	10.69 ^b ± 0.20	9.92 ^{ab} ± 0.27	0.110	0.018
6% FCM	9.93 ^a ± 0.24	11.01 ^{ab} ± 0.33	10.24 ^a ± 0.32	10.30 ^a ± 0.30	11.47 ^b ± 0.24	10.96 ^{ab} ± 0.33	0.125	0.002
ECM	12.90 ^a ± 0.33	14.16 ^{ab} ± 0.41	13.16 ^a ± 0.41	13.65 ^{ab} ± 0.40	15.01 ^b ± 0.31	14.33 ^{ab} ± 0.44	0.164	0.001
6%FCM/DMI	0.72 ± 0.01	0.79 ± 0.02	0.74 ± 0.02	0.75 ± 0.05	0.82 ± 0.03	0.81 ± 0.05	0.014	0.366
Milk composition (%)								
Total solid	10.02 ^a ± 0.07	10.51 ^b ± 0.09	10.72 ^b ± 0.09	10.18 ^a ± 0.07	10.60 ^b ± 0.06	10.73 ^b ± 0.05	0.035	0.000
Fat	6.03 ^a ± 0.04	6.57 ^b ± 0.06	6.78 ^b ± 0.07	6.17 ^a ± 0.07	6.60 ^b ± 0.05	6.81 ^b ± 0.05	0.031	0.000
Protein	3.99 ± 0.05	3.93 ± 0.06	3.94 ± 0.06	4.00 ± 0.04	3.99 ± 0.03	3.92 ± 0.02	0.020	0.778

Based on the current research study, it could be concluded that the positive effects of alteration of dietary fiber and protein on nutrient intake, apparent digestibility, efficiency of nutrient utilization and hence milk production in mid lactating Murrah buffaloes under thermal stress could be achieved by including 34.5% dietary NDF and increasing metabolizable protein content to 8.4% MP in diet of Murrah buffaloes in tropics as an ameliorative strategy to combat the effect of heat stress.

Development and Evaluation of Additives for Small Scale Silage Production

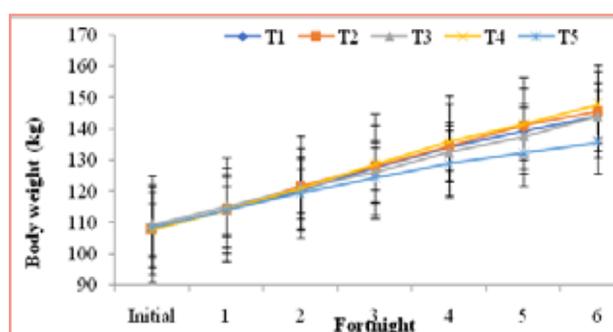
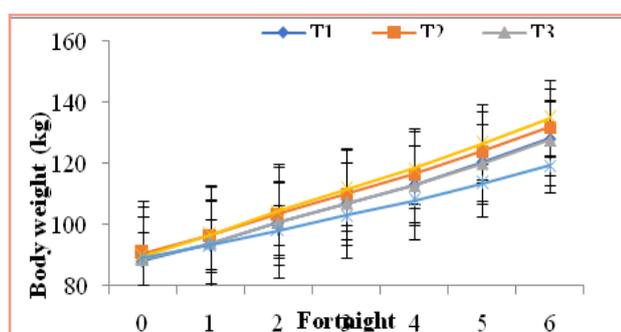
The present study was carried out to compare the effect of different additive combinations on Maize/ Sugargraze / Sugarcane Tops silage quality and development of the silage additive product for enhancing silage quality. After testing numerous chemical. Enzymes and bacterial additives and additive combinations, in plastic vacuum sealed containers, following combinations were tried in last phase of research project; *Lactobacillus Plantarum* (LF), *L. Fermentum* (LF), Cellulase (C), Xylanase (X). The containers were stored at room temperature for 30 days. Sampling was done after 30 days and analyzed for their fermentation parameters, chemical composition and microbiology. Additives used in maize study was effective in reduction of silage pH and the lowest pH was observed in LP+LF+C+X. Lactic content was higher in additives treated fodder as compare to control and the highest value was observed in LP+LF+X+C i.e. 8.43 (P<0.05). On the basis of modified fitness value LP+LF+X+C, LP+LF+X, LP+LF+C, LP+X+C, LP+LF+PA are best additive combination for maize silage. Sugarcane tops silage treated with a combination of EFE and LAB inoculants showed a decline in pH and NDF as comparative to control. Lowest value of pH was observed in C+X+LP+LF. The lactic acid content ranged from 4.89 (control) to 8.76 (C+X+LP+LF), all enzymes and bacterial inoculants treated silage has (p<0.05) higher lactic acid contents than control. The highest LAB count was observed in C+X+LP+LF, it was 9.85 log10cfu/g at 15 days, followed by C+X+LF, C+X+LP respectively, Ensiling increased LAB number at the beginning because of high available substrate. On the basis of Flieg point C+X+LP+LF, C+X+LF, X+LP+LF, C+X+LP and PA+LP+LF are the best additives combination for Sugarcane tops silage. On the basis of cost LP+LF+X combination was finalised for silage additive, in case of sugarcane tops molasses (1.5% FM basis) and Urea (0.5% FM basis) was added.



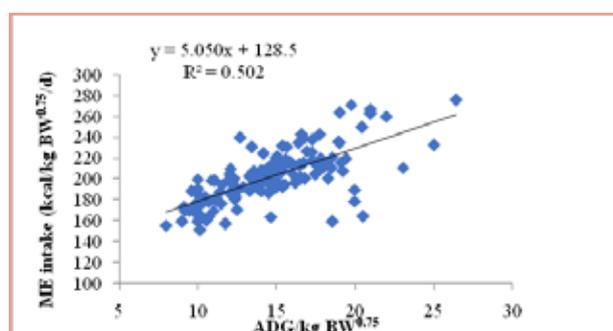
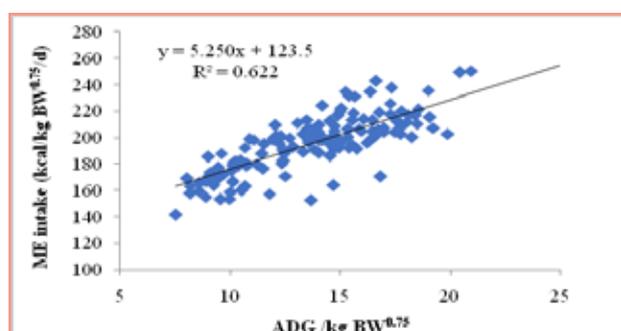
Season-specific Metabolizable Energy (ME) and Protein (MP) Requirement of Growing Sahiwal Heifers

In order to assess the metabolizable energy (ME) and metabolizable protein (MP) requirements and effect of different levels of metabolizable energy and protein on growth performance and certain metabolic hormones in female Sahiwal calves the present study was conducted in two seasons. For this purpose two feeding trials were conducted one in winter season and another in summer season on 50 female Sahiwal calves. Animals in control ME₀MP₀ were fed standard rations to meet their nutrient requirements (ICAR, 2013). Animals in groups ME₀MP₁₅ and ME₀MP_{0.15} were fed 115% and 85% MP. Animals in groups ME₁₅MP₀ and ME₁₅MP₀ were fed 115% and 85% ME of control, respectively during both the trials. The basal diet of animals was consisting of wheat straw, Sugargraze (green fodder) and concentrate mixture. Intake of CP (kg/100kg BW) and MP (g/100kg BW) were higher (P<0.05) in ME₀MP₁₅, whereas DMI (kg/100kg BW) and ME (Mcal/d) intake were found to be higher in (P<0.05) ME₁₅MP₀ during both the seasons. There was no significant difference in digestibility of the nutrients between groups during summer season but CP digestibility was found increased as increasing the CP content of the diet during winter season trial. Nitrogen intake (g/d) and urinary nitrogen excretion (g/d) were higher in group ME₀MP₁₅ (P<0.05). Absorbed nitrogen (% NI) and retained nitrogen (g/d and % NI) showed significant difference and were found to be higher in groups ME₀MP₁₅ and ME₁₅MP₀, respectively during both the seasons. Physiological parameters like respiration rate (bpm) and skin temperature (°C) were similar among the groups; however rectal temperature (°C) showed a significant (P<0.05) increase in group ME₁₅MP₀ compared to other groups during both the seasons. Plasma concentration of IGF-1, insulin, leptin and total immunoglobulin's were higher (P<0.05), whereas, concentrations of growth hormone

and cortisol were lower ($P < 0.05$) in group $ME_{15}MP_0$ as compared to other groups during winter and summer trials. Average daily gain (g), higher weight gain and lower FCR were recorded in $ME_{15}MP_0$ group compared to the rest of the groups in both the seasons. The ME requirements for maintenance and growth of Sahiwal calves were 123.57 kcal/kg $W^{0.75}$ and 5.25 kcal ME for g ADG/kg $W^{0.75}$ /d and MP requirements for maintenance and growth were 2.545g/kg $BW^{0.75}$ and 0.267 g ADG/kg $W^{0.75}$ /d respectively for winter season. Likewise the ME requirements for maintenance and growth of Sahiwal calves were 128.51 kcal/kg $W^{0.75}$ and 5.05 kcal ME for g ADG/kg $W^{0.75}$ /d and MP requirements for maintenance and growth were 2.713 g/kg $W^{0.75}$ and 0.263 g ADG/kg $W^{0.75}$ /d, respectively for summer season. Nutrients intake (% BW), N balance (g/d) were higher ($P < 0.05$) during the winter season, digestibility (%) of nutrients (DM, CP) was significantly ($P < 0.05$) higher in summer season. During the winter season antioxidant and immune status, plasma concentration of GH, IGF-1, Insulin, Leptin, T_3 and T_4 were higher ($P < 0.05$) however cortisol was higher in summer season. ADG and FCR were higher ($P < 0.05$) during the winter season as compared to summer season. As compared to the ICAR (2013) recommendations for growing cattle in general, MP requirement for growing Sahiwal heifers may be reduced by 15%, whilst the ME content may be increased by 15%. These breed specific requirements would be beneficial in achieving optimum growth performance of this valuable indigenous germplasm. Additional benefits of this increment in ME are increased plasma concentration of IGF-1, Insulin, Leptin and Tlg and lower concentrations of GH and Cortisol. Requirements of ME and MP should be higher during the summer season as compared to winter season.



Effect of feeding different levels of metabolizable energy and protein on fortnightly body weight (kg) in female Sahiwal calves during winter season



Relationship between ME intake (kcal/kg $BW^{0.75}$ /d) and ADG /kg $BW^{0.75}$ of female Sahiwal calves during winter season

A Study on Comparative Nutrient Utilisation and Methane Emission in Cattle and Buffaloes

The study was conducted at Livestock Research Center of ICAR-National Dairy Research Institute, Karnal. Total eighteen apparently healthy lactating animals that are 6 Murrah buffaloes, 6 Karan fries and 6 Sahiwal of mid lactation were selected and divided in to three groups of six animals each. Grouping of animals based on their average body weight, average milk yield and average milk fat percentage. All the animals were fed as per their nutrient requirements as per ICAR (2013) feeding standards starting from mid lactation stage for 90 days. Green Oat forage was supplied by farm section of the institute and chopped freshly to feed experimental animals twice a daily. Proximate analysis and estimation of cell wall constituents were done by AOAC, (2005) and Von soest *et al.*, (1991). Body weights were taken fortnightly, and milk yield was recorded daily for 90 days. Fortnightly milk composition and Milk urea nitrogen were performed by automated milk analyzer and MUN kit. Methane production by the animals was measured by SF_6 tracer technique (Johnson *et al.*, 1994). Enteric methane (CH_4) emission and related parameters of experimental animals were estimated. CH_4 emission (g/d) was significantly ($P \leq 0.05$) lower ($p < 0.05$) in GP-II (93.06 ± 18.47) as compared to GP-I (224.45 ± 16.12) and GP-III (150.64 ± 11.37). Methane emission per kg DMI was non-significantly different among groups, however CH_4 produced (g/kg DDMI) and g/kg milk was lower in GP-II as compared to GP-I and GP-III. Moreover, methane emission (Mcal /d) as well as % of GE and ME intake was also lower ($P \leq 0.05$) in GP-II in comparison to GP-I and GP-III.

Table: Methane emission and Loss of methane energy (%) from energy intake in the three groups.

Parameter	GP-I	GP-II	GP-III	P value
CH ₄ (g /d)	224.45 ^a ± 16.12	93.06 ^b ± 18.47	150.64 ^{ab} ± 11.37	<0.001
CH ₄ (Mcal /d)	2.99 ^a ± 0.09	1.24 ^a ± 0.11	2.00 ^b ± 0.09	<0.001
CH ₄ (g/kg milk)	28.06 ^a ± 3.37	19.00 ^{ab} ± 5.99	12.55 ^b ± 2.68	0.02
CH ₄ (g/kg DMI)	21.68 ± 1.84	16.95 ± 2.84	22.80 ± 1.45	0.2
CH ₄ (g/kg DDMI)	34.96 ^a ± 2.97	21.50 ^b ± 0.48	36.20 ^a ± 2.31	0.01
Methane energy loss as %				
GEI	6.84 ^a ± 0.47	3.74 ^b ± 0.19	4.32 ^b ± 0.18	<0.001
DEI	11.14 ^a ± 0.73	6.13 ^b ± 0.35	6.8 ^b ± 0.30	<0.001
MEI	13.34 ^a ± 0.87	7.33 ^b ± 0.42	8.16 ^b ± 0.36	<0.001

^{a,b} bearing different superscripts in same row differ significantly (p<0.05)

The results of the study indicated that methane emission and loss of energy as methane was higher in buffaloes in comparison to indigenous and crossbred cattle.

Effect of Different Concentrate to Forage Ratios on the Performance of Goat Kids

The present study was undertaken to evaluate the effect of isonitrogenous diets varying in concentrate to forage ratio on growth performance, enteric methane emission and nutrient utilization in goat kids. Fifteen goat kids (3-4 months age) were divided into three groups based on average body weight and treatments were assigned to the different groups randomly. The first group (GP-I) received a total mixed ration (TMR) containing concentrate mixture and berseem fodder in the ratio of 70:30. The TMR of second (GP-II) and third (GP-III) groups consisted of concentrate mixture and berseem fodder in the ratio of 50:50 and 20:80, respectively. The results of 90 days feeding study revealed that the intake of dry matter (DM), crude protein (CP) and total digestible nutrients (TDN) was significantly higher (p<0.05) in GP-I than GP-II and GP-III. Furthermore, although the digestibility coefficients of DM and CP were not affected by the treatments, NDF and ADF digestibility increased significantly in GP-II and GP-III compared to GP-I. The average weight gain was significantly higher (p<0.05) in GP-I than GP-II and GP-III, however the nitrogen balance and enteric methane emission did not differ across the groups.

It was concluded that increased level of concentrate in TMR may improve the growth performance of goat kids without any effect on enteric methane emission. CH₄ emission (g/day) in groups T₁, T₂ and T₃ was 7.73 ± 0.45, 10.25 ± 0.67 and 8.72 ± 1.15, respectively. The value was lower in T₁ than in other groups, however, the difference among the treatment groups were not significant (p>0.05). Methane emission (g/kg DMI) was found to be 12.88 ± 1.87, 19.57 ± 0.73 and 15.17 ± 2.84 in T₁, T₂ and T₃, respectively. CH₄ (g/kg DMI) was lowest in the highest energy fed group but the results were statistically non-significant (p>0.05). CH₄ emissions (g/kg DDMI) were 19.84 ± 2.86, 30.97 ± 3.03 and 23.57 ± 4.38 in groups T₁, T₂ and T₃, respectively. CH₄ emission (g/kg DDMI) was also lower in T₁ as compared to groups T₂ and T₃, but the difference was non-significant statistically (p>0.05). Methane energy loss as % GE ranged from 4.13 ± 0.60 to 6.28 ± 0.23 and was found to be lowest in high energy fed group T₁, though the results were non-significant (p>0.05). CH₄ loss as percentage of DE and ME were found to be statistically not different (p>0.05) among the groups and the values were 5.57 ± 0.81 and 6.43 ± 0.93 in T₁, 9.01 ± 0.34 and 10.53 ± 0.39 in T₂ and 7.74 ± 1.45 and 9.24 ± 1.73 in T₃, respectively.

Table: Enteric methane emission in goat kids in three treatment groups fed rations with different concentrate to forage ratios

Parameter	T ₁ (70:30)	T ₂ (50:50)	T ₃ (20:80)
CH ₄ (g/d)	7.73 ± 0.45	10.25 ± 0.67	8.72 ± 1.15
CH ₄ E (MJ/d)	0.431 ± 0.025	0.572 ± 0.037	0.487 ± 0.064
GEI (MJ/d)	10.76 ± 1.21	9.12 ± 0.57	10.30 ± 0.95
DEI (MJ/d)	7.99 ± 0.90	6.36 ± 0.40	6.48 ± 0.60
MEI (MJ/d)	6.92 ± 0.78	5.44 ± 0.34	5.43 ± 0.50
DMI (kg/d)	0.402 ± 0.048	0.338 ± 0.040	0.381 ± 0.041
CH ₄ g/kg DMI	12.88 ± 1.87	19.57 ± 0.73	15.17 ± 2.84
CH ₄ g/kg DDMI	19.84 ± 2.86	30.97 ± 3.03	23.57 ± 4.38
CH₄ energy loss as %			
GE intake	4.13 ± 0.60	6.28 ± 0.23	4.87 ± 0.91
DE intake	5.57 ± 0.81	9.01 ± 0.34	7.74 ± 1.45
ME intake	6.43 ± 0.93	10.53 ± 0.39	9.24 ± 1.73

Status of Nickel in Feeds and Effect of its Supplementation on Growth Performance in Crossbred Calves

Nickle (Ni) has been classified as probably essential element. The concentration of Ni in commonly used feedstuffs and its roles in animals particularly ruminants are not well elucidated. Sixty samples of feeds were collected from Karnal district of Haryana and 30 from Palampur area of Himachal Pradesh for Ni estimation. The range of Ni content in cereal fodders, leguminous fodders, oilseed cakes, agroindustrial byproducts and straws was 0.11-6.13 ppm, 1.01-3.09 ppm, 1.13-5.38 ppm, 0.46-1.46 ppm and 1.64-1.87 ppm, respectively in Karnal while the variation in Ni concentration was 1.12-1.42 ppm, 3.91-4.68 ppm, 1.98-5.25 ppm and 1.03-2.03 ppm in cereal fodders, leguminous fodders, oil seed cakes and agroindustrial byproducts in Palampur. Supplementation of Ni at 5.0, 7.5 and 10.0 ppm to the basal diet (ICAR, 2013) was not found to affect feed intake (3.10% of BW), daily body weight gain (760 g) and feed conversion ratio (8.75 kg feed consumed/kg gain) to a significant extent in Karan Fries male calves in a 150 days study.

Performance of Fodder Maize and Cowpea Intercropping Followed by Oats for Seed Production under Different Nutrient Management Practices

Experiment was conducted during *kharif* and *rabi* season of 2018-19 in *split plot design*. The treatment was allocated in main plot with 4 intercropping [C1: Fodder maize-Oats; C2: Fodder cowpea-Oats; C3: Fodder maize cowpea (1:1)-Oats; C4: Fodder maize+cowpea (2:1)-Oats] and in sub plots with 5 nutrient management practices [F1: Control; F2: 100% RDNPK+Zn; F3: 125%RDNPK+Zn; F4: 75%RDNPK+Zn+FYM+PGPR; F5: 100%RDNPK+Zn+FYM] consisted 20 treatment combinations and replicated thrice. Application of ZnSo₄ @12.5 kg to 1st *kharif* and 2nd *rabi* season crop. Application of FYM @10t/ha to *kharif* season crop. The performance of crops was recorded and worked out the system productivity and profitability of the systems. At harvest, except plant height other parameters viz., stem girth, leaf length, number of leaves of maize were recorded in maize+cowpea-oats (1:1) at harvest while in cowpea the maximum plant height, no. of leaves were recorded in maize+cowpea-oats (1:1) and leaf width, leaf length in maize+cowpea-oats (2:1). However the maximum growth parameters of maize and cowpea were recorded with the application of 75% RDNPK+Zn+FYM+PGPR at harvest. It was significant difference from control at harvest. Significantly higher total green fodder and dry matter yield were obtained by Maize as sole cropping followed by maize+cowpea (1:1)-oats. The highest system productivity was worked out by Maize+Cowpea (1:1)-Oats crop sequence with application of 75%RDNPK+Zn+FYM+PGPR gave highest profitability which was at par with 125% RDNPK+Zn application.

Evaluation of Oat and Berseem Varieties under Different Agronomic Practices vis-a-vis Management of Nitrate Toxicity

Field experiment was conducted to evaluate the oats varieties under varying fertility levels and seed rates. The experiment was conducted in split plot design by keeping four oats varieties (Kent, JHO-851, HJ-8 and HFO-114) in main plot and combination of fertility levels (100% RDF, 125% RDF, 75% RDF+ PGPR and 75% RDF+ PGPR+ FYM) and seed rates (75, 90 and 105 kg seed/ha) in subplot. The first year results indicated that oats variety JHO-851 with 125% of RDF recorded highest growth and yield followed by HJ-08. Seed rate of 105 kg/ha, recorded highest grain and fodder yield was recorded. The experiment would be repeated for two years and concluded based on two year pooled data analysis.

Development of Diversified Fodder cum Seed Production System for Sustainable Production and Profit Maximization of Dairy Farmers in Indo-Gangetic Plains of India

The objective of the study was to evaluate the different cropping system for year round quality fodder production under assured irrigation condition. The experiment was conducted in *RCBD* with three replications. The following treatments were evaluated viz. Sole Bajra Napier Hybrid; Sole Guinea Grass; Bajra Napier Hybrid + Cow pea-Berseem; Guinea Grass + Cow pea-Oat; Multi cut sorghum- Berseem; Cow pea(seed)-Maize- Oat; Baby corn-Cow pea-Chinese cabbage; Summer Moong (seed)- Multi cut sorghum-Rye grass. The experiment was repeated two consecutive years and represented by the average data. Among the different fodder crops, NBH + cowpea/- berseem (2 cutting) produced significantly higher green fodder yield (173 t/ha), DMY (31.5 t/ha) and Crude Protein yield (41 q/ha) over to other cropping systems. However, lowest was produced by Baby corn-cowpea-chinese cabbage(s) (60 t/ha). The economic analysis of different systems the Baby corn-cowpea-chinese cabbage (Seed) were recorded higher gross as well net income over to rest fodder crops. Based on growth duration it was generate maximum profit around 2.40 lakh Rs./year/ha or 658 Rs./day/ha with 3.17 B: C ratio. But green fodder availability through this system was limited in some parts of year. It could be concluded that round the year quality green fodder production, adoption of NBH + Cowpea-Berseem inter cropping system was found more productive in comparison to others cropping system.

Crop Diversification through Fodder Crop to Maximization of Fodder Yield, Profitability and Sustain Soil Health

Field experiment was conducted to evaluate the different fodders crops for higher biomass production and sustain the soil health. The experiment was conducted in split plot design with three replications. The main plot consisted with Rice-wheat and Maize-pear millet cropping sequence and sub plot was nutrient management. Based on one year study of crop diversification with inclusion of nutrient management strategies it was found that cereal based cropping system application of PGPR with RDF gave highest yields (Grain/straw/green fodder) compared to recommended dose of chemical fertilizers, RDF+Cow urine spray and 75% RDF+CU+PGPR. Moreover, application of 75% RDF+CU+PGPR recorded almost equal yield as compared to RDF and RDF+CU under Maize -cowpea-wheat cropping system. In terms of economics, it was recorded that rice-berseem cropping system gave maximum returns followed by rice-wheat and maize-wheat-cowpea.



NBH+Berseem intercropping



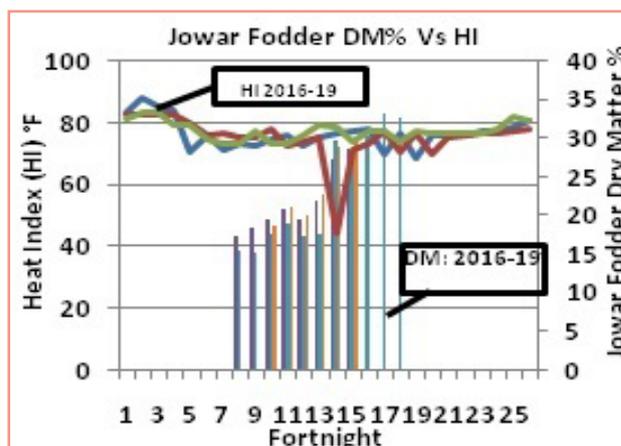
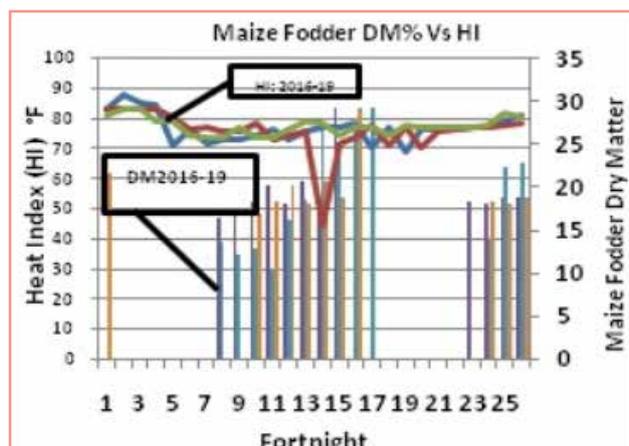
Field Performance of Hybrid Napier Bajra

Relationship Between Chemical Composition and Heat Index in Cultivated Fodder Crops

Fortnightly fodder quality, seasonal soil fertility and daily weather forcing parameters were studied for 3 consecutive years (2016-19) to measure the dependency relation. Soil pH ($P < 0.01$), electrical conductivity ($P < 0.01$) and organic carbon ($P < 0.10$) were differed significantly between years. Mean N, P and K was 281, 209 and 565 kg/h and vary between years ($P < 0.01$ to 0.02). Chemical composition of perennial grasses showed parabolic trend with the heat index (HI) during the different fortnights for 3 consecutive years. Their chemical composition was more fragile but, seasonal fodders are not much affected by the weather forming forcing variables. Seasonal fodder crops viz., Maize and Jowar chemical composition had no relation with the HI but significantly correlated with rainfall and rain days. Biochemical quality of grasses was transitive and tolerance space was greater for Hybrid Napier (Tall variety grass) followed by guinea (Short and Hard stem) and para (Medium and hollow stem) grass. Cultivated fodder biochemical quality was quasitransitive and largely depended on seasonal weather forming forcing variables.

Alternative Feed Resource for Dairy Animals

The study was conceptualized to explore crude glycerol from non-edible-oils (NEOs) viz., Pongamia, Simaruba, Mahua, Jatropha, Neem in dairy rations as alternative energy supplement. Based on the analysis of 1440 replicates, it was observed that the crude glycerol harvested during transesterification process of NEOs could be used as energy supplement in dairy rations at 70 to 80% of purity. Presence of plant secondary metabolites (PSM) at threshold levels were indeed improved the fermentation because the rumen microbes have ability to bioremediation of PSMs.



Based on the advancement of ethanoveterinary use of PSMs to promote the health of the cows; multi-nutritional licks were prepared. These multi nutritional licks were prepared from the by-products of NEOs and their evaluation as dairy cattle supplements to promote health and nutrition is under progress.



Trans-esterfication unit (50L/d capacity)

Byproducts of non-edible oilseeds as dairy feeds

Formulation and Evaluation of Milk Replacers for Kids of Black Bengal Goat

The study was conducted to develop suitable milk replacers for Black Bengal kids and validate their efficiency on control of kid mortality and growth performances. Proximate analysis of Black Bengal goat milk revealed, $12.91 \pm 0.31\%$ total solids, $3.44 \pm 0.13\%$ crude protein $3.75 \pm 0.14\%$ fat, $9.16 \pm 0.15\%$ SNF. Based on the proximate composition, two milk replacers with soybean (SBMR) and skimmed milk powder (SMMR) base were formulated and tested by conducting 90 days growth trial. The control (T_0) group was fed with their dams' milk while two treatments groups were fed exclusively with milk replacer devised for their group (T_1 - SBMR and T_2 - SMMR) and remaining two groups fed with dams' milk and milk replacer both (T_3 - Milk + SBMR and T_4 - Milk + SMMR). The overall mortality in T_0 , T_1 , T_2 , T_3 and T_4 groups was 50.00, 50.00, 33.33, 0.00 and 0.00 per cent respectively. Average daily DMI in T_0 , T_1 , T_2 , T_3 and T_4 groups was 197.34 ± 4.94 , 186.99 ± 9.02 , 212.73 ± 2.40 , 235.63 ± 5.11 and 274.91 ± 13.35 g/day, respectively and it differ significantly ($P < 0.05$). Average total gain in weight in T_0 , T_1 , T_2 , T_3 and T_4 groups was 4046.67 ± 93.87 , 2731.67 ± 91.76 , 3322.25 ± 92.62 , 4296.67 ± 103.33 and 5436.67 ± 265.63 g, respectively. Average daily gain in T_0 , T_1 , T_2 , T_3 and T_4 groups was 44.95 ± 1.04 , 30.35 ± 1.02 , 36.91 ± 1.03 , 47.74 ± 1.15 and 60.41 ± 2.95 g, respectively. T_4 group recorded significantly ($P < 0.05$) higher average final weight, average total gain in weight and average daily gain. Feed conversion efficiency in T_0 , T_1 , T_2 , T_3 and T_4 groups was 22.80 ± 0.54 , 16.26 ± 0.40 , 17.35 ± 0.39 , 20.26 ± 0.12 and 21.98 ± 0.24 per cent, respectively. Treatment group T_4 and T_3 recorded significantly ($P < 0.05$) higher feed conversion efficiency. Mean BUN and SGOT levels did not differ ($P > 0.05$) among the groups. From present investigation, it can be concluded that, supplementation of SMMR with milk showed positive impact on control of kid mortality and growth performance of Black Bengal kids.



Preparation of skim milk based milk replacer

Evaluation of Eastern Himalayan Forest Tree Leaves as Herbal Feed Additives to Manipulate Rumen Fermentation for Improving Animal Productivity

Manipulating the rumen microbial ecosystem to reduce ruminal methane, ciliate protozoa and ammonia nitrogen production by using feed additives for efficient utilization of dietary energy and protein is a useful strategy to improve production efficiency of ruminant animals. Recently, there has been an increase interest to use natural products containing plant secondary compounds like tree leaves to modify rumen fermentation for improving feed utilization and productive performances of ruminant animals. Seventeen tree leaves were collected from Sikkim and they were nutritionally evaluated by *in vitro* gas production technique. Based on *in vitro* studies three tree leaves e.g., Nevaro (*Ficus roxburghii*),



Ficus clavata

Lutekhamew (*Ficus clavata*) and Thotne (*Aconogonum molle*) were selected to study their effect as feed additive on ruminal methogenesis and fermentation pattern in a paddy straw based diet *in vitro*.

Ruminal gas production was lowered ($P < 0.01$) when 25, 50 and 100 mg of control substrate was replaced by each tested tree leaves. Methane production was lowest ($P < 0.01$) due to replacement of control substrate by Lutekhamew tree leaves. Supplementation of Nevaro and Thotne tree leaves in a paddy straw based diet as feed additive had lower effect on ruminal methane production in comparison to Lutekhamew tree leaves. Percent methane production in total gas also lower due to supplementation of Lutekhamew tree leaves as feed additive in comparison to Nevaro and Thotne tree leaves. Rumen protozoal count was lowest ($P < 0.01$) for

Lutekhamew tree leaves followed by Thotne and Nevaro tree leaves. Rumen ciliate protozoal number was reduced by 4.4, 12.1 and 15.2% due to replacement of 25, 50 and 100 mg control substrate by Lutekhamew tree leaves as feed additive. TVFA and molar proportion of propionate production were highest ($P < 0.01$) while ammonia nitrogen concentration was lowest ($P < 0.01$) due to replacement of control substrate by Lutekhamew tree leaves followed by Nevaro and Thotne tree leaves as compared to control substrate. Activities of carboxymethyl cellulase enzyme was not influenced by the inclusion of Nevaro, Lutekhamew and Thorne tree leaves as feed additives in the paddy straw based diet. However, activities of xylanase, β -glucosidase and amylase enzyme was highest ($P < 0.01$) due to inclusion

Thotne tree leaves in the control substrate in comparison to Lutekhamew and Nevaro tree leaves. Microbial biomass production per g digested DM was highest ($P < 0.01$) due to inclusion of Lutekhamew tree leaves followed by Nevaro and Thotne tree leaves. *In vitro* true dry matter digestibility (IVTDMD) was highest ($P < 0.01$) due to inclusion of Nevaro tree leaves followed by Lutekhamew tree leaves in the control substrate whereas IVTDMD was decreased due to inclusion Thotne tree leaves as feed additive in the incubating substrate. The results indicated that Lutekhamew (*Ficus clavata*) tree leaves had the potential to manipulate rumen fermentation to reduce ruminal methanogenesis and protozoal population as a herbal feed additives on a paddy straw based diet for efficient utilization of dietary energy and protein for improving animal productivity.

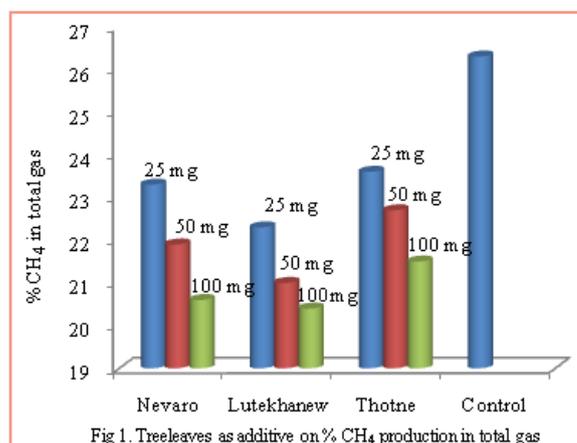


Fig 1. Treeleaves as additive on % CH₄ production in total gas

Effect of Various Nutrient Inputs on Yield and Chemical Composition of *Azolla Microphylla*

Azolla, an aquatic ferns of the family Azollaceae, is an attractive source of protein, minerals, vitamins and antioxidants, not only for the livestock and poultry but also in aquaculture species. In the present investigation the effect of different level of some nutritional inputs on yield and chemical composition of *Azolla microphylla* were studied. Twenty one *Azolla* pits of 3 sq.m (3m x 1m) dimension and 15 cm depth were evenly distributed in seven treatment groups in which different levels of cow dung, SSP and vermin-compost were applied at weekly interval. Soil (@5 kg /sq.m), Water (upto 12 cm level) and *Azolla* culture (@150g /sq.m) were added to all the pits. The Yield of *Azolla* ranged from 38.58 to 188.06 g/sq.m./day. The highest yield was obtained in T₂ treatment which had cow dung and SSP @ 0.5kg/ sq.m. and 5g/ sq. m., respectively. The treatment groups (T₀, T₄, T₅ and T₆) which were not having cow dung as input, showed significantly lower crude protein as compared to other treatments. Protein fraction B3, which was very less degradable in rumen, was very high in case of all the groups ranging narrowly from 56.1 to 58.76% of CP. The concentration of all the micro minerals, Cu, Co and Zn in particular were found to be higher in the groups having cow dung as input. Variation in nutritional input at weekly interval had significant effect on the yield and nutrient content of *Azolla microphylla*. As per present study, optimum weekly nutritional input was 0.5 kg cow dung and 5 g SSP per sq.meter.



Comparative Nutritional Evaluation of Wetland Plants Available in Old Alluvial Zone of West Bengal

Wetland vegetation/ aquatic plants are widely available in water bodies and nearby areas throughout India mainly in the eastern part of India. These are considered as weeds and sometimes destroyed by people. Some of these

plants are expected to have good nutritional value, they can be used as animal feed, which will be helpful to fulfil the gap between demand and supply of fodder/ nutrients to large extent. The present study was carried out to evaluate the chemical composition of different wetland plants available in Old Alluvial Zone of West Bengal. The study was conducted taking three districts under old alluvial zone. The DM content of the wetland plants ranged from 5.9% (*Najas flexilis*) to 14.8% (*Persicaria barbata*). The reason for such a big variation of DM content of different samples are due to the fact that the samples contain both fully aquatic (submerged, floating, floating leaved) as well as semi aquatic plants and the marshy land plants. The dominant wetland species were identified



and screened based on crude protein content. Fifteen aquatic plants having crude protein content more than 8% were collected and analysed for their chemical composition in terms of proximate composition, fiber fractions, protein fractions and mineral profile. Out of fifteen wetland plants eleven plants (around 73 %) had more than 10% crude protein content and out of those, six plants (around 40 %) had more than 15% crude protein content. The results of present study showed that these wetland plants available in old alluvial zone were good sources of most of the minerals specially calcium, zinc, manganese and iron. Some of the plants though were poor in protein but rich in mineral profile. Some plants like *Eichhornia* though good source of CP and minerals but were having high content of ADL and PC fraction which reduce its value as feed supplement. Finally, critically analysing different parameters analysed here, five wetland plants namely, *Jussiaea repens*, *Enhydra fluctans*, *Spirodela Polyrhiza*, *Lemna minor* and *Marsilea minuta* were found to be better sources of essential nutrients and can also serve as potential alternative feed resource in ruminant ration in old alluvial zone of West Bengal.



INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS

Improved Feeding and Shelter Management to Reduce Age at Puberty in Murrah Bulls

Buffaloes are reported to grow relatively at slower and mature late as compared to crossbred cows thus limiting economic gain to the farmers. Nutritional and housing interventions have shown a positive effect on growth and maturity age in cattle including buffaloes. However, the synergetic effect of both these interventions has not been fully understood in buffaloes. Hence this study was undertaken to evaluate the effect of dietary energy and linseed on growth performance, age at first ejaculation, semen quality and to study the behaviour, physiological responses, hormones and blood biochemicals of Murrah buffalo males under different shelter management conditions. A total of 30 Murrah buffalo males of 6- 8 months of age were selected and distributed randomly into five groups as T1, T2, T3, T4 and T5. Where, T1 (control) was provided with standard feeding (ICAR, 2013) under existing housing management (12 ft height and 10 ft width, cemented floor, one time body wash during summer), T2 with 10 % higher energy (HE) (through molasses) diet till attainment of age at first ejaculation under existing housing management as in T1. The calves under T3 were provided with 10 % HE till 12 months of age thereafter, supplemented with roasted linseed till attainment of age at first ejaculation under existing housing management. Similarly, group T4 was provided with 10 % HE and T5 with 10 % HE plus roasted linseed under modified housing management (15 ft height and 20 ft width; rubber mat bedding). The males under modified housing were provided with fans and high pressure foggers during summer and curtains during winter months. The results revealed that THI of modified house remained low ($P < 0.01$) during summer and higher in winter compared to the routine housing. The overall average DMI, TDNI and CPI / 100 kg body weight was higher ($P < 0.01$) in treatment groups than control. ADG was higher ($P < 0.01$) in T5 compared to T1. The bulls under modified housing had lower ($P < 0.01$) physiological and skin temperature and higher eating, ruminating and resting time. The bulls of T5 ejaculated at an early age (15.58 ± 0.41 m) followed by the T4 (16.98 ± 0.50 m), T3 (17.08 ± 0.26 m), T2 (18.00 ± 0.42 m) and T1 (18.67 ± 0.64 m). The semen quality was better ($P < 0.01$) in T5 compared to other groups, however, T1 bulls produced lower ($P < 0.01$) quality among groups. It was concluded that Murrah buffalo males can grow faster, attain early puberty and AFE with better semen quality when provided with improved feeding and seasonal shelter management.



Figure: Overview of experimental shed

Social Interactions Effects Cognitive Behavior and Performance of Sahiwal Calves

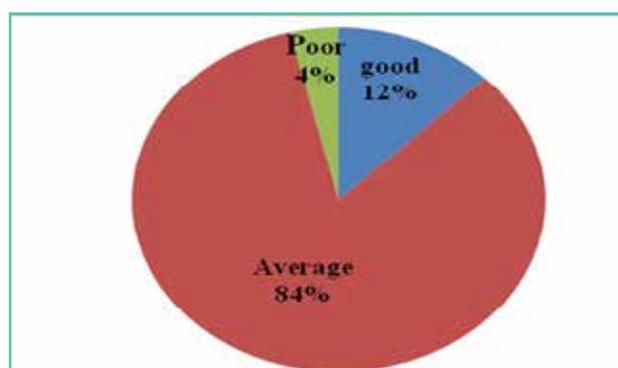
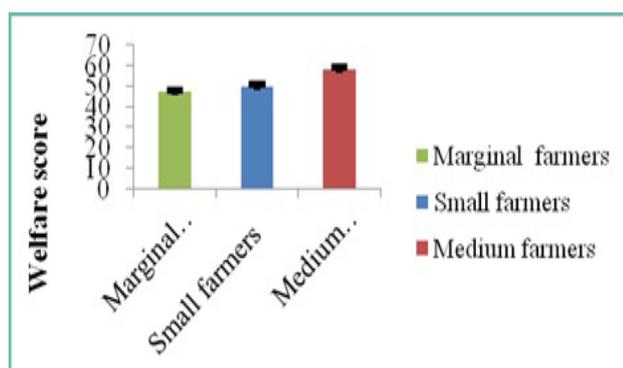
The significance of behavioral studies is enormous in managing dairy animals under modern management practices. However, behavioral aspects of indigenous dairy animals have not been understood/studied. Therefore, the study was conducted to observe the effect of social interaction on cognitive behaviour and performance of Sahiwal calves. For this, twenty four, 6 day old Sahiwal calves were selected from Sahiwal herd of the institute and they were initially kept in two groups i.e. individually housed (group 1, having 16 calves, kept in individual pen) and group housed (group 2, having 8 calves, kept in group). After 6 week of age, 3rd group was formed i.e. late pair housed (group 3, containing 4 pair where two calves in each pair were kept together). Calves across the groups were trained for bottle feeding from day one of age. These were trained for initial and reversal learning in Y-maze. Each calf was given training sessions comprising 12 trials each for learning. If calf performed > 80% correct attempts in three consecutive sessions, then the calf was treated as qualified for that learning. Different behavioral parameters viz. lying time, eating time, frequency of licking inanimate objects, self-licking and cross-sucking were observed. Results revealed that significant ($P \leq 0.01$) difference was observed in sessions taken in initial and reversal learning among the groups in color discrimination task in Y-maze. Group housed took less number of sessions

than individual housed and late pair calves in initial learning and reversal learning, respectively. In memory retention test, group housed calves performed better than other groups. It also revealed that the mean lying and eating time was higher ($P \leq 0.05$) in late pair followed by group and individual housed calves. Mean frequency of licking inanimate objects and self-licking was higher ($P \leq 0.01$) in individual followed by late pair and group housed calves. Mean frequency of cross-sucking/inter-sucking was higher in late pair than group housed calves. Social interaction effect on behavior expression of calves; lying time was higher in group followed by late pair and individual housed calves, whereas eating time did not differ among groups. Social index and dominance index was higher in group followed by late pair and individual housed calves. Social interaction did not show any effect on DMI and ADG. Occurrence of illness was slightly higher in group housed calves. Individual housed rearing leads to impaired cognitive and general behavior. So, from the study it can be concluded that the calves are social animals and should be kept in group housing for better social interaction, which can potentially be a better option in optimizing their performance and welfare in modern calf management practice.



Management Practices and Welfare Status of Dairy Animals in Smallholder Production System

Animal welfare is considerable issue in intensively managed large commercial dairy farms. In India there is traditional smallholder production system comprising more than 70 million farmers maintaining 2-5 heads of cattle each. The animal welfare issues in this system are supposed to be unique in view of availability of feedstuffs, housings, health cover and management practices. The aim of this study, therefore, was to measure the availability of major inputs and assess the welfare of dairy cows and buffaloes kept under smallholder production system. For this, a total of 80 dairy farmers, 20 each from 4 villages of Muzaffarnagar district of Uttar Pradesh were selected on the basis of landholding. Three landholding size categories were made as marginal (<1 hac), small (1-2 hac) and medium (2-10 hac) as per Ministry of Agriculture and Farmer's Welfare, Government of India and number of farms selected from each category on the basis of proportionate sampling as 39, 24 and 17, respectively. For assessing the level of animal welfare score, the methodology suggested under Integrated Diagnostic System Welfare by Calamari and Bertoni (2009) and modified according to Indian conditions by Kamboj and Kumar (2014) was utilized. Accordingly a total of 20 welfare indicators were identified and grouped into three components viz., housing and other facilities –A, feeds and feeding practices– B, animal health, performance and behaviour- C with a weightage of 30, 30 and 40, respectively. Results revealed that the average herd size was 2.12 ± 0.37 , 3.31 ± 0.42 and 4.73 ± 0.42 ; fodder intake was 16.03 ± 0.80 , 18.96 ± 0.73 and 23.53 ± 0 kg/animal/day; floor area per adult unit was 47.54 ± 2.99 , 50.41 ± 2.91 and 54.10 ± 6.26 sq ft in marginal, small and medium category farms, respectively. Welfare score in components A was 12.38 ± 0.45 , 13.75 ± 0.45 and 14.47 ± 0.51 , in B was 23.36 ± 0.50 , 24.50 ± 0.64 and 29.53 ± 0.65 and in C it was 11.28 ± 0.40 , 11.38 ± 0.48 and 14.00 ± 0.42 with an overall total score of 47.03 ± 0.86 , 49.63 ± 0.98 and 58.00 ± 1.08 for marginal, small and medium farms, respectively. In welfare component A welfare score did not differ among the farm size categories, whereas in component B and C it was higher ($P < 0.05$) in medium farms than in marginal and small farms. Proportions of farmers under good (60-80), average (40-60) and poor (<40) welfare ranking was 12.50, 83.75 and 3.75 percent, respectively, whereas only 12.50% farmers achieved an acceptable welfare level (welfare score > 60) across farm size categories. It was concluded that cattle welfare at most of the dairy farms in Muzaffarnagar district of Uttar Pradesh was average and only a few farms had acceptable level of welfare.



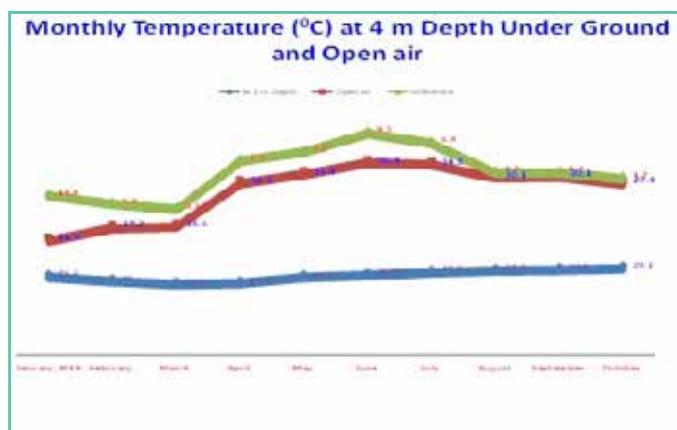
Welfare score of dairy animals in different categories of farmers

Proportion of farmers with different levels of dairy animals' welfare

Harnessing Geothermal Energy for Cooling and Heating of Animal Shed

This project is being implemented to develop a heating and cooling system for animal shed by harnessing geothermal energy. To implement it, a pilot study was carried out on air heating/ cooling through geo-thermal heat exchanger, a bore-well of 150 mm diameter and 12 m depth was drilled in the cattle yard of NDRI, Karnal. Six numbers of temperature sensing probes (PT-100) were fixed at different depths at 2m, 4m, 6m, 8m, 10m and 12m with the help of a PVC pipe in the bore-well. These probes along with two other probes for measuring temperature of earth surface and open air were connected with the 8-channel digital temperature scanner placed on surface adjacent to bore-well. One another U-shape tube set with one leg of galvanized iron pipe 35 mm bore and 12 m length for air inlet and other leg of PVC pipe 25 mm bore and 12 m length for air outlet was also lowered down in the bore-well to work as a heat exchanger. The remaining void space in the bore-well was then filled and tightly packed with the same soil which was extracted from bore-well during drilling. This whole set-up was then left unattended for more than a month for proper setting of soil and temperature and moisture equalization before switching on the temperature scanner on 5th January 2019. It was set to record hourly readings of temperature of all the points in an Excel file in a pen-drive through USB output. The temperature data of every month was recorded and stored in computer on the last day of month. After analysis of this data, it was found that the maximum value of atmospheric temperature variation was 12 °C on a particular day in the month of January and 10 °C on a particular day in the month of March. But this surface temperature perturbation penetrates approximately upto 6m depth and beyond it, temperature of earth was found to be varying by less than 1 °C. The maximum difference between atmospheric temperature and earth temperature at 8m depth was noticed as 19.8 °C during January month in the early morning hours around 6:00 am and minimum at 4 °C in the afternoon hours around 2:30 pm during the month of January 2019. However, some more important salient observations of the system given below:

- Diurnal variation in open air temp was higher during June and January months. Diurnal variation of UG temperature at 2 m depth was very less
- Effect of surface temperature was found to be negligible on UG temperature beyond 4 m depth. Variation in temperature at 4 m depth was very less throughout the year (January- October)
- Temperature difference between open air and 4m depth was 15 °C (5-15°C) during June and up to 6-16°C during January. Therefore, geothermal heat exchanger/pipes can be placed between 2 to 4 m depth



Strengthening Agro-Dairy Development through Need Based Interventions

A service project of ICAR- NDRI being run at village Lalukheri district Muzaffarnagar (UP), is providing inputs services to the farmers for improving their dairy animals performance in the surrounding villages. Under this project, seed of different fodder and grain crops and frozen semen doses of buffalo and different breeds of cattle distributed to the farmers of different villages around the center. A Kishan Gosthi was also organized at the center and apprised farmers for various animal husbandry practices for getting better return through dairying. One day training for the AI workers, who take frozen semen from the center, was also organized for refining their AI skill in dairy animals. In this training about 15 AI workers participated, they were from the surrounding villages of Lalukheri center. Lectures related to frozen semen handling, estrus detection, right time of AI, proper method of AI and sources of frozen semen were delivered by the experts from NDRI.

Dietary Supplementation of *Lactobacillus Plantarum* and *Lactobacillus Rhamnosus* on Growth Performance of Murrah Buffalo Calves

There are several challenges to buffalo calf rearing such as high morbidity, poor growth and mortality. The effect of probiotics is well known on improving the health and growth of dairy calves. Generally these probiotics which are

proven to give beneficial effects have been tried separately and their synergetic effect has not been studied. For this study 40 new born Murrah buffalo calves of 5-7 days old were taken from Livestock Research Centre (LRC), NDRI, Karnal and divided into four groups with ten calves in each and all the calves were fed milk as per NDRI schedule. Group 1st (T1) was fed without probiotics, T2 was fed *Lactobacillus plantarum* CRD2 (As a fermented milk @ 100 ml/calf/day having 108cfu per ml), T3 was fed *Lactobacillus rhamnosus* CRD9 (As a fermented milk @ 100 ml/calf/day having 108cfu per ml) and group T4 was fed *Lactobacillus plantarum* CRD 2 and *Lactobacillus rhamnosus* CRD9 (As a fermented milk @ 100 mL/calf/day(1:1 Ratio) having 108cfu per ml). The growth and health status of calves were recorded at fortnightly interval up to pre-ruminant stage. It was found that the calves of T4 group consumed significantly ($P<0.05$) higher DM as compared to other groups, whereas numerically higher DM intake was observed in T3 group as compared to T2. All the probiotics supplemented group consumed significantly ($P<0.05$) higher DM than the control (T1). The overall body weight gain (g/d) was also significantly ($P<0.05$) higher in T4 as compared to other groups.

Effect of Azolla Feeding on Growth and Health Status in Sahiwal Calves

Azolla is a rich source of protein, its supplementation in the diet of dairy animals can be useful in reducing the rearing cost. Therefore this study was conducted to see the effect its feeding on growth and health of Sahiwal calves. For this 18 Sahiwal female calves of 4-5 months age with average body weight 56.85 ± 0.04 kg were taken from Livestock Research Centre (LRC), NDRI, Karnal and divided into three groups with six calves in each. All the calves were fed as per ICAR feeding standard (2013); 0, 15 and 30% protein of concentrate mixture was replaced with azolla in T0, T1 and T2 group, respectively. All the calves were fed individually and dry matter intake was recorded at weekly



interval. The body weight of calves was recorded at morning hour before offering the feed and water. The results obtained showed that dry matter intake did not differ significantly among the groups, however daily weight gain was significantly ($P<0.05$) higher in T2 (0.456 ± 0.01 kg) than that observed in T0 (0.411 ± 0.02 kg) but it did not differ between T1 and T2 groups. It can be concluded from this finding that protein source of concentrate mixture can be replaced upto 30% with improvement in growth rate compared to control of growing Sahiwal calves, which can reduce the cost of concentrate feeding to dairy animals.

Azolla production for feeding of animals

Development of Dairy Based Integrated Farming System for Income Enhancement of Small Farmers

Dairy farming is considered as an instrument to enhance the income and quality of life with equity. Integration of crop-dairy-poultry and fishery has potential to increase resource use efficiency, sustainability and overall resilience of dairy production systems. The present study was planned with the objective to develop dairy based integrated farming system model for efficient use of resources. The project was laid on an area of 1.00 ha with following components viz., crop production (0.4 ha), fodder production (0.4 ha), dairy production (cattle-2; buffalo-2, goats-6), poultry farming (40 birds), fish pond and vermin-compost pits (0.2ha). The soil samples were collected and analyzed for soil organic carbon (SOC) content and major elements. Results revealed that the average SOC was 0.56% and soil pH was 7.3. The Nitrogen content of selected field was low (188-192 kg/ha) with medium in phosphorus and high in Potash. In 0.4 ha area, wheat (PBW 343) was sown and yield of 57 quintal/ha was recorded. Animals (two Sahiwal cattle, two Murrah buffaloes and six goats) were maintained on fodder and crop residues obtained from the system under cut and carry system. During summer months, when green fodder availability was limited, UMMB were prepared at ATIC and supplemented to the animals. Total milk production was of 2700 liters from cattle and buffaloes and 960 liters from goat was recorded during the period under report.

Fish pond was constructed and fish seed procured from KVK was grown in the ponds. Provision of recycling of cattle waste particularly urine and roof water harvesting was made into the fish ponds, and subsequently pond

water was recycled for irrigation of the Moringa and Hybrid napier. Four vermi compost pits were constructed and earthworms (*Eisenia foetida*) were introduced for converting waste into organic manure. On pond dyke, papaya and lemon plants were planted. Transplanting of Napier and Moringa was also done in 0.4 ha area for round the year fodder production. Since, the project is in the initial stage and most of the components output (result) is yet to be obtained; therefore, cost benefit analysis was not possible at this stage. Three training programmes on 'Dairy based Integrated Farming Systems' were conducted in which 107 farmers including 42 farm women participated.



Fish pond



Fodder crops field



Lactating cow



Vermicompost beds

Integrated Farming System Demonstration Unit

Characterization of Dairy Farming Practices in Western Uttar Pradesh

The survey for present study was conducted in Muzaffarnagar and Shamli district of western Uttar Pradesh to characterize the existing dairy farming practices, economics of milk production, and constraints faced by the farmers in dairy farming. Primary information on rearing practices was collected through questionnaire survey, and formal group discussion with key informants. Results revealed that buffaloes were the preferred milch animal as majority of respondent rear buffaloes (80.83%) followed by crossbred cows. The ratio of milk and dry animal was found to be 75:25. The average herd size was 6.68 ± 0.20 , the average dairy milk yield of crossbred cow was higher in Shamli district than Muzaffarnagar district (11.33 vs. 10.46 l/h/d), whereas average yield of buffaloes was more in Muzaffarnagar district than Shamli (7.47 vs. 7.07 l/h/d). The average age at first conception was 26.52 ± 1.42 months for crossbred cattle in Muzaffarnagar and 30.28 ± 1.72 months in Shamli district, whereas for buffalo it was 32.46 ± 1.45 and 30.28 ± 1.77 months, respectively. About 63% of milk was sold and remaining 37% was consumed by the household in the study area. Natural breeding was practiced by the majority of respondent (76.67%) in case of buffaloes, whereas, AI was used in case of cattle by majority of respondent (76.67%). Semen for A.I. was used by 83.33% farmers from private practitioners. Anestrus (71.67%) and repeat breeding (15.83%) were reported major reproductive problems faced by the farmers. About 55.83% of farmers reported to offer extra concentrate feed to their cows for milk letdown on the event of death of calves. Colostrum of one teat was fed to the newly born calf by 58.33% of farmers. The majority of farmers (62.50%) were seeking services of veterinarian in treatment of sick animals. Availability of veterinary services (60%) and lack of milk collection centre (62.5%) were major constraints reported by the farmers. Market availability in nearby village (81.67%) and awareness about market information (74.17%) was another constraint mentioned by the respondents. The overall cost per liter of milk production from crossbred cattle worked out to be ₹ 21.17 with overall return per liter of milk of dairy herd of ₹ 8.32. The overall cost per liter for milk production in buffaloes was ₹ 25.69 with overall return per litre of dairy herd in buffaloes was ₹ 15.31.

Polyherbal Mixture Supplementation: Effect on Milk Production and Postpartum Reproduction in Crossbred Cows under Field Conditions

The present study was conducted at farmer's field in Muzaffarnagar district of Uttar Pradesh to assess the response of polyherbal mixture supplementation on milk production and postpartum reproduction in crossbred cattle. The polyherbal mixture was prepared by mixing 25 g each of *Foeniculum vulgare* (Saunf), *Trachyspermum ammi* (Ajwain), *Trigonella foenum-graecum* (Methi), *Zingiber officinale* (Sundh), *Anethum graveolens* (Sowa) and *Elettaria cardamomum* (Cardamom). Sixteen crossbred cattle were divided into two groups on eight each as T_0 : control and T_1 : treatment and the animals of T_1 were supplemented polyherbal mixture from the day of calving till day 10 of postpartum. The data was recorded for 2 months duration. The animals were managed as per the standard feeding practices followed by the farmers. Significant increase in milk yield ($P < 0.05$) was recorded due to supplementation of polyherbal mixture as compared to control group. From 0 to 60th day, an average increase of 21.53% in milk yield was recorded due to polyherbal mixture supplementation as compared to 6.91% in unsupplemented group. No case of foetal membrane retention was recorded in treatment group, whereas in control group, two cases were observed. Time required for expulsion of foetal membranes was reduced significantly ($P < 0.05$) in supplemented animal as compared to control (4.38 vs 7.38 hours). Supplementation has also reduced number of insemination per conception in cattle (2.38) as compared to unsupplemented group (2.88). Considering the present cost of feed supplement and the market price of milk, polyherbal mixture supplementation appears to be both economical

and cost effective, and had a positive effect on milk production and postpartum reproduction in crossbred cattle maintained under small holder conditions.

Table: Effect of polyherbal mixture on reproduction

Details	Control(n=8)	Treatment(n=8)
Average milk yield/h/d (liter) (60 days)	8.46 ^b ± 0.19	11.57 ^a ± 0.77
Retention of foetal membrane (no)	2	0
Time taken for expulsion of placenta (hour)	7.38 ^b ± 0.89	4.38 ^a ± 0.67
Number of insemination per conception	2.88 ^b ± 0.23	2.38 ^a ± 0.18
Benefit: cost ratio	-	10.31



Ingredients of polyherbal mixture

Polyherbal Mixture Supplementation: Effect on Milk Production and Postpartum Reproduction in Murrah Buffaloes under Field Conditions

Similar to crossbred cows a study was conducted at farmer's field in Muzaffarnagar district of Uttar Pradesh to assess the response of polyherbal mixture supplementation on milk production and postpartum reproduction in buffaloes. The polyherbal mixture was prepared by mixing 25 g each of *Foeniculum vulgare* (Saunf), *Trachyspermum ammi* (Ajwain), *Trigonella foenum-graecum* (Methi), *Zingiber officinale* (Sundh), *Anethum graveolens* (Sowa) and *Elettaria cardamomum* (Cardamom). Sixteen buffaloes were divided into two groups on eight each as T₀: control and T₁: treatment, animals of T₁ was supplemented polyherbal mixture from the day of calving till day 10 of postpartum. The animals under trial were managed as per the standard feeding practices followed by the farmers. The data was recorded for 2 months duration Significant increase in milk yield (P<0.05) was recorded due to supplementation of polyherbal mixture (T₁) as compared to control group (T₀). An average increase of 20.81 % in milk yield was recorded over a period of 60 days due to polyherbal mixture supplementation as compared to un-supplemented group. No case of foetal membrane retention was recorded in treatment group, whereas in control group, one case was observed. Time required for expulsion of foetal membranes was reduced significantly (P<0.05) in supplemented animals as compared to un-supplemented (5.44 vs 6.94 hours). Polyherbal mixture supplementation has also reduced number of insemination per conception in buffaloes (1.86) as compared un-supplemented group (2.88). Considering the present cost of feed supplement and the market price of milk, polyherbal mixture supplementation appears to be both economical and cost effective, and had a positive effect on milk production and postpartum reproduction performance in buffaloes maintained under small holder conditions.

Table: Effect of poly-herbal mixture on milk yield and postpartum reproduction

Details	Control(n=8)	Treatment(n=8)
Average milk yield/h/d (liter) (60 days)	7.88 ^b ± 0.19	9.52 ^a ± 0.39
Retention of foetal membrane (no)	1.0	0.0
Time taken for expulsion of placenta (hour)	6.94 ^b ± 0.44	5.44 ^a ± 0.36
Number of insemination per conception	2.88 ^b ± 0.13	1.86 ^a ± 0.18
Benefit: cost ratio	-	6.47

Effect of Urea Molasses Mineral Block Supplementation on Milk Production in Murrah Buffaloes

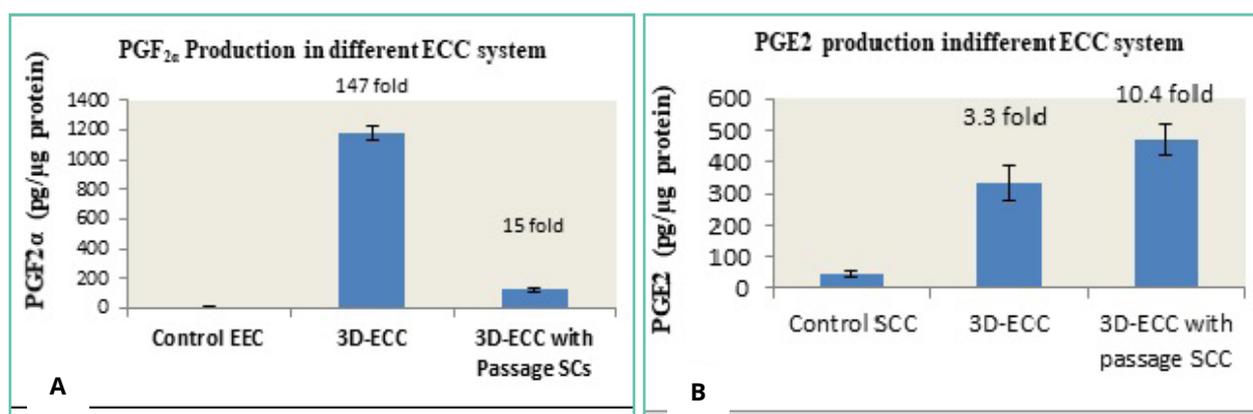
The study was conducted at farmer's doorstep in Muzaffarnagar district of Uttar Pradesh to assess the response of UMMB supplementation on milk production in buffaloes. Twenty Murrah buffaloes in early lactation were selected, and divided into two groups on ten each as T₀; control and T₁, treatment. Animals of T₁ group were given free access to UMMB for two-three hours in the morning in addition to their normal ration for eight weeks. The buffaloes were managed as per the standard feeding practices followed by the farmers. Significant increase in milk yield (P<0.05) was recorded due to feeding of UMMB as compared to control group. The daily milk yield of buffaloes was increased by 26.95 % due to supplementation of UMMB. Considering the present cost of feed supplement and the market price of milk, UMMB supplementation appears to be both economical and cost effective in buffaloes maintained under small holder conditions.

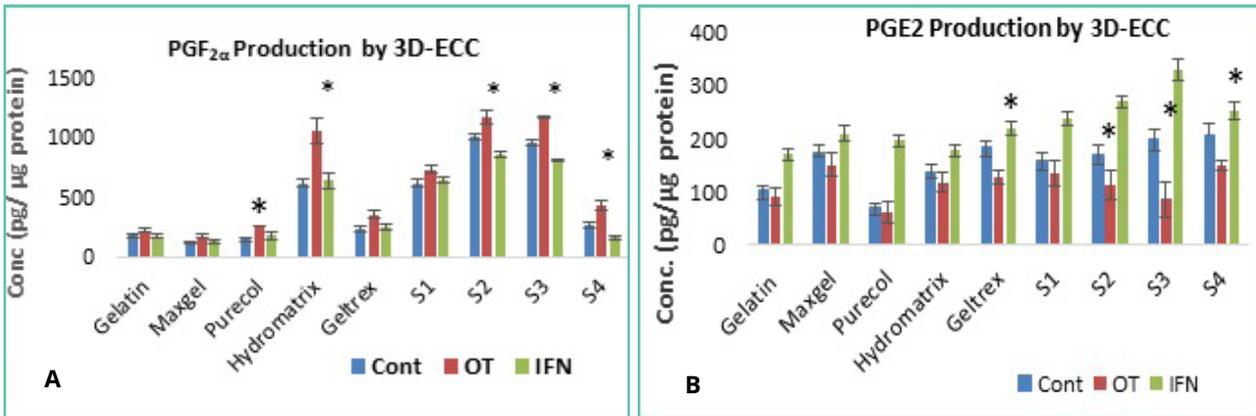
Table: Economic evaluation of UMMB supplementation in lactating buffaloes (Rs./day/animal)

Particulars	Control (n=10)	UMMB (n=10)
Initial body condition score (5 scale)	2.50 ± 0.08	2.98 ± 0.07
Final body condition score (5 scale)	2.43 ^b ± 0.07	3.15 ^a ± 0.06
Average milk yield (liter/cow/day)	8.09 ^b ± 0.16	10.27 ^a ± 0.33
Benefit: cost ratio	-	2.49

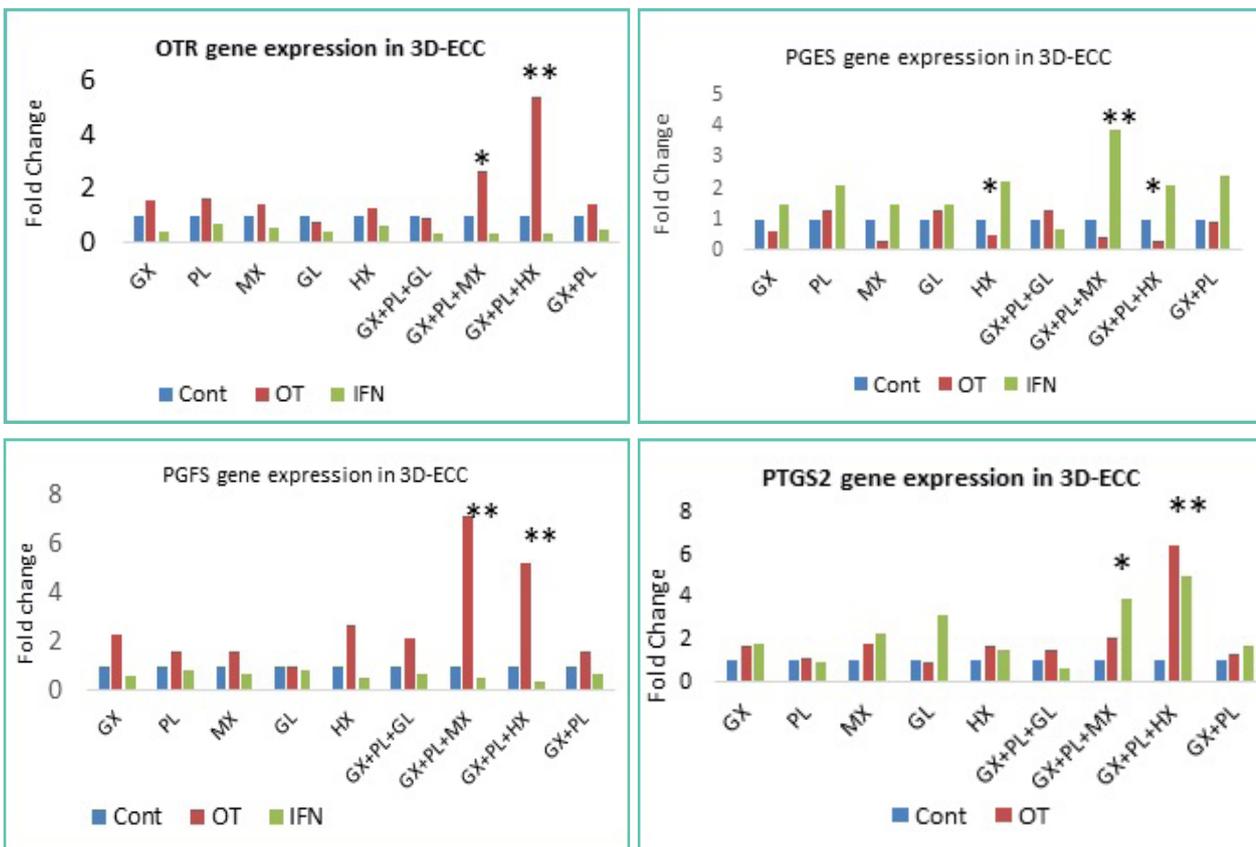
Synthetic Endometrium: A Novel Model to Understand Early Embryonic Developments and Uterine Health in Ruminants

An architecturally and functionally competent multicellular 3D-endometrial culture system (3D-EC; synthetic endometrium) developed would serve as a surrogate for whole animal experiments as it mimics the *in vivo* settings. Investigations of cell-cell/ECM interactions using the 3D- endometrial cell culture holds key for manipulating uterine functions to enhance receptivity of embryo and to generate biomarkers of endometrial function. A structurally and functionally competent bubaline 3D-Endometrial Cell Culture (3D-ECC) system in terms of cellular integrity, alignment, stratification, glandular differentiation and prostaglandin (PGE₂ & PGF_{2α}) production was developed. Stromal cells (2-3x10⁵ cells /well) were allowed to grow first at the bottom of the plate which have already been coated with Purecol (PC, 1:30), Geltrex (GT, 1:10), Gelatin (GL, 0.1%), Hydromatrix (HX, 1:10), Maxgel (1:30) and their combination {S1 (GT+PC+MX), S2(GT+PC+GL), S3(GT+PC+HX), S4 (GT+PC)}. Once 60-70% confluency of stromal cells obtained, then a thin layer of basement membrane was made using same type of matrices by lying over the stromal cells. Then epithelial cells were seeded above it immediately after isolation (3-4x10⁵ cells/well) and the developed model was observed for 1 week for its structural and functional details.

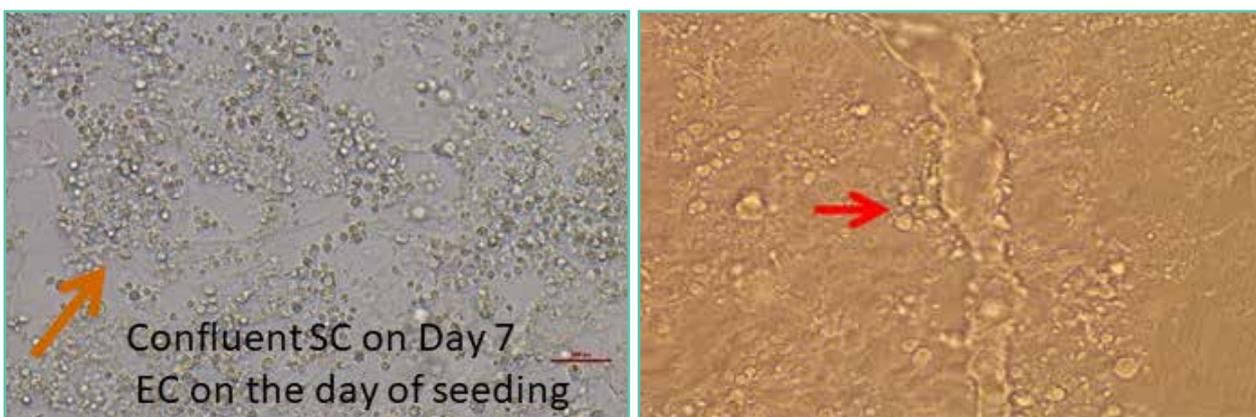
**Prostaglandin {PGF_{2α} (A) and PGE₂ (B)} production by different endometrial cell culture system (ECC)**



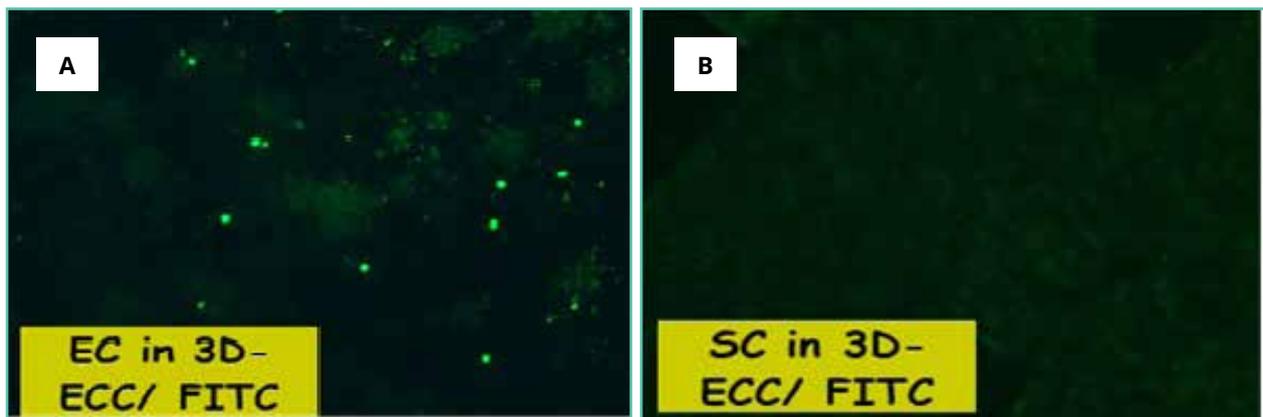
Prostaglandin {PGF_{2α} (A) and PGE₂ (B)} production by 3D-Endometrial cell culture system (3D-ECC) developed using different extra-cellular matrices



Expression of certain key genes related to prostaglandin production in 3D-endometrial cell culture system (3D-ECC) developed using different extra-cellular matrices



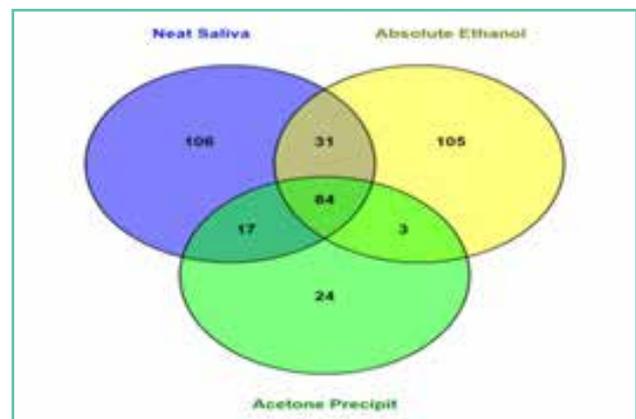
3D-Endometrial epithelial and stromal cell culture on day 0 (A) and day 7 (B) after seeding of epithelial cells over confluent stromal cells.



Endometrial epithelial and stromal cells (A & B) stained positive with anti-cytokeratin (C & D) and anti-vimentin in 3D-endometrial culture system (3D-ECC).

Standardization of Protein Extraction Protocol for Identification of Estrus Associated Proteins using Lc-ms/ms Analysis

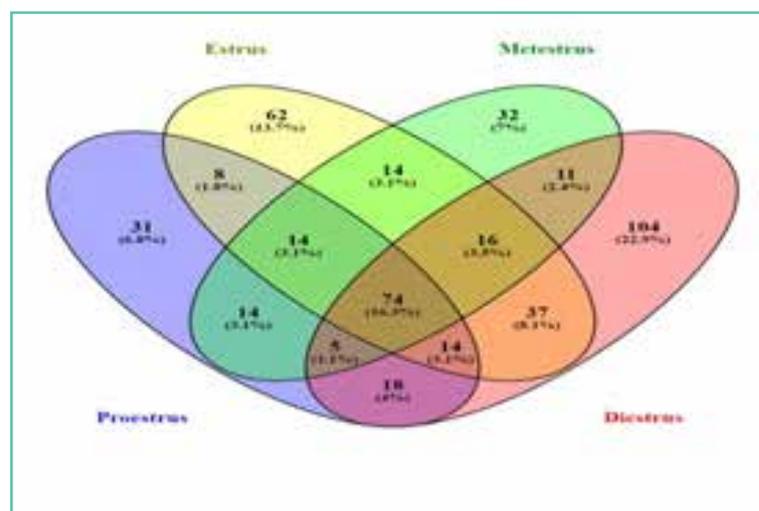
- Three different strategies were followed such as neat saliva without any precipitation, acetone precipitated saliva and absolute ethanol precipitated saliva for extraction of proteins followed by identification of proteins using LC-MS/MS analysis.
- A total 309, 170 and 254 proteins were identified in neat saliva, absolute ethanol and acetone precipitated saliva samples with high confidence. Out of identified proteins, 106, 24 and 105 proteins found exclusively in neat saliva, acetone precipitated and absolute ethanol precipitated saliva samples. Since most of the important proteins were identified in neat saliva and few important proteins were not identified in precipitated saliva samples, hence, neat saliva without any precipitation considered as best method for proteomics study.



Proteins identified in neat saliva and acetone precipitated and ethanol precipitated saliva samples are depicted in Venn diagram using Venny 2.1.0 software.

Profiling of Proteins during Different Stages of Estrous Cycle for Identification of Estrus Specific Proteins i Saliva Of Buffalo:

A total of 275, 371, 304 and 565 proteins were identified with ≥ 2 peptides during proestrus, estrus, metestrus and diestrus stages of estrous cycle. Among the identified proteins 31, 62, 32 and 104 proteins were found specific to proestrus, estrus, metestrus and diestrus stage of the estrous cycle.



Venny schematic diagram depicted the protein identified at proestrus, estrus, metestrus and diestrus stages in buffalo saliva.

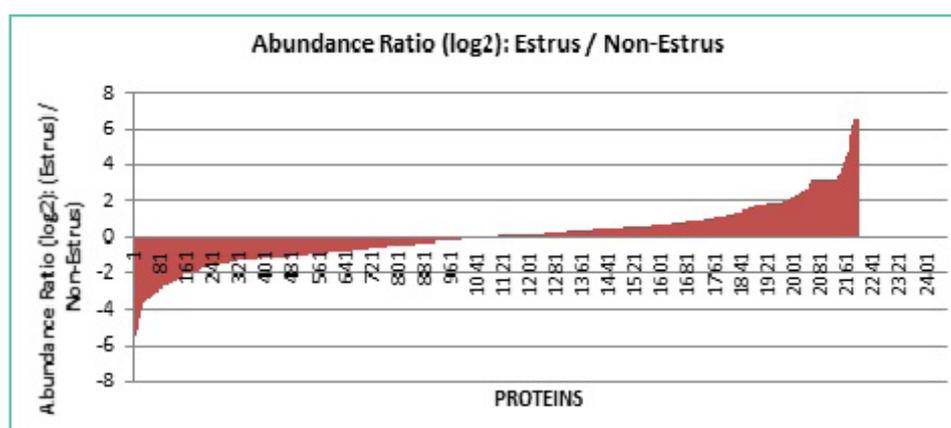
Identification of Differentially Expressed Proteins in Saliva during Estrus and Non-estrus Stages of Estrous Cycle in Buffalo using Label Free Quantification (LFQ) and Labelled Method (TMT)

A total of 742 proteins were identified as differentially expressed (DEPs) using label free quantification (LFQ). Out of these DEPs, 05 potential candidate proteins were found up-regulated with fold change ≥ 1.5 were selected, which would be used for further validation.

A total of 583 proteins were differentially expressed during estrus as compared to other stages of estrous cycle in saliva of buffalo using iTRAQ coupled mass spectrometry. Among the differentially expressed proteins, 28 proteins identified with at least two peptides were up regulated with fold change ≥ 1.5 and 32 proteins identified with at least two peptides were down-regulated with fold change ≤ 0.6 at estrus stage as compared to metestrus and diestrus stage of estrous cycle. Out of these DEPs, 03 potential candidate proteins found up-regulated with fold change ≥ 1.5 were selected, which would be used for further validation.

Identification of Differentially Expressed Proteins in Cervico-Vaginal Fluid (CVF) Samples during Peri-estrus Period in Buffalo using Label Free Quantification

The protein concentration obtained was in the range of 150-1000 $\mu\text{g}/\text{ml}$ during peri-estrus period i.e. from -1, 0 and +1 days in CVF in buffaloes. A total of 2463 proteins were identified in CVF and out of which >500 proteins were differentially up-regulated with fold change ≥ 1.5 at estrus vs. non-estrus stage. Out of these DEPs, 04 important proteins were found with high abundance at estrus vs. non-estrus stage were selected, which would be used for further validation.



Proteins identified in CVF using label free quantification (LFQ).

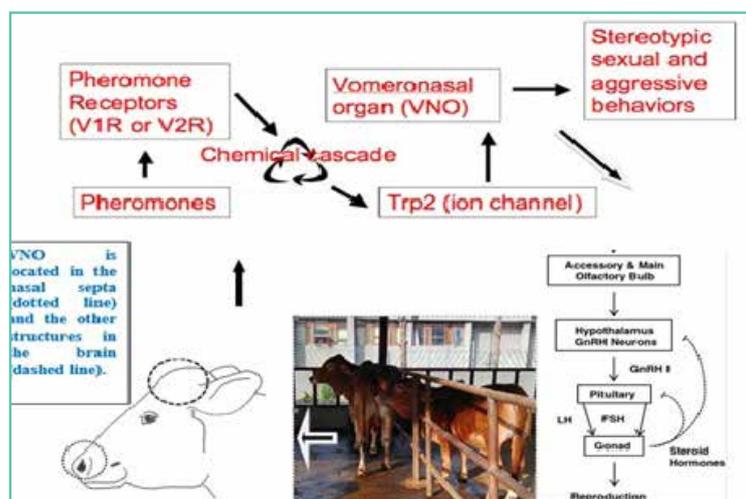
Elucidating the Effect of Kisspeptin on Onset of Puberty and Induction of Estrus in Murrah Buffaloes

The objectives of this study were to assess the effect of exogenous kisspeptin in hastening age of puberty in pre-pubertal buffalo heifers and to find out the effect of exogenous kisspeptin-10 on follicular and hormonal parameters and changes in KISS1/R gene in PMNs during peri-pubertal period in buffalo heifers. To find out the effective dose of kisspeptin-10 for exogenous administration, a pre-requisite study was carried out to assess the effect of different doses of kisspeptin on the release of LH. For that purpose, 24 number of pre-pubertal buffalo heifers were selected and divided into 4 groups (Control, T1, T2, and T3), having 6 animals in each group. Kisspeptin-10 was injected at the dose of 2 $\mu\text{g}/\text{kg}$ body weight, 1.5 $\mu\text{g}/\text{kg}$ body weight, 1 $\mu\text{g}/\text{kg}$ body weight respectively in T1, T2 and T3 group, equal volume of NSS was injected in control group. Blood sampling was done in every 20 minutes interval beginning with zero minutes to till 2 hours and analysed for LH concentration. The LH concentration was significantly higher ($p < 0.05$) in T1 group. The peak level was recorded at 20 minutes post injection and comes to basal level 60 minutes post injection. Therefore 2 $\mu\text{g}/\text{kg}$ bwt dose of kisspeptin-10 is used for main experiment, for that 20 pre-pubertal buffaloes were divided into 2 groups (control and treatment; $n=10$) having mean age of 16.19 ± 0.60 month and body weight 231.8 ± 7.62 kg in control group and 16.73 ± 0.6 age and 231.34 ± 7.6 body weight in treatment group. KP-10 was injected at the dose of 2 $\mu\text{g}/\text{kg}$ body weight at twice a week interval. Four animals from treatment and one animal from control group attained puberty at the age of 20.56 ± 0.77 and 23.5 months, respectively. There was no significant difference in body weight and average daily gain in both the groups. Expression of KISS1 gene and KISS1R was increased significantly ($p < 0.05$) at different days. There was no significant difference between number of small size follicle between groups, but the number of medium and large size follicle were significantly more ($p < 0.05$) in treatment group. Progesterone concentration also showed increasing trend with increase in number of days. Similarly LH concentration was also found to be increased as the age of animal

advances, however animals of treatment group had significantly higher ($p < 0.05$) LH concentration 100 days after the start of experiment. It could be concluded that Kisspeptin was found to be effective in reducing age at puberty as indicated by more number of heifers attaining puberty in treated groups, improvement in folliculo-hormonal and gene expression status in Murrah buffalo heifers.

Effect of Bull Biostimulation on Puberty and Estrus Behaviour of Sahiwal Breed Heifers

Provision of social cues through biostimulation by exposing the heifers to bull during their growing period may offer a clean, green and ethical strategy for early onset of puberty. The biostimulation has been reported to act through bull pheromones using visual, olfactory, auditory and tactile pathways and stimulate neuro-endocrine cascade in female hypothalamus which leads to onset of puberty. It has also been reported to improve estrus detection and reproductive performance in some beef breeds of cattle through direct contact during post-partum period. The hypotheses of the present study were to investigate the effect of biostimulation on growing heifers through only fenceline bull contact and both fenceline and direct bull contact on age at puberty, estrus behaviour and reproductive performance of Sahiwal heifers.



Simulatory pathways of pheromone of biostimulation in cattle

For this a total of 24 pre-pubertal Sahiwal heifers were allotted to 3 groups of 8 each on the basis of age (14.44 ± 0.28 mo) and body weight (152 ± 6.12 kg). In no bull exposure (NBE) group, the heifers were not exposed to bull; in fenceline bull exposure (FBE) group, the heifers were exposed to a bull through a fenceline contact and in FBE+DBE (direct bull exposure) group, the heifers were housed in a fenceline contact with bull round-the-clock along with direct contact for a period of 6 hours through another bull. The estrus behaviours were recorded on day -3, -2 and -1 (prior to estrus), d 0 (on the day of estrus) and on day +3, +2 and +1 (post estrus) using 24 hours CCTV camera recording.

Age and weight at puberty: The average number of heifers reaching puberty in NBE, FBE and FBE+DBE groups was 5 (62.5%), 7 (87.5%) and 7 (87.5%), respectively. The mean age and body weight at puberty in FBE (19.33 ± 0.36 month and 226.20 ± 6.35 kg) and FBE+DBE (19.11 ± 0.58 month and 224.19 ± 4.54 kg) were similar but significantly ($p < 0.05$) lower than in NBE (24.00 ± 0.12 month and 258.35 ± 13.13 kg). The average age at puberty was reduced by 4.7 to 4.9 months in biostimulated groups of heifers. The significant reduction in age of puberty in biostimulated heifers may be attributed due to priming of these heifers by the presence of bull through visual, tactile, olfactory and auditory cues which may have resulted in the activation of the neuro-endocrine response. The mean live weight of 225 kg recorded at puberty in FBE and FBE+DBE groups was ideal for the onset of puberty in Sahiwal heifers. (about 60% of mature body weight of 375 kg).

Table: Average age and body weight at puberty

Parameter	Group of heifers		
	NBE (n=8)	FBE (n=8)	FBE+DBE (n=8)
Age at start of experiment (mo)	14.53 ± 0.97	14.45 ± 0.86	14.36 ± 0.88
Body weight at start of experiment (kg)	151.91 ± 10.85	152.41 ± 11.06	152.49 ± 11.40
No. of heifers reaching puberty	5 (62.5%)	7 (87.5%)	7 (87.5%)
Age at puberty (mo)	$24.13^b \pm 0.16$	$19.33^a \pm 0.36$	$19.11^a \pm 0.58$
Body weight at puberty (kg)	$262.50^b \pm 8.50$	$226.20^a \pm 6.35$	$224.19^a \pm 4.54$

Figures in parenthesis indicate percentage of total animals in the group
Values with different superscript in same row differ significantly ($P \leq 0.05$)

Proportion of heifers reaching puberty at varying ages: More than two-thirds proportion of heifers in FBE and FBE+DBE group (71.4% each) attained puberty between the age of 18–20 months, whereas, all the 5 heifers which came into estrus during the experimental period in NBE attained puberty later as compared to bull exposed heifers, i.e. between the age of 23–25 months. It is worth noting that 1 heifer out of 7 in FBE+DBE group attained puberty at a very young age (between 15–17 months).

Table: Proportion of heifers reaching puberty at varying ages

Group of animals	No. of heifers attained puberty	Proportion of heifers attained puberty at different ages (mo)			
		15-17	18-20	21-23	23-25
NBE	5	--	--	--	100 (5)
FBE	7	--	71.4 (5)	28.6 (2)	--
FBE+DBE	7	14.3 (1)	71.4 (5)	14.3 (1)	--

Figures in parenthesis indicate the number of heifers

Reproductive performance: The average age at first service in FBE (20.41 ± 0.45 months) and FBE+DBE (20.78 ± 0.36 months) groups was significantly ($P < 0.05$) lower than that in NBE (25.15 ± 0.14 months) group. The conception rate was as high as 85% in both bull exposed group whereas it was 60% in non-bull exposed heifers. This may be attributed to proper detection of estrus and presentation of animals for artificial insemination during standing estrus. The average age at first calving was significantly ($P < 0.05$) lower in FBE (30.20 ± 0.73) and FBE+DBE (29.90 ± 0.44) groups as compared to NBE (34.29 ± 0.53) group. These results may be attributed due to the priming of heifers by bull pheromones which have resulted in early onset of puberty and proper estrus detection in all 3 groups have led to insemination of heifers during standing estrus.

Estrus behaviour: In first estrus the mean frequencies of estrus behaviours viz., sniffing/licking, tail raising, micturition, chin resting, and allowing mounting attempts were similar in FBE and FBE+DBE but significantly ($P < 0.05$) higher than in NBE heifers from d-2 and d0 of estrus and then declined from d+1. These frequencies of estrus behaviour increased in second estrus as compared to first estrus in all groups of heifers. The percent reduction in daily times spent on eating on the day of estrus from the reference day was 29.41, 42.92 and 43.64; in rumination was 44.44, 44.77 and 44.0 and in resting was 39.02, 47.96 and 44.12 in NBE, FBE and FBE+DBE heifers, respectively.

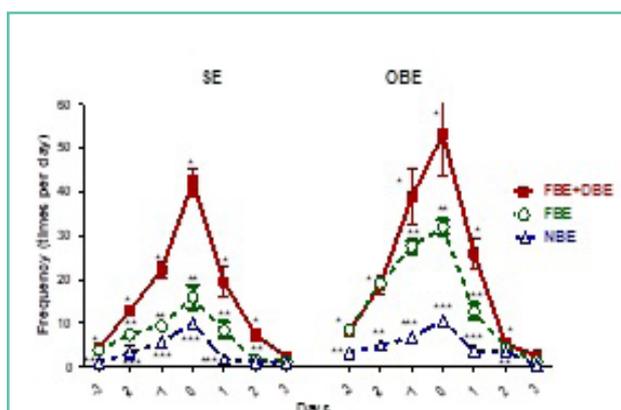


Fig. 1

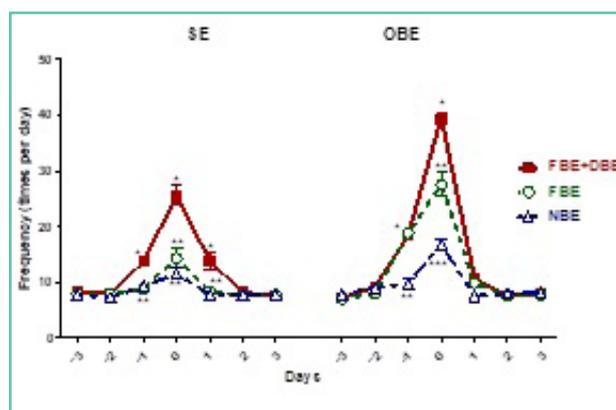


Fig. 2

Fig. 1 Frequency of sniffing/licking by bull or other pen-mates and **Fig. 2** Frequency of mounting attempts of heifers by the bull or other pen-mates in Sahiwal heifers in NBE, FBE and FBE+DBE on the 3 days before, day of (d 0) and 3 days after oestrus when there is a silent oestrus (SE, $n = 18$) or an overt behavioural oestrus (OBE, $n = 21$).

It was concluded that biostimulation of Sahiwal heifers both by fenceline bull contact or fenceline plus direct bull contact appeared to advance the age at puberty and elicited greater expression of estrus behaviour. Fenceline plus direct bull exposed heifers showed higher frequencies and intensities of estrus behaviours than only fenceline bull exposed heifers.

Effect of Bull Biostimulation on Estrus Behaviour and Reproductive Performance of Postpartum Sahiwal Cows

The aim of this study was to investigate the effect of biostimulation on estrus behaviour, estrus intensity and reproductive performance of postpartum Sahiwal cows through 2 types and durations of bull contact. For this, 24 postpartum cows were divided into 3 groups (T_0 , T_1 and T_2) of 8 each based on their yield in previous lactation in pleuriparous cows and expected producing ability of primiparous cows. In T_0 , cows were not exposed to bull; in T_1 , the cows were exposed to the bull after 15–30 days of calving through a fenceline contact round-the-clock and in T_2 , the cows were exposed to the directly bull contact for 12 hours daily. The estrus behaviours were recorded

on day -3, -2 and -1 (prior to estrus), d 0 (on the day of estrus) and on day +3, +2 and +1 (post estrus) by 24 hours CCTV cameras.

Reproductive performance: The average days to first estrus post-partum in T_1 (65.63 ± 7.91 d) and T_2 (52.75 ± 6.60 d) were significantly ($p < 0.05$) lower than in T_0 ($89.9.28$ d). There was no significant difference in the mean days to first estrus in cows between fenceline and direct bull exposed cows. There was a reduction in the length of anestrus period from 24 days in fenceline bull exposed cows and 37 days in direct bull expose cows in comparison to non-bull exposed cows. All the cows in the bull exposed groups were detected correctly in estrus whereas only 40 per cent of the cows in control group were detected correctly in estrus.

Estrus behaviour: During first estrus, mean frequencies of different estrus behaviours viz., sniffing/licking (8.75 ± 0.52 , 16.00 ± 1.22 and 26.88 ± 0.78), tail raising (5.88 ± 0.61 , 14.50 ± 0.63 and 23.63 ± 1.36), micturition (10.13 ± 0.80 , 15.50 ± 0.48 and 18.88 ± 0.71), chin resting (8.38 ± 0.65 , 18.62 ± 0.77 and 25.25 ± 0.86), number of steps (3053.88 ± 55.86 , 3767.75 ± 81.39 and 4106.50 ± 87.69), allowing mounting attempts (8.37 ± 0.41 , 15.50 ± 1.01 and 23.62 ± 1.48), flehmen's response (0 , 6.38 ± 0.88 and 10.88 ± 0.97) and agonistic interactions of cows and bull (6.25 ± 0.32 , 13.88 ± 0.47 and 19.50 ± 0.66) were significantly ($p \leq 0.05$) higher in T_2 than in T_1 and T_0 on the day of estrus. These frequencies of estrus behaviours were increased in second estrus as compared to first estrus in all 3 groups of cows.



Sniffing/licking of estrus cow by bull



Estrus cow allowing mounting by pen mates

Estrus intensity: Mean intensity of estrus during first estrus in T_0 was largely weak (83.65%) and in T_1 was weak to moderate (54.05 and 36.48 %) whereas in T_2 the percentage of weak, moderate and intense was 34.48, 26.02 and 35.46, respectively. The per cent mean intensity of estrus in second estrus was weak to moderate (69.75 and 31.12) in T_0 whereas, percentage of weak, moderate and intense estrus was 36.92, 40.90, 22.03 and 14.51, 29.98, 55.71 in T_1 and T_2 , respectively.

It was concluded that the biostimulation of Sahiwal cows by exposure to bull contact from 15-30 days post-partum improved the expression as well as intensity of estrus symptoms and reduced the days of first estrus post partum in comparison to non bull exposed cows. The biostimulation by exposure to bull by direct contact was found to have greater effect than fenceline bull contact in improving the expression and intensity of estrus.

Behaviour and Performance of Sahiwal Cows Milked Using Different Milking Machine Systems

In recent years commercial dairy farming based on indigenous breeds of cows such as Gir, Sahiwal, Rathi is gaining popularity. Milking at most of these farms is done at present with hand requiring a lot of labour, which ultimately affects the farm profitability. The aim of this study was, therefore, to find out the suitability and effects of different type of milking machine systems and milking parlours on the milking behaviour, productive performance and milk quality of Sahiwal cows. For this study, 23 freshly calved Sahiwal cows (parity=1-3) were selected at parturition and were blocked into 3 groups. Cows in control group (C) were hand milked ($n=7$), in group T_1 were milked in flat barn parlour with pipeline type machine ($n=8$) and in group T_2 were milked in automated herringbone milking parlour ($n=8$). T_2 cows were habituated to milking routine in milking parlour for 15 days before parturition. Milking was done twice daily and milk ejection stimulus was provided by offering concentrate mixture in milking parlour in case of C and T_1 cows whereas in T_2 cows there was no such provision.



Hand milking of Sahiwal cows in flat milking parlour



Milking of Sahiwal cows by pipeline type milking machine in flat milking parlour



Milking of Sahiwal cows by automatic milking machine system in Herringbone milking parlour

The practice of pre-milking habituation of cows to the milking routine indicated that the cows get almost accustomed to the milking routine within a period of 7 days (one session daily in the morning or in the evening). The hand milked cows and the cows milked in pipeline type milking system attained a milking temperament of almost desirable level (docile) whereas the cows milked in Herringbone milking parlour had a milking temperament between docile to slightly restless after the end of experimental period. The overall mean milk let-down time was significantly higher in the cows milked under herringbone milking System (93.72 ± 2.78 sec) in comparison to pipeline system (85.60 ± 2.07 sec) and hand milking method (84.68 ± 2.10 sec). The mean milking time was significantly ($P < 0.05$) higher in the cows milked by hand milking method (12.39 ± 1.89 min) followed by pipeline system (9.38 ± 0.83 min) and herringbone milking System (7.80 ± 0.56 min). The overall mean daily milk yield did not differ significantly among the 3 groups of cows. The daily mean milk yield (in kg) was 7.36 ± 1.70 , 7.69 ± 0.84 and 7.45 ± 0.89 in Control, T1 and T2, respectively.

The overall mean SCC ($\times 10^3$ cells/ml) was significantly ($P < 0.05$) higher in both the machine milked groups of cows (147.65 ± 10.04 and 185.79 ± 11.94) as compared to the hand milked group of cows (102.48 ± 12.09). The overall mean standard plate count (SPC) was significantly higher ($P < 0.05$) in Herringbone milking parlour milked cows as compared to hand milked cows. The quality of milk as determined by MBRT in all 3 groups was very good to good in all 3 groups of cows. The average California Mastitis test (CMT) score was significantly ($P < 0.05$) higher in both machine milked groups of cows as compared to hand milked cows. The number of animals showing teat reactions (redness, chapness, dryness and ring formation) was slightly higher in cows milked in herringbone milking parlour followed by pipeline milking system. These teat abnormalities were not seen in cows which were hand milked. It was further observed that animals affected with teat reactions increased in number as the lactation progressed (being highest during the last fortnight).

It was concluded that the milking behaviour, performance and milk quality of Sahiwal cows was not affected by milking them either by pipeline type or by herringbone milking machine system and these cows can be successfully milked by milking machines after about 2 weeks of pre-partum habituation to milking routine.

Uterine Infection Affects Blood and Uterine Fluid Parameters in Crossbred Cows and Buffaloes

Peripartum period is very critical for health and post-partum productive and reproductive performance in dairy animals. During this period the cows and buffaloes remain at a higher risk of oxidative stress as well as for various infectious diseases like mastitis, clinical endometritis, metritis, pyometra etc. This study therefore was carried out to understand the changes in concentration of oxidative stress indicators in peripheral blood and in uterine fluid during transition period in relation to uterine health in crossbred dairy cows ($n=24$) and Murrah buffaloes ($n=24$). Blood was collected during peripartum period i.e. from day -7 to day +35 of calving. Based on uterine health i.e. assessed by uterine fluid scoring, trans-rectal USG, clinical signs, animals were classified into healthy and uterine infected groups. Results indicated that nitric oxide (NO) concentration was significantly ($P < 0.05$) higher in serum during peripartum period i.e. on day -7 to +35 and in uterine fluid during postpartum period i.e. on day +7 to +35 in both species whereas malondialdehyde (MDA) concentration in serum was elevated throughout peripartum period in cows with uterine infection and in uterine fluid during postpartum period, it was significantly ($P < 0.05$) higher in uterine infected cows as compared to healthy cows. Similar result was found in Murrah buffaloes. Percentage of neutrophils was significantly higher ($P < 0.05$) in peripheral circulation on day -7, 0, +7, +14, +21, +35 in uterine infected crossbred cows and +14, +21 and +35 in uterine infected Murrah buffaloes as compared to their healthy counterparts. *In vitro* phagocytic activity was higher ($P < 0.05$) during peripartum period in uterine infected cows than healthy cows whereas in case of buffaloes significantly higher ($P < 0.05$) on day 0 in both uterine infected buffaloes and healthy buffaloes. It was concluded that both NO and MDA concentration in serum and uterine fluid in crossbred cows and only NO concentration in buffaloes may act as promising indicator for predicting uterine health before onset of clinical infection.

NOVEL APPROACHES IN VALUE ADDITION AND FUNCTIONAL FOODS

Production of Milk Protein Concentrate 80 from Buffalo Milk

Buffalo milk-based milk protein concentrate 80 (BM-MPC80) powder was manufactured and characterized for its physicochemical, functional and reconstitution properties, morphological characteristics and rheological behaviour. The 5.41×UF retentate (5.41×UFR, protein to total solids ratio = 0.80) was spray-dried at 200/95 ± 5°C. Wettability, apparent viscosity, foam capacity and foam stability of BM MPC80 powder were 6.33 ± 0.32s, 455 ± 2.88 mPas, 36.27 ± 1.56%, and 70.53 ± 1.34%, respectively. Porosity, dispersibility, specific surface area, flowability, solubility and heat stability values of BM-MPC80 powder were low. Scanning electron micrographs revealed extensive aggregation in BM-MPC80 powder particles. Retentate and reconstituted BM-MPC80 solutions exhibited shear-thinning rheological behaviour.

Studies on Structure, Rheology and Functional Properties of Paneer

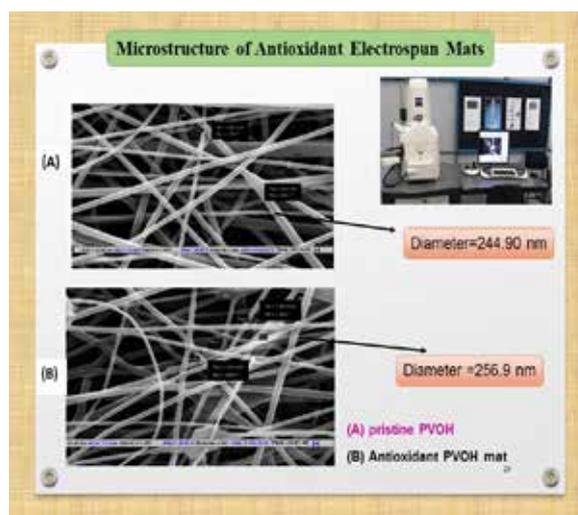
Effect of processing treatments viz. heating temperature-time combinations (90°C/no hold, 90°C/5min, 90°C/10, boiling) and coagulation temperatures (70°C, 80°C, 90°C) on structure, rheology and textural attributes of paneer were studied. Higher coagulation temperatures for milk resulted in higher hardness values of paneer. Treatments viz. 90/5/90 (heat treatment of milk 90°C/5min holding followed by coagulation at 90°C) obtained significantly ($P<0.05$) higher hardness (N) values when compared to the remaining treatments. Scanning electron microscopy (SEM) of paneer samples revealed that core and lining structure become denser at higher heat treatments. Viscoelastic study indicated that storage modulus (G') was always higher than loss modulus (G'') over the whole frequency range (0.1-100 Hz) for all the paneer samples tested. Effect of freezing treatments, viz. Still air freezing (SAF) (-20°C), Brine freezing (BF) (-20°C) and Air blast cooling (ABC) (-5°C) on textural attributes paneer prepared using optimum processing treatment i.e. 90/NH/70 was studied. Frozen samples obtained lower values for hardness, gumminess, chewiness and cohesiveness values compared control samples. This could be attributed to formation of ice crystals and breakage of protein matrix at 4°C (slow freezing) during low temperature storage. Salt migration kinetics revealed that salt penetration in paneer increased with increasing the cooking time. Instrumental hardness, springiness, chewiness and gumminess values of paneer samples increased with an increase in cooking time. Correlation of rheology, sensory and textural data indicated that a good amount of relationship occurs between these quality parameters. Hardness, Storage modulus and sensory firmness were positively correlated. Total solids, hardness and chewiness were also positively correlated, whereas loss modulus and total solids were negatively correlated.

Antioxidant Active Packaging of *Burfi* using Electrospun Structures

An attempt was made to develop and characterize active electrospun mat for application as wrapping material for *burfi* with two antioxidants namely α -tocopherol (α -TC) and ascorbyl palmitate (AP) Rheological behaviour of the electrospinning solution at three different temperatures (25°C, 35°C and 45°C) were found to be shear-thinning. Parameters of electrospinning namely voltage, distance and flow rate were optimized based on 'Larger the better' characteristic of Taguchi design by using 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical and 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt (ABTS) antioxidant assays. FTIR spectroscopy confirmed the presence of antioxidant inclusion complex while SEM images revealed that incorporation of antioxidant inclusion complex into polymer matrix did not affect the bead-free PVOH fiber morphology. The overall migration was found to be within the prescribed limits for food simulants namely *n*-heptane and 3% acetic acid, indicating that the mat could be potentially used for acidic and fat-rich food products as a wrapping material. The changes in the physico-chemical, biochemical, microbial and sensory attributes of active wrapped *burfi* were analysed at 5°C and 30°C. Significant decrease ($P<0.05$) in moisture content and water activity and significant increase ($P<0.05$) in titratable acidity of *burfi* samples was observed irrespective of the package conditions and storage temperature. However, both sensory and microbial characteristics of *burfi* remained unaffected by the active wrapping of *burfi*.



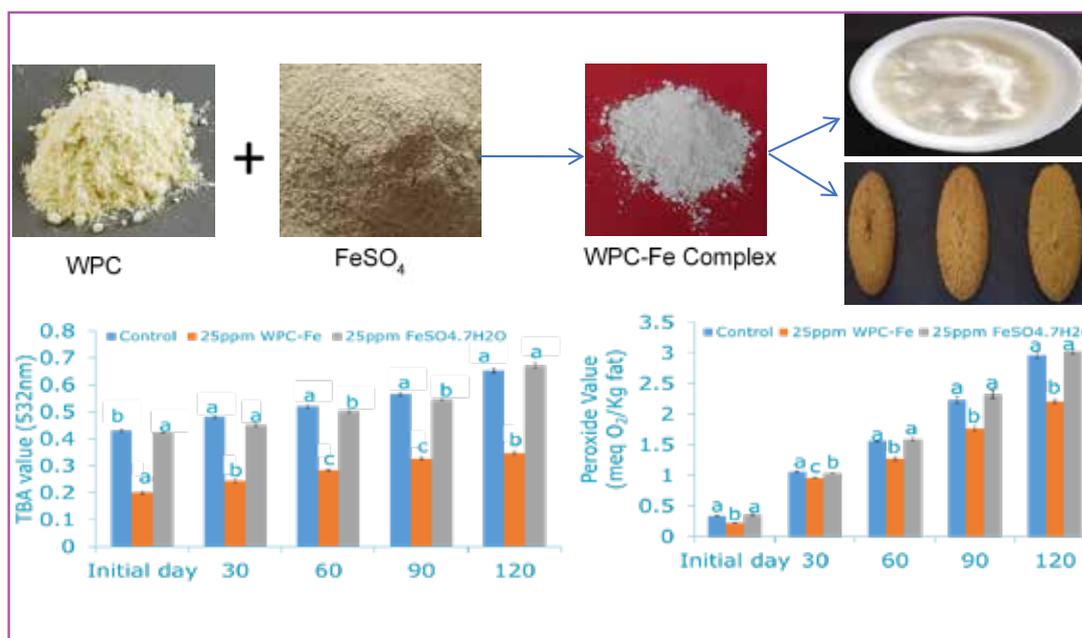
Electrospun mat as wrapping material for burfi



Microstructure of Antioxidant Electrospun Mats

Application of Spray Dried WPC-Fe complex in Biscuit and Dahi

Spray-drying process was optimized to produce whey protein concentrate-iron (WPC-Fe) complex with the aim of making iron compatible with food products. WPC-80 and FeSO_4 complex formation was achieved using centrifugation (to remove insoluble iron), ultrafiltration (to remove unbound iron) and spray-drying. Dahi fortified with upto 20 ppm of spray dried WPC-Fe complex showed higher sensory scores, better textural properties, water holding capacity, lower amount of spontaneous syneresis, optimal titratable acidity and pH, comparable to that of control dahi. Similarly, biscuits fortified with 25 ppm of WPC-Fe complex showed higher sensory scores and better textural properties as compared to control. Significant difference ($p < 0.05$) in colour values, oxidative parameters and sensory scores were observed in WPC-Fe complex fortified biscuits as compared to that of FeSO_4 fortified biscuits. WPC-Fe complex obtained was rich in protein and iron content and could be used as a better and innovative organic iron fortificant with enhanced bioavailability of iron with minimal effect on sensory acceptability, physico-chemical characteristics and shelf life, thus, alleviating the prevalent iron deficiency.



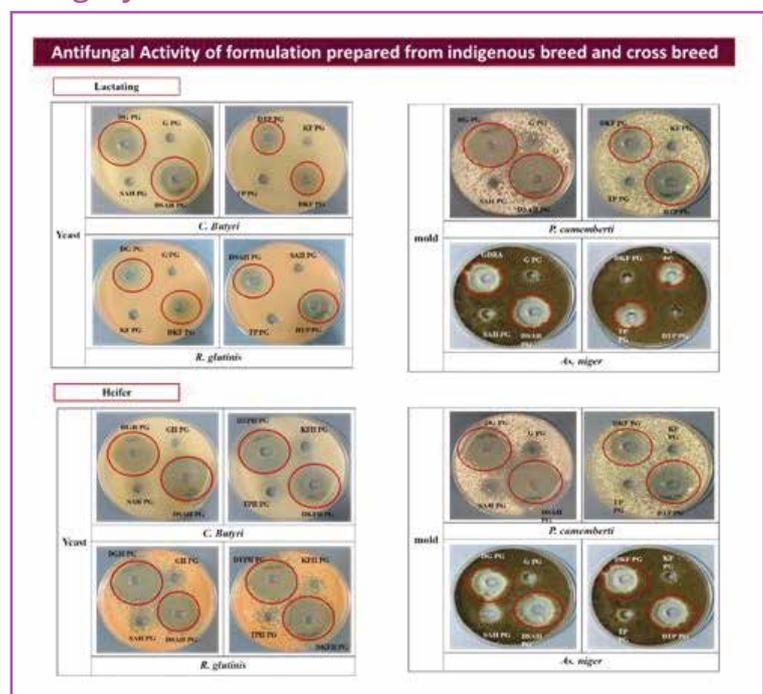
Preparation, Characterization and Application of Vitamin A & D Loaded Milk Protein Nano-complexes

Spray drying conditions for lab scale preparation of milk protein-VAVD complexes were optimized. Reassembling of succinylated milk proteins resulted in improved solubility of prepared complexes. Binding and spray drying (SD) of VAVD to milk protein did not have any influence on the electrophoretic mobility and elution profile on RP-HPLC. Milk protein-VAVD-SD complexes were stable at pH 7.0 and 5.0, indicating their suitability for fortification in food

systems falling in pH range of 5.0-7.0. On the basis of binding ability and solubility, NaCas-VA/VD-SD and RSNaCas-VA/VD nano complexes were selected for fortification in milk. Physico-chemical characterization of milk protein-VA/VD-SD complexes fortified milk showed that milk protein-VA/VD complexes could be used as promising fortificant. Pasteurized milk fortified with VA/VD showed higher retention in LDPE pouches as compared to transparent glass bottles during storage at 4-7°C exposed to different light intensities. VA/VD content was lowest in sterilized milk followed by boiled and pasteurized fortified milk samples. Free vitamin (fat soluble form) fortified milk showed the lowest stability of VA/VD after respective heat treatments. RSNaCas-VA/VD-SD fortified milk showed the highest VA/VD stability followed by NaCas-VA/VD-SD with nonsignificant differences among them. The application of milk protein-VA/VD complexes could be further extended for fortifying various dairy products (e.g. ice cream, yogurt, cheese, infant formula, curd etc.), fruit juices, whey beverage, fruit concentrate etc. It was evident from the results that the total uptake of VA/VD by Caco-2 cells was highest for milk fortified with reassembled succinylated milk protein-VA/VD complexes. The improved retention of the vitamins in rats after feeding fortified milk indicated higher bioavailability from the prepared complexes

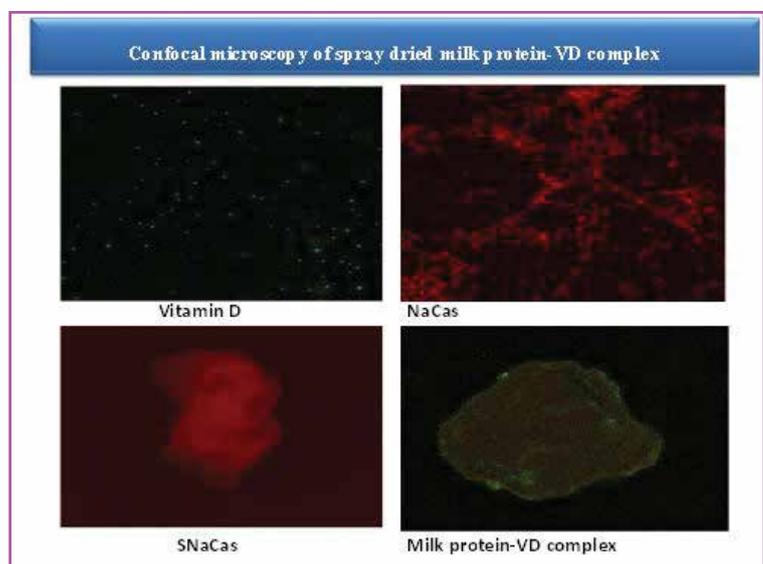
Development of Methodology for Panchgavya

A methodology was developed for analysis of the panchgavya components. Method standardized in the present investigation could be used for the compositional analysis of panchgavya available in the local market. The panchgavya samples had been prepared by mixing the five basic ingredients obtained from different indigenous and cross bred cow KF in equal ratio and used for analyzing compositional parameter and antimicrobial activity. Among different breeds, panchgavya sample of Gir and Sahiwal cow showed better antifungal activity followed by panchgavya sample of Tharparkar and Karan Fries cow. Distillate obtained from the panchgavya formulation prepared from different indigenous cow breed possess potent antifungal activity would be helpful in future to explore such formulation in the field of agriculture and animal based applications.



Evaluation of Storage Stability of Astaxanthin and Antioxidant Activity in Selected Dairy Products

Astaxanthin at a concentration of 0.04% can be used as colourant with antioxidant properties in preparation of flavoured milk, whey beverage and yoghurt. Isolation protocol for sample and analytical conditions were standardised for estimation of astaxanthin using C_{18} column and PDA detector. Pasteurization of selected dairy products resulted in lower recovery (loss in stability). However, the losses were low due to the use of microencapsulated astaxanthin. Astaxanthin was found to be more stable in flavoured milk packed in LDPE pouches than in glass bottles as LDPE pouches were opaque and light could not penetrate it easily. Stability of astaxanthin in dairy products i.e. flavoured milk; whey beverage and yoghurt were influenced by the heat treatment, pH and storage conditions.



Physico-chemical Characterization and Bioaccessibility of the Milk Protein-Vitamin Complexes

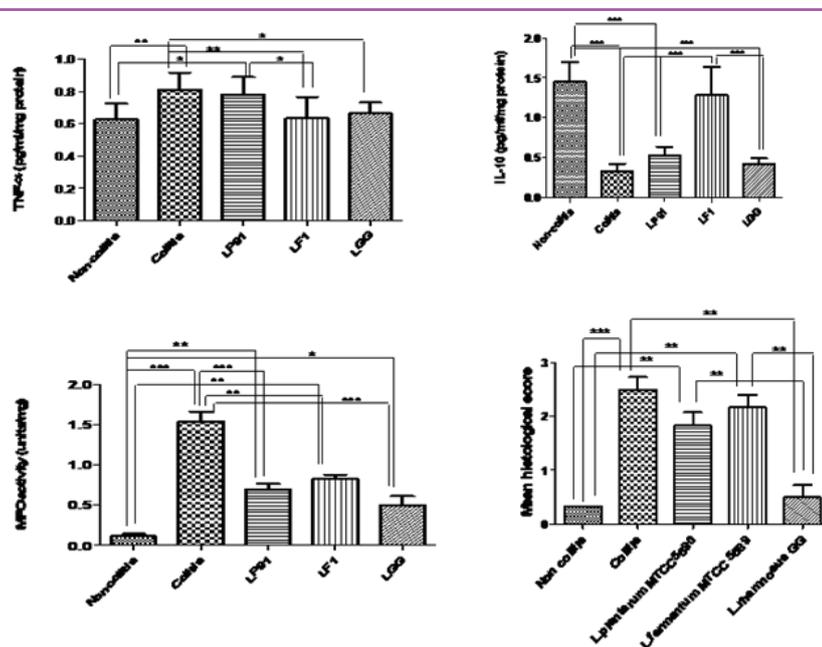
Spray drying conditions for lab scale preparation of milk protein-VA/VD complexes were optimized. Reassembling of succinylated milk proteins resulted in improved solubility of prepared complexes. Milk protein-VA/VD-SD complexes were stable at pH 7.0 and 5.0, indicating their suitability for fortification in food systems falling in pH range of 5.0-7.0. On the basis of binding ability and solubility, NaCas-VA/VD-SD and RSNaCas-VA/VD nano complexes were selected for fortification in milk. Pasteurized milk fortified with VA/VD showed higher retention in LDPE pouches as compared to transparent glass bottles during storage at 4-7°C exposed to different light intensities. VA/VD content was lowest in sterilized milk followed by boiled and pasteurized fortified milk samples. Free vitamin (fat soluble form) fortified milk showed the lowest stability of VA/VD after respective heat treatments. RSNaCas-VA/VD-SD fortified milk showed the highest VA/VD stability followed by NaCas-VA/VD-SD with non significant differences among them. It was evident from the results that the total uptake of VA/VD by Caco-2 cells was highest for milk fortified with reassembled succinylated milk protein-VA/VD complexes. The improved retention of the vitamins in rats after feeding fortified milk indicated higher bioavailability from the prepared complexes.

Cell Wall Components of Probiotic Lactobacilli as Therapeutics for Amelioration of Inflammatory Gut Diseases

The postbiotic preparations i.e. heat killed cells (HK) and the peptidoglycan extracted from the two indigenous probiotic *Lactobacillus* strains viz. *L. plantarum* MTCC 5690 and *L. fermentum* MTCC 5689 alongwith probiotic reference strain *L. rhamnosus* GG were used to investigate their anti-inflammatory potential in DSS (Dextran Sulfate Sodium) induced colitis mouse model. A remarkable ($p < 0.01$) decrease in the secretion of TNF- α was observed in the colonic homogenate of mice fed with HK *L. fermentum* 5689. On the other hand, the level of IL-10 was found to be significantly increased in live *L. fermentum* MTCC 5689 and *L. rhamnosus* GG groups. Myeloperoxidase activity was found to be significantly reduced in the colon of treated mice in HK *L. rhamnosus* GG followed by HK *L. plantarum* MTCC 5690. Among the treated groups, a statistically significant reduction in the histological score was observed in HK *L. fermentum* and HK *L. rhamnosus* GG.

In order to study anti-inflammatory potential of peptidoglycan, the three treatment groups were administered with peptidoglycan extracted from *L. plantarum* MTCC 5690, *L. fermentum* MTCC 5689 and *L. rhamnosus* GG group, respectively, by oral gavage. The secretion of TNF- α , a pro-inflammatory cytokine, was found to be significantly ($p < 0.05$) decreased in the mice colonic homogenate of *L. fermentum* 5689 and *L. rhamnosus* GG groups. The level of IL-10 was found to be significantly increased in *L. fermentum* MTCC 5689 group. The highest reduction in MPO was observed for *L. rhamnosus* GG followed by *L. plantarum* MTCC 5690 and *L. fermentum* 5689. Among the treated groups, lowest histological score was obtained with *L. rhamnosus* GG group.

Lipoteichoic acid (LTA) was extracted by n-butanol and further purified by Hydrophobic Interaction Chromatography (HIC) column (Octylsepharose CL-4B). Although, LTA from MTCC-5690, MTCC-5689 and LGG was able to decrease the secretion of TNF- α , no significant changes in secretion was observed. Similarly, in case of anti-inflammatory cytokine IL-10, no significant improvements in secretion was observed.



Anti-inflammatory effect of peptidoglycan of probiotic lactobacilli in colitis mouse model

Scheme on Dairy Microbes under Network Mode

The four native B₁₂ producing cultures, three *L. plantarum* (F2, V7 and F9), and one *L. rhamnosus* (F5) from infant's fecal samples were found positive for *cbiK* gene. The extracellular vitamin B₁₂ production was highest in F2 (132.216 ± 1.94 ng/mL), followed by V7 (41.303 ± 1.58 ng/mL) and F5 (53.551 ± 2.65 ng/mL) in vitamin B₁₂ deficient media. The highest vitamin B₁₂ production in optimized soy-curd sample was observed in F2 (145.60 ± 3.49 ng/mL). The vitamin B₁₂ bio-fortified soy-curd showed appreciable physical (rheology, texture and viscosity), chemical (pH and acidity) and microbiological and sensory properties.

In hypocholesterolemic study, administration of EPS400 along with SD or HCD significantly (P<0.05) decreased cholesterol, triglycerides, LDL-Cholesterol, VLDL-Cholesterol and increased HDL-Cholesterol in serum. EPS400 showed 10.15% (81.55 ± 0.99 to 73.27 ± 0.77 mg/dL) cholesterol reduction in serum in SD group and 15.86% (124.72 ± 0.37 to 104.93 ± 0.56 mg/dL) in high cholesterol diet (HCD). *Lactobacillus fermentum* NCDC 400 (pellet) in HCD showed 10.12% total cholesterol reduction in serum, 13.12% in liver and 8.05% in adipose tissue. In prophylactic study, catalase and SOD activities were improved when rats fed with EPS400 alongwith SD or HCD. EPS400 alongwith SD or HCD in liver significantly (P<0.05) increased the activity of antioxidative enzymes i.e. higher than *L. fermentum* NCDC400 (pellet). The fatty vacuolization and lipid deposition in liver was moderate in SD group, , high in HCD, and lower in SD+EPS400 andHCD+EPS400 group and *L. fermentum* NCDC400 (pellet) and β-Glucan groups.

Bile Responsive Proteo-transcriptomics Investigation of Native Probiotic Strain *Lactobacillus Helveticus* MTCC 5463

The transcriptomics data of *L. helveticus* MTCC5463 under normal and bile treated conditions (0.9 and 1.2%) revealed the identification of 50 million reads in individual replicates. The bioinformatics pipeline was used for matching the reads using HISAT, StringTie, DESeq, KEGG, GO analysis. A total of 2151 genes were determined and interestingly 406 were **Pseudo genes**. Analysis also revealed over expression of binding activity in molecular functions and membrane parts in cellular component for the bacterial cells perturbed with 0.9% and 1.2% bile stress. This finding indicated the importance of membrane and respective binding proteins for overcoming the hazardous impact of the bile in bacteria. Upon performing the unsupervised hierarchical clustering for 0.9% bile stress, GMP synthase, ABC transporter permease, Holiday junction, Multidrug resistance, family of transcriptional regulators and histidine kinase were identified. Presence and up-regulation of these genes described their importance during tolerance to the perturbation. Importantly, the same proteins were identified in cell when performed the clustering with 1.2% bile stress. However, more number of multi drug resistance genes were also identified. On the other hand, ATP dependent helicase was found to be down regulated in both the conditions. The KEGG pathway analysis showed the identification of specific pathways to be highly important to tolerate the bile salt that includes the nucleotide excision repair, mismatch repair, homologous recombination, beta-lactam resistance in connection with biosynthesis of the peptidoglycan and bacterial secretion system.

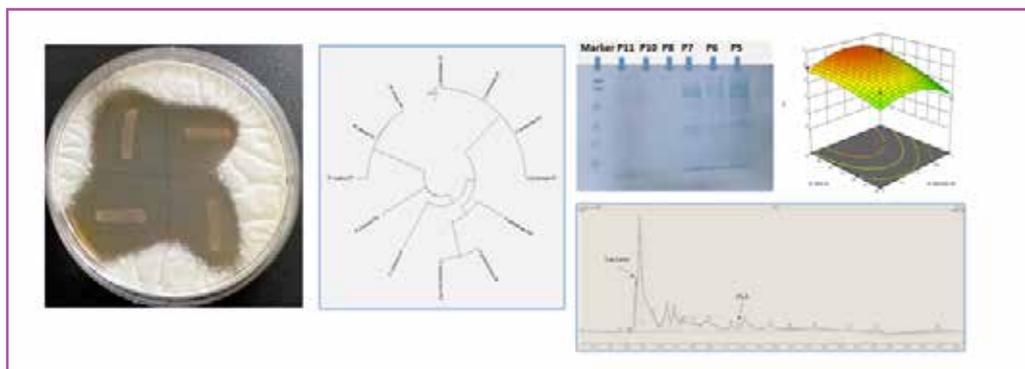
Development of Immunomodulatory Exopolysaccharides Containing Healthy Fermented Dairy Foods

In order to perform *in vitro* immunomodulatory assay using Raw 267 cell culture, EPS production from 28 lactic acid bacteria including eight *Lactobacillus* and twenty *Streptococcus* cultures was performed in deproteinized media. EPS from the medium was extracted by repetitive ethanol precipitation. Highest EPS production was observed for *Lactobacillus delbrueckii* subsp. *bulgaricus* Bha8 i.e. 445.64 mg/L while lowest for *Lactobacillus acidophilus* Ind7 i.e., 199.5 mg/L. Among the *Streptococcus thermophilus* cultures, MC1 produced maximum quantity of EPS i.e. 393.2 mg/L. Other strains such as Sha5, Vis2, Kan3, MM1 and Shu3 also showed good quantity of EPS production i.e., 382.86, 365.84, 361.16, 354.42 and 324.12 mg/L, respectively. Protein content in various EPS extracted was found to be less than 1%.

Development of Edible Antimicrobial Packaging Films for Traditional Dairy Sweetmeats Using Metabolites of Lactic Acid Bacteria

A total of 12 Lactic acid bacteria strains showing antifungal activity were identified by 16S rRNA partial gene sequencing and the sequences deposited in the NCBI GenBank. The influence of different factors such as carbohydrate source, inoculum level, incubation temperature, pH and salt concentration was checked on the antifungal activity of the *W. cibaria* P6 and *L. plantarum* P10 and found that dextrose %, inoculum level and incubation time had a profound effect. Response surface methodology was used to optimize the above combination of conditions for both the cultures. A synergistic effect was also observed between the combinations of the broth fermentate of the two isolates against the tested fungi. RP-HPLC of the MRS broth fermentate at the optimized conditions confirmed the presence of significant amount of organic acids *viz.* lactate and acetate alongwith phenyllactate in the two cultures. However, no presence of antimicrobial proteinaceous compounds was observed in the any of the two

LAB isolates. During the spoilage study of the traditional dairy sweetmeats, fungal microflora of fresh khoa burfi was predominated by yeast (80%) comprising mainly of *Candida* spp. and *Kodamaea* spp. followed by mold (20%) of *Aspergillus* spp. The spoilage was apparent at 6-7 days at 37°C and dominated mainly by molds of diverse types such as *Aspergillus* spp., *Cladosporium* spp., *Lasiodiplodia* spp., *Eurotium* spp. etc. in addition to some of the spoilage yeast that was initially present. A similar trend was also observed in chhana sandesh. In paneer, a number of fungi active during its spoilage were identified belonging to the genus *Candida* spp., *Aspergillus* spp., *Cladosporium* spp. *Schizophyllum* spp. etc. by ITS region gene sequencing.

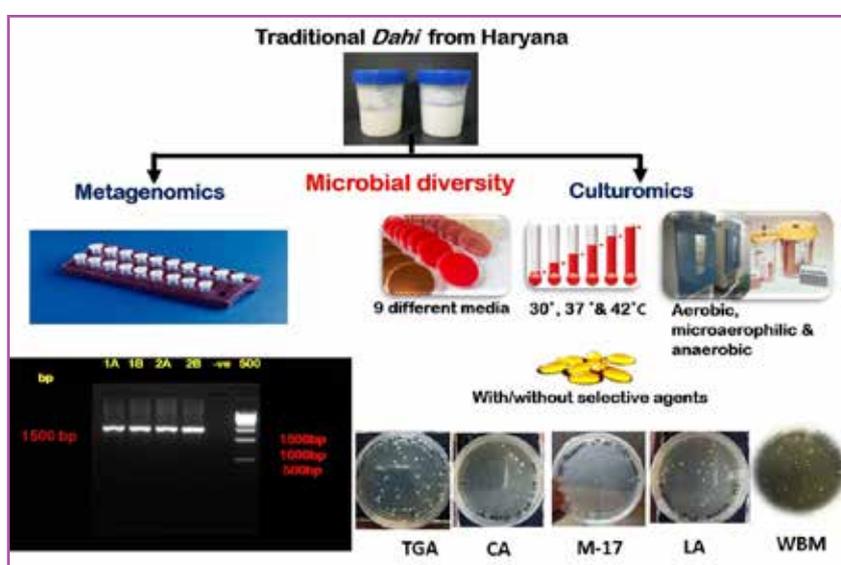


Identification of antifungal LAB isolates and characterization of its antifungal activity

Unveiling the Microbial Diversity of Traditional Indian Fermented Milk Product 'Dahi' Through Culturomics and Metagenomic Approaches

Different protocols and kits were used for the extraction of high quality metagenomic DNA from traditional *Dahi* samples to study their microbial diversity. The lab adopted protocol for extraction of metagenomic DNA was further standardized with different concentrations of Lysozyme (1 to 2 mg/ml) and Proteinase K (1 to 2.5 mg/ml). The adopted lab protocol using 2mg/ml of Lysozyme, 1mg/ml Proteinase K yielded DNA with 1µl of RNaseA (10 mg/ml) treatment yielded metagenomic DNA of satisfactory quality and adequate quantity (500 – 1200 ng/µL) to be used in metagenomics study.

Later, the PCR amenability of metagenomic DNA was assessed with 16S rRNA gene PCR and the metagenomic DNA extracted from traditional *Dahi* sample was found amenable for preparation of amplicons in metagenomics study. For culturomics based microbial diversity analysis of traditional *Dahi*, the questionnaire was drafted for the collection of traditional *Dahi* samples and initially a single sample of *Dahi* was collected and cultured with 10 different culture media (Lactic agar, thioglycollate agar, trypticase soy agar, cooked meat agar, Columbia Agar, Plate Count agar, Nutrient agar, Brain Heart Infusion agar, MRS and M-17



agar) including customized whey based medium for culturing the maximal number of microbes of dairy origin. Amongst, lactic agar, Thioglycollate agar, Columbia agar, M-17 and tailored whey based medium were found to be equivalent in culturing of *Dahi* bacteria under all the atmospheric conditions. Further, the efficacy of developed whey based medium was evaluated with standard culture medium M-17 for the cultivation of *Lactococci* and *Streptococci* and MRS for the cultivation of *Lactobacilli* and *Leuconostoc*. The developed whey based medium was able to improve the growth of all test LAB equivalent to the standard medium.

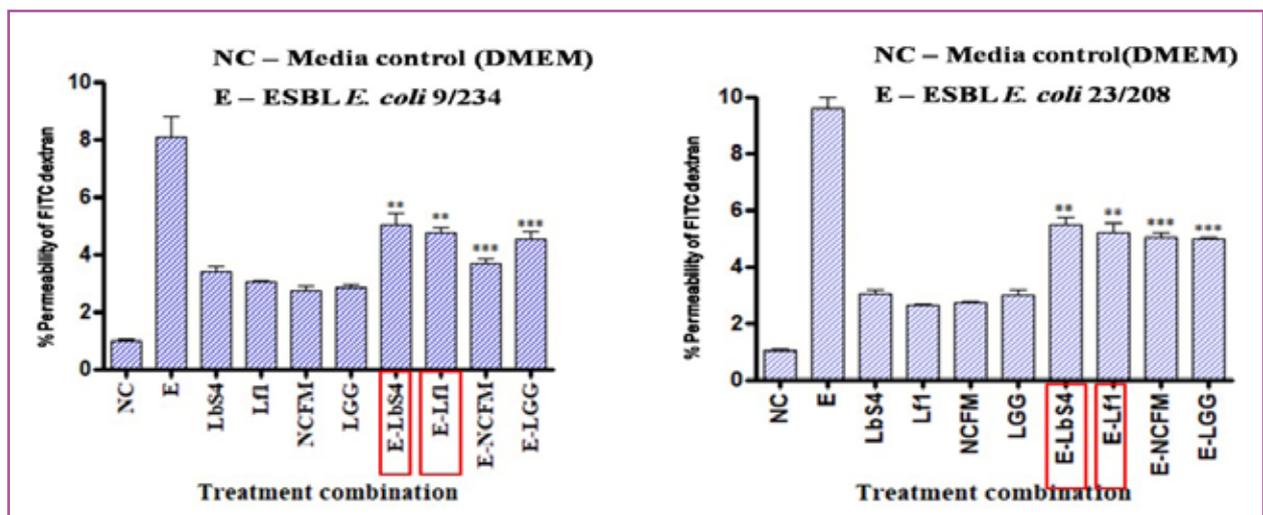
Anti-colonization Efficacy of Indigenous Probiotics and their Surface Proteins against Methicillin Resistant *Staphylococcus aureus* (MRSA)

A total of ten well characterized indigenous probiotic strains viz. *Lactobacillus plantarum* (A1, A5, Lp9, Lp91), *L. fermentum* (LbS4, Lf1, Ad06), *L. rhamnosus* LrhS3, *L. reuteri* Lre120 and *L. casei* LbS2, along with two standard reference

strains viz. *L. acidophilus* NCFM and *L. rhamnosus* GG were screened against six MRSA isolates (12/241, 12/206, 25/214, 5/255, 9/265, 25/224) along with *S. aureus* ATCC 25923 (control strain). Two MRSA strains viz. 12/206 and 5/255 exhibiting utmost tendency to colonize in gut epithelium were selected by profiling the virulence (coagulase, nuclease, hemolysis, capsule production), adherence (mucin binding ability, biofilm formation, cell surface hydrophobicity and auto-aggregation) and drug resistance pattern. Two putative indigenous probiotic candidates viz. Lf1 and A5 exhibiting strong potentiality to combat MRSA 12/206 and 5/255 apart from other MRSA isolates were selected by studying cell surface properties (cell surface hydrophobicity and auto-aggregation), adherence property (mucin binding ability) and antagonistic abilities (antimicrobial, antibiofilm and co-aggregation). In *in vitro* bacterial interference assays, indigenous probiotic strains (Lf1 and A5), their heat killed preparations and their surface proteins demonstrated substantial ($P \leq 0.05$) reduction in adhesion of MRSA isolates to gut enterocytes (HT-29 cells). In addition, the surface proteins of Lf1 and A5 also mitigated ($P \leq 0.05$) the adhesion of MRSA 12/206, 5/255 and ATCC 25923 to mucin in all three bacterial interference assays with the maximal reduction in adhesion of MRSA by protective assay. Besides, the biosurfactants of LbS4, Lf1 and A5 (glycolipids or glycopeptide or lipoprotein class) exhibited excellent antagonistic activities by affecting the surface topology of staphylococcal isolates. Surface proteins and heat killed preparations of two putative indigenous probiotic strains viz. *L. fermentum* Lf1 and *L. plantarum* A5 possessed greater tendency to create colonization resistance against clinical isolates of MRSA as compared to live probiotic cells. Additionally, the biosurfactants of probiotic strains viz. LbS4, Lf1, A5 also emerged as strong antimicrobial agents against multidrug resistant MRSA.

Probiotics and their Surface Proteins Mediated Colonization Resistance against Extended Spectrum Beta Lactamase (ESBL) *Escherichia Coli*

Decolonization efficacy of indigenous probiotic *Lactobacillus* strains and their surface proteins against clinical isolates of ESBL *E. coli* was studied in HT-29 cell line model. A total of ten well characterized indigenous probiotic strains viz. *Lactobacillus plantarum* (A1, A5, Lp9, Lp91), *L. fermentum* (LbS4, Lf1, Ad06), *L. rhamnosus* LrhS3, *L. reuteri* Lre120 and *L. casei* LbS2 along with two standard reference strains viz. *L. acidophilus* NCFM and *L. rhamnosus* GG were screened against six ESBL *E. coli* isolates (2/417, 21/210, 23/209, 9/234, 1/236, 23/208). Two indigenous probiotic strains viz. LbS4 and Lf1 displayed strong potentiality to encounter robust ESBL *E. coli* strains 9/234, 23/208 and were selected by studying cell surface properties (cell surface hydrophobicity, autoaggregation), adhesion to mucin, and antagonistic abilities (antimicrobial, antibiofilm and coaggregation). Besides, extracted surface proteins of selected probiotic strains (LbS4, Lf1, NCFM and LGG) also significantly ($p < 0.001$) reduced the adhesion of ESBL *E. coli* 9/234 and 23/208 both in protective and competitive assay. In *in vitro* bacterial interference assays, indigenous probiotic strains (LbS4 and Lf1), their surface proteins and heat killed preparations displayed considerable reduction in adhesion of ESBL *E. coli* isolates to HT-29 cells. Statistically the live probiotic strains of LbS4 and Lf1 and their total surface proteins significantly ($P \leq 0.01$) reduced the adhesion of ESBL *E. coli* 9/234, 23/208. Probiotics (LbS4, Lf1, NCFM and LGG) and their surface proteins played a key role in improving gut barrier permeability against ESBL *E. coli* isolates by significantly ($P \leq 0.01$) reducing the para cellular permeability of FITC dextran across the HT-29 monolayer. Probiotics and their surface proteins have potential to develop adjuvant therapies to combat ESBL *E. coli* colonization in gut since the probiotic strains and their surface proteins exhibited efficient *in vitro* colonization resistance against ESBL *E. coli* isolates.



Gut barrier protective efficacy of live probiotics against ESBL *E. coli* isolates

Ameliorative effect of Vitamin B₁₂ bio-enriched Soybased Functional Food on Adverse Pregnancy Outcomes in Wistar Rat

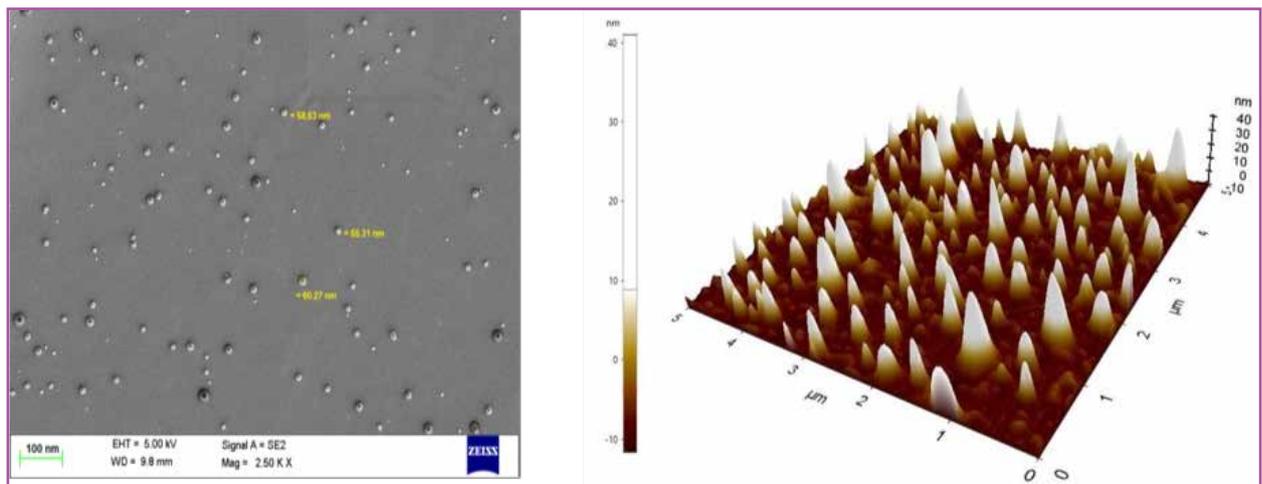
Extracellular Vitamin B₁₂ producing two lactobacillus cultures viz. *Lactobacillus plantarum* F2 and *Lactobacillus reuteri* V7 were evaluated for probiotics attributes. Both cultures showed good acid and bile tolerance, cell surface hydrophobicity, auto and co-aggregation properties and were safe. Bio functional properties of fermented soy product viz. antioxidant, ACE- and DPPIV inhibitory activities by both cultures were also evaluated. Appreciable antimicrobial activity of fermented soy product was observed both against bacterial pathogens (*B.cereus* NCDC240, *Enterococcus faecalis* NCDC 115, *S. typhi*, *E.coli* NCDC135, *S. aureus* NCDC100) and fungi (*R. glutinis*). F2 exhibited antimicrobial activity against *C. butyri* in addition to all pathogens. Further, for *in-vivo* study, F2 culture was selected as highest B₁₂ producing culture for preparation of bio-enriched soy based food. The feeding of vitamin B₁₂ bio-enriched fermented soy product to B₁₂ deficient dams significantly (P<0.05) improved the B_{12b} levels in blood, kidney and liver. It also concomitantly lowered down the lipid profile of serum and liver of dams significantly. Besides, it showed lower level of oxidative stress markers viz. catalase and SOD in kidney and liver of dams *vis-à-vis* B₁₂ deficient group. Furthermore, also lowered down the pro-inflammatory cytokines TNF- α and IL-6 in serum of dams. Birth weight of pups delivered from B₁₂ deficient dams group fed with fermented soy product was significantly (P<0.05) higher than B₁₂ deficient group and yet similar with B₁₂ supplemented group. Death rate of pups delivered from B_{12b} deficient dams fed with fermented soy product group during lactation was found to be significantly lowered and was similar to that of the control group. Vitamin B₁₂ level in the serum of the pups delivered from the group fed with fermented soy product was significantly higher than that of B₁₂ deficient group. The functional evaluation of vitamin B₁₂ bio-enriched soy fermented product in this study indicated its potential for commercial adaption to combat vitamin B₁₂ deficiency.

Hypocholesterolemic Effect of Lactic Acid Bacteria Derived Exopolysaccharides

The study was undertaken to investigate the stability of cholesterol binding EPS 400 from *L. fermentum* NCDC 400 in simulated gastric conditions and its effect on cholesterol level in animal model. Initially, the cholesterol binding by EPS 400 at 2 and 3% was evaluated under different pH conditions i.e. 2, 4 and 7, which indicated that the cholesterol binding ability increased with increase in concentrations of EPS and decreased with decline in pH. However, EPS 400 could bind more than 63% cholesterol even at pH 2. Under simulated gastric conditions, the stability of cholesterol binding EPS 400 was $76.14 \pm 0.91\%$, while for β -glucan it was $83.33 \pm 0.81\%$ which may be due to the presence of carboxyl, hydroxyl and methyl group in EPS 400 as observed in FTIR spectra. Group of rats fed with EPS 400 along with standard diet or high cholesterol diet significantly lowered the body weight of rats. There was no significant change observed in feed intake among the groups, except rats fed with EPS 400 standard diet or high cholesterol diet after 60th day. Group of rats fed with EPS 400 along with standard diet or high cholesterol diet significantly (P<0.05) lowered the total cholesterol, triglycerides and LDL-cholesterol, while increased HDL-cholesterol in serum, liver and adipose tissues. EPS 400 reduced 10.15% total cholesterol in serum, 14.83% in liver and 8.65% in adipose tissues of rats. Histopathology of liver of rat fed with EPS 400 showed minimum fatty vacuolization and lipid deposition as compared to rats maintained on standard diet. Rats fed with high cholesterol diet showed high degree of vacuolization and lipid deposition, which was greatly lower in HCD+ EPS group. Incorporation of EPS 400 in the diet of rats significantly (P<0.05) increased the activity of antioxidative enzymes (catalase and SOD). EPS 400 exhibited higher level of restoration of antioxidant enzymes. EPS 400 of *L. fermentum* NCDC 400 has greater cholesterol lowering capability *in-vivo* and could be used to develop hypocholesterolemic fermented dairy products.

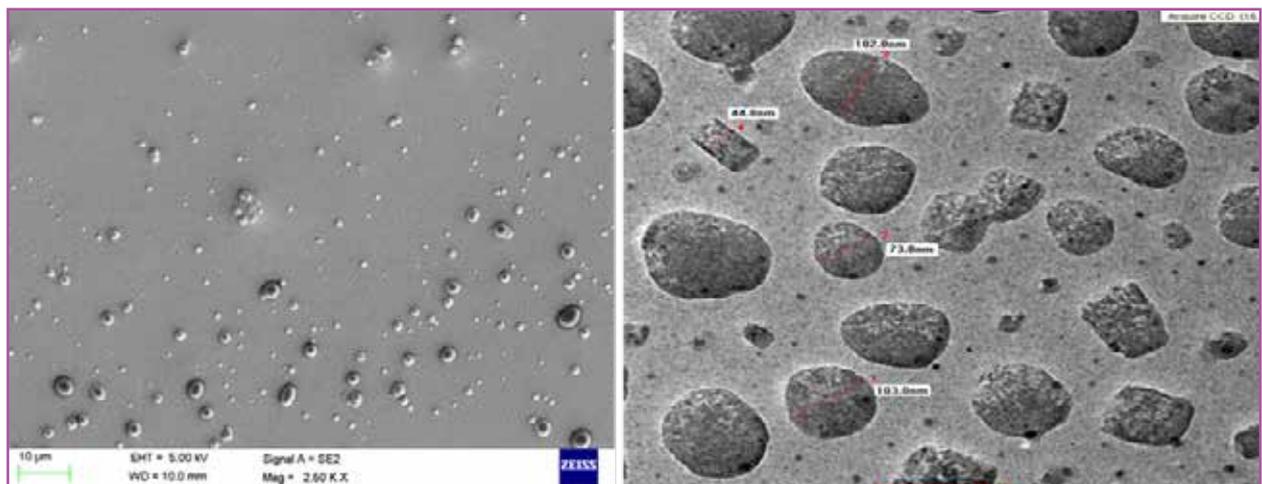
Preparation and Characterization Catechin Loaded Niosomes and Fortification of Milk

Niosomes (the nonionic surfactant vesicles), are promising nanocarriers in providing targeted and controlled release of bioactivities. Catechins belonging to the class of flavonoids, sourced from green tea, have promising therapeutic benefits but, have limited efficacy mostly due to poor absorption and bioavailability. Catechin loaded niosomes were prepared using food-grade surfactants and different stabilizers by thin film hydration technique and high shear homogenization. The niosomal suspensions were evaluated for structural, morphological characteristics, release behavior, antioxidant properties, solubility and photostability. Catechin loaded niosomes prepared with Tween 60 and 80 using lauryl alcohol exhibited small z- mean diameter of about ~60 nm and high entrapment efficiency when compared to those prepared with cetyl alcohol and cholesterol. DLS, SEM, AFM images confirmed that the particle size is less than 60 nm. FTIR results showed interaction among surfactant, stabilizer and catechin, thereby confirming the successful encapsulation of catechins. Controlled and sustained release was observed for niosomes under simulated GI conditions; 66.2% in 24 h when compared to >85% for free catechin in 2 h. The solubility and photostability of catechin niosomes were improved when compared with free catechins. Fortification of milk with catechin niosomes did not show any significant (p<0.05) difference in sensory parameters. The developed niosomes can serve as promising delivery vehicles for improved bioavailability and functionality of catechins.



Bioactive Peptides Loaded Niosomes: Preparation and Characterization and Fortification of Milk

Casein was hydrolysed with flavourzyme and the hydrolysates were subjected to ultrafiltration to obtain 10 kDa permeate. Biopeptides-niosomes were prepared using thin layer hydration and high shear homogenization method. Different parameters were optimized for preparation of niosomes on the basis of particle size and encapsulation efficiency viz Duration of high shear homogenization (5, 10 & 15 min), Speed of high shear homogenization (5000, 10000, 150000 & 20000 rpm), Stabilizers (Lauryl alcohol, Cetyl alcohol & Cholesterol), Non-Ionic Surfactants (Tween 60, Span 60 & combination), Concentration of NIS (150, 200 & 250 μ M) and Ratio of NIS & Stabilizer (1:1, 1:0.5 & 1.5:1). The optimized biopeptides-niosomes were characterized for their functional property like anti-oxidant and *in-vitro* release of peptides from niosomes. DPPH radical scavenging abilities of free and nanoencapsulated peptide were concentration dependent, with the highest activity observed at highest peptide concentration. It was observed that 99% of peptide in its free form was released within 6 h whereas; nanoencapsulated peptide showed a controlled release. Morphological characteristics of niosomes were studied using SEM, TEM and FTIR. SEM and TEM images of niosomes demonstrated spherical morphology with smooth surface. The characteristic peaks of free peptide were not observed in the FTIR spectrum of peptide loaded niosomes, indicating its encapsulation into the niosomes.



Functional Properties of Casein Bioactive peptides

Casein isolated from Deoni milk was hydrolysed using 4 different proteolytic enzymes; trypsin, pepsin, flavourzyme and protease K. The casein hydrolysates were evaluated for antioxidant, antidiabetic (alpha amylase and alpha glucosidase inhibition) and antihypertensive (ACE inhibition) properties. Casein hydrolysates obtained using protease K showed better antioxidant and antidiabetic properties, while there from trypsin exhibited better ACE inhibition property. Based on the properties exhibited by casein hydrolysates obtained using individual enzymes, different combination of enzymes was selected. The combination of protease k + flavourzyme showed better antioxidant and alpha amylase inhibition property, while that from protease K + trypsin showed better alpha glucosidase and trypsin + pepsin showed better ACE inhibition properties. The hydrolysates were subjected to sequential ultrafiltration using 10, 5 and 3 kDa membrane filters. The functional activities increased with decrease in the molecular weight in the order of $10 > 5 > 3$ kDa. The 3 kDa permeates were further fractionated using preparative RP-HPLC and the

major fractions collected were assayed for the functional properties. The fractions showing the best functional properties were subjected to LC-MS/MS analysis for determining the sequence of amino acids. The peptides were observed to have 6-10 amino acids. The sequence, fragment and functional properties of the biopeptides were well compared with those reported in the literature.

Development of Cow Side Diagnostic Test for Regular Monitoring of Udder Health Status of Dairy Cows

To develop of cow side diagnostic test (as farmer's friendly) for regular monitoring of udder health (SCM), experiment was conducted by collecting random milk samples from farm lactating cows (528) and field dairy cows (800). After lot many trial and error methods, this milk test was developed as Surf Field Mastitis test (SFMT). It was based on surf (detergent) powder which was prepared as 3 % solution by mixing with clean tap water. A battery of different other diagnostic tests were applied to compare and validate the efficacy of this Surf Field Mastitis test (SFMT). Statistically analyzed data revealed that the highest (%) sensitivity, specificity, positive predictive value, negative predictive value, highest positive likelihood ratio with lowest negative likelihood ratio were recorded from farm animal's milk samples where highest (%) of true positive, true negative, accuracy with lowest (%) false positive and false negative were found in following order for different diagnostic tests viz: milk SCC then MCMT, SFMT, MWST, EC and pH, respectively. While considering milk SCC as bench mark (gold standard for SCM diagnosis), it was ranked-1st and with it other diagnostic tests were compared. All most similar trend of observations of highest (%) order of sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio with lowest (%) order of negative likelihood ratio were recorded from field animal's milk samples where highest (%) order of true positive, true negative, accuracy with lowest (%) order of false positive and false negative were found for different diagnostic tests viz: milk SCC then MCMT, SFMT, MWST, EC and pH, respectively. The conclusion of study is that surf field mastitis test can be considered as an easy, reliable and farmer's friendly test which can be applied by any milker as a regular management practice to monitor udder health status of dairy animals.

Influence of Herbal Fly Control Measures on Udder Health and Milk Production of Jersey Crossbred Cows

Present investigation was conducted to find out the effect of herbal fly control measures to repel fly attack and milk production in cows. Based on the literature suitable herbal mixture (*Acorus calamus* root+charcoal of coconut shell+Turmeric powder+Neem oil) was prepared and it was packed in coconut leaf ball and such 4 balls were arranged/stitched in a piece of cotton cloth which was put as neck belt of individual cows. The coconut tree leaves was specially designed to form a ball (container) to hold this mixture in such porous container which liberated smell in and around by which fly may repel from body parts of 6 experimental (treatment) cows. Overall milk somatic cell count significantly ($p<0.01$) reduced in cows of treatment than control group (under regular farm practice) during overall lactation period. Different diagnostic parameters (MCMT, MWST, pH, electrical conductivity, SFMT) of subclinical mastitis indicated a significantly ($p<0.01$) lower (acceptable) values in treatment than control group. The overall milk production significantly ($p<0.01$) increased in treatment than control group. The milk quality was significantly ($p<0.01$) better in treatment than control group. No significant differences were found for milking time, MTS (milking temperament score) and milk composition parameters. Fly repelling/defensive behavioral parameters (viz: tail flicking, skin twitching, striking, kicking, head throwing, ear flicking) indicated that treatment group spent significantly ($p<0.01$) less time than control group which revealed that less fly attack in treatment than control group. It was inferred that fly control measures with herbs was having positive influence on milk production by maintaining good udder health status of Jersey crossbred cows.



Comparison of Micro-climate of Thermo-comfortable (TC) Experimental and Existing Asbestos Shed of Jersey Crossbred Cows

A thermo-comfortable model shed was constructed at Eastern Regional Station, Kalyani for thermal stress amelioration of cows and to provide better housing comfort. Thermo-comfortable shed was made up of thatched roof and having facilities of ridge ventilation in roof design. The microclimatic conditions of experimental shed were better as compared to existing shed. In TC shed, environmental temperature, relative humidity and temperature humidity index (THI) in both morning and afternoon were lower as compared to control asbestos roof shed. The

average environmental temperature and humidity in the morning were 1.10 to 1.84°C and 0.89 to 2.98% less in experimental shed compared to existing shed. The corresponding values in the afternoon were 1.13 to 2.61°C and 0.06 to 2.89% higher across different months. In winter season differences were less. In summer and rainy seasons micro-environmental differences between TC and existing shed was significantly higher than winter. Thus observations indicated that experimental shed was more comfortable than existing shed. Temperature humidity index of both TC and asbestos shed during morning and afternoon was also recorded. Results revealed that THI values of both morning and afternoon were significantly higher in control shed compared to TC shed. During afternoon, differences were more as compared to morning hours. In thermo-comfortable shed ceiling surface temperature was 8 to 15°C less than existing shed in morning hours and 10 to 16°C in afternoon. The obtained results indicated that thermo-comfortable thatch roof shed was very good thermo-protective as compared to others. Under roof asbestos ceiling by paddy straw was also effective to reduce roof-thermal radiation inside the shed.

Effect of Housing on Milk Yield (Trial-2) and Cardinal Physiological Parameters of Jersey Crossbred Cows

The study was conducted on 20 Jersey crossbred cows divided in two groups, each containing 10 animals and they were kept in two different housing patterns i.e., existing shed (control group) and Thermo-comfortable shed (experimental group). Average daily milk yield /cow in the thermo-comfortable shed (9.03 ± 0.08 kg) were significantly higher than that of existing shed (8.46 ± 0.07 kg). Thus result indicated that cows of thermo-comfortable shed had 0.57 kg/day/cow more milk yield as compared to cows kept at asbestos shed.

Housing significantly influenced the cardinal physiological parameters of Jersey crossbred cows. During morning hours, temperature and respiration rates were significantly higher in cows of kept in existing housing than that of thermo-comfortable shed. In control group, morning body temperature was 0.13°C and respiration rate was 7.89% higher compared to experimental group. Similarly in afternoon the values were 0.13°C and 8.76%. The results indicated that cows kept in thatched shed with ridge ventilation were more comfortable than cows kept in existing shed.

Heat tolerance indices of cows maintained at thermo-comfortable and existing shed were measured using 3 different heat tolerance indices. In all the methods, it was evident that indices were favourable for cows housed in experimental shed than the control shed. Results indicated that experimental thermo-comfortable shed was more comfortable for cows than the existing shed and cows of thermo-comfortable shed had 0.57 kg/day/cow more milk yield as compared to cows kept at asbestos shed.

Livelihood Security vis-a-vis Resilience to Adverse Weather Events Among Tribal and Non Tribal Livestock Farmers

Under the project one 'Resilience scale' was constructed and items were grouped by using Principal Component Analysis (PCA). According to the results of rotated component matrix, five components were retained and different items under each dimension were identified. After that, different components were named as: Adverse weather preparedness dimension, Peer Support and recognition dimension, Pessimistic attitudinal dimension, Optimistic attitudinal dimension and Priority setting dimension. One livelihood security Index was developed under the project and from the index it was found that, tribal farmers from Jhargram were in most distressed condition in terms of livelihood security when compared to other districts; though the mean difference of tribal from Jhargram and Birbhum was not significantly different. On the other hand, non-tribal from both the blocks of N. 24 Pgs was in the better position and their livelihood condition was significantly better than all the other groups though the condition of Block-1 was the best. The condition of tribal communities was comparable in Birbhum and S. 24 pgs district though the condition was worst in case of Jhargram tribal population. In case of resilience, the non-tribal farmers from Birbhum were the worst than other non-tribal farmers from other regions though their scores are comparable with non-tribal farmers from Jhargram and farmers of Block-2 from S. 24 Pgs districts. It was found that there was difference in perception about the role of dairying in resilience to adverse weather events among tribal and non tribal farmers.



DEVELOPMENT AND VALIDATION OF HEALTH PROMOTING DAIRY FOODS

Effect of Plasmin Activity on Bio-Functional Properties of Gouda Cheese

Plasmin activity and its relation with physico-chemical, bio-functional & sensory attributes of Gouda cheese were evaluated. Plasmin activity was significantly affected by the ripening period, heating temperature and types of brine salting. Antioxidant activity and ACE-inhibitory activity were also affected significantly. A possible set of process variables and extent of ripening were obtained for achieving highest bio-functional properties in Gouda cheese.

Technology of Probiotic Curd Rice

A technology was developed for production of probiotic curd rice containing probiotics in the form of encapsulated bead. Inulin at a concentration of 3% was used as prebiotic for encapsulation of *Lactobacillus rhamnosus* CRD-11 in alginate beads. Microencapsulation has significantly ($P < 0.05$) increased the survivability of probiotic against low pH, high bile and moderately high thermal conditions. For standardization of curd rice, levels of curd, rice and salt were varied and selection was made on the basis of sensory scores and probiotic count. For probiotic curd rice, free and encapsulated probiotic were added in curd separately. Standardized levels of curd, rice and salt for probiotic curd rice were 55%, 50% and 0.75%, respectively. The probiotic count was 9.78 log cfu/g.



Probiotic Curd Rice

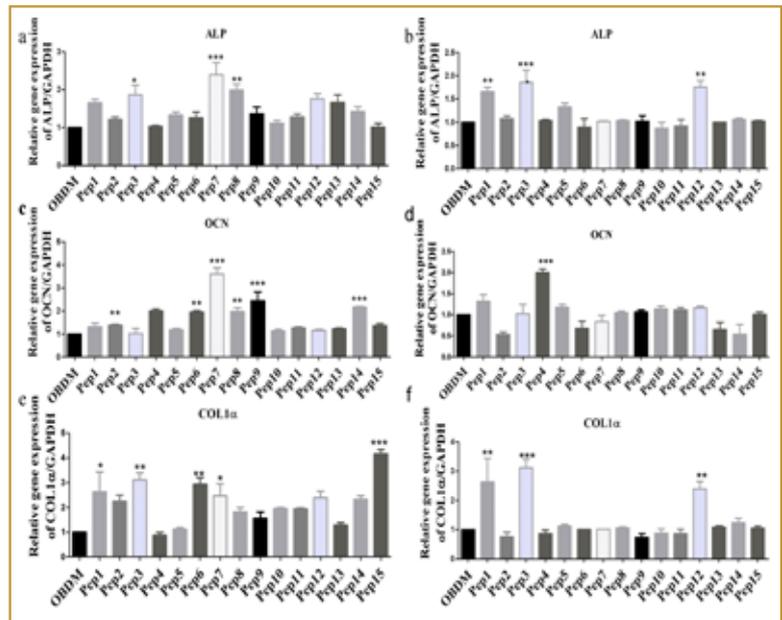
Technology for Omega-3 Rich Table Spread

Table spreads have tremendous advantage due to their nutritional value, simplicity and consumer appeal. A table spread was developed using flaxseed oil (as a source of vegan omega-3 fatty acid) and butter as a source of fat. The developed product contained around 51% fat, 37% moisture and 4.5% protein. The pH of product was 5.34. The peroxide value, TBA value and p-Anisidine value of the product was 0.135 meq/kg oil, 0.383 and 0.222 meq/kg oil, respectively at the start of storage; which increased to the corresponding value of 0.385, 1.057 and 0.578 at the end of the storage. The colour value of the product was 76.02, -2.546 and 22.076 in terms of its L^* , a^* and b^* value, respectively, revealing its yellow hue with a tinge of green. The antioxidant properties of the product (ABTS and DPPH) were analysed and were approximately 100 microgram Trolox eq./ml, while its phenolic content was 0.114 mg GAE/g. The textural parameters of the product revealed its good spreading characteristics, like firmness 8.89 N, work of shear 21.49 Ns, stickiness -9.49 N and work of adhesion -8.21 Ns. The salient feature of the product was its alpha-linolenic acid content which was around 13.8 g α -linolenic /100 g of fat and is good enough to meet around 50% of its RDA at a serving size of 10 g. The shelf life of developed product was 120 days under refrigerated storage.

Augmenting the Osteoanabolic Activity of Buffalo B-Casein Derived Heptapeptide Using Structure-activity Relationship

To augment the osteoanabolic activity of β -casein derived heptapeptide, 14 different peptides were synthesized by substitution of each position of heptapeptide based on the naturally available amino acid present in the available β -casein sequences of different species. The property of osteogenesis of the peptides was assessed in terms of proliferation, differentiation and mineralization of rat calvarial osteoblasts. The osteoblast proliferation was studied by MTT assay and osteoblast differentiation was characterized by alkaline phosphatase (ALP) activity

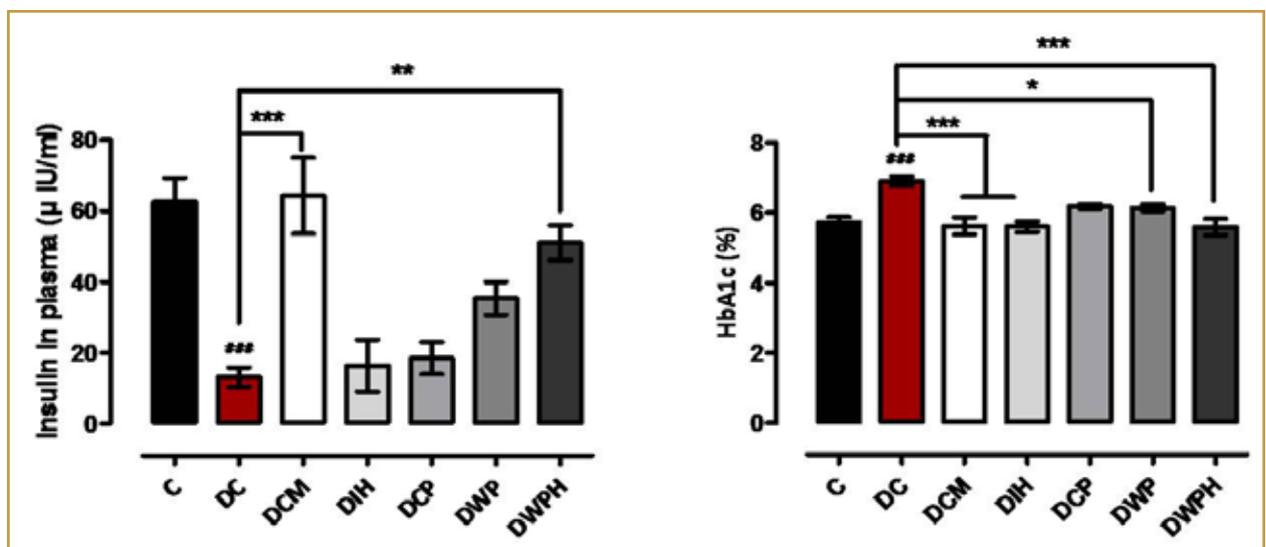
and by the expression of ALP, osteocalcin (OCN) and Collagenase-1 α (COL-1 α). All the peptides induced osteoblast proliferation significantly ($P < 0.05$) as compared to control (without peptide) at different concentration. The expression of marker genes of osteoblast cells differentiation ALP, OCN, COL-1 α were analyzed at 4th day of the treatment. The peptide 7 and 8 showed maximum ALP expression whereas PEP 7 and 14 showed highest OCN expression and PEP 15 showed highest expression in case of COL-1 α significantly ($P < 0.05$) among the 15 peptides in comparison to the control. Furthermore, mineral deposition also increased in all the peptides. The antioxidative property of enzyme were analysed by ABTS method in which pep 8 had shown maximum antioxidative property. Based on the effect of peptides on proliferation, differentiation and mineralization of osteoblasts, the PEP7, PEP6, PEP8 and PEP2 exhibited the better osteoanabolic potential than parent peptide and could be used for the therapy/prevention of osteoporosis. Among these four peptides PEP7, further showed the highest osteoanabolic effect.



Relative gene expression of ALP, OCN, COL1a at selected concentrations of the peptides 716 (A-C) and at 30ng/ml (D-F). OBDM Osteoblast Differentiation Medium. The results are described as Mean \pm S.E.M., $n=3$. (***) $p < 0.001$, (**) $p < 0.01$ and (*) $p < 0.05$.

Antidiabetic Potential of Camel Milk Protein Hydrolysates

Camel milk protein hydrolysates were prepared using different digestive enzymes and among them the pepsin hydrolysates of whey proteins stimulated the pancreatic beta cell proliferation and insulin secretion by RIM-5F cell lines significantly. All the hydrolysates of camel casein and whey proteins exhibited DPP-IV inhibitory activity. The antidiabetic effect of pepsin hydrolysates of whey proteins (WPH), whey proteins (WP), casein proteins (CP), camel milk (CM) was carried out in the diabetic rat model. Hyperglycemic conditions in experimental rats were created by intraperitoneal injection of streptozotocin. The administration of camel milk to diabetic rats for two months resulted in significant enhancement in body weight. There was significant decrease in the levels of blood glucose, HbA_{1c} and increase in the insulin levels in the diabetic rats maintained on whey protein hydrolysates based diet. Camel milk and its protein and protein hydrolysates were effective in decreasing the levels of plasma TC, TGs, VLDL-C, LDL-C, atherogenic index and increasing the levels of HDL-C in the diabetic rats. The hepatic cholesterol and TGs were reduced significantly on feeding CM, WP and WPH whereas only CM and WPH helped to increase cholesterol and TGs excretion in feces significantly. Moreover, WPH also helped to improve liver antioxidative enzymes (Catalase



Effect of feeding camel milk and its protein hydrolysates on plasma insulin and glycosylated hemoglobin levels in blood of normal and streptozotocin induced diabetic male wistar rats after a period of 8 weeks. Significant level ** $P < 0.01$ and *** $P < 0.001$ in comparison to the control group.

C-control group; DC-Diabetic control; DCM- Diabetic + Camel milk; DIH- Diabetic + Insulin hormone; DCP- Diabetic +Casein protein; DWP-Diabetic + Whey protein; DWPH- Diabetic + Whey protein hydrolysates.

and SOD). The kidney function markers were improved in the diabetic rats by the administration of WPH as depicted by decreased levels of urea, uric acid and creatinine in plasma. CP, WP and WPH also decreased the urea level in urine & WP and WPH increased the levels of uric acid in urine but excretion of creatinine significantly increased with the treatments of CM and WPH. Liver enzyme AST was significantly reduced in groups treated with CM, CP, WP and WPH and treatment of WP and WPH decreased ALP enzymes significantly. Expression of gluconeogenesis enzyme gene (*pepck*) and bile acid synthesizing gene (*CYP7A1*), HMGCoA and *g6pase* in liver were significantly downregulated in CM, CP, WP & WPH. Thus all the *in vitro* and *in vivo* results indicated that among different interventions camel WPH has the maximum antidiabetic potential.

Role of Probiotic Lactobacilli on Immune Signaling in Intestinal Epithelial Cells via the NF- κ B Pathway as a Master Inflammatory Regulator

Incubation of cells with probiotic lactobacilli (*L.rhamnosus* and *L.fermentum*) under exclusion, competition and displacement of inflammatory agents resisted the inflammation induced increased NF- κ B mRNA expression. On the other hand, mRNA expression of SIGIRR (a negative regulator of TLR-4 signalling) involved in another downstream signalling pathway increased considerably ($p < 0.01$) with both lactobacilli than either of the inflammatory agents during various modes of challenge assays. In the case of transcript expression of adaptor protein MyD-88 associated with TLR signalling, probiotic lactobacilli showed insignificant changes during various types of inflammatory challenges.

Significant ($p < 0.05$) translocation of NF- κ B (p-65 subunit) from the cytoplasm to the nucleus was observed in Caco-2 cells on treatment with inflammatory agents *E.coli* and LPS, respectively than control by western blotting. The presence of probiotic *L. fermentum* significantly resisted NF- κ B translocation from cytoplasm to nucleus during exclusion and competition challenges with *E. coli* and LPS, respectively. Similarly, treatment with probiotic *L. rhamnosus* during exclusion of *E.coli* and LPS also appeared to resist NF- κ B nuclear translocation, respectively. Nuclear translocation of NF- κ B (p-65 sub-unit) during the inflammatory challenge was also established by immunofluorescent staining which appeared to defy by the presence of probiotic *L. fermentum* during exclusion and competition assay whereas exclusion assay with *L. rhamnosus* was only found effective.

Quenching of AHL-mediated Quorum Sensing by Cell-free Supernatant of Lactic Acid Bacteria in *Pseudomonas Aeruginosa*

Antibiotic mediated therapies targets the growth related processes of the pathogen hence imparting a strong selection pressure on pathogen to develop antibiotic resistance. Recently anti-virulence strategies have gained lots of attention amongst scientific community, wherein instead of inhibiting normal growth of pathogen, it interferes with the regulation of virulence factors of the pathogens, therefore interfering with its pathogenesis. In *Pseudomonas aeruginosa*, virulence mechanism accountable for various types of infections in humans depending on N-acyl homoserine lactone (AHL) mediated quorum sensing. So quenching of these molecules, pose as a promising tool against *P. aeruginosa* pathogenesis. Lactic acid bacteria cell free supernatant (acidic and neutralized) were evaluated in quorum quenching of *P. aeruginosa* PAO1 (MTCC 3541) after their initial screening for anti-biofilm potential against this pathogen. Though reduction in biofilm formation with acidic and neutralized supernatants of lactic acid bacteria revealed strain specific response but acidic fractions showed stronger ($P > 0.05$) inhibition of bio-film irrespective of the type of treatment given to *P. aeruginosa*. Similarly, acidic supernatant fractions of lactic acid bacteria (*L. lactis*, *L.rhamnosus* and *L.fermentum*) showed significant reduction ($P < 0.05$) of auto-inducer AHL involved in quorum sensing as well elastase activity which were important virulence characters directly controlled by the quorum sensing signaling. Further significant decrease in expression of *lasI* and *rhII* by acidic fractions of lactic acid bacterial supernatants further confirmed quorum quenching process in *P. aeruginosa*.

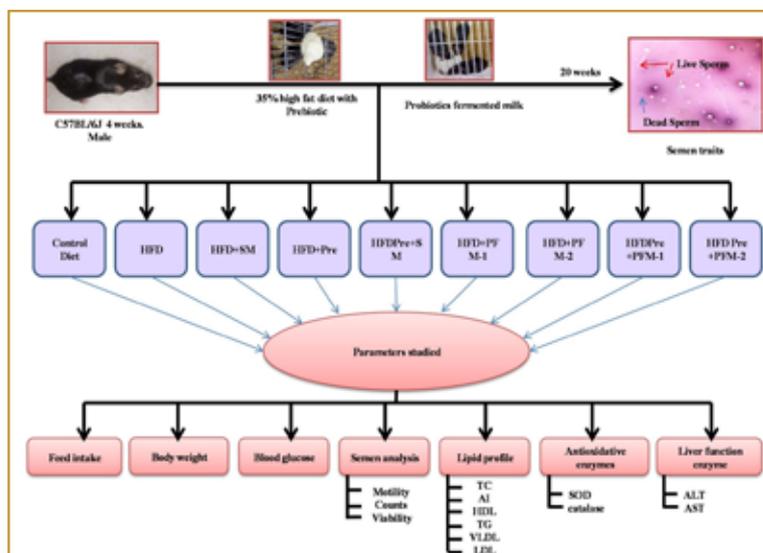
Role of Probiotic Administration on Male Reproductive Parameters and Seminal Characteristics in Male Mice Model

Dietary intervention with functional probiotics and prebiotics to alter the abundance and activity of intestinal bacteria may ameliorate or prevent the development of metabolic syndrome, while improving not only reproductive performance but also total well being as effected by recordable parameters both in males and possibly in females. In such conditions, the Testosterone Replacement Therapy (TRT) which produces wide range of side effects to men can be relooked. The quality of semen is continuously getting damaged over the past few decades, possibly due to modern lifestyle factors. These trends in modern society, characterized by caloric abundance, obesity, reduced physical activity, use of more electronic devices, alcohol consumption, smoking, and stressful environment which directly/indirectly affects fertility as well as reproductive performance. Nowday's fat rich diet is very common in our daily feeding schedule. Obesity induced inflammation affects the overall health of human being. Continuous intake of high fat diet causes the dysbiosis of colonized microbiota in the intestine, further depleting the thick layer of mucous which protects the intestinal barrier. This depletion makes intestinal wall weak and transform in a leaky

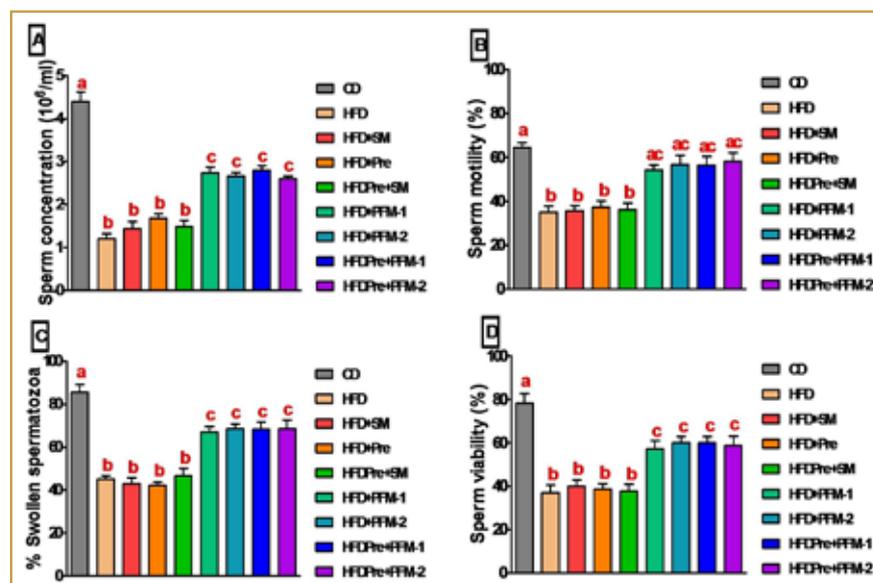
gut structure through which released endotoxins enter inside the lumen. Total animals were separated equally in 8 different treatment groups and were being fed different feeding diets for a period of 20 weeks. After dissection, sample collection and sample processing were done. Gains in body weight, daily food intake, blood glucose were being checked during the trial. Organ weight, blood glucose, body weight and height again noted down during dissection. Seminal parameters (semen pH, sperm count, sperm viability, hypo-osmotic swelling test (HOST)), was studied after completion of feeding trails. Enzymatic assays mainly super oxide dismutase, catalase, from liver and testis tissue homogenate to be done. Total cholesterol and triglyceride from blood serum sample of mice. Hormonal assays via ELISA methods and gene expression related to steroidogenesis was done via qPCR to study the effect of probiotic and prebiotic on fertility related traits influenced due to physical and psychological stress in mice. Stress is a common factor involvement of our daily life. Its influence on health and many metabolic as well mental diseases are well documented. Stress is defined as physical, mental and emotional response to a particular stimulus, otherwise called as stressor. Psychological stress interferes with the endocrine and spermatogenic function of male gonads. Chronic stress conditions may leads to hypogonadotropic hypogonadism, disorders of spermatogenesis which is characterized as reduced sperm concentration and motility and increased percentage of sperm cells of abnormal morphology. Psychological stress primarily lowers serum total testosterone which altered seminal quality.

Post *In-vitro* studies on assessment of probiotics effects on leydig cell line, the work was carried out towards long term animal trials for *In-vivo* supplementation of probiotics in combination with prebiotics in C57BL6j and albino

mice. Animals were divided into eight groups and provided different treatments of probiotics alongwith prebiotic for 20 weeks. High fat diet, which reflected stress of ER type were given to animal for longer duration to mimic the natural onset of obesity after ER stress as it happens in human Physiological parameters such as body weight, feed intake, organ weight were recorded at regular intervals. Body weight showed the reduction in probiotic and probiotic-prebiotic treated groups after 12 weeks which became more significant in the 20th week. Paired testes weight was improved in all treated groups especially in *RS13A*+prebiotic group, while epididymal fat weight showed significant decrease in all treated groups profoundly in *RS13A* group.



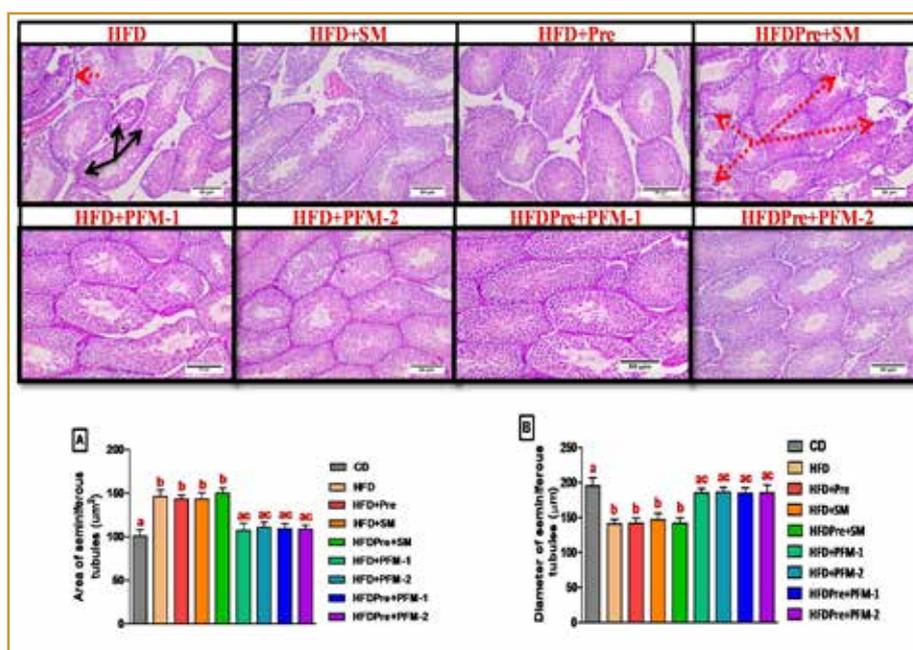
Blood glucose was checked at 10 weeks and 20 weeks in all animals and it was found that serum Glucose level was appreciably reduced in all the probiotic treated groups as compared to high fat diet group. The viability and number of sperm cells significantly increased in all the probiotic treated groups as recorded by Eosin-Nigrosin and Trypan Blue staining. Further, an enhanced effect was observed in the combination of probiotic and prebiotic



Control Diet (CD), HFD-High Fat Diet (35% w/w), HFD+SM-High Fat Diet Skim Milk, HFD+Pre, Prebiotic (Fructooligosaccharides (FOS) 5% w/w), HFDPre+SM, HFD+Probiotic Fermented Milk (*Lactobacillus rhamnosus-610*), HFD+ PFM-2 (*Lactobacillus fermentum-400*), HFDPre+PFM-1 and HFDPre+PFM-2. Mice were fed CD and high fat diet (HFD) with prebiotic and probiotic fermented milk for 20 weeks and measured fig (A) Sperm concentration (B) Sperm motility (C) % Swollen spermatozoa (D) Sperm viability significantly increased in HFD-PFM fed mice as compared to HFD mice groups. Statistical significance was evaluated by One Way Anova followed by Tukey test for comparison of all pairs of multiple groups to each other. Values are mean \pm SEM, n=6 and Columns with different letter differ significantly ($P < 0.05$).

groups. Hypo-osmotic test (HOST) confirmed that membrane integrity of sperm cells were well maintained in probiotics and prebiotic groups while it was weakening in HFD and SM groups

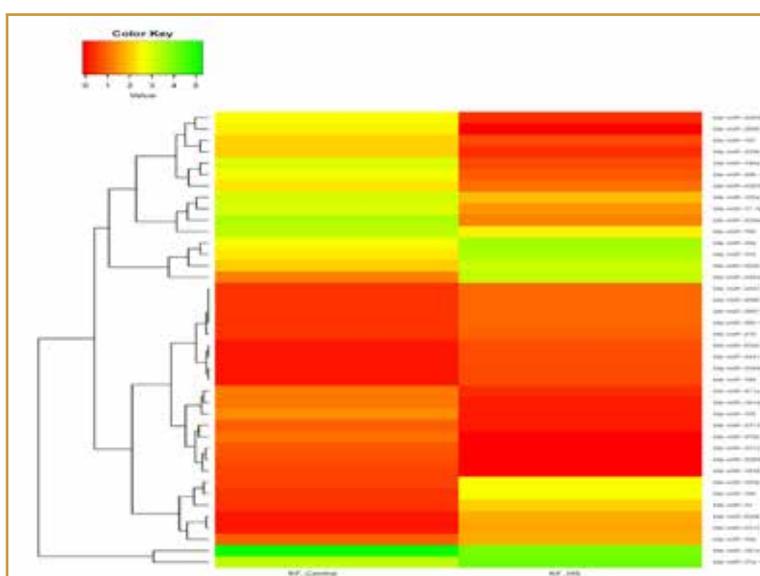
In another competitive animal trial, psychological and anxiety stress were used as the inducer of compromised fertility. The restraint stress was given to mice and thereafter fed them with probiotics for 8 weeks. After that the stress combating abilities of the subjects/mice was tested by three types of test mainly; EPM, FST, SPT. Quantitative data was being collected and analysed. In continuation of this work, another trial was carried out to check efficacy of probiotics on fertility of protein deficient mice, herein using low protein as a stress inducer. Swiss Albino mice were divided into 6 experimental groups and fed low protein, normal protein and probiotics till 8 weeks. Histopathological analysis was carried out for all the treated groups and was found that cellular morphology and arrangement was quite intact in normal and probiotic treated group while distorted in low protein group.



Hematoxylin and eosin-stained testicular sections from mice fed CD, HFD and HFD+PFM (Scale bar = 50 µm). Changes in testis morphology and increase the separation of germinal epithelium, vacuolization (black arrows), alteration of basement membrane (red arrows) of the seminiferous tubules in HFD fed mice as compared to HFD-PFM mice. (A) Area of seminiferous tubules significantly decreased in HFD-PFM fed mice as compared to HFD fed mice. (B) Diameter of seminiferous tubules in HFD-PFM fed mice groups increased as compared to HFD fed mice. Values are mean ± SEM, n=6 (P < 0.05).

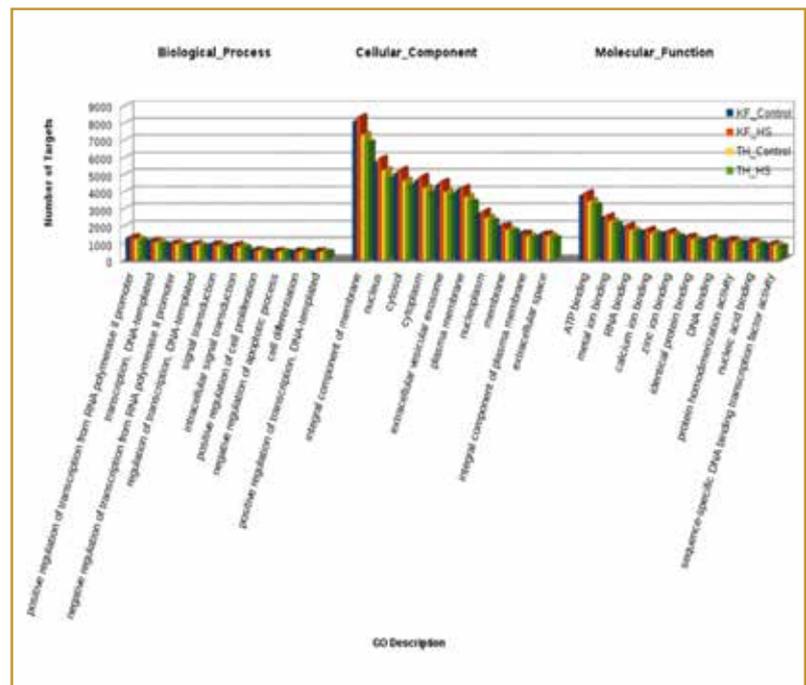
Exploring Heat-stress Responsive microRNAs in Cattle to Decipher the Thermotolerance Mechanism

Illumina single end reads were generated for 4 RNA samples and carried out small RNA analysis against *Bos taurus*. UMD3.1 build genome data. MicroRNA analysis was carried out on an average of 16.6 M data generated. An average of 387 known and 77 novel miRNA were identified. Less than 8% of the reads were known to have the contamination of other ncRNAs. The raw data was received in FASTQ format. Reads were pre-processed to remove adapter and low quality bases. Small RNA-workbenchV3.0_ALPHA1 was used to trim the 3' adapter sequences. Trimmed reads were filtered based on the length criteria (minimum length 16 bp and maximum 40 bp). Average of 3.6 Lakh high quality non-redundant data was used for miRNA population identification. Read count table for all the samples were generated. DGE analysis was carried out using DESeq8



Heat map created of top 20 up and down regulated miRNAs in two different experimental conditions. Heat map is showing vividly the upregulation and downregulation of the miRNAs of the heat stressed animals. Most of the miRNAs are upregulated during the heat stress as is evident from the predominant red areas of the heat map.

tool. Variations in the reads were normalized by library normalization method opted from DESeq library. DESeq calculates size factor, each read count was normalized by dividing with size factor. Mean normalized read counts of the samples in a given condition were used for DGE calculation and heatmap. For regulation calculation between the comparisons, log2fold of 1 was used as cutoff. miRNAs >1 were considered as “UP” regulated, miRNAs <-1 were considered as “DOWN” and those between 1 and -1 were flagged as “Neutral”. Twelve healthy non pregnant cows of Tharparkar and Karan Fries breed (6 from each breed) of uniform age (4-5 years) were selected from NDRI cattle yard. The animals were maintained at experimental animal sheds under well-ventilated and proper hygienic conditions. There were two groups one control and one heat stress group with three animals in each group. Three animals from heat stress group (n=3) were exposed to heat stress at 42°C for 4-6 h for 15 days in climatic chamber present in the Institute. Other three animals from each breed were used as control group. The physiological parameters like rectal temperature, respiration rate and pulse rate of the animals was also taken to confirm the heat stress after the heat exposure. Blood samples were collected from jugular vein of the animals from control and HS group by using the EDTA containing vacutainer tubes. All the pooled RNA samples were used for small RNA library construction and NGS sequencing.

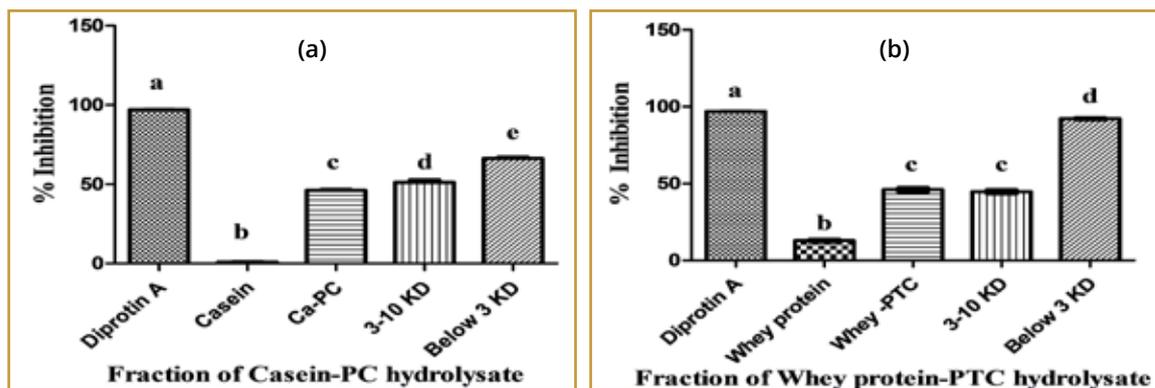


The figure above shows Gene Ontology distribution of miRNA targets. The miRNA target genes shown above are involved in biological, cellular and molecular pathway and regulate growth, development, health and milk production in cattle. Sequences not showing hits with known miRNA's were extracted and were considered for novel miRNA prediction. These reads were aligned to the reference genome using bowtie. Novel miRNAs were predicted from the aligned data using Mireap_0.22b5. To identify true novel miRNAs predicted candidate miRNAs were matched against Bos taurus miRNAs predicted in the genomes but not present in miRBase. Unaligned predicted miRNAs were considered as potential novel miRNAs if the predicted secondary structure is a proper stem-loop structure defined for a miRNA.

High-throughput RNA Sequencing conducted to Assess the Impact of ZnO Nanoparticles and SWCNT on Gene Regulatory Mechanisms

The transcriptomic study was performed at non-cytotoxic concentration (2 µg/ml ZnO NPs, 10 µg/ml SWCNT, 15 µg/ml MSN, 25 µg/ml MCN) of NMs at which only 10% cell viability loss was observed. The RNA sequencing generated 5-6 Gb of data distributed between three analysed samples. Various statistical tests were conducted which revealed the expression of ≥ 4000 genes with NMs exposure. Two different strategies were applied to gain deeper insights into the biological effects of the NMs on the cells. In the first strategy, genes with more than 10 fold up and down regulated were taken for the gene annotation and gene-GO term enrichment analysis by considering all the default statistical parameters. In the next strategy, genes with more than 3 up and downregulated fold change values and again performed the GO analysis. The GO analysis played important role to understand the basic dysregulation of genes involved in number of processes that gave overall picture of the molecular response. In DAVID analysis, significant number of GO terms was observed in BP, MF and CC categories. Out of these number of GO BP terms, top five GO terms were selected related to Endocytosis, Cell cycle, Cell cytoskeleton, Transcription, Ubiquitination and DNA damage & Repair. Subsequently the venn diagrams were prepared for each of the category using Venny 2.1.0 and jvenn.

The genes in the molecular function majorly identified were protein binding, zinc on binding and ubiquitin transferase activity that suggested a role of ubiquitination related degradation of proteins. In the cellular component category, majority of genes were found in the nucleus and cytoplasmic region of the cell. The use of DAVID provided 10 most prominent regulated clusters, which belonged to Rap1 signaling, PI3-Akt signaling, protein processing in endoplasmic reticulum, endocytosis, cytoskeleton, cellular response to DNA damage, cell cycle and protein polyubiquitination. The unambiguous analysis revealed that NMs elicited variety of cellular responses that affected the protein processing in cell and show particular molecular response inside the cell. Furthermore, similarity matrix was prepared for each of the observed category to define the direct relationship between the deregulated genes. Recent focus in the field of nanotoxicology shifted towards understanding the details of unintended or undesired interactions of nanomaterials with biological molecules.



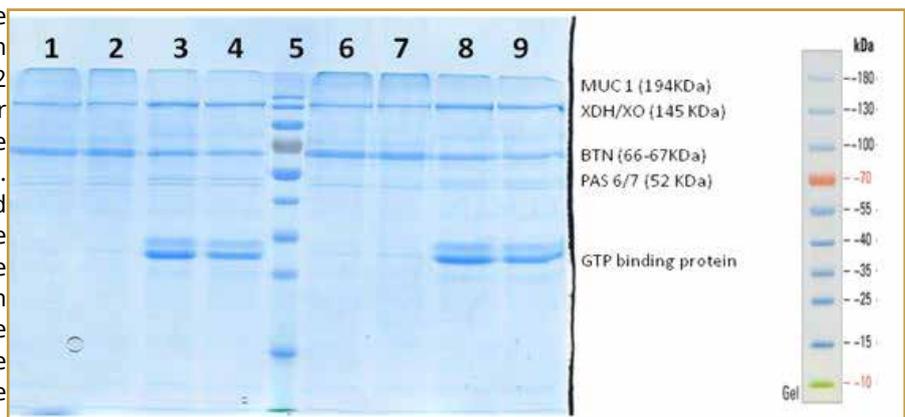
DPP-IV inhibition by fractions of (a) Casein PC and (b) whey protein PTC hydrolysates

Effect of Dioxin Present in Milk on the basis of Three-dimensionally (3D) Cultured Buffalo Hepatocyte Model System

The concentration of dioxins in milk were reported in a range of 0.023 to 26.46 and 0.88 to 19 pg/g of fat in cow and human milk, respectively. However, no studies have been conducted to explore the toxic effects of the dioxins in the milk in this range of concentrations. Hence, the present study was targeted to understand the effect of dioxins present in the milk on three-dimensionally (3D) cultured buffalo primary hepatocyte spheroids by considering the outbred livestock tissues as better models than that of inbred laboratory animals. The buffalo hepatocyte spheroids were treated with a model dioxin, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), either directly or through milk fat at different concentrations (i.e. 0.02-20 pg/mL) for 24 h. In this study, the hepatocyte spheroids appeared to be active both functionally and transcriptionally. This interpretation was on the basis of a similar expression of albumin (*ALB*) and an upregulated expression of hepatocyte nuclear factor alpha (*HNF4 α*) in the hepatocyte spheroids in all treatments. This observation was further supported by a similar expression of antiapoptotic genes in the spheroids, which indicated the survivability of the spheroids during dioxin treatments. The expression of the *CYP1A1*, one of the selected TCDD responsive (*CYP1A1*, *CYP1A2*, *AHR*, *CYP1B1*, and *TIPARP*) genes, showed a nonsignificant increasing trend from 0.2 to 10 pg/mL of TCDD concentration through milk fat. This expression pattern was similar to the reported insensitive response of human primary hepatocytes toward dioxins than that of rat primary hepatocytes. Having a similar trend of *CYP1A1* response in both human and buffalo hepatocytes towards dioxins, the buffalo hepatocyte spheroids could be better models than rats for TCDD hepatotoxic studies. In addition, the present study emphasized that the TCDD in the milk may not be very hepatotoxic, especially in the range of 0.02-20 pg/mL concentration.

Profiling of Fat Globule Membrane Proteins of Cow and Buffalo Milk and their Fractions

In cow, buffalo milk and its different fat globule size fractions the identified MFGM proteins by SDS-PAGE are of MUC-1 (194 KDa), xanthine oxidase (146.6 KDa) butyrophilin (66-67 KDa) and PAS6/7 (52 KDa). All these are the major and abundant milk fat globule membrane associated proteins. In case of buffalo milk and its small, medium and large fractions, two major bands were observed which are absent in cow milk and its different size fat globule fractions. These are between 25 to 35 KDa and some researchers name them as GTP-binding protein.

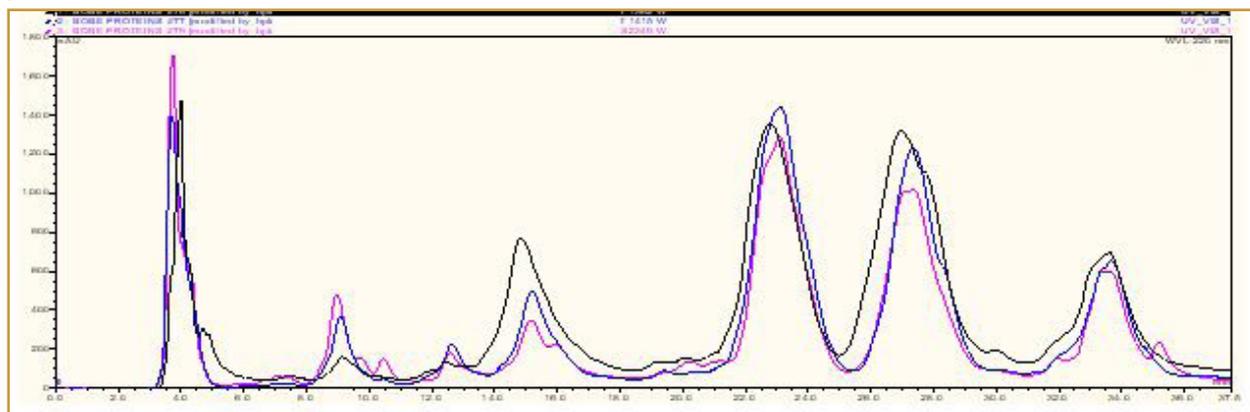


SDS-PAGE of MFGM of cow, buffalo milk extracted from small, medium and large fractions (1) cow milk (2) SFG CM (3) BM (4) SFG BM (5) Marker (10 to 180 KDa) (6) MFG CM (7) LFG CM (8) MFG BM (9) LFG BM

Protein Profiling of Milk from Indigenous Breeds of Cattle

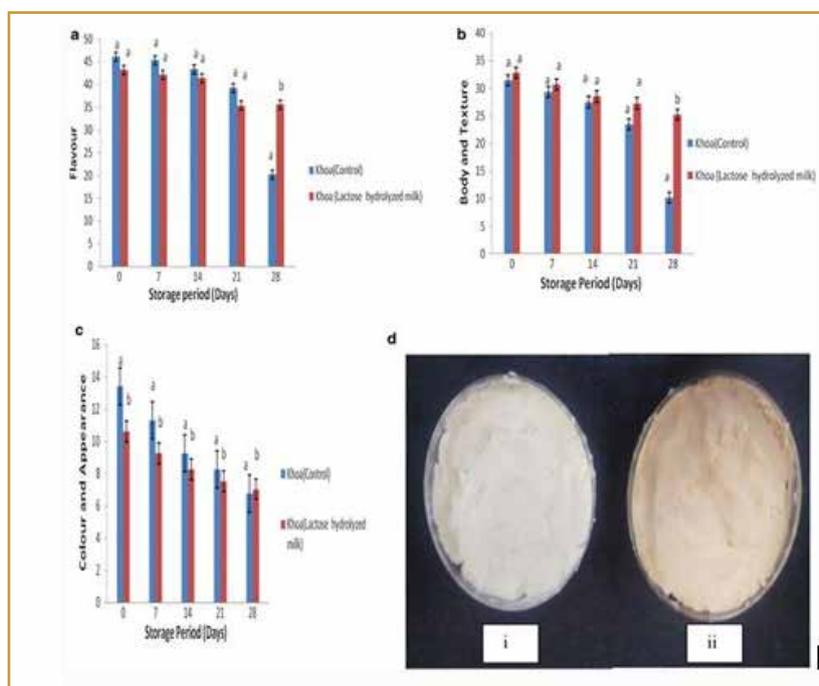
Among different breeds (Gir, Sahiwal, Tharparkar) of cattle the level for α -CN, β -CN and κ -CN fractions corresponded to 52-60%, 23-34% and 11-17%, respectively and whey protein 16-28% of α -La and 47-61% of β -Lg was found. No significant difference was observed on individual casein fractions among different breeds of cattle. Single peak was obtained for α ₂-CN and α -La. whereas multiple peaks were obtained for α ₁-CN, β -CN, κ -CN and β -Lg. Multiple

peaks of the κ -CN were observed majorly in all the breeds. Crossbreed cattle (Karan Fries) demonstrated multiple peaks for all the fractions.



Physico-chemical Properties of *Khoa* Prepared from Lactose Hydrolyzed Buffalo Milk

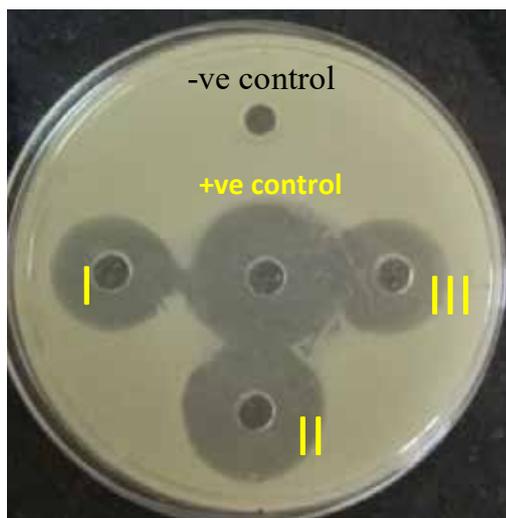
Lactose is a reducing sugar which is abundantly found in mammalian milk. Lactose intolerance affects more than 70% of the world population, being apparent by the absence of β -galactosidase enzyme, thus leading to the inability to consume dairy products. In the present work, *Khoa* was prepared from lactose hydrolysed milk and its physico-chemical, textural and microbiological quality were examined during storage at 5–7°C for 28 days. The sensory quality of low lactose *Khoa* was comparable with that of the control *Khoa* up to the 14th day of storage. Significant differences ($p < 0.05$) between the acidity, hydroxyl methyl furfural (HMF) content, lightness, redness, springiness, chewiness and hardness values of the low lactose *Khoa* and the control *Khoa* were observed. The standard plate count (SPC), coliform and yeast and mould counts of the low lactose *Khoa* were within Food Safety and Standards Authority of India (FSSAI) standards throughout the 28 days of storage. Therefore, the low lactose *Khoa* developed in this study had different physicochemical properties from the control sample with better shelf life.



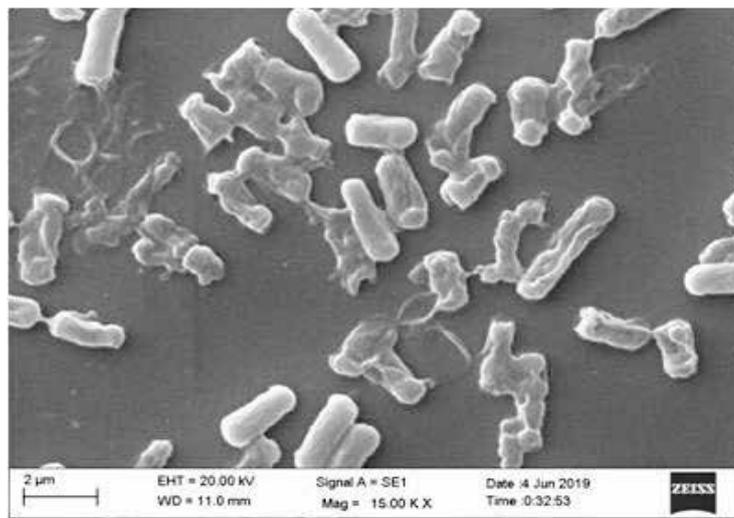
Effect of storage at 5–7 °C on the sensory attributes of *Khoa* samples (a) flavour, (b) body and texture, (c) colour and appearance, d (i) control and (ii) low lactose *Khoa*. Error bars show the variations of three determinations in terms of standard error of mean. Different lowercase letters denote significant difference ($p < 0.05$) between *Khoa* samples

Preparation and Evaluation of Pancharit for Immunomodulation

Pancharit is, in essence, a traditional product of India, with concoction of cow milk, Dahi, Ghee, honey and sugar. *Streptococcus thermophilus* NCDC74 was selected for Dahi preparation on the basis of growth pattern, titratable acidity and pH. Pancharit was prepared using Dahi and milk with addition of honey 5%, Ghee 5% and sugar 3%. Pancharit II exhibited higher antimicrobial activity against *Bacillus cereus* (23.667 ± 0.882 mm), *Escherichia coli* (31.33 ± 0.667 mm), *Enterococcus faecalis* (19.667 ± 0.882 mm), *Salmonella enterica* subsp. *enterica* serovar Abony (25.333 ± 0.333 mm) and *Staphylococcus aureus* (23.333 ± 0.667 mm). The Pancharit II was also having antioxidant activity ($88.074 \pm 0.028\%$ ABTS). *In vitro* immunomodulatory activities of Pancharit was evaluated by exposing HT-29 cell to pathogenic *E. coli* by quantifying the induction of IL-10 cytokines with pre (six h and 24h) and post-treatments of HT-29 cell line by pathogenic *E. coli*. Among the three treatments Pancharit induced IL-10 secretion from HT-29 cells after 6 h and 24 h pre-treatment and post treatment in challenged cells. Pancharit, thus, prepared had antimicrobial activity against many pathogens, antioxidant activity and immunomodulatory activity as well.



A. Zone of inhibition shown by cell free supernatants extracted from Panchamrit formulations against (A) *B. cereus*



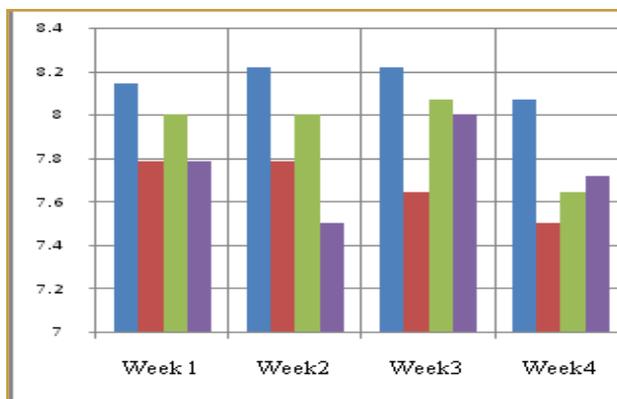
B. Electron microscopic view of antimicrobial activity against *B. cereus* (ATCC 13061) with Panchamrit showing complete lysis of cells as well as cell shrinkage.

Optimization and Evaluation of Panchamrit – A Dairy Based Functional Fermented Food

Dahi was prepared using *Streptococcus thermophilus* NCDC74. Three formulations of Panchamrit i.e., I, II and III were prepared, using milk and Dahi (1:1, 1:2, 2:1), Ghee and honey (5%), and sugar (3%). The pH was recorded as 5.345 ± 0.026 , 5.230 ± 0.017 and 5.620 ± 0.058 for I, II and III formulations, respectively. The increase in titratable acidity was also observed i.e., 0.468 ± 0.011 % la for I, 0.504 ± 0.005 % la for II and 0.434 ± 0.016 % la for III formulations. Similarly, fat per cent of formulations I, II and III were 10.500 ± 0.404 , 10.105 ± 0.459 and 9.960 ± 0.410 , and the per cent protein was 3.990 ± 0.066 for I, 3.803 ± 0.241 for II and 3.900 ± 0.112 for III formulations, respectively. Total solids (%) of three formulations were 25.293 ± 1.256 , 26.839 ± 0.622 and 25.995 ± 1.287 for I, II and III, respectively. Apparent viscosity of Panchamrit was measured in the shear rate range of 1 to 100 sec^{-1} . As viscosity decreased with increasing shear rate, which means all the three formulations are non-Newtonian in nature with shear thinning behavior. Total bacterial counts in I, II and III formulations were 9.053 ± 0.053 , 9.197 ± 0.040 and 8.820 ± 0.075 Log CFU/gm, respectively. The total lactic counts were 9.070 ± 0.048 , 9.162 ± 0.027 and 8.748 ± 0.077 Log CFU/gm for Panchamrit formulations I, II and III, respectively. Proteolytic counts were 8.820 ± 0.075 , 8.748 ± 0.077 and 8.469 ± 0.077 Log CFU/gm for I, II and III formulations, respectively. For sensory evaluation of Panchamrit formulations (I, II and III), nine point hedonic scale was used as scorecard for sensory. The overall acceptability of the Panchamrit formulations is II>III>I. Panchamrit was stored at 4°C up to four weeks and was observed for its stability and acceptability for the aforesaid period. The product was stable for four weeks at 4°C with respect to its Physico-chemical and biofunctional characteristics and overall sensorial acceptability.



Panchamrit stored in refrigerated conditions (4°C) in PET bottles for four weeks



Preparation of CSP Cellulose Reinforced Composite for Biodegradable Film Preparation

The extracted cellulose was blended with casein at 3:6 ratio and the films were prepared by solution casting method and dried at 40°C. The pre-conditioned films (27°C and 65% RH) were evaluated for their moisture content, thickness, and tensile properties such as tensile strength, tensile strain and modulus of elasticity. The mean thickness of casein film was 0.214 mm and was lower compared to cellulose reinforced casein film (0.287 mm). Addition of cellulose

increased the tensile strength and elastic modulus from 4.980 to 8.609 MPa and 9.99 to 105.18 MPa, respectively as compared to casein films. However, the tensile strain decreased from 51.64 to 8.74%. The moisture content decreased with addition of cellulose from 18.90 to 15.71%. The whiteness index and transparency too decreased with addition of cellulose.

Development of Nutri-cereal Incorporated Protein Rich Probiotic Dairy Spreads and Dips

Attempts were made to develop composite dairy spread, using finger millet (KMR 204) and dairy ingredients, which could cater to needs of rising demands for healthy and convenient foods for current generation. Finger millet was subjected to pre-treatments like steeping, germination and fermentation in order to decrease the anti-nutrients majorly phytic acid content. It was found that steeping for 12h and germination for 48h significantly reduced the phytic acid content from $0.82 \pm 0.05\%$ to $0.24 \pm 0.018\%$. Fermentation of finger millet didn't show significant effect on phytic acid content. Steeping and Germination of finger millet significantly improved the flavor and color of the spread. The preliminary studies were conducted using finger millet malt (7%) along with other dairy ingredients viz. Butter, curd, Whey Protein Concentrate-80 (WPC-80), Milk protein concentrate and sodium tri polyphosphate (STPP). The spread produced using 8% finger millet malt, 25% butter, 35% curd, 7% milk protein concentrate, 10% WPC-80 and 1% STPP recorded sensorially acceptable product. Trials for optimization of ingredients and processing conditions are in progress.

Assessment of Functional Properties in Cheddar Cheese Made from the Milk of Deoni and Crossbred Cows

Ripening characteristics and functional properties between the Cheddar cheese made from the milk of Deoni (DMCC) and Crossbred cows (CMCC) was compared. The Free fatty acid content (meq KOH/100 g of fat) of cheeses was increased significantly ($p < 0.05$) throughout the ripening and after 4th month of ripening, it was significantly higher ($P < 0.05$) in CMCC than till 8th month of ripening. The degradation of protein was more in DMCC compared to CMCC throughout the ripening. At end of ripening, soluble protein content of DMCC was significantly higher ($P < 0.05$) than CMCC. The pH of the cheeses decreased till 2nd month of ripening, afterwards it increased throughout ripening for both the cheeses. The overall acceptability score of DMCC was appreciably higher ($P < 0.05$) compared to CMCC. Water soluble extract (WSE) of DMCC had higher ($P < 0.05$) % DPPH scavenging activity compared to CMCC. The higher ($P < 0.05$) ACE inhibition was observed for WSE of DMCC compared to CMCC.

Process Optimization for the Development of Functional Processed Mozzarella Cheese

Functional Processed Mozzarella Cheese (PMC) by incorporating rennet casein gel (RCG), whey protein hydrolysate (WPH) and mixture of emulsifying salts at the rate of 1 to 3% was standardized. The meltability of PMC improved in the presence of emulsifiers but its stretchability was adversely affected. Therefore, the challenge was to improve the stretchability of PMC without compromising its meltability and other functional properties. Thus, both RCG and WPH were incorporated in PMC. It was found that on increasing the concentration of RCG, meltability reduced whereas stretchability improved significantly. On the other hand, replacement of some amount of RCG with WPH; improved the meltability and bio-functional characteristics in PMC. The concentration of RCG and WPH was standardized using optimal custom design of response surface methodology. The PMC made with optimized formulation showed acceptable meltability and stretchability even after 45 days of storage.

Technology for the Development of Fortified Sweetened Milk Kefir

An attempt was made to develop sweetened milk kefir similar to *Misti Doi*. Kefir is an acidic-alcoholic fermented milk product that was originated in the Eastern Europe and the Caucasus region. Regular kefir consumption is known to be helpful in relieving intestinal disorders, promote bowel movement and create healthier digestive system. Fortified sweetened milk kefir prepared with 0.1% pectin, 6% sugar and 3% inulin resulted in superior flavour, optimum acidity, pH and better textural properties.

Process Standardization, Packaging and Shelf Life Studies of Malai

The manufacturing process of *malai*, an indigenous fat rich dairy product, was standardized. The maximum yield of *malai* was obtained at 90°C temperature of heating, 50 minutes of heating and at cooling temperature of 30°C. The *malai* prepared at the standardized conditions obtained highest sensory scores. The optimised *malai* samples had 48-50% total solids, 36-40% fat, 9-10% protein, 1-2% lactose and 0.9-1.2% ash content. It was observed during the shelf life study that the product could be stored at $5 \pm 1^\circ\text{C}$ for 18 days with satisfactory acceptance. Glass and polypropylene were used as packaging materials. No significant differences were observed between the packaging materials over the storage period.

Evaluation of Dipeptidyl Peptidase-IV Inhibitory Potential of Hydrolysates of β -lactoglobulin and α -lactalbumin Isolated from Gir Cow Milk

Whey was separated from Gir cow milk by precipitation of casein, it was then subjected to ultrafiltration (UF) to remove lactose and salts as permeate. The retentate of UF, largely consisted of whey proteins, was then separated to β -lg and α -La by salting out technique and further purified through dialysis membrane. These fractions were hydrolysed with pepsin and trypsin at their optimal temperature and pH for 12h at enzyme to substrate at different E:S ratios. The degree of hydrolysis was found to increase with duration. Pepsin and trypsin treated β -lg hydrolysates showed maximum % DH 28.48 ± 1.29 and 22.07 ± 0.95 , respectively after 12h, whereas α -La hydrolysates obtained with pepsin and trypsin showed maximum $23.07 \pm 1.61\%$, and $22.17 \pm 1.31\%$ DH, respectively. Maximum DPP-IV inhibition ($87.81 \pm 0.84\%$) was observed in α -La hydrolysates treated with pepsin. The IC 50 value of this hydrolysate was found to be 0.78 mg/ml.

Development and Quality Evaluation of Omega-3 Fatty Acid Fortified Butter

The process for omega-3 fatty acid fortified butter was optimized by studying the effect of flaxseed oil @ 2.9 to 5.1% and flaxseed oil emulsion @ 4.8 to 8.6% into cream at two different stages i.e. before ageing and after ageing on textural, sensory and colour characteristics. The sensory acceptability of fortified butter was comparable to control butter. Differential scanning calorimetry confirmed the presence of flaxseed oil in fortified butter. The alpha-linolenic acid content was higher in the butter fortified with flaxseed oil (3.149%) as well as with emulsion (3.174%) than control (0.86%) as determined by gas chromatography-mass spectrometry. The optimized butter samples were examined for storage stability under refrigeration and frozen conditions for 90 days. Peroxide value, free fatty acids and TBA value during storage were within the acceptable range. The overall sensory acceptability during storage were between 7.5 on 9 point hedonic scale. No yeast and mould, coliform was detected during 90 days storage. Developed butter provides nearly 25% recommended dietary allowance of ALA in one serving.



MECHANISATION AND PROCESS ENGINEERING

Development of Mechanized Whey Dewatering System for Chhana

Chakka is the semi-solid intermediate dairy product obtained by draining off the whey from the curd mass. Traditional method of whey removal from curd mass is very tedious, time consuming and unhygienic. Whey draining by gravimetric method was studied during manufacturing of chakka and mathematical modelling was carried to understand the draining kinetics. It helps to describe the draining kinetics for designing an efficient whey draining system. It helps in predicting draining characteristics such as moisture ratio which gives better understanding the process of moisture removal from *chakka*. On the basis of gravimetric study and mathematical modelling the experiments was designed for mechanised removal of whey during manufacturing of *chakka*. Some preliminary trials were conducted to study the mechanism and to obtain range of process parameter. It was observed that desired quality chakka could be manufactured by controlling the speed and spin time. Reduction in whey-draining duration was found as compared to conventional method. The work is in progress to optimize the process parameters of developed whey-dewatering mechanism. The developed equipment would be suitable for small-entrepreneurs for the production of chakka and fulfils the requirement of time saving and hygienic production.



Mechanized whey dewatering system

Development of Low Cost Mechanized Stretching and Portioning Unit for Mozzarella Cheese Production at Small Scale

The proposed mechanized portioning unit (batch type) was designed and fabricated by using SS-304 as material of construction for direct contact parts. It consisted of a double jacketed cylindrical shell, hopper, screw conveyor, portioning section, an electric motor etc. The double jacketed cylindrical shell was fabricated by cutting of two pipes, one was mild steel (MS) pipe and another one was stainless steel (SS) pipe and joined concentrically by using SS plate. The outer jacketed shell consisted of two valves for circulation of hot water i.e. one for inlet and another one for outlet. These two valves were placed at exactly opposite side, i.e. one at top side and another one at bottom side. The outer shell length was lower than inner shell as the gap was provided on both ends for hopper and supports to stand. The SS flanges were welded on both ends. The hopper was welded on screw shaft side on inner jacket. The whole double jacket was insulated with glass wool. The screw conveyor was placed inside the inner jacket to convey the product from one side to the other. An electric motor (1 HP, 3-phase) was used to rotate the conveyor shaft. V-belt and Pulleys alongwith Variable Frequency Drive (VFD) were used for variation of rotational speed. The portioning mechanism was mounted with the help of springs. The cutting blade was mounted by using SS sheet, one edge of which was sharp and another edge was fitted to SS square type pipe with help of SS nut and bolts. This assembly was placed on two springs, which were supported by SS rod at its center and by stand at bottom. The cutting of product was done by manually pressing the blade assembly at its center from top. The product coming out from the outlet was supported by SS sheet. On the SS sheet support, exactly below the SS blade, a horizontal slot was made for ensuring complete cutting



Developed mechanized portioning unit for Mozzarella cheese

action. The SS sheet was bent to provide slope for directing the portioned *Mozzarella* cheese into brine tank. After preliminary trials, the studies were conducted for performance evaluation of the mechanized portioning unit with varying process parameters i.e. outer water jacket temperature (80-90°C) and conveyor screw speed (50-300 rpm).

Development of Automatic Endo-exo Thermal unit for Fermented Milk Products

Thermal imaging technique was used to determine the temperature distribution during the heating and cooling phase. The thermal unit was divided into different 6 zones. Zone 1, Zone 2, Zone 3, Zone 5 exhibited similar trend in temperature profile while Zone 4 and Zone 6 had similar trend. In Zone 1, initial fermentation temperature was 43.65°C which dropped to 40.8°C immediately after 20 min. Temperature data showed that the system was in process of achieving thermal equilibrium and steady state conditions during the initial 30 minutes of the fermentation process. After initial 20 minutes, the temperature of dahi gradually increased from 41.88 to 43.75°C. Peak temperature 46.33°C was observed at the end of fermentation period of 280 minute. During cooling cycle, initial cooling rates of 0.7 °C/min was observed which reduced to 0.1 °C/min at the end of 80 min. Temperature profile for Zone 1 and 2 exhibited exponential curve while in case zone 3 and 4 the trend was quadratic. Air flow pattern inside the unit was ascertained at different loading capacity. Results indicated that 5x8 cup loading resulted in uniform distribution of air inside the unit. A pH based controller was integrated with the existing endo-exo unit.

Development of Electrochemical Sensing System for Automation of CIP in Dairy Plants

Arduino Uno (a low-cost microcontroller) was used for design of standalone electrochemical sensing system to connect pH sensor and LCD screen with display unit. It was programmed suitably to display values of pH measured by sensor continuously. Pt-100 sensor was connected to SELEC DTC-303 controller for displaying temperature values of CIP forward steam. Spectrum conductivity monitor MC-2000 was connected with electrical conductivity sensor, mounted in CIP return line, to display electrical conductivity values of return CIP stream. Preliminary trials were conducted for all three sensors individually to check for errors/malfunctioning, if any. An attempt was made to design store mode system for logging of various process parameters of CIP process was undertaken. Arduino Uno due to its low variable and programme memory along with lesser number of input/output(I/O) ports (up to 14 Digital and 6 Analog connections) available was insufficient to be used for logging/store mode only system. Hence, Arduino Mega (a higher version of Arduino Uno microcontroller, supporting up to 54 Digital I/O ports and 16 Analog I/O ports) was selected to be utilised for the design attempt. Arduino Mega was connected to (i) A Real time clock (RTC) module (2 connections), (ii) SD Card module (4 connections), (iii) 20x4 LCD module (6 connections), (iv) pH sensor (1 connection), (v) level indicators (15 connections) and (vi) suitably programmed for logging of pH, level sensor readings, control panel temperature, date, time at an interval of 10 seconds (minimum) or more. Integration of temperature and electrical conductivity sensors was also attempted but due to proprietary sensors and compatibility issues the same could not be accomplished, but still attempts were being made to integrate the same to logging system. The logging system was tested while in program mode for errors/malfunctions, if any and then after testing mounted back on to the control panel.

Development of Low Cost Farm Level Milk Cooling System

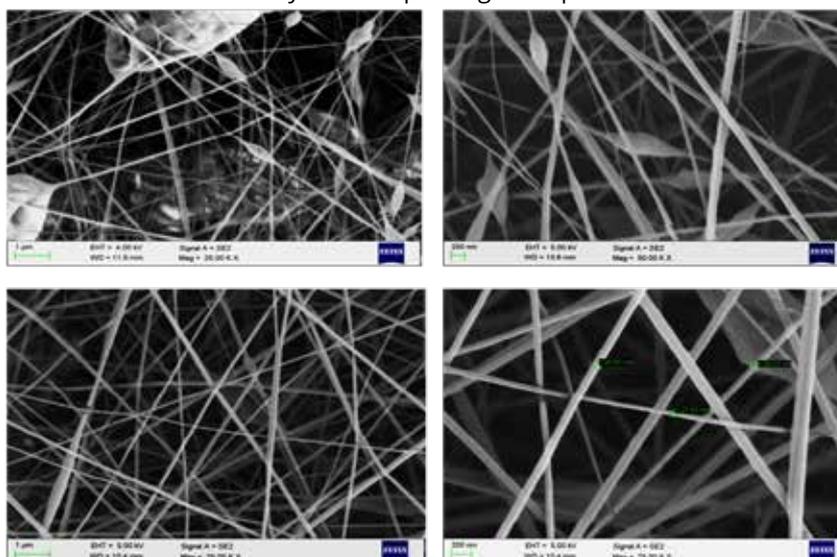
The experimental setup of Farm Milk Cooler (FMC) for 40-80 litres capacity was designed and fabricated. Data logger based sensors were placed at different locations in the developed unit to record temperature as a function of time. Refrigeration system of 1 TR capacity was used to cool the milk in FMC. Forced water-air cooled condenser designed and evaluated and the system was compared with the air cooled condenser. Performance evaluation of the system was done in order to know the improvement in performance of FMC with modified water cooling condenser system in terms of different factors. Controlled environment chamber (CEC) designed and fabricated for testing of refrigeration system of farm milk cooler. CEC enabled testing of refrigeration system during winter and monsoon season by creating artificial environment. The testing chamber has provision for venting to enable complete exposure to the external environment if required. The air was used for the condenser being passed through the evaporative cooling system to reduce the dry bulb temperature of the air. The compressor inlet and outlet temperature, suction pressure, discharge pressure, temperature drop inlet and outlet condenser, evaporator temperature, and expansion valve were also recorded. Power consumption of experimental FMC at various chamber condenser temperatures (30, 35, 40, 45 ° C) with and without water cooling was noted. It was noted that the suction pressure did not remain constant at different temperatures in all experimental studies. During the FMC operation without water cooling, which is traditionally used method of refrigerant condensation, the same trend was also noticed. The pressure of condensation ranged from 13 bars to 15 bars, 13.90 bars to 16.00 bars and 14.5 bars to 16.50 bars at different temperatures. The study revealed that the air temperature used for the condenser significantly influenced the condensing pressure of the FMC vapor compression cooling system. The values of the FMC's actual electrical consumption obtained different temperatures ranged from 3.1 kWh to 6.1 kWh for non-WC tests, while for WC tests ranged from 2.1 to 4 kWh for different temperatures.

Determination of Engineering Properties of Ghee in Relation to Frying Oil Quality Management

Transmission based Colour measurement system was designed and developed. Results of Colour value for heated ghee sample showed uneven change with negative slope in lightness of ghee with heating time. Initially, CIE b value decreased when ghee was exposed to heat treatment after that it showed more or less constant trend. Yellowness index of ghee initially higher when it was exposed to heat treatment and after 8 h of heating, YI showed an increasing trend. CIE b value of fresh ghee sample was 17.07 and it initially decreased to 7.57 but at the end of heating process (40 h) it increased to 13.42. Yellowness Index for fresh ghee was observed to be 74.74 and it decreased to 58.96 at the end of trials. CIE a value were not shown any significant changes with frying time and it appeared as a parallel line to time axis. Yellowness Index for fresh ghee was observed 74.74 and it initially decreased to 28.93 its final value was 50.36. Among colour attributes yellowness index (YI) was found more suitable to monitor quality changes in ghee during frying operation.

Resveratrol and Catechin-Loaded Niosomes and Nanoparticles as Delivery Vehicles for Fortification of Milk and Milk Products

Utilization of resveratrol as a nutraceutical in foods is limited due to its low bioavailability and chemical instability. Therefore, resveratrol was encapsulated into nanofibres by electrospinning. The process conditions were optimized as 18% TS, 18 kV applied voltage and 0.6 mL/h flow rate. SEM images showed formation of clean and continuous fibres at 18 and 23 kV applied voltage, with mean fibre diameter of 63 to 208 nm and encapsulation efficiency of 74 and 96.70%. Successful encapsulation of resveratrol was confirmed by FTIR and XRD analyses. The zeta potential of resveratrol-loaded nanofibres was in the range of -20.5 to -32.2 mV, suggestive of higher stability. The antioxidant property of resveratrol in nanofibres was retained. No significant physiochemical and sensorial changes were observed in resveratrol fortified milk.



Anti-Fouling Plate Heat Exchanger for Milk Processing

A study was undertaken to alter the surface properties of the plates of PHE by applying non-sticky coating of nanomaterials in order to mitigate the fouling deposition during heat treatment of milk. The skid mounted module had two PHE units, balance tank, PID-controlled hot water generator, piping and pumping systems. The ratio of coating materials (PTFE:TiO₂) and the coating thickness was selected based on the change in thermal conductivity of SS 316 discs after coating. The uncoated SS 316 plates realized significantly more ($P < 0.05$) foulant deposition (26.07 to 27.77 mg/cm²) than PTFE-TiO₂ coated plates (1.14 to 1.39 mg/cm²) after processing milk for 480 min. The heat transfer coefficients for uncoated surface decreased continuously with the processing time, after an initial induction period, whereas those of the coated surface were almost constant.



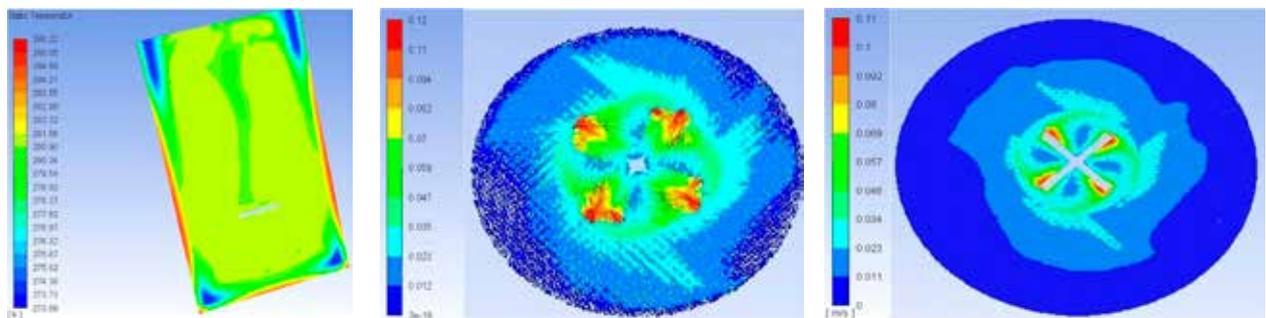
Microencapsulated Zinc Powder: Preparation, Engineering Properties and Fortification of Milk

Microencapsulated zinc powder was produced by spray drying technique and the engineering properties of powder were studied. Optimization was done using Taguchi design, considering encapsulation efficiency and bulk density as decisive response variables. Microencapsules prepared with HiCap-100 in the ratio of 20:1 at 185°C showed maximum encapsulation efficiency, whereas microencapsules with HiCap-100 in the ratio of 10:1 at 185°C showed maximum bulk density. FTIR and XRD analyses showed the successful encapsulation of zinc. Fortification of milk

with microencapsulated zinc powder was carried out and the sensory evaluation was done using Fuzzy-logic method. Microcapsules with HiCap-100 as wall material were adjudged as best by the panelists. Fortification did not affect the inherent properties of milk.

Numerical Simulation of Process Performance during Chilling of Milk using Phase-Change-Materials

Custom designed Phase-Change-Materials (PCMs) with enhanced storage performance were engineered and numerically simulated for its phase-transition characteristics during the chilling milk from 37°C to below 10° C using Fluent ver.19.0, the Computational Fluid Dynamics (CFD) package of Ansys-19. The physical domain was translated to a meshed digital space using Graphic User Interface (ICEM-CFD) and coupled with the appropriate governing equations. Transient, multiphase, unsteady, buoyancy driven melting and solidification behaviour of PCMs during the milk chilling process were studied in a cylindrical geometry. The temporal profile of the temperature of PCMs and milk during its melting and concurrent chilling, respectively, were mapped and the predicted values were found to closely match the profile generated using the experimental results. Similarly, the velocity profile of the milk (5 L) being chilled by the developed PCMs in the chilling pail, described in terms of the velocity vectors and magnitude profile in the presence of a central agitator rotating at 30 RPM, were also found to match the real time data recorded during validation trials.



Engineering Properties of Dry-Crystallized Palada Payasam Mix Prepared in A Custom Designed Mechanical Unit

A mechanical unit was custom designed and developed at the Southern Regional Station, ICAR- NDRI for the dry-crystallization process to prepare a convenience mix for *Palada Payasam*, a traditional dairy product of Kerala. The mix prepared in the unit was comparatively evaluated against a control sample of the dry crystallized mix prepared using the conventional manually stirred process, in terms of its engineering properties and sensory quality.

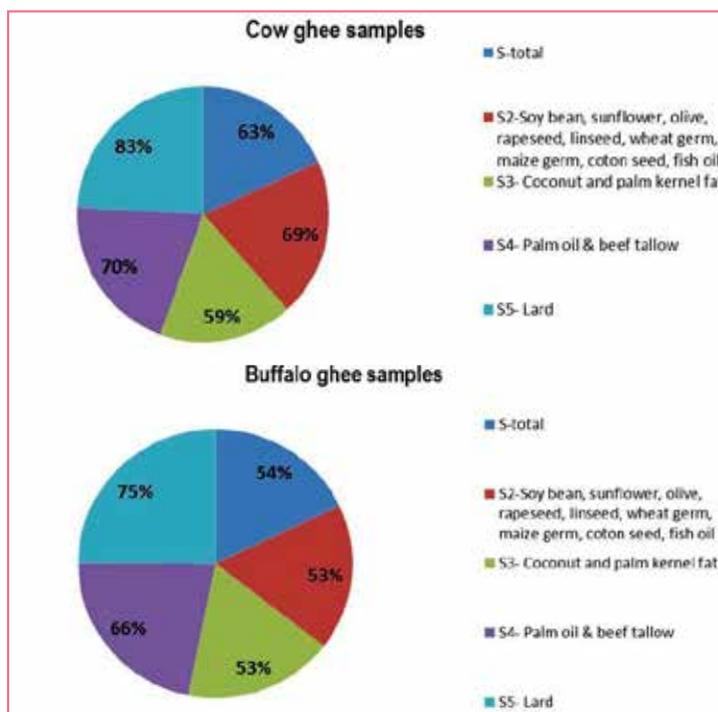
Particle size analysis revealed that the average mean diameter of control and experimental sample to be 2.55 and 2.49 mm, respectively. Colour of the samples determined using image analysis indicated that the control sample had a slightly higher Browning Index (14.08) than the experimental sample (8.11); the difference was, however, not reflected in the colour and appearance scores during subjective evaluation of the reconstituted samples. Both the samples demonstrated near identical flowability. XRD graphs yielded sharp peaks for both the samples indicative of the crystalline nature of sugar, whereas the XRD data for the dry uncooked *ada* flakes confirmed their amorphous nature. The study revealed that the mechanical unit could be used to prepare dry-crystallized *Palada payasam* mix that closely resembled the control samples in terms of its engineering properties and sensory acceptability, in a more controlled and less laborious process.



RISK ASSESSMENT AND NEW GENERATION METHODS TO ASSESS THE QUALITY AND SAFETY OF MILK AND MILK PRODUCTS

Relevance of ISO Standard of Milk Fat Purity in Case of Cow and Buffalo Ghee

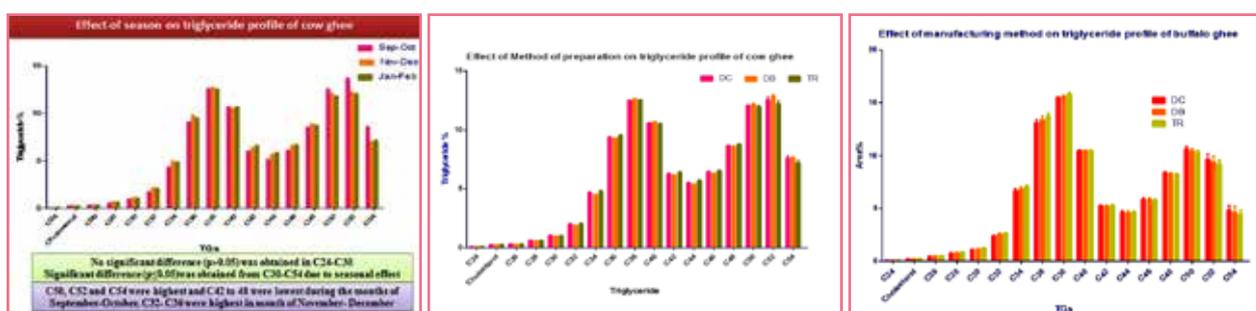
S-limits for different types of ghee (cow and buffalo) were calculated, which indicated a variation from the ISO standard specified for cow milk fat. S-limits of buffalo ghee showed higher S-total and S-limits for palm oil & beef tallow. Level of detection of different oils/ fats in ghee was also found to be above 5% except buffalo body fat.



Percentage of cow & buffalo ghee samples meeting S-limits specified in ISO method for cow milk fat

Triglyceride Profile of Cow and Buffalo as Affected by Season and Processing Conditions

Triglyceride profile was affected by season and thereby S-equations of cow and buffalo ghee. Percentage of triglycerides with carbon number C50, C52 and C54 was found to be maximum during the month of September-October in both cow and buffalo ghee. Method of manufacture also affected the triglyceride profile of cow ghee. Lower concentrations of triglycerides with carbon number C52 and C54 were observed in cow ghee prepared by traditional method in comparison to other methods.



Development of Analytical Tools to Assess Quality of Milk-Protein Based Health Supplements

A study was undertaken to analyze composition and to suggest analytical tools to assess the quality of whey protein-based health supplements. A total 14 samples of whey protein-based health supplements were collected from the market and were categorised into two types viz., products having labelled protein content more than 80% and those having protein content less than 80%. The study indicated that both the estimated total protein and true protein content were less than the claimed values in majority (78%) of samples. Presence of whey proteins in samples was also ascertained by SDS-PAGE and results were in agreement with RP-HPLC. Except two samples, the β -lactoglobulin to α -lactalbumin ratio in most of the samples was around 3:1. In 6 samples of health supplement, the estimated fat content was significantly higher than the labelled fat content. The results also indicated the absence of sucrose and other carbohydrates (glucose, galactose) in all samples. Ash content varied from 1.88 to 5.28% in whey protein supplements. Calcium, sodium and iron was present in all types of samples, however in some of the samples the estimated values differed from claimed values. Caffeine, though not declared on the label, was found in all samples and the content varied from 1.57 to 19.77 ppm. All the samples were found positive for urea and level varied from 200 to 8700 ppm. The study indicated that 14% of samples grossly deviated from claimed values for protein and fat content. It is suggested that level of true protein and individual whey proteins should be part of the quality parameters for such products.

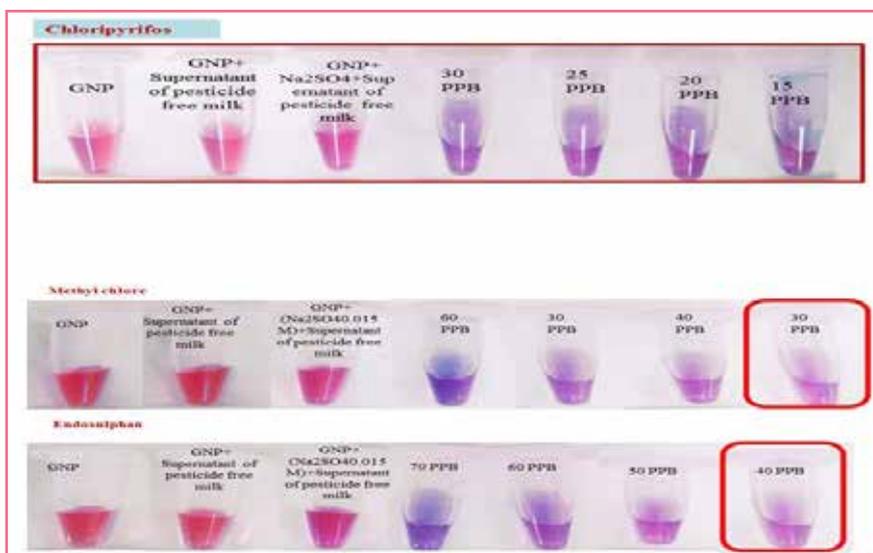
Protein, Fat and Moisture Content of Whey Protein Based-Health Supplements

Samples	Total protein (%)		Fat (%)		Moisture (%)
	Estimated value	Claimed value	Estimated value	Claimed value	Estimated value
S-1	65.96 ± 0.67	72.72*	5.08 ± 0.086	3.87*	6.37 ± 0.04
S-2	63.63 ± 1.47	63.15	6.44 ± 0.04	7.89*	6.46 ± 0.05
S-3	47.19 ± 0.76	78.12*	2.12 ± 0.046	2.03	6.13 ± 0.12
S-4	60.21 ± 0.76	64.00*	9.46 ± 0.17	11.40*	3.9 ± 0.11
S-5	66.69 ± 0.49	68.51*	5.34 ± 0.04	5.42	3.39 ± 0.23
S-6	60.07 ± 1.14	59.82	6.48 ± 0.18	7.14*	6.19 ± 0.06
S-7	71.65 ± 0.72	80.00*	5.00 ± 0.14	5.00	3.37 ± 0.18
S-8	69.46 ± 0.99	93.75*	1.07 ± 0.19	0.94	3.56 ± 0.07
S-9	76.71 ± 0.84	80.64*	3.05 ± 0.13	3.22	4.15 ± 0.08
S-10	82.27 ± 0.72	83.33	4.95 ± 0.18	5.12	2.30 ± 0.10
S-11	74.56 ± 0.34	78.12*	1.09 ± 0.09	1.56*	3.65 ± 0.07
S-12	29.99 ± 0.18	88.00*	11.80 ± 0.17	1.93*	3.80 ± 0.03
S-13	76.94 ± 0.84	80.17*	5.18 ± 0.14	5.47	4.21 ± 0.04
S-14	78.55 ± 0.52	82.43*	4.59 ± 0.15	4.81	3.57 ± 0.52

Values are expressed as Mean ± Standard Error of Mean, n=3. The superscript letters shows the significance of calculated & labelled value (P<0.05).

Application of Gold Nanoparticles for Detection of Organophosphorus Pesticide Residues in Milk

Pesticide residues in animal feed and fodder are the main source of contamination in milk and milk products. Nanotechnology, a novel approach using gold nanoparticles is exploited as an alternative to conventional methods due to simplicity, rapidity, reliability, low cost and on field detection up to the ppb level. Hence, the study was focused on gold nanoparticles based detection of pesticide residues in milk that includes synthesis of gold nanoparticles (GNPs), functionalization of GNPs with different salts and development of assays for

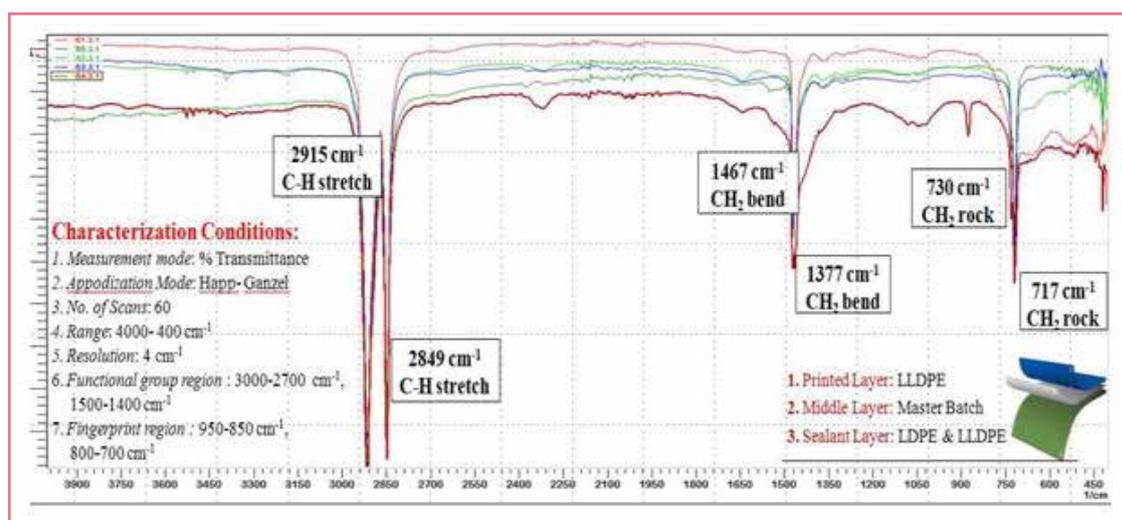


detection of pesticide residues up to regulatory standards which includes malathion, chlorpyrifos, lindane, alchlor, endosulphan, DDT, ethion, phorate, methoxy-chlor and methyl parathion within 20-25 minutes.

Migration Studies of Chemical Additives from Food Packaging Polymers into Milk and Ghee

Characterization of the flexible packaging material used for dairy products was carried using ATR- FTIR spectroscopy to identify and obtain sample spectra; digital micrometer for thickness standard conformity against IS: 11805:2007 and IS: 14636: 1998 and contact ratio calculation to test the efficacy of standard factor of 6 for dairy based products. Further, overall migration (OM) was carried out to assess preliminary safety and exposure dose of extractives from packaging materials into simulants. The ATR- FTIR optimized conditions affirmed that low density polyethylene (LDPE) and octene/butene based linear low density polyethylene (LLDPE) are the polymeric layers widely used as food contact materials in multilayer co-extruded packaging material used for milk and ghee. While in few of the ghee packaging samples, Nylon-6 (polyamide) was present on the printable side. Nearly 98% of packaging samples conformed to IS: 11805:2007 with thickness $\geq 50 \mu\text{m}$ and contact ratio for majority of packaging material samples was greater than $6 \text{ dm}^2/\text{kg}$. Whereas, for all analyzed samples the OM extractive values was less than $10 \text{ mg}/\text{dm}^2$ (as prescribed by FSSAI, 2019), but these values obtained for same sets of packaging samples differed significantly for stimulant 'A' and 'D'. Also, there exists a positive correlation between the increasing thickness of the packaging material and OM rate; $r = +0.76$ with stimulant 'A' and $r = +0.79$ with stimulant 'D' and OM values obtained for stimulant 'A' are higher than that of stimulant 'D' for all packaging samples analyzed, signifying the major presence of polar chemical additives.

* Simulant 'A': Distilled water, Simulant 'D': n-heptane



Spectra of flexible milk pouches using Attenuated Total Reflectance- Fourier Transform Infrared Spectroscopy (ATR- FTIR)

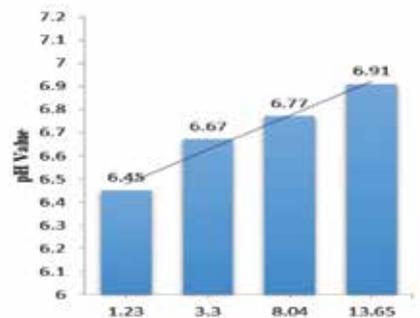
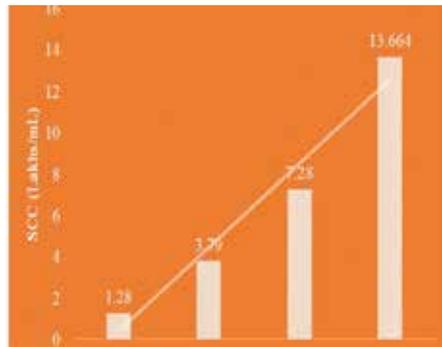
Quality Evaluation of Butter and Ghee Prepared from Milk of Indigenous and Cross bred Cattle

Milk samples of indigenous breed (Gir, Sahiwal and Tharparkar) and cross bred cattle (Karan Fries) were screened for mastitis using California Mastitis Test. Animals showing negative test were selected and analyzed for gross chemical composition i.e. fat, total solid, protein and lactose. Gir cow milk showed fat and Total solids as 3.2 – 5.0% and 11.95 – 13.75%. The protein content ranged from 2.98 – 4.08%. In Sahiwal milk, the fat % varied from 4.1 – 4.9%. In KF milk, fat was found between 3.8 – 5.0%. Likewise total solids and protein also varied in indigenous breeds. Buffering capacities (BC) of milk of indigenous and cross bred cows was investigated. Tharparkar cow milk exhibited a maximum BC value of 0.0544 at pH values 5.0, whereas in Karan Fries cow milk, maximum BC value was 0.022 at pH values 5.0. Higher buffering capacity in the milk of indigenous breed is attributed due to the sum of different amino acids and proteins. A wider hump obtained at the maximum buffering values for cross bred cow milk indicated that it contained less concentration of buffering constituents than indigenous cow milk. Ghee was prepared from milk of indigenous breeds (Gir and Sahiwal) and crossbred (Karan Fries) using desi and creamery butter method for comparative study. Physico-chemical constants such as RM value and Saponification value were significantly higher in Gir cow ghee irrespective of method, whereas BR reading and free fatty acids were higher in Karan Fries cow ghee prepared by desi and creamery butter method respectively. Also, Polenske Value was found to be higher in Sahiwal and Gir cow ghee obtained from creamery butter and desi method, respectively. Saturated

Fatty acids were higher in Sahiwal cow ghee, whereas MUFA and PUFA were observed significantly higher in Karan Fries cow ghee irrespective of method of preparation.

Evaluation and Validation of Enzyme Substrate Based Strip Test for Detection of Subclinical Mastitis

Subclinical mastitis is difficult to detect at an early stage. Present investigation was aimed to validate performance of paper strip assay developed at NDRI for detection of subclinical mastitis in milk of different breeds and its comparison with conventional tests i.e. Somatic cell count (SCC), pH, California mastitis test (CMT) and chloride test. A total of 120 milk samples of different indigenous breeds (Sahiwal, Tharparkar, Gir and Murrah) were evaluated for their mastitis status by conventional tests viz., somatic cell count, California mastitis test, pH and chloride content. These milk samples were also validated for their mastitis status with developed paper strip assay. Observations on mastitis status indicated that 23.33 and 26.66% of milk samples were infected with subclinical and clinical infections, respectively. Correlations were established between intensity of colour development with CMT score, somatic cell count and pH. The increase in somatic cell count, CMT score and pH resulted increase in intensity of colour development indicative of positive correlation. The sensitivity and specificity of the developed test was found to be desirable for mastitis milk. The developed strip assay will be helpful in detection of subclinical mastitis in dairy animals under field conditions.

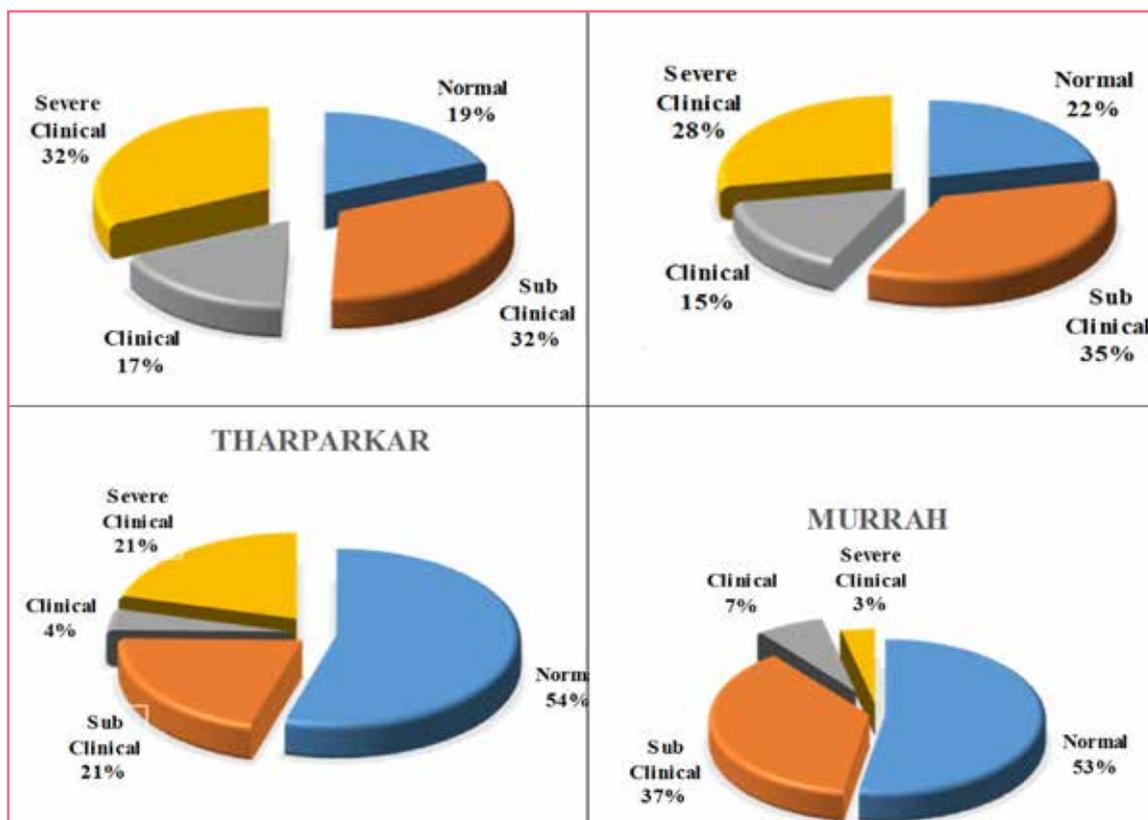


Colour intensity score

Correlation between colour intensity, somatic cell count, pH and somatic cell count

Validation of Paper Strip Assay for Detection of Subclinical Mastitis Milk

Performance of developed mastitis detection assay was validated with 287 milk samples of individual quarters of four breeds. Based on somatic cell count (SCC), 32.00, 35.44, 20.77 and 36.86% quarters of Sahiwal, Gir, Tharparkar and Murrah were found infected with subclinical mastitis. Average SCC of subclinical mastitis for Sahiwal, Gir, Tharparkar and Murrah was 3.79, 3.88, 3.30 and 3.55 lakhs/ml and average pH was 6.67 ± 0.04, 6.64 ± 0.01, 6.67 ±

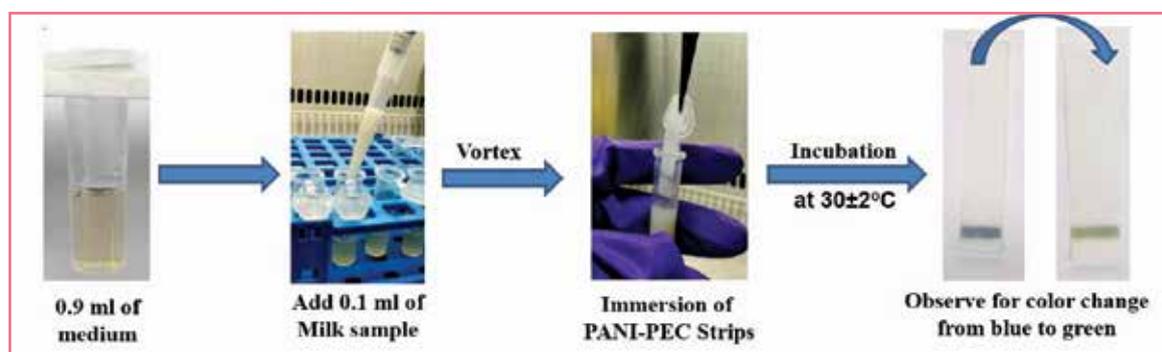


Incidence of mastitis based on somatic cell count in different breeds

0.02 and 6.66 ± 0.01 . Based on CMT score of ≤ 1 , incidences of subclinical mastitis were 46.66, 39.24, 19.48, 50.86% in Sahiwal, Gir, Tharparkar and Murrah. A good correlation was also observed between SCC, CMT and pH. On the basis of paper strip assay, out of 287 milk samples, 32.00, 40.50, 19.48 and 42.10% of Sahiwal, Gir, Tharparkar and Murrah were found to be positive for subclinical mastitis. On basis of colour intensity developed on paper strip assay, a better correlation was also established between SCC, pH, and CMT scores. Overall sensitivity and specificity of paper strip test was recorded as 92 and 89%, respectively for mastitis positive samples, however, it was 86 and 94% for subclinical mastitis. Sensitivity and specificity for subclinical mastitis detection was 94.92, 87.50; 96.61, 80; 83.33, 86.2 and 92.59, 86.21% of milk samples of Sahiwal, Gir, Tharparkar and Murrah, respectively. Observations on cross reactivity of antibiotics (penicillin, ampicillin, tetracycline, oxy-tetracycline, gentamycin & streptomycin) and pesticides (chlorpyrifos, chlorpyrifos-methyl, malathion, carbaryl, aldrin, endosulfan) showed no interference in working performance of paper strip assay with respect to development of colour intensity up to recommended MRL levels and beyond. Storage investigations revealed that paper strip can be stored safely >6 months in both packaging materials (laminated aluminium foil and coextruded film i.e. (copolymer of EVOH & polyethylene) at $4 \pm 1^\circ\text{C}$ & $-20 \pm 1^\circ\text{C}$.

Conducting-polymer Based Rapid Detection of Microbial Quality of Milk

Polyaniline-Pectin colloidal dispersion was synthesized with some modifications. The prepared homogenous dispersion was in emeraldine salt form of polyaniline with green colour. The lyophilized PANi-Pec particles were re-dispersed in Milli-Q water by ultrasonication. The solution obtained was in Emeraldine Salt (ES) form of polyaniline with pH around 2.5 ± 0.2 that was converted to Emeraldine Base (EB) form by addition of few drops of NaOH (1N) to pH ~ 7 . For the construction of colorimetric sensor strips, Whatman filter paper grade 4 was used and PANi-Pec solution was immobilized using easy printer to get sharp and clear colour development. It was observed that as the concentration and volume PANi-Pec solution was increased, the time taken for colour change also increased. The concentration and volume of PANi-Pec solution immobilized/strip was optimized to be 3 mg/ml and 1.12 μl , respectively as it exhibited good sensitivity and colour intensity. The modified PANi-Pec strips were used in the detection of total microbial load in milk using optimized medium using raw milk and the performance of the strip was found to be 5 $\frac{1}{2}$ to 6 hrs at 7.0 log counts. Further, assay using modified PANi-Pec strips and medium specifically developed for total microbial load was being optimized for getting the results faster in terms of time reduction. Shelf life study revealed that the developed PANi-Pec colorimetric sensor strips were stable at room temperature up to six months exhibiting same level of sensitivity and intensity of colour.

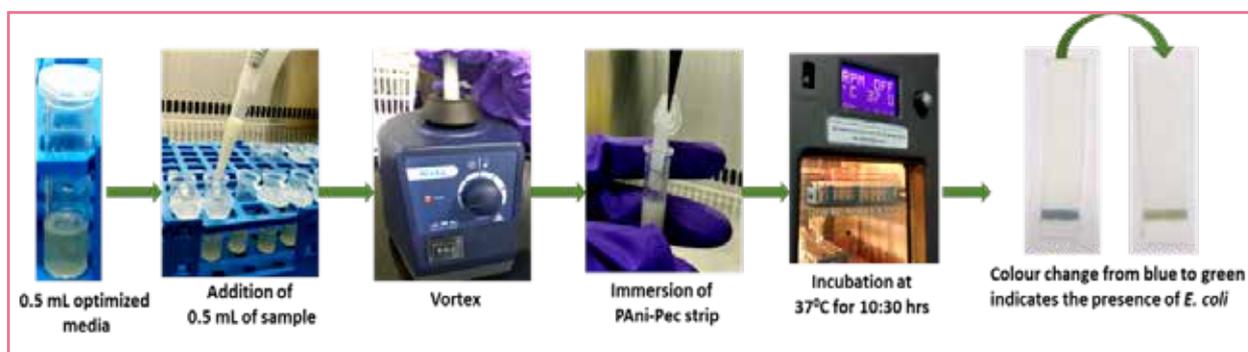


PANI-Pec strips based sensor for detection of total microbial load in milk

Evaluation of Conducting Polymer Strip Based Sensor for the Detection of *Escherichia Coli* in Milk and Milk Products

A Polyaniline-Pectin colloidal dispersion was synthesized and immobilized on Whatman filter paper grade 4 using easy printer. Targeting the β -galactosidase and β -glucuronidase activity of *E. coli*, medium components used for the assay were optimized on the basis of acid production and selectivity for *E. coli*. The developed PANi-Pec colorimetric strip based sensor detects 0.52 ± 0.17 log cfu/mL *E. coli* within $10:21 \pm 0:10$ h. The developed assay exhibited good selectivity by retaining the blue colour of the strip for other Gram negative and Gram positive bacterial contaminants up to ~ 6 and 8 log cfu/mL at 37°C , respectively. The developed assay was evaluated with 60 milk samples, 10 butter samples and 10 dried milk samples and random samples were analyzed with approved IS: 5887-1 (1976) method, AOAC official method and two stage enzyme substrate assay. Out of 40 raw milk samples analyzed, 24 samples showed positive for *E. coli* and all the pasteurized milk samples and dairy whitener samples showed negative for *E. coli* whereas all the 10 butter samples showed positive for *E. coli* and the assay was found not suitable for the detection of *E. coli* in roller dried skim milk powder. Further, shelf life study revealed that the developed PANi-Pec colorimetric sensor strips were stable at room temperature up to six months exhibiting same sensitivity and colour intensity. Based on the above findings, it could be concluded that the developed PANi-Pec

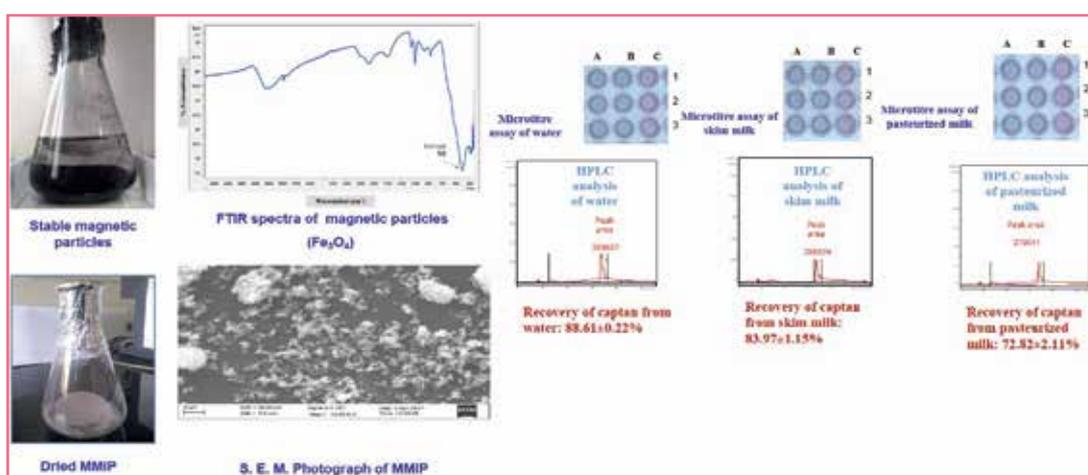
colorimetric strip based sensor assay is a sensitive, cost effective and simple to use method for the detection of *E. coli* and it has lot of industrial importance enabling routine monitoring of *E. coli* in milk and milk products at various stages of production and processing.



PAni-PEC paper strips for the detection of E. coli

Magnetic Molecularly Imprinted Polymer Mediated Enzyme Inhibition Based Microtiter Assay for the Detection of Captan Pesticide

Eight enzymes namely β -glucosidase, α -glucosidase, α -galactosidase, α -amylase, protease, alkaline phosphatase, peroxidase and esterase out of ten enzymes evaluated were found to be expressed in a *Bacillus megaterium* strain. However, expression time / enzyme activity was varied among different enzymes. All expressed enzymes were screened for their inhibition by twenty four pesticides of different groups using microtiter plate assay. The inhibition of β -D-glucosidase, α -D-glucosidase, α -D-galactosidase, protease, peroxidase and esterase was observed at 200, 100, 10, 100, 100 and 10 ppb, respectively for different pesticides. Esterase enzyme was selected for assay development based on its better sensitivity in 15 minutes. Assay was further optimized for volume of spores and time of incubation. With optimized microtiter assay, LOD of 0.1 ppb for captan pesticide was achieved. Magnetic molecularly imprinted polymers were synthesized based on iron magnetite encapsulated polymer of methacrylate (monomer) and ethyleneglycoldimethacrylate (monomer-cross-linker) for selective extraction of captan pesticide from natural samples. Different parameters like pH, temperature and solvent for binding, washing and elution were optimized. The selectivity of prepared polymers was tested for binding with other pesticides i.e. maneb, atrazine, carbendazim and thiram. Developed assay successfully achieved 88.61 ± 0.22 , 83.97 ± 1.15 and $72.8 \pm 2.11\%$ recovery of captan in water, skim milk and pasteurized milk respectively and met their MRL. The analysis could be completed in 3.30-4.0 h which is a cost effective option as compared to conventional techniques as it exploits the use of bacterial spores as an inexpensive source of enzyme, eliminating the need of expensive sample treatments as MMIP can be reused and has long shelf-life.

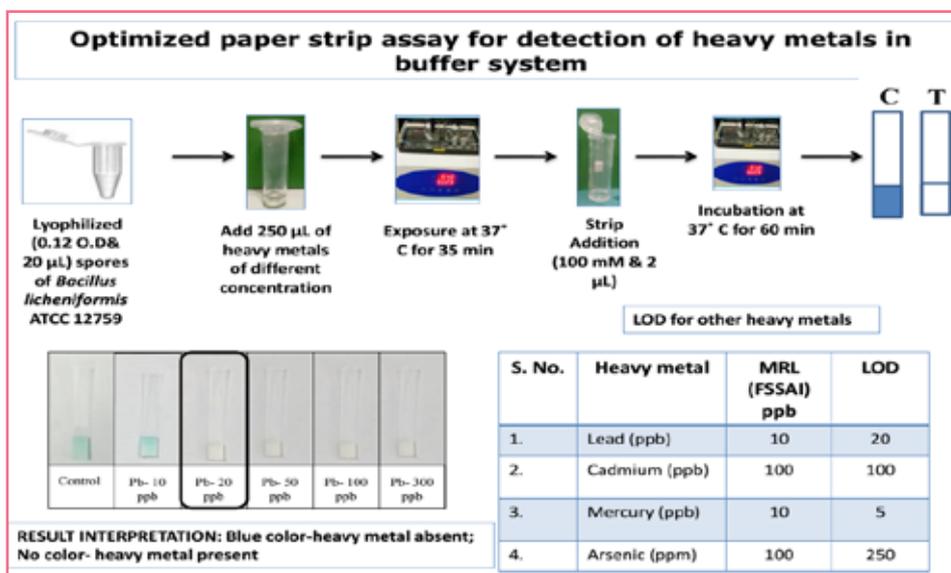


MMIP-enzyme inhibition based microtiter assay for the detection of Captan pesticide

Outreach Programme on Monitoring of Drug Residues and Environmental Pollutants

Paper strip based sensor for detection of heavy metals in Milk: For development of paper strip based sensor for detection of heavy metal, different enzymes were screened on paper strip in different *Bacillus* cultures. Based on sensitivity, stability of the strips and time of colour development, β -galactosidase enzyme produced by *B. licheniformis* ATCC 12759 was selected for further studies. Interference study of β -galactosidase enzyme was also

done with other inhibitors like antibiotics, pesticides, aflatoxin-M1, detergent and disinfectant used in dairy industry and no interference was observed. Other test conditions like spore volume, substrate concentration, exposure time, incubation time, solvent containing heavy metals, whatman paper were optimized. The optimized assay protocol for detection of heavy metals was evaluated in buffer system and detection of lead, cadmium, mercury, and arsenic could be achieved at 20 ppb, 100 ppb, 5 ppb and 250 ppm as against FSSAI standards of 20 ppb, 100 ppb, 10 ppb and 100 ppb, respectively.

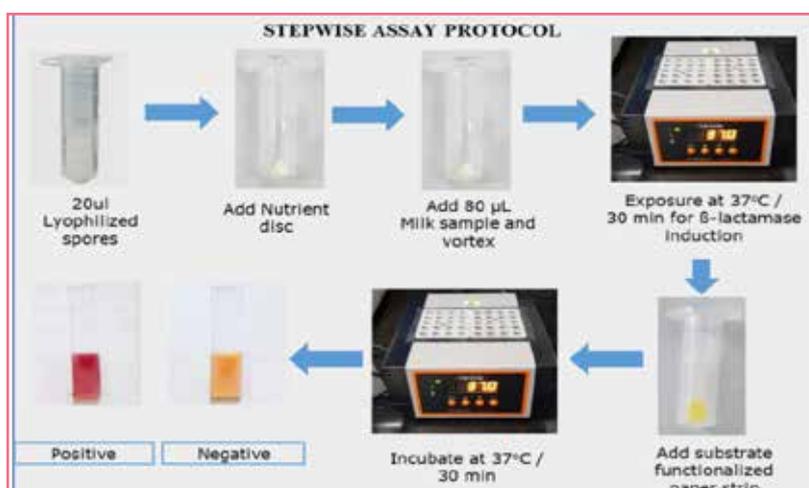


Paper strip test for detection of heavy metals in buffer system

Qualitative screening of antibiotics residues in milk using strip based tests developed at NDRI: Milk samples comprising of 534 raw and 168 pasteurized procured from Rajasthan and Haryana were initially screened using developed strip based test and 4.68 % samples of raw milk were found contaminated with antibiotic residues. 2.24% samples showed the presence of antibiotics at \geq MRL with predominance of β -lactam, chloramphenicol, sulfa drugs. Enrofloxacin in quinolone group was detected at \leq MRL level set by codex. The samples positive for enrofloxacin were analyzed for confirmation using HPLC at GADVASU Ludhiana and similar results were obtained. Pasteurized milk samples (168) were also screened but none of the sample was found to be contaminated. Samples were also tested for pesticides residues and 3.55 % in raw milk and 0.59 % pasteurized milk were found contaminated.

Diagnostics for One Health User Driven Solution for AMR - DOSA

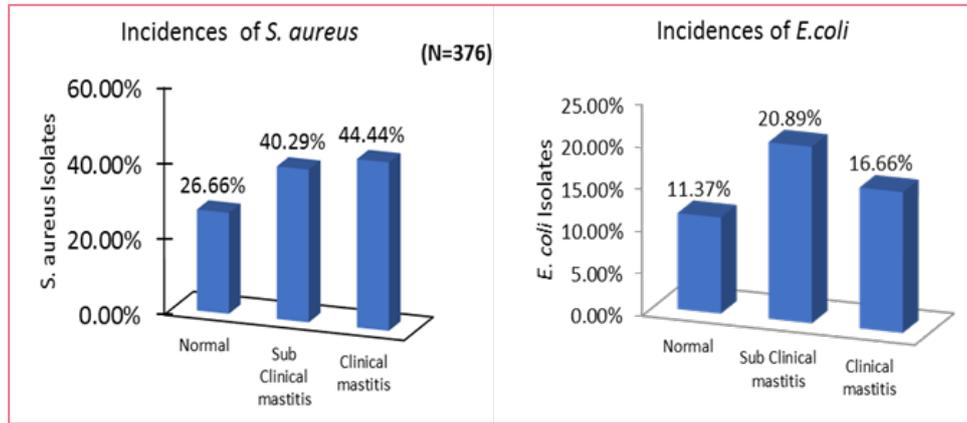
Proof of concept for detection of β -lactam group based on induction principle: A proof of concept was developed for the detection of β -lactam group of antibiotics in milk which works on the induction of β -lactamase enzyme in germinating bacillus spores. The concept was transformed on paper strip for specific detection of β -lactam group of antibiotics as specified in FSSAI standards. The strip making process and other assay parameters like spore concentration (20 μ L), incubation & exposure time (30 min), substrate conc. (5 μ L), incubation temperature (37°C) were optimized.



Stepwise protocol for the detection of β -lactam group of antibiotics in milk

Baseline Assessment on Mastitis, *E. Coli* and *S. Aureus* in Dairy Settings

The prevalence of mastitis in dairy animal is one of the growing concerns in dairy setting. A baseline data was generated by collecting 376 raw milk samples including large dairy farms (n=282) and small dairy farms (n=94) from Haryana. These samples were tested for mastitis using somatic cell counter and 14.36 % samples were observed positive for clinical mastitis while 17.81 % with subclinical mastitis. The samples showed the prevalence of *S. aureus* 40.29% in sub-clinical and 44.44% in clinical cases where as *E. coli* was found in 20.89% and 16.66%, respectively.



Prevalence of *S. aureus* and *E. coli* in Subclinical and Clinical Mastitis

Assessment on Pesticide Residues in Dairy Farm Using Paper Strip Based Sensor

In current investigation, strip making process was re-designed to achieve better colour/differentiation on strip shelf-stability was extended up to 8 months at 4° C in vacuum packed condition. Pesticide extraction protocol was developed successfully with interventions of PSA and MgSO₄ for removal of pigments from dairy farm samples to prevent their interference in enzyme-pesticide interaction leading to colour development on strip. PSA in combination with MgSO₄ (1:2 ratio) was found successful in extraction of pesticide from cattle feed and fodder. Optimized extraction protocol was evaluated with 340 dairy farm samples which includes green feed, dry feed, concentrated feed, fermented feed, soil, water, milk and manure collected from NDRI dairy farm. Five per cent of the samples were found pesticides positive when tested with strip based test with optimized extraction protocol. LODs of 12 pesticides from OP, OC, fungicide, pyrethroid ester and neonicotinoid group recommended for application in dairy farm were evaluated in feed /fodder and their LODs were in the range of 10-100 ppb, 10-50 ppb, 1-50 vppb, 1-50 ppb and 1-100 ppb, respectively complying FSSAI regulatory standards. Current investigation revealed that developed extraction protocol and strip based test was found to be effective in detection of pesticides in different dairy farm matrix like green feed, dry feed, concentrated feed, fermented feed, soil, water, milk and manure etc. The developed technology could be used as semi-quantitative test for pesticides monitoring in dairy farm as well as for screening of primary produce under field condition for organic certification of various food/ feed commodities.

Surveillance of Dairy Products for Antibiotic Resistant Zoonotic Bacterial Pathogens under Field Conditions

The zoonotic bacterial pathogens including *E. coli*, *Salmonella*, *Coagulase +ve Staphylococcus aureus*, *Enterococcus* spp. were screened in raw milk samples collected from Organized and Unorganized dairy farms using BIS/ISO methods approved by FSSAI (FSSR, 2016). Overall suspected prevalence of 23.7% *E. coli*, 26.1% *Enterococcus*, 5.8% *Salmonella* and 31.3% *Coagulase positive Staphylococcus aureus* was found in raw milk collected from LRC and Unorganized sector. The suspected zoonotic bacterial pathogenic isolates were evaluated for antibiotic resistance phenotypically by disc diffusion method and multi-drug resistance by streaking

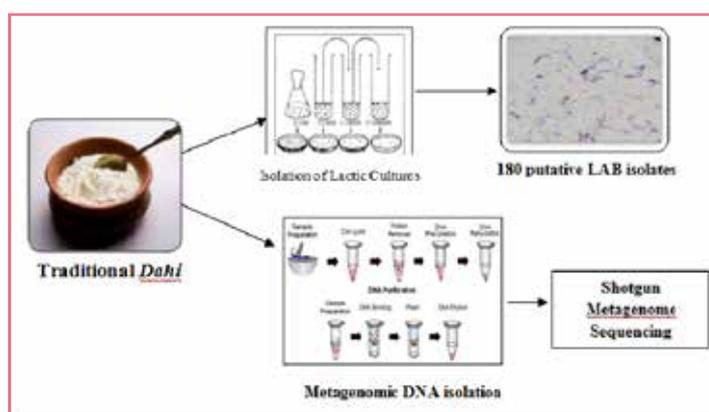


Prevalence of antibiotic resistance in zoonotic bacterial isolates from raw milk

Hi-chrome Agar. Eleven strains of *E. coli* were screened for antibiotic resistance against extended spectrum β -lactam (ESBL) antibiotics wherein six isolates of *E. coli* had shown resistance towards ESBL antibiotics. Among these, three isolates had shown resistance to CTR, four to CTX, and six to CPD antibiotics. Three out of six isolates had shown resistance to CTR, CTX and CPD and one of the *E. coli* isolate had shown resistance to CTX and CPD. None of the eleven isolates showed any resistance towards Carbapenem antibiotics. In case of 18 isolates of *Enterococcus* spp. in raw milk samples, 3.92% isolates showed resistance to Trimethoprim followed by 1.96% isolates to vancomycin and 1.96% of each isolates had shown resistance to Vancomycin, Penicillin G and ampicillin, respectively. Further, out of ten isolates of Coagulase positive *Staphylococcus aureus* evaluated for antibiotic resistance against nine antibiotics, five showed resistance towards oxacillin while one isolate against of antibiotics.

Prevalence of Antimicrobial Resistance in Dairy Lactic Starters in Haryana Region

A total of 13 traditional *Dahi* samples prepared by backslopping method were collected from rural as well as urban households of Karnal (6) and Kaithal (7) regions of Haryana. These 13 *Dahi* samples were then used to isolate 180 isolates of putative Lactic Acid Bacteria (LAB) by pour plating method in MRS and M-17 agar plates. The isolates were tentatively identified by morphological study and catalase activity test. DNA was also isolated to confirm their identity by PCR assay. Metagenomic DNA was isolated from all the 13 *Dahi* samples and quality was ascertained by agarose gel electrophoresis and PCR using universal primers. The relevant samples were pooled and outsourced for shotgun metagenomic sequencing.



Isolation of lactic acid bacteria as well as Metagenomic DNA to study the prevalence of antimicrobial resistance/resistome in Traditional Dahi

Physiological and Bacteriological Risk Factors on Prevalence of Subclinical Mastitis in Dairy Cows

Prevalence of subclinical mastitis (SCM) and its risk factors were estimated in lactating HF crossbred ($n=45$) and Deoni cows ($n=43$) at fortnightly intervals using milk somatic cell count (SCC: reference test using 200×10^3 cells/ml as a cut off value), California mastitis test (CMT) and differential electrical conductivity (DEC) methods. SCM positive milk samples ($n=34$) were inoculated in selective media for *E. coli*, *Streptococcus* sp. and *Staphylococcus* sp. and DNA was isolated from these organisms ($n=10$) for their species confirmation by 16s rDNA sequence-based method. The cumulative prevalence of 31% and 65% SCM was found in Deoni and HF crossbred cows, respectively. Multivariate analysis revealed stage of lactation (SOL) in Deoni and parity, SOL and mastitis treatment history in current lactation in HF crossbred cows as risk factors. ROC analysis revealed better accuracy of CMT than DEC. One sample was positive for *E. coli* and *Streptococcus* sp. while 11 samples positive for *Staphylococcus* sp. alone and 20 samples were positive for both *Staphylococcus* sp. and *Streptococcus* Sp. in culturing method. Molecular method revealed lesser known mastitis pathogens in SCM. It is concluded that indigenous cows had lesser prevalence of SCM and lesser known mastitis pathogens requires molecular diagnostic tool for their specific identification.

DAIRY DEVELOPMENT: POLICY ANALYSIS, STRENGTHENING DATABASE AND IMPACT ASSESSMENT

Policy Imperatives for Promoting Value Chains of Agricultural Commodities in India with Reference to Dairy Start-ups

The value chain of ICAR-NDRI start-ups and commercial dairy farms was mapped on basis of primary data collected from states of Andhra Pradesh, Delhi, Gujarat, Haryana, Jharkhand, Punjab, Rajasthan, Uttarakhand and Uttar Pradesh. The study revealed multiple marketing channels and co-existence of informal value chain driven by milk vendors, local traders, small processing units, consumer households, and formal value chain driven by cooperatives and private processors. Some resource rich and well managed dairy farms, guided and trained by ICAR-NDRI explored the potential of territorial market and targeted elite customers in metro, particularly in National Capital Region (Delhi, Faridabad and Noida). They were selling milk @ ₹ 100 to 110 per litre on account of *swadeshi* nudge (A2 milk of indigenous cow: *Sahiwal, Gir, Kankrej*) and addressing consumer concerns of safe and quality of milk/ milk products. Ensuring milk produced under hygienic conditions and maintaining safety at each stage in a value chain is imperative from consumer and market perspectives. Hence, food safety index for milk production was developed based on 47 standard dairy practices relevant for food safety and quality of milk produced at farmer's level. Another index for different stakeholders involved in milk value chain was developed by considering the 69 scientific practices. Subsequently, level of food safety practices adopted by the commercial dairy farmers and other value chain partners (stakeholders) was evaluated against the aggregate score obtained from experts. Overall, only 74% food safety practices were found to be adopted at the farm level, emphasising the need for more hygienic practices, particularly personal hygiene during milking and milk handling, as these practices carry more weightage in the index.

Further, product flow and core actors involved in liquid milk value chains of informal sector were mapped based on primary data collected from 27 small and micro dairy processing units, applying simulation model Vensim PLE x32 package. It was inferred that cost of milk procurement (transportation cost, reception cost and chilling cost) as well as processing cost of milk was lower in case of Collection Centre (Model-I). The profit earned by integrated production and processing units (Model-II), i.e., ₹ 7.21 per litre was over and above the assumed model profit of ₹ 2.5 per litre. The profit of processing units (Model-I) was marginally higher than model profit whereas, profit of private vendor system (Model-III) was lower than model profit. The profitability was found to be linked with quality and value chain approach.

Vulnerability of Dairy Farmers to Risk and Uncertainty in Coastal Odisha

Dairy farmers of coastal Odisha are subject to risk and uncertainty both from climatic and man-made factors. The livestock is an important activity in the state of Odisha where this sector accounts for about 17% of the Gross State Value Added (GSVA) from agriculture as a whole. The study assessed farm level vulnerability of dairy farmers to these risks both at region and farm levels. An effort was made to adjudge effectiveness of alternative risk mitigation strategies and develop risk efficient farm plans. The analysis was based on both primary and secondary data. The primary data were collected from 400 households among four coastal districts of Odisha. The secondary data were collected from district headquarters, Department of Agriculture and Animal Husbandry of the state. The farm level vulnerability index was constructed taking it as a function of exposure, sensitivity and adaptive capacity. The MOTAD model was used to develop risk efficient composite farm plans.

The study revealed that among reproductive problems, the repeat breeding was affecting the crossbred cows much more than the local cows, with the HH loss amount standing at ₹ 20,000 and ₹ 6,400 for CB and local cows, respectively. At regional level, this loss from repeat breeding accrued to about rupees 9 lakhs. In case of loss due to diseases, mastitis was found to be the greatest contributor to household losses among all the diseases at about 40% share, while FMD and blood protozoan diseases were the second and third highest contributors. At regional level, FMD was the major disease causing the highest losses to the extent of rupees 5 lakhs. The overall mortality rate of dairy animals was found to be about 4.89% with household mortality loss at about ₹ 1,942 per annum. The

natural calamity mortalities were found to be very less in comparison to diseases at 0.33 and 4.56%, respectively. Reverse trend was observed in case of crop loss, where natural calamity appeared to be the greatest factor.

About 77% of the farms in coastal Odisha were found vulnerable to very highly vulnerable to risk and uncertainty. The extent of vulnerability was different for different categories of household. The extent of vulnerability was high among landless (87.51%) and lower farm size categories, e.g., marginal farmers (82.24%) and small (51.89%). Only 50% of the medium category of farms were vulnerable to risk and uncertainty in coastal Odisha. The farms were more vulnerable, not because of their exposure to risk but because of their less adaptive capacity and high sensitivity. Therefore, there is a need to improve the adaptive capacity of the farmers by increasing their off-farm income, providing productive assets and training, and improving diversification. The study observed moderate trends of enterprise diversification in case of animal husbandry and crop by about 0.446 and 0.534%, respectively. The overall crop insurance adoption among all types of farmers was found to be 75.41%.

The risk efficient farm plans provided a picture of better resource allocation with prospects of higher return. The main cereal and pulse crops, appeared not to be increasing beyond a certain limit, favouring the cash crops like groundnut and vegetables underlining the comparatively lower risks with higher prospects of return associated with them. In the optimal plans, dairy animals appeared to be less favourable in comparison to their crop counterparts. This may be owing to the higher risk and low return associated with them. The small animal holdings like goatary and the fisheries were found to be appearing marginally in the final plan, underlining their role as risk efficient farm activities.

Economic Analysis of Peri-Urban Dairy Farms in East and South-Eastern Coastal Plain Zone of Odisha

Milk production plays an important role in the economy and socio-economic development of the country. Dairy farming has always been looked upon as a subsidiary occupation and not as a primary occupation. In recent years, however, dairy sector is witnessing a shift towards specialised dairy farming in the urban areas. Increasing demand for milk in the urban area has led to market-oriented dairy farming, which is providing both profit and self-employment to the urban youth. These urban and peri-urban dairy production systems evolved to satisfy the increasing demand for milk in urban areas. The reasons for increasing demand for milk are increasing urbanisation, rising per capita income and increasing cost of imported milk and milk products. Therefore, keeping in view the above facts, an investigation was taken up with the specific objectives as to work out the cost and returns of milk production of Peri-Urban dairy farms, to estimate the profit efficiency of peri-urban dairy farms and to assess the sustainability of scientific management practices on selected dairy farms. Data were collected from 120 peri-urban dairy farms of two towns, namely, Cuttack and Bhubneshwar falling in Cuttack and Khorda districts, respectively. The peri-urban farms were classified into small, medium and large farms based on milch animals using cumulative square root frequency method. Overall gross maintenance cost for milch crossbred cow was worked out to be ₹ 269.53/day which varied from ₹ 272.88 for small category to ₹ 250.25 for large category. Overall gross maintenance cost for milch buffalo was worked out to be ₹ 276.63/day, which varied from ₹ 247.16 for small category to ₹ 300.58 for large category. Overall, per-litre return from milk was ₹ 9.83 and ₹ 6.46 in case of crossbred and buffalo, respectively. For crossbred per-litre return from milk was highest in case of large farms (₹ 13.20) followed by small (₹ 9.22) and medium farms (₹ 8.09). For buffalo per-litre return from milk was highest in case of large farms (₹ 9.10) followed by small (₹ 6.45) and medium farms (₹ 4.55). Profit efficiency of dairy farmers ranged from 18 to 99% and mean level of profit efficiency was 54%. Mean level of profit efficiency was the highest in case of large farms (76%) followed by medium (64%) and small farms (60%). Wage and concentrate application were significantly affecting the profit efficiency in an overall situation. About 61% of the sample dairy farms were found to be in low sustainable category. Only 7% of farms were found in high sustainable category and 32% farms came under medium sustainable category. Most of the farms were performing low level of nutrition, animal health and shelter management practices. Chi-square test result showed that shelter management, breeding and animal nutrition practices significantly affected the sustainability index-based distribution of farms.

Milk Supply and Input Demand Elasticities in Eastern Region of India

The country requires a threefold increase in milk production to maintain its topmost position in production. To lure farmers into dairy farming, the suitable policy support is important and the prices act as instrument for policy implementation. Thus, a study was undertaken to determine the degree of responsiveness of milk supply and factor demand to own prices, prices of other inputs and level of fixed factors. It is equally important to analyse the impact of input prices on cost of milk production, which is explained by the elasticities of costs with respect factor and output prices. These elasticities provide fair base to find out the kind of effect the change in input and output prices will have on profit/net income. This study was confined to the eastern region of India as there is an immense scope of dairy development in the region. Moreover, a large number of government programmes are directed towards the eastern region to bring about agricultural development. Eastern region of India comprises

the states of West Bengal, Odisha, Chhattisgarh, Bihar, Assam, Eastern Uttar Pradesh and Jharkhand. Out of the 7 states of the eastern region, the states of Bihar, Jharkhand and West Bengal were selected on the basis of highest per capita availability of milk. From the selected states, a sample of 300 respondents was selected according to probability proportional to size representing three strata dairy farmer categories, i.e., small (1-3 milch animals), medium (4&5 milch animals) and large (>5 milch animals). In order to estimate elasticities, duality approach was used to derive output supply and input demand functions. A normalised *translog* profit function alongwith five-factor share functions were estimated jointly using Zellner's Seemingly Unrelated Regression Equation (SURE) procedure. The output supply and input demand elasticities were further used to calculate cost and net income elasticities. The study also estimated profit efficiency of the dairy farmers in the eastern region by using stochastic *translog* profit frontier.

The overall milk supply elasticities were estimated with respect to milk price and the prices of inputs used in its production. The milk supply elasticity with respect to own price was estimated to be 0.7154 showing its positive effect on milk supply but was comparatively inelastic. On large farms, the milk supply elasticity with respect to its own price was elastic (1.6746) as the large farms were capable of increasing the milk supply in response to increase in its price. It was very low on middle herd size category (0.3390). The milk supply elasticities with respect to input prices were negative but were positive with respect to fixed factors (herd size and farm capital). The overall milk supply elasticity was the highest negative (-0.3682) with respect to wage rates. The value of overall milk supply elasticity to green fodder price was very low (-0.0238) showing very less decrease in milk supply with the increase in green fodder price. The situation was same on herd size categories. The sensitivity of large farms to supply milk with respect to input prices was found more as the value of milk supply elasticities with respect to the prices of dry fodder, concentrate and labour was comparatively higher.

All the factor demand elasticities with respect to own price were negative for all the herd size categories, thereby, revealing that all the inputs were normal goods, whose demand increases as their prices fall. The overall own price elasticity of demand for concentrate (-0.0006) was almost perfectly inelastic, which means that irrespective of the change in prices, required quantity of concentrate was demanded while the same for veterinary services was almost unity (-0.9843). All factor demand elasticities with respect to milk prices were found to be positive. Overall, factor demand elasticities with respect to milk prices were inelastic for all the factors, except dry fodder where it was elastic (1.1763) showing that demand for dry fodder increases more than the proportionate increase in milk price. On large farms, these were found to be elastic for all factors except veterinary services. On small farms, these elasticities were relatively elastic for all the factors and unitary elastic for labour demand.

Table: Milk supply and its input demand elasticities for the eastern region of India

Elasticities	Prices						Fixed Factors	
	Milk	Green Fodder	Dry Fodder	Concentrate	Labour	Veterinary Services	Herd Size	Farm Capital
Supply Elasticities								
Milk	0.7154	-0.0238	-0.1604	-0.1643	-0.3682	-0.0014	3.5886	1.1594
Demand Elasticities								
Green Fodder	0.7888	-0.0668	-0.0742	-0.0876	-0.5513	-0.0088	0.1593	8.6020
Dry Fodder	1.1763	-0.0164	-0.4240	-0.5113	-0.2555	0.0310	2.7489	2.9817
Concentrate	0.8201	-0.0132	-0.3479	-0.0006	-0.4711	0.0115	2.9850	2.4695
Labour	0.9547	-0.0432	-0.0903	-0.2447	-0.5783	-0.0018	3.2266	1.9451
Veterinary Services	0.2635	-0.2476	0.7548	0.4124	-0.1282	-0.9843	-14.4898	40.3943

Overall, the net income elasticities were negative with respect to variable factor prices but were positive with respect to milk price. Its elastic value (-2.4646) with respect to wages verify labour intensive nature of milk production and sensitivity of net income from milk to the labour wages. The net income elasticity with respect to wages was highest (-3.2628) on small farms followed by large farms. Besides labour wages, the net income of medium herd size category of farms was found elastic (-1.1575) to concentrate price. It was inferred from the findings that to increase the income of the dairy farmers, the control on price of concentrate and wage rate are important. The mean profit efficiency of the dairy farmers in the study area was 0.7215, which implies that the profit can be increased by 27.85% if both technical and allocative inefficiencies are removed.

Economic Valuation of Indigenous Breed: A Case of Sahiwal Cattle

As a result of continuous emphasis on raising the milk production and market failure to account for other benefits of indigenous breeds, the indigenous cattle biodiversity is under severe threats, which calls for their valuation and designing of suitable strategies. This study was carried out to standardise the methodology for valuation of

indigenous dairy cattle breeds, which was then used to assess the economic value of Sahiwal breed that is one of the best indigenous cattle breeds of India; which is also facing threat of extinction in its own homeland. Cost of conservation was also estimated for the breed. Primary data were collected from 84 Sahiwal rearing farmers and 84 crossbred rearing farmers spread over prominent breeding tract of Sahiwal in India. Various techniques such as Garrett's ranking, conjoint analysis, choice modelling, dichotomous choice CVM and cost analysis were applied to the collected data. Valuation of genetic traits of an indigenous dairy cattle breed comprised of following steps – compilation of attributes, identification of attributes, inclusion of monetary attributes, deciding the levels of attribute, generation of animal profiles, schedule designing, implementation of survey, data analysis and valuation while valuation of non-market benefits comprised of identification of attributes, classification of attributes, selection of attributes, inclusion of monetary attribute, deciding the levels of attributes, designing the choice sets, schedule designing, survey implementation, data analysis and valuation. High disease resistance and low milk yield were respectively the most important positive and negative attributes of the Sahiwal. Direct non-consumptive use value of Sahiwal occupied the major share of total economic value followed by indirect use value and existence value. Farmers in Sri Ganganagar and Fazilka assigned more value to the Sahiwal breed. Thus, more conservation efforts can be directed to these areas. Subsidy on purchase price, higher price for milk and ensured availability of pure breed figured out as the most essential requirement for rearing Sahiwal cattle. Total cost per conception in Sahiwal through use of cryopreserved semen was found to be ₹ 193.26. For encouraging the crossbred rearing farmers to rear Sahiwal an additional expenditure of ₹ 19,075 per animal per year is required. At present only 8% of total value of Sahiwal is being allocated for its conservation in the three states which varies from 0.15% in Rajasthan to 13.73% in Haryana. On an average, at least around 10 per cent of total value of the breed in each state can be allocated for its conservation.

Economic Analysis of Manufacturing Dairy Products: A Case Study of Hassan Cooperative Milk Plant in Karnataka

A co-operative dairy plant of Karnataka was selected for study to estimate costs and returns from manufacturing dairy products. The analysis of data collected during 2017-18 from Hassan Co-operative milk plant, revealed that the electricity consumption by plant was 2372 thousand units and the most of it was consumed by refrigeration section (44.5%). The total water utilisation of plant was 4.6 kilo litre per day and most of the water was used in cleaning and washing of crates and cans (31%). The permanent labour utilisation was found to be highest in Engineering, Security and Account sections (15.18% each) while the contractual labourers were found highest in packaging section. The use of steam was found highest in Ghee (0.12 kg/1000 ml). The cost of refrigeration was worked out to be ₹ 16.46 per ton and the highest refrigeration requirement was in Skimmed Milk Powder (SMP) (48.37 kilo calories/unit/hour). The costs of manufacturing Toned, Special Toned, Standard and UHT milks were ₹ 28.49, ₹ 34.32, ₹ 34.44 and ₹ 35.56 for 1000 ml of each product, respectively. On the other hand, the costs of Curd, Peda, Butter milk, Ghee, and SMP were observed to be ₹ 17.54/500g, ₹ 27.9/100g, ₹ 3.26/200 ml, ₹ 415.2/1000 ml, and 212.2/kg, respectively. The share of UHT in total revenue was highest (34.34%) and that of Peda was lowest (0.20%). The profit margin over cost was found to be highest in Butter Milk (38.04%) and it was lowest (1.75%) in case of SMP. All the products manufactured in the plant were above their break-even quantities and the margin of safety over the Break Even Point (BEP) was found the highest in Curd (86.95%) and the lowest in SMP (32.90%).

Comparison of Dairy Farming Income in Haryana and Gujarat

This study used secondary data at two different points of time, i.e., 2003 and 2013, a gap of ten years, to reveal changes in the real income from dairy farming in two dairy developed states of Haryana and Gujarat. It was found that income from dairy in both the states had increased for farmers of all farm-size categories. However, difference was observed in dairy farming incomes of similar farm-size categories while comparing that of Haryana with Gujarat. In Haryana, marginal farming households were earning 30% less than the state average of ₹ 2400 per month. On the other hand, in Gujarat, real monthly income increased from Rs.1000 per month to ₹ 2500 per month for marginal; and from ₹ 1100 per month to ₹ 3600 per month for small farming households. Situation was also found to have improved for scheduled groups in the state. Real monthly income from dairy increased from ₹ 800 per month to ₹ 2800 per month for scheduled tribes; and from ₹ 1000 per month to ₹ 1600 per month for scheduled castes.

While comparing real incomes from dairy in different regions in the two states, it was found that for three regions of Gujarat, viz., the South Eastern, Plains Northern, and Dry Areas, the income had more than doubled between 2003 and 2013. In Haryana, dairy was found to be more profitable in the Western region, where households earned 29% more than the state average. In eastern Haryana, households earned 41% less income from dairy than the state average. Nonetheless, real costs in dairy production in Haryana decreased by 5% and receipts increased by 3% between 2003 and 2013, making it a profitable enterprise. Both costs and receipts from dairy on an average increased in Gujarat during the same period. An exception to the trend of increasing costs was seen in the South Eastern region of the state, where costs witnessed a reduction but only by 0.8%. Since the average increase in costs

was 3.5% and the average increase in receipts was 3.3%, the net effect was that income from dairy was unable to achieve its full potential despite its co-operative backbone in the state.

Modelling of Rheological Behaviour of Paneer Using Machine Learning Approach

Intelligent modelling of rheological properties of paneer was investigated with Machine Learning (ML) algorithms vis-à-vis conventional regression methods. Data on textural properties of paneer (116 records) were generated in three batches and compiled, which included input parameters, i.e., Protein to Moisture ratio (P/M), Fat%, Minerals, pH as per actual observation in the sample and Temperature of coagulation [(T), °C (70,80,90)] with 3 replicates; and output parameters such as Hardness, Cohesiveness, Gumminess, Springiness, Adhesiveness, and Chewiness. The data were analysed for developing various intelligent predictive models using emerging ML algorithms such as Artificial Neural Network (ANN), Random Forest (RF) and Support Vector Regression (SVR) in contrast to conventional linear/nonlinear regression models to predict aforementioned output variables for the paneer samples. The open source WEKA software environment was used for implementing the models. A comparative analysis of the developed models' predictive accuracy (in terms of Root Mean Squared Error) is briefly summarised. The Hardness of paneer was better predicted by conventional regression model with accuracy as 9.5738 against ML models 10.3305 (ANN), 9.9015 (SVR) and 10.2016 (RF); Cohesiveness of paneer was better predicted by ML models with accuracy as 3.6399 (ANN), 4.252 (SVR) and 4.0248 (RF) against 3.9527 of the conventional regression model; Adhesiveness of paneer was better predicted by ML models with accuracy as 0.1239 (ANN), 0.176 (SVR) and 0.0954 (RF) against 0.1812 of the conventional regression model; Chewiness of paneer was better predicted by ML models with accuracy as 3.2703 (ANN), 3.7197 (SVR) and 3.6679 (RF) against 3.5686 of the conventional regression model. The results revealed that ML models and regression method were not able to predict output parameters, viz., Cohesiveness and Springiness. The values of both as well as RMSE were very low in these cases and could not be interpreted anything meaningfully from these results. The data were visualized through scatter plots to understand the pattern and found that the data values were scattered and didn't show any trend in these cases while for other parameters there was clear pattern of data. Evidently, the ML models exhibited relatively better predictive potential as compared to that of the conventional regression models in predicting all output parameters of textural properties except Hardness. Hence, it was deduced that the machine learning algorithms performed reasonably well for modelling textural properties of paneer in comparison with classical regression methods especially in case of nonlinear relationship of the data attributes.

Impact of Extension Services on Dairy Farming in Karnal District of Haryana

The study was conducted to explore the existing dairy farming practices, impact of extension services on productive and reproductive performance of animals, to delineate the socio-economic status of respondents and perceived opportunities & challenges in dairy farming animals. Therefore, data was gleaned from 120 dairy farmers from adopted and non-adopted village of Karnal district. It was found that herd size in adopted villages (12.43) was higher than non-adopted villages (5.98), respectively. Feed & fodder intake of cattle in adopted villages were found more than non-adopted villages. About 93.33% and 75.00% of respondents were using rubber mats for the animal in adopted and non-adopted villages, respectively. It was observed that full hand milking practices was mostly adopted by the most of the respondents. In the comparison of different parameters in the reproductive performance of animals in both villages, were found to be significant at 1.00% of level of significance in all categories of animals except in indigenous cattle, where calving interval & service period were obtained significant score at 5.00%. In comparison of productive performance in adopted and non-adopted villages, cross-bred cattle was showing a statistically significant result at 1.00% level of significance in all parameters. It was found that respondents of adopted villages belonged to high to medium level of socio-economic status category, whereas in non-adopted villages, respondents classify into low & high group of socio-economic status. Dairy farming was found as a source of regular income and employment to the households & expanding it as the commercial scale was recognized as the best strength & opportunity among others. Lack of regulated milk market, a male calf born as a hindrance as weakness in both adopted and non-adopted villages, respectively.

The present study showed that there was significant difference between adopted and non-adopted villages, so it could be nice opportunity for further extension intervention to demonstrate the potential technologies

Aspiration of under Graduate Dairy Students in Career Prospect in Dairy Sector

Aspiration of the under graduate dairy students in career prospect in dairy sector was operationalized as the orientation of under graduate students towards future career goals in different aspects of dairy sector which is essentially based on past experience, present status and future opportunities. A Three dimensional (Achievement aspiration; Leadership aspiration; and Educational aspiration) Career Aspiration Scale developed by Gregor & O'Brien, 2015 was used in the present study with suitable modification as well as reliability and reproducibility was verified and found to be Cronbach's α - 0.856 (Highly reliable) and Guttman's λ - 0.855 (highly reproducible),

respectively. Dairy graduates were having higher level of achievement aspiration followed by leadership aspiration and education aspiration particularly for the students of first and second year. Dairy graduates opted B. Tech (DT) for their higher studies due to placement opportunity in private dairy industry. Therefore, they were having higher level of achievement aspiration. Educational aspects of the future aspiration were suppressed over the achievement aspiration, which indicated that dairy graduates were highly motivated to join service immediately after graduation rather than higher study. The study also highlighted the sharp decline of the overall aspiration score from the first-year students to the third-year students. Students expressed that they admitted in B.Tech (DT) programme as this programme had the assurance of job in dairy-based company, but, lower pay package of their senior batches demotivated them. Therefore, overall aspiration score the third year students were comparatively lower than the other two years students.

Impact of Watershed Interventions on Agriculture in Chitradurga District of Karnataka

Watershed helps to harvest run-off water for its productive use in farming with active participation of community in drought prone areas. The study was undertaken to identify the impact of watershed interventions on agriculture in Chitradurga district of Karnataka which is prone to extreme drought. The data collected from 160 respondents revealed that majority of the respondents belonged to middle aged group (52.50%) and semi-medium land holders (56.88%). Adoption of soil and water conservation measures by the respondents in the treatment village was about 44.17% at higher level and 36.67% at medium level. People participation in planning, implementation and post-project maintenance immensely contributed to the success of the programme with their high (39.17%) and medium (41.67%) level of participation. The respondents perceived great improvement in soil erosion control, ground water level and cropping intensity. Watershed impact index was developed to assess the level of impact of watershed interventions which showed significant change in the social participation, extension contact, crop income increase, dairy income increase, control in soil erosion, adoption of technologies, cropping intensity change and milk yield. Farmers considered land disputes, lack of co-operation, political interference, favouritism, slow operation and inferior quality of work as the main constraints. The study suggested collective actions to promote high value and labour intensive crops, setting up customs hiring centers, watershed structures along the migration path of sheep and goat farmers and involvement of KVK services in watershed programs for enhancing the visibility of watershed interventions.

An Assessment of Perception and Practices of Water Footprint in Dairy Farming

The study was conducted in two Agro climatic zones namely Trans-Gangetic Plains Region and Western Dry Region. Both the zones were selected purposively based on well-established dairy sector and major contribution in milk production. Total of 216 respondents were selected from both the zones. The total water requirement (Direct and Indirect) for crossbred was 14.72 m³/animal/day followed by buffaloes and indigenous cow which was 13.82 m³/animal/day and 10.02 m³/animal/day, respectively. The water productivity for milk production for local cow was 1.90 m³/lit followed by buffaloes and cross bred, which was 1.72 m³/lit and 1.62 m³/lit, respectively. The prioritization of water conservation practices was done by using Garret ranking method in which the water conservation practices like "Lifesaving irrigation from water harvesting structure" was given first rank and garret score was 81.14 in Bikaner district as well as in Sonipat and Hisar district "Lifesaving irrigation if available" was given first rank and garret score was 86.18. It would be a useful tool for reducing water footprint of milk production, which could be achieved by educating the dairy farmers about the negative consequences of high consumptive water use.

Assessment of Flood-induced Vulnerability among Livestock-rearers of Odisha

In Odisha, disasters like flood have had been creating havoc among farmers repeatedly by washing out all the investments of a farmer; damaging the crop-fields, and adversely affecting the amount of feed and fodder available for the livestock. Animals, which are continuously standing in contaminated floodwater for longer periods are susceptible to various types of infections in their hooves and skin. Ultimately, all these adversely affected the livelihood of the livestock-rearers of Odisha. Therefore, the present study was undertaken to assess the flood-induced vulnerability among livestock-rearers of Odisha. Out of 30 Districts in Odisha, 17 are major flood-prone districts and 13 are minor-flood prone districts. From each category, one district was selected, randomly. Thus, Dhenkanal and Balasore districts were selected from minor-flood prone districts and major-flood prone districts, respectively. Primary data were collected from randomly selected 120 livestock-rearers of these two districts. Composite Livelihood Vulnerability to Flood Index (CLVFI), Perceived Impact to Flood Index (PIFI), Flood Adaptation Index (FAI) were developed exclusively for this study for the quantification of livelihood vulnerability to flood, perceived impact of flood, and adoption of adaptation strategies, respectively. The study revealed that livestock-rearers of the major flood-prone district (Balasore) were having comparatively lower adaptive capacity than the minor-flood prone districts (Dhenkanal). Villages located far away from the nearest markets and 'Veterinary Centres' were more vulnerable. Majority of the livestock-rearers perceived economic, social and environmental impact of

flood on their livelihood & livestock-rearing. Severity of perceived impact increased with increase in degree of flood-proneness. Livestock-rearers adopted several adaptation strategies to cope up with adverse impact of flood; and it was found that degree of adoption increases with the increase in flood-proneness.

An Economic Analysis of Cattle Insurance in Select Districts of Karnataka

The factors influencing the cattle insurance, willingness to pay for cattle insurance, the influence of cattle insurance on dairy farmers and the constraints of various stakeholders in adoption of cattle insurance were studied in Kolar, Shivamogga and Dharwad districts of Karnataka state. Majority of the farmers insured their cattle in Kolar (66.25 %) followed by Shivamogga (40.00 %) and Dharwad 17.50 (%) respectively. Majority of animals insured were crossbreds (87 %) followed by buffalo (9 %) and indigenous (4 %), due to their high market value and milk yield of crossbreds. The education level, number of crossbreds in herd, animal herd size and membership in dairy cooperatives had positive significant influence on adoption of cattle insurance. Highest net returns found for insured farmers in Kolar district (₹ 6.72 per litre) followed by Dharwad (₹ 5.38 per litre) and Shivamogga (₹ 4.03 per litre) as compared to non-insured farmers. In the case of indigenous cattle, a negative net returns across the district for both insured and non-insured farmers was observed. It is concluded that cattle insurance is one of the most risk mitigation strategies and would definitely help the farmers by stabilizing their income and insuring the valuable rural assets.

A Spatio-temporal Analysis of Bovine Population Dynamics, Milk Production Trends and Economic Contribution of Dairy Sector in India

The bovine population dynamics and growth trends in milk production across different states of India and the contribution of dairy sector to the livestock and agriculture gross domestic product across Indian states were analyzed. For all India, the share of CB in-milk population nearly doubled from 10 % in 2000 to 18% in 2018, while, in the case of buffalo, it was almost stagnant at 49%. With regard to Indigenous cattle, it decreased to 36 % from 43 % in 2000. The decomposition of milk production growth indicated that in India, the contribution of population & productivity was 42% and 39%, respectively, which varied across the regions. The contribution of dairy sector to the livestock sector GDP, it was found that for all India, it was 67 %, which varied from 48 % in Southern region to 78 % in Northern region. Contribution of livestock sector to agriculture and allied sector increased from 24% to 29% during period, indicating growing relevance of the sector in agrarian economy. The findings indicated that dairy sector has been sustaining strong annual growth. The study contributed a comprehensive and updated information on state-wise dairy statistics.

Forecasting of Milk Prices in Karnataka and Telangana States using Multivariate Time Series Models

The cost of feed and fodder has a significant bearing on profitability of milk production. Periodic calculation of cost of milk production is very difficult and time consuming. Hence, a time series database on milk prices and its related factors and price forecasting models would be useful tools for policymakers. The study included the objectives of analysis of the prices of feed, fodder, milk and milk products and developing models for forecasting of milk prices. The data pertained to the time period from 2005 to 2019. The compound annual growth rate (CAGR) of procurement prices of milk (real) during 2012-13 to 2018-19 was 2.23% in Karnataka whereas in Telangana it was 4.27%. However, the CAGR of feed prices during the period was over 6%. Forecasted procurement prices using Vector Autoregressive (VAR) model with selected endogenous (feed cost, labour wages, and previous year milk prices) suggested that the present procurement and retail prices of milk need to be revised to match with input costs of milk. VAR model with lag= 1, appeared to produce good short-term forecasts of milk prices and would be useful tools for the policy makers and planners.



EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING

Dairy Farmers' Willingness to Pay For Need-based Dairy Extension Services in Haryana

For estimation of effectiveness public extension services, an index was developed. It was found that commercial dairy farmers perceived higher effectiveness of the existing dairy extension services than the dairy farmers, but there was no significant difference in knowledge and adoption toward scientific dairy farming practices between them. Incomplete Order of Merit Rating as suggested by Garret was used to assess the degree of importance of the identified need-based dairy extension services for commercial dairy farmers. A total 26 dairy extension services were demanded by the commercial dairy farmers of the eastern Haryana amongst which three services for specialized breeding services, five for animal feeding purposes, seven for livestock production & management, six for healthcare related and five services towards marketing and extension services. Commercial dairy farmers had a highest demand for conventional dairy extension services like timely AI services, vaccination services and non-conventional extension service like demonstration-cum-training programme on Azola production and conservation. Overall perceived effectiveness index value of dairy extension services of dairy farmers & commercial dairy farmers were 0.55 and 0.57, respectively, which indicated moderate level satisfaction. It was also established that commercial dairy farmers' perceptions towards effectiveness of the dairy extension services were significantly higher than the dairy farmers at 1% level of significance. It could be concluded that commercial dairy farmers were the major beneficiary of the public extension system and efforts may be given for inclusive growth by providing equal opportunities for each categories of these farmers.

Sustainability of Rearing Deoni Cattle in Bidar district of Karnataka

The study was conducted in Bidar district of Karnataka on native breed Deoni cattle, which is well acclimatized to this dry region. A total of 120 dairy farmers were selected for data collection. The study revealed the fact that productive performance of Deoni cattle was reported as 3.07 ± 0.08 l/animal/day of average daily milk yield, 774.14 ± 12.71 l of lactation milk yield, 251.86 ± 8.60 days of lactation length, 04.01 ± 0.07 l of peak milk yield, and 42.71 ± 0.50 days required to reach peak milk yield. The reproductive performance of Deoni cattle was reported as 35.78 ± 0.10 months of age at puberty, 46.18 ± 0.08 months of age at first calving, 152.17 ± 21 days of service period, 162.63 ± 1.33 days of dry period, and 413.75 ± 0.77 days of calving interval. The average net profit earned by the respondents by rearing Deoni cattle was ₹ 5106.74/annum. More than 65% of the respondents were chosen informal marketing channels for selling of milk, 59.17% of the respondents used to sell milk near home, 61.67% had medium community relation, and 77.50% had medium access to resources and support services. Majority of the respondents had a medium level of economic sustainability (47.50%) of overall mean value 0.50, medium level of social sustainability (53.33%) of overall mean value 0.53, and a medium level of socio-economic sustainability (56.67%) of overall mean value 0.51. From the study, it was found that education, land holding, herd size, social participation, extension contact, and milk production were positively correlated with socio-economic sustainability.

Development of Dairy Tourism Model for Trans-Gangetic Plains of India

An attempt was made to provide dairy farmers with new income-generating activity. A total of 160 tourists were interviewed to assess their expectations from dairy tourism. Collectively, more than 60% of the respondent-tourists deemed all the identified expectations (assets, activities, and attractions) as important and very important. Tourist inclination towards Dairy tourism was assessed to understand their level of a mental tendency towards dairy tourism. Respondent-tourists were having a higher level of inclination towards dairy tourism. The dairy tourism model was developed by applying the partial least square- structural equation modelling. More than two-thirds (71.00 %) of the respondent-dairy farmers belonged to medium, through high to a very high level of the individual entrepreneurial orientation category. Dairy farmers' expectations were assessed to develop a model for dairy farmers' support for dairy tourism development. Collectively, more than 75.00% of the respondent-dairy farmers considered all the identified expectations from government and extension services as important and very important. Eight of the nine

hypothesized paths (H₁, H₂, H₃, H₄, H₅, H₆, H₇, H₈, and H₉) in the “dairy farmers’ support for dairy tourism development” model were statistically significant. The “dairy farmers’ support for dairy tourism development” model provided insights into the factors that are important to seek dairy farmers’ support for dairy tourism development. While studying the Dairy Entrepreneurship among Women SHGs under “Shri Kshethra Dharmasthala Rural Development Project” in Karnataka, it was revealed that majority of respondents possessed medium level of achievement motivation (50%), decision making ability (40%), risk bearing ability (56.67%), planning ability (65.83%), information seeking behaviour (36.67%), self confidence (56.67%) as well as marketing orientation (58.33%) and low level of innovativeness (50%), economic motivation (67.50%). Majority of the respondents (56.66%) had medium level of entrepreneurial behaviour.

Nurturing Latent Agro-animal based Entrepreneurship Among the Youth in Mewat District of Haryana

The study was conducted in the Nuh district, formerly known as Mewat district Mewat in Haryana is the most backward district of the county as per the NITI Aayog, (2018). Despite huge potential and prospects of agripreneurship development in the mewat district there are some important challenges in the process of agripreneurship development which needs to be taken care very seriously and timely. The challenges faced by the latent entrepreneurs in the study area were categories as financial, technical & managerial, marketing, production and labour and personal and general. In financial category indicated that high rent of the shop in main market, insufficient financial assistance by financial institutions and high interest rate in local area (*Sahookar*), it was reported by 89, 85 and 71% of the respondents, respectively. In case of technical and managerial constraints 90% of the respondents considered shop as livelihood not as business, whereas 87% reported lack of knowledge about government policies concerning taxes, regulations. Low price/margin for the produce/ products (96%), Competition in the market (68%), Lack of faith of consumers (64%) reported as constraints in marketing. High cost of equipment’s/ machinery reported by 73% respondents as major constraints in production and labour category. Respondents were asked to enlist the promising agriculture and dairy business in the Nuh district for the youth. Top 12 agro animal based enterprises suggested by the respondents were Rice biryani (vegetarian and non-vegetarians), dairy automation, Tea/ Coffee vending shops, sugarcane juice shops, fast food & cream shops, and agro based shops have the prospects of agripreneurship development in the Nuh district.

Effectiveness of Climate Resilient Agricultural Technologies in Coastal Low Lying Region of Kerala

Coastal low lying regions of Kerala are highly vulnerable to coastal erosion, inundation of saline water as well as high level of salinity. Therefore, Krishi Vigyan Kendra, Alappuzha introduced climate resilient agricultural technologies in coastal Kerala under the Technology Demonstration Component (TDC) of National Innovations on Climate Resilient Agriculture (NICRA) during the last few years. The present study was undertaken to evaluate effectiveness of climate resilient agricultural technologies introduced in coastal area as well as to appraise farmers’ satisfaction towards these technologies and to study farmers’ willingness to pay for these technologies. It was found that the beneficiaries of these technologies were having higher level of awareness regarding climate change and its impact on agriculture than the non-beneficiary farmers and adoption of these technologies had enhanced the adaptive capacity of the beneficiary farmers. In case of farmers’ satisfaction, the crop related technology “Site specific acidity-nutrient management through soil test based fertilizer, dolomite application and eco-friendly pest and disease management” and livestock related technology “Improved shelter for intensive goat rearing” were the most satisfied technologies with index value of 0.86. More than 85% of the farmers were willing to pay for all the selected technologies, except two technologies namely “Enerfat to reduce the incidence of ketosis and to increase the milk production” related to livestock rearing and “Intercropping short duration cassava (*Vellayani Hraswa*) in coconut gardens to overcome water logging” related to crop farming.

Perception of and Adaptation to Climate Change by the *Changpa* Pastoral Nomads of Leh-Ladakh

Changthang region of Ladakh of the Indian Himalaya is a unique agro-ecological region i.e. cold arid. Therefore, crop farming as well as livestock production system of this region is totally different from other parts of the Himalaya. The *Changpas* are the custodian of the *Changthangi* goat, producer of the finest cashmere wool or *Pashmina* in the world which is about 80% of the total production of India. But, in recent past, the *Changpa* pastoral community is facing newer challenges due to degradation of high altitude pastures, and subsequently shortage of feed and fodder resources. But, these challenges would transform into threats as a synergistic effect of impending climatic change in this region. Hence, it is also customary to assess their perception on changing climatic scenario and coping mechanisms before planning to make their livelihood more comfortable. Focused group discussions were organized across the *Changthang* to understand perception of *Changpa* pastoral nomads towards climate change.

They perceived changing climatic scenario as increased in temperature, decreased in precipitation and snowfall which was validated through secondary data. Impact of climate change as perceived by the *Changpa* pastoral nomads were delineated and these are drying up mid altitude streams; water scarcity for agricultural activity; degradation of pastures and grazing ground; reduced pastures area; soil salinity of pasture area; reduced palatability of pasture grasses; increased in wildlife and livestock conflict; increased in ecto-parasite infestation; deterioration in quality of *Pashmina* wool. Adaptation strategies followed by the *Changpa* pastoral nomads at Leh-Ladakh to cope up with changing climatic scenario were also documented which were change in pasture utilization strategy; special emphasis of fodder production and conservation; shifting towards small ruminant (particularly *Pashmina* goat) from large ruminant; proliferation of inter spp. hybridization of yak and cattle.

Survey Conducted for Identification of Factors Responsible for Facilitation of Women Led Entrepreneurship

A survey conducted with 162 respondents comprising development functionaries in different states of India to identify the factors responsible for facilitation of women led entrepreneurship in agriculture and allied enterprises revealed that women can undertake preparation of value added products on small/large scale (60%); commercial dairy farming (59.90%). About three-fourth (75.9%) of respondents considered direct sale of milk and milk products as best option for entrepreneurship under dairy marketing sector. Around 61% of respondents felt that patriarchal mindset of society constrain the women participation in agro-based entrepreneurship. Survey revealed that women with middle to higher secondary level of education showed more interest in starting dairy based value addition units. Among the women who underwent training, only 20% came forward for further training and starting of business ventures while others hesitate to move further due to various prevailing socio-economic hurdles. It was also observed that women groups could able to earn additional income ranging from ₹ 5,000 to ₹ 20,000 per month depending upon their networking and festive seasons.

Farmer Participatory Assessment of Cost Effective Solution for Management of Ticks and Mites in Dairy Animals: An Action Research in Haryana

The study was conducted in 6 villages of Haryana, two each in three different agro-climatic zones as classified by Haryana Kisan Aayog (HKA) to treat ticks using NIF poly-herbal medication. First demonstrations were conducted in six villages in Karnal, Jind and Bhiwani districts with 104 infested animals. The relevance and efficacy of polyherbal medication was shared in 13 farmer interaction meets in the respective villages. The indigenous polyherbal medicine was prepared and administered only for first three days in all the six villages. The medicine was administered two times both in morning and evening. Treatment solution (*Azadirachta indica*+ *Vitex negundo*) was provided for three days to the animals to treat the ticks and mites in dairy animals. After providing treatment, observations were recorded after 7th day, 14th day, 21st day and 28th day. It was found that for sample size (n=104) animals were found with rate of tick infestation upto 54.57 ± 4.56 [Mean \pm S.E] in dewlap regions. These animals upon treatment with the NIF open source technology was found to reduce to 34.57 ± 3.35 [Mean \pm S.E] by 48 hours. However by end of 56 hours, the reduction was 24.63 ± 2.34 [Mean \pm S.E]. These animals were relatively cured by end of 7th day of experimentation [15.97 ± 1.44]. The observation upto 28th day reflected that there was not much recurrent infestation as the rate was found to be 3.84 ± 0.29 . The percent efficacy of this preparation over infested animals was found to be 92.97% by 28th day of observation.

Perspective of Farmers on Precision Farming Technologies in North India

The present study was conducted in Punjab, Haryana and Himachal Pradesh. By using snowball sampling, a total of 270 farmers were interviewed. Majority of the user, planner and non user farmers considered benefit cost ratio and investment cost as the major pre-purchase consideration for precision farming technologies. Semi-automatic milking machine and protected cultivation alongwith drip irrigation system were the most common precision farming technologies adopted by the user farmers. Majority of the user farmers had high to moderate perceptual level towards precision farming technologies whereas, planners and non users were having moderate to high and low to moderate perceptual level, respectively. Majority of the user farmers had high to medium level of knowledge about precision farming technologies whereas, planner and non user farmers were having medium to high and low to medium level of knowledge, respectively. High yield obtained with precision farming technologies and non-availability of skilled labour was the major pull and push factor for adoption of precision farming technologies. Analysis of difference in cost of inputs used for capsicum production in 500 m² before and after adopting the protected cultivation along with drip system using paired-t test had shown a significant difference in the cost spent on seeds, plant protection chemicals, electricity and labour cost. It was found that for a small dairy unit (20 to 30 milch animals), medium dairy unit (30 to 50 milch animals) and a large dairy unit (50 to 70 milch animals), additional benefits due to adoption of semi-automatic milking machine were found to be 55331.72 ₹/ year, 80500.82 ₹/ year and 135082.11 ₹/ year, respectively.

Dairying amongst the *Brokpa* Transhumance Pastoral Nomads: An Ethnographic Study

Pastoralism is a complex food producing system. The *Brokpa*, community followed the zero-input yak and cattle-yak hybrid farming, but they were poorly documented. On the other hand, the migratory system of animal rearing by the pastoralists is unique, although it was not extensively highlighted. They had enriched indigenous techniques in milk processing and preservation. Therefore, the present study was undertaken to document the dairy husbandry practices followed by the *Brokpa* pastoral Nomads. Furthermore, this pastoral community exist in Arunachal Pradesh; and mostly reside in Tawang and West Kameng districts. Therefore, the Arunachal Pradesh State and Tawang district & West Kameng district were selected, purposively, followed by identification of migratory routes. From each district, four migratory routes were identified, Further, from each migratory route, 15 pastoralists were selected. Thus, a total of 120 pastoralists were selected as the respondents. Staying at alpine pastures during summer season was also extended. Feed and fodder scarcity, water problem and lack of proper shelter-home at high-altitude especially during winter were encountered. The economy of *Brokpa* was found to be based on selling of milk products such as *chhurpi*, *churkam* and butter. But, the young generations have lost their interest in yak-rearing & preparing of milk products, as the farming required highly skilled manpower, as perceived by respondents. As per health-care of animals was concerned, Leech-infestation, Bebesia, Tick-infestation and poor night vision were reported by the respondents. Besides, lack of basic amenities, viz. health-centre, school, banks etc. at higher altitude were also unseen.

Automation on Commercial Dairy Farms in North India: Farmers Perspective Appraisal

The present study was conducted in north India. North India consists of 7 states; out of these 7 states 5 namely Haryana, Punjab, Delhi, Rajasthan and Uttar Pradesh were selected for the study. The results of the study indicated that majority (72.00%) of the farmers considered ICAR, SAU, SVS personal; as the most important source of information to update the knowledge on dairy automation/ mechanization technologies followed by State departments and other private agencies. It was found that majority of the farmers considered benefit cost ratio as the most important with mean value of 2.88 prior to purchasing dairy automation/ mechanization technologies followed by total investment cost. Results revealed that the maximum number of the farmers (54.44%) was having a high perceptual level, while only 10% of the farmers were in the category of low perceptual level. However, 35.56% of the farmers were found in the category of having moderate perceptual level. The results indicated that 81 farmers were having moderate to high perceptual level towards dairy automation/ mechanization technologies. Pull factors are defined as the positive factors which attracts farmers to adopt the dairy automation/ mechanization technologies. It was apparent from the survey that, 'High yield obtained with dairy automation/ mechanization technologies' was found to be the first most important pull factor as expressed by the 86.66% of the user farmers. 'Saving of time and labour' was reported to be the second most important pull factor as perceived by 78.89% of the farmers. Whereas, 'Non availability of skilled labour required for conventional technologies' happens to be the major push factor as perceived by 84.44% of the farmers and it ranked first.

Capacity Building of Resource Poor Farmers in Paddy-wheat cum Dairy Production System through Farmer FIRST Programme under Irrigated Agro-Eco Region of Haryana

The extent of knowledge among the respondents were 86.00%, 80.00%, 73.68%, 86.25%, 83.33%, 85.00%, 83.33% and 83.33% regarding sowing time of fodder maize, Season of growing Dhaincha (summer), use of endo-parasites, use of ecto-parasite, use of Theilariosis vaccine, use of mineral mixture, feeding of bypass fat and use of balanced rationing, respectively. Majority of the farmers (90%) agreed that control of endo-parasites was very helpful in improvement of health of animals. Majority of the farmers (55%) revealed that it was helpful in milk production. The economic performance of endo parasitic control was observed in terms of increases in milk yield of 0.36 litres per animal per day, improvement in health, and increase in milk production. The economic performance of ecto parasitic control was observed in terms of increase in milk yield of 0.2 litres per animal per day and improvement in health also. The economic performance of Bypass fat was observed in terms of increases in milk yield of 1.20 litres per animal per day, returns from increased milk yield (₹ 4536.00 per three months), improvement in health (₹ 397.49 per three months), increase in value of animal (₹ 4333.33) and increase in reproductive efficiency (₹ 485.83 for three months). Estrus synchronization in dairy animals proved as a set tool to tackle anestrus problem and overall success rate of estrus synchronization protocol was found to be 77% in addition to it ovulation synchronization in dairy animals success rate was found to be 81.25% which is little better than estrus synchronization protocol.

Technological Needs and Manpower Requirement of Dairy Production and Processing Units in Karnataka

The technological needs of selected dairy production and processing units including manpower requirement of selected dairy production and processing units were assessed. The technology needs of dairy production units, were focused on good quality cost-effective feed (70%), farm level testing kits for mastitis detection (65%). The technology

needs of dairy processing units comprised cost-effective-eco-friendly packaging technology (60%) and utilisation of dairy by-products & management of dairy wastes (50%). The manpower requirement of dairy production units as expressed in the study area were unskilled / casual farm labour for dairy farm activities (70%), Vets / Para-Vets for breeding and health care services (50%) skilled supervisors and managers (25%). In case of dairy processing units, the manpower requirement was for operational level skilled manpower (60%), supervisory and managerial technical manpower (35%) and Food safety and quality assurance manpower (25%).

Dairy Extension Delivery System in Karnataka State: A Stakeholder Analysis

Survey data collected from 150 farmer respondents representing three districts of Karnataka State indicated that Department of Animal Husbandry & Veterinary Services plays a major role in providing basic animal husbandry breeding and health care services with a weighted mean score of 83.73 and 89.23, respectively. The Dairy Cooperative Societies are very effective in providing assured market facility and extending input services with a weighted mean score of 86.43 and 76.73, respectively. Whereas, other actors like private input dealers play an important role in providing input support services (50.34) and KVKs in providing dairy education services (18.71) for improved knowledge and skills on dairy farming. Further the effectiveness of different extension service providers were also analyzed in terms of provision of 'regular services' (84.37) and 'quality of services' (92.73) by DCSs were more effective; whereas, private input dealers were more effective in terms of extending 'timely services' (79.18) and department of animal husbandry was more effective in providing 'cost effective' services (96.00) to the farmers.

Farmers FIRST Project

Improved varieties of green fodder seeds of Fodder Maize, Hybrid Napier and Lucerne were introduced and distributed among the selected 25 farm beneficiaries of the project villages (Hosadurga, Vasappanadoddi, Balepura, Chikkalegowdanadoddi). Awareness Campaigns was organized on Balanced Feeding in Dairy Animals for the benefit of 100 farm families. Animal Health camps were organised for addressing Infertility and Reproductive problems and the dairy animals attended included 80 cases, treated for, Mineral Deficiency, Infertility, Mastitis and Deworming and first-aid. Institute interventions for mastitis management, included, screening of dairy animals for mastitis detection with CMT KITS (California Mastitis Test Kits). For hygienic milk production at farm level for benefit of the clientele groups two units of hand operated milking machine and dairy animal and shed cleaning units were provided for community use to SHG groups in two project villages.



RESEARCH PRIORITIZATION, MONITORING AND EVALUATION (PME)

Intensification of R&D activities at NDRI Karnal in recent years has necessitated introduction of professional management approach for managing research functions. PME Cell has been created at NDRI to coordinate and manage research activities and facilitate the decision support system with the following terms of reference:

- » To co-ordinate and synthesize the recommendations of QRT, RAC, IRC and Vision document of Institute and ICAR.
- » To recommend research priorities of the institution for short-listing researchable problems at Institute level.
- » To co-ordinate and arrange for annual monitoring of each on-going project and evaluation of completed projects through internal and external experts.
- » To co-ordinate and arrange for technology validation and impact assessment of successful technologies through internal and external experts.
- » Regularly sensitizing and capacity building of research managers and scientists through training programmes.
- » Maintaining a database on all publications, technologies developed, IPRs, consultancy projects undertaken in the past and on-going projects.

Research Advisory Committee (RAC)

The main functions of the RAC are:

- » To suggest research programmes based on national and global context in the thrust areas.
- » To review the research achievements of the Institute and to see that these are consistent with the mandate of the Institute.
- » The meeting of RAC of ICAR-NDRI, Karnal was held on April 29-30, 2019 under the chairmanship of Dr. M. L. Madan, Former, Deputy Director General (Animal Sciences), ICAR, New Delhi.

Institute Research Committee (IRC)

The key functions of Institute Research Committee (IRC) are to critically review the on-going and completed research projects, to consider the new research proposals and to advise on fostering of linkages between the groups/divisions of the Institute in respect of multi-disciplinary/multi-locational projects. The IRC meetings to evaluate the outcome of the completed research projects and to consider new research projects proposals were held on May 7-10, 2019 at NDRI, Karnal, and June 3, 2019 at SRS, Bengaluru and July 20, 2019 at ERS, Kalyani. The completed and new research projects were critically discussed in order to address current emerging issues of the dairy sector. The mid-term review of IRC projects of NDRI was taken up on October, 30-31, November, 1, 4 and 5, 2019 at NDRI, Karnal, December 7, 2019 at ERS, Kalyani and December 9, 2019 at SRS, Bengaluru. The meetings were conducted under the Chairmanship of Director and convened by Joint Director (Res.), NDRI, Karnal.

Project Information Management System (PIMS)

The PME Unit implemented on-line database/computerization of research projects under PIMS introduced in collaboration with IASRI. The unit acted as a nodal agency to facilitate and coordinate with PI of the project at IASRI, New Delhi and PIs of all the on-going and completed research projects at NDRI for smooth functioning of PIMS activity.

Screening and Evaluation of Concept Proposals of Externally Funded/ Contract/Consultancy Projects

PME Cell also screened and evaluated Externally Funded/Contract/Consultancy research proposals received from time to time with a view to facilitate Decision Support System. Fifteen PME cell meetings to consider the following Externally Funded/ Contract/Consultancy research projects proposals and other proposals were held on March 6, 2019; March 16, 2019; April 24, 2019; July 26, 2019; August 6, 2019; August 19, 2019; September 5, 2019; September 28, 2019; October 14, 2019; October 24, 2019; November 7, 2019; November 8, 2019; November 29, 2019; December 12, 2019; December 24, 2019. MoUs were also signed with the concerned organizations.

- » Consultancy Project proposal on “Calibration of portable NIR based device for various parameters with milk”.
- » Contract Project Proposal on “Estimation of production and utilization pattern of milk and milk products in India”.
- » DBT Project Proposal on “Development of ready to drink functional fermented milk for immune-compromised host” under the scheme ‘Biotechnology Industry Research Assistance Council (BIRAC).
- » DBT Project Proposal on “Fabrication of porcine origin cells by CRISPER/Cas9 towards lean meat production”.
- » Project proposal on “Development of functionalised traditional milk-based sweetmeats using 3-D food Printing Technology” in collaboration with Centre for Rural Development and Technology, IIT, Delhi.
- » Research project proposal on “Comparative analysis of human gut microbiome and metablome in diabetic and healthy subject” to be funded by DHR under Grant-in-aid Scheme .
- » Project proposal on “Survey on physico-chemical characteristics and nutritional status of ghee obtained from desi cows from different regions of India” to be funded by Verghese Kurien Centre of Excellence (VKCoE), IRMA.
- » Project proposal on “Development and validation of PCR base rapid diagnostic test for beta-Thalassaemia (beta globin gene mutation”.
- » Project proposal on “Functional modification of dairy-based ingredients using nanofibrills and their application in selected dairy products”.
- » Proposal for implementing of Dairy Business School in Karnal District for forwarding to DG, NIAM, Jaipur .
- » Concept Note of Project Proposal on “Efficacy of a preservative formulation developed by NDRI as an alternative to formalin for chemical analysis of milk and milk products” for submission to FSSAI.
- » Consultancy Research Proposal on “Formulation and characterization of whey protein enriched drinks”.
- » Advisory consultancy proposal to provide guidance to their employees of Vishakha Dairy, Visakhapatnam on recent trends of production, processing, packaging, quality improvement and interventions to minimize energy utilization of dairy plant.
- » Consultancy Project Proposal on “Performance evaluation of curd maker” to carry out performance evaluation of curd maker developed by Samsung India Pvt. Limited.
- » Contract Research Project Proposal on “Development of Laban drink like beverages” .
- » DBT Project Proposal on “Differential carriage of extracellular vesicles (EVs) in seminal plasma of cattle and buffalo bulls as a novel fertility indicator”.
- » Project Proposal on “Accelerating farmers’ prosperity through mastitis management of dairy animal in eastern Haryana: Application of integrated technological interventions” for its funding from Indian Council of Social Science Research (ICSSR), New Delhi.
- » Project Proposal on “Assessment Gaushalas in Southern India: A Multi-Dimensional Approach” for its funding from Indian Council of Social Science Research (ICSSR), New Delhi.
- » Project Proposal on “Development of analytical strategies to assess the quality of health supplements” for submission to Science and Engineering Research Board (SERB).
- » Project Proposal on “Process technology for instant mixes for varieties of payasam, kheer and phirni using dry crystallisation approach” for submission to Ministry of Food Processing Industries.
- » Project Proposal on “Development of Milk-Pigmented Rice based Novel Fermented Milks in Bioplastics” in response to a call from the Dept. of Science and Technology (DST), Govt of India under Indo-Sri Lanka Joint Research Programme in the area of Food Technology.
- » Project proposal on “Treatment of Mastitis, Metritis, Cancer and other Diseases of Livestock by Mesenchymal Stem Cell Therapy” for submission to Animal Husbandry & Dairying Department, Chandigarh under the scheme of Rashtriya Krishi Vikas Yojna (RKVY).
- » DBT Project Proposal on “Process for the preparation of lactose free skim milk powder with approaches to minimize maillard reaction.”
- » Concept note for the project on “Stability of fortificants (Vitamin A, D and folic acid) during processing and storage of dairy foods (milk and powdered milk), vegetable oils and wheat flour” for submission to DBT under Research Grant Call for “Food Fortification and Newer Technologies to Improve Bioavailability of Nutrients.”
- » Concept note for the project on “Potential of phosphopeptides prepared using sequential enzymatic hydrolysis for synthesis of peptide-multi mineral complex and its application in infant food as fortification” for submission to DBT under Research Grant Call for “Food Fortification and Newer Technologies to Improve Bioavailability of Nutrients.”
- » SUPRA-DST Project Proposal on “Molecular understanding of transient post vaccination fertility loss in breeding bulls”.
- » SUPRA-DST Project Proposal on “Metagenomics and metabolomics fingerprints of Milk from Indigenous dairy cattle”.
- » Request for inclusion of Gir herd of ICAR-NDRI under AICRP (GIR) at ICAR-CIRC, Meerut.
- » Request for pre-mature termination of the Consultancy Project on “ Evaluation and selection of corn hybrids for feed nutritional quality & feeding study on silage performance for digestibility, milk yield and compositions”.

- » Project Proposal on “Controlled release Nanodispensors of olfactory cues for management of lesser weevil, *Sitophilus oryzaea*”.
- » Project Proposal on “Comparison of iron fortified non-fermented and fermented milk on bioavailability of native dairy calcium and iron due to their interaction in food matrix”.
- » Project Proposal on “Vitamin A and D nanoemulsions: Preparation, characterization and application in milk and dahi”.
- » DBT Project Proposal on “Milk fortification with natural health promoting fatty acids, polyphenols and antioxidant functionality by dietary interventions in indigenous dairy animals”.
- » DBT Project Proposal on “Effect of micronutrients-polysaccharides complex enriched fermented dairy product on anti-aging associated proteome and microbiota changes in murine model”.
- » Draft MOU to be signed between ICAR-NDRI-Karnal and Samsung India Electronics Pvt. Ltd.
- » Technical Workshop and Training for Kemin Industries South Asia Pvt. Ltd .
- » Summer Training of 6 weeks to be organized at Animal Biotechnology Centre for under-graduate/post-graduate students of Biotechnology from Other Institutes and Universities of the Country.

Research Projects Database Management

A database through PIMS package of research projects was updated for all the research projects in operation during the year 2019. The database of research projects containing the targets and achievements of the preceding six months and targets fixed for the next six months was updated in HYPM package.

Technical Screening Committee Meetings

Technical Screening Committee constituted under the Chairmanship of Joint Director (Res.) evaluated the manuscripts for publication in the form of books, technical bulletins, manuals etc. Based on the recommendations of the committee, the manuscripts were also sent to outside experts for evaluation. The same were again evaluated in light of the comments received from experts and the contents of the publications got modified and subsequently got published as Institute publications. During the period under report, four meetings of Technical Screening Committee were held on February 22, 2019; March 20, 2019; September 20, 2019 and November 7, 2019.

Research Documentation and Publication

The PME Cell of the Institute is responsible for documentation and dissemination of research output through Annual Reports, Six Monthly Reports, Quarterly Reports, Monthly Reports, Technical Reports/Bulletins, etc. During the period under report, the following publications were prepared, edited and published through this cell:

- » Annual Report 2018-2019.
- » NDRI News Letter - a quarterly newsletter in English.
- » Director's Report for the 17th Convocation.
- » Research Projects (2019).
- » Institute Research Committee (IRC) Proceedings (2 No) under the identified research programmes of the Institute.
- » Research achievements of NDRI for inclusion in ICAR/DARE Annual Report 2019-2020.

Research Information Management

This Unit also prepared/consolidated/collated the following information for submission to the Council and other research and development organizations:

- » Prepared proceedings of the RAC meeting held from April 29-30, 2019 and submitted the same to the Chairman for approval.
- » Additional information with respect to NDRI, Karnal for inclusion in the ICAR/DARE Annual Report (2019-2020).
- » Information on major technologies developed/ transferred/ commercialized by NDRI through (ITMU) Unit of the Institute.
- » Information on research achievements of the Institute for the period of last ten years (2014-2017).
- » Mechanism of interaction with commodity boards with respect to NDRI, Karnal.
- » Inputs regarding the schematic interventions in the aspiration districts of NER.
- » Parliamentary committee of OBC regarding staff strength of KVK and ERS of ICAR-NDRI, Kalyani..
- » Implementation strategy of the action plan on the recommendations of inter-ministerial committee on doubling farmers' income.
- » 15th Finance Commission regarding a status note on most significant achievements in XIII Plan and future research thrust during the period 2020-25.

- » Rationalization of ICAR Institutions/ centres in prescribed format covering performance indicators with unit numbers/ quantity (kg/q./l).
- » Salient achievements of the Institute with effect from 27th June, 2019 for presentation in Governing Body Meeting at ICAR.
- » Achievements of the Institute regarding number of patents applied/ granted/number of agri-entrepreneurs incubated new and graduated / skills imparted to farmers/number of young farmers trained through training programmes, dissemination of superior male germplasm/technologies transferred to the dairy stake holders and farming community.
- » Justification of Continuation/Extension of public funded on- going schemes being carried out at ICAR-NDRI, Karnal.
- » Weekly/monthly reports on significant achievements/events of the Institute
- » Consolidated information on Action point "Integrated mobile apps" emerged during the meeting held on May 7, 2019 at Krishi Bhawan, New Delhi under the Chairmanship of Secretary, DARE & DG, ICAR.
- » Research activities carried out at Eastern Regional Station, Kalyani under Tribal Sub Plan (TSP) and North-Eastern Hill (NEH) Region.
- » Quarterly, Six monthly and Annual progress report with respect to implementation of Tribal Sub Plan (TSP) and North-Eastern Hill (NEH) Region schemes being carried out at Eastern Regional Station, Kalyani.
- » One page write up on research on development of low cost fodder and forage crops (like Moringa, Total Mixed Ration)/ research to bring about competitiveness in cost of production of milk, meat and eggs/ climate resilient indigenous breeds and identification of responsible Genes.
- » Information on PMO reference regarding various suggestions pertaining to Agriculture made by Prof. Richard Hay, Ex MP (Lok Sabha).
- » Six Monthly Progress Reports of the research achievements and targets for next six months.

Formulation of XIII Plan EFC Memo Document (2020-25)

- » Formulated EFC plan document under the theme No. 24: "Dairy Production & Technology" Sub-scheme 24(i) ICAR-NDRI, Karnal with total outlay of (Rs.28220.41) lakhs.
- » Prepared information regarding justification of continuation/extension of on-going schemes proposed under EFC document of the Institute for the period (2020-25) alongwith significant achievements of XIII Plan and year-wise outputs/deliverables of XIV Plan.

Research Co-ordination

Action Taken Reports: This Unit also prepared the following Action Taken Reports on recommendations emerged during the following meetings and submitted the same to the Animal Science Division of ICAR, New Delhi.

- » XXIV Meeting of ICAR Regional Committee-IV held on September 14-15, 2018 at IIMRG, Ranchi, Jharkhand and submitted the same to the Animal Science Division of ICAR, New Delhi.
- » Meeting of ICAR Regional Committee-IV held on November, 2-3, 2018 at ICAR-CSSRI, Karnal.
- » XXV Meeting of ICAR Regional Committee-VI held on February 4-5, 2019 at AAU Anand, Gujrat.
- » Action Taken Report (revised) on recommendation No. 41 on the development of a PCR based test kit for A1/ A2 milk differentiation made during ICAR-Regional Committee No. VI meeting held at AAU Anand, Gujrat from February 4-5, 2019.
- » Action Taken Report on the recommendation (The germplasm production facilities of the Institutes viz. ICAR-NDRI, Karnal, ICAR-IVRI, Izatnagar and ICAR- CIRB, Hisar should be duly accredited & converted into state-of-the-art facilities on the priority) finalized in the meeting of goal setting in ICAR held on April 16, 2019 and May 9, 2019 at the Council.
- » Review meeting of Agri-CRP on water project.
- » Proceedings of the ICAR- Directors conference held on January 31- February 1, 2019 at NASC Complex, New Delhi.
- » Minutes of the meeting held under the Chairmanship of Hon'ble Minister of Fisheries, Animal Husbandry & Dairying, Government of India held on June 17, 2019 at Krishi Bhawan, New Delhi.
- » Buffalo cloning programmes being carried out at ICAR-NDRI, Karnal and a revised project on goat (similar to Noori).
- » Status on e-Samiksha web portal covering the ATR on month wise/ activities wise calendar from November 26, 2019 to April 14, 2020 to be carried with farmers, SHGs, Youth clubs, Grampanchayat etc to propagate the flagship schemes of Govt. of India.
- » Action Taken Report on the observation(s) /suggestion(s) made in the cabinet meetings, Govt. of India.
- » Proceedings of the ICAR- Directors conference held on January 31- February 1, 2019 at NASC Complex, New Delhi.
- » Waste Management Systems being followed at the Institute.

Collation

This Unit also consolidated the following information sought by the Council:

- » Information on NDRI for ranking of Agricultural University.
- » Replies of Audit memo No. 1 (Sr. No. 47, 48, 49) dated September 16, 2019 for external audit party.
- » List of existing equipments costing more than 25 lakhs available at Animal Biotechnology Laboratory of the Institute.
- » Quarterly reports in terms of financial and physical targets of TSP activities being carried out at Eastern Campus, Kalyani.
- » NEH/TSP and women component for annual plan (2019-20).
- » Additional information on the slides sent earlier to DDG (AS) regarding the major achievements of NDRI during 2019.
- » Technologies transferred during last three years by NDRI.
- » Details of training programmes conducted by NDRI, Karnal for the period (2017-20).
- » Evidence of the representatives of the Ministry of Agriculture and Farmers' Welfare (DARE) in connection with examination of demand for grants (2020-21).
- » Evaluation of R & D programmes of the Institute.
- » Information on ICAR-NDRI, Karnal in prescribed format for presentation of DDG (AS) in ICAR review meeting.
- » Foreign research projects being carried out at ICAR-NDRI, Karnal in prescribed format.
- » Training programmes organized by All India Indigenous Cattle Organization, Indore.
- » Status report of various schemes runs by DARE.
- » Semen sexing research work being carried out at ICAR-NDRI, Karnal.
- » Information on activities taken-up at ICAR-NDRI, Karnal during last ten years (2009-14) & (2014-19).
- » National dialogue on land use for integrated livestock.
- » Information on revision of document on technologies developed by the ICAR Institutes for creation of wealth from waste.

Research Papers: Research papers submitted by the scientists were processed by the unit for publishing in various journals of National and International repute. In addition, a large number of abstracts of papers were also processed for presentation at various Seminars/ Symposia/Workshops/Conferences etc.

Parliament Questions: During the period under report, a total number of 27 parliament questions (Lok Sabha & Rajya Sabha) were attended.

Action Taken Report on 10 point agenda items in English and Hindi asked by Parliamentary Standing Committee on Agriculture on the performance review of NDRI and the same was submitted to Animal Science Division of the Council for onward submission to Parliamentary Standing Committee on Agriculture.

Promotion of National and International Linkages

The unit also acted as a catalyst to promote and strengthen linkages with other Institutions of national and international repute. Visits of international delegations and distinguished visitors at the national level were coordinated and through scientific interactions/deliberations, agenda for mutual collaboration was chalked out with a view to arrive at MoUs for promotion of research and educational endeavours. During the period, 16 visits were coordinated by the section.

Highlights of Major Activities of PME Unit

» In-house Research Projects	:	69
» New Research Projects	:	15
» Externally Funded Projects (National)	:	75
» Externally Funded Projects (International)	:	05
» Concept Notes of Extra-mural /Contract/ Consultancy Projects Screened	:	32
» IRC Meetings Convened and Co-ordinated	:	02
» Manuscripts of Technical Bulletins/Books Scrutinized/ Evaluated	:	06
» NDRI- Annual Report (2018-2019)	:	01
» Quarterly NDRI News Letter (4 Issues)	:	04
» Proceedings of IRC	:	02
» Proceedings of RAC	:	01
» Various Write-ups on NDRI	:	32
» Action Taken Reports/Status Reports	:	23
» Six Monthly Reports	:	02
» Parliament Questions Attended	:	27
» Monthly Reports	:	12
» Assessment Cases of Scientists Handled	:	03

Research Projects-2019-20 (In-house)

SL. No.	Project Title	PI
1.	Identification and targeted validation of unique proteins expressed during subclinical mastitis in Sahiwal and Karan Fries cattle (Lead Division: Animal Biotechnology Centre).	Sudarshan Kumar
2.	Genetic diversity and evaluation of Gir and Tharparkar cattle (Lead Division: Animal Genetics & Breeding).	Archana Verma
3.	Mastitis related bacterial antibiotic resistance pattern mapping in Karnal district (Lead Division: Animal Biotechnology).	S. De
4.	Characterization of beta-defensin genes and their relation with bull fertility (Lead Division: Animal Biotechnology).	Rakesh Kumar
5.	Influence of different growth promoting factors and macromolecules on <i>in vitro</i> development of cattle embryos (Lead Station: ERS, Kalyani).	S. K. Das
6.	Screening the role of seminal proteins and antioxidants on cryopreservation of buck semen (Lead Station: ERS, Kalyani).	M. Karunakaran
7.	Orchestrating reproduction in bovine: Crosstalk between phoenixin (PNX) and Kisspeptin (KiSSI) (Lead Station: ERS, Kalyani).	Mohan Mandal
8.	Genetic analysis of lactation persistency and its relationship with economic traits of crossbred cattle (Lead Station: ERS, Kalyani).	Ajoy Mandal
9.	Use of mesenchymal stem cells for treatment of mastitis and metritis in bovine (Lead Division: Animal Biotechnology Centre).	D. Malakar
10.	Production of CRISPR-Cas9 mediated β -lactoglobulin gene edited buffalo embryos (Lead Division: Animal Biotechnology Centre).	Satish Kumar
11.	Exploration of buffalo estrus specific salivary miRNA for LAMP color reaction development (Lead Division: Animal Biochemistry).	Suneel Kumar Onteru
12.	Genome-wide Association Studies to Identify SNPs for Lactation Persistency in Murrah buffalo using ddRAD approach (Lead Division: Animal Genetics and Breeding)	Vikas Vohra
13.	Assessment of Genetic Diversity and Trends for Performance Traits in Karan Fries Cattle- (Lead Division: Animal Genetics and Breeding)	S. M. Deb
14.	Exploring the use of Panchagavya and Mesenchymal Stem Cells for treatment of diabetes and cancer in rats (Lead Division: Animal Biotechnology Centre)	D. Malakar
15.	Development of suitable housing for dairy cows in lower Gangetic regions of West Bengal (Lead Station: ERS-Kalyani).	D. K. Mandal
16.	Studies on the causes of truncated lactation in Sahiwal cows (Lead Division: Animal Physiology).	A. K. Roy
17.	Development of suitable management measures to augment milk production, quality and udder health status in dairy cattle at lower Gangetic region (Lead Station: ERS, Kalyani).	Champak Bhakat
18.	Harnessing geothermal energy for cooling and Heating of Animal Shed (Lead Division: Livestock Production & Management).	Pawan Singh
19.	Effect of biostimulation on puberty and reproductive performance of dairy cattle and buffaloes (Lead Division: Livestock Production & Management).	M. L. Kamboj
20.	Elucidating the effect of Kisspeptin on onset of puberty and induction of estrus in Murrah buffaloes (Lead Division: Livestock Production & Management).	Nishant Kumar
21.	Development of dairy based integrated farming system for income enhancement of small farmers (Lead Division: Livestock Production & Management).	A. K. Mishra
22.	Effect of moringa supplementation on hastening puberty in buffalo heifers (Lead Division: Animal Physiology)	A. K. Roy
23.	Development of on-farm remote monitoring sensor device and its evaluation to predict parturition in cows (Lead Station: SRS, Bengaluru)	S. Jeyakumar

SL. No.	Project Title	PI
24.	Development of diversified fodder cum seed production systems for sustainable production and profit maximization of dairy farmers in Indo-Gangetic plains of India (Lead Division: Animal Nutrition).	Rajesh Kumar Meena
25.	Performance of fodder Maize and Cowpea intercropping followed by Oats for seed production under different nutrient management practices (Lead Division: Animal Nutrition).	Magan Singh
26.	Development and evaluation of additives for small scale silage production (Lead Division: Animal Nutrition).	Nitin Tyagi
27.	Nutritional evaluation of some aquatic macrophytes available in lower Gangetic Plain Region for utilization as ruminant feed resources- (Lead Station: ERS, Kalyani).	A. Chatterjee
28.	Evaluation of eastern Himalayan forest tree leaves as herbal feed additives to manipulate rumen fermentation for improving animal productivity (Lead Station: ERS, Kalyani).	A. Santra
29.	Evaluation of oat and berseem varieties under different agronomic practices vis-à-vis management of nitrate toxicity (Lead Division: Animal Nutrition).	Rakesh Kumar
30.	Crop diversification through fodder crops to maximization of fodder yield, profitability and sustain soil health (Lead Division: Animal Nutrition).	Hardev Ram
31.	Effect of organic nutrients management on different fodder crops (Lead Division: Animal Nutrition).	Sanjeev Kumar
32.	Formulation and evaluation of milk replacers for kids with special reference to black Bengal Goat (Lead Station: ERS, Kalyani).	M. K. Ghosh
33.	Evaluation of Seaweeds as novel products to augment ruminant production performance (Lead Division: Animal Nutrition)	Asit Das
34.	Therapeutic efficacy and immunomodulatory role of trisodium citrate and nano-minerals supplementation of subclinical mastitis in dairy cows (Lead Station: SRS, Bengaluru)	A. Manimaran
35.	Evaluation of osteogenic potential of milk derived peptides in osteoporosis model (Lead Division: Animal Biochemistry).	Suman Kapila
36.	Effect of probiotic administration on male reproductive parameters and semen characteristics in male mice model (Lead Division: Animal Biochemistry).	Gautam Kaul
37.	Technology of goat milk based functional beverage (Lead Division: Dairy Technology).	Heena Sharma
38.	Efficacy of buttermilk as an encapsulating agent for omega 3 fatty acids (Lead Division: Dairy Technology).	Manoj Kumar C. T.
39.	Technology of ricotta cheese from cow and buffalo milk system (Lead Division: Dairy Technology).	Sangita Ganguly
40.	Evaluation of coconut shell and areca sheath as packaging material for select dairy products (Lead Division: SRS, Bengaluru).	Sathish Kumar M. H.
41.	Elucidation of physico-chemical quality and nutraceutical properties of select indigenous cattle milk and ghee (Lead Station: SRS, Bengaluru).	Laxman Naik N.
42.	Preparation and evaluation of panchamrit for immunomodulation (Lead Division: Dairy Microbiology).	Shilpa Vij
43.	Protein profiling of milk from native indigenous breeds (cow and buffalo) in relation to their bioactive potential (Lead Division: Dairy Chemistry).	Rajesh Kumar
44.	Comparative evaluation of camel milk protein hydrolysates in combating diabetes (Lead Division: Animal Biochemistry).	Sunita Meena
45.	Project Title: Unveiling the microbial diversity of traditional Indian fermented milk product 'Dahi' through culturomic and metagenomic approaches (Lead Division: Dairy Microbiology)	Rashmi H. M.
46.	Development of nutria-cereal based protein rich probiotic dairy spreads and dips (Lead Station: SRS, Bengaluru)	Devaraja H. C.
47.	Preparation and characterization of micro/nano delivery system for 'green' carotenoids (Lead Division: Dairy Technology).	Neelam Upadhyay

SL. No.	Project Title	PI
48.	Development of automatic endo-exo thermal unit for dahi (Lead Division: Dairy Engineering).	Chitranayak
49.	Design and development of whey dewatering mechanism for intermediate Indian dairy product-chhana and chakka (Lead Division: Dairy Engineering).	Vairat Amita Dinkar
50.	Development of low cost mechanized stretching and portioning unit for mozzarella cheese production at small scale (Lead Division: Dairy Engineering).	P. Barnwal
51.	Development of electrochemical sensing system for automation of CIP in dairy plants (Lead Division: Dairy Engineering).	Ankit Deep
52.	Modelling of rheological behavior of selected dairy products using machine learning approach (Lead Division: DES&M).	A. P. Ruhil
53.	Technology of spray dried camel milk preparations (Lead Division: Dairy Technology).	A. K. Singh
54.	Preparation of polyphenols rich whey powder (Lead Division: Dairy Technology).	Manoj Kumar C. T.
55.	Development of low cost farm level milk cooling system (Lead Division: Dairy Engineering).	P. S. Minz
56.	Development of processed cheese from milk protein ingredients (Lead Division: Dairy Technology)	Yogesh Khetra
57.	Development of fermented whey with enhanced bioaccessible iron content (Lead Division: Dairy Technology)	Writdhama G Prasad
58.	Conducting polymer based rapid detection of microbial quality of milk (Lead Division: Dairy Microbiology).	Raghu H. V.
59.	Evaluation and validation of enzyme substrate based strip test for detection of sub clinical mastitis (Lead Division: Dairy Microbiology).	Chand Ram
60.	Determination of engineering properties of ghee in relation to frying oil quality management (Lead Division: Dairy Engineering).	P. S. Minz
61.	Development of analytical tools to assess quality of milk-protein based health supplements (Lead Division: Dairy Chemistry)	Rajan Sharma
62.	Quality evaluation of butter and Ghee prepared from Milk of indigenous and cross bred cattle (Lead Division: Dairy Chemistry)	Raman Seth
63.	Functional analysis of urine of indigenous vis-à-vis crossbred cows (Lead Station: SRS, Bengaluru)	Mamta
64.	Development & application of multi-market model for policy analysis in Indian Dairy Sector (Lead Division: DES&M).	B. S. Chandel
65.	Fodder crop management interventions through bio-fertilizers and bio-pesticide for sustainable dairy farming (Lead Station: ERS, Kalyani)	Asif Mohammad
66.	Modeling production and reproductive performance in dairy cattle using time series analysis (Lead Division: DES&M).	R. Malhotra
67.	Dairy farmers' willingness to pay for need-based dairy extension services in Haryana (Lead Division: Dairy Extension).	Sanchita Garai
68.	Automation on commercial dairy farm in North India: Farmers perspective appraisal (Lead Division: Dairy Extension).	H. R. Meena
69.	Dairy extension delivery system in Karnataka state: A stakeholder analysis (Lead Station: SRS, Bengaluru).	S. Subhash



EXTRA-MURAL FUNDING AND COLLABORATIONS

The scientists of the Institute maintained close liaison with various organizations to exchange information and acquire current and advanced knowledge in basic and applied fields of Dairy Science. The scientific competence and excellence of past performance in conducting various research programmes attracted funds from various organizations/ agencies.

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
International Collaborations					
1.	Regulation of the Gonadotrophin-ovarian Axis by Kisspeptin-KISSI/R System in Cattle and buffaloes.	Mohan Mandal	-	Indo-Egyptian Collaboration	2017-2019
2.	Assessment of antimicrobial residues and resistance in dairy animals in India.	Naresh Kumar	-	ICAR/ILRI	2017-2019
3.	Nutrient utilization, milk production and accretion of acetamide in milk of cows supplemented with ammoniated paddy straw pellet.	Bandla Srinivas	A. Manimaran	Michigan State University USA	2018-2019
4.	DOSA- Diagnostics for one health and user driven solutions for AMR.	Naresh Kumar	Raghu H. V.	Indo-UK DBT	2018-2021
5.	Molecular markers for improving reproduction of cattle and buffaloes (MMIRCB).	T. K. Datta	Rakesh Kumar, Dheer Singh, Suneel Onteru, Rubina K. Baithalu, A. K. Mohanty, Sudarshan Kumar, T. K. Mohanty and A. Kumaresan	Bill & Melinda Gates Foundation, USA	2018-2023
6.	The mechanism behind formation of coocable milk gels (GELCOOK)"	Yogesh Khetra	S. A. Hussain	University of Copenhagen, Denmark	2019-2022
National Collaborations					
7.	Scheme on Dairy Microbes under Network Mode.	S. K. Tomar	P.V. Behare	Network	2010-2022
8.	Water budgeting and improving water productivity livestock based farming.	Ashutosh	Mahendra Singh, Sunita Meena and Satish Kumar (CTO)	ICAR	2015-2020
9.	Network programme on veterinary type culture (VTC)-Rumen Microbes.	Sachin Kumar	Nitin Tyagi	ICAR	2009-2019
10.	Study of fodder crop assessment for dairy industry and potential areas of intensification of state level.	Magan Singh	V. K. Meena and Sanjiv Kumar	ISRO Application Centre, Ahmedabad	2016-2020
11.	Capacity building of resource for farmers in paddy-wheat cum dairy production system through Farmer First Programme.	Gopal Sankhala	B. S. Meena, H. R. Meena, S. S. Lathwal, Rakesh Kumar, Ajmer Singh, A. K. Singh, V. K. Pandita (IARI), Nitin Tyagi, Sanket Borad, Heena Sharma, Sachin and Omvir Singh (CTO)	ICAR	2016-2020

12.	Enriching knowledge-integrating technology and institutions for holistic village development in horticulture based farming system.	-	M. C. A. Devi and S. Subhash	ICAR	2016-2020
13.	Deciphering the circulating miRNAs from terminal stage pre-implantation embryos and placentomes for early detection of pregnancy in buffalo.	T. K. Datta	Rakesh Kumar and A. Kumaresan	DBT	2016-2019
14.	Upgradation of methane emission factors for Indian livestock and preparation of inventory of GHGs emission from Indian livestock.	Madhu Mohini	Gautam Mandal	MoE&F	2016-2019
15.	Preparation, characterization and application of Vitamin A & D loaded milk protein nano-complexes.	Sumit Arora	Vivek Sharma, A. K. Singh and Suman Kapila	DBT	2016-2019
16.	Role of probiotic lactobacilli in modulation of intestinal epithelium barrier functions and immune signals.	Rajeev Kapila	Suman Kapila and Ajay Dang	DBT	2016-2019
17.	Validation and standardization of the GC analysis method given in ISO 17678:2010 for determination of milk fat purity in bovine milk other than cow's milk.	Vivek Sharma	Sumit Arora and Priyanka S. Rao	FSSAI	2016-2019
18.	Synthetic Endometrium: A novel model to study early embryonic development and uterine health in ruminants.	Rubina K. Baithalu	M. K. Singh	NASF	2017-2019
19.	Utilization of crude glycerol obtained in biodiesel production as an alternate to glycogenic feed supplement for dairy cows.	B. Srinivas	S. N. Sondur (KSCST, IISc, Bengaluru)	ICAR-NDRI & KSCST, IISc, Bengaluru	2017-2019
20.	Whey protein-iron complexes: Preparation, characterization and application in biscuits, milk and dahi.	Kamal Gandhi	-	DST	2017-2019
21.	Identification and characterization of peptidic antagonist to the recombinant cysteine synthase protein of <i>Haemonchus Contortus</i> .	Vedamuthy G. V.	-	DST	2017-2019
22.	National facility on bioactive peptides from milk.	B. Surendra Nath	P. Heartwin Amaladhas, N. Laxmana Naik, F. M. E. Emerald, K. R. Ruckmani and Subramanian (Anna University)	DST	2017-2019
23.	Development of phytopharmaceutical product for bovine mastitis.	A. K. Dang	T. K. Mohanty	DBT	2017-2019
24.	Network project on buffalo improvement-Field Unit (CIRB Hisar).	I. D. Gupta	Pawan Singh, T. K. Mohanty, Mukesh Bhakat and Vikas Vohra	ICAR	2017-2020
25.	Network project on buffalo improvement-Institute herd (CIRB Hisar).	S. M. Deb	I. D. Gupta, Vikas Vohra and Om Vir Singh	Network	2017-2020
26.	Monitoring of drug residues and other environmental pollutants-outreach project of ICAR.	N. K. Goel	Raghu H. V	ICAR	2017-2020
27.	Indigenous breed programme (Sahiwal Cattle).	Anupma Mukherjee	Vikas Vohra, T. K. Mohanty, S. S. Lathwal and Mukesh Bhakat	ICAR	2017-2020
28.	National innovations in climate resilient Agriculture.	Anjali Aggarwal	Mahendra Singh, Parveen Kumar, S. S. Lathwal, A. K. Mohanty, Nishant Kumar, Rajan Sharma, K. Ponnusamy, Ritu Chakravarty and Nitin Tyagi	CRIDA (ICAR)	2017-2020

29.	Upliftment of socio-economic condition of tribal people through integrated livestock farming in north eastern hill region/eastern part of India –ICAR.	T. K. Dutta	M. K. Ghosh, S. K. Das, A. Santra, C. Bhakat, A. Chatterjee, D. K. Mandal, Mohan Mondal, M. Karunakaran, A. Mohammad, S. Rai and R. Behera	ICAR	2017-2020
30.	Incentivizing Research in Agriculture Project-V: Semen sexing in cattle (Component A).	T. K. Mohanty	A.K.Chakravarty, Mukesh Bhagat, A. Kumaresan, A. K. Gupta and Pawan Singh	ICAR	2017-2020
31.	Incentivizing Research in Agriculture-Project-V-Semen Sexing in Cattle (Component 'B').	A. K. Mohanty	Sudarshan Kumar	ICAR	2017-2020
32.	Conservation of indigenous pig of Assam through handmade coning technique.	Manoj K. Singh	-	DBT	2017-2020
33.	Genetic variability of milk protein and its characterization by proteomic approach in Indian goats.	S. De	Sunita Meena	NASF	2017-2020
34.	Synthesis, characterization and effect of graded levels of nano-selenium supplementation on the performance of broiler chicken.	A. K. Mohanty	Sudarshan Kumar	NASF	2017-2020
35.	Manipulation of rumen microbes using medicinal plants extract to enhance the nutraceutical value of milk as a functional food.	A. K. Tyagi	Sachin Kumar, Nitin Tyagi and Sumit Arora	DBT	2017-2020
36.	Cell wall components of probiotic lactobacilli as therapeutics for amelioration of inflammatory gut diseases.	Sunita Grover	Rashmi H. M, J. K. Kaushik and Diwas Pradhan	ICMR	2017-2020
37.	Bile responsive proteo-transcriptomics investigation of native probiotic strain lactobacillus helveticus MTCC 5463.	P.V. Behare	A.K. Mohanty, Sudarshan Kumar and J. B. Prajapati (AAU)	SERB	2017-2020
38.	Resveratrol and catechins-loaded niosomes and nanoparticles as delivery vehicles for fortification of milk products.	B. Surendra Nath	-	NASF	2017-2020
39.	Improving the livelihood through dairy farming in North Eastern region of India.	T. K. Dutta	M. K. Ghosh, S. K. Das, A. Santra, C. Bhakat, A. Mandal, A. Chatterjee, D. K. Mandal, Mohan Mondal, M. Karunakaran, A. Mohammad, S. Rai, R. Behera, Chander Dutt, S. Bandopadhyay (IVRI-ERS-Kolkata) Samiran Bandopadhyay (IVRI-ERS-Kolkata), S. Naskar (IVRI-ERS-Kolkata) and P. Dandapat (IVRI-ERS-Kolkata)	ICAR	2017-2020
40.	Improving livelihood of rural women through dairy based secondary agriculture.	K. Ponnusamy	G. S. Meena and Parvinder Sharma/ Latha Sabikhi	DST	2017-2020
41.	Development of edible antimicrobial packaging films for traditional dairy sweetmeats using metabolites of lactic and bacteria.	Diwas Pradhan	-	DST	2017-2020
42.	Tissue-specific mitochondrial biogenesis, transcriptomics and proteomics studies in buffalo.	Sadeesh E M	-	DST	2017-2020
43.	Proteo-genomic approach to elucidate productive and reproductive performance of Malnad Gidda, Deoni and Hallikar Breeds of Cattle.	K. P. Ramesha	M. A. Kataktalware, S. Jeyakumar, A. Manimaran, D. N. Das, A. Kumaresan, Keshavaprasad and H. Gowda	DAHVS, Karnataka	2017-2021

44.	Livelihood vulnerability to climate change among the Changpa Pastoral Nomads of Leh-Ladakh.	Sanjit Maiti	K. S. Kadian, Sanchita Garai and Mukesh Bhakat	ICSSR	2018-2019
45.	Field application of salivary fern pattern based estrus detection in buffaloes using foldscope.	Suneel K. Onteru	Dheer Singh and Vedamurthy	DBT	2018-2019
46.	Policy imperatives for promoting value chains of agricultural commodities in India.	K. Dixit	A. K. Singh, Gunjan Bhandari and A. K. Sharma	ICAR	2018-2020
47.	Amelioration of infertility in dairy cows through nutritional and biotechnological interventions.	M. Karunakaran	Asif Mohammad, M. K. Ghosh, Mohan Mondal and Ajay Mandal	DBT	2018-2020
48.	Genome editing of MFG8 and S100 genes in bovine mammary epithelial cells to understand their role in milk production.	A. K. Mohanty	Sudarshan Kumar, J. K. Kaushik and D. Malakar	SERB-DST	2018-2021
49.	Global transcriptome and miRNA analysis for deciphering reasons for low cloning efficiency in buffalo.	P. Palta	M. K. Singh	SERB-DST	2018-2021
50.	Surveillance of dairy products for Antibiotic resistant zoonotic bacterial pathogens under field conditions.	Raghu H. V.	Rashmi H.M	SERB-DST	2018-2021
51.	Improving the usability of buffalo spermatozoa by sperm surface remodeling and immune acceptance in female reproductive tract.	T. K. Dutta	Rakesh Kumar, S. M. Deb, T. K. Mohanty, J. K. Kaushik and Sarika (IASRI)	NASF/ICAR	2018-2021
52.	Valorization of industrially produced soybean and groundnut de-oiled meals/cakes by extraction, purification and production of protein isolates.	Suman Kapila (CCPI)	Sanket Borad	NASF/ICAR	2018-2021
53.	Development of a rapid and robust high throughput reporter cell-based bioassay for detection of xenobiotics in milk.	Dheer Singh (CCPI)	Suneel Kumar Onteru and Vedamurthy G. V.	NASF/ICAR	2018-2021
54.	Genomic and proteomics approaches to develop specific diagnostic assay for detection of estrus/silent estrus in buffaloes.	Rubina K. Baithalu	K. Mohanty, Sudarshan Kumar, T. K. Mohanty and A. Kumaresan	DBT	2018-2021
55.	Process development for production of dipeptidyl peptidase-IV (DPP-IV) inhibitory peptides from milk of Gir Cows and their encapsulation through double emulsification technique.	Satish Kumar M. H.	Latha Sabikhi, Yogesh Khetra, Shaik Abdul Hussain and Sunita Meena	NASF/ICAR	2018-2021
56.	Targeted immobilization of Y-bearing spermatozoa and modulation of oviduct milieu for skewing sex ratio towards female offspring in dairy cattle.	A. Kumaresan	Rakesh Kumar	NASF/ICAR	2018-2021
57.	Mitochondrial DNA Haplotypes as candidate biomarkers for prediction of reproductive efficiencies in buffalo.	Sadeesh E. M.	Sudarshan Kumar, S. De	DBT	2018-2021
58.	CRISPR/CAS9 guided functional analysis of genes regulation early embryonic in buffalo.	D. N. Das and D. Malakar	-	NASF	2018-2021
59.	Development of early pregnancy diagnostic assay through discovery of biomarkers in cattle and buffalo.	A.K. Mohanty and A. K. Dang	Rubina K. Baithalu, T. K. Mohanty, Sudarshan Kumar and Rajiv Kapila	DBT	2018-2021
60.	Production of multiple copies of elite buffalo bulls using animal cloning technology.	P. Palta	M. K. Singh, S. S. Lathwal and Subhash Chand T. O (Vety.)	NASF-ICAR	2018-2022
61.	Exploring the dairy industry needs for research and better employability of dairy graduates.	Richa Singh	Bimlesh Mann and Rajan Sharma	ICAR	2019-2020
62.	Farmer participatory assessment of cost effective solution for management of ticks and mites in dairy animals.	K. Ponnusamy	T. K. Mohanty and S. Raju	NIF-India	2019-2020
63.	Mastitis related antibiotic resistance pattern mapping in three districts of Haryana.	S. De	Rakesh Kumar and Raghu H	SERB-DST	2019-2022

64.	Modulating the immune-cellular components and their signaling molecules in bovine colostrum and milk after micro-nutrient interventions and their functional validation under ex-vivo and in vivo animal models.	K. Dang	Sujata Pandita, S. S. Lathwal and Rajeev Kapila	DBT	2019-2022
65.	Understanding the aetiology of infertility associated with prolonged follicle dominance in bovine and its therapeutic management.	A. Kumaresan	Jeyakumar S, A. Manimaran, and K. P. Ramesha	DBT	2018-2021
66.	Understanding extracellular vesicles (EVs) protein cargo of seminal plasma as a reason for poor fertility in cattle & buffalo bulls.	Rakesh Kumar	T. K. Datta and Mukesh Bhakat	SERB-DST	2019-21
67.	Nurturing latent Agro-animal based entrepreneurship among the youth in Mewat district of Haryana.	H. R. Meena	K. S. Kadian, B. S. Meena and Gunjan Bhandari	RKVY-RAFTAAR	2019-
68.	Development of immunomodulatory exopolysaccharides containing healthy fermented dairy foods.	Pradip Behare	S. K. Tomar, S. A. Hussain and Suman Kapila	MOFPI	2019-21
69.	Formulating coping up strategies for extreme weather events in Sundarbans region through livestock based integrated Farming System: A societal perspective.	Asif Mohammad	T. K. Dutta and A. Chatterjee	ICSSR	2019-2021
70.	Evaluation and impact of dairy farmer collectives in Gujarat: A study in Saurashtra and Kutchh Regions.	R. Malhotra	Udita Chaudhary, A. K. Dixit and Gunjan Bhandari	IRMA	2019-2022
71.	Cow dung processing and its conversion to bio-fortified fertilizer: A pilot study- National Fertilizer Limited (An Undertaking of Govt. of India), Noida.	K.P. Ramesha	Mukund A. Katakaware, Menon Rekha Ravindran and S. Jeyakumar	National Fertilizer Limited (An Undertaking of Govt. of India), Noida	2018- 2021
72.	Relevance of dairy as a source of income for farmers in Haryana and Gujarat.	Udita Chaudhary	Vishat Thorat (Navarsi Agriculture University, Gujarat)	V K C o E a t IRMA	Jan, 2019-Dec, 2019
73.	Studies on iodine deficiency in livestock and its management.	Chander Datt-CCPI	Lead Centre: SKUAST, Jammu	D S T , N e w Delhi	2019-2020
74.	Salinity and drought stress adaptability of cactus (Opuntia ficus-indica).	Chander Datt-CCPI	Lead Centre: CSSRI-Karnal	D S T , N e w Delhi	2019-2021
75.	Development of calcium enriched high milk protein powder for convenience formulations of traditional dairy products.	Sumit Arora	Vivek Sharma, A. K. Singh and G. S. Meena	MOFPI	2019-2021
76.	Identifying factors affecting health behaviour of tribes of Uttarakhand and developing dairy based interventions to improve their health and livelihood status.	Nishant Kumar	Pawan Singh, S. S. Lathwal, M. L. Kamboj, T. K. Mohanty and K. Ponnusamy	ICMR	2019-2021
77.	Empowering farmers through selective interventions in salt affected agroecosystems of Ghaghar Plains (Farmers FIRST Programme, Funded by ICAR).	Sohanvir Singh CCPI	K. Ponnusamy	ICAR	2018-2021
78.	Characterization of Kisspeptin and Kiss1 gene during reproductive cyclicity and pregnancy in Assam local and crossbred cows.	Mohan Mandal	M. Karunakaran	DBT	2017-2020
79.	Fitness Black Box: Deciphering the Ovar-MHC variability in sheep breeds of India.	G. R. Gowane	-	SERB	2019-2021
80.	Evaluation of the efficacy of oral probiotics supplementation in children with Autism Spectrum disorders (ASDs): A randomized double blind, placebo controlled trial.	Rashmi H.M	Sunita Grover	AIIMS Delhi	2019-2021
81.	Design of functional traditional sweetmeats through 3-D Food Printing.	Kaushik Khamrui	Writdhaa Prasad	IIT Delhi/ICAR Collaboration	2019-2020
82.	Mitigation of stubble burning through custom hiring centres for agricultural machinery in trans genetic plain region of India.	H. R. Meena	K. S. Kadian, B. S. Meena and Gopal Sankhala	ICSSR, New Delhi	2019-2021

INTELLECTUAL PROPERTY MANAGEMENT

Institute Technology Management Unit (ITMU)

Institute Technology Management Unit at NDRI is managed by Institute Technology Management Committee (ITMC). ITMC is the highest body which takes important decisions for the intellectual property management at NDRI viz., filing of patents, approval of the technology for commercialization, pricing of the technologies ready for commercialization etc. ITMC is chaired by the Director.

ITMC Meetings Conducted

- 41st ITMC meeting was held on January 16, 2019
- 42nd ITMC meeting was held on July 6, 2019
- 43rd ITMC meeting was held on November 22, 2019

ITMC meetings were held to discuss pricing of technologies and examination of patent applications for their novelty and commercial applicability before filing them.

Seven technologies developed at the Institute were transferred to 5 commercial houses through 7 different license agreements during 2019 and thereby, earning a total of Rs. 20.60 Lakhs (excluding Service Tax) for the Institute through technology transfer fee.

Technologies Approved for Commercialization (2019)

S. No.	Technology Developed	Inventors
1.	Process Technology for Palada Payasam Mix Preparation by Dry Crystallization Method in a Mechanical Unit	Menon Rekha Ravindra, B. Surendra Nath and Gajanan P. Deshmukh
2.	Indigenous Probiotic <i>Lactobacillus rhamnosus</i> NCDC 610	S. K. Tomar, Pradip Vishu Behare, Sandip Basu and A. K. Singh
3.	Cholesterol Binding Indigenous Probiotic <i>Lactobacillus fermentum</i> NCDC 400 strain	Pradip Vishu Behare, Mrignyani Kolhekar, S. K. Tomar and A. K. Mohanty
4.	Food Colour Measurement System Colour Desk D1	P. S. Minz, I. K. Sawhney, Chitranayak Sinha and A. K. Dodeja
5.	Development of Whey Dewatering Mechanism for Chhanna	Vairat Amita Dinkar, Chitranayak Sinha, P. S. Minz, K. J. Dabas and Khushbu Kumari
6.	Development of Automatic Endo-exo Thermal Unit for Dahi	Chitranayak Sinha, K. J. Dabas, P. S. Minz, Vairat Amita Dinkar and Khushbu Kumari
7.	Production of Milk Protein Concentrate 60 (MPC60), a High Protein Low Lactose Powder from Buffalo Milk	Ganga Sahay Meena, Ashwajit Tejram Patil, Neelam Upadhyay, Yogesh Khetra, Sanket G .Borad and Ashish Kumar Singh
8.	Process Optimization of Cow Milk Protein Concentrate 70 (MPC70) with Improved Functional Properties	Ganga Sahay Meena, Ashish Kumar Singh and Vijay Kumar Gupta
9.	Technology of Long Life Kheer Mohan	Ganga Sahay Meena, Gaurav, Yogesh Khetra and Raghu H V
10.	Technology of High Protein Ice Cream	Shaik Abdul Hussain, Suchismita Roy, Writdhama Prasad and Yogesh Khetra
11.	Technology of Fruit Yoghurt	B. C. Ghosh, Satish Kumar, Monika Sharma, Devaraja H. C. and K. Jayaraj Rao
12.	Spray Dried Milk-malted Millet Beverage Mix	P Heartwin Amaladhas, F, Magdaline Eljeeva Emerald and B. Srendra Nath
13.	Hybrid Baking Oven	F Magdaline Eljeeva Emerald, P Heartwin Amaladhas, M. Manjunatha and B. C. Ghosh
14.	Technology for Omega-3 Fatty Acid Fortified Curd and Flavoured Milk	Monika Sharma, Devaraja H.C., Pramod Bhivasen Tambade, B. C. Ghosh and Laxmana Naik N.

S. No.	Technology Developed	Inventors
15.	Green Technology for Texture Modification of Ghee	B. Surendra Nath and Laxmana Naik
16.	Functional Butter with Hypocholesterolemic Attributes	Devaraja H. C., Kaushik Khamrui, Satish Kumar, Suman Kapila and Rajan Sharma
17.	Probiotic Bacterial Culture to Augment Neonatal Health of Calves	Sachin Kumar, Amrisha Kumar Tyagi, Rashmi and Nitin Tyagi

Technologies Transferred (2019)

S. No	Technology	Inventors	Date of Signing of MoU	Revenue Generated (Rs.)	Name of the Firm
1.	Spore Based Kit for Detection of Antibiotic Residues in Milk at Dairy Farm	Naresh Kumar, A. Khan, S. Arora, P. K. Sharma and Roghu H.V., M. Balhara and S. Shaikh	13.03.2019	Rs. 3.00 Lakhs + 18% GST	Delmos Research Private Limited, Haryana
2.	Technology of Sour Dahi Using Prolific Acidifying Lactic Cultures	Pradip V. Behare, Sudhir Kumar Tomar and Surjit Mandal	19.03.2019	Rs. 1.50 Lakhs + 18 % GST	Lacpro Biotech Private Limited, Pune
3.	Misti Doi With Fast Acidifying High Sugar Tolerating Lactic Culture(S)	Surjit Mandal, Sudhir Kumar Tomar and Pradip V. Behare	19.03.2019	Rs. 1.60 Lakhs +18% GST	Lacpro Biotech Private Limited, Pune
4.	Process Technology For Palada Payasam Mix Preparation By Dry Crystallization Method In A Mechanical Unit	Menon Rekha Ravindra, B. Surendra Nath and Ganjanan P. Deshmukh	28.03.2019	Rs. 3.00 Lakhs +18% GST	Manjilas Food Tech Private Limited, Kerala
5.	Paper Strip Assay for Rapid Detection Of Pesticide Residues	Naresh Kumar, N. Tehri, R. Gopaul, P. K. Sharma and Roghu HV.	01.07.2019	Rs 5.00 Lakhs +18% GST	Floreecer Services Private Limited , New Delhi
6.	Paper Strip Based Assay For Detection Of Antibiotic Residues In Milk	Naresh Kumar, S. P. Shukla R. Suman, P. K. Sharma and Raghu HV	01.07.2019	Rs 5.00 Lakhs +18% GST	
7.	Technology for Preparation of Self-Stable, Nutritionally Rich Smoothies using Dairy and Non-Dairy Ingredients	Sathish Kumar M. H., Latha Sabikhi, D. K. Thompkinson, Devaraja H. C. and Sumit Arora	17.12.2019	Rs. 1.50 Lakhs +18% GST	Zest Fresh Foods, Andhra Pradesh
		Total		Rs. 20.60 Lakhs excluding GST	

Patents Filed (2019)

S. No	Title of Patent	Inventors	Date of Filing	Application Number
	A Preservative formulation for Milk and Milk Product Samples Stored for Analytical Purpose	Richa Singh, Bimlesh Mann, Sumit Arora, Mitul Bumbadiya, Priyanka Singh Rao and Diwas Preadhan	9.8.2019	201911032383
	Gluten-free Pasta Dough Composition and Method of Preparation Thereof	Manoj Kumar C.T., Latha Sabikhi and Ashish Kumar Singh	25.11.2019	TEMP/E-1/50963/2019-DEL



Request for Examination (2019)

S. No	Application/Registration No.	Name of Innovation/Technology/ Product/ Variety	Date of Filing/Registration	Application Granted/Registered	Remarks*
1.	201611018434	Rapid Spores-enzyme Based Miniaturised Assay (s) For Detection of Pesticide Residues	15.02.2019	----	Submission of Request for Examination
2.	201711023424	Preparation of Buffalo Milk Casein Hydrolysates with Enriched Antioxidative Peptides and the Process thereof	23.07.2019	----	Submission of Request for Examination

Patents Granted (2019)

S. No	Title of Patent	Inventors	Date of Filing	Patent Grant No.	Grant date
1.	A Process for Preparation of Feta Cheese from Buffalo Milk Using Microbial Rennet (128/DEL/2011)	Sanjeev Kumar and S. K. Kanawjia	19/01/2011	305768	16/01/2019
2.	Process for Shelf Stable Low -fat Tomato-whey Soup (1714/DEL/2006)	Sudhir Singh, Kamavaram Sudheer, Alok Jha, Ashoke Ambalal Patel and Girdhari Ramdass Patil	26/07/2006	306128	23/01/2019
3.	Spectrophotometric Method of Estimation of Tannin Acyl Hydrolase Activity in Rumen digesta (1120/DEL/2005)	Keshab Barman and S. N. Rai	04/05/2005	310997	09/04/2019
4.	A Formulation and Process for Ready-to-reconstitute Basundimix (2226/DEL/2007)	Prateek Sharma, R. R. B. Singh, Girdhari Ramdas Patil and Ashok Ambalala Patel	24/10/2007	311005	09/04/2019
5.	Casein Hydrolysates Rich in Caseinophopeptides (331/DEL/2013)	Bimlesh Mann, Prerna Saini and Rajesh Kumar	05/02/2013	319794	04/09/2019
6.	Aptamers Specific for aflatoxin M1 and Aflatoxin B1 (1864/DEL/2013)	Shilpi Malhotra, Y. S. Rajput and Rajan Sharma	25/06/2013	324848	11/11/2019
7.	A Qualitative and Quantitative Test for Detection of Anionic Detergent in Milk and like (3677/DEL/2011)	Amit K. Barui, Rajan Sharma and Y. S. Rajput	16/12/2011	325924	27/11/2019
8.	Real Time Detection of <i>Enterococci</i> in Dairy Foods using Spore Germination Based Bioassay also Licensed to M/s. Neugen Diagnostic Pvt. Ltd Hyderabad in 2013 with Revenue Generation of 3.5 lakhs (119/DEL/2012)	Gurpreet Kaur, Naresh Kumar, G. Thakur, Raghu, H.V., N. Singh, V. K. Singh, and Raghav, N.	12/01/2012	325986	27/11/2019



Release of ICAR-NDRI technology compendium 2019-2020 by Dr. Trilochan Mohapatra, Secretary (DARE) & Director General (ICAR) during workshop and annual review meeting of ABIs/ ZTMUs/ ITMUs held on October 4-5, 2019 at NASC Complex, New Delhi.



ENTREPRENEURSHIP DEVELOPMENT AND BUSINESS INCUBATION ACTIVITIES AND CONSULTANCY SERVICES

Business Planning and Development (BPD) Unit of ICAR-National Dairy Research Institute, Karnal acts as nodal point for the execution of various professional service functions (PFS) of ICAR.

Contract Research

Institute is engaged in active collaboration with industry, government agencies and other stakeholders for executing the research projects funded by them. In year 2019-20, one contract research projects on "Estimation of production and utilization pattern of milk and milk products in India" funded by the Ministry of Statistics and Plan Implementation, Government of India was initiated. Two projects from the previous year were completed during the period.

Consultancy Projects

Institute is offering both general and advisory consultancy to individuals or organization on various aspects of dairy production, processing and management. Four consultancy assignments were undertaken by the scientists of the Institute during the period. These assignments were advisory in nature and clients include Shri Vijaya Vishakha Milk Producers' Company Limited, Vishakhapatnam, Haryana State Industrial and Infrastructure Development Corporation Limited and two start-up companies. A consultancy project was taken-up with Samsung India on "Performance Evaluation of Curd Maker" for a period of three months.

Capacity Building Programmes

BPD Unit is also coordinated and organized short and long-term training programmes for entrepreneurs, students from other universities and educational institutions, officials from industry and government organization and other development agencies. A total number of 12 Entrepreneurship Development Programmes (EDPs) were organized in the area of commercial dairy farming and milk processing & value addition for 194 participants across the country. For promotion of entrepreneurship, 10 days specialized training programme on "Practical Training on Commercial Dairy Farming and Milk Processing" was organized with the aim to impart the theoretical and practical knowledge about the rearing of dairy animals and effective management practices for running it as enterprise for 16 army personnel. No fee was charged from the participants and all arrangements on their boarding and lodging were part of Social Outreach activity of SINED (TBI). Animal Biotechnology Centre of the Institute organized a one month "Summer Training on Biotechnological Techniques" from June 1-30, 2019 for 15 students from 10 different universities of the country on various techniques including PCR, RT-PCR, A one month training programme was organized on "Food Processing Technologies" by the Dairy Technology Division of the institute from June 1-30, 2019 for 22 students from 13 universities and colleges. A specialized training programme on "Advanced Feed Technologies" was organized for 15 employees of M/S Kemin Industries South Asia Pvt., Ltd., Chennai by the Animal Nutrition Division of the Institute. A total number of 52 students from other universities and educational organization were imparted training from 1 to 6 months duration in various divisions and sections of the Institute during the period.

Contract Services

Institute assisted stakeholders through offering the services of analysis, supply of testing kits, cultures and custom hiring of equipment. Through contract services institute served to 85 organization, individuals and industries.

Entrepreneurship Promotion among the Students of ICAR-National Dairy Research Institute

As per the suggestion of 5th Dean Committee, UG students were provided mentor support under Student Ready Programme for development of technological packages for value added dairy products. Six teams consisting of 8 students were asked to develop a business model for new range of innovative dairy products under the mentorship

of expert faculty. The students developed the technology and also business canvas model for chhana based Muffins, Goat milk cheese, Malt ice cream/Kulfi, Fruit barfi, Ghee residue based chocolate barfi was developed. The students conducted consumer acceptance studies and based on the feedback formulation and processing parameters were also modified. The aim of the training was to inculcate the research based developmental activities and business acumen among the student fraternity.

Achievements of Incubatees of SINED TBI

- Mrs. Japna Rishi Kaushik, Co-Founder, Hungry Foal won Time She Unltd Award-2019 in the food category. The company has micronutrient enriched energy bars, proteins bars, muffins and certain savoury items in their portfolio. The award was launched to promote the entrepreneurs and startups in various segments and more than 5000 applications were received. An eminent jury has selected entrepreneurs across the nation for their exemplary entrepreneurial success.
- Delmos Pvt. Ltd. Gurugram incubatee company of SINED (TBI), NDRI, Karnal has won "Eat Right Startup Award" and cash prize of Rs. 50,000/- only in the "Food Testing" category organized by FSSAI under "Food Innovation Network with the aim to encourage "Eat Right India Movement" The award was given by Shri Ashwini Kumar Choubey, Minister of State for Health & Family Welfare and Mr. Pawan Agarwal, CEO, FSSAI.
- Delmos Pvt. Ltd. Gurugram has been selected amongst the tops 10 startups by Indigramlabs and recommended for Rs. 4.0 Lakh grant from the Ministry of Micro, Small and Medium Enterprises, Government of India under ASPIRE scheme.

SUCCESS STORIES OF INCUBATEES

1. Aadvik Foods & Products Pvt. Ltd, Bikaner

Aadvik Foods, is India's first company to process, market camel milk and its products in the country and abroad. In a short span of 3 years, it has acquired over 2, 50,000 customers who buy camel milk on a daily basis. One of the prime objectives of company is to dispel the gap between the camel milk and its consumers. In a pursuit to diversify their product portfolio, company joined as Incubatee Company TBI, NDRI, Karnal in 2018 to carry out the core Research and Development in camel milk and goat milk products. The company has launched camel milk based flavoured powder and goat milk powder in the market. The other products which are in pipeline include cheeses from goat and camel milk, flavoured drink and yoghurt. The company has established two processing facilities in Rajasthan and Gujarat states. They have also conducted market survey of goat and camel milk based product in export market and received an overwhelming response.

2. Milkybay, Gurgaon



<i>Milkybay, Gurgaon, Established in 2017</i>			
Commercial Dairy Farming: Trainee at 14-19 September, 2015			
Father's Name	Vivek Bhatnagar	City	Gurgaon
Age	27	State	Haryana
Education	<i>B.Sc (H) Food Technology, MBA – Agriculture and Food Business</i>	Mobile No-	+91- 9990020048
Products	<i>Market Milk, Flavored Milk, Desi Ghee</i>	E-mail:	77jayati@gmail.com

To fulfill her desire for cows and farming, Jayati left her corporate job at PepsiCo International to become a Dairy farmer. Her venture **Milkybay** is a sustainable farm which started with two main purposes- to supply farm fresh dairy products and to generate employment in the local village area.

The farm is spread over an acre with a shed, feed storage, processing rooms, staff quarters and a Biogas plant. Milkybay started with 3 Desi Cows and today they have more than 27 Indigenous Cows. Fodder is grown organically in the 3 acres of land near the farm. Milkybay is an environment friendly venture using only sanitized glass bottles and jars for packing their products. Logistics are handled by their own



vehicles, which ensure timely and safe delivery as well as duly return of milk bottles. The venture is currently supplying dairy products to 85 households in Gurgaon on a daily basis, 8 restaurants and 6 bakeries as per their requirements. Milkybay plans on getting into retail market with Ghee and Flavored milk in the near future. Jayati, a woman entrepreneur and Founder of Milkybay is extremely grateful to NDRI – TBI for introducing her to the vast world of Dairy Business and helping her through the struggles and success pertaining to this sector.



3. B. K. Products (Gwaal)



B K Products (Gwaal)			
Commercial Dairy Farming: Trainee at			
Father's Name	Harish Patel	City	2014 / B / 2, Vimaj, Kadi,
Age	32	State	Gujarat
Education	MBA – Finance	Mobile No-	+91- 9825305440
Products	Market Milk, Ghee, Paneer, Curd and Mattha	E-mail:	rumitp087@gmail.com

Mr. Rumi Patel (MBA in Marketing and Finance) became a successful dairy farmer. Mr. Rumi attended the training programme organized by ICAR- National Dairy Research Institute and under the guidance of faculty, he has constructed a three modern thatch for 250 animals alongwith a milk processing unit with estimated capacity to handle 500 liters per hour. At present, they are able to produce 10,000 liters of milk per day by using 27 Haringboon parlour and 5 bucket type milking machines. Complete dairy farm is automated and for cost cutting they grow green fodder by following the practices of organic agriculture. Rumi is providing employment to 35 persons and processing milk and the milk products like Ghee (Cow, Buffalo & indigenous cow), Paneer, Buttermilk and Curd and market under the brand name of B. K Products with the help of 25 distributors in Ahmedabad. The current annual turn-over is ` 4.0 Crores and expansion plant targets the enhancement in milk production from existing 10,000 to 50,000 liters / day in next five years.

4. Milky Joy (Yamuna Nagar, Haryana)



Milky Joy (Yamuna Nagar, Haryana)			
Commercial Dairy Farming: Trainee at 2015			
Father's Name	Vajeer Chand	City	2014 / B / 2, Vimaj, Kadi,
Age	35	State	Haryana
Education	Ph.D. Computer Science	Mobile No-	+91- 728678424
Products	Kulfi, Dahi & Ice cream	E-mail:	ahuja_24@yahoo.com

Ishaan Ahuja is a young entrepreneur from Yamunanagar joined for a training programme in 2015 under the aegis of BPD unit of National Dairy Research Institute, Karnal, on milk and milk processing and subsequently to Business Incubation programme to develop innovative range of kulfi and other frozen novelties. With the assistance of scientists of NDRI, Ishaan has developed 14 different types of kulfies using natural additives and flavors. Later on, Ishaan has introduced range of frozen products, sweets and other dairy products under the brand “**Milky Joy**”. The company is having 10 employees and distributor's network in Ambala, Saharanpur and Roorkee through cold chain logistics.

5. Golden Cow (Kamrej, Surat)

Mr. Ram Dutt Shukla hails from Surat of Gujarat. In 2014, he has established an institute named “Krishi Mantra” for promoting the modern methods of agriculture and animal husbandry. With the guidance and training of NDRI scientists, he has established a dairy farm with 92 cross breed cows. He follows the scientific management practices

	Golden Cow (Kamrej, Surat)			
	Commercial Dairy Farming: Trainee at 2014			
	Father's Name	Jyotinder Shukla	City	Kamrej, Surat
	Age	48	State	Gujarat
	Education	Science Graduate	Mobile No-	+91- 9909086505
	Products	Liquid Milk	E-mail:	ramdatt4bank@yahoo.com

in feeding, animal health care, reproduction and waste management of the farm with the help of 20 employees. About 1200 litres of milk is produced daily in his farm and also procured from other farmers, process, packed and market to customers directly. In future, Mr. Shukla has a vision for expanding the range of dairy products and reach out to other cities of Gujarat.

6. Nandini Gaushala, Delhi

	Nandini Gaushala, Delhi , Established in 2017			
	Commercial Dairy Farming: Trainee at 2-7 January,2017			
	Father's Name	Hemant Rathore	City	Rohini
	Age	27	State	Delhi
	Education	B.Sc (H)Botany,PG Diploma –IPR, Pursuing CS	Mobile No-	+91-9871441289
	Products	Market Milk, Ghee , Buttermilk, White Butter	E-mail:	77jayati@gmail.com

Tarun, being a fresh graduate from University of Delhi, was eagerly waiting for the chance of executing all his studies of biology till now. Coming from the urban background with no hands on experience of farming and animal husbandry, it was quite challenging decision to venture in the field of dairying. He started interacting with local dairy farmers, breeders, experts and even visited state of Gujarat for understanding the rearing of indigenous breeds. He owned about 30 Gir cattle with the aim of establishing a Breeding Farm. Tarun an entrepreneur and Founder of Nandini Gaushals is extremely grateful to NDRI, Karnal for introducing him to the vast world of Dairy Business and helping through the struggles.





DAIRY EDUCATION

EDUCATION AND TRAINING AND ACADEMIC ACTIVITIES

ICAR-National Dairy Research Institute is the premier Institution of International repute in Human Resource Development for the growing dairy industry in India. ICAR-NDRI which has been conferred deemed to be University status vide Govt. of India, Ministry of Human Resource Development, Department of Education, and Notification No. F. 9-15/85-U.3 dated 28.3.1989, is well equipped and staffed to meet emerging needs of the 21st Century of the Dairy Industry.

The University offers academic programmes at Diploma, under-graduate and post-graduate levels in the field of Dairy Science and Technology. The following courses were offered by NDRI Deemed University during the academic session 2018-19. The courses have been so designed to provide broad based specialized training on different aspects of dairying.

Diploma in Dairy Technology

Diploma in Animal Husbandry & Dairying

B.Tech. (Dairy Technology)

Master's Degree Programmes

The Institute offers Master's degree programme in the following disciplines:

1	Dairy Microbiology	9	Animal Genetics and Breeding
2	Food Safety and Quality Assurance	10	Livestock Production and Management
3	Dairy Chemistry	11	Animal Nutrition
4	Dairy Technology	12	Animal Physiology
5	Food Technology	13	Agricultural Economics
6	Dairy Engineering	14	Agricultural Extension Education
7	Animal Biochemistry	15	Agronomy
8	Animal Biotechnology	16	Veterinary Gynaecology and Obstetrics

Doctoral Degree programme

The Institute offers Doctoral degree programme in the all the above disciplines except Food Technology.

Career Guidance, Training and Placement Cell

The placement Cell provides career guidance, training and placement services for the passing out students in various disciplines of the Deemed University. B.Tech. (Dairy Technology) and Masters in Dairying students were provided employment in reputed organizations through campus interviews.

Counselling for Admissions

Online Counselling for admission to UG/PG programme was held by the Education Division of ICAR New Delhi. Counselling for admission to Ph.D. programme was held by NDRI at Karnal campus.

Entrance Examination

An all India Competitive entrance examination for admission to Diploma in Dairy Technology/Diploma in Animal Husbandry & Dairying and Ph.D. Programme for the session 2019-20 was conducted by NDRI on June 9, 2019 at five centers i.e. Karnal, Delhi, Mumbai, Bengaluru & Kolkata

Admissions

Admission for the academic session 2019-20 for Diploma in Dairy Technology, Diploma in Animal; Husbandry & Dairying, B.Tech. (Dairy Technology), M.Sc./M.V.Sc./M.Tech. and Ph.D. programmes were made.

Sr. No.	Courses	No. of Students Admitted
1.	Diploma in Dairy Technology	03
2.	Diploma in Animal Husbandry & Dairying	04
3.	B. Tech.(Dairy Technology)	54
4.	Masters' Programme	178 (including one foreign student from Zambia)
5.	Ph.D. Programme	122 (including two foreign students from Liberia and Myamar)

Meetings

- » The 91st meeting of the Standing Committee on Course Curricula and Academic Affairs was hold on November 7, 2019.
- » The 74th, 75th, 76th meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on June 25, November 8 and December 12, 2019, respectively.
- » The 47th meeting of Academic Council was held on November 23, 2019.

Memorandum of Understanding Signed

- » Memoranda of Understanding (MoU) were signed with following Universities:
- » CSKHPKV, Palampur
- » SHUATS, Allahabad
- » Dept. of Animal Husbandry, Andhra Pradesh
- » Chhatisgarh Kamdhenu University, Durg

Agri-unifest 2020

A total number of 22 students (5 Girls & 17 Boys) participated in the 20th All India Inter Agricultural University Youth Festival (Agri-Unifest 2020) sponsored by the Indian Council of Agricultural Research, New Delhi and organized by Indira Gandhi Krishi Vishwavidyala, Raipur (Chhattisgarh) during February 8-12, 2020.

Celebration of Agricultural Education Day

ICAR-National Dairy Research Institute, Karnal, celebrated *Agricultural Education Day* on December 3, 2019, to commemorate the Birth Day of Bharat Ratna, *Dr. Rajendra Prasad*, and first President of Independent India.

Institutional Development Plan Project (NAHEP)

Different activities under four broad objectives viz. strengthening academic programmes, leveraging alumni network, nurturing soft skills of the students, and equity action plan plus green campus initiatives were conducted by IDP (NAHEP) project during the year 2019-20. A total of 16 faculty members were selected for international training and out of which 7 faculty were deputed for availing advance training at 6 different universities located in USA and Netherlands. A total 24 students completed their overseas internship at 11 different universities in 4 different countries. Foundation course was also organized for fresher students to nurture their innate talents during which sessions on literary activities, communication skills, leadership skills, theatre art, cultural dance, music, physical and sports activities including yoga, values, ethics and social awareness were conducted. Also, skill development programme i.e. N-Reach was conducted by Nestle India Pvt. Ltd. for B.Tech final year students to improve their communication skills. Six workshops on various topics viz. women empowerment, leadership and social entrepreneurship; sensory evaluation techniques; mammalian genome editing; advances in starter culture technology; textural analysis of dairy & food products and computer vision applications in dairying were organised for the benefit of the faculty and students. Subject experts including four overseas professors' from USA, UK and

Ireland were invited to deliver the lectures in these workshops. A skill development programme on microbiological quality and safety analysis of dairy products and a certificate course on starter culture and fermented milk products were also organized.

Also, linkage establishments with different industry, academic institutions were initiated. A MoU was signed with Institute of Rural Management Anand (IRMA), Anand, India for initiation of Post Graduate Diploma in Dairy Management Course to cater the needs of dairy industry looking for human resource having administrative capabilities. Alumni data base was updated to strengthen Global Alumni network. Eleven entrepreneurial development programmes for prospective entrepreneurs, and one innovative idea contest and an experiential learning programme for UG students were also conducted to nurture business ideas of undergraduate students.

Other Outreach Activities

- » As a part of outreach activity, a total of 61 MOOCs were developed in the field of dairy production and processing with the help of ICAR-NAARM, Hyderabad. Also, B. Tech. students visited surrounding villages to teach students and created awareness about the environment and cleanliness among the common masses.
- » Twenty meritorious students from sister Dairy Science Colleges across the country were imparted internship (live research projects) for two months duration in laboratories and other facilities at NDRI.
- » As a part of social equity and environmental sustainability initiative, women students were given self-defence training; remedial classes were conducted for academically weak students; incinerator for biohazard waste was procured to treat biological waste; kitchen automation equipment, CCTV cameras were installed and lawn movers procured to strengthen the student hostel amenities.
- » Three recently passed-out (2018-19 pass-out) B.Tech. students (beneficiaries in our IDP) proceeded to pursue Masters at three different universities in USA.
- » Dr. Charles Long, Texas A&M University, USA delivered a talk on ‘Mammalian Genome Editing by CRISPR Technique’ on November 15, 2019 at NDRI, Karnal.
- » Dr. Olivia McAuliffe, Teagasc, Food Research Centre, Ireland delivered a talk on “Advances in Starter Culture Technology” on December 12, 2019 at NDRI, Karnal.
- » N_REACH workshop organized by Nestle India Pvt. Ltd., at NDRI, Karnal during November 27-28, 2019.



TECHNOLOGY DISSEMINATION AND EXTENSION PROGRAMMES

DAIRY EXTENSION DIVISION

Field/Farm Technician (FFT) Laboratory

The Field/Farm Technician (FFT) Laboratory of Dairy Extension Division provides a base for extension work in the adopted villages around Karnal and keeps the records of all extension activities of the Division. Newly adopted villages are Shahpur, Hemda and Dadupur. The FFT Laboratory is operated through Stockman Centres. The Stockmen are the grass-root level workers through whom a live contact between scientists and farmers is established. The major activities being carried out through these Centers are:

- » To organize fertility and veterinary aid campaigns.
- » To provide necessary treatment to the animals.
- » To provide vaccination against contagious diseases.
- » To educate farmers regarding scientific methods of breeding, feeding, improved management practices.

In order to upgrade the existing breeds of dairy animals, cross-breeding was continued in cows and selective breeding in local buffaloes through A.I. using high pedigree bulls. To reduce age at maturity and to minimize inter-calving interval, infertility and veterinary aid campaigns were conducted in adopted villages.

Activities Conducted in Adopted Villages

Sl. No.	Activities	No. of Cases
1	A.I. in Cows (Conception Rate)	485 (45.20%)
2	A.I. in Buffaloes (Conception Rate)	289 (41.60%)
3	No. of Crossbred Calves Born	256
4	No. of Buffalo Calves Born	144
5	General Treatment Cases	520

Infertility and Veterinary Aid Campaigns

A total of twenty eight camps were organized in Kulweri, Daniyalpur, Subhri and Jhanjhari villages. During the Campaigns, animals were treated for reproductive disorders and various other veterinary ailments. Ectoparasitic control campaign & deworming programmes for control of endo-parasites were also conducted. Special attention was given to improve the productive & reproductive parameters of animals by diagnosis and proper treatment. A total number of 981 animals were treated during these campaigns.

Kisan Sangoshthies

Twenty eight Kisan Sangoshthies were organized at village level and following topics were discussed in detail:

- » Management of animals during unseasonal rainfall
- » Adaptation practices during extreme climate variability
- » Clean milk production practices in rural areas
- » Role of reducing inter-calving period in lactating animals

- » Preparation of value added milk products
- » Deworming animals and tick control
- » Preventive measure of H.S. Disease
- » Awareness on ecto-parasite infestation
- » Cutting management in multi cut sorghum
- » Role of mineral mixture in animal diet
- » Awareness on ecto-parasite infestation
- » Importance of animal deworming
- » Role of mineral mixture in animal diet
- » Correct Time of Breeding of females

Question/Answer sessions were also arranged in these sessions which provided excellent opportunities to the farmers and explained the solutions to their day to day problems and also collected the feedback on the extension programmes.

Dairy Education at Farmers' Door (DEFD)

A new Extension Education Programme "Dairy Education at Farmers' Door" was continued to strengthen the effective dissemination of dairy production and processing technologies among farming community. Under this programme, a team of NDRI scientists including subject matter specialists from production, processing and management group visited in various villages on 2nd Saturday of every Month. Scientists also obtained the feedback from the participating farmers. During visits, the primary focus was on discussions on dairy farming, veterinary practices and clean milk production. A total number of 3447 farmers participated in these visits and solutions of their problems were provided to them.

Farmers' Farm School: A New Initiative of NDRI for Farmers

The Institute has started an ambitious programme wherein farmers of Haryana State are being provided formal Education in the field of Dairying, Horticulture and Agriculture through Farmers' Farm School. In this School, farmers interact with the scientists of the Research Institutes through class room teaching as well as practical classes. There is provision of enrolling 25 farmers in one batch on first come first basis and the course duration is for one year. The candidates enrolled in the 5th batch of the Farmers' Farm School passed out in the month of July 2019. The 6th batch consisting 20 farmers of village Bhoji Khalsa is in progress and classes were started from August 9, 2019.

Dairy Samachar

Quarterly Hindi Magazine "Dairy Samachar" was compiled, edited and published by Division Dairy Extension, NDRI, Karnal to make farmers well aware about newly developed dairy technologies of the Institute.

Educational Visits: A total of 10094 visitors (students & faculty) of 180 colleges/ Institutions/Universities visited the Institute. The groups were sensitized about the different research, teaching and extension achievements and facilities available in the Institute. The details of educational tours are as follows:



Advisory Services

Dairy Extension Division provided regular advisory services through postal, e-mail, phone to individual farmers / NGO's / relevant departments all over the country in response to their particular / general queries regarding latest technologies of the institute and modern dairy farming practices.

Student Practicals & Visits in Villages

- » To provide the first hand knowledge of farming community to the students, following practicals were conducted in villages.
- » Participatory Rural Appraisal was conducted in village Shahpur, Hemda and Dadupur to understand status of farmers as well dairy farming in village condition.

- » Students interacted with the dairy farmers and learned from field level exposure.
- » To provide the first hand knowledge of social system and existing animal rearing practices to the students of Dairy Extension, the practical classes were conducted in adopted villages.

Exhibitions Organised

Sr. No.	Date	Subject	Place
1.	January 3-7, 2019	Indian Science Congress	LPU, Jalandhar
2.	January 7-9, 2019	Golden Jubilee International Salinity Conference	CSSRI, Karnal
3.	January 9-11, 2019	Pashu Arogya Kisan Mela	KVK Center, Motihari, Bihar
4.	February 9-11, 2019	Agri Summit 2019	Gandhi Maidan, Motihari Bihar
5.	February 20-23, 2019	XIV Agricultural Science Congress	IARI, New Delhi
6.	March 15-17, 2019	Global Scientific Alumni meet	NDRI, Karnal
7.	March 19, 2019	Farmer FIRST programme	Kamalpur Rodan, Karnal
8.	July 16 -17, 2019	Foundation Day of ICAR	NASC Complex, New Delhi
9.	September 11-12, 2019	Launching National Animal Disease Control Programme (NADCP) for FMD and Brucellosis and Nationwide Artificial insemination Programme for 600 districts.	Pandit Deen Dayal Upadhyay Pashu Chickitsa Vigyan University
10.	September 21-23, 2019	Regional Agriculture and Pashu Palan Mela	GADVASU campus, Ludhiana Punjab
11.	October 5, 2019	Farmers- Scientists Workshop and seed day	ICAR-IIWBR, Karnal
12.	November 10-12, 2019	Entrepreneurship issues and challenges in dairy & food processing industries	Jiwaji, University, Gwalior at Gwalior
13.	November 26, 2019	Milk Day	Milk Parlour, NDRI, Karnal

Training Programmes for Skill Development under FFP

Sr. No.	Name of Training	Duration	No. of Participant
1.	Training on Improved Varieties of Paddy i.e. Pb-1509, Pb-1718, PUSA Basmati - 1121	One day	225
2.	Integrated Nutrient Management	One day	100
3.	Green Fodder Intervention	One day	100
4.	Bypass fat Supplementation	Two day	18
5.	Mineral Mixture	Two day	48
6.	Varietal Trial of Wheat	Two day	70
7.	Growing Dhaincha for Soil Health & Fodder Availability, Training cum Input Supply Programme	Two day	22
8.	IPM in Paddy Training cum Input Supply Programme	Two day	78
9.	IWM in Wheat Training cum Input Supply Programme	Two day	100
10.	Rumen Protected Amino Acid	Two day	22
11.	Balance Feeding	Two day	22
12.	Crop Residue Management	Two day	200
13.	Training on Dairy Farming Practices	Two day	50
14.	Training on Value Addition of Milk for Rural women	One day	50

Extension Council

The Division conducted 46th Meeting of Extension Council on March 12, 2019 to review the progress of current extension programmes and also to recommend changes to streamline the extension activities of the Institute. This council also aims to promote the interdisciplinary extension with development departments to bring out horizontal and vertical coordination of extension activities.

KRISHI VIGYAN KENDRA (KVK)

Krishi Vigyan Kendra (Karnal) became operational in July 1976. The Kendra has linkages with all the line departments in the district in addition to contacts with most of the Agricultural Universities and all the ICAR Institutes in the country. These linkages helps the Kendra updated on the recent technologies in agricultural and allied sectors. Highly qualified professionals in each fields of agriculture working with Kendra facilitate to modify these technologies suiting to local requirements by adopting various scientific methodologies.

At KVK, need based training courses are designed for different types of clientele. After training, follow up extension programme is undertaken. While designing the courses, the entire concept of farming system is taken into consideration to make the enterprises economically viable for the farmers. The training starts with field units, different farms, live demonstration units, workshops and terminates in discussion assembly.

Major Programmes

To achieve the set goals, KVK has the following main activities in the field of dairy production, dairy processing, crop production, fisheries, bee-keeping, home science and vermicompost making.

On-campus training

- » Off-campus training
- » In-service training
- » On-farm trials
- » Front-line Demonstration on Oilseeds, Pulses & Horticultural Crops
- » Seed Production
- » Field/Extension Activities:
 - » Organizing Women in Agriculture Day, Farmers' Day/World Food Day etc..
 - » Survey and evaluation in villages of the district.
 - » Extension through radio, news papers and T V.

Infrastructural Facilities Available

Instructional farm - Total land under (35 Acres)

Instructional Units

- » Crop & Seed Production (30 Acres)
- » Horticulture (2 Acres)
- » Bee-keeping (45 Bee Colonies)
- » Fish Farming (3 Acres water area)
- » Vermicompost (4 beds size 10'x3')
- » Laboratories: Home science, Milk testing & processing and Soil testing

On Campus Training Programmes (2019)

Title of the course	Duration (days)	No. of courses	No. of beneficiaries
Dairy Production	5	32	1470
Dairy Processing	5	8	184
Crop Production	4	4	92
Bee-keeping	4	2	65
Fish Farming	4	3	116
Home Science	1-12	4	89
Post Harvest Technology	2	1	48
Crop Residue Management	4	1	34
Skill Development Training in Vermicompost Making	25	1	20
Sub-Total (a)		56	2118
Short Visit cum Training Programmes (b)	1-5	131	4914
Total (a+b)		187	7032

Off Campus Training Programmes (2019)

Title of the course	Duration (days)	No of courses	No. of beneficiaries
Crop production	1	16	249
Home Sciences	1	11	159
Vermicompost	1	1	14
Value addition in milk	1	6	98
Bee keeping	1	3	57
Total		28	577

State-wise Beneficiaries of KVK Training Programmes

State	No. of Beneficiaries
Haryana	1435
Bihar	517
Jharkhand	45
Himachal Pradesh	42
Uttar Pradesh	38
Uttarakhand	28
Rajasthan	13
Total	2118

Gender wise Beneficiaries of KVK Training Programmes

Gender	Beneficiaries	Percentage
Male	1856	87.62
Female	262	12.38
Total	2118	100.00

Category wise Beneficiaries of KVK Training Programmes

Category	No. of Trainees	Percentage
Others	1769	83.52
S.C./S.T.	349	16.48
Total	2118	100.00

Exposure Visits cum Short Training Programmes

KVK being located in National Institute for Dairying and having live demonstration units attracts the attention of various State governments, NABARD and NGOs which send various groups of farmers, farm women and youth on exposure and study visits to KVK. In total 131 visits were organized in which 4914 number of farmers and farm women participated from Haryana, Himachal Pradesh, Uttar Pradesh, Chhattisgarh, Punjab, Gujarat, Jammu and Kashmir, Uttarakhand, Rajasthan, Madhya Pradesh, Kerala, Bihar, Tamil Nadu and West Bengal.

State-wise Beneficiaries of KVK Exposure Visits (2019)

State	No. of Beneficiaries
Uttar Pradesh	1151
Gujarat	984
Haryana	666
Chhattisgarh	529
Himachal Pradesh	374
Uttarakhand	333
Madhya Pradesh	273
Rajasthan	243
Jammu & Kashmir	119
Punjab	70
West Bengal	68
Kerala	57
Bihar	30
Tamil Nadu	17
Total	4914

Results of FLD's during the Year (2019)

Sr. No	Crop	Variety	Total No of Demo.	Area (ha.)	Av. Yield (q/ha)	BC Ratio
1.	PULSEES	Gram	59	20.00	18.22	1:2.82
		Summer Moong	52	20.00	5.50	1:1.77
2.	OILSEED	Mustard	38	15.00	21.50	1:3.84
			38	15.00	19.21	1:3.43

Sr. No	Crop		Variety	Total No of Demo.	Area (ha.)	Av. Yield (q/ha)	BC Ratio
3.	FODDER	Sorghum	CSH-24	24	5.00	620.00	1:2.61
4.	CEREAL	Wheat	WB-2	4	1.62	59.28	1:3.25
			DBW-88	4	1.62	62.36	1:3.42
			PBW-723	1	0.40	62.24	1:3.41
			HD-2967	2	0.80	56.81	1:3.11
Total				222	79.44		

Demonstrations Carried Out during the Year (2019)

Sr. No	Crop		Variety	No of Demo.	Area (ha.)
1.	Pulses	Gram	HC-5	50	20.00
		Summer Moong	MH 421	52	20.00
2.	Oil Seed	Mustard	CS-58	25	25.00
			CS-60	25	25.00
3.	Cereal	Wheat	DBW-173	12	4.85
			DBW-90	3	1.20
4.	Fodder	Sorghum	CSH-24	24	5.00
Total				191	101.05

FLD Field Visits Organized

During the period under the report, KVK organized following field visits in different villages of Karnal district

Field Visits Organized

Sr. No	Date	Village	Crop	No. of Farmers
1.	January 3, 2019	Kulwheri	Mustard	12
2.	January 4, 2019	Dabri	Mustard and Wheat	9
3.	January 7, 2019	Kunjpura and Nalvikhurd	Gram, Mustard and Wheat	9
4.	January 8, 2019	Kujpura, Kulwheri	Mustard and Wheat	16
5.	January 15, 2019	Dabhri	Mustard and Wheat	12
6.	January 16, 2019	Kunjpura	Wheat	17
7.	January 29, 2019	Kulwheri and Kunjpura	Mustard and Wheat	11
8.	January 30, 2019	Nalvikhurd	Mustard	16
9.	March 8, 2019	Mainmati and Mugal Majara	Mustard	8
10.	March 22, 2019	Sambhali and Kachhva	Mustard and Gram	13
11.	March 28, 2019	Unispur, Barsalu and Bheni Khurd	Mustard and Gram	12
12.	March 29, 2019	Badarpur, Kalsora, Rindal, Gheed and Sahapur	Mustard and Gram	18
13.	March 31, 2019	Kunjpura and Kulwheri	Mustard and Wheat	12
14.	April 4, 2019	Bheni Khurd, Dabri, Sultanpur and Kalampura	Gram and Wheat	16
15.	April 8, 2019	Uplana	Gram and Mustard	28
16.	May 9, 2019	Kunjpura, Kulwehri and Nalvi Khurd	Summer Moong and Sorghum	18
17.	June 4, 2019	Bheni Khurd and Sultanpur	Summer Moong	18
18.	June 7, 2019	Kulwehri	Summer Moong	6
19.	June 11, 2019	Tikari Kailash	Summer Moong and Sorghum	11
20.	June 22, 2019	Kunjpura	Sorghum	9
21.	July 8, 2019	Sultanpur	Summer Moong	12
22.	July 16, 2019	Daha Jagir	Sorghum	15
23.	August 9, 2019	Dabri	Sorghum	8
24.	September 7, 2019	Tikri Kailash	Sorghum	12
25.	November 6, 2019	Bheni Khurd	Wheat	12
26.	November 7, 2019	Kulwheri	Wheat	8
Total				338

Seed Produced at Crops Production Unit (2019)

Name of the crop	Date of sowing	Date of harvest	Area (acre)	Details of production		
				Variety	Type of produce	Qty (q.)
Seed						
Cereal (Wheat)	Nov, 2018	April, 2019	15.00	HD-2967	Seed	264.00
Paddy	June, 2019	Oct, 2019		PB-1509	Seed	175.00 approx
	June, 2019	Oct, 2019	PR-114		Seed	210.00 approx
Fodder	Nov, 2018	May, 2019	15.00	BL-42	Seed	31.60
Berseem	Oct, 2018	March, 2019	1.00	Chinese	Seed	2.01
Mustard				Cabbage		

Production from other Demonstration Units

Sr.No	Products	Species/Varieties	Quantity
1.	Fish seed (fry size)	Rohu, Katla & Mrigal	7,60,000 Nos
2.	Fish Fingerlings	-do-	20,000 Nos
3.	Earthworm	Eisenia foetida	4 kg
4.	Vermicompost	-	4.30 qtl
5.	Honey Production	-	2.33 qtl

Seed Sold (2019)

Sr. No	Crop	Variety	Quantity	No of Farmers
1.	Paddy Seed (Produced in Kharif 2018)	PR-114	63.10 qtl	90
		CSR 30	10.00 qtl	8
		PB 1509	143.50 qtl	334
2.	Wheat Seed (Produced in Rabi 2017)	HD-2967	264.00 qtl	85
3.	Berseem Seed (Produced in Rabi 2017)	BL 42	27.84 qtl (3.76 qtls available with KVK)	215
4.	Mustard (Produced in Rabi 2019)	Chinese Cabbage	2.01 qtl	95

Bio-products Sold (2019)

Bio-products	Varieties	Quantity	No of Farmers
Fish (fry size)	Rohu, Katla & Mrigal	7,60,000 Nos	7
Earthworm	Eisenia fetida	4 Kg	5
Vermicompost	-	4.30 qtl	46

Projects/Schemes being Implemented by KVK

This KVK implemented the following projects and schemes of DOAC&FW, ICAR and IMD during the year 2019 and continuing to carry out various assigned activities under these.

- » Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of NCT Delhi and Haryana.
- » Cluster Front-line Demonstrations (Pulses) under the scheme NFSM.
- » Cluster Front-line Demonstrations (Oilseed) under the scheme NFSM.
- » Training for Skill Development in Vermiculture on behalf of ASCI.
- » Establishment of District Agro Meteorology Unit at KVK.
- » Establishment of Demonstrations unit on Micro-Irrigation System under Pradhan Mantri Krishi Sinchai Yojana.
- » Installation of Unipole hoarding at KVK.
- » Nutri Sensitive Agricultural Resources and Innovation (NARI).
- » Jal Sanrakshan Yojna.
- » Procurement of Farm Machinery & Equipments under submission on Agricultural mechanization.

Field Extension Activities

- » Arranged a visit and delivered lecture on the topic "Marketing of Milk and Milk products" for 60 trainees from HAU regional centre Uchani on January 24, 2019 as a part of skill development programme.
- » Subject matter specialists of KVK participated in monthly meetings of Kisan club and delivered expert lectures on Rabi and Kharif crop cultivation and other topics.
- » The scientific advisory committee meeting was held on January 29, 2019 under the chairmanship of Dr. R. R. B. Singh, Director, NDRI, Karnal to review the progress of KVK during the year 2018 and action plan for the year 2019.
- » On February 24, 2019 live webcast was arranged for about 400 farmers on the launch of Prime Minister-Kisan scheme (Pradhan Mantri Samman Nidhi). Dr. Shiv Kumar Kimothi, ADG (TC), ICAR and ADC, Karnal. Director NDRI presided over the function.

- » KVK organized exposure visit for 44 farmers at IARI Pusa New Delhi during Krishi Unnati Mela on March 6, 2019, to expose the farmers to the latest developments in agriculture and allied fields.
- » KVK organized a workshop with PCRA (Petroleum Conservation Research Association), Ministry of Petroleum on March 14, 2019 to sensitize farmers on reducing the cost of production in agriculture by adopting the method for conservation of petrol and oil. Around 100 farmers from Karnal and adjoining districts attended the workshop.
- » A three days programme on “Youth leadership and community development” was organized from March 18-20, 2019 alongwith Nehru Yuva Kendra, Karnal. The programme was attended by 39 participants.
- » Celebrated “World No Tobacco Day” on 31st May 2019 to educate the participants on ill effect of Tobacco. This programme was attended by trainees and staffs of KVK.
- » To create awareness on the importance of soil health in crop production, KVK organized “Soil Health Day” on December 5, 2019 in which more than 90 farmers and farmwomen from different villages of Karnal district and other states participated. In the programme the farmers were educated about importance of assessing the soil health and linking it with productivity. Dr. P. C Sharma, Director CSSRI Karnal was the Chief Guest of the function. Dr. R. R. B. Singh, Director NDRI Karnal presided over the function. The farmers who had done excellent work in conservation of soil health were honoured in the function by the Chief Guest
- » KVK Organized a kisan mela and awareness programme on Jal Sanrakshan on July 19, 2019. Mayor of Karnal, Mrs. Renu Bala Gupta was the chief guest and Dr. R. R. B. Singh, Director, NDRI presided over the function. More than 100 farmers and youth from Karnal and nearby districts participated in the programme.
- » Awareness programme on water conservation was conducted on July 10, 2019 at KVK which was attended by 95 farmers and youths.
- » Organized kisan mela under ‘Jal Shakti Abhiyan’ on August 9, 2019 which was attended by more than 100 farmers from Karnal district.
- » An awareness programme on water conservation was organized at village Sultanpur on September 3, 2019 and 160 school students and 14 farmers participated.
- » An awareness programme on water conservation was organized at village Jalmana on October 18, 2019 in which 65 farmers participated.
- » Field day on Gram varieties was organized at village Uplana on April 8, 2019 where 28 farmers participated.
- » Field day on Summer Moong was organized at village Kulwheri on June 7, 2019 in which 16 farmers participated.
- » Field day on Summer Moong was organized at village Kunjpura and Kulwehri on June 22, 2019 for 16 farmers.
- » Field day on Summer Moong was organized at village Sultanpur on July 8, 2019 for 12 farmers.
- » Field day on sorghum Fodder crop was organized at village Dabri on August 9, 2019 for 16 farmers.

Linkage of KVK with Different Organizations

KVK maintained strong linkage with line departments to carry out various activities in the district. The type of linkages with various organizations is shown in the following table:

Sr. No.	Name of organization	Nature of linkage
1.	Animal Husbandry Deptt., Govt. of Haryana	Planning annual training schedule, organizing dairy activities in villages
2.	Agriculture Deptt, Govt. of Haryana	Organization of field activities, planning of training schedule.
3.	Agriculture Unversities (CCSHAU, Hisar; PAU, Ludhiana; GBPAU Pantnagar)	Field visits, Procurement of latest varieties of seeds and guest speakers, interchange of subject-matter specialists.
4.	Haryana Khadi Gramodyog Board, Karnal	Loans for trainees of bee-keeping, guest speakers.
5.	ICAR Institutes, Karnal	Field visits, Procurement of latest varieties of seeds and guest speakers, interchange of subject-matter specialists.
6.	CCS HAU, Regional Station, Uchani, Karnal	Planning annual training schedule and guest speakers.
7.	Krishi Vigyan Kendra (HAU), Karnal	Collaborative training programme and guest lectures
8.	Nehru Yuva Kendra, Karnal	Organizing training programmes for their volunteers/extension workers.
9.	NGOs (Haryana Gyan Vigyan samiti, Arpana Trust and others)	Organizing training programmes for their volunteers/extension workers & for utilizing services of field activities
10.	Financial Institutions (Banks etc.)	Loans for trainees of dairy farming, bee-keeping etc. and inviting guest lecturers on finance facilities.
11.	District Horticulture Department, Karnal	Planning annual training schedule and guest speakers.
12.	District Forest Department, Karnal	Planning annual training schedule and guest speakers.
13.	District Fisheries Department, Karnal	Sponsoring farmers for training in fisheries & guest speakers
14.	Rural Institutions (a) Gram Panchayat (b) Co-operatives (c) Schools	In village training programmes/demonstration work, field activities, Awareness programmes
15.	Haryana Agro Industries Corporation Ltd.	Planning, annual training schedule & Guest speakers.

Promotion of Agriculture Mechanization for In-situ Management of Crop Residue

Karnal is known as a major paddy growing district of Haryana. Farmers used to burn the paddy straw in a run-up to wheat sowing leading to the degradation of soil health and environment pollution. KVK promoted agriculture mechanization for In-situ management of crop residue in the states of NCT Delhi and Haryana by motivating farmers not to burn paddy stubbles and use them in fields to improve the soil health.

Procurement of Machine/Equipment during the year (2019)

Name of the Machine/ Equipment	Physical Targets (Nos.)	Physical achievements (Nos.)
Happy Seeder	2	2
Hydraulic Reversible M.B. Plough	2	2
Rotavator	1	1
Mulcher	2	2
Zero tillage seed drill	4	4

Demonstrations on In-situ Management of Crop Residue

KVK was able to demonstrate in-situ management of paddy straw with the help of mulcher, shrub master, hydraulic reversible M. B. plough, Happy Seeder and Zero Till seed drill in different villages of Karnal district. Sowing of wheat was also demonstrated in two adopted villages namely Bhaini Khurd and Sultanpur of Karnal district with the help of happy seeder and zero tillage to check the stubble burning.

KVK organized sowing of wheat with the help of happy seeder and zero tillage seed drill in 144.0 acre and 237.0 acre area, respectively in Bhaini Khurd and Sultanpur villages. A total number of 43 farmers were benefitted.

Field Visits Organized Under Crop Residue Management

Subject matter specialists from KVK visited the plots, in two adopted villages, on which the sowing was done with the machines, particularly happy seeder and zero tillage seed drill, provided by KVK to monitor the progress of wheat crop and clear the doubts of farmers. During the year 2019, KVK organized 22 field visits in villages i.e. Kulwheri, Dabri, Kunjpura, Sultanpur and Bhaini Khurd and 347 farmers were benefitted.

Mobilization of School Students Against Crop Residue Burning and Crop Residue Management

A total of 615 students of government schools of different villages of Karnal district were also involved to convey the message against crop residue burning in their respective villages. Students, along with the staff of KVK, took out *prabhat pheri* in their villages with playcards and banners in their hands. Students were given lectures on ill effects of crop residue burning by experts and were also encouraged to dissuade their farmer parents, neighbours and relatives from burning of paddy residue in their fields. Elocution competition was also arranged on crop residue burning in a government college at Indri block of Karnal and best students were awarded in the programme. The detail of activity is given in following table.

Publicity on crop residue management

KVK developed pamphlets and folders on In-Situ crop residue management for distribution among the farmers in different villages and to those coming to KVK to attend various training programmes. KVK also created slogans to stop farmers from paddy straw burning and encourage them for In-situ crop residue management using happy seeder, zero tillage and MB plough. Wall paintings with slogans, against crop residue burning and to encourage crop residue management, were done on prominent public places in two adopted villages namely Bhaini Khurd and Sultanpur. To generate mass awareness on crop residue management, the selected places on highways, near by the adopted villages, were also painted with slogans. Hoardings and banners, conveying the message on In-situ crop residue management were placed at prominent places, like mandis, ICAR institutes and main gates of railway stations, for maximum outreach among farmers in the district.

Awareness Programmes Organized in KVK and Villages

KVK organized 32 awareness programme and kisan sangoshthies to sensitize farmers on against burning of crop residue in the fields and use of machines for In-situ management of crop residue. In these programmes, a total number of 1356 farmers participated.

KVK Organized a stake holders meet under the project on In-situ crop residue management on March 26, 2019 alongwith ICAR-ATARI, Jodhpur. The event was attended by more than 100 farmers and SMS of various KVKs in state of Haryana.

KVK arranged for participation of 17 progressive farmers from Karnal district, in the national conference on Crop Residue Management, organized by ICAR, at NASC complex New Delhi on September 9, 2019. The farmers shared their experiences and gained knowledge from experts on use of specially designed machines for in-situ residue management.

Training Programme Organised at Krishi and Dairy Vikash Kendra (KDVK), KVK, Piprakothi, East Champaran, Bihar (January 2019 to December 2019)

Sr. No.	Date	Topic	Resource person	Participant
1	January 28-30, 2019	Commercial dairy farming and reproduction management (3days)	Dr. Ravi Sankar Dev Barman, RA	109
2	May 25- 27, 2019	Commercial dairy farming and reproduction management (3days)	Dr. T. K. Mohanty, PS, ICAR-NDRI Dr. Shailendra Kumar Rjak, SMS, Piprakothi	52

A training programme on AI and semen laboratory in ICAR-NDRI, Karna. Semen handling and AI was organized for Mr. Ujjal Kumar skilled worker looking after the sale of Frozen semen in KVK, Piprakothi.

Activities of Krishi Vigyan Kendra, Nadia (Additional)

Under the aegis of ICAR-NDRI, ERS, Krishi Vigyan Kendra, Nadia (Additional) organized 48 training programmes for the benefits of the farming community in the Nadia district of West Bengal. Demonstration of improved cultivation practices of different agricultural crops and scientific way of managing animals in the farmer's field was carried out by the KVK.

A total of 1305 farmers were trained out of which 279 male farmers and 40 female farmers belonged to SC community, 78 male and 132 female farmers belonged to ST community and 633 male and 143 female farmers belonged to other communities. They were trained for different cultivation practices of green gram, mustard, fodder crops like- oats, berseem etc; soil health management, weed management, scientific dairy and goat farming etc. Four front Line Demonstrations (FLDs) and two 'On Farm Testing' (OFT) were carried out under the field level. The number of farmer beneficiaries from FLDs is given in the following Table:

SC		ST		Others		Total		
Male	Female	Male	Female	Male	Female	Male	Female	Total
97	9	1	0	83	3	181	12	193



The details of farmer beneficiaries from OFT is given in the following Table:

SC		ST		Others		Total		
Male	Female	Male	Female	Male	Female	Male	Female	Total
38	0	5	1	13	3	56	4	60

A total of 299 extension activities including exposure visits were organized under KVK from which 3606 farmers got direct benefits through this new KVK.



AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

Agricultural Technology Information Centre at NDRI Karnal became operational in November 2004. This centre is engaged in disseminating information on dairying and allied agricultural fields. Besides NDRI, relevant information available from other research stations of ICAR and state institutions located at Karnal are utilized by this centre for the farmers and other stakeholder visiting this centre. A large number of entrepreneurs, practicing farmers, extension workers and students are availing the facilities of ATIC together latest information related to dairying and allied fields.

Mandate

- » To provide a single window delivery system for agricultural information as well as products and technologies developed by the research institute with a view to deliver quality services to the clientele.
- » To strengthen the farm advisory services by adopting a multi disciplinary approach to problem solving.
- » To provide mechanism for feedback from the end users to the research system.
- » To function as a repository of agricultural information pertaining to farming skills and practices, farm inputs and agricultural education.
- » To offer consultancy services to the different stakeholders in the state.
- » To arrange training to unemployed youth to equip them to become job providers, rather than job seekers.

Dissemination of Technological Information

Presently, ATIC NDRI is using following methods in dissemination of information to its users:

- » Personal interaction with visiting farmers.
- » Display of Models etc; organizing /participating in Melas and Exhibitions.
- » Audio/Video shows
- » Visits to Dairy farm
- » Information through toll free telephone number (1800-180-1199)
- » Providing Publications.
- » Providing material inputs like improved seed varieties, Vermi compost etc.
- » Through email



Services Rendered in Agricultural Technology and Technology Products (2019)

Sr. No.	Detail of services	No. of Services	No. of Persons
1.	Dairy/Agriculture related information through Video show and Lecture	76	2378
2.	Personal Discussion with Subject-Matter-Specialist on Dairy Farming	9	20
3.	Information through Dairy/Agriculture Literature	67	67
4.	Information on Agriculture (Seed/Fertilizer/Compost etc)	1581	1581
5.	Information through telephone (Toll-free) on Agriculture & Dairying etc.	1175	1175
6.	Information through e-mail on Agriculture & Dairying etc.	224	224
	Total	3132	5445

WOMEN EMPOWERMENT AND MAINSTREAMING OF GENDER ISSUES

Capacity Building of Women

Women empowerment lab was established in Dairy Extension division in 2013 for capacity building of different self help groups of NDRI, DRDA and NGOs. This lab was established with the objective to create awareness and impart skills in the field of dairy processing and fruit and vegetable preservation and also mobilize these groups to take up vocation in these areas. For this lab., all items of Dairy Processing Unit viz. Eco Milk Testing Machine, Refractrometer, pH Meter, Moisture Balance were procured. Regular women empowerment trainings and campaigns were organized to create awareness among rural farmwomen in the field of dairying and home science and also impart skill in these areas so that farmwomen could generate more income from dairying and maintain healthy atmosphere in their respective families. During the period under report, one Women Dairy Self Help Group named "Saraswati Self Help Group" was formulated in Kulwehri Village of Karnal district.

On Campus Women Empowerment Training Programme-cum-Demonstrations (2019)

Sr. No.	Title	No of Trainings	No. of Participants
1	Training programme on value added milk product of rural women (SHG)	4	44
2	Training cum demonstration programme on preparation of homemade value added traditional dairy products for employment of rural women	1	30
3	Demonstration cum training programme on value added milk products for rural women	5	64
4	Training programme on traditional dairy products of rural women	1	8
	Total	11	146

- » **Mahila Kisan Divas:** KVK celebrated Mahila Kisan divas on January 23, 2019 for 108 farmwomen. The theme of the Mahila divas was "Kheto ki parali khet mein". The women were educated to impress upon male members of the families from farming community not to burn paddy straw and mix it in the fields using machines available in the market for the purpose to improve soil health. It was informed to women that machines available with KVK for In-situ management of paddy straw may be made available to farmers as and when required.
- » **International Women's Day:** The Institute arranged direct telecast of PM on International women's day on March 8, 2019 followed by the interaction of PM with the women. About 70 farm women participated in the event.
- » **World Breast Feeding Week:** KVK organized world breast feeding week at Daha Jageer village on August 1, 2019 in which about 33 women participated. The participants were given classes on the importance of breast feeding, infant nutrition and the advantages of colostrum to the new born.
- » Awareness programme on water conservation was conducted on September 2, 2019 alongwith Arpana trust, Madhuban, Karnal, which was attended by 45 women.

Preparation of Dairy Products

- » A gender sensitisation and dairy products demonstration was held in Keherba village of Indri block of Karnal district on April 12, 2019. World Environment Day was celebrated in DPS school of Gharunda on June 5, 2019. Subsequent interactions and demonstrations were held with the farm women of Amritpur Khurd and Dinger Majra of Karnal district on June 20, 2019; Manglora village on July 5, 2019, July 9, 2019 and July 17, 2019; display and sale of dairy products by Lakshmi SHG women group at DPS school of IOCL, Panipat. Interaction meeting with rural women of Ramnagar village in Sonapat district, Pattikalyana village in Panipat district and Raseen

village in Karnal district was organised on August 5, 2019; Salwan village in Karnal district on September 6, 2019 to motivate them on taking up dairy based enterprise. Training was imparted to 11 farmwomen of Salwan village on October 9, 2019 at NDRI. Training of women was organized in Bharatpur village on January 15, 2020 and Sangohi village on January 20, 2020.

- » Training programmes for potential women entrepreneurs from Karnal, Panipat, Sonapat district on milk and milk products processing (*dahi, paneer, ghee etc.*) were organized.
- » Two training programmes on Dairy Husbandry and Integrated Farmer System Management of dairy animals were conducted for 77 farmers including 72 farmwomen on January 10, 2010, August 1, 2019 and August 4, 2019, respectively.



HONOURS AND AWARDS

International Award

- » **Mr. Ravi Prakash**, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru received "**BRICS-Young Innovator Prize-2019 (First Place, 25000 USD Prize Money) in 4th BRICS-Young Scientist Forum-2019**" held from November 6-8, 2019 at Rio de Janeiro, Brazil (Guide: Dr. Menon Rekha Ravindra).



National/ICAR Awards

- » **Dr. T. K. Datta**, Principal Scientist, Animal Biotechnology Centre, **Dr. A. Kumaresan**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru, **Dr. Savita Yadav**, AIIMS and **Dr. T. K. Mohanty** Principal Scientist, Artificial Breeding Research Center were conferred "**Hari Om Ashram Trust Award**" for the biennium 2016-17 for Outstanding Team Research by the ICAR during the ICAR Award function held at New Delhi on July 16, 2019.



- » **Mr. Ravi Prakash**, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru received "**India Innovation Growth Program-(IIGP 2.0)-University Challenge Award-2019**", awarded by Department of Science and Technology (DST), Govt. of India with research grant ₹ 10 Lakhs on July 17, 2019 in Hotel Taj Palace, New Delhi (Guide: Dr. Menon Rekha Ravindra).



- » **Dr. S. Jeyakumar**, Principal Scientist received “**Best Researcher Award**” in the field of Infrared Thermal Imaging and its Application in Veterinary Medicine, under Research Ratna Award of the Year 2019 jointly Awarded by RULA Awards and United Medical Council in Association with World Research Council on February 26, 2019.
- » **Mr. Rakesh Kumar Raman, Ms. Uma Karpurapu and Dr. Narender Raju Panjagari**, Scientist, Dairy Technology Division received “**All India 3rd Best Research Project Award**” under the Basic Sciences category alongwith a cash prize of Rs. 25,000/- at the National Students Research Convention (ANVESHAN-2019) held during March 12-14, 2019 at Ganpat University, Mehsana, Gujarat and sponsored by the Association of Indian Universities, New Delhi.

Institute Award

- » **Dr. Narender Raju Panjagari**, Scientist, Dairy Technology Division received prestigious “**Best Teacher Award**” for the year 2018 during 17th Convocation of ICAR NDRI Deemed University on March 23, 2019.
- » **Fellowships and Associateship of National Academies/ Agricultural Societies**
- » **Dr. A. K. Puniya** Principal Scientist and **Dr. Naresh Kumar**, Principal Scientist, Dairy Microbiology Division were selected as “**Fellow of National Academy of Agricultural Sciences (NAAS)**”, New Delhi for the year 2020.
- » **Dr. Pawan Singh**, Principal Scientist, Livestock Production & Management received “**National Fellowship**” of ISAPM Society in ISAPM National Conference in January, 2019 held at Trissur (Kerala).
- » **Dr. Sohan Vir Singh**, Principal Scientist, Animal Physiology Division received “**Animal Physiologists Association Fellow Award**” from Hon’ble DG, ICAR New Delhi in presence of Director & VC, ICAR-IVRI, Izatnagar (U.P.) and VC, SVVU, Tirupati during “2nd Annual Meeting of APA & National Conference on Issue and Strategies for Physiological Capacity Building in Animals” held at SVVU, Tirupati from October 14-15, 2019.



Receiving APA Fellow award from Hon'ble DG, ICAR New Delhi

- » **Dr. M. K. Singh**, Principal Scientist, Animal Biotechnology Centre awarded “**Associate Member**” of National Academy of Veterinary Sciences.

- » **Dr Sunita Meena**, Scientist, Animal Biochemistry Division was awarded “**Associate Fellow**” of National Academy of Dairy Science 2019.
- » **Dr. Neelam Upadhyay**, Scientist, Dairy Technology Division received “**Associate Fellowship**” of National Academy of Dairy Science (NADSI), India.
- » **Dr. A. K. Puniya**, Principal Scientist, Dairy Microbiology Division selected as “**Fellow of BRSI, 2019**” by Biotech Research Society of India during XVI BRSI Convention; International Conference on New Horizons in Biotechnology (NHBT 2019) held from November 20-24, 2019 at Thiruvananthapuram.
- » **Dr. Sanjit Maiti**, Scientist, Dairy Extension Division received “**Prestigious Fulbright-Kalam Climate Fellowship for Postdoctoral Research 2018-19**” to carry out the research project on “Vulnerability Mapping of Cyclone Prone Coastal Agro-Ecosystem by the Application of *Analytical Hierarchy Procedure* in GIS Environment” at University of Michigan, Ann Arbor, Michigan, USA for eight months from March 2019.
- » **Dr. H. R. Meena**, Principal Scientist, Dairy Extension Division received “**Fellow of Indian Society of Extension Education**” for his outstanding contribution in the field of Extension Education during National Seminar on Holistic Approaches for Enhancing Agricultural Growth in Changing Rural Scenario held at Swami Keshwanand Rajasthan Agricultural University, Beechwal Bikaner, Rajasthan during November 14-16, 2019.
- » **Dr. S. K. Jha**, Principal Scientist, Dairy Extension Division received “**Fellow Award**” by the Indian Society of Extension Education (ISEE), New Delhi for contributions in the Discipline of Extension Education on November 22, 2019.

Professional Societies Awards

- » **Mr. Ankur Sharma, Dr. A. Kumaresan**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru and **Dr. M. S. Chauhan**, Director, NDRI, Karnal received “**Young Scientist Award**” during 35th Annual Convention of Indian Society for Study of Animal Reproduction (ISSAR) held at Namakkal, Tamil Nadu during December 18-20, 2019.
- » **Ms. Shabhat Mumtaz**, Animal Genetics & Breeding Division received “**Young Scientist Award**” during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.
- » **Dr Sunita Meena**, Scientist, Animal Biochemistry Division received “**Young Scientist Award**” during National Conference entitled “Technological and Emerging Aspects in Agriculture and Community Science” held at International Buddhist Research Institute, Vipin Khand, Gomti Nagar, Lucknow from February 7-8, 2020.
- » **Dr. P. C. Kotresh, Dr. Pawan Singh**, Principal Scientist, **Mr. D. Barman, Dr. S. S Lathwal**, Principal Scientist, **Mr. S. Choudhary, Mr. G. Panchbhai** and **Dr. M. Bhakat**, Sr. Scientist, Livestock Production & Management Section received “**Dr. N. S. R. Sastry Young Scientist Award**” for the research paper entitled “Effect of Microclimatic Conditions in Different Housing Systems on Performance of Murrah Buffalo Claves” in National Conference on “Innovations in Animal Production for Sustainability and Doubling Farmers’ Income” organized during 26th Annual convention of ISAPM held at C.V.A.S, KVASU, Mannuthy, Thrissur from January 23-25, 2019.
- » **Dr. A. K. Puniya**, Principal Scientist, Dairy Microbiology Division received “**Dr. Rana Memorial Award, 2019**” by Association of Microbiologists of India (AMI) during 60th Annual Conference of AMI held at Central University of Haryana from November 15-18, 2019 at Mahendragarh.
- » **Dr. Gopal Sankhala**, Principal Scientist, Dairy Extension Division received “**Rashtriya Gaurav Award-2019**” for Meritorious Services in Agricultural Extension by His Excellency Shekhar Dutt, Former Governor of Chhattisgarh at a Seminar on “Economic Growth & National Integration” organised by India International Friendship Society at New Delhi on November 27, 2019
- » **Dr. K. P. Ramesha**, Head, SRS, ICAR-NDRI, Bengaluru was conferred with “**Karuna Trust Award 2019**” for his contribution to Livestock sector by the Karuna Trust for National Progress (Regd.) on December 22, 2019.
- » **Dr. A. K. Puniya**, Principal Scientist, Dairy Microbiology Division received “**APSI International Plant Scientist Award, 2019**” by Academy of Plant Sciences of India during APSI Scientists Meet & International Conference held from November 23-25, 2019 at NMP Pharmacy College, Ahmedabad.

Best Paper Awards

- » **Mr. B. Singh, Dr. K. Khamrui**, Principal Scientist, **Mr. J. Lodh, Mr. A. Debnath**, and **Dr. W. Prasad**, Scientist, Dairy Technology Division received “**Best Paper Award**” for the paper entitled, “Selection of Levels of Ingredients for the Preparation of Milk-Coconut Sweet based on Sensory and Instrumental Colour Attributes” at 47th Dairy Industry Conference, organized by IDA-East Zone, Patna during February 7-9, 2019.

- » **Ms. Kiran Lata, Mr. Laxamn Naik, Dr. Bimlesh Mann**, Head and **Dr. Rajan Sharma**, Principal Scientist, Dairy Chemistry Division received **"Best Paper Award"** by Indian Dairy Association in the category of "Dairy Processing" for the year 2017 at 47th Dairy Industry Conference, Patna on February 7-9, 2019.
- » **Dr. R. B. Kale, Dr. K. Ponnusamy**, Principal Scientist, **Dr. A. Mohammad, Dr. S. K. Jha**, Principal Scientist, **Dr. B. S. Chandel**, Head and **Dr. A. K. Chakravarty** received **"Best Paper Award"** for their article, "Differential Dairy Development Status in India: A Perception Analysis", *Indian Journal of Dairy Science* 70 (3): 371-377 during 47th Dairy Industry Conference held from February 7-9, 2019.
- » **Dr. Pawan Singh**, Principal Scientist, Livestock Production & Management Section received **"Best Paper Award"** for the paper entitled, "Effect of Micro Climatic Conditions in Different Housing Systems on Performance of Murrah Buffalo Calves" during ISAPM National Conference in January, 2019 held at Trissur (Kerala).
- » **Dr. Hardev Ram**, Scientist, Forage Research and Management Centre received **"Best Paper Award"** for the paper entitled, "Effect of Resources Conservation Techniques on Production Potential of Baby Corn" during International Conference on "Soil and Water Resources Management for Climate Smart Agriculture, Global Food and Livelihood Security" November 5-9, 2019 at NASC, Complex, Pusa, New Delhi.
- » **Ms. Kiran Lata, Dr. Laxmana Naik N., Dr. Rajan Sharma**, Principal Scientist, **Mr. Arvind Jaiswal, Dr. Bimlesh Mann**, Head and **Dr. Y. S. Rajput**, Dairy Chemistry Division received **"Best Paper Award"** from Indian Dairy Association for First Best Research Article in the category of "Dairy Processing" for the year 2019 during the organization of 47th Dairy Industry Conference at Patna in 2019.
- » **Dr. Laxmana Naik, Ms. Kiran Lata, Dr. Rajan Sharma**, Principal Scientist **Dr. Bimlesh Mann**, Head, **Dr. B. Surendra Nath** Principal Scientist and **Dr. Siddaramanna**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru received **"Best Paper Award"** (Review/popular article category) for the article entitled, "Status of Antibiotic Residues in Milk-A Systematic Review," published in *Indian Journal of Dairy and Bio Science*, Vol. 27, 2016.
- » **Dr. S. Subash**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru received the **"Best Paper Award"** for a paper presented on "Role of Indigenous Cattle Farming in augmenting Farmers Income" in the Workshop organized by Karnataka Veterinary Association held during July 20-21, 2019 at GKVK, Bengaluru.
- » **Dr. Asif Mohammad**, Scientist, ERS, ICAR-NDRI, Kalyani got **"Best Paper Award"** for the article "Differential Dairy Development Status in India: A Perception Analysis" published in *India Journal of Dairy Science*, 2017 during the 47th Dairy Industry Conference organized during February 7-9, 2019.
- » **Mr. A. Fahim, Dr. M. L Kamboj**, Principal Scientist, **Mr. S. Prasad, Mr. A. S. Sirohi**, and **Mr. R. Bhakat**, Livestock Production & Management Section received **"Best Research Paper Award"** for their paper entitled, "Preference of Side and Standing in Relationship with Milking Characteristics and Temperament Score of Crossbred Dairy Cows Milked in Herringbone Milking Parlour" during National Conference organised by Indian Society for Animal Production Management at College of Veterinary and Animal Sciences, Munnuthy, Trissur, Kerela from January 23-25, 2019.
- » **Ms. Rajshree Rath, Dr. Pawan Singh**, Principal Scientist, **Dr. M. L. Kamboj**, Principal Scientist, **Dr. S. S. Lathwal**, Principal Scientist, **Dr. T. K. Mohanty**, Principal Scientist and **Ms. Himani Tiwari**, Livestock Production & Management Section were awarded the **"Best Research Paper Award"** on their paper, "Assessing Cognitive Performance of Murrah Buffalo Calves in a Visual Discrimination Task" by Commonwealth Veterinary Association during 7th Pan Commonwealth Veterinary Conference held at National Institute of Animal Nutrition and Physiology, Bengaluru from March 3-7, 2019.
- » **Dr. M. L Kamboj**, Principal Scientist, **Mr. Pranay Bharti, Mr. P. K. Singh, Ms. Mayamitta Saini** and **Dr. Sanjay Choudhary**, Livestock Production & Management Section received the **"Best Research Paper Award"** on their paper entitled, "Effect of Natural Suckling and Weaning on the Growth, Health and Behaviour of Murrah Buffaloes and Sahiwal Cow Calves" during Animal Welfare and Behaviour Session of the National Conference organised by Indian Society for Animal Production Management at College of Veterinary and Animal Sciences, Munnuthy, Trissur, Kerela from January 23-25, 2019.
- » **Mr. Rakesh Kumar Raman, Ms. Uma Karpurapu** and **Narender Raju Panjagari**, Scientist, Dairy Technology Division received **"Best Research Project Award"** under the Basic Sciences category at the Students Research Convention (North Zone ANVESHAN-2019) and qualified for National event during February 27-28, 2019 at National Institute of Food Technology, Entrepreneurship and Management (NIFTEM), Kundli and sponsored by the Association of Indian Universities, New Delhi.
- » **Dr. Ganga Sahay Meena**, Scientist, **Dr. Ashish Kumar Singh**, Principal Scientist, **Dr. Vijay Kumar Gupta, Mr. Dharin Jayswal, Dr. Pankaj T. Parmar** and **Dr. Hari Ram Gupta**, CTO, Dairy Technology Division received **"2nd Best Research Paper Award"** for their paper entitled "Estimating Cost for Production of Soluble Milk Protein Concentrate 70 (MPC70)" at 47th Dairy Industry Conference organized at Patna, Bihar from February 9-11, 2019.
- » **Dr. K. Ponnusamy**, Principal Scientist, Dairy Extension Division received **"Best Article Award of 2017"** for the article on "Differential Dairy Development Status in India: A Perception Analysis" published in the *Indian Journal*

of Dairy Science given by Indian Dairy Association, New Delhi during 47th Dairy Industry Conference held from February 7-9, 2019 at Patna.

- » **Mr. Ramendra Das, Dr. Ishwar Dayal Gupta**, Principal Scientist, **Dr. Archana Verma**, Principal Scientist, **Mr. Mahesh Vishwas Chaudhari, Mr. Lalrengpuui Sailo and Dr. Sohanvir Singh** Principal Scientist, Animal Physiology Division received **"Best Research Article Award"** for their research article entitled "Identification of SNPs in ATP1A1 Gene and their Association with Heat Tolerance in Sahiwal and Karan Fries (Bos Taurus x Bos indicus) Cattle under Tropical Climatic Condition" in the category of "Dairy Production" for the year 2018 published in Indian Journal of Dairy Science to be awarded by IDA during the 48th Dairy Industry Conference to held at Jaipur from February 20-22, 2020.
- » **Dr Sunita Meena**, Scientist, Animal Biochemistry Division received **"Best Paper Presentation Award-2020"** for her paper entitled, "Milk Improves Cholesterol Homeostasis by Protecting Liver Against Oxidative Damage in Hypercholesterolemic Rats" during National Conference at International Buddhist Research Institute, Vipin Khand, Gomti Nagar, Lucknow during February 7-8, 2020.
- » **Dr. Anupam. Chatterjee**, Principal Scientist, **Dr. Asif Mohammad**, Scientist, **Dr. Champak Bhakat**, Principal Scientist, **Dr. D. K. Mandal**, Principal Scientist, **Dr. Saroj Rai**, Scientist and **T. K. Dutta**, Head, ERS, ICAR-NDRI, Kalyani received **"Best Paper Presentation Award (Oral)"** for the paper entitled, "Comparative Nutritional Evaluation of Wetland Plants Available in Old Alluvial Zone of West Bengal" at International Symposium organized by NIRD and UST, Meghalaya during September 6-7, 2019.
- » **Dr. S. Subash**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru received **"Best Paper Presentation Award"** for a paper presented at International Seminar organized by TANUVAS, Chennai during June 27-28, 2019.
- » **Mr. Deepak Chand Meena, Dr. Sanchita Garai**, Scientist, **Dr. B. S. Meena**, Principal Scientist and **Dr. Sanjit Maiti** Scientist, Dairy Extension Division received **"Best Research Presentation Award"** for the research paper "Migration as Planned Livelihood among Raika Pastoralist of Marwar Region of Rajasthan" during ISEE National Seminar held at Swami Keshwanand Rajasthan Agricultural University, Beechwal, Bikaner, Rajasthan during November 14-16, 2019.
- » **Dr. Pawan Singh**, Principal Scientist, Livestock Production & Management Section received **2nd Best Paper Award"** for the paper entitled "Relationship among Testicular, Physical and Semen Quality Parameters of Murrah Buffalo Breeding Bulls" during 47th Dairy Industry Conference (DIC) held from February 7-9, 2019 at Patna.

Best Poster Award

- » **Ms. Aneet Kour** and co-workers, Animal Genetics & Breeding Division received **"Best Poster Award"** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.
- » **Ms. Kaushalya Devi** and co-workers, Animal Genetics & Breeding Division received **"Best Poster Award"** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.
- » **Mr. D. Dua, Mr. G. Tripathi, Dr. P. Palta**, Principal Scientist and **Dr. M. K. Singh**, Principal Scientist, Animal Biotechnology Centre received **"Best Poster Award"** for their paper "Developmental Competence of Ovarian Follicles Affected by Culture Media" at Global Conference on Reproductive Health organized by ISSRF at JNU, New Delhi from February 22- 24, 2019.
- » **Ms. Hema J. M., Ms. Richa Singh**, Scientist, **Dr. Bimlesh Mann**, Head, **Dr. Rajesh Bajaj**, Principal Scientist, **Dr. Priyanka Rao**, Scientist, and **Mr. Saurabh Gosewade**, Dairy Chemistry Division received **"Best Poster Award"** for the poster entitled "Comparative Fat Digestibility from Milk of Different Breeds using Simulated GI conditions presented at National Conference on "SLIETCON-2019" held from March 1-2, 2019 at Chandigarh.
- » **Mr. Harisha Bodemala, Dr. Sumit Arora**, Principal Scientist, **Ms. Seema Rana, and Dr. Vivek Sharma**, Principal Scientist, Dairy Chemistry Division received **"Best Poster Award"** for the poster entitled "Optimization of Spray Drying Conditions for lab Scale Preparation of Milk Protein-Vitamin Complexes" presented in the NDRI Global Alumni Scientific Meet-2019 held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- » **Mr. Ranvir, Dr. Kamal Gandhi**, Scientist, **Dr. Rajan Sharma**, Principal Scientist and **Dr. Bimlesh Mann**, Head, Dairy Chemistry Division received **"Best Poster Award"** presented in the NDRI Global Alumni Scientific Meet-2019 held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- » **Dr. Nishant Kumar**, Scientist, Livestock Production & Management Section received **"Best Poster Award"** for the paper entitled "Effect of Zinc Supplementation on Performance of Peri-parturient Crossbred Cows during

Heat Stress Condition" during Dairy Industry Conference 2019 organized by Indian Dairy Association from February 7-9, 2019 at Patna.

- » **Mr. S. K. Yadav, Dr. Nitin Tyagi, Sr. Scientist, Dr. B. Sharma, Dr. Sachin Kumar, Scientist, and Dr. A. K. Tyagi, Head, Animal Nutrition Division** received "**Best Poster Award**" at International Conference, INCAN, Kolkata, held from December 17-19, 2019.
- » **Ms. Taruneet, Animal Biochemistry Division** received "**Best Poster Award**" for poster entitled "Milk Derived Peptide as Supportive Diet Ingredient in the Prevention of Osteoporosis Modulates Bmp2 Pathway" during NDRI Global Alumni Scientific Meet 2019. Future Perspective for Dairy Science and Education held at ICAR-NDRI during March 15-17, 2019.
- » **Mr. Harisha Bodemala, Dr. Sumit Arora, Principal Scientist, Ms. Seema Rana and Dr. Vivek Sharma, Principal Scientist, Dairy Chemistry Division** received "**Best Poster Award**" for the poster entitled "Optimization of Spray Drying Conditions for Lab Scale Preparation of Milk Protein-Vitamin Complexes" in the NDRI Global Alumni Scientific Meet-2019, NGASM-2019/PPD-033, March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- » **Mr. Maulik Patel, Dr. Writdhama Prasad, Scientist Dr. Sumit Arora, Principal Scientist and Dr. Pradip Behare, Scientist, Dairy Chemistry Division** received "**Best Poster Award**" for the poster entitled "Evaluation of Iron Binding Ability of EPS Producing Cultures" presented in the 9th International Conference held from December 13-14, 2019 at Anand Agricultural University (AAU), Anand.
- » **Mr. Ravi Prakash, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru** received "**Best Poster Award**" during Nano-India Conference-2019, organized by DST, Govt. of India, held at Center of Nano-Science and Nano-Technology, M.G. University, Kottayam, Kerala, from April 26-27, 2019.
- » **Mr. N. Das, Dr. R. K. Bajaj, Principal Scientist, Dr. B. Mann, Head and Dr. R. Sharma, Principal Scientist, Dairy Chemistry Division** received "**2nd Best Poster Award**" for the poster "Chemical Composition and Protein Profiling of Milk from Indigenous Cattle" presented 47th Dairy Industry Conference at Patna from 7-9, 2019.
- » **Dr. Latha Sabikhi, Head, Mr. Gunvantsinh Rathod Scientist and Mr. Rajender Kumar, Dairy Technology Division** received "**2nd Best Poster Award**" for the poster entitled "Development of Buttermilk Solids-based Omega-3 Oil Encapsulate by Utilizing the Emulsion Stabilization Potential of Buttermilk". NDRI Global Alumni Scientific Meet-2019 held from March 15-17, 2019 at National Dairy Research Institute, Karnal.
- » **Mr. Prashant Goel, Dr. Naresh Kumar, Principal Scientist, Ms. Sonia Ranveer, Mr. Pradip Kumar Sharma and Ms. Karanpriya, Dairy Microbiology Division** received "**2nd Best Poster Award**" on "Spore-based Technology for Rapid Detection of Antibiotics and Pesticides Residues in Milk" NDRI Global Alumni Scientific Meet at ICAR-NDRI, Karnal during March 15-17, 2019.
- » **Ms. Priya Patel, Dr. Sumit Arora, Principal Scientist, Ms. Seema Rana and Mr. Harisha Bodemala, Dairy Chemistry Division** received "**3rd Best Poster Award**" for the poster entitled "Evaluation of Storage Stability of Astaxanthin in Flavoured Milk" presented in the National Seminar-Vision 2030 for Dairy Industry and 13th Alumni Convention, from January 4-5, 2019, at AAU, Anand.
- » **Mr. R. Suvartan, Dr. R. Sharma, Principal Scientist Dr. K. Gandhi, Scientist, Dr. B. Mann, Head and Mr. P. Nikam, Dairy Chemistry Division** received "**3rd Best Poster Award**" for the poster "Novel ATR-FTIR Based Method for Assessing Proteolysis in Ultra-High-Temperature (UHT) Treated Milk" during NDRI Global Alumni Scientific Meet held at ICAR-NDRI, Karnal during March 15-17, 2019.
- » **Mr. R. Suvartan, Dr. R. Sharma, Principal Scientist Dr. M. Singh, Dr. B. Mann, Head, Mr. P. Nikam, and Dr. A. Hooda, Dairy Chemistry Division** received "**3rd Best Poster Award**" for the poster "New Method for Assessing Proteolysis in UHT Milk" presented during the organization of National Seminar held at NDRI, Karnal during May 26-27, 2018.
- » **Mr. Bhagvat Kisan, Mr. Sunil Sakhala, and Dr. Sangita Ganguly, Scientist, Dr. Yogesh Khetra, Scientist and Dr. Latha Sabikhi, Head Dairy Technology Division** received "**3rd Best Poster Award**" for the poster entitled "Valorization of Mozzarella Cheese Whey into Probiotic Ricotta Cheese" during "NDRI Global Alumni Scientific Meet-2019" held from March 15-17, 2019 at National Dairy Research Institute, Karnal.
- » **Ms. Rebeka Sinha, Ms. Beena Sinha, Ms. Ragini Kumari, Mr. Vineeth M. R., Dr. Archana Verma, Principal Scientist and Dr. Ishwar Dayal Gupta, Principal Scientist, Animal Genetics & Breeding Division** received "**3rd Best Poster Award**" for the poster "Principal Component Analysis of Linear Udder Type Traits for Sustainable Milk Production in Sahiwal Cattle (TS-02-06)" during National Conference organised at ICAR-Central Institute for Research on Cattle, Meerut Cantt. during November 3-4, 2019.
- » **Mr. V. Batra, Dr. Rakesh Kumar, Principal Scientist and Dr. T. K. Datta, Principal Scientist, Animal Biotechnology Centre** received the "**3rd Best Poster Award**" for their paper "Unusual Evolutionary Positioning of Buffalo Class A B Defensins and their Distinct Selective Pressures vis-à-vis other Defensins" at NGASM 2019 organised at NDRI Karnal from March 15-17, 2019.

Best Poster Presentation Award

- » **Mr. R. V. Rajanikar, Mr. S. Ranvir, and Dr. P. V. Behare**, Dairy Microbiology Division received “**Best Poster Presentation Award**” for their paper on “Production of Phenyllactic Acid Enriched Anti-Microbial Formulation from *L. Plantarum*” during 47th Dairy Industry Conference, FSQ 9, held from February 7-9, 2019 at Patna.
- » **Ms. Anjali, M. K.**, Dairy Microbiology Division received “**Best Poster Presentation Award**” for the paper on “Conducting Polymer Strip Based Sensor for the Detection of Escherichia Coli in Milk” under Food Security, Quality Safety and Regulatory Aspects Category” during 47th Dairy Industry Conference 2019 held on February 7-9, 2019 at Patna.
- » **Dr. S. Roy, Dr. S. A. Hussain, Dr. W. G. Prasad**, Scientist, **Dr. Y. Khetra**, Scientist and **Dr. R. R. B. Singh**, Acting Director received “**Best Poster Presentation Award**” for the paper entitled “Development of High Protein Ice Cream” presented at 47th Dairy Industry Conference held at Patna, Bihar from February 7-9, 2019.
- » **Dr. Magan Singh**, Principal Scientist, **Dr. R. Kumar**, Principal Scientist, **Dr. H. Ram**, Scientist, **Dr. R. K. Meena**, Scientist, **Dr. V. K. Meena**, ACTO, **Dr. Sanjeev Kumar** Scientist, and **Mr. S. Ote**, Forage Research and Management Centre received “**Best Poster Presentation Award**” at 18th Biennial Conference, 2019 (INCAN 2019) held at Kolkata from December 17-19, 2019.
- » **Dr. Magan Singh**, Principal Scientist, Forage Research and Management Centre received “**Best Poster Presentation Award**” for the paper entitled “Quality Analysis of Fodder Maize with Cowpea Intercropping Followed by Oats for Seed Production” during International Conference organized by Department of Animal Nutrition, West Bengal University of Animal and Fishery Sciences, Kolkata in Collaboration with Animal Nutrition Society of India on December 17-19, 2019 at Kolkata.
- » **Mr. Yallappa, M.S., Dr. S. V. Singh**, Principal Scientist, **Mr. Aditya Deshpande, Ms. Parvender Sheoran, and Mr. V. P. Chahal**, Animal Physiology Division received “**Best Poster Presentation Award**” for the poster entitled, “Effect of Dietary Supplementation of Astaxanthin and Prill Fat to Lactating Buffaloes for Amelioration and Sustained Productivity during Heat Stress” presented at SVVU, Tirupati from October 14-15, 2019.
- » **Ms. Neeti Lakhani, Dr. Nitin Tyagi**, Sr. Scientist, **Mr. Antony T. Johnson** and **Mr. Digvijay Singh**, Animal Nutrition Division received “**Best Poster Presentation Award**” for their paper entitled, “Effect of Optimizing Dietary Fiber Levels on Production Performance of Heat Stressed Lactating Murrah Buffaloes” during International Conference on Animal Nutrition 2019 held from December 17-19, 2019 at Kolkata West Bengal.
- » **Mr. A. Sharma, Ms. V. Kumari, Mr. R. Srivastava** and **Dr. G. Mondal**, Sr. Scientist, Animal Nutrition Division received “**Best Poster Presentation Award**” for the presentation on “Effect of Different Combination of Inulin and *L. Plantarum* CRD7 on Performance on Health, Immunity and Antioxidant Status of Preruminant Calves” during National Conference held from November 3-4, 2019 at CIRC, Meerut.
- » **Mr. Sushil Kumar Yadav, Dr. Nitin Tyagi**, Sr. Scientist, **Ms. Bharti Sharma, Mr. Digvijay Singh, Ms. Neelam Tanwar, Dr. Sachin Kumar**, Scientist and **Dr. A. K. Tyagi**, Head, Animal Nutrition Division received “**Best Poster Presentation Award**” for the poster entitled “Responses of Combination of Xylanase and Lactic Acid Bacterial Inoculants on Quality of High Moisture Maize Silage” during International Conference on Animal Nutrition 2019 held from December 17-19, 2019 at Kolkata West Bengal,
- » **Mr. M. Thakur, Mr. R. Srivastava, Dr. M. Bhakat**, Sr. Scientist **Dr. T. K. Mohanty**, Principal Scientist, **Dr. Veena Mani**, Principal Scientist and **Dr. G. Mondal**, Sr. Scientist, Animal Nutrition Division received “**Best Poster Presentation Award**” for the poster entitled, “Effect of Dietary Supplementation of Trace Minerals on Semen Production Performance of Sahiwal Bulls during hot Season” organized by ANSI and WBUAFS, Kolkata during December 17-19, 2019.
- » **Mr. Rajender Kumar**, Ph.D. student, **Dr. Latha Sabikhi**, Head **Dr. Gunvantsinh Rathod**, Scientist and **Dr. Yogesh Khetra**, Scientist, Dairy Technology Division got “**Best Poster Presentation Award**” at the International Conference organised by Agro-Environmental Development Society at YS Parmar University of Horticulture & Forestry, Solan during September 27-29, 2019.
- » **Mr. S. Roy, Mr. S. A. Hussain, Dr. W. G. Prasad**, Scientist, **Dr. Y. Khetra**, Scientist and **Dr. R. R. B. Singh**, Acting Director received “**Best Poster Presentation Award**” for the Master’s work titled “Development of High Protein Ice Cream” presented at 47th Dairy Industry Conference held at Patna, Bihar during February 7-9, 2019.
- » **Ms. Soniya Ranveer, Ms. Vaishali Dasriya** and **Dr. Naresh Kumar**, Principal Scientist, Dairy Microbiology Division received “**Best Poster Presentation Award**” for the paper entitled “Development and Validation of Paper Strip Biosensor for Pesticide Residues Detection in Dairy Farm Chain”. NDRI Global Alumani Scientific Meet from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- » **Ms. Vaishali Dasriya, Ms. Ritu Joshi** and **Dr. Naresh Kumar**, Principal Scientist, Dairy Microbiology Division received “**Best Poster Presentation Award**” for the paper entitled “Spore Based Technology for Detection of

Pesticide in Cereal Based Food and Fruit Juices” during NDRI Global Alumani Scientific meet held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.

- » **Ms. Shruti Nayyar, Mr. Maulik Patel and Dr. Diwas Pradhan**, Scientist (SS), Dairy Microbiology Division received **“Best Poster Presentation Award”** for the Hindi poster entitled “Antimicrobial Resistance in Food Chain” during Rajbhasa Hindi Ullas Mass on September 30, 2019 at ICAR-NDRI, Karnal.
- » **Mr. K. Sudarani, and Dr. B. Srinivas**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru received **“Best Poster Presentation Award”** for the presentation on “Impact of Mono, Di and Polysaccharide Source of Energy Fortification to Diet on Dry Matter Intake in Crossbred Cows Prior to Calving” during International Conference on Animal Nutrition 2019 from December 17- 19, 2019 at Kolkata.
- » **Mr. Rajender Kumar**, Ph.D. student, **Dr. Latha Sabikhi**, Head and **Dr. Gunvantsinh Rathod**, Scientist, Dairy Technology Division got **“2nd Best Poster Presentation Award”** at NDRI Global Alumni Scientific Meet organised by ICAR-NDRI, Karnal during March 15-17, 2019.
- » **Mr. Rajender Kumar**, Ph.D. student, **Dr. Latha Sabikhi**, Head **Dr. Gunvantsinh Rathod**, Scientist and **Dr. Yogesh Khetra**, Scientist, Dairy Technology Division got **“2nd Best Poster Presentation Award”** at the National Conference organised by Department of Life Sciences and Department of Biotechnology at GraphicEra University, Dehradun during April 25-26, 2019.
- » **Mr. Gaurav Kumar Deshwal**, Scientist, **Mr. Debi Prasad Sahoo, Dr. P. Narender Raju**, Scientist, and **Mr. Tanweer Alam**, Dairy Technology Division received **“3rd Best Poster Presentation Award”** on Development of Electrospun Antioxidant Primary Packaging Material for Burfi at New Delhi on May 10, 2019.
- » **Ms. Sonia Mor, Dr. Surendra Nath**, Principal Scientist, **Dr. Laxmana Naik**, Principal Scientist, **Dr. F Magdalene Emerald Eljeeva**, Principal Scientist and **Dr. P. Heartwin Amaladhas**, Principal Scientist, SRS, ICAR-NDRI, Bengaluru received **“Best Poster Merit Award”** for the poster/Talk entitled preparation and characterization of milk biopeptides loaded niosomes at the National Conference on Health and Wellness through Nutrition and Nutraceuticals – 2020 organized by The Nutrition and Nutraceutical Research Centre, Ramaiah University of Applied Sciences, Bengaluru, India, from January 22-24, 2020.
- » **Dr. S. K. Jha**, Principal Scientist, Dairy Extension Division received **“Best Paper (Poster) Award”** during the ISEE National Seminar-2019 on “Socio-Digital Approaches for Transforming Indian Agriculture”, organized by Indian Society of Extension Education (ISEE), in collaboration with CCSHAU, Hisar (Haryana) and Banda University of Agriculture & Technology (BUAT), Banda (UP), during November 20-22, 2019, at CCSHAU, Hisar (Haryana)
- » **Ms. Anjali M. K., Mr. Raghu H. V.**, Scientist and **Dr. Naresh Kumar**, Principal Scientist, Dairy Microbiology Division got **“First Prize”** for poster presentation on “Conducting Polymer Strip based Sensor for the Detection of Escherichia Coli in Milk” Under Food Security, Quality Safety And Regulatory Aspects Category” during 47th Dairy Industry Conference held from February 7-9, 2019 at Patna.
- » **Mr. Avinesh Sharma, Dr. Chander Datt**, Principal Scientist, **Mr. Jitendra Kumar, Ms. Shambhvi, Dr. A. K. Tyagi**, Head, **Dr. Veena Mani**, Principal Scientist and **Mr. Prince Chauhan**, Animal Nutrition Division received **“First Prize”** for poster presentation on “Supplementary Effect of Red Seaweed Based Product on Feed Intake and Nutrient Utilisation in Lactating Crossbred Cow” during “National Conference held at Central Institute for Research on Cattle, Meerut, Uttra Pradesh from November. 3-4, 2019.
- » **Ms. Soniya Ranveer, Ms. Vaishali Dasriya**, Students and **Dr. Naresh Kumar**, Principal Scientist, Dairy Microbiology Division got **“First Prize”** for poster presentation on “Development and Validation of Paper Strip Biosensor for Pesticide Residues Detection in Dairy Farm Chain” during NDRI Global Alumani Scientific Meet held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- » **Ms. J. M. Hema, Dr. Richa Singh**, Scientist, **Dr. Bimlesh Mann**, Head, **Dr. Rajesh Kumar Bajaj**, Principal Scientist, **Dr. Priyanka Singh Rao**, Scientist, **Mr. Saurabh Gosewade**, Dairy Chemistry Division received **“First Prize”** for poster presentation on “Comparative Fat Digestibility from Milk of Different Breeds using GI Condition” during National Conference SLIETCON-2019” held at Chandigarh during March 1-2, 2019.
- » **Mr. Prashant Goel, Dr. Naresh Kumar**, Principal Scientist, **Ms. Soniya Ranveer, Mr. Pradip Kumar Sharma, Mr. Karanpriya**, Dairy Microbiology Division got **“Second Prize”** for poster presentation on “Spore based Technology for Rapid Detection of Antibiotic and Pesticide Residues in Milk” during NDRI Global Alumani Scientific meet held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.

Best Oral Presentation Awards

- » **Ms. Rita, Dr. Bimlesh Mann**, Head, **Dr. Rajan Sharma**, Principal Scientist, **Dr. Rajesh Bajaj**, Principal Scientist and **Mr. Saurabh Gosewade**, Dairy Chemistry Division received **“Best Oral Presentation Award”** for the presentation entitled “Characterization of Bioactive Peptide in Sodium Substituted Cheddar Cheese during Storage” presented during National Conference on “SLIETCON-2019 held from March 1-2, 2019 at Chandigarh.

- » **Dr. Vikas Vohra**, Principal Scientist and co-workers, Animal Genetics & Breeding Division received **“Best Oral Presentation Award”** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.
- » **Mr. S. A. Ali, Mr. K. Yadav, Mr. S. Kumar and Dr. A. K. Mohanty**, Principal Scientist, Animal Biotechnology Centre received **“Best Oral Presentation Award”** for the abstract ‘Phosphoproteomics, Proteo-transcriptomic and miRNAomics-based Analysis of Hormonal Clues for Mammary Gland Development’ during International Conference on “Proteomics for System Integrated Bio-omics, One Health and Food Safety” held at NDRI, Karnal from December 2-4, 2019.
- » **Dr. Magan Singh**, Principal Scientist, Forage Research and Management Centre received **“Best Oral Presentation Award”** for presentation on “Effect of Nutrient Management & Fodder Sorghum Cultivars on Yield and Quality of Fodder” during International Conference on Animal Nutrition 2019 organized by Department of Animal Nutrition, West Bengal University of Animal and Fishery Sciences, Kolkata in Collaboration with Animal Nutrition Society of India on December 17-19, 2019 at BBCC, Kolkata.
- » **Dr. G. P. Singh, Dr. Nitin Tyagi**, Sr. Scientist, **Dr. Madhu Mohini**, Principal Scientist and **Dr. G. Mondal**, Sr. Scientist, Animal Nutrition Division received **“Best Oral Presentation Award”** for the presentation on Depotash Vinasse as an Alternative to Molasses as Pellet Binder of Lactation Ration during International Conference on Animal Nutrition held from December 17-19, 2019 Kolkata at West Bengal.
- » **Dr. A. K. Puniya**, Principal Scientist, Dairy Microbiology Division received **“Best Oral Presentation Award”** (NPDF), 2019 during 7th International Conference on Biological Sciences (9th World food and Agriculture Congress) held from April 15-17, 2019 at New Delhi.
- » **Dr. B. S. Meena** Principal Scientist, Dairy Extension Division received in the form of **“Best Oral Presentation Award”** for the paper entitled “Employment Diversification and its effect on Livelihood Security of Farmers In Punjab” presented in ISEE National Seminar-2019 organized by Indian Society of Extension Education (ISEE), in collaboration with CCSHAU, Hisar and Banda University of Agriculture & Technology, Banda, during November 20-22, 2019, at CCSHAU, Hisar (Haryana)
- » **Mr. G. Savitha, Mr. B. Prithviraj, Dr. S. Bandla and Mr. S. N. Sondur**, SRS, ICAR-NDRI, Bengaluru received **“Best Oral Presentation Award”** for the presentation on “Characterization of Purified Glycerol Obtained from Jatropa Biodiesel as Cattle Feed” during International Conference organized by M. S. Ramaiah College of Art, Science and Commerce, Bengaluru during October 22-24, 2019.
- » **Mr. Ravi Prakash**, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru received **“Best Oral Presentation Award”** in JNANA CHILUME-2019, National Conference on Emerging Trends in Food Technology, held at Jain University, Bangalore, on March 29, 2019.
- » **Dr. S. Mondal, Dr. M. Bhakat**, Sr. Scientist, **Mr. A. Singh, Dr. T. K. Mohanty**, Principal Scientist, **Mr. M. Abdullah** and **Mr. S. K. Yadav**, Artificial Breeding Research Centre got **“2nd Best Oral Presentation Award”** for their paper entitled “Libido Problem is Untraceable through Testosterone and LH Rhythm in Zebu Breeding Bulls” presented at 19th Indian Veterinary Congress and 26th Annual Conference of IAAVR and National Symposium held from February 1-2, 2019 at WBUAFS, Kolkata, WB.
- » **Mr. Z. Danish, Dr. T. K. Mohanty**, Principal Scientist, **Dr. A. K. Dang**, Principal Scientist, **Dr. S. S. Lathwal**, Principal Scientist, **Dr. G. Mondal**, Sr. Scientist, **Mr. A. Rahim, Mr. R. Kumar, Mr. R. Sinha, Mr. A. R. Paray, Mr. H. P. Yadav** and **Ms. Priyanka Pratoliya**, Artificial Breeding Research Center received **“2nd Best Oral Paper Presentation Award”** for the paper entitled “Evaluation of Subclinical and Clinical Mastitis using Infrared Thermography in Dairy Animals” in National Conference held at Post Graduate Institute of Veterinary Education and Research, Jaipur during February 4-6, 2020.

Awards Won by Students

- » **Mr. Mohd. Iqbal Bhat**, Ph.D. Scholar under the supervision of **Dr. Rajeev Kapila**, Principal Scientist was awarded **“Best Thesis Award”** in “Dairy Processing” during 17th Convocation of ICAR-NDRI Deemed University on March 23, 2019.
- » **Mr. Himanshu Pandey** (Major Advisor : Dr Nishant Kumar) Livestock Production & Management Section received **“Best PG Thesis Award 2019”** in International Seminar on Modern Agriculture Approaches in 21st Century organized by Samagra Vikas Welfare Society (SVWS) from November 22-23, 2019 at University of Lucknow, Lucknow (UP).
- » **Mr. Yallappa Mallappa Somagond**, Animal Physiology Division received **“Best M.V.Sc Thesis Award”** for his thesis “Effect of Astaxanthin and Prill Fat Supplementation on Energy Metabolites, Stress Markers and Milk Production during Summer season in Rural Buffaloes” during “2nd Annual meeting of APA & National Conference on Issue and Strategies for Physiological Capacity Building in Animals” held at SVWU, Tirupati from October 14-15, 2019.

- » **Dr. Mohammad Rayees Dar** received “**Best Ph.D. Thesis Award 2019**” given by Innovations in Plant and Animal Sciences for Sustainable Agriculture and Rural Development (IPASSARD 2019) at Jaipur.
- » **Dr. P. Manjari** received “**Dr. Mridula Kamboj Young Scientist Award**” for her Ph.D. Thesis entitled “Monitoring of Plasma Cytokines, Hormones and Nutrophilic Activity during Implantation in Sahiwal Cows” at the Global Conference on Reproductive Health with Focus on Occupational, Environmental & Lifestyle Factors alongwith 29th Annual Meeting of the Indian Society for the Study of Reproduction and Fertility (ISSRF) held at AIIMS, New Delhi during February 22-24, 2019.
- » **Mr. Chaitanya Kumar Thota Venkata**, Ph.D. student under the guidance of Dr. Suneel Kumar Onteru, Principal Scientist, Animal Biochemistry Division received “**Best Poster Award**” for the paper entitled “Non Genetic Factors Associated with Post-Partum Anestrus in Murrah Buffaloes” during 2nd Annual Meeting of Animal Physiologists Association and National Conference on “Issues and Strategies for Physiological Capacity Building in Animals” held at Department of Veterinary Physiology, College of Veterinary Science, Tirupati, Andhra Pradesh, from October 14-15, 2019.
- » **Mr. Rajender Kumar**, Ph.D. student (Dairy Technology) got “**Japan East Asia Network of Exchange Fellowship**” for Students and Youth-2019 organised by Japan International Co-operation Centre for visiting Japan during November, 25 to December 3, 2019, as a participant from SAARC Countries.
- » **Mr. Shivam Panwar** (M.Tech, Dairy Technology) received “**Best Thesis Award**” (Processing Group) at 17th Convocation of ICAR-NDRI (Deemed University), Karnal during March 2019 who did his M.Tech. (Dairy Technology) dissertation work under the guidance of Dr. Narender Raju Panjagari.
- » **Dr. P. C. Kotresh, Dr. Pawan Singh**, Principal Scientist, **Mr. D. Barman, Dr. S. S Lathwal**, Principal Scientist, **Mr. S. Choudhary, Mr. G. Panchbhai**, and **Dr. M. Bhakat**, Sr. Scientist, Livestock Production & Management Section received “**Shri A. Lakshman Rao Award**” for Ph.D. thesis entitled “Effect of microclimatic conditions in different housing systems on performance of Murrah buffalo calves” in the National Conference on “Innovations in Animal Production for sustainability and doubling Farmers’ income” organized during 26th Annual convention of ISAPM held at C.V.A.S, KVASU, Mannuthy, Thrissur during January 23-25, 2019.
- » **Mr. Ravi Prakash**, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru received “**First Prize in Refcold India-Daikin Global Poster Competition**” held in *International Exhibition and Conference on Cold Chain, Industrial Refrigeration & Reefer Transportation* at Hitex Exhibition Center, Hyderabad, India (Cash Prize: INR 25,000; Guide: Dr. Menon Rekha Ravindra).



- » **Mr. Ravi Prakash**, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru received “**First Prize in Best Poster Award Competition**” during Indian Science Congress-2020, held from January 3-7, 2020 at University of Agricultural Science, GVKK campus, Bangalore (Cash Prize: INR 5,000; Guide: Dr. Menon Rekha Ravindra).
- » **Mr. Manjunatha B. M.**, Ph.D. Scholar at SRS, ICAR-NDRI, Bengaluru secured “**First Prize in Oral Presentation**” in FOOD XPLORE’19, 11th National Seminar on New Vistas in Food Processing Sectors, organized by Tamil Nadu Agricultural University, during October, 2019.
- » **Mr. S. Khalandar** received “**Best Thesis Award**” for his M.Sc. Thesis work entitled “Dynamics of Bovine Population and Milk Production Trends in Karnataka State” under the guidance of Dr. M. Sivaram during the International Conference on Global Research Initiatives for Sustainable Agriculture and Allied Sciences (GRISAAS-2019) held at NAARM, Hyderabad during October 20-22, 2019.
- » **Mr. Narender Kumar**, SRS, ICAR-NDRI, Bengaluru received “**Sushila Pathak Memorial Award**” for his M.V.Sc Thesis work under the guidance of Dr. A. Manimaran, Scientist of SRS, ICAR-NDRI Bangalore, during November 3, 2019 at ICAR-CIRC, Meerut from National Academy of Veterinary Nutrition and Animal Welfare.

- » **Ms. Harpreet Kaur**, Ph.D. student under the guidance of **Dr. Rajeev Kapila**, Principal Scientist, Animal Biochemistry Division participated in ANVESAN 2019-20 at Student's Research Convention (North Zone) under the area of Nutrition and Health held at Amity University Haryana during January 16-17, 2020 and presented project entitled "Role of *Lactobacilli* Fermented Sweet Whey in Reinforcement of Intestinal Epithelial Barrier Function"
- » **Ms. Ankita Kumari**, Ph.D. student under the guidance of **Dr. Rajeev Kapila**, Principal Scientist, Animal Biochemistry Division secured "**First Position**" for the presentation of project entitled "Deciphering the Role of Probiotic Lactobacilli on DNA and Histone Modifications in Intestinal Epithelial Cells" during ANVESAN 2019-20 at Student's Research Convention (North Zone) under the area of basic and applied sciences held at Amity University Haryana during January 16-17, 2020.

Other Awards/Appreciations

- » ICAR-NDRI won "**Best Stall Award**" in Agri. Summit 2019 organized at Motihari, Bihar from February 9-11, 2019.
- » **Best Division Award** (2017-18) was conferred on Southern Regional Station of ICAR-NDRI, Bengaluru for outstanding performance in Research and Education on March 23, 2019 during 17th Convocation of ICAR-NDRI by Dr. T. Mahapatra Hon'ble Director General, ICAR & Secretary, DARE, New Delhi.
- » **Dr. Bimlesh Mann**, Head, Dairy Chemistry Division selected as a Member of the Scientific Panel on Milk and Milk Products by Food Safety and Standards Authority of India (FSSAI) in January, 2020.
- » **Dr. Rajan Sharma**, Principal Scientist, Dairy Chemistry Division nominated as a Member of the Scientific Panel on Milk and Milk Products of Food Safety and Standards Authority of India (FSSAI) in 2019.
- » **Dr. Rajan Sharma**, Principal Scientist, Dairy Chemistry Division selected as a Member of the Scientific Panel on Method of Sampling and Analysis by Food Safety and Standards Authority of India (FSSAI) in January, 2020.
- » **Dr. Sumit Arora**, Principal Scientist, Dairy Chemistry Division nominated as a Member of the Scientific Panel on Panel on Nutrition and Fortification of Food Safety and Standards Authority of India (FSSAI) in 2019.
- » **Dr. Sumit Arora**, Principal Scientist, Dairy Chemistry Division nominated as a Member of the Scientific Panel on Panel on Sweets, Confectionery, Sweeteners, Sugars and Honey of Food Safety and Standards Authority of India (FSSAI) in 2019.
- » **Dr. Sumit Arora**, Principal Scientist, Dairy Chemistry Division selected as a Member of the Scientific Panel on Method of Labelling & Claims/Advertisements by Food Safety and Standards Authority of India (FSSAI) in January, 2020.
- » **Dr. Sumit Arora**, Principal Scientist, Dairy Chemistry Division selected as a Member of the Scientific Panel on Method of Sweets, Confectionery, Sweeteners, Sugars and Honey by Food Safety and Standards Authority of India (FSSAI) in January, 2020.
- » FSSAI has recently adopted a method "RP-HPLC based Method to Determine the Adulteration of Vegetable Oil in Ghee" developed in the laboratory on 25th March, 2019. (**Dr. Vivek Sharma**)
- » **Dr. Satish Kumar**, Principal Scientist, Animal Biotechnology Centre received "**Middle Career Scientist Award**" in the National Seminar of Indian Society of Sheep and Goat Production and Utilization (ISSGPU) on February 14-16, 2019 held at Bihar Animal Sciences University, Patna.
- » **Mr. P. S. Banakar**, **Dr. A. K. Tyagi**, Head, **Dr. Sachin Kumar**, Scientist, **Dr. B. Tyagi**, **Dr. Vinay, V. V.** and **Dr. C. K. Prasad**, Animal Nutrition Division received "**Mohammed Ismail Siddiqui Award**" at ISAPM, Conference, Jaipur held from February 4-6, 2020.
- » **Mr. P. S. Banakar**, **Dr. A. K. Tyagi**, Head **Dr. Sachin Kumar**, Scientist, **Dr. B. Tyagi**, **Dr. Vinay, V.V.** and **Dr. C. K. Prasad**, Animal Nutrition Division received "**Certificate of Merit**" at ISAPM, Conference, Jaipur held from February 4-6, 2020.
- » **Dr. A. K. Puniya**, Principal Scientist, Dairy Microbiology Division received "**Certificate of Appreciation**" presented by the Chairperson of 'The Annual Bio-medical Research Conference for Minority Students (ABRCMS)' held at Anaheim, California, USA, 2019, in recognition of his outstanding contribution as pre-conference abstract reviewer.
- » **Dr. B. S. Meena**, Principal Scientist, Dairy Extension Division conferred "**Certificate of Appreciation**" for his contribution in 6 programmes telecast through "ANNADATA" on News-18 Uttar Pradesh /Uttarakhand during the period from March, 2019 to June, 2019.
- » **Dr. B. S. Meena**, Principal Scientist, Dairy Extension Division conferred "**Certificate of Appreciation-2019**" in recognition of an outstanding contribution to quality of the journal by "Pashupati Foundation India", Noida (UP) India.
- » **Dr. B. S. Meena** Principal Scientist, Dairy Extension Division received "**Certificate of Special Honour**" for his oral presentation on fodder cultivation during "National Seminar and Exhibition on Entrepreneurship Issues and Challenges in Dairy & Food Processing Industries" organized by ICAR-NDRI, Karnal, Jiwaji University and Doodh Dairy Vyavsaai Sangh, Gwalior, during November 10-12, 2019 at Jiwaji University, Gwalior.

Rajbhasha Purskar

- » **Dr. Nishant Kumar**, Scientist **Dr. Pawan Singh**, Principal Scientist and **Dr. S. S. Lathwal**, Principal Scientist, Livestock Production & Management Section received "**Vishesh Pramaan Patra**" for technical bulletin entitled "Dairy Pashuon Mein Kritrim Garbhaadhaan" by Rajbhasha Vibhaag, NDRI, Karnal.
- » **Dr. Chitranayak**, Sr. Scientist, Dairy Engineering Division received "**Sansthan Rajbhasha Gourav Award**" during Rajbhasha Ullas Mas held from October 18, 2019 at ICAR-NDRI, Karnal.
- » **Dr. Chitranayak**, Sr. Scientist, Dairy Engineering Division received "**1st Prize**" in Essay competition organized by Town Official Language Implementation Committee during Rajbhasha Ullas Mas held from October 18, 2019 at ICAR-NDRI, Karnal.
- » **Dr. Surinder Kumar**, CTO and **Mr. Mohar Singh**, CTO, KVK got "**1st Prize**" for the year 2017-18 in folder preparation. The award was given for the folder "Mrida Swasthya Evom Pariyavaran Ko Bachane Ke Liye Dhaan Fasal Avashesh Prabandhan" under Hindi scientific writing category.
- » **Dr. Nishant Kumar**, Scientist, Livestock Production & Management Section received "**1st Prize**" for technical hindi article entitled "Dudharu Pashu Mad Mein Naa Aaye to Kya Karein" published in Dugdha Sarita (Hindi Magazine of Indian Dairy Association) in Vaigyanik Tatha Takniki Vishyon Ki Mul Hindi Lekhan Pratiyogita for year 2018-19 organized by ICAR-NDRI, Karnal.
- » **Dr. Asif Mohammad**, Scientist, ERS, ICAR-NDRI, Kalyani got "**1st Prize**" in "Byagyanik Bishay Par Byakhyan" (Presentation in Hindi) during celebration of Hindi Pakhwada during September 16-30, 2019 at Eastern Regional station of ICAR-NDRI.
- » **Dr. Asif Mohammad**, Scientist, ERS, ICAR-NDRI, Kalyani got "**1st Prize**" in "Gair Byagyanik Bishay Par Byakhyan" (Presentation in Hindi) during celebration of Hindi Pakhwada during September 16-30, 2019 at Eastern Regional station of ICAR-NDRI.
- » **Dr. Nishant Kumar**, Scientist, Livestock Production & Management Section received "**2nd Prize**" in Takniki Hindi Aalekh Pratiyogita organized by Rajbhasha Unit NDRI, Karnal for paper entitled "Gaabhin Gaay Ki Behtar Dekhbhaal Se Adhik Doodh Utpaadan"
- » **Ms. Anjali Kumari**, **Dr. Ramesh Chandra**, Principal Scientist, and **Mr. Suresh Kumar** Livestock Production & Management Section received "**2nd Best Poster Prize**" for the poster entitled "Utility of Polyherbal Mixture during Transition Period in Crossbred Cows" in "Rajbhasha Hindi Ullas Mas" organized by National Dairy Research Institute, Karnal on September 30, 2019.
- » **Dr. Magan Singh**, Principal Scientist, Forage Research and Management Centre received "**3rd Prize**" for hindi article entitled "Bajra: Garmiyon Ka Ek Saksham Chara" by Official Language Unit ICAR-NDRI, Karnal on June 29, 2019 ICAR-NDRI, Karnal.
- » **Dr. Rajesh Kumar Meena**, Scientist, **Dr. Magan Singh**, Principal Scientist **Dr. Ram Kishore Fagodia** and **Mr. Vijendra Kumar Meena**, ACTO, Forage Research and Management Centre received "**3rd Prize**" for writing popular article in Hindi entitled "Dhan Ke Samekit Popshak Tatv Prabandhan Main Azola Ka Mahtav" during Hindi Ullas Mas-2019 on June 29, 2019 ICAR-NDRI, Karnal.
- » **Mr. Jitendra Kumar**, **Mr. Muralidhar**, **Mr. Mitr**, **Mr. Hanumaan Prasad Yadav**, **Mr. Hari Brahm Singh** and **Dr. Chander Datt**, Principal Scientist, Animal Nutrition Division received "**3rd Prize**" for article in Hindi "Swachh Barat Ki Dairy Mein Prasangikta: Pradushan Avum Swasthya" published in Dugdha Ganga (8th issue, 2019) by ICAR-NDRI, Karnal.
- » **Mr. Dinesh Kumar**, **Dr. Magan Singh**, Principal Scientist **Mr. Taramani Yadav**, **Dr. Rakesh Kumar**, Principal Scientist and **Dr. Uttam Kumar**, CTO, Forage Research and Management Centre received "**4th Prize**" for Hindi poster presentation entitled "Til Adharit Antar Fasal Pranali Ka Utpadan Kshamata Evam Arthik Aklan" during Hindi Ullas Mas-2019, at ICAR-NDRI, Karnal.
- » **Mr. Avinesh Sharma**, **Dr. Chander Datt**, Principal Scientist, **Mr. Jitendra Kumar**, **Ms. Shambhvi**, **Dr. A. K. Tyagi**, Head and **Dr. Veena Mani**, Principal Scientist, Animal Nutrition Division received "**4th Prize**" for poster presentation on "Lal Samudri Shaival Ki Purakta Ka Dudharu Sankar Gayon Mein Aahar Upyog Aur Dudh Utpaadan Par Prabhav" during Rajbhasha Hindi Ullas Mas-2019 on September 30, 2019 at ICAR-NDRI, Karnal, Haryana.
- » KVK was awarded Institute shield for encouraging work in Hindi from Dr. R. R. B. Singh, Director NDRI, Karnal in a programme organized by Hindi cell on October 18, 2019.
- » **Mr. Mohar Singh**, CTO and **Dr. Surinder Kumar**, CTO, KVK received award for the folder "Gehoon Ki Adhik Paidavar Ke Liye Naveentam Krishi Taknik" in a programme organized by Hindi cell on October 18, 2019.



PUBLICATIONS

Institute Publications/Technical Bulletins/Training Manuals/Compendia

- Aggarwal, A. (2019) *Heat Shock Proteins as Biomarker of Thermal Stress in Cows and Buffaloes under Changing Climatic Scenario*. Technical Bulletin, NICRA, NDRI Publication no. 171/2019.
- Aggarwal, A. and Kumar, N. (2019) *Jalvayu Parivartan Aur Dudharu Pashuon Ka Prabandhan*. NDRI Publication No. 170/2019.
- Deb, S. M., Arora, Sumit, Prasad, Writdhama, Khamrui, Kaushik, Yadav, Karmveer, Mittal, Deepti and Ali, Syed Azmal (2019) (Ed.) (Souvenir) "NDRI Global Alumni Scientific Meet-2019" March 15-17, 2019 at NDRI, Karnal. Conference organised ICAR- NDRI, Karnal
- Devaraja, H. C., Sharma, Monika, Satish Kumar, M. H., Rao, Jayaraj, Ghosh, B. C. (2019) *Laboratory Manual for Fat Rich and Indigenous Dairy Products*. Southern Regional Station of ICAR-NDRI, Bengaluru.
- Dixit, A. K., Chandel, B. S., Sharma, A. K., Bhandari, G. and Yadav, H. (Editors), (2019) *Market Strategies for Promotion of Dairy Products*. Training Lectures' Compendium, Jointly Published by ICAR-NDRI, Karnal and CCS-NIAM, Jaipur.
- Dixit, P. K., Ramesha, K. P., Naik, Laxmana and Kataktalware, Mukund M. (2019) *NDRI Profile Brochure in Kannada*. Southern Regional Station of ICAR-NDRI, Adegodi, Bengaluru-560 030.
- Jeyakumar, S., Satish Kumar, M. H, Laxmana Naik, N., Devaraja, H. C., Ramesha, K. P., and Subash, S. (2019) *Quality Assurance and Safety of Dairy Products – An Update on FSSAI Regulations*. Souvenir of Workshop, July 1, 2019, Bengaluru. pp: 89.
- Kataktalware, M. A., Jeyakumar, S. Manimaran, A. and Ramesha, K. P. (2019) *Teaching Manual on Dairy Production Management*. Southern Regional Station of ICAR-NDRI, Bengaluru. pp: 1-91.
- Kataktalware, M. A., Ramesha, K. P. and Jeyakumar, S. (Eds). (2019) Compendium of ICAR sponsored Winter School on 'Conservation and Improvement of Indigenous Bovine Genetic Resources through Integrated Omic Approaches and Optimal Resource Utilization' held at Southern Regional Station of ICAR-NDRI, during November 6-26, 2019. pp: 1-146.
- Singh, M. and Roy, A. K. (2019) *Innovative Tools for Teaching in Animal Physiology*. ICAR-National Dairy Research Institute, Karnal (Haryana) pp: 61..
- Singh, Richa, Rao, Priyanka, Gandhi, Kamal, Sharma, Rajan, and Mann, Bimlesh (2019) "Technological Advances in Functional Food Ingredients and Validation of their Claims". ICAR-National Dairy Research Institute, Karnal.
- Subash, S. and Devi, M. C. A. (2019) *Model Training Course on Good Dairy Management Practices for Sustainable Dairy Farming*. Southern Regional Station of ICAR-NDRI, Bengaluru, India, pp: 1-140.

Animal Genetics & Breeding

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Ali, S. S., Kuralkar, S.V., Ingawale, M. V., Waghmare, S. P., Manwar, S. J., Kataria, R. S. and Vohra, V. (2019) Phenotypic characterization, management and socio-economic impact of Purnathadi buffaloes. <i>Indian J. Anim. Sci.</i> , 89 (10): 1161-66.	Nil	6.23
2	Lavakumar, S., Singh, R., Niranjana, S. K., Mishra, S. K., Kumar, P., Vohra, V., Dash, S. K. and Kataria, R. S. (2019) Cytogenetic characterization of Sambalpuri and Manda buffaloes of Odisha. <i>Indian J. Anim. Sci.</i> , 89 (1): 53-56.	Nil	6.23
3	Mishra, S. K., Dubey, P. K., Dhiman, A., Dubey, S., Verma, D., Kaushik, A. C., Singh, R., Niranjana, S. K., Vohra, V., Mehrara, K. L., and Kataria, R. S. (2019) Sequence-based structural analysis and evaluation of polymorphism in buffalo Nod-like receptor-1 gene. <i>3 Biotech.</i> , 9 (1): 26. https://doi.org/10.1007/s13205-018-1534-2 .	1.786	7.79

S. No.	Research Papers	Impact Factor	NAAS Rating
4	Mukherjee, Anupama, Mukherjee, Sabyasachi, Imsusosang, Longkumer, Moonmoon, Mech, Nazrul, Haque, Kezhavituo, Vupru, Kobu, Khate and Rajkhowa, Chandan (2019) Genomic characterization of mithun (<i>Bos frontalis</i>) populations using high density SNP array. <i>Indian J. Genetics</i> , 79 : 1.	0.465	6.47
5	Mukherjee, Sabyasachi, Zexi, Cai, Mukherjee, Anupama, Imsusosang, Longkumer, Moonmoon Mech, Kezhavituo Vupru, Khate, Kobu, Rajkhowa, Chandan, Mitra Abhijit, Bernt, Guldbrandtsen, Lund, Mogens Sandø and Goutam, Sahana (2019) Whole genome sequence and de novo assembly revealed genomic architecture of Indian Mithun (<i>Bos frontalis</i>). <i>BMC Genomics</i> , 20: 617-29.	3.53	9.50
6	Saikia, J., Verma, A., Gupta, I. D., Singh, S. and Hazarika, D. (2019) Identification of genetic variants in HSF1 gene and their association with heat tolerance in Murrah buffaloes. <i>Indian J. Anim. Sci.</i> , 89 (10): 1099-1103.	Nil	6.23
7	Shabhat, Mumtaz and Mukherjee, Anupama (2019) Incidence of inbreeding and its influence on performance traits in Sahiwal cattle. <i>J. Livestock Biodiversity</i> , 9 (1): 36-41.	Nil	2.38
8	Sharma, R., Ahlawat, S., Sharma, H., Kulkarni, V. S., Kataria, R. S., Vohra, V. and Tania, M. S. (2019) Microsatellite based genetic diversity and mutation-drift equilibrium in Dharwadi Buffalo (<i>Bubalus bubalis</i>) of India. <i>Agric. Res.</i> , 8 (4): 553-58.	Nil	5.90
9	Singh, N. P., Vohra, V., Das, R., Verma, U., Tania, M. S. and Kataria R. S. (2019) Elucidating the genetic diversity using SSR based markers in Gojri buffalo. <i>Indian J. Anim. Sci.</i> , 89 (5): 522-27.	Nil	6.23
10	Sinha, Rebeka, Sinha, Beena, Kumari, Ragini, Vineeth, M. R., Verma, Archana and Gupta, Ishwar Dayal (2019) Effect of season, stage of lactation, parity and level of milk production on incidence of clinical mastitis in Karan Fries and Sahiwal cows. <i>Biological Rhythm Res.</i> DOI: 10.1080/09291016.2019.1621064.	0.773	6.77
11	Verma, Uma Kant, Vohra, V., Gupta, I. D., Verma, A., Mukherjee, A. and Deb, S. M. (2019) Assessment of lactation curve parameters for test-day milk yield, Fat% and SNF% in Murrah Buffalo. <i>Indian J. Dairy Sci.</i> , 72 (6): 639-44.	Nil	5.26
12	Vineeth, M. R., T. Surya, Jayakumar, Sivalingam, Kumar, Anshuman, Niranjana, S. K., Dixit, S. P., Singh, Karanveer, Tania, M. S. and Gupta, I. D. (2019) Genome-wide discovery of SNPs in candidate genes related to production and fertility traits in Sahiwal cattle. <i>Trop Anim Health Prod.</i> https://doi.org/10.1007/s11250-019-02180-x .	1.089	7.09

Livestock Production & Management

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Acharya, P., Lathwal, S. S., Baithalu, R. K., Patnaik, N., Thul, M. R. and Moharana, B. (2019) Supplementing rumen protected choline with green tea extract improves reproductive performances in transition Karan Fries cows. <i>Ind. J. Anim. Res.</i> Online ISSN:0976-0555: 1-4.	0.437	6.20
2	Acharya, P., Lathwal, S. S., Moharana, B., Patnaik, N. M., Thul, M. (2019) Analysing the effect of supplementing rumen protected choline with green tea extract in transition Karan Fries cows. <i>Int. J. Curr. Microbiol. App. Sci.</i> , 8 (2) : 2432-40.	Nil	5.38
3	Acharya, Parag, Lathwal, S. S., Patnaik, Neela Madhav, Moharana, Baisakhi (2019) Rumen protected choline along with green tea extract maintain glucose homeostasis in transition Karan Fries cows. <i>Ind. J. Anim. Nutr.</i> , 36 (3) : 276-80.	Nil	5.02
4	Baithalu, R. K., Singh, S. K., Kumaresan, A., Kumar, S., Maharana, B. R., Mallick, S., Mohanty, T. K. and Mohanty, A. K. (2019) Targeted transcript analysis revealed association of suboptimal expression of certain endometrial immunity-related genes with disparate uterine diseases in zebu cows. <i>Trop. Anim. Health Prod.</i> , 51: 2493-2503.	Nil	6.98
5	Chandrasekar, T., Lathwal, S. S., Singh, Pawan and Karuthadurai, T. (2019) Effect of polyherbal mixture supplementation on postpartum productive performance in Karan Fries (KF) cows. <i>J. Anim. Res.</i> , 9 (1) : 115-18.	Nil	6.44
6	Chaudhary, Sanjay, Kamboj, M. L., Raheja, Nitin, Kotresh Prasad C., Singh, Pawan, Kumar, Nishant, Barman, Deepandita and Bhakat, Mukesh (2019) Influence of bull exposure on the behavioural intensity of estrus in Sahiwal Heifers (<i>Bos Indicus</i>). <i>Ind. J. Dairy Sci.</i> , 72 (3) : 307-11.	Nil	5.26
7	Choudhary, Man Singh, Lathwal S. S., Prasad C. Kotresh, Magotra, A., Gupta, A., Lathwal, Indu and Saini, M. (2019) Feeding management practices followed by farmers rearing Haryana cattle in its breeding tract. <i>J. Entomol Zool Studies</i> , 7 (1): 1358-60.	Nil	5.53
8	Choudhary, Man Singh, Lathwal, S. S., Prasad, C. Kotresh, Dey, Deepak, Gupta, Anuradha, Saini, Mayamitta, Lathwal, Indu, Sharma, Bharti, Kumar, Muneendra and Sharma, Vijay (2019) Availability of feed sources and nutritional status of Haryana cattle in different seasons in the breeding tract. <i>Biol. Rhythm Res.</i> , https://doi.org/10.1080/09291016.2019.1607222	Nil	6.77

S. No.	Research Papers	Impact Factor	NAAS Rating
9	Choudhary, S. and Kamboj, M. L. (2019) Effect of bull biostimulation on estrous behaviour of pubertal Sahiwal (<i>Bos indicus</i>) heifer. <i>Anim. Reprod. Sci.</i> , 209 : 106-49.	Nil	7.82
10	Choudhary, S., Kamboj, M. L., Raheja, N., Prasad, C. K., Singh, P., Kumar, N., Barman, D. and Bhakat, M. (2019) Influence of bull exposure on the behavioural intensity of estrus in Sahiwal heifers, <i>Ind. J. Dairy Sci.</i> , 72 (3): 307-11.	Nil	5.26
11	Choudhary, S., Kamboj, M. L., Raheja, N., Kumar, N., Saini, M. and Lathwal, S. S. (2019) Influence of bull biostimulation on age at puberty and reproductive performance of Sahiwal breed (<i>Bos indicus</i>) of cattle. <i>Ind. J. Anim. Sci.</i> , 90 (1) : 28-34.	Nil	6.23
12	Devi, Indu, Singh, Pawan, Lathwal, Surender S., Dudi, Kuldeep, Singh, Yajuvendra, Ruhil, Anand P., Kumar, Anil, Dash, Sukanta and Malhotra, Ravinder (2019) Threshold values of acoustic features to assess estrous cycle phases in water buffaloes (<i>Bubalus bubalis</i>). <i>Appl. Anim. Behav. Sci.</i> , 219 : 104838.	Nil	7.82
13	Gupta, S. K., Chandra, R., Kumar, N., Shinde, K. P., Lone, S. A. and Patel, B. (2019). Effect of Azolla feeding on testicular biomtry of Alpine x Beetal crossbred kids. <i>Haryana Vet.</i> , 58 : 70-72.	Nil	5.36
14	Jaiswal, L., De, S., Singh, R. K. and Baithalu, R. K. (2019) Molecular characterization and protein structure prediction of heat shock transcriptional factors in goat (<i>Capra hircus</i>) and sheep (<i>Ovis aries</i>). <i>Anim. Biotechnol.</i> , 4 : 1-8.	1.263	6.93
15	Kerketta, S., Mohanty, T. K., Bhakat, M., Kumaresan, A., Baithalu, R. K., Gupta, R., Mohanty, A. K., Abdullah, M., Kar, S. K., Rao, V. and Fahim, A. (2019) Moosense pedometer activity and peri-estrous hormone profile in relation to oestrus in crossbred cattle. <i>Ind. J. Anim. Sci.</i> , 89 (12): 1338-44.	0.227	6.28
16	Kumar, Nishant, Ghosh, S. K., Mohanty, T. K., Prasad, J. K., Singh, R. K. and Patel, B. (2019) Effect of heat stress on physico-morphological characteristics and sperm functions in Murrah buffalo semen. <i>Ind. J. Anim. Sci.</i> , 89 (4) : 390-93.	Nil	6.23
17	Misra, A. K. (2019) Approaches for enhancing productivity of smallholder dairy production in India. <i>Ind. J. Anim. Prod. Manag.</i> , 35 (1- 2): 59-67.	Nil	
18	Misra, A. K. (2019) Fodder production and utilization strategies for sustainable livestock development in India. <i>Annals of Arid Zone</i> , 58 (1 & 2): 1-11.	Nil	3.02
19	Raheja, N., Kumar, N. and Lathwal, S. S. (2019) Dietary betaine reduces incidence of follicular cyst in post-partum Karan Fries cows during hot-humid season. <i>Ind. J. Anim. Sci.</i> , 89 (12) : 1332-37.	Nil	6.23
20	Rawat, Nawal S., Lathwal, S. S., Panchbhai, Girish J., Sawant, Manish N., Jha, Amit K. and Gupta, Shailesh K (2019) Physical and microbial characteristics of fresh urine and dung of heifer and lactating Sahiwal cow. <i>J. Pharmacog Phytochem</i> , 8 (1) 2753-56.	Nil	5.21
21	Regar P. C., Kamboj, M. L., Sawant, Manish, Ojha, S. N. and Roat, B. L. (2019) Housing and management system practiced by tribal farmers in Rajasthan. <i>Asian J. Agri. Extn., Eco. and Sociology</i> , 32 (2) : 1-6.	Nil	4.35
22	Selvan, A. Sakthivel, Tanta, M. S., Kumar, D. Ravi, Karuthadurai, T., Upadhyay, Arpan, Lathwal, S. S., Kumaresan, A. (2019) Factors influencing calf mortality in zebu and crossbred cattle reared under subtropical agroclimatic conditions. <i>Ind. J. Anim. Sci.</i> , 89 (3) : 80-85	Nil	6.23
23	Shinde, K. P., Chandra R., Grover C. R., Verma S. and Gupta, S. K. (2019) Chemical composition of dahi prepared from whole Murrah buffalo milk using <i>Lactobacillus plantarum</i> CRD 2 and <i>Lactobacillus rhamnosus</i> CRD 9 probiotic cultures. <i>International J. Chem. Studies</i> , 7 (2): 885-88.	Nil	5.31
24	Shinde, K. P., Chandra, R., Grover C. R., Panchbhai G., Verma S., Gupta, S K. and Singh A. K. (2019) Effect of supplementation of <i>Lactobacillus plantarum</i> CRD 2 and <i>Lactobacillus rhamnosus</i> CRD 9 probiotic cultures on physiological responses in Murrah buffalo calves. <i>J. Pharmacog Phytochem</i> , 8 (2): 1790-99.	Nil	5.21
25	Singh, A. K., Misra, A. K., Raghubansi, N., Singh, S. K. and Singh, V. K. (2019) Strategies for promotion of dairy farming in eastern Uttar Pradesh. <i>Mulilogic Science</i> . www.ycjournal.net , ISSN 2277-7601.	Nil	
26	Singh, Premlata, Kumar, Nishant and Pandey, R. P. (2019) Large white yorkshire boar semen preservation at refrigeration temperature. <i>International J. Curr. Microbiol. Appl. Sci.</i> , 8 (6) : 3403-08	Nil	5.38
27	Sinha, R., Kamboj, M. L., Ranjan, A. and Devi, I. (2019) Effect of microclimatic variables on physiological and hematological parameters of crossbred cows in summer season. <i>Ind. J. Anim. Res.</i> 53 (2): 173-77.	Nil	6.44
28	Yadav, Satendra Kumar, Singh, Pawan, Kumar, Pradeep, Singh, S. V., Singh, Ajeet and Kumar, Sunil (2019). Scrotal infrared thermography and testicular biometry: Indicator of semen quality in Murrah buffalo bulls. <i>Anim. Reprod. Sci.</i> , 209 : 106-45.	Nil	7.82

Animal Biotechnology Centre

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Batra, V., Maheshwarappa, A., Dagar, K., Kumar S., Soni, A., Kumaresan, A., Kumar, R. and Datta, T. K. (2019) Unusual interplay of contrasting selective pressures on β -defensin genes implicated in male fertility of the Buffalo (<i>Bubalus bubalis</i>). <i>BMC Evolutionary Biology</i> , 19 : 214.	3.02	9.03
2	Choudhary, S., Janjanam, J., Kumar, S., Kaushik, J. K. and Mohanty, A. K. (2019) Structural and functional characterization of buffalo oviduct-specific glycoprotein (OVGP1) expressed during estrous cycle. <i>Bioscience Reports</i> , 39 (BSR20191501): 1-17.	2.535	8.535
3	Dua, D., Nagoorvali, D., Chauhan, M. S., Palta, P., Mathur, P. and Singh, M. K. (2019) Calcium ionophore enhanced developmental competence and apoptotic dynamics of goat parthenogenetic embryos produced <i>in vitro</i> . <i>In Vitro Cellular & Developmental Biology - Anim.</i> , 55 (3): 159-168.	1.447	7.45
4	Gupta, A. K., Kumar, G. K., Rani, K., Pokhriyal, R., Khan, M. I., Kumar, D. R., Goyal, V., Tripathi, M., Gupta, R., Chadda, R. K., Vanamail, P., Mohanty, A. K. and Hariprasad, G. (2019) 2D-DIGE as a strategy to identify serum protein biomarkers to monitor pharmacological efficacy in dopamine-dictated states of Parkinson's disease and schizophrenia. <i>Neuropsychiatric Disease and Treatment</i> , 15: 1031.	2.195	8.195
5	Jaiswal, L., De, S., Singh, R. K. and Baithalu, R. K. (2019) Molecular characterization and protein structure prediction of heat shock transcriptional factors in goat (<i>Capra hircus</i>) and sheep (<i>Ovis aries</i>). <i>Animal Biotechnology</i> , 4 : 1-8.	1.263	7.236
6	Jaiswal, L., De, S. and Singh, R. K. (2019) Seasonal variation in expression pattern of heat shock factor genes in <i>Ovis aries</i> and <i>Capra hircus</i> . <i>Indian J. Anim. Sci.</i> , 89 (9): 951-54.	0.26	6.26
7	Jena, M. K., Jaswal, S., Kumar, S. and Mohanty, A. K. (2019) Molecular mechanism of mammary gland involution: An update. <i>Developmental Biology</i> , 445 (2): 145-56.	2.936	8.936
8	Kumar, S., Balhara, A. K., Buragohain, L., Kumar, R., Sharma, R. K., Phulia, S. K., Mohanty, A. K. and Singh, I. (2019) Identification of novel proteomics markers involved in ovarian endocrinology of riverine buffalo (<i>Bubalus bubalis</i>). <i>Biological Rhythm Res.</i> , Doi 10.1080/09291016.2019.16580-61: 1-13.	0.77	6.77
9	Lagah, S. V., Sood, T. J., Palta, P., Mukesh, M., Chauhan, M. S., Manik, R. S., Singh, M. K. and Singla, S. K. (2019) Selection of reference miRNAs for relative quantification in buffalo (<i>Bubalus bubalis</i>) blastocysts produced by hand-made cloning and in vitro fertilization. <i>Cellular Reprogramming</i> , 21 (4): 200-209.	1.453	7.453
10	Lotfan, M., Choudhary, S., Yadav, M. L., Tripathi, I., Bhan, S. S., Bathla, S., Rawat, P., Kumar, S., Mohanty, T. K., Kaushik, J. K. and Mohanty, A. K. (2019) Characterization of buffalo native pregnancy-associated glycoprotein: Mass spectrometry-based glycan composition analysis, sugar-binding characteristics and proteolytic activity assay. <i>J. Proteins and Proteomics</i> , 10 (1): 23-32.	Nil	4.5
11	Mehta, P., Kaushik, R., Singh, K. P., Sharma, A., Singh, M. K., Chauhan, M. S., Palta, P., Singla, S. K. and Manik, R. S. (2019) Comparative analysis of buffalo (<i>Bubalus bubalis</i>) non-transgenic and transgenic embryos containing human insulin gene, produced by SCNT. <i>Theriogenology</i> , 135: 25-32.	2.299	8.299
12	Parkunan, T., Ashutosh, M., Sukumar, B., Chera, J. S., Ramadas, S., Chandrasekhar, B., Kumar, S. A., Sharma, R., Kumar, M. S. and De, S. (2019) Antibiotic resistance: A cross-sectional study on knowledge, attitude, and practices among veterinarians of Haryana state in India. <i>Vet. World</i> , 12 (2): 258-65.	1.12	7.12
13	Raja, A. K., Sahare, A. A., Jyotsana, B., Priya, D., Palta, P., Chauhan, M. S., Manik, R. S. and Singla, S. K. (2019) Reducing the cytoplasmic volume during hand-made cloning adversely affects the developmental competence and quality, and alters relative abundance of mRNA transcripts and epigenetic status of buffalo (<i>Bubalus bubalis</i>) embryos. <i>Anim. Reprod. Sci.</i> , 208 : 106-36.	1.817	7.817
14	Rawat, N., Singh, M. K., Sharma, T., Vats, P., Nagoorvali, D., Palta, P., Chauhan, M. S. and Manik, R. S. (2019) Media switching at different time periods affects the reprogramming efficiency of buffalo fetal fibroblasts. <i>Animal Biotechnology</i> , 10 : 1-14.	0.69	6.69
15	Sharma, A., Shandilya, U. K., Sodhi, M., Jatav, P., Mohanty, A. K., Jain, P., Verma, P., Kataria, R. S., Kumari, P. and Mukesh, M. (2019) Milk-derived mammary epithelial cells as non-invasive source to define stage-specific abundance of milk protein and fat synthesis transcripts in native Sahiwal cows and Murrah. <i>3 Biotech</i> , 9 (3): 106.	1.786	7.786
16	Sood, T. J., Lagah, S. V., Mukesh, M., Singla, S. K., Chauhan, M. S., Manik, R. S. and Palta, P. (2019) RNA sequencing and transcriptome analysis of buffalo (<i>Bubalus bubalis</i>) blastocysts produced by somatic cell nuclear transfer and in vitro fertilization. <i>Molecular Reproduction and Development</i> , 86 (9): 1149-67.	2.124	8.124

S. No.	Research Papers	Impact Factor	NAAS Rating
17	Singh, S., Choudhary, S., Anand, V., Jaswal, S., Verma, A. K., Kumar, S., Kaushik, J. K. and Mohanty, A. K. (2019) New insights into the catalytic inactivity of mammary gland protein-40, a chitinase-like protein expressed during mammary gland involution. <i>Molecular Biology Reports</i> , 46 (2): 2243-57.	2.11	8.11
18	Singh, S., Kalra, S., Bubber, P., Datta, T. K., Mohanty, A. K. and Kaushik, J. K. (2019) Functional analysis of recombinant buffalo lactoferrin and monoferric lobes and their cytotoxic effect on buffalo mammary epithelial cells. <i>BioMetals</i> , 32 (5): 771-83.	2.46	8.46
19	Singh, S., Shyam, S., Sah, S., Singh, M. K. and Palta, P. (2019) Treatment of buffalo (<i>Bubalus bubalis</i>) somatic cell nuclear transfer embryos with microRNA-29b mimic improves their quality, reduces DNA methylation, and changes gene expression without affecting their developmental competence. <i>Cellular Reprogramming</i> , 21(4): 210-19.	1.453	7.453
20	Verma, M., Dige, M. S., Kaushik, R., Gautama, D., De, S. and Rout, P. K. (2019) Milk composition traits in Jamunapari goats: Genetic parameters and effect of CSN1S1 gene variants. <i>Int. J. Dairy Tech.</i> , https://onlinelibrary.wiley.com/doi/epdf/10.1111/1471-0307.12651	1.522	7.522

Animal Physiology Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Aggarwal, A., Dar, M. R., Preeti, Singh, Mahendra, Kumar, Parveen, Renuka, U. and Rawal, V. (2019) Physiological changes and blood flow in different breeds of dairy cows during different seasons. <i>Biological Rhythm Res.</i> , DOI: 10.1080/09291016.2019.1627642.	Nil	6.77
2	Choudhary, R., Sharma, A., Kumar, S., Upadhyay, R. C., Singh S. V. and Mohanty A. (2019) Role of alpha-melanocyte stimulating hormone (α -MSH) in modulating the molecular mechanism adopted by melanocytes of <i>Bos indicus</i> under UVR stress. <i>Molecular and Cellular Biochemistry</i> . DOI: 10.1007/s11010-019-03674-w.	2.561	8.88
3	Grewal, S., Aggarwal, A. and Alhussien, M. (2019) Integrated effects of seasonal and parturition associated stress on the inflammatory response and metabolic status in Sahiwal (<i>Bos Indicus</i>) cows. <i>Biological Rhythm Res.</i> , https://doi.org/10.1080/09291016.2019.1627657 .	0.773	6.77
4	Grewal, S., Aggarwal, A. and Alhussien, M. (2019) Seasonal alterations in the expression of inflammatory cytokines and cortisol concentrations in periparturient Sahiwal cows. <i>Biological Rhythm Res.</i> , https://doi.org/10.1080/09291016.2019.1670971 .	0.773	6.77
5	Irshad A. P., Shah, M. A., Punetha, M., Hussain, H. Dar, Rautela, A., Gupta, D., Singh, Mahendra, Naik, M. A., Rayees, M., Dar, P. S. and Malla, B. A. (2019) Feed fortification of periparturient Murrah buffaloes with dietary yeast (<i>Saccharomyces cerevisiae</i>) elevates metabolic and fertility indices under field conditions, <i>Biological Rhythm Res.</i> , DOI: https://doi.org/10.1080/09291016.2018.1557834 .	0.773	6.77
6	Kumar Amit, Pandita, Sujata, N. Anand Laxmi, Bhakat, Mukesh and Mohanty, T. K. (2019) Effects of prostasomes on functional parameters of fresh and cryopreserved-thawed spermatozoa of crossbred Karan Fries (KF) bulls. <i>Indian J. Anim. Res.</i> , 53 (9): 1167-71.	0.044	6.44
7	Kumar, Amit, Pandita, Sujata and Anand Laxmi N (2019) <i>Bacillus megaterium</i> in vitro growth inhibition and sperm motility and viability improvement in karan fries (Tharparkar \times HolsteinFriesian) and Sahiwal bulls by prostasomes supplementation. <i>J. Entomology and Zoology Studies</i> , 7 (5): 232-37.	Nil	5.53
8	Kumar, S. and Singh, S. V. (2019) Heat stress amelioration by astaxanthin supplementation and Nrf2 transcribed down regulation of HSP70 and MnSOD in Karan Fries (Holstein Friesian \times Tharparkar) heifers. <i>Indian J. Anim. Sci.</i> , 89 (11): 1211-16.	0.279	6.23
9	Manjari, P., Hyder, I and Dang, A. K. (2019) Implantation associated divergence in neutrophil glucocorticoid and cysteine-X-cysteine receptor genes in cattle. <i>Molecular Biology Reports</i> , https://doi.org/10.1007/s11033-019-04865-w .	2.107	7.83
10	Panda, B. S., Mohapatra, S. K., Alhussien, M. N. and Dang, A. K. (2019) Amount of milk neutrophil percentage and associated CD molecular changes on the compositional and technological properties of milk. <i>Open Biotechnology, J.</i> , 13 (1): 129-36.	Nil	Nil
11	Singh, S. V. and Naskar, S. (2019) Adaptation and mitigation strategies for sustained livestock production under changing climatic scenario. <i>J. Agrometeorol.</i> , 21 : 15-28.	0.64	6.64
12	Singh, S.V., Kumar, Y. and Kumar, S. (2019) Impact of temperature humidity index (THI) on physiological responses and milk yield of Tharparkar and Karan Fries cows exposed to controlled environment. <i>J. Agrometeorol.</i> , 21 (4): 405-10.	0.64	6.64

S. No.	Research Papers	Impact Factor	NAAS Rating
13	Somagond, Y. M., Singh S. V. and Deshpande, A. (2019) Effect of dietary supplementation of astaxanthin, prill fat and combination on stress indicators, milk yield and composition during heat stress in buffaloes, <i>Biological Rhythm Research</i> , DOI: 10.1080/09291016.2019.1658426.	0.773	6.77
14	Vaidya, M. M. and Singh S. V. (2019) Body heat storage and physiological responses of periparturient Karan Fries and Sahiwal cows during summer and winter season. <i>Indian J. Anim. Nutr.</i> , 36 (3): 266-275. doi: 10.5958/2231-6744.2019.00044.6.	Nil	5.02
15	Vaidya, M. M. and Singh S. V. (2019) Liver enzymes activity in periparturient high and low yielding Sahiwal and Karan Fries Cows during summer and winter season. <i>Indian J. Dairy Sci.</i> , 72 (4): 408-12.	Nil	5.26
16	Vaidya, M. M., Singh, S.V. and Singh, A.K. (2019) Effect of thermal stress on HSP 72 and leptin mRNA expressions and milk yield of periparturient dairy cows. <i>J. Agrometeorol.</i> , 21 : 15-28.	0.64	6.64

Animal Nutrition Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Gupta, S., Mohini, Madhu, and Mondal, G. (2019) Effect of Dietary monensin supplementation on methane and nitrous oxide emissions from fresh dung of non pregnant non lactating dry buffaloes. <i>Toxicology Int.</i> , 25 (1): 1-6.	Nil	5.23
2	Ojha, L., Kumar, S., Kewalramani, N., Sarkar, S., Singh, A. K. and Tyagi, A. K. (2020) Effect of dietary supplementation of <i>Lactobacillus acidophilus</i> on blood biochemical profile, antioxidant activity and plasma immunoglobulin level in neonatal Murrah buffalo calves. <i>Indian J. Anim. Sci.</i> , 90 (1): 48-54.	0.23	6.23
3	Loomba, Rinchu, Filippini, Tommaso, Chawla, Rajinder, Chaudhary, Rohit, Cilloni, Silvia, Datt, Chander, Singh, Shavinder, Dhillon, K. S. and Vinceti, Marco (2019) Exposure to a high selenium environment in Punjab, India: effects on blood chemistry. <i>Science of the Total Environment</i> . doi: 10.1016/j.scitotenv.2019.135347.	5.59	11.59
4	Sediqi, J., Chaudhari, A., Tyagi, N., Kumar, S., Mondal, G. and Tyagi, A. K. (2019) Changes in nutrient intake and metabolic profile of murrah buffaloes on varying metabolizable protein intake. <i>Anim. Nutr. and Feed Tech.</i> , 19 (2): 303-13.	0.31	6.31
5	Sharma, A. and Datt, Chander (2020) Effect of red seaweed <i>Kappaphycus alvarezii</i> based feed additive on feed intake, nutrient utilization and nitrogen balance in lactating crossbred cows. <i>J. Entomology and Zoology Studies</i> , 8 (2): 487-90.	Nil	5.53
6	Sharma, A., Datt, Chander, Gupta, Ritika, Kumar, Jitendra, Shambhvi, Tyagi, A. K. and Mani, Veena (2019) Effect of supplementation of <i>Kappaphycus alvarezii</i> based seaweed product on rumen fermentation parameters under <i>in vitro</i> conditions. <i>Indian J. Dairy Sci.</i> , 72 : 514-17.	Nil	5.26
7	Sharma, A. and Datt, Chander (2020) Supplementation effect of red seaweed powder on dry matter intake, body weight and feed conversion efficiency in crossbred cows. <i>J. Entomology and Zoology Studies</i> , 8 (2): 1056-59.	Nil	5.53
8	Singh, Digvijay, Datt, Chander, Mishra, Akash, Shivani, Swati, Gupta, Ritika and Mani, Veena (2019) Effect of dietary vanadium supplementation on growth performance, mineral balance and antioxidant activity in male Sahiwal calves. <i>Indian J. Anim. Sci.</i> , 89 (5): 543-48.	0.23	6.23
9	Singh, Digvijay, Datt, Chander, Mishra, Akash, Shivani, Swati, Gupta, Ritika and Mani, Veena (2020) Influence of dietary vanadium supplementation on nutrient utilisation, growth performance and blood biochemical parameters in Sahiwal calves. <i>Indian J. Anim. Res.</i> DOI: 10.18805/ijar.B-3852.	0.44	6.44
10	Singh, G. P., Vandana, K. L., Sharma, A. N., Mohini, Madhu, Arora, N. and Mondal, G. (2019) Effect of depotash vinasse on rumen fermentation kinetics <i>in vitro</i> . <i>Indian J. Anim. Nutr.</i> , 36 : 353-57.	Nil	5.02
11	Thakur, M., Din, Asgar ud, Mani, Veena, Bhakat, M., Mohanty, T. K. and Mondal, G. (2019) Effect of dietary supplementation of trace minerals on semen production performance of Sahiwal bulls during winter months. <i>Indian J. Anim. Nutr.</i> , 36 (2): 136-45.	Nil	5.02
12	Thakur, S., Mohini, Madhu, Malik, T. A., Howal, S., Varun, T. K., Madavi, A., Yadev, R. D., Mondal, G. and Datt, C. (2019) Performance of crossbred goat kids fed with diets varying in concentrate-to-forage ratio: intake, nutrient utilization, enteric methane emission and body weight changes. <i>Biological Rhythm Res.</i> , https://doi.org/10.1080/09291016.2019.1627644 .	0.77	6.77

S. No.	Research Papers	Impact Factor	NAAS Rating
13	Yadav, D., Singh, A. K., Kumar, B., Mahla, A. S., Singh, S. K., Patra, M. K., Kumar, H., Kumar, S., Tyagi, B., Verma, M. R. and Krishnaswamy, N. (2019) Effect of n-3 PUFA-rich fish oil supplementation during late gestation on kidding, uterine involution and resumption of follicular activity in goat. <i>Reprod. in Domestic Animals</i> , 54 (12): 1651-59.	1.64	7.64
14	Yadav, D., Singh, A. K., Teeli, A.S., Kumar, P., Kumar, B., Singh, S. K., Kumar, H., Singh, G., Kumar, S., Tyagi, B., Verma, M. R. and Krishnaswamy, N. (2019) Effect of n-3 PUFA rich fish oil supplementation on the reproductive performance of seasonally acyclic goats. <i>Indian J. Anim. Sci.</i> , 89 (8): 848-52.	0.23	6.23

Forage Research and Management Centre

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Dutta, S., Singh, M., Kumar, Meena, R. K., Basak, N., Mondal, G. and Hindoriya, P. S. (2019) Effect of Organic and Inorganic Nutrient Sources on Yield and Quality of Fodder Cowpea [<i>Vigna unguiculata</i> (L.)Walp.]. <i>Indian J. Anim. Nutr.</i> , 36 (2): 173-78.	Nil	5.02
2	Dutta, S., Singh, M., Meena, R. K., Onte, S., Basak, N., Kumar, S. and Meena, V. K. (2019) Effect of Organic and Inorganic Nutrient Sources on Growth, Yield, Nutrient Uptake and Economics of Fodder Cowpea [<i>Vigna unguiculata</i> (L.) Walp.]. <i>Legume Res.</i> , 43 : 1-7.	Nil	6.12
3	Ginwal, D. S., Kumar, R., Ram, H., Dutta, S., Mallikarjun and Hindoriya, P. S. (2019). Fodder productivity and profitability of different maize and legume intercropping systems. <i>Indian J. Agri. Sci.</i> , 89 (9): 1451-55.	Nil	6.23
4	Hindoriya, P. S., Meena, R. K., Kumar, R., Singh, M., Ram, H., Meena, V. K., Ginwal, D. and Dutta, S. (2019) Productivity and Profitability of Cereal-Legume Forages Vis-a-Vis Their Effect on Soil Nutrient Status in Indo-Gangetic Plains. <i>Legume Res.</i> , 42 (6): 812-17.	Nil	6.23
5	Makarana, G., Kumar, A., Yadav, R. K., Kumar, R., Soni, P. G., Lata, C. and Sheoran, P. (2019) Effect of saline water irrigations on physiological, biochemical and yield attributes of dual purpose pearl millet (<i>Pennisetum glaucum</i>) varieties. <i>Indian J. Agri. Sci.</i> , 89 (4): 624-33.	Nil	6.23
6	Makarana, G., Yadav, R.K., Kumar, A., Kumar, R., Sheoran, P., Kushwaha, M. and Yadav, T. (2019) Physiological, Biochemical and Yield Traits of Pearl-millet (<i>Pennisetum glaucum</i> L.) Accessions under Saline Irrigation. <i>J. Soil Salinity and Water Quality</i> , 11 (1): 98-107.	Nil	4.94
7	Mallikarjun, Ram H., Kumar R, Meena R. K., Kumar U. and Manjunath S. K. (2019) Nutritional quality of baby corn fodder as influenced by tillage practices and nitrogen management, <i>Indian J. Anim. Sci.</i> , 89 (8): 889-93.	Nil	6.28
8	Onte, S., Gudadhe, N., Ladumor, R. G., Karmakar, N. and Singh, M. (2019) Identification of suitable cobalt application method and optimum level for enhancing of chickpea yield. <i>Legume Res.</i> , 1-6.	Nil	6.12
9	Onte, S., Singh, M., Kumar, S. and Pyati, P. S. (2019) Impact of organic nutrient management on crop quality, yield and soil health: A review. <i>International J. Current Microbiology and Applied Sci.</i> , 8 (5): 394-402.	Nil	5.38
10	Onte, S., Singh, M., Meena, V. K., Kumar, S., Meena, B. L. and Dutta, S. (2019) Organic nutrient management in context to sustainable fodder production: A review. <i>International J. Current Microbiology and Applied Sci.</i> , 8 (9): 2434-49.	Nil	5.38
11	Pandey, A. K., Singh, M., Kumar, S., Meena, V. K., Onte, S. and Kushwaha, M. (2019) Influence of stage of harvesting and zinc application on yield and zinc uptake in clusterbean [<i>Cyamopsis tetragonoloba</i> (L.)TAUB]. <i>Legume Res.</i> , 42 (5): 661-65.	Nil	6.12
12	Sharma, A., Chopra, N. K., Chopra, N. K. and Kumar, R. (2019) Nutritive capacity building in baby corn fodder through enhanced agronomic strategies. <i>Indian J. Anim. Sci.</i> , 89 (10): 1123-27.	Nil	6.28
13	Singh, R. K., Rathore, S. S., Ram, H., Shekhwat, K., Singh, C. and Upahdyay, P. K. (2019) Agronomic interventions for high seed productivity and quality of wheat (<i>Triticum aestivum</i>). <i>Indian J. Agri. Sci.</i> , 89 (7): 1071-76.	Nil	6.23
14	Subrahmanya, D. J., Kumar, R., Pyati, P. S., Ram, H., Meena, R. K., and Tamta, A. (2019) Growth, Yield and Economics of Fodder Maize (<i>Zea Mays</i>) as Influenced by Plant Density and Fertility Levels. <i>Forage Res.</i> , 45 (2): 127-31.	Nil	4.48
15	Yadav, N., Yadav, S. S., Yadav, N., Yadav, M. R., Kumar, R., Yadav, L. R., Yadav, V. K. and Yadav, A. (2019) Sulphur management in groundnut for higher productivity and profitability under semi-arid condition of Rajasthan, India. <i>Legume Res.</i> , 42 (4): 512-17.	Nil	6.23

Dairy Technology Division

S. No.	Research Papers	Impact factor	NAAS Rating
1	Alam T., Goyal, G. K., Mann, B., Bhardwaj, A. and Deshwal, G. K. (2019) Electrophoretic behaviour of casein hydrolysis of modified atmosphere packaged Mozzarella cheese. <i>Indian J. Dairy Sci.</i> , 72 (5): 562-64.	Nil	5.26
2	Baria, B., Upadhyay, N., Singh, A. K. and Malhotra, R. K. (2019) Optimization of 'green' extraction of carotenoids from mango pulp using split plot design and its characterization. <i>LWT-Food Sci. Technol.</i> , 104 : 186-94.	3.714	9.13
3	Borad, S. G., Singh, A. K., Kapila, S., Behare, P., Arora, S., Sabikhi, L. (2019) Influence of unit operations on immunoglobulins and thermal stability of colostrum fractions. <i>Int. Dairy J.</i> , 93 (1): 85-91.	2.201	8.2
4	Chaudhary, N., Sabikhi, L. and Hussain, S. A. (2019) Emblicanin rich <i>Emblica officinalis</i> extract encapsulated double emulsion: Controlled release during phagocytosis and <i>in vitro</i> digestion. <i>J. Food Sci. Technol.</i> DOI: 10.1007/s13197-019-04171-0.	1.85	7.8
5	Chaudhary, N., Sabikhi, L., Hussain, S. A., and M. H., S. K. (2020) A Comparative study of the antioxidant and ace inhibitory activities of selected herbal extracts. <i>J. Herbal Med.</i> , doi.org/10.1016/j.hermed.2020.100343	1.554	7.554
6	Chaudhary, N., Sabikhi, L., Hussain, S. A., Kumar, R., and Choudhary, U. (2020) Emblicanin rich <i>Emblica officinalis</i> encapsulated double emulsion and its antioxidant stability during storage. <i>European J. Lipid Sci. Techol.</i> , https://doi.org/10.1002/ejlt.201900316 .	Nil	Nil
7	Ganguly, S. Sabikhi, L. and Singh, A. K. (2019) <i>Effect of whey-pearl millet-barley based probiotic beverage on Shigella-induced pathogenicity in murine model. J. Functional Foods</i> , 54 : 498-505.	3.47	9.47
8	Hossain, S., Khetra, Y., Ganguly, S. and Sabikhi, L. (2019) Effect of processing parameters on proteolysis during ripening in Cheddar cheese. <i>Indian J. Dairy Sci.</i> , 72 (4): 365-69.	Nil	5.26
9	Hossain, S., Khetra, Y., Ganguly, S., Kumar, R., and Sabikhi, L. (2020) Effect of heat treatment on plasmin activity and bio-functional attributes of Cheddar cheese. <i>LWT-Food Sci. Technol.</i> , 120 : 108924.	3.71	9.13
10	Prasad, W., Khamrui, K., Rathod, G. and Gupta, H. R. (2019) Cost estimation and consumer acceptance studies of herbal burfi. <i>Indian J. Dairy Sci.</i> , 72(2): 228-30.	Nil	5.26
11	Sameer, B., Ganguly, S., Khetra, Y., and Sabikhi, L. (2020) Development and characterization of probiotic buffalo milk ricotta cheese. <i>LWT-Food Sci. Technol.</i> , 121: 108944.	3.71	9.13
12	Sawale, P. D., Patil, G. R., Hussain, S. A., Singh, A. K. and Singh, R. R. B. (2019) Effect of sterilization treatment on polyphenol content, antioxidant activity and stability of free and encapsulated herb (<i>Terminalia arjuna</i>) added milk drink. <i>Indian J. Dairy Sci.</i> , 72 (2): 148-54.	Nil	5.26
13	Sawale, P. D., Patil, G. R., Hussain, S. A., Singh, A. K., and Singh, R. R. B. (2020) Development of free and encapsulated Arjuna herb extract added vanilla chocolate dairy drink by using Response Surface Methodology (RSM) Software. <i>J Agric Food Res.</i> , https://doi.org/10.1016/j.jafr.2020.100020 .	Nil	Nil
14	Singh, R., and Khamrui, K. (2019) Estimating cost for production of wheat flour based <i>Pinni</i> . <i>J. Pharmacognosy Phytochem.</i> , 8 (1): 532-36.	Nil	5.21
15	Singh, R., Prasad W., and Khamrui, K. (2019) Effect of ingredients and processing parameters on the sensory, instrumental colour, texture and microstructure of <i>Pinni</i> . <i>Indian J. Dairy Sci.</i> , 72 (5): 462-72.	Nil	5.26
16	Singh, R., Prasad W., and Khamrui, K. (2019) Sensory Characterization of <i>Pinni</i> – a milk cereal based sweet using quantitative descriptive analysis and principal component analysis. <i>Indian J. Dairy Sci.</i> , 72 (3): 241-48.	Nil	5.26
17	Tiwari, S., Upadhyay, N., Singh, A. K., Meena, G. S., and Arora, S. (2019) Organic solvent-free extraction of carotenoids from carrot bio-waste and its physico-chemical properties. <i>J. Food Sci. Technol.</i> , 56 (10): 4678-87.	1.85	7.8
18	Uttamrao, H. J., Meena, G. S., Borad, S. G., Punjaram, S. A., Khetra, Y., Upadhyay, N., and Singh, A. K. (2019) Effect of disodium phosphate and homogenization on physico-chemical and rheological properties of buffalo skim milk based ultrafiltered retentate. <i>J. Food Sci. Technol.</i> , 56 (5): 2426-35.	1.85	7.8

Animal Biochemistry Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Bhat, M. I., Singh, V. K., Sharma, D., Kapila, S. and Kapila, R. (2019) Adherence capability and safety assessment of an indigenous probiotic strain <i>Lactobacillus rhamnosus</i> MTCC-5897. <i>Microbial Pathogenesis</i> , 130 : 120-30.	2.58	8.58
2	Bhat, M. I., Sowmya, K., Kapila, S. and Kapila, R. (2019). Potential Probiotic <i>Lactobacillus rhamnosus</i> (MTCC-5897) inhibits <i>Escherichia coli</i> impaired intestinal barrier function by modulating the host tight junction gene. <i>Probiotic and Antimicrobial Protein</i> , doi: 10.1007/s12602-019-09608-81-12.	2.96	8.96
3	Bhat, M.I., Sowmya, K., Kapila, S. and Kapila, R. (2019) <i>Escherichia coli</i> K12: An evolving opportunistic commensal gut microbe distorts barrier integrity in human intestinal cells. <i>Microbial Pathogenesis</i> , 133: 103545 doi: 10.1016/j.micpath.2019.	2.58	8.58
4	Dahiya, S., Onteru, S. K., Singh, D. (2019) Inhibition of indoleamine 2,3-dioxygenase attenuates endotoxin-mediated tolerance in granulosa cells through kynurenine pathway. <i>J. Cellular Biochemistry</i> , 120 (7): 11931-940.	3.448	9.45
5	Devi, S., Pal, G. K., Kapila, R. and Kapila, S. (2019) C-terminal sequence deletion effect on antioxidative characteristics of VLPVPQK bioactive peptide from buffalo milk casein. <i>LWT-Food Sci. and Technology</i> , DOI: 10.1016/j.lwt.2019.108816.	3.71	9.71
6	Goud, E. S. K., Pandey, M., Singh, C., Vedamurthy, G. V., Singh, D. and Onteru, S. K. (2019) Effect of dioxins in milk on the 3D cultured primary buffalo hepatocyte model system. <i>J. Agri. and Food Chemistry</i> 17, 67(28): 8007-19.	3.571	9.57
7	Kumar, S., Devi, S., Sood, S. K., Kapila, S., Narayan, K. S. and Shandilya, S. (2019) Antibiotic resistance and virulence genes in nisin-resistant <i>Enterococcus faecalis</i> isolated from raw buffalo milk modulate the innate functions of rat macrophages. <i>J. Applied Microbiology</i> , 127 (3): 897-910.	2.68	8.68
8	Kumar, S., Narayan, K. S., Shandilya, S., Sood, S. K. and Kapila, S., (2019) Role of Non-PTS dependent glucose permease (GlcU) in maintaining the fitness cost during acquisition of nisin-resistance by <i>Enterococcus faecalis</i> . <i>FEMS microbiology letters</i> , 366 (19) DOI: 10.1093/femsle/fnz230.	2.00	8.00
9	Sharma, S., Pandey, M., Onteru, S. K., Singh, D. (2019) Loop-mediated isothermal amplification (LAMP) for detection of <i>Ureaplasma diversum</i> from cervico-vaginal swab of buffaloes. <i>Applied Biochemistry and Biotechnology</i> , 2019 Nov. 15. doi: 10.1007/s12010-019-03155-2.	2.14	8.14
10	Shekar, C. and Kaul, G. (2019) Butyrate: a simple gut microbiota metabolite in the modulation of epigenetic mechanism. <i>Current Sci.</i> , 117 (3): 362-64.	0.756	6.88
11	Singh, S., Golla, N., Sharma, D., Singh, D. and Onteru, S. (2019) Buffalo liver transcriptome analysis suggests immune tolerance as its key adaptive mechanism during early postpartum negative energy balance. <i>Functional and Integrative Genomics</i> , 19 (5): 759-73.	2.745	8.75

Dairy Chemistry Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Aggarwal, Ankur, Seth, Raman, Gandhi, Kamal, and Wangdare, Sachin (2019) Physico-chemical properties of Khoa prepared from lactose hydrolyzed buffalo milk. <i>J. Food Sci. and Tech.</i> , 56 (6): 3067-76.	Nil	7.80
2	Banjare, Indrajeet Singh, Gandhi, Kamal, Sao, Khushbu, and Sharma, Rajan (2019) Spray-dried whey protein concentrate-iron complex: preparation and physicochemical characterization. <i>Food Tech. and Biotech.</i> , 57 (3) : 331-40.	Nil	7.17
3	Banjare, Indrajeet Singh, Gandhi, Kamal, Sao, Khushbu, and Sharma, Rajan (2019) Optimization of spray-drying conditions for the preparation of whey protein concentrate-iron complex using response surface methodology. <i>International J. Food Properties</i> , 22 (1): 1411-24.	Nil	7.85
4	Banjare, Indrajeet Singh, Gandhi, Kamal, Sao, Khushbu, Arora, Sumit, and Pandey, Vanita (2019) Physicochemical properties and oxidative stability of milk fortified with spray-dried whey protein concentrate-iron complex and in vitro bioaccessibility of the added iron. <i>Food Tech. and Biotech.</i> , 57 (1): 48-58.	Nil	7.17
5	Bhatia, Piyush, Sharma, Vivek, Arora, Sumit and Rao, Priyanka Singh (2019) Effect of cholesterol removal on compositional and the physicochemical characteristics of anhydrous cow milk fat (cow ghee). <i>International J. Food Properties</i> , 22 (1): 1-8	1.398	7.85

S. No.	Research Papers	Impact Factor	NAAS Rating
6	Bumbadiya, Mitul, Chilbule, Amit, Singh, Richa, Mann, Bimlesh, Arora, Sumit and Rao, Priyanka (2020) Efficiency of bronopol and kathon in preservation of milk and milk products samples stored for analytical purpose. <i>Indian J. Dairy Sci.</i> , 73 (1).	Nil	5.26
7	Chilbule, A, Singh, Richa, Mann, Bimlesh, Arora, Sumit, Sharma, Rajan and Rao, Priyanka Singh (2019) Development and validation of an analytical method for determination of bronopol and kathon preservative in milk. <i>J. Food Sci. and Tech.</i> , 56 (6): 3170-76.	1.849	7.85
8	Gandhi, Kamal, Devi, Savita, Gautum, Priyae Brath, Sharma, Rajan, Mann, Bimlesh, Ranvir, Suvartan, Pandey, Vanita (2019) Enhanced bioavailability of iron from spray dried whey protein concentrate-iron (WPC-Fe) complex in anaemic and weaning conditions. <i>J. Functional Foods</i> , 58 : 275-81.	Nil	9.71
9	Gautam, Priyae Brath, Sharma, Rajan, Ranvir, Suvartan, Gandhi, Kamal, and Mann, Bimlesh (2019) Soymilk protein detection in milk- A review. <i>Indian J. Dairy Sci.</i> , 72 (3): 231-40.	Nil	5.26
10	Gowda, Avinash, Sharma, Vivek, Goyal, Ankit, Singh, A. K. and Arora, Sumit (2018) Process optimization and oxidative stability of omega-3 ice cream fortified with flaxseed oil microcapsules. <i>J. Food Sci. and Tech.</i> , 55 (5): 1705-15.	1.85	7.80
11	Gupta, Chitra, Arora, Sumit, Sharma, Apurva and Sharma Vivek (2019) Evaluation of effective storage conditions and <i>In-vitro</i> bioaccessibility of vitamin A from native and modified sodium caseinate-Vitamin A complexes LWT. <i>Food Sci. and Tech.</i> , 111: 284-90.	3.714	9.71
12	Hazra, Tanmay, Sharma, Vivek, Sharma, Rekha and Arora, Sumit (2018) Triglyceride profiling of ghee containing goat tallow and admixture of soy oil and goat tallow for detecting such an adulteration. <i>Indian J Dairy Sci.</i> , 71 (2): 176-82.	Nil	5.26
13	Kumar, Anil, Naik, Satya Narayan, Gandhi, Kamal and Pandey, Vanita (2019) Functional lipid components for obesity management: a review. <i>International Food Res. J.</i> , 26 (4): 1111-22.	Nil	Nil
14	Meghwat, Karuna, Patra, Falguni and Rao, Priyanka Singh (2018) A consensus and controversies over the index organism for milk pasteurization: A brief review. <i>J. Pharmacognosy and Phytochemistry</i> , 7 (5): 873-76.	Nil	5.21
15	Meghwat, Karuna, Patra, Falguni and Rao, Priyanka Singh (2018) <i>Pithecellobium dulce</i> : A power house of biofunctional attributes ready to be exploited for development of functional foods. <i>Medicinal Plants - International J. Phytomedicines and Related Industries</i> , 10 (4): 278-84.	Nil	5.12
16	Rana, Seema, Arora, Sumit, Gupta, Chitra and Kapila Suman (2019) Effect of milk protein and vitamin A complexation on bioavailability of vitamin A in Caco-2 cells. <i>Food Res. International</i> , 121 : 910-18.	3.579	9.58
17	Sharma, Vivek, Hazra, Tanmay, Kandhol, Rakesh, Sharma, Rekha and Arora Sumit (2018) Confirmation of buffalo tallow in anhydrous cow milk fat using gas liquid chromatography in tandem with species-specific polymerase chain reaction. <i>International J. Dairy Tech.</i> , 71 (1): 158-63.	1.522	7.23
18	Sihag, Manvesh Kumar, Sharma, Vivek, Goyal, Ankit, Arora, Sumit and Kapila, Rajeev (2019) Dietary intake of pearl millet based weaning food supplemented with iron and vitamin A enhances bio availability of vitamin A in anemic rats. <i>International J. Vitamin and Nutr. Res.</i> , 1-11.	1.251	6.0
19	Singh, Manju, Sharma, Rajan, Ranvir, Suvartan, Gandhi, Kamal and Mann, Bimlesh (2019) Assessment of contamination of milk and milk products with heavy metals. <i>Indian J. Dairy Sci.</i> , 72 (6): 608-15.	Nil	5.26
20	Singh, Manju, Sharma, Rajan, Ranvir, Suvartan, Gandhi, Kamal and Mann, Bimlesh (2019) Profiling and distribution of minerals content in cow, buffalo and goat milk. <i>Indian J. Dairy Sci.</i> , 72 (5): 480-88.	Nil	5.26
21	Sukthija, Sharma, Vivek, Arora, Sumit, Singh, Richa, Raghu, H.V. and Raju, P. N. (2019) Evaluation of reversed-phase thin layer chromatographic protocol to detect vegetable oil/fat in milk. <i>Indian J Dairy Sci.</i> , 72 (4): 370-74.	Nil	5.26
22	Syama, M. A., Arora, Sumit, Gupta, Chitra, Sharma, Apurva and Sharma, Vivek (2019) Enhancement of vitamin D2 stability in fortified milk during light exposure and commercial heat treatments by complexation with milk proteins. <i>Food Biosci.</i> , 29: 17-23.	3.22	9.22
23	Yadav, K., Bajaj, R. K., Mandal, S. and Mann, B. (2019) Encapsulation of grape seed extract phenolics using whey protein concentrate, maltodextrin and gum arabica blends. <i>J. Food Sci. and Tech.</i> , doi: 10.1007/s13197-019-04070-4.	Nil	Nil

Dairy Microbiology Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1.	Adewumi, G. A., Grover, S., Isanbor, C. and Oguntoyinbo, F. A. (2019) Phylogenetics, safety and in vitro functional properties of bacillus species isolated from Iru, a Nigerian fermented condiment. <i>Microbiol. Biotechnol. Lett.</i> , 47: 498-509.	Nil	Nil
2	Behare, P. and Kumar, S. (2019) Exopolysaccharides producing lactic acid cultures for indigenous fermented milk products. <i>J. Agri. Search</i> , 6: 142-45.	Nil	4.41
3	Borad, S. G., Singh, A. K., Meena, G. S. and Raghu, H. V. (2019) Storage related changes in spray dried colostrum preparations. doi: 10.1016/j.lwt.2019.108719.	3.129	9.13
4.	Borad, S. G., Singh, A. K., Kapila, S., Behare, P., Arora, S., Sabikhi, L. (2019) Influence of unit operations on immunoglobulins and thermal stability of colostrum fractions. <i>International Dairy J.</i> , 93 : 85-91.	2.735	8.20
6	Manimaran, A., Raghu, H.V., Kumaresan, A., Sreela, L., Yadav, A., Layek, S. S., Mooventhan, P., Chand, S., Sarkar, S. N. and Sivaram, M. (2019) Oxytetracycline is more suitable antibiotic for clinical endometritis cows. <i>Indian J. Anim. Sci.</i> , 89 (5): 501-05.	0.29	6.23
7.	Meena, G. S., Singh, A. K., Gupta, V. K., Borad, S. G., Arora, S. and Tomar, S. K. (2019) Alteration in physicochemical, functional, rheological and reconstitution properties of milk protein concentrate powder by pH, homogenization and diafiltration. <i>J. Food Sci. and Tech.</i> , 56 (3): 1622-30.	1.80	7.80
8	Owusu-Darko, R., Allam, M., deOliveira, S. D., Ferreira C. A. S., Grover, S., Mtshali, S., Ismail, A., Mallappa, R. H., Tabit, F., Buys, E. M. (2019) Genome sequences of <i>Bacillus sporothermodurans</i> strains isolated from ultra-high-temperature milk. <i>Microbiol. Resour. Announc.</i> , 8 : e00145-19.	Nil	Nil
9	Pradhan, P., Kumar, N., Singh, P., Gujjar, P. (2019) Antagonistic activity of <i>Lactobacillus reuteri</i> strains isolated from different niches against food bacteria and its biopreservative application along with nisin in milk system. <i>Indian J. Dairy Sci.</i> , 72 (5): 1-10.	Nil	5.26
10	Shinde, Kuladip Prakash, Chandra, K. P., Grover, Ramesh, Ram, Chand, Panchbhai, G., Verma, Sunita, Gupta, S. K. and Kumar, A. (2019) Effect of supplementation of <i>Lactobacillus plantarum</i> CRD 2 and <i>Lactobacillus rhamnosus</i> CRD 9 probiotic cultures on physiological responses in Murrah buffalo calves. <i>J. Pharmacognosy and Phytochemistry</i> , 8 : 1790-99.	Nil	Nil
11.	Singh, N., Kaur, R., Singh, B. P., Rokana, N., Goel, G., Puniya, A. K. and Panwar, H. (2019) Impairment of <i>Cronobacter sakazakii</i> and <i>Listeria monocytogenes</i> biofilms by cell-free preparations of lactobacilli of goat milk origin. <i>Folia Microbiologica</i> , doi: 10.1007/s12223-019-00721-3	1.31	7.31
12.	Sukthija, Sharma, V., Arora, S., Singh, R., Raghu, H. V. and Raju, P. N. (2019) Evaluation of reversed-phase thin layer chromatographic protocol to detect vegetable oil/fat in milk. <i>Indian J. Dairy Sci.</i> , 72 (4): 370-74.	Nil	5.26

Dairy Engineering Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Manjunatha, M., Chitranayak, Kumar G. Mahesh, Kumari, Khushbu, Anand, B. A. and Vairat, Amita (2019) Antioxidant activity of orange peel powder in ghee at accelerated temperature. <i>Indian J. Dairy Sci.</i> , 72 (2): 223-26. doi.org/10.33785/IJDS.2019.v72i02.016	Nil	5.26
2	Krishnendu, A. R., Dabas, J. K., Chitranayak, Singh, A. K. and Minz, P. S. (2019) Effect of air velocity on heat transfer characteristics of curd during cooling in High Impact Polystyrene cups. <i>Indian J. Dairy Sci.</i> , 72 (4): 375-82. doi.org/10.33785/IJDS.2019.v72i04.005	Nil	5.26
3	Rangi, P., Minz, P. S., Deshmukh, G. P., Subramani, P., and Singh, R. (2019) Application of image analysis technique to determine cleaning of ohmic heating system for milk. <i>J. Food Sci. Technol.</i> , 56 : 5405-14. https://doi.org/10.1007/s13197-019-04011-1	1.8	7.8
4	Singh, G., Singh, P. J., Tyagi, V. V., Barnwal, P., and Pandey, A. K. (2019) Energy, exergy and exergoeconomic analysis of high temperature short time milk pasteurisation plant. <i>Int. J. Exergy</i> , 30 (1): 26-62.	1.13	7.13

Dairy Economics, Statistics & Management Division

S. No.	Research Papers	Impact Factor	NAAS Rating
1.	Bhandari, G. (2019) An economic analysis of influence of out-migration on income, food consumption and inequity in hills. <i>Indian J. Economics and Development</i> , 15 : 241-49.	Nil	4.82
2.	Bijla, S., Singh, Ajmer, Khalandar, S. and Sharma, P. (2019) An analysis of economic sustainability of Gaushalas in Haryana. <i>Int. J. Livestock Res.</i> , 9 : 171-88.	Nil	5.36
3.	Chandel, B. S., Lal, P. and Kumari, B. (2019) Livestock production systems, subsidies and its implications: An investigation through review of literature. <i>Indian J. Dairy Sci.</i> , 72 : 121-28.	Nil	5.26
4.	Devi, I., Singh, P., Dudi, K., Lathwal, S. S., Ruhil, A. P., Singh, Y., Malhotra, R., Baithalu, R. K. and Sinha, R. (2019) Vocal cues based decision support system for estrus detection in water buffaloes. <i>Computers and Electronics in Agriculture</i> , 162 : 183-88.	3.17	9.17
5.	Devi, I., Singh, P., Lathwal, S. S., Dudi, K., Singh, Y., Ruhil, A. P., Kumar, A., Dash, S. and Malhotra, R. (2019) Threshold values of acoustic features to assess estrous cycle phases in water buffaloes (Bubalus bubalis). <i>Applied Anim. Behaviour Sci.</i> , https://doi.org/10.1016/j.applanim.2019.104838	1.82	7.82
6.	Doni, R., Lal, P. and Chauhan, A. K. (2019) Economics of resource utilization: A case study of Sirsa Cooperative Milk Plant. <i>Indian J. Economics and Development</i> , 15: 455-60. DOI: 10.5958/2322-0430.2019.00057.X.	Nil	4.82
7.	Kharkwal, S. and Malhotra, R. (2019) Livestock holding pattern and economics of milk production in Kumaon hills of Uttarakhand. <i>Res. J. Agri. Sci.</i> , 10 : 696-700.	Nil	4.54
8.	Priscilla, L. and Chauhan, A. K. (2019) Economic impact of cooperative membership on dairy farmers in Manipur: A propensity score matching approach. <i>Agri. Economics Res. Review</i> , 32 : 117-23. DOI: 10.22004/ag.econ.292210.	Nil	5.90
9.	Rathore, R., Chauhan, A. K. and Kumar, P. (2019) A study on the magnitude of recoveries and overdues of loans disbursed by Rajasthan Marudhara Gramin Bank. <i>Indian J. Economics and Development</i> , 15 : 111-16. DOI: 10.5958/2322-0430.2019.00013.1.	Nil	4.82
10.	Ravishankara, K. M., Dixit, A. K., Datta, K. K. and Singh, S. P. (2019) Effect of cooperative dairy society on the performance of dairy farms in Mandya district of Karnataka. <i>Indian J. Economics and Development</i> , 15 : 580-85.	Nil	4.82
11.	Singh, S. P. and Chandel, B. S. (2019) Factors influencing in adoption of livestock insurance with special reference to Haryana. <i>Indian J. Dairy Sci.</i> , 72 : 336-41.	Nil	5.26
12.	Singh, S. P., Chandel, B. S., Jaiswal, P. and Adarsha, L. K. (2019) Profile of dairy animals covered and farmers adopted livestock insurance in Karnal District of Haryana. <i>Indian J. Economics and Development</i> , 15 : 68-76.	Nil	4.82
13.	Vishwakarma, R. K., Jha, S. N., Dixit, A. K., Kaur, A., Rai, A. and Ahmed, T. (2019) Assessment of harvest and post-harvest losses of major pulses in India. <i>Agri. Economics Res. Review</i> , 32 : 247-58. DOI:10.5958/2322-0430.2019. 0074.X.	Nil	5.90

Dairy Extension Division

S. No.	Research Paper	Impact factor	NAAS rating
1	Bhatt, Archana, Meena, B. S. and Paul, Pampi (2019) Draught animal power: Opportunities and challenges in mountain agriculture. <i>Int. J. Livestock Res.</i> , 9 (7): 127-34.	Nil	5.36
2	Chatterjee, D. Jha, S. K. and Maiti, S. (2019) Effect of multimedia on preparation of traditional dairy products at the household level. <i>Indian Res. J. Ext. Edu.</i> , 19 (4): 38-42.	Nil	4.81
3	Das, Jagruti; Raju, R. Sirohi, Smita., Chandel, B. S., Raju, P. N Meena, B. S. (2019) Consumption pattern of fermented probiotic dairy Products in metropolitan Delhi. <i>J. Pharmacognosy and Phytochemistry</i> , 1 : 45-49.	Nil	5.21
4	Devayan, Chatterjee, Jha, Sujeet Kumar and Maiti, Sanjit (2019) Effect of multimedia on preparation of traditional dairy products at the household level. <i>Indian Res. J. Ext. Edu.</i> , 19 (4): 38-42.	0.11	4.81
5	Dutta, S., Maiti, S., Garai, S., Abrar, F., Jha, S. K., Bhakat, M., Mondal, S. and Kadian, K. S. (2019) Adaptation strategies to climate change among the farming community of the indian sundarbans. <i>Indian J. Ext. Edu.</i> , 55 (3): 49-55.	Nil	5.32
6	Garai, S., Ghosh, M. K., Maiti, S., Garai, S., Meena, B. S. and Dutta, T. K. (2019) Development and Application of Dairy-based Sustainable Livelihood Security Index in the districts of West Bengal, India.:A tool for dairy development planning. <i>J. Rural Studies</i> , DOI: https://doi.org/10.1016/j.jrurstud.2019.01.017 .	3.301	9.30

S. No.	Research Paper	Impact factor	NAAS rating
7	Jose, Elizabeth and Meena, H. R. (2019) Analysis of services rendered to dairy farmers by farmer producer companies. <i>Int. J. Livestock Res.</i> , 9 (4): 225-29.	Nil	5.36
8	Jose, Elizabeth and Meena, H. R. (2019). Profile of farmer producer company (Dairy based) members in Kerala. <i>Indian J. Extension Edu.</i> 55 (2): 47-51.	Nil	5.32
9	Jose, Elizabeth, Meena, H. R. and Meena, B. S. (2019) Genesis of dairy based farmer producer companies in Kerala. <i>Indian J. Dairy Sci.</i> , 72 (2) : 218-22.	Nil	5.26
10	Kale, R. B., Ponnusamy, K., Sendhil, R., Maiti, S., Chandel, B. S., Jha, S. K., Mohanty, T. K. and Lal, S. P. (2019) Determinants of inequality in dairy development of India. <i>Natl. Acad. Sci. Lett.</i> , 42 (3): 195-98.	0.331	6.331
11	Kar, Priyajoy and Meena, H. R. (2019) Customer's decisiveness about food safety apprehensions of dairy products: A consumer-centric approach. <i>Indian J. Dairy Sci.</i> 72 (5): 547-54.	Nil	5.26
12	Meena, B. S., Meena, H. R., Kadian, K. S. and Garari, Sanchita (2019) Technological change in dairy farming in trans-gangetic plains and its effect on employment generation. <i>Indian Res. J. Ext. Edu.</i> , 19 (4): 53-56.	Nil	4.81
13	Parameswaranaik, J., Jha, S. K., Meena, H. R. and Manu, H. A. (2019) Perceived constraints of return migrated rural youths in agripreneurship development. <i>Asian J. Agri. Ext., Eco. & Sociology</i> , 36 (2): 1-6.	Nil	4.35
14	Patel, D. and Ponnusamy, K. (2019) A tool to assess the management of reproductive problems in dairy animals. <i>Trends in Biosci.</i> , 12 (2): 139-43.	Nil	3.94
15	Patel, D. and Ponnusamy, K. (2019) Development and validation of extension strategies for effective management of reproductive problems of dairy animals. <i>Indian J. Dairy Sci.</i> , 72 (2): 212-17.	Nil	5.26
16	Patel, D. and Ponnusamy, K. (2019) Major reproductive problems of dairy animals under different daily production systems. <i>Int. J. Current Microbiol. App. Sci.</i> , 8 (3): 1269-74.	Nil	5.38
17	Patel, D., Ponnusamy, K and Sendhil R. (2019) Development and testing of potential indicators for evaluation of dairy production systems. <i>Indian J. Anim. Sci.</i> , 89 (11): 1274-82.	Nil	6.23
18	Paul, Pampi, Meena, B. S., Meena, H. R., Sirohi, Smita, Oberoi, P. S., Jha, S. K. and Singh, M. (2019) Feeding pattern of dairy animals and enteric methane emission: a study of commercial dairy farms of Haryana. <i>Range Mgmt. & Agroforestry</i> , 40 (2): 318-22.	Nil	6.10
19	Ponnusamy, K. (2019) Gender sensitive para extension worker model for enhancing technology adoption in agriculture. <i>Int. J. Develop. Ext.</i> , 10 (2): 26-32.	Nil	Nil
20	Ponnusamy, K. (2019) Mainstreaming women in animal husbandry: Review of Issues and strategies. <i>Int. J. Develop. Ext.</i> , 10 (1): 23-31.	Nil	Nil
21	Ponnusamy, K., Chakravarty, Ritu and Singh, Sohanvir (2019) Extension interventions in coping of farmers against effect of climate change in dairy farming. <i>Indian J. Dairy Sci.</i> , 72 (4): 430-36.	Nil	5.26
22	Raj, Khusboo, Ponnusamy, K. Raja, Yadav, Kishore, C. N. and Begum, Mehrunnissa (2019) Job satisfaction of field extension functionaries in promotion of public private partnership model of dairy farming. <i>Int. J. Livestock Res.</i> , 9 (12): 142-50.	Nil	5.36
23	Sreeram, Gupta, J. and Maiti, S. (2019) Quantifying the social learning behaviour of livestock rearers vis-a-vis technology adoption. <i>Indian J. Ext. Edu.</i> , 55 (3): 1-9.	Nil	5.32
24	Suchandra, Dutta, Maiti, Sanjit, Garai, Sanchita, Abrar, Fatheen, Jha, Sujeet, Mukesh, Bhakat, Mondal, Subhashis and Kadian, K. S. (2019) Adaptation strategies to climate change among the farming community of the Indian Sundarbans. <i>Indian J. Ext. Edu.</i> , 55 (3): 49-55.	Nil	5.32
25	Tengli, B. Mahesh, Meena, B. S., Paul, Pampi and Onte, Santosh (2019) Dairy tourism, a new facet of dairy entrepreneurship: Visitors' perception. <i>Indian J. Dairy Sci.</i> , 73 (3): 347-51.	Nil	5.25

Library

S. No.	Research Papers	Impact Factor	NAAS Rating
1.	Rohila, Narendra Singh, Singh, B. P. and Deb, S. M. (2020). Citation analysis of doctoral dissertations in Animal Physiology Division submitted to ICAR-NDRI, Karnal. <i>J. Indian Library Association</i> . 56 (1): 22-31.	Nil	Nil

Southern Campus, Bengaluru

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Anup, Suryawanshi, Arvind, Menon, Rekha Ravindra, M., Manjunatha, F., Magdaline Eljeeva Emerald, Gajanan, P. Deshmukh and Rupesh, Datir (2019) Control of matting temperature during pressing of paneer and its effect on paneer quality. <i>J. Food Sci. and Tech.</i> , 56 (4): 1715-22.	1.79	7.85
2	Ashwin, K. and Bandla, Srinivas (2019) Effect of Oral supplementation of the optimized dose of vitamins on milk yield, hematological parameters and udder health in Deoni cows. <i>Indian J. Anim. Health</i> , 58 (2): 193-202.	Nil	4.08
3	Basak, Sukanta, Das, D. N. and Mundhe, U. T. (2019) <i>CYP11B1</i> and <i>PPARGC1A</i> genes polymorphism controlling reproductive traits and estimation of breeding value of first lactation milk yield in <i>Bos indicus</i> (Deoni) cattle. <i>Veterinarski Arhiv.</i> , 89 (4): 463-79.	0.426	6.43
4	Beegum, P. P. S., Manikantan, M. R., Sharma, Monika, Pandiselvam, A. M., Hebbar, K., Gupta, R. K. (2019) Optimization of processing variables for the development of virgin coconut oil cake based extruded snacks. <i>J. Food Process Engineering</i> , 42 (4) : e13048. DOI: https://doi.org/10.1111/jfpe.13048 .	1.45	7.45
5	Boopathi, V., Prasad, S., Kumaresan, A., Manimaran, A., and Prakash, M. A. (2019) Environmental factors affecting reproductive performance of Murrah buffaloes. <i>Biological Rhythm Res.</i> , 1-7.	0.77	6.77
6	Chandra, Satish, Das, D. N., Kannegundla, Uday, Reen, Jagish Kour, Ramesha, K. P., Nath, Sapna and Katakataware, Mukund A. (2019) Polymorphism in inhibin alpha gene and its association with semen quality traits in Murrah bulls. <i>Indian J. Anim. Res.</i> , 51 (1): 58-63.	0.437	6.44
7	Jadhav P. V., Tarate, S. B., Das, D. N. and Suresh, K. P. (2019) Screening of animals for subclinical mastitis: A discriminate function analysis. <i>Indian J. Anim. Res.</i> , 53 (5): 672-74.	0.437	6.44
8	Japheth, K. P., Kumaresan, A., Ganaie, B. A., Oberoi, P. S., Lathwal, S. S., and Singh, P. (2019) Effect of polyherbal mixture supplementation on incidence of mastitis and milk production in postpartum Murrah buffaloes. <i>Indian J. Dairy Sci.</i> , 72 (1): 85-88.	Nil	5.26
9	Karuthadurai, T., Chakravarthy, A. K., Kumaresan, A., Kour, A., Nag, B. S., Rana, E., Kumar, D. R. and Yousuf, S. (2019) Identification of genetic marker for prolactin gene related to milk yield in pedigreed Sahiwal population. <i>Indian J. Anim. Res.</i> , 53 (5): 566-71.	0.437	6.44
10	Khalandar, S., Sivaram, M., Dixit, P. K. and Bijla, S. (2019) Spatio-temporal analysis of milk production in Karnataka State. <i>Indian J. Dairy Sci.</i> , 72 (5): 525-33.	Nil	5.26
11	Kuntareddi, C., Kumaresan, A., Saraf, K. K., Nag, P., Paul, N., Kurati, S. P., Selvaraju, S., Jeyakumar, S., Manimaran, A., Ramesha, K. P. and Arangasamy, A. (2020) Characterization of antisperm antibody binding patterns in relation to sperm phenotypic attributes and field fertility in dairy bulls. <i>Theriogenology</i> , 141 : 161-67.	2.29	8.30
12	Magdaline Eljeeva Emerald F., Heartwin A. Pushpadass, K. Manimala, Manjunatha, M., and B. Surendra Nath (2019) Application of D-optimal mixture design and fuzzy logic approach in the preparation of chhana podo (Baked milk cake). <i>J. Food Process Engineering</i> , 42 (5): e13121.	1.45	7.45
13	Manimaran, A., Kumaresan, A., Sarkar, S. N., Yadav, A., Boya, S., Sreela, L., Layek, S. S., Mohanty, A. K., Mooventhan, P. and Wankhade, P. R. (2019) Peripheral concentrations of metabolic and inflammatory indicators during transition period and their relationship with postpartum clinical endometritis in dairy cattle. <i>Indian J. Anim. Sci.</i> , 89 (11): 1205-10.	0.23	6.23
14	Manimaran, A., Raghu, H. V., Kumaresan, A., Jeyakumar, S., Ramesha, K. P., Sejian, V., Rajendran, D., Bagath, M. and Sivaram, M. (2019) Oxytetracycline is more suitable antibiotic for clinical endometritis cows. <i>Indian J. Anim. Sci.</i> , 89 (5): 501-05.	0.23	6.23
15	Mohan M., Das D. N., Avinash, C. H. and Ramesha K. P. (2019) Influential non-genetic parameters affecting milk yield performance in Deoni cows. <i>J. Entomology and Zoology Studies</i> , 7 (6): 271-73.	Nil	5.53
16	Revanasiddu D., Ramesha, K. P., Kour, R. Jagish, Kumar, A. Maneesh, Divya, P., Katakataware, M. A., Basavaraju, M., Das, D. N., Kumar, N. Anand and Sapna, N. (2019) Genetic variants in male specific region (MSY) of <i>ZNF280BY</i> gene and their association with semen quality traits in Murrah buffalo bulls. <i>Indian J. Anim. Res.</i> , 1135-39.	0.437	6.44
17	Rohit, G.V., Dixit, P. K. and Jeyakumar, S. (2019) Performance of cattle insurance in select districts of Karnataka. <i>J. Anim. Res.</i> , 3 (3): 431-38.	0.437	6.44
18	Rohit, G.V., Dixit, P. K., Sivaram, M. and Subash, S. (2019) Status of cattle insurance in select districts of Karnataka: A micro study. <i>Indian J. Dairy Sci.</i> , 72 (5): 518-24.	Nil	5.26

S. No.	Research Papers	Impact Factor	NAAS Rating
19	Seethu, B. G., Heartwin A. Pushpadass, F. Magdaline Eljeeva Emerald, B. Surendra Nath, N. Laxmana Naik and Subramanian, K. S. (2019). Electrohydrodynamic encapsulation of resveratrol using food-grade nanofibres: Process optimization, characterization and fortification. <i>Food and Bioprocess Technology</i> , https://doi.org/10.1007/s11947-019-02399-4 .	3.03	9.03
20	Selvan, A. S., Tantia, M. S., Kumar, D. R., Karuthadurai, T., Upadhyay, A., Lathwal, S. S., and Kumaresan, A. (2019) Factors influencing calf mortality in zebu and crossbred cattle reared under subtropical agroclimatic conditions. <i>Indian J. Anim. Sci.</i> , 89 (3): 80-85.	0.23	6.23
21	Sharanabasava, Menon Rekha R, Praveen Kumar Y. S., Manjunatha, M., Kumar, G. Mahesh and Nath, B. Surendra (2020) Comparative evaluation between atmospheric and sub-baric processing of gulabjamun. <i>Indian J. Dairy Sci.</i> , 73 (2): 1-10.	Nil	5.26
22	Smitha, S and Devi, M. C. A. (2018) Linkage among stakeholders in livestock sector-a technology adoption perspective. <i>Agriculture Update</i> , 13 (4) : 470-76.	Nil	4.39
23	Smitha, S., Devi, M. C. A. and Subash, S. (2019) Dynamics of linkage among the stakeholders involved in dairy farming in Kerala State. <i>J. Community Mobilization and Sustainable Development</i> , 14 (2): 276-82.	Nil	5.30
24	Smitha, S., Devi, M.C.A., Letha Devi., and Subash, S. (2019) Analysis of constraints in dairy farming in Kerala- multi stakeholder perspective. <i>Indian J. Dairy Sci.</i> , 72 (3): 342-46.	Nil	5.26
25	Srinivas, B. and Chaturvedi, O. H. (2019) Prosopis Juliflora DC. As cattle feed: Toxicity and palatability of different parts, and fermentation kinetics in vitro. <i>Indian J. Experimental Biology</i> , 57 : 553-56.	0.93	6.93
26	Varghese, M. R., Katakaware, M. A., Jeyakumar, S., Das, D. N., Ramesha, K. P. and Wankhade, P. R. (2019) Testicular biometry and its relationship with age and body weight in young Deoni males. <i>Indian J. Anim. Res.</i> , 53 : 1624-28.	0.437	6.44
27	Wankhade, P. R., Manimaran, A., Kumaresan, A., Jeyakumar, S., Sejian, V., Rajendran, D., Bagath, M, Sivaram, M. and Ramesha, P. (2019) Active immune system and dry matter intake during the transition period are associated with postpartum fertility in lactating Zebu cows. <i>Livestock Sci.</i> , 228 : 18-24.	1.38	7.38
28	Wasnik, P. G., Menon, R. R., Sivaram, M., Surendra Nath, B., Balasubramanyam, B. V. and Manjunatha, M. (2019) Development of mathematical model for prediction of adulteration levels of cow ghee with vegetable fat using image analysis. <i>J. Food Sci. and Tech.</i> , 56 (4): 2320-25.	1.79	7.85

Eastern Regional Station, Kalyani

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Baneh, B., Ahmadpanah, J. and Mandal, A. (2019) Studies on inbreeding and its effects on growth traits of Iran-Black sheep. <i>Songklanakarin J. Sci. & Tech.</i> , 41 (6):	Nil	Nil
2	Bhakat, C., Singh, A., Kumari, T., Chatterjee, A., Mandal, D. K., Rai, S. and Dutta T. K. (2019) Dairy development at lower Gangetic region: Constrains and it's management. <i>Advances in Economics and Business Management</i> , 6 (5): 344-47.	Nil	Nil
3	Chatterjee, A., Mohammad, Asif, Bhakat, C., Mandal, D. K., Rai, S. and Dutta, T. K. (2019) Comparative nutritional evaluation of wet land plants available in Old Alluvial Zone of West Bengal. <i>J. Agri. Engineering and Food Tech.</i> , 6 (3): 245-49.	Nil	Nil
4	Dey, D., Sharma, B., Mohammad, A., Mandal, D. K., Bhakat, C., Dutta, T. K. and Chatterjee, A. (2019) Effect of feeding rice distillers dried grain with solubles as major protein source on nutrient digestibility and growth performance of Jersey crossbred calves. <i>Indian J. Anim. Res.</i> , (DOI: 10.18805/ijar.B-3788).	Nil	6.44
5	Dutta, T. K., Yadav, S. K. and Chatterjee A. (2019) Antibiotics as feed additives for livestock: Human health concerns <i>Indian J. Anim. Health</i> , 58 (2): 121-136.	Nil	4.08
6	Gautam, P. K. and Mohammad, A. (2019) Deciphering the efficacy of multimedia based intervention for augmenting knowledge status: A clean milk production perspective. <i>Indian J. Dairy Sci.</i> , 72 (4): 422-29.	Nil	5.26
7	Hoque, Ekramul, Dutta, T. K., Chatterjee, A. and Sathapathy, D. (2019) Effect of feeding urea molasses treated straw based total mixed ration on growth performance in crossbred calves. <i>International J. Chem. Studies</i> , 7 : 1581-84.	Nil	5.31
8	Hoque, Ekramul, Dutta, T. K., Chatterjee, A. and Sathapathy, D. (2019) Evaluation of nutritive value of urea treated paddy straw added with different levels of molasses. <i>J. Entomology and Zoology Studies</i> , 7: 538-40.	Nil	5.53

S. No.	Research Papers	Impact Factor	NAAS Rating
9	Karunakaran, M., Gajare, V. C., Mandal, A., Mondal, M., Das, S. K., Ghosh, M. K., Rai, S. and Behera, R. (2019) Electrophoretic profile of seminal proteins and their correlation with <i>in vitro</i> sperm characters in Black Bengal buck semen. <i>Vety. World</i> , 12 (5): 621-28.	Nil	5.71
10	Kumar, Ajit, Mandal, D. K., Mandal, A., Bhakat, C., Chatterjee, A. and Rai, S. (2019) Effects of milking temperament on milk yield, udder health and milk composition in crossbred jersey cows. <i>Int. J. Livestock Res.</i> , 9 (1): 187-94.	Nil	5.36
11	Mandal, D. K., Bhakat, C., Chatterjee, A., Mandal, A., Rai, S., Santra, A., Das, S. K. and Dutta, T. K. (2019) Shelter management of dairy crossbred cattle in small household milk production system. <i>J. Basic and Applied Engineering Res.</i> , 6 (7): 379-81.	Nil	Nil
12	Mantri, R. S., Kedare, G. M., Lonkare, S., Mandal, A., Karunakaran, M. and Ghosh, M. K. (2019) Effects of supplementation of milk replacer on haemoglobin and blood biochemical parameters of Black Bengal kids. <i>Indian J. Anim. Health</i> , 58 (2): 187-92.	Nil	4.08
13	Kumar, Rohit, Chandra, P., Konyak, P., Karunakaran, M., Santra, A. and Das, S. K. (2019) <i>In vitro</i> development of preimplantation caprine embryo using cryopreserved black bengal buck semen'. <i>Indian J. Anim. Res.</i> , (DOI:10.18805/ijar.B-3886).	Nil	6.44
14	Sahu, D., Mandal, D. K., Dar, A. H., Podder, M. and Gupta, A. (2019) Modification in housing system affects the behavior and welfare of dairy Jersey crossbred cows in different seasons, <i>Biological Rhythm Res.</i> , (https://doi.org/10.1080/09291016.2019.1619130).	Nil	6.77
15	Santra, A. and Karim, S. A. (2019) Chemical composition and <i>in vitro</i> ruminal fermentation of common tree forages in the semi-arid range lands of India. <i>Indian J. Anim. Sci.</i> , 89 (4): 442-47.	Nil	6.23
16	Santra, A. and Karim, S. A. (2019) Nutritional evaluation of some Indian tree leaves and herbs as fodder and defaunating agent in sheep. <i>Indian J. Anim. Sci.</i> , 89 (10): 1128-34.	Nil	6.23

Review Articles

S. No.	Research Papers	Impact Factor	NAAS Rating
1	Bhushan, B., Singh, B. P., Saini, K., Kumari, M., Tomar, S. K. and Mishra, V. (2019) Role of microbes, metabolites and effector compounds in host-microbiota interaction: A pharmacological outlook. <i>Environmental Chemistry Letters</i> , pp: 1-20.	3.13	9.13
2	Deshwal, G. K. and Panjagari, N. R. (2019) Review on metal packaging: Materials, forms, food applications, safety and recyclability. <i>J. Food Sci. Technol.</i> , DOI: 10.1007/s13197-019-04172-z.	1.80	7.80
3	Deshwal, G. K., Panjagari, N. R. and Alam, T. (2019) An overview of paper and paper based food packaging materials: health safety and environmental concerns. <i>J. Food Sci. Technol.</i> , 56 (10): 4391-4400.	1.80	7.80
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TRAINING AND CAPACITY BUILDING

According to the Government of India National Training Policy in 2012 based on the tenet of 'competency-based training for all, Human Resource Management (HRM) unit has been established at NDRI for effective coordination and implementation of training programmes. The training plan of NDRI addresses the gap between the existing and the required competencies and provides opportunities to the employees to develop their competencies.

A. Deputations Abroad

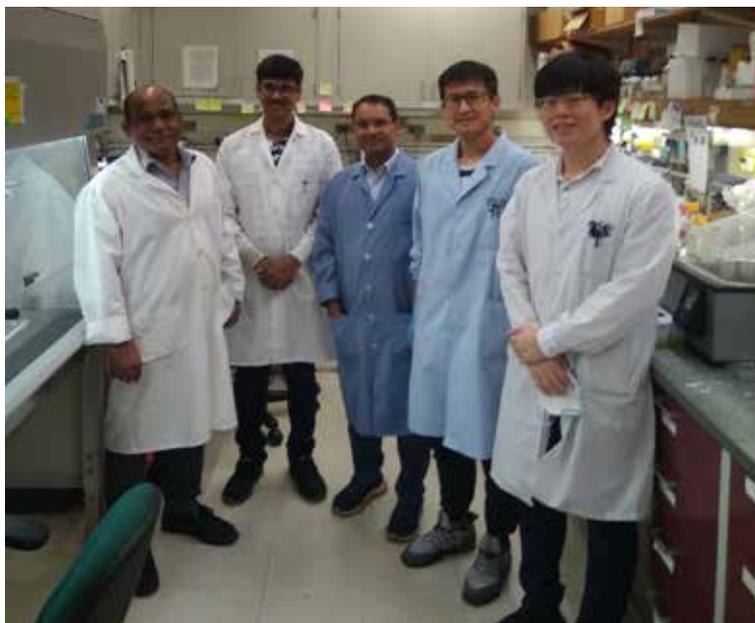
The following scientists of the Institute were deputed for availing advance trainings in various foreign universities across the globe under Institutional Development Plan-sub-project "Incentiving Dairy Education through Innovative Learning Approaches under NAHEP ICAR:

- » Dr. Vivek Sharma, Principal Scientist, Dairy Chemistry Division at Food Chem. & Tech. Department of Aarhus University, Denmark from March 25 to May 23, 2019.



- » Dr. Bikash C. Ghosh, Principal Scientist, Southern Campus of NDRI, Bengaluru visited Germany for three months (April 1 to June 30, 2019.) on Renewed Research Programme of Alexander von Humboldt Foundation, Bonn. The research topic was Effect of High-Pressure Processing on enzyme, protein hydrolysate and their bio functional activities.
- » Dr. Shilpa Vij, Principal Scientist, Dairy Microbiology Division at Massey Institute of Food Science and Technology, New Zealand from April 3-17, 2019.
- » Dr. (Mrs.) Priyanka Singh Rao, Scientist, Dairy Chemistry Division at University of Nebraska, Lincon, USA from April 3 to August 30, 2019.
- » Dr. (Mrs.) Heena Sharma, Scientist, Dairy Chemistry Division at University of Oklahoma, US from April 3 to August 30, 2019.
- » Dr. Kamal Gandhi, Scientist, Dairy Chemistry Division at Riddet Institute, Massey University, New Zealand from April 4 to September 4, 2019.
- » Dr. Rajesh Kumar, PS, Dairy Chemistry Division at School of Food Science and Nutrition University of Leeds, UK from April 9 to April 23, 2019.

- » Dr. Bimlesh Mann, Head, Dairy Chemistry Division at Food Science Department, Rutgers University, New Jersey, USA from April 22 to May 3, 2019.
- » Dr. Narender Raju P, Scientist (SS) Dairy Technology Division at Michigan State University, USA from April 26 to June 25, 2019.
- » Dr. Raghu H.V., Scientist (Sr. Scale), Dairy Microbiology Division at Purdue University, West Lafayette, Indiana, USA April 26 to September 27, 2019.



Dr. Raghu H. V. (second from left) with Dr. Arun Bhunia (left), Professor, Molecular Food Microbiology Lab, Purdue University, Indiana, USA

- » Dr. Mukesh Bhakat, Sr. Scientist Livestock Production & Management at University of New Castle Callaghan, Australia from April 29 to June 28, 2019.
- » Dr. Diwas Pradhan Scientist (SS), Dairy Microbiology Division participated in the annual meeting of International Scientific Association for Probiotics and Probiotics – Students and Fellows Association (ISAPP-SFA), 2019 in Antwerp, Belgium and presented a paper entitled “Surface Proteins of Three Probiotic Lactobacilli exhibit Strain Specific Anti-Inflammatory Effects in TNBS-induced Colitis Mice” from May 14-16, 2019.
- » Dr. Sachin Kumar, Scientist Animal Nutrition Division at Brisbane from May 22 to October 18, 2019.
- » Dr. Goutam Mondal, Sr. Scientist, Animal Nutrition Division at Michigan State University, USA from May 24 to July 23, 2019.
- » Dr. G. S. Meena, Scientist, Dairy Technology Division at Ireland from June 4 to November 1, 2019.
- » Dr. Shaikh Abdul Husain, Scientist, Dairy Technology Division at Ireland from June 4 to November 1, 2019.
- » Dr. Pradip Vishno Behre, Scientist (SS), Dairy Microbiology Division at Ireland from June 4 to November 1, 2019.
- » Mr. Prashant Goel, Ph.D. student of Dr. Naresh Kumar attended two week international training under DOSA Project at University of Southampton, UK from June 6-20, 2019.
- » Dr. Sanjit Maiti, Scientist, Dairy Extension Division was deputed to attend Sustainability and Development Conference held at University of Michigan, Ann Arbor, USA from October 11-14, 2019.
- » Dr. Sanjit Maiti, Scientist Dairy Extension Division was deputed to attend Fulbright Enrichment Seminar on Preserving and Advancing Rural Economies organised by US Dept of States, Institute of International Education, Washington DC and Global Minnesota held at Minneapolis, USA from November 13-16, 2019.

Training Provided to Foreign Students

- » Mr. Olalekan S. Fadare, Lecturer, Department of Biological Sciences, Elizade University, Ondo State (Nigeria) currently undergoing Ph.D. research from University of Benin, Nigeria joined the lab of Dr. Diwas Pradhan, Scientist, Dairy Microbiology Division, ICAR-NDRI, Karnal for his 5.5 months research training under the Research and Training Fellowship-Developing Country Scientist (RTF-DCS) scheme of DST, India.

B. Trainings (Category-wise)

Scientists

Name of Employee	Name of Training Programme Attended	Duration	Organizing Institute
Dr. Richa Singh, Sci.	A Training Programme on "Laboratory Quality Management System and Internal Audit"	January 8-11, 2019	Noida
Dr. Sanjit Maiti, Sci.	A Training Programme on "Geospatial Analysis using QGIS &R" at NAARM.	February 1- 6, 2019	Hyderabad
Dr. Ashwani Kumar Roy Sr. Sci.	A Training Programme on "Improving e Government in Agriculture" at MANAGE.	February 4- 8, 2019	Hyderabad
Dr. A. K. Sharma, PS	A Training Programme on "Big Data Management & Comprehensive Analysis".	February 11 -15, 2019	Mohali
Dr. Ajmer Singh, PS	A Training Programme on "Stress Management" at NAARM.	June 26-29, 2019	Hyderabad
Dr. P. Barnwal, Head Dr. Chitranayak, Sr. Sci.	Training Workshop on "Education Management and Academic Leadership" at NAARM.	September 20-25, 2019	Hyderabad
Dr. Chitranayak, Sr. Sci. Dr. P. S. Minz, Sci. Ms. Vairat Amita Dinkar, Sci. Er. Ankit Deep, Sci. Dr. Khusbu Kumari, Sci.	On line course "Massive Open Online Course (MOOC) on Teaching Excellence" at NAARM.	November 1- 30 2019	Hyderabad
Dr. Anil Kumar Dixit, PS	Training for Management Development Programme on "Leadership Development a Pre-RMP Programme" at NAARM.	December 2-13, 2019	Hyderabad
Dr. Sanjeev Kumar, Sci.,	CAFT Training Programme on "Statistical and Machine Learning Techniques for Modelling and Forecasting Agricultural Data" at ICAR-IASRI.	December 20, 2019 to January 9, 2020	New Delhi
Dr. Naresh Kumar, PS Dr. Raghu H V., Sci.	Training on "Transition ISO 17025: 2017 (Laboratory Quality Management System)" at NITS.	December 23-24, 2019	Noida

Technical Staff

Name of Employee	Name of Training Programme Attended	Duration	Organizing Institute
Sh. Narender Kumar, TO Sh. Deen Dayal Kumar, STA	Training Programm on "Khoa for Library Staff of ICAR" at NAARM.	February 21-26, 2019	Hyderabad
Sh. Ramesh Kumar, STA	Training Programme on "Automobile Maintenance Road Safety & Behavioral Skill" at CIAE.	February 19-25, 2019	Bhopal
Dr. Om Vir Singh, CTO	Seminar on "Dairy Business and Challenges"	February 19-25, 2019	Bhopal
Mr. Braj Kishor ACTO	Training Programme on "Project Setting Monitoring and Evaluation of Agricultural Research Project (PME)" at NARRM.	July 18-23, 2019	Hyderabad

Administrative Staff

Name of Employee	Name of Training Programme Attended	Duration	Organizing Institute
Sh. Vivek Purwar, CAO Sh. Kunal Kalra, FAO Sh. Vishal Acharya, AF&AO	MDP on "Administrative & Financial Management" organised by NAARM at NDRI, Karnal.	September 24-27, 2019	Hyderabad
Sh. Vishal Acharya, AF&AO Sh. Brahm Parkash, AAO Sh. Sukhdev Singh, AAO	Training Programme on "Admn. & Finance Management" organised by ICAR-NAARM at NIANP, Bangalore.	November 25-29, 2019	Hyderabad
Sh. Kunal Kalra, FAO	Training Development Programme for various cadres of Admn. & Finance Staff at ICAR-NAARM.	December 4- 9, 2019	Hyderabad

C. Participation in Conferences/ Seminars/Workshops within India

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. Pawan Singh, PS Dr. S. S. Lathwal, PS Dr. M. L. Kamboj, PS Dr. Mukesh Bhakat, Sr. Sci.	National Conference on "Innovation in Animal Production for Sustainability and Doubling Farmer's Income" held at College of Vety. & Animal Sciences, Munnuthy, Trissur, Kerela.	January 23-25, 2019
Dr. K. P. Ramesha, Head	National Training on "Accreditation Evaluation and Surveillance Procedures" held at APEDA, New Delhi.	January 30-31, 2019
Dr. T. K. Dutta, Head Dr. M. K. Ghosh, PS Dr. A. Mandal, PS	19 th Indian Veterinary Conference and National Symposium on "Innovative Progress in Animal Health and Production for Safe and Secured Food Under one Health Perspective" held at Belgachia, Kolkata.	February 1-2, 2019
Dr. A. Chatterjee, PS Dr. A. Mohammad, Sci.	National Seminar on "Sustainable Resource Management for Enhancing Farm Income, Nutritional Security and Livelihood Improvement" held at Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Birbhum, W.B.	February 1-3, 2019
Dr. F. Magdaline Eljeeva Emerald, PS	Short Course on "Applied Rheology" held at Anton Paar India, Raman Research Institute, Bengaluru.	February 6, 2019
Dr. S. K. Jha, PS	National Conference on "Women Empowerment through Agro-Entrepreneurships for Livelihood Security", held at SKUAS&T, Kashmir.	February 7-8, 2019
Dr. K. Ponnusamy, PS	ICAR-CSSRI Golden Jubilee International Salinity Conference 2019 on "Resilient Agriculture in Saline Environment under Changing Climate: Challenges and Opportunities" held at CSSRI, Karnal.	February 7- 9, 2019
Dr. Latha Sabikhi, Head Dr. K. P. Ramesha, Head Dr. T. K. Dutta, Head Dr. K. S. Kadian, Head Dr. T. K. Mohanty, PS Dr. S. S. Lathwal, PS Dr. B. S. Meena, PS Dr. P. K. Dixit, PS Dr. B. C. Ghosh, PS Dr. Nishant Kumar, Sci. Dr. Shaik Abdul Hussain, Sci. Dr. G. S. Meena, Sci. Dr. W. Prasad, , Sci. Dr. Narender Raju P., Sci.	47 th Dairy Industry Conference on "Innovative Approach for Enhancing Dairy Farmers' Income" held at Patna organized by Indian Dairy Association (EZ), Kolkata.	February 7- 9, 2019
Dr. A. K. Singh, PS	National Agri-Business Entrepreneurship Conclave organized by ABI Centre, ICAR Research Complex for NEH region, Umiam, Meghalaya.	February 9-11, 2019
Dr. A. K. Sharma, PS	Training Programme on "Big Data Management & Comprehensive Analysis" (sponsored by Department of Science & Technology, Govt. of India), C-DAC, Mohali.	February 11-15, 2019
Dr. Latha Sabikhi, Head	Annual Review Meeting of the NASF project at NASC Complex, New Delhi.	February 12, 2019
Mr. Devaraja H.C., Sr. Sci.	Workshop on "Probiotics - Ambassadors of Human Health" held at Dairy Science College, KVAFSU Hebbal, Bengaluru.	February 14-15, 2019
Dr. Surinder Kumar, CTO Mr. Mohar Singh, CTO	State Level Workshop at CCSHAU, Hisar to Discuss Work Plan of KVK's of Haryana and Delhi.	February 15, 2019
Dr. K. P. Ramesha, Head Dr. B. Srinivas, PS Dr. Mukund A. Kataktalware, PS Dr. F. Magdaline Eljeeva Emerald, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. Mamta, PS Dr. A. Kumaresan, PS	Symposium on "Group Dynamics of Small holder Farmers" organised by NABARD in collaboration with SRS:ICAR-NDRI, ICAR-ATARI and ICAR-NIANP, Bengaluru.	February 16, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. A. Kumaresan, PS Dr. Gopal Sankhala, PS Dr. Sanjit Maiti, Sci. Dr. Sanchita Garai, Sci.	"14 th Agricultural Science Congress" organised by NAAS, IARI, New Delhi.	February 20-23, 2019
Dr. S. Jeyakumar, PS	International Conference on "Role of Veterinary Science in Farmers Livelihood" organized by Kalnadi Ariviyallyakkam, TANUVAS, Chennai.	February 22-23, 2019
Dr. T. K. Dutta, Head Dr. M. K. Ghosh, PS Dr. C. Bhakat, PS Dr. A. Mandal, PS Dr. A. Chatterjee, PS Dr. M. Mondal, Sr. Sci. Dr. Asif Mohammad, Sci. Dr. Saroj Rai, Sci. Dr. Rajlaxmi Behera, Sci.	National Seminar on "Industry Oriented Research in Dairy Processing: An Update and Future Strategies" held at BCKVV, Mohanpur, West Bengal.	February 22-23, 2019
Dr. Nishant Kumar, Sci.	Global Conference on "Reproductive Health with Focus on Occupational, Environmental and Life Style Factors & 29 th Annual Meeting of the Indian Society for the Study of Reproduction and Fertility (ISSRF)" held at Jawaharlal Nehru University, New Delhi.	February 22-24, 2019
Dr. Madhu Mohini, PS	2 nd International Conference on "Innovations in Chemical, Biological & Environmental Sciences" held at Arya P. G. College, Panipat.	February 27-28, 2019
Dr. Pawan Singh, PS Dr. M. L. Kamboj, PS Dr. A. Manimaran, Sci.	7 th Pan Commonwealth Veterinary Conference on "The Role of Veterinarians in Addressing the Global Challenges to the Lives of Our Pets, Livestock, Wildlife, Humans, and our Environment" held at National Institute of Animal Nutrition and Physiology, Bengaluru.	March 3-7, 2019
Dr. Sangita Ganguly, Sci.	National Symposium on "Probiotics and Functional Foods on Health Management" held at Department of Food Engineering and Technology, Tezpur University, Tezpur.	March 4-5, 2019
Mr. Devaraja H.C., Sr. Sci.	Workshop organized by Bengaluru District Co-Operative Milk Producers Societies, Bidadi, Ramanagara.	March 9, 2019
Dr. M. C. A. Devi, PS Dr. S. Subash, Sci.	Training Programme on "Empowerment and Entrepreneurial Development in Agriculture" held at UAS, Bengaluru.	March 11-15, 2019
Dr. M. Sivaram, PS	State Level Unit Cost Committee (Karnataka State) at NABARD, Bengaluru.	March 14, 2019
Dr. F. Magdaline Eljeeva Emerald, PS Dr. Monika Sharma, Sci.	International Conference on "Emerging Scenario in Agribusiness" held at Indian Institute of Plantation Management, Bengaluru.	March 21-22, 2019
Ms. Gunjan Bhandari, Sci.	National Seminar on "Prospects of Making Haryana a Total Organic State" held at Department of Economics, Kurukshetra University, Kurukshetra.	March 28, 2019
Dr. Monika Sharma, Sci.	National Conference on "Emerging Trends in Food Technology & Advance Chemistry" held at Jain Deemed to be University (SET), JGI Global Campus, Kanakapura, Bengaluru.	March 29, 2019
Dr. K. Ponnusamy, PS	National Conference on "Livestock Development for Societal Needs: Extension and Allied Sectors Initiatives" at GBPUA&T, Pantnagar.	April 3-5, 2019
Dr. P. Heartwin Amaladhas, PS Dr. F. Magdaline Eljeeva Emerald, PS Dr. Chitranayak, Sr. Sci.	International Conference on "Role of Agricultural Engineering Towards Global Food Security" at Bengaluru, Karnataka.	April 11-13, 2019
Dr. M. Sivaram, PS	International Workshop on "Social Network of Animals in Extreme Environment of Antarctica with Special Reference to Penguins, including Field Studies" ZSI, Andaman & Nicobar Regional Centre, Port Blair.	April 22-24, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. Asif Mohammad, Sci.	Workshop on "Opretionalisation of Veterinary Component in NAP on AMR" jointly organized by ICAR and FAO at Kolkata.	April 25-27, 2019
Dr. Pawan Singh, PS	Workshop on "Andro Vision CASA System" at Jaypee Siddharth Hotel, 3, Rajendra Place, New Delhi.	May 28, 2019
Dr. Vikas Vohra, PS Dr. Anupama Mukherejee, PS	National Symposium on "Exploring the Potential for Sustainable Use of Indigenous Animal Genetics Resources for Enhancing Productivity & Profitability" at Sher-e-Kashmir University of Agricultural Sciences & Technology at Jammu.	May 29-30, 2019
Dr. S. Subash, Sci.	National Workshop on "New Frontiers in Agricultural Extension" at MANAGE, Hyderabad.	May 29-31, 2019
Dr. A. Kumaresan, PS	Flow Cytometry Workshop on "Fundamentals and Advanced Concepts of Flow Cytometry Experimental Designing, Data Analysis and Presentation" at Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.	June 4-7, 2019
Dr. Asif Mohammad, Sci.	Workshop for KVKs under ICAR-ATARI, Kolkata organised by UBKV at Coochbehar, West Bengal.	June 8-10, 2019
Dr. K. P. Ramesha, Head Dr. A. Kumaresan, PS	Selected peer groups meeting on "Livestock Sector at Trust for Advancement of Agricultural Sciences" at New Delhi.	June 10, 2019
Dr. S. Subash, Sci.	Workshop on "Scale Development in Social Sciences" organized by CRISP in association with SRS of ICAR-NDRI, MANAGE and AESA at SRS NDRI.	June, 10-14, 2019
Dr. S. Subash, Sci.	Short Course for Mid-Career Agricultural and Rural Development Professionals on "Building Evaluation Capacity" organized by NIRD, Hyderabad in association with MANAGE, Hyderabad and Michigan State University, US at NIRD, Hyderabad.	June 17-22, 2019
Dr. Surinder Kumar, CTO Mr. Mohar Singh, CTO	Zonal Workshop of KVK's organized by ICAR-ATARI, Jodhpur at NPAUT, Udaipur.	June 22-24, 2019
Dr. K. Ponnusamy, PS Dr. Anupama Mukherejee, PS Dr. S. Subash, Sci. Dr. A. Manimaran, Sci.	International Seminar on "Innovative Extension Management for Uplifting Livelihood of Farmers-Status, Initiatives and Way Forward - ISEM2019" at TANUVAS, Chennai.	June 27-28, 2019
Dr. K. P. Ramesha, Head Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. S. Jeyakumar, PS Dr. Mukund A. Kataktalware, PS Dr. M. C. A. Devi PS, Dr. Jayaraj Rao, PS Dr. Devaraja HC, Sr. Sci. Dr. A. Manimaran, Sci. Dr. S. Subash, Sci. Dr. Monika Sharma, Sci.	National Seminar on "Quality Assurance and Safety of Dairy Products-An Update on FSSAI Regulations" organized by Alumni Association, SRS, ICAR-NDRI, Bengaluru.	July 1, 2019
Dr. Chander Datt, PS Dr. Manoj Kumar C.T, Sci	Training Programme on "Science Administration and Research Management" at ASCI, Hyderabad.	July 1-12, 2019
Dr. S. Jeyakumar, PS	National Symposium on "Infrared Thermography and its Application" at BMS College of Engineering, Bengaluru, Karnataka.	July 4, 2019
Dr. S. S. Thakur, Emeritus Scientist	Workshop on "Sustainable Livestock Production in Doubling the Farmers Income" at Sri Venkateshwara Veterinary University, Tirupati.	July 11-12, 2019
Dr. A. K. Singh, PS	Brainstorming Session on "Technological Innovations and Strategies for Farmer's Prosperity in Rajasthan" organised at NASC Complex, New Delhi.	July 13, 2019
Dr. A. Kumaresan, PS	91 st Foundation Day Celebrations of ICAR at National Agricultural Science Centre Complex, New Delhi.	July 17, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. Sumit Arora, PS	Brainstorming Meeting on "Food Fortification on Newer Technologies to Improve Bioavailability of Nutrients at Department of Biotechnology, New Delhi.	July 18, 2019
Dr. Mukund A. Katakataware, PS Dr. A. Kumaresan, PS Dr. S. Subash, Sci.	Workshop on "Role of Veterinarians in Augmenting the Farmers Income for Rural Prosperity" organized by Karnataka Veterinary Association, GKVK, Bengaluru.	July 20-21, 2019
Dr. Mahendra Singh, Head	NICAR Review Meeting on "Technical programme (Fisheries and Animal Sciences)" at NASC Complex, New Delhi.	July 24, 2019
Dr. S. Subash, Sci. Dr. A. Manimaran, Sci.	International "Social Science Summer School" led by the DARPI Project consortium, WP1 Team funded by the Global Challenges Research Fund at SRS, NDRI, Bengaluru.	July 29, 2019 to August 2, 2019
Dr. Latha Sabikhi, Head	All India Animal Husbandry Officers' Workshop (AIAHOW)-2019	August 2-3, 2019
Dr. Sohanvir Singh, PS	J&K Agriculture Science Congress Announcement on "Climate Change Management for Sustainable Agriculture, Livestock and Ecological Development" at Sher-e-Kashmir University of Agricultural/Science & Tech., Jammu.	August 8-10, 2019
Dr. Anupam Chatterjee, PS Dr. M. Karunakaran, PS	Workshop on "Innovation & Entrepreneurship" organized by DSIR-TOCIV-IIT Kharagpur, CSIR-CGCRI and CSIR-CMERI in association with WBUAFS, Kolkata.	August 13, 2019
Dr. K. P. Ramesha, Head Dr. S. Jeyakumar, PS Dr. A. Kumaresan, PS	Brain Storming Session on "Semen Biology National Academy of Dairy Science (India)" at SRS of ICAR-NDRI, Bengaluru.	August 17, 2019
Dr. Anupam Chatterjee, PS Dr. D. K. Mandal, PS Dr. C. Bhakat, PS	International Symposium on "Recent Trend and Practices in Science, Technology, Management and Humanities for Sustainable Rural Development (STHM-2019)" organized by NIRD and University of Science and Technology, Meghalaya.	September 6-7, 2019
Dr. A. K. Sharma, PS	Workshop on "Internet: Protocol & Standards", Indian Internet Engineering Forum Bengaluru & C-DAC at Mohali.	September 16, 2019
Mr. Gaurav Kr. Deshwal, Sci.	"National Faculty Development Programme in Entrepreneurship" at Entrepreneurship Development Institute of India, Ahmedabad.	September 16-27, 2019
Dr. A. K. Roy, Sr. Sci.	ICAR-Short Course Training on "Gender Gaps and Interventions to Address Gender Issues in Agri." at Bhubaneswar (Odisha).	September 17-26, 2019
Dr. Bandla S., PS	International Conference on "Biotechnological Advances in Medicinal Plants and Natural Products" at Garden City University, Bengaluru.	September 19-20, 2019
Dr. Dheer Singh, Head	International Conference on "Natraceuticals & Chronic Diseases" at IIT Guwahati.	September 23-25, 2019
Dr. A. K. Singh, PS	Annual Workshop cum Meeting of "National Agricultural Innovation Fund Scheme" organised at NASC Complex, New Delhi.	October 4-5, 2019
Dr. Meena Malik, Professor	Golden Jubilee and 14 th International Conference of "English Language Teachers Association India (ELTAI) in "Right to English" at Amity University, Noida.	October 9-12, 2019
Dr. Sohanvir Singh, PS Dr. A. Kumaresan, PS Dr. Nishant Kumar, Sci.	2 nd Annual Meeting of Animal Physiologists Association cum National Conference on "Issues & Strategies for Physiological Capacity Building in Animals" at Tirupati.	October 14-15, 2019
Dr. Rajesh Kumar Meena, Sci.	International Conference on "Crop Residue Management" organized by Bihar Agricultural University, Sabour, Bhagalpur Bihar.	October 14-15, 2019
Dr. Rajan Sharma, PS	Training Programme on "Intellectual Property Valuation and Technology Management" organized by ICAR-NAARM, Hyderabad.	October 15-19, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. A. Kumaresan, PS	Symposium of Indian Society for the Study of Reproduction and Fertility on "Impact of Lifestyle and Environmental Factors on Reproductive Health" at College of Veterinary Science, Tirupati.	October 16, 2019
Dr. Bandla S., PS	Global Research Initiatives for Sustainable Agriculture & Allied Sciences (GRISAAS -2019) at ICAR-National Academy of Agricultural Research and Management, Hyderabad.	October 20-22, 2019
Dr. Bandla S., PS	International Conference on "Life, Chemical and Health Science" at M. S. Ramaiah College of Art, Science and Commerce, Bengaluru.	October 22-24, 2019
Dr. K. P. Ramesha, Head	Brainstorming session at CRDT, IIT, Delhi on proposal of SUTRAPIC at IIT, Delhi.	October 31, 2019
Dr. (Mrs.) Madhu Mohini, PS Dr. M. K. Ghosh, PS Dr. D. Malakar, PS Dr. A. Mandal, PS Dr. Nitin Tyagi, Sr. Sci. Dr. Sachin Kumar, Sci.	National Conference on "Livelihood Improvement through Sustainable Livestock & IV Annual Convention of Pashu Poshan Kalyan Samitee (PPKS) at ICAR-CIRC, Meerut.	November 3-4, 2019
Dr. Manoj Kumar Singh, Sci.	Workshop on "CRISPR Editing in Mammalian Cells and Embryos" at ICAR-Central Institute for Research on Buffaloes (CIRB) Hisar.	November 4-9, 2019
Dr. Hardev Ram, Sci.	International Conference on "Soil and Water Resources Management for Climate Smart Agriculture, Global Food and Livelihood Security" at NASC Complex, Pusa, New Delhi.	November 5-9, 2019
Dr. Asif Mohammad, Sci.	Agricultural scientists meet' as part of 'India International Science Festival', 2019 held at Biswa Bangla Convention Centre.	November 6, 2019
Dr. A. Kumaresan, PS	Kerala Veterinary Science Congress on "Veterinary Practice to Address Challenges of Climate Change and Antibiotic Resistance in Animal Health Care and Food Safety" at College of Veterinary Sciences, Pookode, Wayanad, Kerala.	November 9-10, 2019
Dr. Raghu H.V., Sci. Dr. Pradip Behare, Sci.	National Seminar on "Entrepreneurship Issues and Challenges in Dairy and Food Processing Industries" at Jiwaji University, Gwalior, Madhya Pradesh.	November 10-12, 2019
Dr. Monika Sharma, Sci.	Symposium on "Ghee and Buttermilk: Synergising Ayurveda Knowledge with Modern Dairy Science". The Transdisciplinary University of Health Sciences and Technology, Bengaluru.	November 13, 2019
Dr. K. Ponnusamy, PS Dr. H. R. Meena, PS	ISEE National Seminar on "Holistic Approach for Enhancing Agricultural Growth in Changing Rural Scenario" at Bikaner.	November 14-16, 2019
Dr. Ravinder Malhotra, PS Dr. M. Sivaram, PS	International Conference on "Agricultural Statistics" at New Delhi.	November 18-21, 2019
Dr. S. Jeyakumar, PS Dr. A. Manimaran, Sci.	International Conference on "Current Scenario and Future Strategies of Disease Control for Augmenting Livestock and Poultry Productivity under Changing Climatic Conditions" at Veterinary College and Research Institute (VCRI), Namakkal, Tamil Nadu.	November 20-22, 2019
Dr. K. S. Kadian, Head Dr. Gopal Sankhala, PS Dr. S. K. Jha, PS Dr. B. S. Meena, PS	A National Seminar on "Socio-Digital Approaches for Transforming Indian Agriculture" at HAU, Hisar.	November 20-22, 2019
Dr. A. K. Puniya, PS Dr. Naresh Kumar, PS Dr. Shilpa Vij, PS	Brainstorming Session on "Food Borne Zoonotic Diseases" held at NAAS New Delhi.	November 21, 2019
Dr. Naresh Kumar, PS	Nano Biotechnology for Agriculture at TERI, New Delhi	November 21-22, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. B. S. Chandel, Head Dr. Ajmer Singh, PS Dr. A. K. Chauhan, PS Dr. A. K. Dixit, PS	79 th Annual Conference of "Indian Society of Agricultural Economics" at College of Agriculture Indira Gandhi Krishi Vishwavidyala at Raipur (Chattisgarh).	November 21-23, 2019
Dr. K. Ponnusamy, PS	National Conference on "Climate Change Adaptation in Agriculture for Sustainable Livelihood" organised by NIRDPR, Hyderabad.	November 22-23, 2019
Mrs. Udita Chaudhary, Sci. (SS)	Workshop on "Ongoing & Completed Research Projects by VKCoE for the year 2019" organized by Verghese Kurien Centre of Excellence (VKCoE)-Instt. of Rural Management Anand (IRMA) at Multipurpose Hall, IRMA, Anand.	November 25-26, 2019
Dr. K. P. Ramesha, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS	Farmers' Meet on "Farmer Friendly Novel Technologies for Quality Milk Production" organized by IDA (SZ) Bengaluru. NIANP, Bengaluru.	November 26, 2019
Dr. Gopal Sankhala, PS	Seminar on "Economic Growth & National Integration" organised by India International Friendship Society, New Delhi.	November 27, 2019
Dr. Sadeesh E.M., Sci.	8 th SMRM and Mitochondria-Metabolism Network Meeting at IISER, Pune.	November 27-30, 2019
Dr. Yogesh Khetra, Sci.	'DISHA' Higher Studies Expo, organized by the Department of General Education - Higher Secondary Education Wing, Government of Kerala at Kasargod, Kerala.	November 27 to December 1, 2019
Dr. Anupam Chatterjee, PS Dr. Asif Mohammad, Sci.	International Seminar on "Agriskills for Convergence in Research, Industry and Livelihood (ACRIL)" organized by Crop and Weed Science Society (CWSS) and BCKV, Mohanpur at FACC, BCKV, Kalyani, West Bengal.	November 28 to December 1, 2019
Dr. A. K. Dixit, PS	MDP on Leadership Development (a pre-RMP Programme) organised by ICAR-National Academy of Agricultural Research Management, Hyderabad.	December 2-13, 2019
Dr. K. P. Ramesha, Head Dr. Pawan Singh, PS Dr. S. S. Lathwal, PS Dr. A. Kumaresan, PS Dr. S. Jeyakumar, PS Dr. Nishant Kumar, Sci. Dr. Rubina K. Baithalu, Sci.	Brain Storming Session on "Livestock Improvement through Artificial Insemination" organized by National Academy of Agricultural Sciences at ASRB, New Delhi.	December 6, 2019
Dr. Pradip Vishnu Behra, Sci.	Application of Bacteriophages in the Milk and Dairy Sector at Bihar Animal Sciences University, BVC Campus Patna.	December 10, 2019
Dr. Gopal Sankhala, PS Dr. B. S. Meena, PS	National Seminar on "Entrepreneurship Issues and Challenges in Dairy & Food Processing Industries" organized by ICAR-NDRI, Karnal, Jiwaji University and Doodh Dairy Vyavsaai Sangh, Gwalior.	December 10-12, 2019
Dr. Bimlesh Mann, Head Dr. Kaushik Khamrui, PS Dr. Sangita Ganguly, Sci. Dr. Pradip Vishnu Behra, Sci.	9 th International Conference on "Fermented Foods, Health Status and Social Well-being" organized at Anand Agricultural University, Anand, Gujarat.	December 13-14, 2019
Dr. Mukund A. Kataktalware, PS	International Conference on "Extension for Strengthening Agricultural Research and Development (eSARD)" at ICAR JSS Krishi Vigyan Kendra, Suttur, Mysuru.	December 14-16, 2019
Dr. Rashmi H.M., Sci.	Workshop on "Statistical Methods in Microbione Research" at NCMR (National Centre for Microbial Research) NCCS, Pune.	December 16-20, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. A. K. Tyagi, Acting JD(Res.) Dr. T. K. Dutta, Head, Dr. S. S. Thakur, Emeritus Professor Dr.(Mrs.) Veena Mani, PS Dr. (Mrs.) Madhu Mohini, PS Dr. A. K. Misra, PS Dr. D. Malakar, PS Dr. Asit Das, PS Dr. M. K. Ghosh, PS Dr. S. K. Das, PS Dr. A. Santra, PS Dr. C. Bhakat, PS Dr. A. Mandal, PS Dr. D. K. Mandal, PS Dr. Anupam Chatterjee, PS Dr. B. Srinivas, PS Dr. Magan Singh, PS Dr. Nitin Tyagi, Sr. Sci. Dr. Goutam Mondal, Sr. Sci. Dr. Asif Mohammad, Sci.	International Conference of Animal Nutrition 2019 (INCAN-2019) on "Nutritional Strategies for Improving Farm Profitability & Clean Animal Production" organized by Department of Animal Nutrition, WBUAFS, Kolkatta.	December 17-19, 2019
Dr. S. Jeyakumar, PS Dr. M. Karunakaran, PS	International Symposium on "Global Perspectives to Enhance Livestock Fertility through Modern Reproductive Techniques for Doubling Farmers Income" at Tamilnadu.	December 18-20, 2019
Dr. A. Manimaran, Sci.	XIX Annual Conference of ISVPT and National Symposium on "Pharmacogenomics in the Development and Validation of Indigenous Drugs" at College of Veterinary and Animal Sciences, Mannuthy Kerala Thrissur.	December 18-20, 2019
Mrs. Heena Sharma, Sci.	27 th Indian Convention of Food Scientists and Technologies on "Raising Agro-processing and Integrating Novel Technologies" at Tezpur University, Tezpur, Assam.	December 18-20, 2019
Dr. Mahendra Singh, Head Dr. A. K. Roy, PS	48 th Dairy Industry Conference on "Dairying for Health and Wealth" organized by Indian Dairy Association (North Zone) at B. M. Birla Auditorium at Jaipur (Rajasthan).	December 20-22, 2019
Dr. Manoj Kumar Singh, Sci.	Scientific Convention on "Futuristic Technologies in Animal Health and Production" at Kamdhenu University, Gandhi Nagar, Gujrat.	December 26-27, 2019
Dr. Rubina Kumar Baithalu, Sci.	XXX Annual Convention of ISSAR and International Symposium at College of Veterinary Science and Animal Husbandry, AAU Anand Gujarat.	December 28-30, 2019



MAJOR EVENTS

Conferences/Seminars/Symposia/Workshops/Training programmes organised

The Institute hosted quite a good number of Seminars, Workshops and Short Courses with the participation of delegates from India and abroad. Some of the important ones are listed as under:

S. No.	Title of Workshop/Conference/Seminar/Training organised	Duration
1	CAFT Training Programme in Dairy Processing on "Rapid Bio-sensors and Micro-techniques for Monitoring Contaminants and Adulterants in Dairy Foods"	January 4-24, 2019
2	An International Training Programme on "Modern Dairy Technology, Management and Cooperatives"	February 5-19, 2019
3	Training-cum-Workshop on "Enhancement of Competency and Work Efficiency in Organization"	February 13-15, 2019
4	An International Training Programme on "Milk and Milk Products Processing"	March 4-18, 2019
5	NDRI Global Alumni Scientific Meet (NGASM)	March 15-17, 2019
6	Leadership-cum-Scientific Meet	March 17, 2019
7	A Workshop on "Women Empowerment, Leadership and Social Entrepreneurship"	March 17, 2019
8	17 th Convocation of NDRI Deemed University	March 23, 2019
9	Training Programme on "Entrepreneurship Development Program on Milk Processing and Value Addition"	April 1-10, 2019
10	Training Programme on "Entrepreneurship Development Program on Milk Processing and Value Addition"	July 1-10, 2019
11	International Training on "Milk and Milk Products Processing"	July 15-29, 2019
12	Training on "Marketing Strategies for Promoting Dairy Products"	July 24-26, 2019
13	Training Programme on "Entrepreneurship Development Program on Milk Processing and Value Addition"	September 2-11, 2019



Release of Compendium of CAFT Training Program on 'Rapid biosensors and microtechniques for monitoring contaminants and adulterants in dairy foods'



International Training Programme on 'Milk and Milk Products Processing' organized for Uganda Nationals during March 4-18, 2019

14	Foundation Programme for the Freshers	September 21, 2019
15	Stem Cell Technology Workshop	September 28, 2019
16	International Training Programme on "Novel and Value Added Dairy Products"	November 4-15, 2019
17	CAFT National Training Programme on "Recent and Emerging Applications of Membrane Processes in Dairy Industry"	November 4-24, 2019
18	N-Reach: A Skill Enhancing Programme	November 27-28, 2019
19	International Workshop on "Targeted Proteomics"	November 28 to December 1, 2019
20	International Conference on "Proteomics for System Integrated Bio-Omics, One Health and Food Safety"	December 2-4, 2019
21	Winter School on "Technological Advances in Functional Food Ingredients and Validation of their Claims"	December 6-26, 2019
22	Workshop on "Innovative Tools for Teaching"	December 10-12, 2019
23	Training Programme on "Entrepreneurship Development Program on Milk Processing and Value Addition"	December 16-25, 2019
24	Seminar on "Restructuring of Primary and Secondary Education"	December 20, 2019

Specific Day(s) Celebrated (January to December, 2019)

1	World Milk Day Celebrated	June 1, 2019
2	World Organ Donation Day Celebrated	August 13, 2019
3	National Milk Day Celebrated	November 26, 2019



International Training Program on 'Novel and Value added Dairy Products' organised under India Africa Forum Summit - III during November 4-15, 2019



CAFT Training Program on 'Recent and Emerging Applications of Membrane Processing' in Dairy Industry organized during November 4-24, 2019



DISTINGUISHED VISITORS

09.01. 2019 Four member delegation from Brazil.



11.01. 2019 Mr. Vinithshivram Poduval, Sr. VP Food Safety & Quality, Schreiber Foods, Washington, USA.

22.03.2019 Dr. Venkatesh, Director General of Health Services, Govt. of India.

16.04.2019 Sh. Sanjay Gupta, IAS, Additional Chief Secretary (AH) to the Govt. of Himachal Pradesh, Director, Animal Husbandry, Himachal Pradesh.

15.05.2019 Twenty eight member delegation as participants of Strategic Management and Policy Studies Course (SMPSC) from Nigeria and three member delegation from Nigeria High Commission, New Delhi.

06.07.2019 Ten member delegation led by Ms. Prema Lhaden, Sr. Programme Officer, Queen's Project of His Majesty's Secretariat of Royal Government of Bhutan (RGOB), Bhutan.

30.07.2019 Nine member Brazilian delegation of Brazilian Association of Breeders of Zebu Cattle (ABCZ).

31.08.2019 African delegation.

12.12.2019 Dr. Olivia MC Auliffe, Principal Research Officer, Cultures, Fermentation and Biotransformation, Teagasc Food Research Centre, Department of Food Biosciences, Moorepark, Fermoy, Ireland.

19.12.2019 Prof. Murari Suvedi (US Citizen) Professor, Department of Community Sustainability, Michigan State University (MSU), Michigan, USA.



PERSONNEL

INSTITUTE STAFF

(As on 31st December, 2019)

Director's Cell

R. R. B. Singh, PhD
Nirmala Kumari, BA

Director (Officiating)
Private Secretary

Joint Director (Research) Cell

A. K. Tyagi, PhD
Ranjana, BA

Acting Joint Director (Research)
Private Secretary

Research Prioritisation, Monitoring and Evaluation Unit

Meena Malik, M Phil, PhD
Braj Kishor, MA, B Lib Sci
Sunil Sharma, MSc

Professor (English)
Assistant Chief Technical Officer
Technical Officer

Joint Director (Academics) Cell

R. R. B. Singh, PhD
Parvesh Lata, BA

Joint Director (Academics)
Private Secretary

Academic Affairs Management Unit

S. K. Tomar, PhD
A. P. Ruhil, PhD
Bhagwan Das, BA

Academic Coordinator
Controller of Examinations
Asstt. Admn. Officer

Administrative Wing

Susanta Saha, MSc, MBA
Vivek Purwar, M Tech
Abhishak Rana, BE
Ram Niwas, BA
Ritu Dalal, B Tech
A. K. Mishra
Rajbir, BA
S. S. Meena, BA
Braham Prakash, BA
Dharam Singh Meena, BA
Subhash Chand, BA

Joint Director (Admn.) & Registrar
CAO
Sr. AO
Admn. Officer
Admn. Officer
Admn. Officer
Asstt. Admn. Officer (DDO)
Asstt. Admn. Officer (Purchase)
Asstt. Admn. Officer
Asstt. Admn. Officer (Stores)
Asstt. Admn. Officer

Ajit Singh, BA
Mukesh Dua, BA
Ram Pal
Krishna Devi Azad
Anita Rani, BA

Asstt. Admn. Officer (E- IV)
Asstt. Admn. Officer (II & V)
Asstt. Admn. Officer (III)
Asstt. Admn. Officer (Audit)
Private Secretary

Right to Information Act (RTI)

Bimesh Mann, PhD
Meena Malik, PhD
Mohinder Singh, PhD
M. K. Ghosh, PhD
Jeya Kumar, PhD
Braj Kishor, MA, B Lib Sci

Appellate Authority
Central Public Information Officer
Transparency Officer
Asstt. Public Information Officer
Asstt. Public Information Officer
Asstt. Public Information Officer

Finance Wing

D. D. Verma, M Com, PGDFM
R. K. Singh
Kunal Kalra, B Com, PGDM
Vishal Acharya, MA

Comptroller
Sr. Fin. & Account Officer
Finance & Accounts Officer
Asstt. Fin. & Account Officer

Animal Genetics & Breeding Division

S. M. Deb, PhD
Archana Verma, PhD
I. D. Gupta, PhD
Anupama Mukherjee, PhD
Vikas Vohra, PhD
Om Vir Singh, PhD
Y. K. Panwar, MA

Head
Principal Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Chief Technical Officer
Sr. Technical Officer

Livestock Production & Management Section

A. Kumar Misra, PhD
Pawan Singh, PhD
T. K. Mohanty, PhD
M. L. Kamboj, PhD
S. S. Lathwal, PhD
Ramesh Chandra, PhD
Mukesh Bhakat, PhD
Nishant Kumar, MSc
Rubina Baithalu, MVSc
Shiv Kumar, MSc

Principal Scientist
Principal Scientist & Incharge
Principal Scientist
Principal Scientist
Principal Scientist
Sr. Scientist
Sr. Scientist
Scientist
Scientist
Assistant Chief Technical Officer

Animal Nutrition Division

A. K. Tyagi, PhD
S. S. Thakur, PhD
Madhu Mohini, PhD
Veena Mani, PhD
Raman Malik, PhD
Chander Datt, PhD
Asit Das
Nitin Tyagi, PhD

Head
Emeritus Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Sr. Scientist

Goutam Mondal, PhD
Sachin Kumar, PhD
Gian Singh, MSc
Sumit Narayan, MSc

Sr. Scientist
Scientist
Sr. Technical Officer
Sr. Technical Officer

Animal Physiology Division

Mahendra Singh, PhD
Sujata Pandita, PhD
Parveen Kumar, PhD
Sohanvir Singh, PhD
A. K. Dang, PhD
Anjali Aggarwal, PhD
A. K. Roy, PhD
Manju Ashutosh, PhD
Ashutosh, PhD
Y. P. Singh, BSc
Mr. Dheeraj Kumar
Avnish Kumar, BCom

Head
Principal Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Principal Scientist
Sr. Scientist
Sr. Scientist
Sr. Scientist
Technical Officer
Technical Officer
Personal Assistant

Animal Biotechnology Centre

Dr. P. Palta, PhD
Dr. T. K. Datta, PhD
Dr. S. De, PhD
Dr. J. K. Kaushik, PhD
Dr. A. K. Mohanty, PhD
Dr. D. Malakar, PhD
Dr. Satish Kumar, PhD
Dr. Rakesh Kumar, PhD
Dr. M. K. Singh, PhD
Dr. S. Kumar, PhD

Principal Scientist and In-Charge
Principal Scientist
Scientist
Scientist

Animal Biochemistry Division

Dheer Singh, PhD
Gautam Kaul, PhD
Rajeev Kapila, PhD
Suman Kapila PhD
Sunil Kumar Onteru, PhD
Ms. Suneeta Meena, MSc
Sadeesh E. M., PhD
Vedamurthy G. V., PhD
Ravi Kant, PhD

Head
Principal Scientist
Principal Scientist
Principal Scientist
Sr. Scientist
Scientist
Scientist
Scientist
Asstt. Chief Technical Officer

Dairy Technology Division

Latha Sabikhi, PhD
A. K. Singh, PhD
Kaushik Khamrui, PhD
Narender Raju Panjagari, PhD
Ganga Sahay Meena, PhD
Yogesh Khetra, PhD
Shaik Abdul Hussain, PhD

Head
Principal Scientist
Principal Scientist
Scientist (Sr. Scale)
Scientist
Scientist
Scientist

Guvantsinh Rathod, M Tech (On Study Leave)	Scientist
Neelam Upadhayay, PhD	Scientist
Wridhama Prasad, M Tech	Scientist
Sanket G. Borad, M Tech	Scientist (till December, 2018)
Sangita Ganguly, PhD	Scientist
Heena Sharma, PhD	Scientist
Manoj Kumar, CT, PhD	Scientist
Gaurav Kr. Deshwal, M. Tech.	Scientist
Prem Kumari, B.A.	Private Secretary

Experimental Dairy

Kaushik Khamrui, PhD	Principal Scientist & In-Charge
Lehri Singh, MSc (Chemistry)	Chief Technical Officer
Sanjeev Kumar, MA (Economics)	Asstt. Chief Technical Officer
Gurpartap Singh, M Tech (Mech. Engg.)	Technical Officer
Jagdish, BA	Technical Officer
Pardeep Singh, M Tech	Technical Officer

Dairy Chemistry Division

Bimlesh Mann, PhD	Head
Raman Seth, PhD	Principal Scientist
Sumit Arora, PhD	Principal Scientist
Vivek Sharma, PhD	Principal Scientist
Rajan Sharma, PhD	Principal Scientist
Rajesh Bajaj, PhD	Principal Scientist
Richa Singh, PhD	Scientist
Priyanka Singh Rao, MSc	Scientist
K. P. Indumati, MSc	Scientist
Kamal Gandhi, PhD	Scientist
Shakuntla Rani, BA	Private Secretary

Dairy Microbiology Division

Sunita Grover, PhD	Head
A. K. Puniya, PhD	Principal Scientist
S. K. Tomar, PhD	Principal Scientist
Naresh Kumar, PhD	Principal Scientist
Shilpa Vij, PhD	Principal Scientist
Chand Ram, PhD	Principal Scientist
P. V. Behare, PhD	Scientist (SS)
Raghu H.V., PhD	Scientist (SS)
Rashmi H. M., M Tech, PhD	Scientist (SS)
Diwas Pradhan, M Tech, PhD	Scientist
Mr. Saurabh Kadyan, M.Tech	Scientist
R. K. Malik, PhD	Emeritus Scientist
Seema Rani, B.A., B.Ed	Personal Assistant

Dairy Engineering Division

A. K. Singh, PhD	Acting Head (01.11.2019)
P. Barnwal, PhD	PS & Acting Head (w.e.f. 02.11.2019)

Chitranayak, PhD	Sr. Scientist
P. S. Minz, M Tech	Scientist (Senior Scale)
Amita Vairat, M Tech	Scientist
Ankit Deep, M Tech	Scientist
Kushbu Kumari, M Tech	Scientist
S. K. Chaudhary, AMIE	Chief Technical Officer
Om Prakash, Dip (Agri. Engg.)	Chief Technical Officer
J. K. Dabas, PhD	Asstt. Chief Technical Officer
Sunil Kumar, M Tech	Asstt. Chief Technical Officer
Sh. Parveen Kumar, Dip (Machinist)	Technical Officer
Ms. Manju Bala, Dip Arch	Technical Officer
Varinder Hans	Technical Officer

Dairy Economics, Statistics and Management Division

B. S. Chandel, PhD	Head
A. K. Chauhan, PhD	Principal Scientist
Ravinder Malhotra, PhD	Principal Scientist
Ajmer Singh, PhD	Principal Scientist
A. P. Ruhil, PhD	Principal Scientist
A. K. Sharma, PhD	Principal Scientist
Anil Kumar Dixit, PhD	Principal Scientist
Udita Chaudhary, MSc	Scientist
Gunjan Bhandari, MSc	Scientist
Tara Chand, BSc	Asstt. Chief Technical Officer

Dairy Extension Division

K. S. Kadian, PhD	Head
S. K. Jha, PhD	Principal Scientist
Gopal Sankhala, PhD	Principal Scientist
K. Ponnusamy, PhD	Principal Scientist
B. S. Meena, PhD	Principal Scientist
H. R. Meena, PhD	Principal Scientist
Ritu Chakravarty, PhD	Sr. Scientist
Sanchit Maiti, PhD	Scientist
Sanchita Garai, PhD	Scientist
Meenu Rani	Private Secretary

Forage Research and Management Centre

Rakesh Kumar, PhD	Principal Scientist & I/c FR&MC
Magan Singh, PhD	Sr. Scientist
Hardev Ram, PhD	Scientist
Rajesh Kumar Meena, PhD	Scientist
Sanjeev Kumar, PhD	Scientist
Uttam Kumar, PhD	Chief Technical Officer
V. K. Meena, PhD	Assistant Chief Technical Officer

Agricultural Technology Information Centre (ATIC)

Arun Kumar Misra, PhD	Principal Scientist & Incharge
Jitendra Rana, PhD	Assistant Chief Technical Officer

Krishi Vigyan Kendra/Trainers' Training Centre

Surender Gupta, PhD	Chief Technical Officer & Incharge
Rajeshwar Dayal, BSc	Asstt. Chief Technical Officer
Mohar Singh, MSc	Asstt. Chief Technical Officer
Kulvir Singh, MSc	Asstt. Chief Technical Officer
Deepa Kumari, BSc, MA	Technical Officer
Balraj	Technical Officer

Forage Production Section

Ashutosh, PhD	Sr. Scientist & Incharge
Satish Kumar, PhD (Horti.)	Chief Technical Officer
Anil Kumar Dagar, MSc	Assistant Chief Technical Officer
Ravi Rawat, MSc (Entomology)	Sr. Technical Officer
Mahender Pal	Technical Officer

Livestock Research Centre

S. S. Lathwal PhD	Principal Scientist & Incharge
Nishant Kumar, MVSc	Sr. Scientist
Rubina Kumari Bithalu, MVSc	Scientist
Pramod Kumar, MSc	Asstt. Chief Technical Officer
Amarpal Singh, PhD	Sr. Technical Officer
Ashwani Kumar, MSc	Sr. Technical Officer
Rajbir	Technical Officer
Samar Singh	Technical Officer

Animal Health Complex

Parveen Kumar, MVSc	Chief Technical Officer
S. Raju, MVSc	Chief Technical Officer
J. K. Pundir, BVSc	Assistant Chief Technical Officer
Sahdev Singh, MSc	Asstt. Chief Technical Officer

Artificial Breeding Research Centre

T. K. Mohanty, PhD	Principal Scientist & Incharge
Mukesh Bhakat, PhD	Sr. Scientist
Subhash Chand, BVSc	Sr. Technical Officer

Library Services

S. M. Deb, PhD	Head
B. P. Singh, MA, PGDCA, M Lib, I Sc	Asstt. Chief Technical Officer
Narendra Singh, MCA, M Lib I Sc	Technical Officer

Computer Centre

A. K. Sharma, PhD	Principal Scientist & Incharge
A. P. Ruhil, PhD	Principal Scientist
Naresh Kumar Dahiya, M Tech	Asstt. Chief Technical Officer
Des Raj Dip. CSP	Technical Officer

Communication Centre

Gopal Sankhala, PhD	Incharge
Dharambir, BA	Technical Officer

Vehicle Maintenance Section

Sanjeev Kumar, B Tech, M Sc (CS) Technical Officer

Official Language Unit

Susanta Saha, MSc, MBA Incharge
Rakesh Kumar, MA Assistant Director (OL)
Kanchan Choudhary, MA Asstt. Chief Technical Officer

Security Section

Ashutosh, PhD Incharge
Deepak Chopra, BA Security Officer
Rajvir Singh, MA, PGDCA Security Supervisor

Maintenance Section

R. K. Bansal, BE (Civil) Incharge
S. K. Saini, B Tech (Mechanical) Asstt. Chief Technical Officer
Balbir Singh, ITI (Electrical) Technical Officer
Arun Kumar, ITI (Electrical) Technical Officer

Health Complex

Dheer Singh, PhD Incharge
Manoj Kumar, MBBS S. M. O.
Richa Walia, Diploma Nursing Technical Officer
Saroj Kathuria, Diploma Nursing Technical Officer
K. S. Khanna Technical Officer
Sarroj Bala, D Pharma Technical Officer
Anuradha, Diploma Nursing Technical Officer

Hospitality Cell

J. K. Dabas, PhD Incharge (Asstt. Chief Technical Officer)
Vinod Kumar Technical Officer (Liaison Officer)

Sports Section

A. K. Singh, PhD Incharge
G. S. Meena, PhD Coordinator
Sandeep Deswal Sports Instructor

Estate Section

Sushil Kumar Kamboj, MSc Incharge (Chief Technical Officer)
P. M. Meena, MSc Asstt. Chief Technical Officer

Southern Regional Station, Bengaluru

K. P. Ramesha, PhD Head
B. Surendra Nath, PhD Principal Scientist
Bikash Chandra Ghosh, PhD Principal Scientist
P. K. Dixit, PhD Principal Scientist
Bandla Srinivas, PhD Principal Scientist
K. Jayaraj Rao, PhD Principal Scientist
D. N. Das, PhD Principal Scientist
M. C. Arunmozhi Devi, PhD Principal Scientist

A. Kumaresan, PhD	Principal Scientist
S. Jeyakumar, PhD	Principal Scientist
P. Heartwin Amala Dhas, PhD	Principal Scientist
M. Sivaram, PhD	Principal Scientist
Menon Rekha Ravindra, PhD	Principal Scientist
Mukund .A. Kataktaaware, PhD	Sr. Scientist
F. Magdaline Eljeeva Emerald PhD	Sr. Scientist
Mamta, PhD	Sr. Scientist
S. Varalakshmi, PhD	Scientist
S. Subash, PhD	Scientist
A. Manimaran, PhD	Scientist
Monika Sharma, PhD	Scientist
H. C. Devaraju, M Tech	Scientist
Sathish Kumar. M. H., PhD	Scientist
Lakshman Naik. N., PhD	Scientist
P. Muruganantham, M Lib Sci	Chief Technical Officer
V. R. V. Surendranath Naik, MD	Chief Medical Officer
B. K. Rajashekaraiyah, BSc (Agri.)	Asstt. Chief Technical Officer
Veeraju, BE (Civil)	Asstt. Chief Technical Officer
P. G. Satish, BVSc	Asstt. Chief Technical Officer
Siddaramanna, PhD	Sr. Technical Officer
R. Keshavamurthy, BSc (Agri.)	Sr. Technical Officer
Gurunath Gouda Patil, BSc (Agri.)	Sr. Technical Officer
K. Ningaraju, MVSc	Sr. Technical Officer
Meganathan, Dip. (Elec. Engg.)	Sr. Technical Officer
K. P. Lakshminarayanappa, DME (Mech.)	Sr. Technical Officer
Janakshi, MCA	Sr. Technical Officer
M. S. Nagarajaiah, Dip. (Civil Engg.)	Sr. Technical Officer
Vimala, BSc	Technical Officer
K. Ramakrishna Prasad, MSc	Technical Officer

Eastern Regional Station, Kalyani

T. K. Datta, PhD	Head
M. K. Ghosh, PhD	Principal Scientist
S. K. Das, PhD	Principal Scientist
A. Santra, PhD	Principal Scientist
C. Bhakat, PhD	Principal Scientist
A. Mandal, PhD	Principal Scientist
D. Mandal, PhD	Principal Scientist
A. Chatterjee, PhD	Principal Scientist
M. Karunakaran, PhD	Principal Scientist
M. Mondal, PhD	Sr. Scientist
Asif Mohammad, PhD	Scientist
Saroj Rai, PhD	Scientist
Rajalakshmi Behra, MVSc	Scientist
Alokesh Goswami, MSc	Chief Technical Officer
Amitava Ghosh, MVSc	Chief Technical Officer
Somnath Dutta, MVSc	Chief Technical Officer
Prabir Saha, MSc	Chief Technical Officer
Sukhdev Singh, BA	Asstt. Admn. Officer

PERSONALIA

Joining/Appointments

- » Sh. Rajneesh Kumar Singh, Sr. F.&A.O. joined at ICAR-NDRI, Karnal after being relieved from ICAR-IISWC, Dehradun (Uttarakhand) w.e.f. 11.02.2019.
- » Sh. Vivek Purwar, Sr. A.O. joined at ICAR-NDRI, Karnal after being relieved from ICAR-NBPGR, New Delhi w.e.f. 11.03.2019.
- » Sh. Abhishek Rana, Sr. A.O. joined at ICAR-NDRI, Karnal after being relieved from CTCRI, Thiruvananthapuram w.e.f. 08.07.2019.
- » Dr. Anil Kumar Puniya, Principal Scientist joined at ICAR-NDRI, Karnal after being relieved from post of Dean, DS&T from GADVASU, Ludhiana w.e.f. 28.09.2019.
- » Dr. Rani Alex, Scientist (SS) joined at Animal Genetics & Breeding Division, ICAR-NDRI, Karnal w.e.f. 26.11.2019.
- » Dr. G. R. Gowane, Sr. Scientist joined at Animal Genetics & Breeding Division, ICAR-NDRI, Karnal w.e.f. 02.12.2019.
- » Dr. Sabyasachi Mukherjee, Principal Scientist joined at Animal Genetics & Breeding Division, ICAR-NDRI, Karnal w.e.f. 07.12.2019.
- » Dr. S. K. Rathee, Scientist joined at Animal Genetics & Breeding Division, ICAR-NDRI, Karnal w.e.f. 23.12.2019.
- » Sh. Arvind, S.F.&A.O. joined at ICAR-NDRI, Karnal w.e.f. 23.12.2019.

Promotions

- » Smt. Sunita Chaudhary, Private Secretary got financial upgradation under MACPs w.e.f. 30.04.2019.
- » Smt. Krishna Devi Azad, Assistant promoted to the post of A.A.O. w.e.f. 16.05.2019.
- » Sh. Rajneesh Kumar Singh, Sr. F.&A.O. promoted as Deputy Director (Finance) and transferred to ICAR Hqrs., New Delhi w.e.f. 13.06.2019.
- » Sh. Vivek Purwar, Sr. A.O. promoted to the post of C.A.O. w.e.f. 01.07.2019.
- » Dr. Rashmi H. M., Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 15.09.2016
- » Smt. Udit Chaudhary, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 05.11.2016.
- » Dr. Rubina Kumari Baithala, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 01.01.2017.
- » Dr. Shaik Abdul Hussain, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 01.01.2017.
- » Dr. Saroj Rai, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 15.09.2017.
- » Dr. Nishant Kumar, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 8000) w.e.f. 20.07.2017.

Retirement/Relieving/ Transfers

- » Dr. Smita Sirohi, Head, Dairy Economics Statistics & Management Division appointed as Advisor (Agricultural Marine Products) at Embassy of India, Brussels & relieved from ICAR-NDRI, Karnal w.e.f. 09.01.2019.
- » Sh. Sanket G. Borad, Scientist (Dairy Technology discipline) resigned from the post of Scientist & relieved from ICAR-NDRI, Karnal w.e.f. 01.01.2019.
- » Dr. Ashok Kumar Gupta, Principal Scientist, Animal Genetics & Breeding Division retired from Council's service w.e.f. 28.02.2019.
- » Sh. Rajinder Kumar, Chief Admn. Officer transferred from ICAR-NDRI, Karnal to join at ICAR H.Q. w.e.f. 14.03.2019.
- » Sh. S. S. Meena, A.A.O. transferred to Southern Campus of NDRI, Bengaluru w.e.f. 01.06.2019.
- » Sh. Rajneesh Kumar Singh, Sr. F.&A.O. relieved from ICAR-NDRI, Karnal to join at ICAR H.Q. w.e.f. 13.06.2019.
- » Smt. Ritu Dalal, A.O. relieved from NDRI, Karnal to join at ICAR-CIAE Bhopal w.e.f. 28.09.2019.
- » Sh. A. K. Mishra, A.O. retired from Council's service w.e.f. 31.12.2019.

Additional Responsibility

- » Dr. S. M. Deb, Principal Scientist entrusted with the additional responsibility of Acting Head, Animal Genetics & Breeding Division for the period of six months w.e.f. 01.03.2019 and subsequently from 01.09.2019.
- » Dr. Latha Sabikhi, Head, Dairy Technology Division entrusted with the additional responsibility of Acting Joint Director (Research) for a period of six months w.e.f. 11.03.2019.
- » Dr. Bimlesh Mann, Principal Scientist was given the responsibility as Acting Head, Dairy Chemistry Division for a period of six months w.e.f. 02.07.2019.
- » Dr. Latha Sabikhi, Principal Scientist was given the responsibility as Acting Head, Dairy Technology Division w.e.f. 10.09.2019.
- » Dr. A. K. Tyagi, Head, Animal Nutrition Division entrusted the responsibility of Acting Joint Director (Research) at NDRI, Karnal for a period of six month w.e.f. 29.09.2019.
- » Dr. Pradyuman Barnwal, Principal Scientist was entrusted the responsibilities of Acting Head, Dairy Engineering Division, ICAR-NDRI, Karnal w.e.f. 01.11.2019 for a period of six months.



MAIN CAMPUS, ICAR-NDRI, KARNAL

RESEARCH DIVISIONS

Animal Genetics & Breeding Division

Animal Genetics & Breeding Division has been actively involved in conducting research in the areas of animal genetics and breeding including cytogenetics and molecular genetics. The research thrust areas of the Division are genetic improvement of indigenous and crossbred cattle and Murrah buffaloes by progeny testing of breeding males, faster multiplication of indigenous cattle, development of sustainable breeding plans, part and complete characterization of genes and their association with production/reproduction traits, disease resistance, screening of young breeding males for genetic disorders and assessment of reproductive efficiency of cattle and buffaloes.

Another important mandate of the Division is the development of human resources through academic activity of master's, Ph.D. programmes and training in the field of animal genetics and breeding. The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at the Division during eighth plan continued its activities on conducting the national training to scientists / teachers from Research Institutes, State Agricultural/ Veterinary Universities and Livestock Development Organizations in advanced areas of Animal Genetics and Breeding. A total of 34 National Training Programs have so far been organized under the aegis of CAFT (AG&B) in the Division.

The Division also fulfills the mandate of extension in the area of Animal Genetics & Breeding through training programs in KVK, TBI and Dairy Extension Division, consultancy services to farmers and various dairy stake holders, supplies superior germplasm in the form of frozen semen and surplus breeding males to farmers, livestock developmental agencies, state governments and other stake holders involved in dairy development in the country.

The organizational structure for research consists of Animal Breeding Lab., Biometrical Genetics Lab., Buffalo Breeding Lab., Molecular Genetics Lab., DNA Bank for cattle and buffaloes, Livestock Record Cell and besides this, breeding herds of cattle (Karan Fries, Karan Swiss, Sahiwal, Tharparkar and Gir) and Murrah buffaloes is also the integral part of the research component of Animal Genetics and Breeding Division. The Divisional Library has 480 books and 232 M.Sc./M.V.Sc. and 143 Ph.D. theses.

Livestock Production & Management Section

The Livestock Production and Management (LPM) Section came into being in June, 2009 after it was disassociated from the Dairy Cattle Breeding Division. Earlier, a separate faculty of LPM was working along with the Dairy Cattle Breeding Division and post graduate and doctorate degrees were being awarded since 1976. The Section is working in the front line areas of all applied aspects of dairy animal production and has been successful in evolving many transferable technologies and development of packages of practice on the routine care and management of dairy animals. Beside research, the faculty of LPM has been engaged in teaching both at UG and PG levels.

The Livestock Production Management (LPM) Section is shouldering the responsibility of various important activities of the Institute. LPM faculty is working as four pillars of Livestock Production Management i.e. breeding, feeding, housing and healthcare. This is contributing very meticulously in Livestock Research Centre and Artificial Breeding Research Centre to cater to the research needs of most of the disciplines of ICAR-NDRI. This faculty is also entrusted with the responsibility of HRD development in the area of scientific dairy farming, commercial dairy farming, infertility management of dairy animals and frozen semen production and quality control.

Animal Biotechnology Centre

Biotechnology was initiated at NDRI, Karnal during mid-eighties under a UNDP 'Centre of Excellence on Biotechnology' programme. The urgent need for application of recent biotechnological advances in reproduction and production of superior females of dairy breeds of ruminants for improving animal productivity in our country formed the basis for the establishment of a state-of-the-art Embryo Biotechnology Centre (EBC) with financial support from the Department of Biotechnology. Biotechnology was further strengthened by establishment of Livestock Genome

Lab and Molecular Biology Unit. Animal Biotechnology Centre was reorganized in June 1999 by consolidating all the infrastructure facilities created under various programmes on biotechnology. Besides research on areas relevant to biotechnology in dairy production and processing, the Centre also offers M.Sc./M.V.Sc./M.Tech and Ph.D. (Animal Biotechnology) programmes.

The objectives of the proposed Division are 1) To undertake biotechnology oriented basic and applied research programmes for improving animal productivity and for developing innovative dairy processes for producing superior quality, safe and wholesome dairy products, 2) To train manpower in application of Biotechnology in Dairy Production and Dairy Processing and 3) To organize Masters and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

A state-of-the-art biotechnology research facility, which offers a working space of more than 20,000 sq. ft., was created in 2007 to consolidate the biotechnology research at NDRI. It has specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research, Structural Biology etc.

Animal Physiology Division

Animal Physiology used to function as a section of the erstwhile Dairy Husbandry Division and subsequently as Dairy Cattle Nutrition and Physiology Division till the end of the 6th Five Year Plan. The discipline of Animal Physiology received the status of an independent division in 1984. The division made a humble beginning with limited resources at its disposal. It was a challenging task to develop infrastructural facilities in the division during those days with limited budgetary provisions. The division not only succeeded in establishing the state-of-the-art research facilities, but also earned fame in publishing the best quality research papers at the Institute. The scientists and the students have earned exemplary recognitions while working at this division and abroad during training and postdoctoral programs. The division has always taken a lead in organizing various brain storming sessions, conferences, symposia and training programs for the benefit of scientific and technical community engaged in research. Being one of the important production disciplines, Animal Physiology has always come forward to solve the problems of dairy farmers. It has one of the biggest and prestigious projects on NICRA running successfully at the Institute. The alumni of the division have achieved higher positions in research and management in the Institute and in ICAR/SAUs. The division has developed certain useful technologies like induction of lactation, rBST to augment milk production, milk SCC for udder health and CMP and application of mist and fan to alleviate summer stress, which have been adopted several progressive farmers of the area.

Animal Nutrition Division

Animal Nutrition Division undertakes basic and applied research in field of post-graduate programmes of education and participates in the process of extension education through various training programmes and field level technology development and refinement in the discipline of animal nutrition and forage production. The research laboratories are equipped with modern analytical instruments for chemical and physical analysis. The Division has developed excellent laboratory facilities, which are central facilities for research and education, not only for the Institute but also for various sister organizations seeking such support from time to time. The central facilities include central fine instrumentation laboratory, laboratory for anaerobic rumen microbial work, laboratory for environment related studies including methanogenesis, quality control laboratory, feed processing unit and nutritional biotechnology laboratory. Some of the sophisticated instruments available include atomic absorption spectrophotometer, gas-liquid chromatography, HPLC system, ¹⁵N-Analyzer, methane analysis equipment using SF₆ technique, spectrophotometer, PCR machine etc. Research on precision nutrition is being undertaken since the past few years. Besides research, Animal Nutrition Division also offers the M.Sc./M.V.Sc. and Ph.D. in Animal Nutrition.

Forage Research and Management Centre

Agronomy Section (Forage Research and Management Centre) was established as sister section of forage production section since July 2013 to strengthen the research and teaching and extension activities related to round the year forage production and quality improvement of forages through agronomic manipulations. The mandate of section includes, generating the human resource in Forage Agronomy, developing the agro-techniques for enhancing the fodder productivity and quality through efficient management of resources and to disseminate the knowledge about new agro-techniques for forage crop production and management to the dairy farmers/extension functionaries. At present, the section offers masters and doctoral programmes in forage agronomy. The section has about 10 acre land for conducting research experiments and facilities for quality analysis of forage.

Animal Biochemistry Division

Research endeavours of the Division are presently directed towards development of probiotic and prebiotic foods, dairy nutraceuticals and their mechanism of action, validation of health benefit claims of Indian dairy products,

nutrigenomics, characterization of buffalo fertility genes, sperm functions and cryopreservation of semen, spermatogonial stem cells research and bioinformatics in dairy processing and production.

The Division has instrument rooms with modern equipments viz. Alpha- and Beta-counters, Ultra-centrifuge, High speed centrifuges, Micro-centrifuges, UV-visible spectrophotometers, Spectrofluorometer, PCR, Real Time PCR, ELISA Plate readers, High Pressure Liquid Chromatography, Gas Liquid Chromatography, Inverted and fluorescent microscopes, Ice flaking machines, Freeze dryer, Gel documentation (Imaging) systems, ultra filtration unit, Ultra-low temperature freezers and Carbon dioxide incubators. The Division has a cold room for carrying out research at low temperature. Cell culture facilities are also available in the Division.

The salient research achievements of the Division are: development of different types of probiotic dahi and validation of their health-benefits in reducing serum cholesterol levels, protection against gastrointestinal cancer and management of diabetes in animal models, validation of nutraceutical attributes of dairy ghee in coronary heart diseases, gastro-intestinal and mammary cancer and improvement of immune system, and elucidation of its molecular mechanism, bioavailability of vitamins and minerals from dairy products, levels of conjugated linoleic acid in milk products, characterization of 8 amino acid transport systems in mammary gland and their induction at the onset of lactation, antiatherogenic properties of milk and its mechanism, hormonal profile of reproductive phases of buffalo, biochemical changes in sperm maturation, capacitation, acrosome reaction and semen freezing, signal transduction mechanism of sperm function, expression and hormonal regulation of fertility related ovarian genes in buffalo, SSCP analysis of CYP19 aromatase gene in anestrus buffaloes and transduction pathways (PI3K and MAPK) in cattle granulosa cells during steroidogenesis and apoptosis.

Dairy Chemistry Division

The mandate of Division is to conduct fundamental and applied research for understanding chemistry of milk and milk products, to impart educational programmes for undergraduate and postgraduate courses and to provide R&D support towards chemical-quality control related problems of the dairy industry.

The Division has contributed significant knowledge on the chemistry of milk and milk products. The salient achievements are: evaluation of physico-chemical properties of buffalo milk and alteration in its calcium and casein levels; casein micelle stability in relation to manufacture of quality dairy products and encapsulation of bioactive components; triglyceride profile of cow and buffalo milk fat; revealing chemistry of ghee and ghee residue flavour; chemical makeup and structural integrity of milk fat globule membrane; influence of various processing parameters on the water soluble vitamins, major minerals and trace elements and their partitioning; lactoferrin structure and its bacteriostatic role; characterization and crystallization of buffalo lactoperoxidase; functional properties of milk protein products; production and characterisation of milk protein derived bioactive peptides enriched ingredients; calcium fortified milk, low cholesterol ghee; nanoencapsulation of bioactive components and nutrients for their application in functional foods; preparation of spray dried milk protein-vitamin A/vitamin D complexes for fortification of various food products; Attenuated Total Reflectance-Fourier Transform Infrared (ATR-FTIR) spectroscopy based analytical method for assessment of proteolysis in UHT milk; A method for analysis of the panchgavya components; rapid and simple methods for the determination of SNF in milk; modification of Gerber test for simultaneous estimation of milk fat; simple tests for the detection of adulteration of milk and milk products; a platform test for detection of detergent in milk; a colour based test to detect adulteration of milk with soya milk; Strip based tests developed for the detection of added Urea, Neutralizers, Hydrogen peroxide, Glucose, Maltodextrin, salt and sucrose in milk; A Method for Vegetable oil detection in ghee using RP-HPTLC; Nanotechnology based method for detection of melamine and pesticide; formulation of quality standards of milk and milk products which are now prescribed Food Safety and Standards Authority under Ministry of Health as well as Bureau of Indian Standards;

The Division has state of the art air conditioned Seminar room, Lecture room equipped with interactive board, LCD projectors, Visualiser, Podium etc., Quality control Lab, Undergraduate and Postgraduate labs, Instrument room (equipped with HPLC, GLC, Mastersizer, Ultra filtration, Electrophoresis, Imaging system, Refrigerated water bath, Dual beam digital Spectrophotometer, Water purification system, BOD incubator, Sonicator etc.), Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ nutraceuticals and quality assurance), chemical section of National Referral Centre for Milk Quality and Safety (equipped with FTIR, HPLC, GC-MS, AAS, PCR, Real-time PCR, Particle size analyser, Electrophoresis, Elisa Reader, Western Blot, Digital Refractometer, Protein Analyzer, Lyophilizer, Fume Hoods, Conductivity & O₂ Meter etc.).

Dairy Technology Division

The Dairy Technology Division has the distinction of being one of the earliest Divisions of NDRI, Karnal. The Division contributes significantly to the teaching, research, training and consultancy activities of the Institute. The educational programmes include the flagship programme of B.Tech. (Dairy Technology), Masters and Ph.D. (Dairy Technology) and Masters (Food Technology). The research efforts of the Division faculty are brought to

fruition through sponsored as well as in-house projects including dissertations of post graduate students. Basic and applied studies to refine processing and packaging technologies for traditional, composite, western and dried dairy products form the major focus of research activities. The Division has developed strong expertise in the area of membrane processing, biotechnological applications, composite dairy and food products and their packaging. It has successfully organised 39 National Training Programs under the ICAR-sponsored Centre for Advanced Faculty Training in Dairy Processing (earlier, Centre for Advanced Studies in Dairy Technology) since 1994, for teaching faculty of State Agricultural Universities and other institutions. The Division of Dairy Technology has received a number of awards in recognition of the outstanding scientific contributions made by the scientists, students and staff, such as Fellow of the Indian Dairy Association, Best Employee Award from ICAR, Best Teacher Awards, Rafi Ahmed Kidwai Awards, Jawaharlal Nehru Award, DAAD Fellowships, Humboldt Fellowships and several others, including Best Research Paper awards. Under the recently awarded Institutional Development Plan under the National Agricultural Higher Education Project for the incentivisation of undergraduate program, several activities for the improvement of faculty and students are in progress in the Division. The most noteworthy contribution of the Dairy Technology Division to the Indian Dairy Industry has been the industry's human resource pool, in addition to the collection of technologies.

Dairy Microbiology Division

Dairy Microbiology Division is currently engaged in research, teaching, consultancy, training and technology transfer in specialized field of Dairy Microbiology. Research work of the Division covers the areas related to starter cultures and fermented milk products; direct vat starters (DVS); indigenous probiotics and their functional efficacy; culturomics, metagenomic and metabolomics of milk and fermented dairy products, prebiotics and synbiotics; functional fermented foods, bioactive peptides, microbial metabolites and biopreservatives; biosensors, quality assurance and food safety. Division has played a leading role in establishing National Collection of Dairy Cultures (NCDC) with current repository of 958 microbial cultures and National Referral Centre for milk quality and safety. The Division has transferred technologies on two indigenous strains of probiotics, Misti Dahi/doi, EPS producing culture for preparation of low-fat dahi, rapid kits for antibiotic residues, *Listeria monocytogenes* and *Enterococci* to potential stake holders in our country for their industrial application. The faculty is also involved in imparting teaching and guidance for both under-graduate and post-graduate programmes. The Division offers M. Tech and Ph.D programmes both in Dairy Microbiology and Food Safety and Quality Assurance has also been initiated. Besides, Division is also contributing in teaching Microbiology courses for B. Tech (Dairy Technology) students. The Division offers contractual and consultancy / training services such as supply of starter cultures, freeze-drying of cultures, microbiological analysis and setting standards for regulatory compliance of dairy products in our country. Division regularly organizes need based specialized short term symposia/ conferences/ Seminars covering basic and applied areas of dairy microbiology including quality assurance, food safety, starter cultures and fermented health foods for HRD development in our country. Division also co-ordinates the activities of National Referral Centre on milk quality and safety.

Dairy Engineering Division

Dairy Engineering Division, established as one of the major research divisions, has been contributing to teaching, research, training and industrial consultancy since the inception of the Institute. The Division has research laboratory facilities to cater to the needs of specific areas and programmes such as process engineering, process equipment design, thermal, electronics and instrumentation. In addition to this, there are post-graduate teaching laboratories, Research & Development workshop and equipment testing hall to support both research and teaching activities. During the past three decades, the Division has achieved breakthroughs in developing a number of process equipment for manufacturing indigenous milk products. Many of these equipment have been patented and efforts are being made to transfer them to the equipment manufacturers. The Division has tie-ups with equipment manufacturers and users for their collaboration in development or in adoption of the research efforts. The Division has developed equipment for the manufacture of khoa, burfi, basundi, ghee etc on industrial scale. Recent research achievements include development of weight based filling system for kheer, machine vision system for colour measurement of dairy products, turbo assisted scraped surface heat exchanger (SSHE) etc. Current research areas focus on development of weight based filling system for rabri and equipment for mechanized production of kheer and rabri. The Division also conducts specialized training to graduate engineers during summer.

Dairy Economics, Statistics and Management Division

A Division of Dairy Economics, Statistics and Management (DES&M) was created in 1972 from erstwhile Statistics Section which was constituted at NDRI in 1960. Dr. R. K. Patel joined as the first Head of the Division. He steered the Division to expand its research and teaching activities and the discipline of Dairy Economics got real impetus under his able leadership. Apart from conducting research on various economic aspects of dairy sector at national

and international level, the Division attempts to understand the complex array of forces that influence the level and behaviour of agricultural products. In the present context, the Division endeavours to further advance the knowledge in economic and statistical analysis techniques pertinent to research work and to assess technologies, programs and policies to make informed judgments about the trade-offs in allocating scarce resources and predicting resulting changes or their economic consequences. The Division harnesses the emerging tools, techniques and research methods in econometrics and statistics to provide direction in designing policies & program, developing institutional mechanisms and facilitating decision-making process of the stakeholders at micro, meso and macro levels.

Dairy Extension Division

Dairy Extension Division was established at NDRI, Karnal in May, 1961 to undertake extension activities, besides teaching and research in Extension Education. Research endeavors of the Division are in the areas of information and communication technologies, organizational behaviour, information management, participatory technology development and impact studies of dairy innovations. The faculty has also been engaged in human resource development through post graduate and doctoral programmes of NDRI. The main extension programme of the institute such as Dairy Mela and demonstrations, field days, etc. are organized by the Division. Research-Extension-Industry-Farmer Interface is also organized by the Division to provide an opportunity for the convergence of all stake holders working together for dairy development. Interface not only helps the dairy organizations to find solutions for today's problems, but also to realize the vision for the future. The Division also organizes technology transfer campaigns, infertility and veterinary aid campaigns, Kisan Sanghoshthies and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, helps in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers. A new Extension Education Programme "Dairy Education at Farmers' Door" is initiated in 09/02/2009, to strengthen the effective dissemination of dairy production and processing technologies among farming community. A new Extension Approach "Farmers' Farm School" in village was initiated in 2014 for updating farmers knowledge in the field of dairy farming in particular and agriculture in general.



SUPPORT SECTIONS

Livestock Research Centre

The total milk production of the herd during the current year was 936281.6 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 8.8 and 10.0 kg per head per day, respectively. The milking average of Sahiwal cows, GIR cows and Murrah buffaloes was 5.8 kg, 3.1 kg and 7.0 kg per animal per day, respectively. One Sahiwal cow (SW-2233) produced best milk yield of 23.5 kg in peak lactation. Best yield in Murrah buffalo (MU-7357) was 18.0 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 34.5 kg (KF-7763) and 21.0 kg (KS-4457), respectively.

Bovine Strength of Cattle and Buffaloes as on 31.12.2019

Age group	Cattle						Buffaloes
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total	Murrah
Male 0-6 month	28	11	09	02	20	70	36
Female 0-6 month	22	07	04	-	16	49	52
Heifers above 0-6	129	56	42	06	123	356	115
Cows/ Buff	196	72	81	12	162	523	213
Male stock young 0-6 month	20	08	15	03	36	82	45
Bulls	-	-	-	06	53	59	27
Teaser Bull	-	-	-	-	-	-	02
Bullock	-	-	-	-	05	05	-
Total	395	154	151	29	415	1144	490

Flock Strength of Goats as on 31.12.2019

Age Group	Alpine x Beetal	Sannen x Beetal	Total
Female			
Kids upto 6 months	31	14	45
6-12 months	06	02	08
Yearling	41	10	51
Goats	78	21	99
Male			
Kids upto 6 months	45	09	54
6-12 months	11	04	15
Bucks	38	19	57
Total	250	79	329

Sale of Livestock during 2019 (01.01.2019 to 31.12.2019)

Mode of Disposal	Cattle	Buffaloes	Goats	Total (in ₹)
Public Auction	282900.00	755000.00	407500.00	1445400.00
Grand Total	282900.00	755000.00	407500.00	1445400.00

» Auction of animals was conducted on May 28, 29 and 30, 2019

Performance of Dairy Animals during the year 2019 (01.01.2019 to 31.12.2019)

Particulars	Genetic Groups									
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total cattle	Murrah	AXB Goats	SXB Goats	Total Goats
Average number of animals in milk per day	81	17	24	06	100	228	113	41	12	53
Average number of dry animals per day	112	50	57	05	63	287	107	12	02	14
Milking average (kg) per day	5.8	4.5	3.1	8.8	10.0	7.3	7.0	1.5	1.6	1.5

Particulars	Genetic Groups									
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total cattle	Murrah	AXB Goats	SXB Goats	Total Goats
Overall average (kg) per day	2.4	1.1	09	4.8	6.1	32	3.6	1.2	1.4	1.2
Best yield (kg) in a day	23.5	12.0	11.0	21.0	34.5	-	18.0	4.3	4.0	
Animal Number	2233	1384	21	4457	7763	-	7357	284	276	

Month-wise Milking Average (kg) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal (01.01.2019 to 31.12.2019)

Months	Cows										Buffaloes		Goats			
	Sahiwal		Tharparkar		GIR		Karan swiss		Karan Fries		Murrah		Alpine x Beetal		Sannen x Beetal	
	No of animals in milk/day	Milk yield (kg)/animal/day	No of Animals in milk/day	Milk yield (kg)/animal/day	No of Animals in milk/day	Milk yield (kg)/animal/day	No of animals in milk/day	Milk yield (kg)/animal/day	No of Animals in milk/day	Milk yield (kg)/animal/day	No of Animals in milk/day	Milk yield (kg)/animal/day	No of animals in milk/day	Milk yield (kg)/animal/day	No of animals in milk/day	Milk yield (kg)/animal/day
January	87	5.4	20	3.8	26	3.2	07	10.0	101	13.2	116	7.8	42	1.5	13	1.7
February	83	5.6	17	2.9	30	3.4	06	11.8	108	12.7	120	7.4	45	1.7	14	1.7
March	82	5.5	13	4.8	31	3.2	07	10.5	115	13.0	122	7.2	46	1.7	14	1.9
April	82	5.9	19	4.6	31	3.2	06	9.8	117	11.2	120	7.4	46	1.8	14	1.9
May	82	6.1	19	4.7	28	3.1	05	10.8	117	10.6	115	7.4	43	1.7	13	1.8
June	88	5.8	16	5.1	28	3.2	05	8.0	110	9.0	103	7.5	40	1.6	10	1.6
July	88	5.6	15	4.6	25	2.8	06	7.8	106	8.4	104	6.9	41	1.2	10	1.3
August	78	5.6	17	4.8	20	2.6	06	8.4	100	7.5	108	6.3	39	0.9	11	1.1
September	74	5.7	18	4.0	16	2.9	06	9.3	94	7.0	112	5.5	23	0.9	09	1.1
October	78	6.0	20	4.5	16	3.2	06	8.2	83	7.7	103	6.0	17	1.3	07	1.8
November	77	6.2	19	4.4	18	3.3	06	5.8	75	8.2	117	7.1	41	1.4	11	1.6
December	74	5.9	17	4.5	17	2.5	06	5.0	77	9.1	123	7.0	66	1.7	17	1.8
Average	81	5.8	17	4.5	24	3.1	06	8.8	100	10.0	113	7.0	41	1.5	12	1.6

Fodder and Concentrate during 2019 (01.01.2019 to 31.12.2019)

Months	Type of Fodder (Qntls.)				Concentrate
	Green	Dry/Hay	Silage	G. Total	(kg)
January	14466.00	730.50	1399.00	16595.50	120931.00
February	16086.50	466.00	2042.50	18595.00	113119.00
March	20172.00	179.50	2045.00	22396.50	115200.00
April	17055.00	740.00	476.00	18271.00	100280.00
May	9600.50	750.00	3345.50	13696.00	102398.00
June	14119.50	479.50	1565.50	16164.50	108930.00
July	18291.00	672.00	-	18963.00	120950.00
August	24322.00	42.00	-	24364.00	114044.00
September	19452.50	311.50	-	19764.00	62800.00
October	14739.00	756.50	-	15495.50	83187.00
November	12475.50	828.50	-	13304.00	101930.00
December	19571.00	2577.50	-	22148.50	88072.00
Total	200350.50	8533.50	10873.50	219757.50	1231841.00

Total Milk Production and Milk Supplied to Experimental Dairy (01.01.2019 to 31.12.2019)

Month	Total Milk Production	Total Calves/ Kids	Total Other Division	Total Disposal Milk	Total Milk Send to Expt. Dairy	Total Milk Recd. by Expt. Dairy
January	94951.3	11668.2	5004.5	16672.7	77975.5	79155.0
February	86456.6	9868.4	4739.5	14607.9	70973.2	70840.0
March	99156.3	9238.2	5175.5	14413.7	84141.0	84185.0
April	92029.9	9320.9	3437.5	12758.4	78974.9	79241.0
May	90919.1	8188.4	2549.0	10737.4	79866.1	80199.0
June	77266.0	7325.7	2606.9	9932.6	67238.6	67290.0
July	72907.0	7671.0	785.5	8456.5	64216.2	64217.0
August	65462.5	7683.1	373.5	8056.6	57131.0	57305.0
September	57587.5	8974.5	5931.7	14906.2	42360.7	42783.0
October	61106.4	10359.4	5063.0	15422.4	44653.6	45026.0
November	66435.2	10812.6	2340.0	13152.6	52878.3	52362.0
December	72003.8	12747.0	2572.0	15319.0	55869.2	55457.0
Total	936281.6	113857.4	40578.6	154436.0	776278.3	778060.0

Fat and SNF Percentage of Cattle And Buffaloes during the year 2019 (01.01.2019 to 31.12.2019)

First Lactation						
Particulars	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No of Observations	249	12	47	9	394	457
Average Fat %	4.42	4.25	4.50	4.41	4.43	7.59
Range	2.90-5.90	3.30-5.60	3.40-5.80	3.50-5.10	3.00-5.80	5.30-10.50
No. of Observations	249	12	47	9	394	457
Average SNF%	8.81	8.79	8.85	8.84	8.79	9.86
Range	8.10-9.30	8.50-9.20	8.50-9.20	8.70-9.00	8.10-9.20	9.00-10.60
All Lactations						
Particulars	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of Observation	901	173	261	64	1135	1292
Average Fat %	4.44	4.32	4.40	4.52	4.45	7.54
Range	2.90-5.90	3.00-5.80	3.00-5.80	3.10-5.70	2.90-5.50	5.20-10.50
No. of Observation	901	173	261	64	1135	1292
Average SNF%	8.82	8.79	8.81	8.82	8.80	9.84
Range	8.50-9.30	8.40-9.20	8.40-9.30	8.50-9.20	8.30-9.30	8.80-10.60

Protein and Lactose Percentage of Cattle and Buffaloes during the year 2019 (01.01.2019 to 31.12.2019)

First Lactation						
Particulars	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of Observations	249	12	47	9	394	457
Average Protein%	3.33	3.29	3.35	3.28	3.34	3.73
Range	2.80-3.70	3.10-3.60	2.90-3.70	2.90-3.50	2.70-3.80	3.00-4.30
No. of Observations	249	12	47	9	394	457
Average Lactose%	4.52	4.44	4.53	4.41	4.53	5.19
Range	3.90-5.00	4.20-4.80	3.90-5.00	4.00-4.60	3.90-5.20	4.30-5.90
All Lactations						
Particulars	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of Observations	901	173	261	64	1135	1292
Average Protein %	3.34	3.34	3.32	3.31	3.33	3.72
Range	2.80-3.80	2.90-3.80	2.80-3.90	2.90-4.10	2.70-3.90	3.00-4.40
No. of Observations	901	173	261	64	1135	1292
Average Lactose%	4.52	4.55	4.52	4.48	4.50	5.19
Range	3.90-5.20	3.90-5.20	3.90-5.00	3.90-5.00	3.90-5.20	4.00-5.90

Month-wise Milking Average (kg) as Fat Corrected Milk of Cows and Buffaloes Maintained at NDRI Karnal (01.01.2019 to 31.12.2019)

Month	Sahiwal 4%Fat		Tharparkar 4%Fat		GIR 4%Fat		Karan Swiss 4%Fat		Karan Fries 4%Fat		Murrah 6%Fat	
	Av. No. of Animals in milk/day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/day	Av. FCM yield (kg.)/ Animals / day
Jan. 2019	87	6.18	20	4.03	26	3.48	7	11.11	101	14.83	116	9.80
Feb. 2019	83	5.69	17	2.98	30	3.31	6	12.95	108	12.98	120	8.34
Mar. 2019	71	7.13	20	6.53	25	5.05	7	13.78	104	14.62	119	9.99
Apr. 2019	82	6.60	19	5.00	31	3.51	6	10.85	117	12.20	120	8.51
May 2019	82	6.53	19	5.08	28	3.25	5	12.72	117	11.96	115	8.66
June 2019	88	5.87	16	5.35	28	3.12	5	8.23	110	9.45	103	8.37
July 2019	88	6.14	15	4.99	25	2.95	6	9.30	106	9.37	104	8.53
Aug. 2019	78	6.41	17	4.91	20	2.77	6	9.77	100	7.99	108	8.00
Sept. 2019	74	5.49	18	3.74	16	2.60	6	9.66	94	7.30	112	6.70
Oct. 2019	78	6.47	20	4.95	16	3.36	6	8.34	83	8.12	103	7.06
Nov. 2019	77	6.69	19	4.82	18	3.25	6	5.70	75	8.48	117	8.20
Dec. 2019	74	6.40	17	5.14	17	2.70	6	5.22	77	10.03	123	8.75
Average	80	6.30	18	4.79	23	3.28	6	9.80	99	10.61	113	8.41

Artificial Breeding Research Center

The Artificial Breeding Research Centre (ABRC) with 158 breeding bulls (Sahiwal-46, Tharparkar-17, Karan Fries-34, Karan Swiss-02, Murrah-49, Gir-09, Pungnur-01) is engaged in progeny testing programme for Sahiwal and Murrah bulls. This center is involved in advanced research on bull management, Breeding soundness evaluation standards for the indigenous bull, semen cryobiology, sperm sexing, early bull fertility assessment and dissemination of quality germplasm to the farmers and developmental agencies. The Artificial Insemination Laboratory under ABRC is also developing strategies for fertility improvement in dairy cows and buffaloes through reproduction management, oestrous synchronization.

Research, Extension and Education Achievements

The scientists working in the center are actively involved in various institute research projects, inter-institute research projects and externally funded projects to achieve the research objectives.

Four Murrah breeding bulls were selected under Network Project on Buffalo Improvement for the 18th set of progeny testing programme.

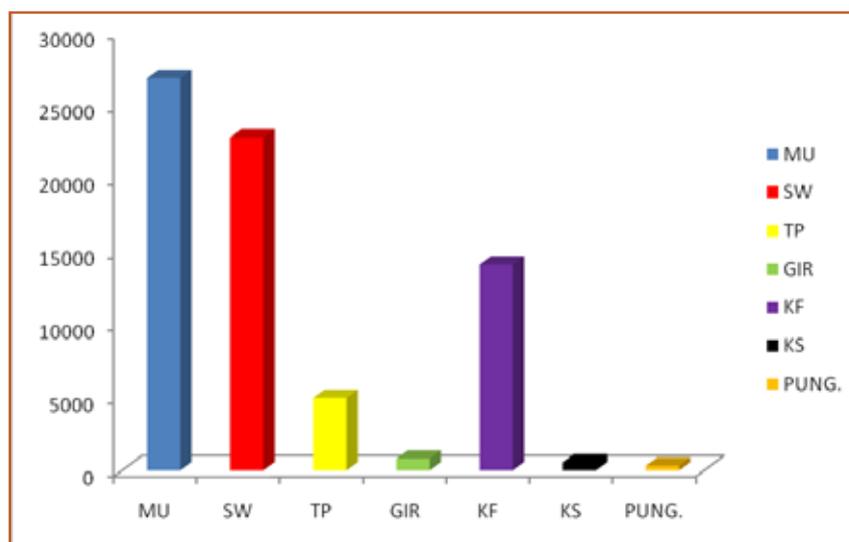
Reproduction Management

Reproductive Status of NDRI Herd during 2019 (01.01.2019 to 31.12.2019)

Particulars	Breeds					
	SW	TP	KS	GIR	KF	MU
Cow / Buffalo						
Nos. of observations	93	30	5	50	62	63
Service period (days)	143.01	147.86	170.40	190.28	197.59	166.12
No. of service/conception	1.40	1.70	2.00	1.76	1.66	1.36
Heifer						
Nos. of observation	24	17	3	9	21	30
Av. age at maturity (Month)	28.08	33.11	28.33	31.11	30.09	34.34
Av. age at conception (Month)	30.24	34.82	37.00	32.44	31.66	36.13
No. of service/conception	1.78	1.41	2.16	1.22	1.33	1.40
Conception Rate (%)						
Conception rate 1st service	55.62	60.34	44.44	51.47	40.33	42.10
Conception rate 3rd service	87.41	89.65	100.00	83.82	78.15	63.81
Over all conception rate	48.46	48.69	39.28	41.10	35.64	38.18

Production of Superior Germplasm

The center is involved in the production and conservation of superior male germplasm of cattle and buffaloes. During 2019-20, a total of 70,457 doses of frozen semen were produced.



Breed wise production of superior germplasm (April, 19 - March, 20)

Dissemination of Superior Germplasm

The center is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes. During the year ABRC distributed 74950 ml doses liquid semen of Sahiwal, KF and Murrah bulls to local farmers and also disseminated/supplied 79997 doses frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers and various Dairy development organizations / Institutes / Gaushalas of 12 states viz., Haryana, Punjab, Uttarakhand, Delhi, U.P, Rajasthan, Bihar, Himachal Pradesh, J&K and Maharashtra.

Month-wise Dissemination of Semen Doses in 2019

Month	Liquid semen doses (ml) to Farmers	Frozen semen doses to Farmers / Institutes / Dairy Development Agencies
January	6505	7328
February	5620	2544
March	6530	4410
April	5530	2467
May	6295	3643
June	5885	7503
July	6025	3580
August	7225	3820
September	8305	3626
October	7945	5918
November	7290	7770
December	7325	5588
Total	80480	58197

Extension Activities

- » Team ABRC provided exposure visit to all the participants came for the Entrepreneurship Development Program on Commercial Dairy Farming under SINED-TBI and KVK.
- » The ABRC maintained the linkages with ICAR institutes, DADF, Govt. of India and state agencies through various projects for vertical growth of the center.
- » Under AICRP on 'Genetic improvement of Sahiwal cattle' with ICAR-CIRC, Meerut as a lead center and NDRI as Germplasm Unit to the supply of Sahiwal bull semen to the following centers i.e. GADVASU, Ludhiana; LUVAS, Hisar, GBPUA&T, Pantnagar, under Govt. as cooperating Data recording Unit (DRU) and CIRC as main coordinating Unit.

Semen Distributed among Farmers from the Center (01.01.2019 to 31.12.2019)

Month	Supply of Semen for AI
January	150
February	22
March	255
April	518
May	220
June	136
July	756
August	764
September	622
October	144
November	286
December	681
Total	4554

Forage Production Section

Economic milk production can only be achieved, if nutritious fodders are made available throughout the year to the dairy herd. The cost of feeding constitutes about 55-65% of the total cost of production of milk. Thus, it is essential to economise the feeding cost. It has been established that cost of milk production is the lowest and animal performance is better if adequate green fodder in the form of cereal and legume mixture and high energy silage are made available for feeding to the Dairy animals.

The foremost responsibility of Forage Production Section is to produce adequate quantity of good quality green fodder to meet the nutritional requirements of the Institute herd. After meeting the day to day requirement of fodder, some area is utilized for production of fodder seed and other grain crops to meet the requirements for transfer of technology programmes of Institute and partial fulfillment of the grain component of feed.

Allocation of the Farm Land to Different Units

Sr. No.	Unit	Area (Acres)
1.	Forage Production Section &RFS (Seed)	805.69
2.	Farm Building, Road Drains, Channel & Silo Pit.	106.21
3.	Area under Eucalyptus trees (Farm)	5.01
	Land under Forage Production Section	916.91
	Land under Campus, Buildings and other Institute Activities	
1.	Narmda Hostel, Kalki Bhawan, Plantation area and Dairy Mela Ground	42.75
2.	Institute campus and Building	324.53
3.	Dairy Demonstration & other schemes, KVK	33.39
4.	Artificial Breeding Research Complex, Block-5	10.00
5.	Model Dairy Plant	20.50
	Total	431.17
	Grand Total (Land with NDRI, Karnal as on May, 2017)	1348.08
	Land handed over to other Agencies	
	Indian Railway	0.49
	33 KVA H.S.E.B., Karnal (Station)	0.49
	NBAGR (ICAR)	74.99
	DWR	47.97
	Total	123.94
	Overall Land	1472.02

Fodder/Feed Production and supply

219564.50 q. Green, 4381.50 q. Dry good quality fodder, and 4543.00 q. Straw produced from high yielding varieties of fodder crops of Maize, Sorghum, Napier Grass, Sugargraze and Cowpea during Kharif season and Berseem, Oats Chinese Cabbage and winter Maize in Rabi season. Similarly seed/grain crops of Oats, Jowar was also grown. During the period under report, a total of 247253.00 q of fodder including 232104.50 q. green fodder 5387.00 q. Silage 4150.00 q. Straw and 5611.50 q. dry fodder was supplied to Livestock Research Centre and other sections.

Production and Productivity of Forage Crops (Green Fodder and Dry Fodder-2019)

S. No.	Crop	Area (ha)	Average Yield (q/ha)	Production in (q)
1.	Berseem + Oats + Mustard	16.40	883.51	14489.50
2.	Berseem + Oats	24.57	1077.00	26462.00
3.	Napier (Rabi harvested)	17.61	178.90	3150.50
4.	Lucern (Rabi harvested)	19.16	369.10	7072.00
5.	Oats (Green & Dry)	64.19	424.84	27270.50 (26552.00 Green + 718.50 Dry)
6.	Maize + Oats + Mustard	03.24	72.99	236.50
7.	Mustard	7.00	131.64	921.50
8.	Maize	53.17	271.54	14438.00
9.	Maize + Jowar	6.03	324.96	1959.50
10.	Maize + Cowpea	20.24	319.54	6467.50
11.	Nutrifeed	29.10	527.25	6211.00
12.	Sugargraze + Maize	48.79	418.58	20422.50
13.	Jowar (Green & Dry)	23.20	309.85	7188.50 (6467.00 Green + 721.50 Dry)
14.	Sugargraze	31.70	424.51	13457.00
15.	Napier Grass (Kharif harvested)	18.99	355.13	6744.00
16.	Jowar + Cowpea	2.94	246.94	726.00
17.	Maize + Nutrifeed	29.74	491.71	14623.50
18.	Nutrifeed + Jowar	2.91	728.69	2120.50
19.	Napier + SG + Jowar	8.10	378.76	3068.00
20.	Alfa-Alfa (Lucern Kharif harvested)	6.56	225.46	1479.00
	Total	433.64	-	1,78,507.50 (177067.50 Green + 1440.00 Dry)

Production and Productivity of Grain Crops at Forage Production Section (2019-20)

S. No.	Crop	Area (ha)	Average Yield (q/ha)	Production (q)
1.	Oats	81.34	16.04	1305.00
Seed Production of Forage Crops				
2.	Sorghum (Jowar)	8.42	2.02	17.00 (on selection basis)

Production and Productivity of Straw at Forage Production Section (2019-20)

S. No.	Crop	Area (ha)	Average Yield (q/ha)	Production (q)
1	Oats Straw	81.34	26.48	2154.00
	Total	81.34	26.48	2154.00

*16.00 q. Grain straw received from FR&MC Agronomy Section and supplied to LRC.

Fodder Supply to Livestock Research Centre / Animal Nutrition/Dairy Mela (2019-20) (FPS & RFS)

Month	Green (q)	Silage (q)	Dry Straw (q)	Dry Fodder (q)	Total (q)
April-2019	16541.50	476.00	598.50	166.50	17782.50
May	10195.50	3345.50	519.50	120.00	14180.50
June	14799.50	1565.50	503.50	-	16868.50
July	19623.00	-	672.00	-	20295.00
August	25924.00	-	42.00	-	25966.00
September	21637.00	-	351.50	-	21988.50
October	16876.00	-	885.50	-	17761.50
November	14091.00	-	505.00	863.00	15459.00
December	21644.50	-	72.50	2337.00	24054.00
January-20	22811.00	-	-	1627.00	24438.00
February-20	21626.50	-	-	498.00	22124.50
March-20	26335.00	-	-	-	26335.00
Total	232104.50	5387.00	4150.00	5611.50	247253.00

Forage Conservation

A total of 5611.50 q. of dry fodder such as oats straw in the form of by-product of these crops was produced. To fulfill the nutritional requirements of the herd during lean period and to provide required dry matter during winter months, when DM content in the lush green forages was very low, silage and oats straw were supplied.

Calculated Cost of Fodder Supplied to Livestock Research Centre /Animal Nutrition from Forage Production Section /RFS (2019-20)

S. No.	Crop Name	Quantity (q.)	Rate (₹ /q.)	Amount (₹)
1.	Green	232104.50	150/-	3,48,15,675.00/-
2.	Silage	5387.00	300/-	16,16,000.00/-
3.	Dry Fodder	5611.50	100/-	5,61,150.00/-
4.	Straw	4150.00	400/-	16,60,000.00/-
	Total	247253.00	-	3,86,52,825.00/-

Revolving Fund Scheme on Seed Production

Unavailability of good quality seeds/ grains of improved varieties of fodder crops is the biggest constraint in increasing the production of fodder grains crops. Thus, a Revolving Fund Scheme on Seed Production of Fodder Crops was initiated at NDRI, Karnal in 80 hectare area to produce the seeds grains of improved varieties of fodder crops for cultivation at Institute Farm Institute Regional stations sale to Farmers and other Agencies. During the year under the report, 3597.60 q. seeds of improved varieties of fodder crops, 24.00 q. grains, 42497.00 q. green fodder, 2941.50 q. dry fodder, 2373.00 q. Bhusa were produced and total calculated cost of Seed, Grain was ₹ 91,42,685.00 Green Fodder Dry Fodder and Bhusa was ₹ 7617900.00 under Revolving fund scheme on Seed Production during the report as per given below:

Production of Seed under RFS Seed Production (2019-20) (Rabi 2018-19 & Kh-19)

Kind of Seed	Quantity of Seed (q.)	Rate (₹ /q.)	Calculated Cost (₹)
Oats Kent	301.25	3500/-	1057375.00
Mustard Chinese Cabbage	28.50	6000/-	171000.00
Oats Kent BR Seed	75.00	7250/-	543750.00
Wheat Seed	3170.70	2300/-	7292610.00
Barley Seed	22.15	1800/-	39870.00
Total	3597.60	-	9101605.00

Production of Grains under RFS Seed Production (2019-20)

Kind of Grain	Quantity of Grain (q.)	Rate (₹ /q.)	Calculated Cost (₹)
Oats	24.00	1700/-	40800.00
Total	24.00	1700/-	40800.00

Production of Green Fodder, Dry Fodder and Bhusa under RFS, Seed Production and Supplied to LRC through Forage Production Section (2019-20)

Kind of Fodder	Quantity (q.)	Rate (₹ /q.)	Calculated Cost (₹)	Remarks
Green Fodder	42497.00	150/-	6374550.00	Supplied to LRC
Dry Fodder	2941.50	100/-	294150.00	
Bhusa	2373.00	400/-	949200.00	
Grand Total	-	-	7617900.00	

Revenue Generation by Sale /Supply of Seed/Grains under RFS (Seed Production) (2019-20)

Kind	Supplied in q.	Sold Qty. in q.	Rate per q.	Amount (₹)
Mustard Seed C. Cabage	1.131	45.005	6000/-	270030.00
Oats Seed	-	301.40	3500/-	1054900.00
Wheat Seed	-	3170.70	2300/-	7292610.00
Oats BR Seed	-	0.30	7250/-	2175.00
Oats grain	24.00	-	1700/-	40800.00
Barley	-	22.15	1800/-	39870.00
Grand Total	25.131	3539.555	-	8700385.00

Maintenance Section

Since 1979, Maintenance Section has been providing the services related to mechanical, electrical, civil, refrigeration and air conditioning etc., new works addition/alterations required in the labs/Institute, maintenance of the sub-station, overhead lines, street lights, service connections maintenance of electric supply to the office area as well as residential area of the Institute, generator power supply to office and residential area including International Girls and Boys hostels, Guest house and Scientist home in case of power failure, liaison works with UHBVN, CPWD, Haryana State Pollution Control Board and Local Authorities, maintenance of the water supply and sewage disposal system in the Institute, planning and inspection of new buildings in the Institute, operation and maintenance of ETP and other miscellaneous works of the Institute.

Human Health Complex

The HHC was established in 1991. It is catering to the health needs of the employees of NDRI as well as to other Sister ICAR Institutes in Karnal i.e. IARI, NBAGR and IIWBR in addition to the students and retired ICAR employees.

The Complex has a Diagnostic Clinical Lab well equipped with Fully Automated Hematology Analyzer. HHC is also equipped with 160 MAS X-RAY Machine. HHC has well qualified Nursing Staff, Lab. Technicians and Pharmacist to assist the Doctors in providing the desired medical facilities.

HHC organized the following free Health check-up Camp and Health talk in public interest for Screening the patients.

- » Free Check-up ENT and DENTAL Camp on 10/4/2019 by Hospital.
- » Free Diagnostic Test Camp (Dr. Nishtha Khara, Bandhu Path. Lab Mahabir Dal, Ram Nagar Karnal) on 08/08/2019.
- » Free Check-up Camp Orthopaedic by Ivy ELITE Hospital, Mohali on 17/09/2019.

During Annual year April 2019-December 2019 approx. 10,794 patients were benefitted by Allopathic and Ayurvedic treatment.



Experimental Dairy Plant

Experimental Dairy was setup in this Institute in 1961 with the objective of providing necessary infrastructure facilities to the scientists for the scaling up of new products/processes developed in the laboratories on the pilot scale as well as to provide training facilities to the students in the operation of dairy plants. After meeting the requirement of research and teaching, the plant is used for converting the surplus milk into variety of dairy products.

Products Manufactured in Experimental Dairy during 2019

S. No.	Product	Quantity
1	Skimmed Milk Powder (Roller)	19399.0 kg
2	Pasteurized Table Butter	377.2 kg
3	Ghee	15555.0 kg
4	Paneer	38322.5 kg
5	Burfi	4682.0 kg
6	Kalakand	26575.0 kg
7	Lassi (200 ml)	159235.0 packets
8	Ice-cream (100 ml)	66889.0 cups
9	Flavoured Dairy Drink (200 ml)	385664 packets
10	Processed Cheese Slices (200 g)	1113 packets
11	Gulab Jamun Mix	3101.0 kg
12	Pizza Cheese	548.6 packets
13	Cheddar Cheese	216.0 kg
14	Khoa	131.0 kg
15	Mozzarella Cheese	8.0 kg
16.	Cooking Butter	6.75 kg

These products were sold through the well established Milk Parlour located at the Institutes main entrance gate. Experimental dairy provides facilities to practical, teaching the training to students and research facility to scientists of the NDRI Deemed University. It also provides training facility to outside students of various universities/colleges and trainees from across the country. A total no of 40 students from several institutions were provided trainings during the year 2019. This self sustaining Experimental Dairy has been running under Revolving Fund Scheme since 1989-90. Revenue generated through scheme is being utilized for development of infrastructure of this dairy. Experimental Dairy is certified under Quality management system ISO 22000: 2018 by BIS, Chandigarh. The revenue generated from the sale of milk and milk products during the year 2019 was ₹ 5,94,02,805/-.

Computer Centre

Computer Centre is a central facility to provide computational support to the scientists and administration and imparts training to students/scholars. The Computer Centre offers two Computer Science courses to under-graduate students and one course to post-graduate students including Ph.D. scholars. There is a well established Computer Laboratory for students' learning, which is equipped with state-of-the-art 64-bit i5 computer systems together with multi-function laser printers. Besides this, the data processing unit of the Centre is equipped with a Line Matrix printer. Moreover, these computer systems are equipped with different software, i.e., operating systems such as Unix/Linux, MS-Windows; and sophisticated licensed software (including open source software) for data analytics and machine learning like SAS 9.3 with JMP, MATLAB, WEKA, R Studio, etc. Recently, Microsoft Office suit has been procured and installed in the PC Lab. that is used for teaching and research purpose. The Centre has a campus-wide well-established Local Area Network (LAN) system connecting all the research divisions and sections including Auditorium/Hospital through optical fibre/UTP cabling to cover the main buildings. The administrative block and various divisions/sections are equipped with Wi-Fi network to provide the seamless connectivity on mobile device. Furthermore, the Director Office, Joint Directors' Offices and the Referral Lab are also converted into Wi-Fi zones.

Besides this, the Centre offered internship programmes on advanced topics in Applied Artificial Intelligence (encompassing Soft Computing and Machine Learning areas) using open source R Programming language, to externally sponsored students through consultancy scheme. Also, faculty of the Centre was invited as experts/guest-/keynote-speakers at various international conferences, committees, etc. The Centre established academic linkages for possible research collaboration with Centre for Development of Advanced Computing (CDAC), Mohali; Department of Statistics & Operational Research and University Institute of Engineering & Technology, Kurukshetra University Kurukshetra; NIFTEM, Sonapat, Chitkara University, Punjab.

The ASRB Online Examinations for NET were conducted successfully by the Online Exam Centre, ICAR-NDRI Karnal.

The Agriculture Knowledge Management Unit (AKMU) is fully functional with the Internet and e-mail connectivity through National Knowledge Network (NKN) node with 1 Gbps bandwidth provided by the National Informatics Centre (NIC), Govt. of India. AKMU is equipped with state-of-the-art, Unified Threat Management (UTM) System FortiGate-600C and Network-Analyser-200D. These devices enforce essential security mechanism (antivirus/antimalware, antispam, vulnerability management), including firewall, VPN, intrusion prevention, application control and Web content filtering, etc. It is also undertaking the implementation of ICAR programmes like Personnel Management Information System (PERMISNet), Half Yearly Progress Monitoring System (HYPM), etc. Also, Statistical Cell is functioning under Computer Centre, which disseminates university related information to various state- and national-level government agencies like UGC, MHRD-AISHE, etc.

Computer Centre continued to prepare various MIS reports relating to milk production, supply of feeds and fodders, herd performance, animal management system, etc., for decision support to the farm managers/heads of divisions using in-house developed software. The processing of pension bills and GPF transactions pertaining to the staff as well as generation of various reports was also carried out by the Centre.

The ICAR-NDRI Website (<http://www.ndri.res.in>) disseminated latest information to its various stakeholders and end-users about Research, Teaching, Faculty, News, Success Stories, RFD, Related Links, Opportunities, Tenders, Office Circulars, Forthcoming Workshop/ Conference/ Winter School announcements, Institute Publications (Annual Reports/Newsletters), RTI related information, Telephone Directory, University Information (B.Tech., M.Sc. and Ph.D. Rules, Admission Notice), etc. Some new Web-pages on Students Empowerment Unit and a portal on 'Sophisticated Analytical Instruments Facility' have been constructed and integrated with the institute Website, which are updated regularly.

The EPABX section managed the communication infrastructure in the institute and extended the efficient service of the Broadband connection available in the institute through cost-effective PRI system.

National Library in Dairying

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 65 scientific periodicals were subscribed to keep track of the current scientific/technical developments. There are 94,591 volumes, which include books, bound journals, theses, standards and annual reports. In addition of that

recently purchased 419 ebook different foreign and Indian publishers for perpetual access at NDRI Campus. Library has an excellent computer section having fifty workstations for students and staff of the institute. Students use these to get current information in the advanced research areas and for communication.

The Library provides Internet, Email, Documentation, Reference, Current Awareness Services, CD- ROM Literature scanning through CD-ROM of CAB Abstract, Food Science Technology Abstract, AGRIS, Derwent Biotechnology Abstract, Indian Standards and ISO Standards on food products including milk and dairy products on CD-ROM. The Library also provides Photocopying, Document Scanning, Printing and Computerised Issue-Return and reservation facilities.

The Library, NDRI is an active partner CeRA (Consortium for e-Resources in Agriculture) and provides single point search for consortia subscribed, Library subscribed and open access journals to its users under institute's IP addresses. The library provides instant Document Delivery Services to users of ICAR sister Institutes, State Agricultural Universities and other participating Institutions on their request. A total number of 163 out of 178 requests were fulfilled and documents provided to ICAR Institutes/State Agricultural Universities.

The Library is also an active partner of Agricat (a sub-portal under WorldCat). Presently 52,907 catalogue records of Library, NDRI available on Agricat/ WorldCat and all the users worldwide participating institution may access catalogue records of national Dairy Research Institute though URL: <http://www.worldcat.org> or www.agricat.worldcat.org.

Library uploaded 5985 digitized records of institute outputs, which includes valuable books, institutional publications, M.Sc. and Ph.D. Dissertations, reports, conference proceedings and ~ reprints etc. on KrishiKosh-Institutional Repository of Indian National Agricultural Research System. In addition of above complete online library catalogue is also available on URL: library.ndri.res.in by using Koha-Library Management System.

The Library, NDRI subscribed anti-plagiarism software iThenticate, which has repository of over 50 million research articles, is one of the largest repositories of database and has exclusive access to Crossref database.

Communication Centre

Communication Centre has audio visual/video and photo laboratories for providing the services to the staff and students of the Institute. This centre covers all the events organized by the Institute. This centre organized 25 exhibitions at different sister Institutes of ICAR and other research and development organizations across the country. The audio visual lab handled Sound and Projection Systems in Dr. D. Sundaresan auditorium, Pinaki hall, University committee room and conference halls of the Institute. Besides this, audio visual lab also provided Sound and Projection Systems in play ground for students and staff activities.

The facilities of audio video editing, recording of audio video clippings on DVD and VCD dubbing and mixing were extended to students, staff and scientists for their research projects. Video coverage of events of the Institute consisting of various national Seminars, Workshops, Conferences, Cultural programmes, Cattle shows, Kisan sangosthies, Exhibitions and other functions of the Institute was carried out and video films were edited.

Exhibitions Organised (2019)

S. No.	Date	Occasion	Place
1.	January 3-7, 2019	Indian Science Congress	LPU, Jalandhar
2.	January 7-9, 2019	Golden Jubilee International Salinity Conference	CSSRI, Karnal
3.	January 9-11, 2019	Pashu Arogya Kisan Mela	KVK Center, Motihari, Bihar
4.	February 9-11, 2019	Agri. Summit 2019	Gandhi Maidan, Motihari Bihar
5.	February 20-23, 2019	XIV Agricultural Science Congress	IARI, New Delhi
6.	March 15-17, 2019	Global Scientific Alumni Meet	NDRI, Karnal
7.	March 19, 2019	Farmer FIRST Programme	Kamalpur Rodan, Karnal
8.	July 16-17, 2019	Foundation Day of ICAR	NASC Complex, New Delhi
9.	September 11-12, 2019	Launching National Animal Disease Control Programme (NADCP) for FMD and Brucellosis and Nationwide Artificial Insemination Programme for 600 Districts.	Pandit Deen Dayal Upadhyay Pashu Chickitsa Vigyan University
10.	September 21-23, 2019	Regional Agriculture and Pashu Palan Mela	GADVASU Campus, Ludhiana, Punjab
11.	October 5, 2019	Farmers-Scientists Workshop and Seed Day	ICAR-IWBR, Karnal
12.	November 10-12, 2019	Entrepreneurship Issues and Challenges in Dairy & Food Processing Industries	Jiwaji, University, Gwalior at Gwalior
13.	November 26, 2019	Milk Day	Milk Parlour, NDRI, Karnal

Video Shows in the Exhibition Unit: 128 no. Video shows were organised in the Exhibition Unit for various types of visitors of the Institute.

Model Dairy Plant

A state-of-the-art commercial Dairy Plant was established in 1996 at NDRI, Karnal through the financial assistance and installed on turnkey basis by the National Dairy Development Board. The Plant has been designed to handle 60,000 liters (Ltrs.) of milk per day and is presently running in full capacity. Model Dairy Plant is presently certified under the **Food Safety Management System ISO 22000:2005**.



Special Features

- » Model Dairy Plant (MDP), an autonomous unit of ICAR, is independently managed by a committee, whose Chairman is the Director of NDRI.
- » Model Dairy Plant provides six months in-plant training to the students of B.Tech. (DT) of the NDRI Deemed University during the 4th year of the course curriculum.
- » The students are provided with complete infrastructure for training, which helps them in gaining sufficient experience in managing the modern commercial Dairy Plant and instills confidence in handling real life problems in production management.
- » It also provides infrastructure facilities to the scientists of NDRI for scaling up R & D concepts from laboratory scale to industrial scale under commercial environment.

Procurement of Milk: MDP does not have its own infrastructure for milk procurement and receives milk on behalf of Mother Dairy from the new generation cooperatives of Punjab and Rajasthan. The average milk procurement per day is around 1.22 lakh liters to 1.25 lakh liters, which is sufficient to meet day to day demand of different milk variants being packed at MDP.

Liquid Milk Processing / Packaging: MDP is currently engaged in processing and packaging of milk for Mother Dairy in different variants (Full Cream, Toned Milk, Double Toned Milk, Standardized Milk and Cow Milk). MDP is presently processing/packing 1,37,548 Ton Litre Per Day (TLPD) of polypack Milk in all the varieties for Mother Dairy Fruit and Vegetable Pvt Ltd, Delhi. The plant is running in three shifts and the supplies from MDP are dispatched in the evening and morning to Delhi market and nearby cities thereby utilizing the plant to more than its full capacity.

Ghee Manufacturing: MDP manufactures Cow Ghee from Cow Butter purchased from different State Federations and its production is taken as per demand. The average production/sale of ghee is 30-35 metric tons per month. All the Ghee manufactured at MDP is being sold through the MDP Sale Counter.

Cheese and Paneer: MDP is also engaged in training students in manufacturing of Cottage Cheese, Processed Cheese, Paneer on trial basis. The section is operated occasionally for the purpose of taking trials and making the students familiar with the manufacturing details.

Pinni Manufacturing: Pinni was launched at the thirteenth Convocation of NDRI Deemed University on February 14, 2015 and developed by the students of batch 2010-14. Total Sale of Pinni was 36.1 metric tons in the year 2019-20.

Students Training: Model Dairy Plant provides In-plant training to the 4th B.Tech. (DT) students of NDRI Deemed University. The students are provided with In-plant Training Manual comprising of unit wise operation covering all the sections of the Dairy Plant. Since its inception in 1996, Model Dairy Plant has provided training to twenty four batches of B.Tech. (DT) students. The student trainees are provided Rs.1500/- per month as stipend. So far, 610 students have been trained at MDP. Students are given hands on experience for plant operations and are trained to manage the shift activities of the plant under the guidance of trained technical staff. In addition to the above, students are also made to involve in other activities like KAIZENS, Small Group Activities etc. The feedback regarding Inplant Training, from the student's trained at MDP and now working in different capacities with different organizations is quite positive and encouraging.

Highlights of MDP in the year (2019)

- » Average milk dispatched per day was 137548 liters.
- » Ghee sale was approximately 396.64 metric tonnes.
- » Pinni sale was 36137 metric tonnes.
- » New Power Genset of 750 KVA Installed.
- » New Milk Cold Room Installed to increase the milk Handling.
- » New Boiler Chimney Installed.
- » New two Milk Silo of 60000 Its capacity Installed to increase the Milk Handling.
- » New High Speed Packing machine of capacity 12000 pouches per hour installed.
- » New CIP THE installed.

REGIONAL CAMPUSES

SOUTHERN CAMPUS, BENGALURU

The National Dairy Research Institute was started at Bengaluru in 1923 as Imperial Institute of Animal Husbandry and Dairying. It was the forerunner institution in starting dairy education programmes to meet the manpower requirements of the dairy industry. Upon shifting the institute Head Quarters to Karnal in 1955, the establishment at Bengaluru continued as the Southern Regional Station of NDRI. The station has been catering to the research, training and extension needs of the dairy farmers and dairy industry of the southern region.

The Campus is endowed with necessary infrastructure in terms of qualified staff, farmland, dairy herd, laboratories, library, staff dispensary, hostel facilities etc. The Campus has a land area of about 46 hectares. About 16 hectares of land is utilized for the cultivation of various forage crops for meeting the feeding requirement of the dairy herd.

The Campus has good laboratory and infrastructural facilities for carrying out research work on animal genetics and breeding, dairy animal production and reproduction, screening of microbes, chemical and microbiological analyses of dairy products, testing of dairy equipments, manufacturing of various dairy products, etc. The research, training and transfer of technology programmes at the campus are carried out through different sections. To cater the needs of the students, the library is stocked with books, journals, theses and reprints. Hostel and guest house facilities are also existed at the campus for students and visitors.

Education

The course work for Ph.D (Dairy Engg.), M.Tech (Dairy Engg.), M.Tech (Dairy Technology), and Diploma (Dairy Technology) are being conducted at the campus. The students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Animal Nutrition, Veterinary Gynecology and Obstetrics, Livestock Production Management, Agricultural Economics and Agricultural Extension Education are being guided for their Doctoral and Masters' dissertation work.

Short term trainings being conducted in Dairy Processing, Quality Assurance, Dairy Production and Extension for the students, dairy farmers/ entrepreneurs and personnel from Co-operative Federations and Private Organisations. Besides, In-plant training and In-lab training are provided to the UG and PG students of other Colleges/Universities. PG students of other Universities are also guided to carry out their Project Work. Further, the station serves as Study Centre for the Post Graduate Diploma in Food Safety and Quality Management (PGDFSQM) of the Indira Gandhi National Open University (IGNOU). During 2019-20, 28 students have registered for their PGDFSQM at Southern Campus.

TECHNOLOGY DISSEMINATION AND EXTENSION PROGRAMMES

Extension Activities

- » Advisory services were rendered to 105 clientele during personal visits to the institute, phone and mail enquiries. The information needs of the advisory comprised technical advice for indigenous cattle farming, cattle feed formulation, hydroponic fodder cultivation, establishing cattle feed plant, dairy start-ups, preparation of dairy products, and management of indigenous dairy cattle.
- » A total of 1492 visitors visited the institute in 46 batches comprising of farmers, farmwomen and farm youth from different parts of Karnataka and neighbouring states, students from various educational institutes and field extension/veterinary officers.
- » Extension folders in regional language was prepared on Mastitis Management, Green Fodder Production, Azolla Production and Hydroponics Fodder Cultivation for Profitable Dairy Farming and an Extension Bulletin on,

Guidelines for Scientific Dairy Management Practices was prepared under Farmer FIRST Collaborative Project for the benefit of the farming community of the project villages /adopted villages and other needy clientele groups.

- » Participated in Dairy Tech India 2019, International Exhibition on Dairy Products & Technology held during August 30 to September 1, 2019 at Bengaluru International Exhibition Centre (BIEC), Bengaluru. NDRI Exhibition Stall depicted dairy processing technologies developed and standardized at the Institute alongwith information on Indigenous breeds of South India and recommended dairy management practices for the benefit of the clientele groups.
- » Participated in the Krishimela 2019 at UAS, GKVK, Bengaluru held from October 24-27, 2019. NDRI Stall focused on need-based knowledge sharing in the event to benefit farming community of the region.
- » Participated in the exhibition organised at ICAR-NIANP, Bengaluru, for the National Milk Day Event and NDRI stall theme focused on Clean Milk Production for the event. The event was well attended by more than 300 farmers.

Major Events

- » An Exposure cum Training programme was organised for 270 trainees in 12 batches comprising farmers, farmwomen and farm youth from seven districts of Tamilnadu and three districts of Kerala under, Support to State Extension Programmes for Extension Reforms (SSEPERs) under Agricultural Technology Management Agency (ATMA) scheme. Brief-up sessions on technical know-how of scientific dairy farming aspects in breeding, feeding and healthcare aspects with focus on clean milk production were presented to the farmer trainees.



Trainees at Southern Campus, Bengaluru

- » An Exposure cum Training programme was organized for 45 trainees in two batches comprising farmers, farmwomen and farm youth from Krishnagiri District Tamilnadu under Agricultural Technology Management Agency (ATMA) programme during April and May 2019. Brief-up sessions on animal healthcare, clean milk production and balanced feeding aspects were arranged for the trainees.



Trainees from Tamilnadu under ATMA programme

- » SRS of ICAR-NDRI in association with Indian Dairy Association (South Zone) and Alumni Association, SRS-NDRI Bengaluru celebrated World Milk Day on June 1, 2019 at NDRI Bengaluru. Dr. Suresh S. Honnappagol, Former Animal Husbandry Commissioner, Dept. of AH & Dairying, Ministry of Agriculture & Farmers Welfare, Govt. of India was the Chief Guest and delivered a lecture on “Present Status and Future Prospective of Dairying in India”. An essay competition on the theme “Dairying as a means for doubling farmers income” was also organized for students and winners were given prizes.



A student receiving prize in essay competition

- » A Farmer's Meet on “Hallikar cattle rearers’ at Southern Campus of ICAR-NDRI, Bengaluru was organized on May 26, 2019 jointly in collaboration with College of Veterinary Science, Hasan and Dept. of Animal Husbandry & Veterinary Services, Govt. of Karnataka. A total of 70 farmers/Hallikar cattle rearers, project staff, and scientific faculties participated in the event. A separate interaction on Hallikar breed conservation and improvement was held among farmers and scientists. The farmers decided to form a “Hallikar Cattle Breeder’s Association.



- » A Model Training Course on ‘Good Dairy Management Practices (GDMP) for Sustainable Dairy Farming’ sponsored by Directorate Extension, Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi, was organized by Extension Section of SRS, ICAR-NDRI, Bengaluru during September 23-30, 2019. The training was attended by 24 officials comprised of Veterinary Assistant Surgeons, Veterinary Officers, Assistant Directors, Joint Directors, Training Coordinator and Managers from the Department of Animal Husbandry and Veterinary Services and State Dairy Federations representing from nine different states viz., Himachal Pradesh, Punjab, Madhya Pradesh, Assam, Uttarakhand, Telangana, Karnataka, Kerala and Tamil Nadu.



Veterinary official trainees receiving certificates

- » The 97th Foundation Day of ICAR-NDRI was celebrated on July 1, 2019 at SRS of ICAR-NDRI, Adugodi, Bengaluru under the aegis of Alumni Association, ICAR-NDRI (SRS), Bengaluru. Prof Alok Dhawan, Director, CSIR-Indian Institute of Toxicology Research (IITR), Lucknow was the Chief Guest and Dr. Suresh Honnappagol, Former Animal Husbandry Commissioner, Govt. of India, New Delhi was the Guest of Honour. Dr N. Balaraman, Former Joint Director (Res) ICAR-NDRI, Karnal and Former Vice-Chancellor, TANUVAS, Chennai, delivered Foundation Day Lecture.



A compendium of lectures being released

- » Southern Campus of ICAR-NDRI, Bengaluru in collaboration with Beckman Coulter Life Sciences, India organized a workshop on “Application of Flow cytometer in Animal Biotechnology Research” during November 13-15, 2019. The objective of the workshop was to impart the participants with theory and practical experiments on flow cytometry instrumentation, experiment designing, hands on experiment, data analysis and interpretation of results. A total of 10 participants selected from different parts of the country attended the workshop.

- » Training Programme on “Production of Cheese and Related Products” was organized at Dairy Technology Section, ICAR- NDRI, Bangalore from December 2-7, 2019. Twelve participants from various industries have participated in this 6-day training programme. Detailed theory and practical exposure on five varieties of cheeses like cheddar, gouda, mozzarella, cottage and processed cheese was given to the participants with hands-on training in Experimental Dairy of the southern campus by the faculty members.



- » ICAR sponsored Winter School: The ICAR sponsored Winter School on “Conservation and Improvement of Indigenous Bovine Genetic Resources through Integrated Omic Approaches and Optimal Resource Utilization” (November 6-26, 2019) was inaugurated on November 6, 2019 at Southern Regional Campus, ICAR-NDRI, Bengaluru. The Winter School was inaugurated by the Chief Guest Sri P.B. Ramamurthy, IAS, Former Additional Chief Secretary, Govt of Karnataka. Fifteen Scientist/ Assistant Professors/ Subject Matter Specialists from ICAR institute/SAUs/ SVU/ Veterinary Colleges from different parts of country are attending the Winter School.



A CD containing lectures being released



A participant receiving certificate

- » An Entrepreneurship Development programme on 'Commercial Dairy Production' for prospective dairy entrepreneurs and progressive dairy farmers was organized at SRS of ICAR-NDRI, Bengaluru during December 16 to 21, 2019. Nineteen participants from Maharashtra, Karnataka, Tamil Nadu, Kerala Andhra Pradesh and Telangana States attended the training. About 25 lectures including four by external faculty and demonstrations on heat detection, AI, dentition, animal selection, etc were conducted. A field trip to organized dairy farms, fodder museum, dairy farm of progressive dairy farmer was organized to provide first-hand experience about status of dairy farming in the region.



- » A team of scientists from SRS, ICAR-NDRI, Bengaluru visited Narayana E-Techno School, Koramangala, Bengaluru on December 3, 2019 and addressed about 80 students of class 10th to apprise them on the importance of agriculture education. The team informed the students about NARS system and academic programmes offered at the Deemed Universities under the ICAR and the State Agril University.



Interaction of scientists with the students

- » National Milk Day was organized by Alumni Association, ICAR-NDRI (SRS), Bengaluru in association with SRS, NDRI to mark the 98th birth anniversary of Dr. V. Kurien. Dr. R. P. Aneja, former Managing Director of NDDB and one of the close associates of late Dr V. Kurien, was present as Guest of Honour. Being himself involved in shaping up of Operation Flood, he enthralled the audience with the story behind Operation Flood.



National Milk Day being Celebrated

- » Constitution Day was observed to bring awareness about adoption of Indian Constitution 70 years ago. On this occasion, Justice Dr. S. B. N. Prakash, Member of Panel of Arbitrators set up by Karnataka High Court and Adjunct

Professor at National Law School, Bengaluru made an emphatic speech on Indian constitution. He dwelt at length on Article 48 of Indian constitution which states that the State shall endeavor to organize agriculture and animal husbandry on modern and scientific lines and shall, in particular, take steps for preserving and improving the breeds, and prohibiting the slaughter of cows and calves and other milch and draught cattle.



Dr. S. B. N. Prakash, Member of Panel of Arbitrators, High Court, Karnataka speaking on the occasion of constitution day at SRS, Bengaluru

LIVESTOCK RESEARCH CENTRE

Lactation performance of Deoni and HF crossbred cows

The Livestock Research Centre (LRC) of the station houses Deoni, HF crossbred and Malnad Gidda cattle. The total milk production of the herd during the current year was 1,88,163.70 kg. The total milk production of Deoni and HF crossbred cattle was 26564.4 and 161599.3, respectively. The average daily milk yield of the Deoni and HF crossbred cows were 4.0 and 12.0 kg, respectively. The average no. of milking Deoni and HF crossbred cattle in the herd in a month was 18 and 37 cows, respectively. Total green fodder production including Paragrass, Hybrid Napier, Guinea grass, fodder Maize, Jowar and miscellaneous including cowpea during the period was 1546.5 tonnes.

SUCCESS STORIES

Vermicomposting Technology using Cow dung as a self-employment venture for a youth: A Success Story of Mr. Bharath, M.Tech. Professional from Karnataka

Vermicomposting technology has long been recognized as a source of creating self-employment, revenue generation *vis- a-vis* a source of organic fertilizer for agriculture production and recently Govt. of India is promoting organic manure production through various schemes for making “wealth from waste”. Keeping in view the above facts and benefits of vermicompost technology, a youth, Shri Bharath, a B.E. (Mechanical) and M.Tech professional in Aircraft Design from Kolar district of Karnataka got interest in vermicomposting production technology as a suitable method for recycling of organic waste and as a source of self-employment. He visited to vermicompost production unit of Southern Campus of ICAR-NDRI, Bengaluru and got acquainted with the knowledge of vermicompost production and purchased two species of earth worms viz. *Eisenia foetida* (red worm) and *Eudrilus eugeniaei* (African Nightcrawler), which are the most commonly used earth worms for vermicompost. He started vermicompost production at his village Vokkaleri which is about 12 km from Kolar and producing around one ton of vermicompost using cow dung every month. In order to



Shri Bharath's vermicompost production unit with his packaged vermicompost ready for sale in the registered name of 'FarmOx' agri product and his website for online sale

commercialize his product, he registered a private limited company by the name "*Farmox Agriculture Solutions*" and started selling vermicompost at a profitable price in packages of 1, 5 and 25 kg to nurseries and other customers in the name of 'Farmox'. He has further ventured into e-trading by creating his own website www.farmoxagri.com sale through Amazon and Flipkart. His success story has become a model for dairy entrepreneurs and unemployed youth for generating 'wealth from waste'

EASTERN CAMPUS, KALYANI

The Eastern Campus was established at the Central Dairy in Calcutta in 1964 and was shifted during 1966 to Kalyani, Nadia district; about 50 km north of Calcutta and was located in the Administrative Building of Kalyani University. The Regional Animal Nutrition Research Centre of the I.C.A.R. till then located at Haringhata, West Bengal, was merged with the ERS of NDRI with effect from June 1, 1968. In 1978 the Government of West Bengal granted 100 acres of land at Kalyani where cattle sheds, forage unit, staff quarters etc. were gradually built up. The Station built its own laboratory building and the entire station started functioning within the same campus from May, 1987.



The main objective of establishing the Eastern Campus at Kalyani is to identify the major constraints of dairy production in eastern and north eastern India and to offer solutions through research and extension activities to these problems. It serves as a vital link between the NDRI, Karnal and the far-flung areas of the eastern and north eastern regions of the country for transfer of technology developed at the institute and provides appropriate feedback after trial for perfection. The research work undertaken at this campus is mainly strategic and applied in nature and the thrust of research is to improve the socio-economic condition of dairy farmers of this region.

The research at Eastern Campus is being conducted in the area of Animal Nutrition (1964 till date), Dairy Chemistry and Bacteriology (1972-1976), Animal Breeding (1977-till date), Soil Science (1977-1985), Dairy Economics and Dairy Extension (1977-till date), Forage Production and Livestock Production and Management (1986-till date), Animal Biotechnology Section started functioning during 2005. The Animal Physiology and Reproduction Laboratory were also established in 2013-14. Goat Farm was established in 2014-15 in a small scale for research, education and training purposes. Krishi Vigyan Kendra-II, Nadia District of West Bengal was sanctioned in 2016-17 for establishment in the Campus of ERS-NDRI, Kalyani.

The Eastern Campus has infrastructure facilities like Research Laboratories, Cattle Herd, Fodder Farm, Library, Computer Section, Academic Cell, Hostels and Guest House, Estate Section etc.

The Cattle Yard of the station maintains around 220 cattle (Jersey crossbreds) and 50 Black Bengal goats. Forage Farm section is engaged in cultivation of quality fodder crops in 27 hectare area for supply of fodder crops to the institute farm animals throughout the year. The library contains 1818 books, 4078 volumes of bound journals and other periodicals in the field of Dairying. Besides, Annual Reports of different Institutes and proceedings of various workshops and seminars are also available for reference. The computer center facilitates the huge database management and analysis of experimental data. The institute has internet connectivity through VSAT/NKN, which is useful for searching literature and references. In addition, the data pertaining to milk production, fodder and feed supply, reproductive performance and meteorology are also being maintained on day-to-day basis.

This campus has laboratory facilities for the research work of M.V.Sc./M.Sc. and Ph.D. scholars. Field Visits, Farmers-Scientists Interface Meetings, Orientation Programmes and Veterinary Camps etc. are organised at regular intervals for the farmers of eastern and north eastern states of India, Dairy Cooperative Societies/Unions and NGOs. Training programmes on "*Scientific Dairy Farming*", "*Scientific Goat Farming*", "*Goat AI and management*" and "*Artificial Insemination and Veterinary First Aid*" for unemployed youths/Farmers/budding Entrepreneurs are also being organised time to time. The feasible technologies are being taken up for transfer through these trainings, field visits and village extension programmes where all efforts are being made by the Institute to popularize latest suitable technologies in order to enhance dairy animal production.

Keeping in view the enormous demand for milk in the eastern region, low milk production potential of the native stock, shortage of feed and fodder resources and diversified agro-climatic and socio-economic conditions; this research station has a great role to play in the field of dairy development in this region.

Livestock Farm

Annual Performance of ERS-NDRI, Kalyani Herd (January-December 2019)

Particulars	Jersey Cross
Herd strength	203
Total milk production (kg)	212705.00
Av. no. of cows' in milk/day	75
Av. no. of cows' in dry/day	25
Wet average (kg)/day	7.8
Herd average (kg)/day	5.9
Age at first calving (month)	33.2
No. of animals inseminated	232
No. of animals pregnant	75
Conception rate (%)	32.3
Service period (days)	105
Inter calving period (days)	430
Mortality (%)	6.90

Milk Production Performance at ERS-NDRI, Kalyani Herd

Months (2019)	Milk Production (kg)	Wet Average (kg)	Herd Average (kg)	Average FAT %	Average SNF %
January	16089.5	7.42	6.00	5.57	9.33
February	16545.5	8.01	6.50	5.60	9.31
March	18727.5	8.10	6.40	5.38	9.13
April	18062.0	8.32	6.21	4.98	8.88
May	18770.5	8.00	6.00	5.00	8.90
June	18355.5	8.30	6.00	5.00	9.04
July	17783.0	7.62	5.50	5.13	8.84
August	18698.5	8.02	5.72	5.05	8.95
September	18037.0	7.61	5.65	5.05	8.92
October	19194.0	7.84	5.74	5.07	9.03
November	15941.0	7.11	5.40	5.27	9.15
December	16501.0	7.26	5.62	5.33	9.23
Total Milk	212705.0				
Overall Average	17725.417	7.81	5.90	5.20	9.06

Forage Farm

Forage Farm section is engaged in cultivation of quality fodder crops in about 27-30 hectares area and manages harvesting and supply of fodder crops either chaffed or unchaffed to the Cattle Yard. Besides cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machineries including tractors, chaffcutter etc. There is a small vermi-compost unit used for training and demonstration purpose. There is an agri-meteorological observatory where regular observations are taken for various meteorological parameters like relative humidity, max. and min. air temperature, soil temperature at different depth, wind speed and direction, Rainfall etc. There are more than 1000 plants of teak, shesham, mango, coconut etc. growing around the Institute premises. Mango and guava based agro-forestry have been developed in the ERS campus. Every year staff of ERS used to plant several saplings of different useful species in the campus. Besides, there is a fodder herbarium for training and demonstration purpose. The Forage Section has necessary facility for covering the theoretical and practical part of training on fodder crop production.



Production of Different Fodder Crops at ERS Fodder Farm 2019

Sl. No.	Particulars of Fodder Crop	Quantity (qtl.)
1.	Maize/ Maize + Cowpea	3666.35
2.	Sorghum/ Sorghum sudan grass hybrid/ Sorghum + Cowpea	5096.85
3.	Oats/ Oats + Fodder <i>Brassica</i>	3330.80
4.	Berseem / Berseem + Fodder <i>Brassica</i>	3290.85
5.	Sole Cowpea	171.45
6.	Hybrid Napier Grass/ Guinea Grass	455.00
7.	<i>Coix</i>	39.00
8.	Bajra /Bajra + Cowpea	1759.45
	Total Fodder	17,809.75

Month-wise Fodder Production at ERS (2019)

Sl. No.	Months	Quantity (Qtl.)
1.	January	2117.00
2.	February	2069.85
3.	March	1679.00
4.	April	1215.25
5.	May	1457.05
6.	June	1730.00
7.	July	1792.50
8.	August	1790.00
9.	September	1227.50
10.	October	728.35
11.	November	760.25
12.	December	1243.00
	Total	17,809.75.0

Academic Cell

M.Sc. / M.V. Sc. and Ph.D. students of different disciplines like Animal Nutrition, Livestock Production & Management, Animal Physiology, Animal Reproduction, Animal Biotechnology, Animal Genetics & Breeding and Dairy Extension are allotted to pursue their dissertation/ research work at Eastern Campus, Kalyani. During the year 2019, five Master degree students and two Ph.D. students completed their thesis works and awarded the respective degrees. Presently, nine Master degree students and eleven Ph.D. students are pursuing their research work. Since 2014, a diploma course on Animal Husbandry & Dairying (DAHD) is also running at this campus. The fourth batch of DAHD course comprising a total number of ten students have successfully completed the course and passed out in 2019. Other than academics, cultural, sports and literary activities were also organized.



Cultural, Sports and literary activities

Extension Approaches for Socio-economic Up-liftment through Dairying/Animal Husbandry

During 2019, the TSP project of the Institute was implemented especially in red and lateritic soil zone, new alluvial zone of West Bengal, hilly zone of Tripura and Meghalaya. In West Bengal the project works were done in Birbhum, Jhargram and Nadia districts; in Tripura the project was implemented in Dhalai district and in Meghalaya the project was implemented in Ri-bhoi district. Several interventions like veterinary health care facilities, deworming and vaccination (In case of cattle & buffalo FMD, HS, BQ, in case of goat and sheep PPR and in case of birds R2B vaccine), improved fodder seed distribution and distribution of several inputs like mineral mixture, cattle feed and livestock etc. were provided to the tribal farmers to scientifically manage their livestock and to improve the livelihood on sustainable basis. Regular dissemination of scientific information was done by using SMS portal developed under TSP project. Several on-campus training programmes were organised for tribal farmers and farmwomen about efficiently managing their animals.

Six camps were organised in different parts of Eastern and North- Eastern India and in these camps, scientists-farmers interaction sessions, animal health and input distribution camps were organised. A total of 635 cattle and 18 buffaloes were vaccinated against FMD, HS and BQ, 443 goats were vaccinated against PPR and 488 birds were vaccinated with R2B Vaccine. Apart from that 2000 chicks, 181 goats, 5000 kg poultry feed and 358 kg mineral mixture were distributed among tribal farmers.

A total of 4 on-campus training programmes were organized for 73 tribal farmers. Three training programmes were organized on 'Scientific Dairy Farming Practices for Tribal Unemployed Youth' and one training programme was organized on 'Scientific Animal Husbandry Practices for Tribal Unemployed Youth'. From these training programmes, the tribal farmers were appraised about the recent advancement in the field of livestock farming.

A total of five 'Scientists farmers interaction sessions cum animal health camps' were organized in different tribal villages of West Bengal and Meghalaya. One camp was organized in the Supur village of Birbhum district on January 25, 2019 and 303 farmers were benefitted from the camp. The Institute participated in the Farmers Fair at Shirshi village of Jhargram district in which one animal health camp was organized. A total of 104 tribal farmers were benefitted through the initiative. One input distribution camp was organized at ERS of ICAR-NDRI and 32 goats and 2000 chicks were distributed among the tribal farmers of Nadia district of West Bengal. One on-campus training programme was also organized. One 'Scientist Farmers interaction session-cum-input distribution camp' was organized in the state of Meghalaya on February 22, 2019. Another 'farmers-scientists interaction programme' was organized on March 22, 2019 at Manmathapur-Mundapara village of 24 paragana district of West Bengal and 20 tribal farmers were benefitted.

Two veterinary animal health-cum-input distribution camps were organized. The first camp was organized on July 25, 2019 at Paruldanga village of Bolpur in Birbhum district of West Bengal and 131 farmers were benefited. A total of 779 animals were treated by the team of ERS of ICAR-NDRI. A total of 52 Black Bengal goats were distributed among the tribal farmers and 145 kg of mineral mixture was distributed among the farmers. Another camp was organized on August 28, 2019 at Raipasa, Kamalachara, Nityadaspara of Tripura district and 25 Black Bengal goats and other inputs were distributed among the tribal farmers.



Scientific interventions were made in tribal areas

Improving the livelihood through livestock based farming in North Eastern region (NDRI-NEH Component)

Some villages from five North Eastern states of India namely, Meghalaya, Tripura, Sikkim, Nagaland and Mizoram were covered under the project during the year 2019. Frequent visits were organized and inputs such as livestock (poultry birds, goats, piglets etc.), veterinary medicines, mineral mixture, concentrate mixture, fodder seeds, extension literatures etc. were distributed among the farmers from North Eastern region of India. In the scientists-farmers interaction sessions several aspects of scientific animal husbandry practices were explained to the farmers of the North Eastern States.

Meghalaya: Two days programmes on awareness about rearing of dairy cattle, demonstrations of use of various inputs alongwith distribution of various inputs in two remote villages of Meghalaya namely *Umshorshor* (Ri-Bhoi dist.) and *Lummyri* (Ri-Bhoi dist) were organized by Eastern Campus, Kalyani, West Bengal with the help of ICAR Research Complex for NEH Region, Umiam, Meghalaya on November 6-7, 2019, respectively. A total of 55 farmers participated in this programme. They were encouraged to take dairy farming as a profitable entrepreneurship and 25 piglets, 30 goats dewormer, mineral mixtures, pig feed (1250 kg), cattle feed (750 kg) etc. were distributed among farmers. Apart from that one training programme on scientific animal husbandry practices was also organized for 17 trainees at Eastern Campus, Kalyani.

Tripura: One scientists farmers interaction sessions-cum-veterinary health camp was organized in Tripura. Several inputs like 25 Black Bengal goats, 1000 poultry birds and 100 kg Mineral Mixture were distributed among 125 farmers. Apart from that regular SMS in Bengali language pertaining to various aspects of scientific dairy/livestock farming were sent to the registered farmers from Tripura.

Sikkim: One animal health camp cum Scientists-farmers' interaction session was organized in Sikkim. Inputs like 4100 kg Cattle Feed and 319 kg Mineral Mixture were distributed among farmers. A total of 68 farmers were benefitted by the intervention provided by Eastern Campus, Kalyani.



Mizoram: One camp was organized in Mizoram by collaborating with CAU, Aizwal. Several inputs like 350 kg Pig feed, 900 kg Poultry feed, 126 kg mineral mixture, 15 Piglets and 1200 Poultry birds were distributed among 150 farmers.

Nagaland: The scientists-farmers' interaction session-cum-input distribution camps were organized at Samzuiram village, Dist. Peren, Nagaland. A total of 45 farmers were benefitted by the distribution of inputs like piglets (45), pig feed (450 kg), veterinary medicines etc. through the camp organized at Nagaland. These programmes including interaction sessions with the scientists/experts created general awareness about the scientific livestock farming among the livestock farmers of North Eastern Himalayan states of India.



Other Extension Activities

- » Regularly ERS of ICAR-NDRI, Kalyani organized different on-farm and off-farm extension activities for field testing of technologies as well as for transfer of technologies in relation to scientific dairy animal production.

- » ERS of ICAR-NDRI, Kalyani provided day-to-day service on treatment of ailing animals, deworming, vaccination, AI etc. in the adopted villages Muratipur and Dakkhin Chandamari.
- » In the two adopted villages namely Muratipur and South Chandamari, ERS of ICAR-NDRI, regularly provided veterinary health care facilities to the livestock farmers. Scientists and technical officers of ERS regularly visited farmers' home and solved their problem at their doorstep. Artificial Insemination of 157 dairy cattle was done through the "Dairy Vikas Kendra" located at Muratipur village managed by ERS of ICAR-NDRI. A total of 1487 animals were treated from the village centre. Veterinary medicines and treatment was done free of cost. Apart from that, six vaccination and veterinary health camps were organized in these adopted villages and 519 animals were treated and vaccinated.
- » One training programme was organized in the institute on "Artificial Insemination and Veterinary First Aid". The duration of the training programme was 32 days from March 26, 2019 to April 26, 2019 for 14 participants. They will work as AI worker under their sponsoring organization.
- » A training programme on "Scientific Dairy Farming" was organized for 9 trainees participants from different parts of West Bengal. Trainees were exposed to recent developments in scientific dairy production technologies in theoretical and practical sessions. One training programme on 'Scientific Goat Farming and Artificial Insemination' was also organized. Nine farmers from West Bengal participated in that training programme which was organized during September 24-28, 2019.
- » During the period under report, 17 major visiting teams comprising of 942 visitors have visited the institute campus at Kalyani. The visitors came through several institutes/organizations like FACC of Bidhan Chandra Krishi Viswavidyalaya, Jawahar Navodaya Vidyalaya, ICAR-IVRI, ICAR-CIFRI, West Bengal and Odisha state government officials. Farmers' groups from different parts of West Bengal also visited the campus and got exposure about the scientific management practices of dairy animals followed at ERS of ICAR-NDRI, Kalyani.



BUDGET AND EXPENDITURE

The financial outlays in terms of actual expenditure for Grants for the year 2019-2020 was Rs. 21374.70 lakhs and the sanctioned budget for Grants in 2019-2020 was Rs. 21491.03 lakhs. These figures include the financial outlays for Regional Campuses.

Financial Outlays & Expenditure during 2019-20

NDRI (including Eastern Campus, Kalyani)

(₹ in lakhs)

Sr. No.	Head	Grants	
		Budget	Expenditure
1.	Grant in Aid : Capital	508.96	449.08
2.	Grant in Aid : Salaries	7230.03	7223.99
3.	Grant in Aid : General	11584.01	11573.74
	Total	19323.00	19246.81

Southern Campus, Bengaluru

(₹ in lakhs)

Sr. No.	Head	Grants	
		Budget	Expenditure
1.	Grant in Aid : Capital	95.04	84.32
2.	Grant in Aid : Salaries	1331.00	1303.38
3.	Grant in Aid : General	741.99	740.19
	Total	2168.03	2127.89



Revenue Generation

The Revenue receipts of the Institute and its Regional Campuses for the year 2019-2020 were Rs. 914.30 lakhs.

Sl. No.	Head	Amount (Rs. in lakhs)
1.	Sale of Milk/Farms Produce	344.04
2.	Sale of Old Vehicle/Equipment etc.	0.00
3.	Sale of Livestock	27.37
4.	Income from Royalty/Sale of Publication/Advertisement	0.24
5.	License Fee	90.88
6.	Interest Earned on Loans and Advances	21.88
7.	Leave Salary and Pension Contribution	10.07
8.	Receipts from Schemes	9.66
9.	Analytical and Testing Fee	12.88
10.	Pre-shipment Fee	0.00
11.	Application Fee from Candidates	1.45
12.	Diploma Charges	0.14
13.	Receipt from Services Rendered	0.89
14.	Interest Earned on Short Term Deposits	113.95
15.	Interest Generated from Internal Resource	39.53
16.	Miscellaneous Receipts	241.32
	Total	914.30

Position of Manpower at NDRI, Karnal and its Regional Stations as on 31.12.2019

Type of Posts	Existing		
	Approved by D/o Expenditure	In position	Vacant
Scientific	195	159	38
Administrative (Group A&B)	36	30	06
Technical	337	186	151
Administrative (Group Non-gazetted)	129	98	31
Supporting	384	345	39
Total	1081	818	265



राजभाषा कार्यकलाप

राजभाषा कार्यकलाप

भारत सरकार की राजभाषा नीति के अनुसरण में राजभाषा हिंदी के प्रचार, प्रसार एवं कार्यान्वयन हेतु संस्थान में वर्ष 1979 में राजभाषा एकक की स्थापना की गई। संस्थान में राजभाषा नीति, नियमों एवं व्यवस्थाओं के नियमानुसार अनुपालन एवं कार्यान्वयन के लिए संस्थान के राजभाषा एकक में वर्ष 1988, 1989 एवं 2011 में क्रमशः हिन्दी अनुवादक, सहायक निदेशक एवं उप निदेशक के पद सृजित किए गए। राजभाषा एकक द्वारा संस्थान के अधिकारियों, वैज्ञानिकों, प्रशासनिक कर्मचारी, तकनीकी स्टाफ आदि को राजभाषा हिंदी में कार्य करने के लिए प्रोत्साहित करते हुए हर संभव सहयोग भी प्रदान किया जा रहा है। संस्थान के राजभाषा एकक द्वारा निम्नलिखित विवरणानुसार विभिन्न गतिविधियों का आयोजन किया गया।

हिन्दी दिवस/राजभाषा उल्लास मास

राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के मुख्यालय तथा इसके कल्याणी व बंगलुरु स्थित क्षेत्रीय केन्द्रों में विगत वर्षों की भाँति इस वर्ष भी हिन्दी दिवस से प्रारंभ कर 14 सितंबर से 13 अक्टूबर 2019 तक राजभाषा चेतना मास का भव्य आयोजन किया गया। हिन्दी उल्लास मास के दौरान वैज्ञानिकों, कर्मचारियों व विद्यार्थियों के लिए विभिन्न हिन्दी प्रतियोगिताओं का आयोजन किया गया। संस्थान में वार्षिक नगरस्तरीय व संस्थान स्तरीय राजभाषा गौरव प्रमाणपत्र प्रतियोगिता (2018-19), नगर स्तरीय हिन्दी गीतगायन प्रतियोगिता (16.9.2019), हिन्दी शब्द ज्ञान प्रतियोगिता (18.9.2019), हिन्दी टाइपिंग प्रतियोगिता (20.9.2019), हिन्दी निबंध प्रतियोगिता (23.9.2019), कुशल सहायक कर्मचारी वर्ग की हिन्दी सुलेख प्रतियोगिता (28.9.2019), वैज्ञानिकों की हिन्दी षोध-पत्र पोस्टर प्रदर्शन प्रतियोगिता (30.9.19), हिन्दी टिप्पणी लेखन प्रतियोगिता (3.10.2019), अनुभव लेखन प्रतियोगिता (5.10.2019), संस्थान तकनीकी हिन्दी लेखन अवॉर्ड प्रतियोगिता 2018-19 व वार्षिक मूल हिन्दी टिप्पणी व आलेखन प्रोत्साहन योजना प्रतियोगिता वर्ष 2018-19 के कुल 160 विजेताओं को पुरस्कार हेतु पात्र पाया गया। निदेशक डा. आर. आर. बी. सिंह ने दिनांक 18.10.2019 को आयोजित वार्षिक राजभाषा पुरस्कार वितरण समारोह में सभी 160 विजेताओं व राजभाषा के क्षेत्र में उत्कृष्ट कार्य करने वाले प्रभागों के प्रथम, द्वितीय व तृतीय पुरस्कार क्रमशः डेरी सूक्ष्मजीवाणु प्रभाग, कृषि विज्ञान केन्द्र व स्थापना-5 अनुभाग को राजभाषा शील्ड व प्रशस्ति प्रमाण पत्रों से सम्मानित किया। संस्थान प्रमुख के द्वारा राजभाषा कार्यान्वयन की दिशा में 1.10.2018 से 30.9.2019 तक की अवधि में अनुकरणीय कार्य करने वाले प्रथम तीन प्रभागों डेरी प्रौद्योगिकी प्रभाग, डेरी अभियांत्रिकी प्रभाग व ऑडिट अनुभाग एवं वर्ष 2018-19 के संस्थान राजभाषा गौरव प्रमाणपत्र के वैज्ञानिक श्रेणी के विजेता डा. चित्रनायक, वरिष्ठ वैज्ञानिक, अधिकारी श्रेणी के विजेता श्री कुणाल कालड़ा, वित्त एवं लेखा अधिकारी, तकनीशियन श्रेणी के विजेता डा. उत्तम कुमार, मुख्य तकनीकी अधिकारी व कुशल सहायक कर्मचारी श्रेणी के विजेता श्री रमीन्द्र कुमार को भी प्रशस्ति प्रमाणपत्रों से सम्मानित किया गया।



राजभाषा के क्षेत्र में उत्कृष्ट कार्य (2018-19) हेतु डेरी सूक्ष्मजीवाणु प्रभाग को उत्कृष्ट प्रमाण का अवॉर्ड



संस्थान के निदेशक डा. आर. आर. बी. सिंह वार्षिक राजभाषा उल्लास व पुरस्कार वितरण समारोह (18.12.19) को संबोधित करते हुए

हिन्दी कार्यशालाएं

वर्ष 2019 के दौरान, राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के द्वारा 5 हिन्दी कार्यशालाओं का आयोजन किया गया। पहली कार्यशाला 1.2.2019 को संस्थान के पशु जीव रसायन प्रभाग के स्टाफ को कंप्यूटरों में यूनिकोड प्रयोग पर प्रशिक्षण के विषय में आयोजित की गई। दूसरी कार्यशाला 22 अप्रैल से 26 अप्रैल 2019 तक संस्थान के कंप्यूटर लैब में आयोजित की गई जिसमें 18 प्रशासनिक कर्मचारियों को हिन्दी टाइपिंग का डेस्क प्रशिक्षण कराया गया। दिनांक 25 से 26 जून 2019 तक "सरकारी कामकाज में राजभाषा हिन्दी का प्रयोग" विषय पर दो पूर्ण कार्यदिवसीय नगरस्तरीय प्रशिक्षण कार्यक्रम व तृतीय कार्यशाला का आयोजन किया गया, जिसमें 65 प्रतिभागियों ने भाग लिया। दिनांक 28 सितंबर 2019 को संपन्न चौथी कार्यशाला में संस्थान के नवनियुक्त 30 तकनीकी सहायकों को राजभाषा नीति, नियमों, व्यवस्थाओं व हिन्दी इनपुट टूल्स तथा सेवा संबंधी मूलभूत नियमों आदि की जानकारी प्रदान की गई। इसी प्रकार संस्थान के कुशल सहायक कर्मचारियों को दिनांक 16 दिसंबर से 21 दिसंबर 2019 तक प्रारंभिक हिन्दी के ज्ञान पर कार्यशाला आयोजित कर प्रशिक्षित किया गया।

सेवा संबंधी नियमों पर हिन्दी में प्रशिक्षण कार्यशाला का आयोजन

राष्ट्रीय डेरी अनुसंधान संस्थान के निदेशक डा. आर. आर. बी. सिंह की अध्यक्षता में संस्थान में प्रशासनिक अधिकारियों एवं कर्मचारियों के लिए दो दिवसीय नगर स्तरीय प्रशिक्षण कार्यक्रम समारोह 26 जून 2019 को संपन्न हुआ। इस कार्यक्रम में एन. डी. आर. आई. सहित करनाल स्थित 23 कार्यालयों के 65 अधिकारियों एवं प्रतिनिधियों ने भाग लिया। इस दो दिवसीय प्रशिक्षण सत्र के दौरान प्रतिभागियों को सामान्य वित्तीय नियमावली 2017, कार्यालय का समग्र पर्यवेक्षण, सामान्य प्रशासन व व्यवस्था, आचरण नियम व व्यवस्थाएं, श्रम कानून, सेवा पुस्तिका पत्राचार, पेंशन नियम एवं सतर्कता नियमों पर प्रशासन व वित्त के अनुभवी व्याख्याताओं ने 8 सत्रों में प्रशिक्षण प्रदान किया। इस कार्यक्रम में राष्ट्रीय डेरी अनुसंधान संस्थान, केन्द्रीय मृदा लवणता अनुसंधान संस्थान, भारतीय गेहूँ एवं जौ अनुसंधान संस्थान, राष्ट्रीय पशु आनुवंशिक संसाधन ब्यूरो, आई. ए. आर. आई, गन्ना प्रजनन संस्थान, एन. एस. एस. ओ., केन्द्रीय विद्यालय, आयकर, रक्षा पेंशन संवितरण कार्यालय, केन्द्रीय विद्यालय, जवाहर नवोदय विद्यालय सग्गा, सैनिक स्कूल, रक्षा पेंशन संवितरण कार्यालय, सहायक श्रमायुक्त कार्यालय, एम. एस. एम. ई. विकास संस्थान और नेहरू युवा केन्द्र संगठन के प्रतिभागियों ने वार्ता-सत्रों में प्रमुखता से भाग लिया।



संस्थान के निदेशक महोदय सरकारी कामकाज में राजभाषा हिन्दी का प्रयोग पर कार्यशाला को संबोधित करते हुए

उपलब्धियाँ

- » संस्थान को राजभाषा नियमावली 1976 के नियम 10 (4) के अंतर्गत भारत सरकार के राजपत्र में अधिसूचना संख्या: 13-5/95-हिन्दी दिनांक 10.3.1995 के तहत अधिसूचित किया जा चुका है व संस्थान के सभी 38 प्रभागों व अनुभागों को नियम 8 (4) के अंतर्गत अपना समस्त प्रशासनिक कार्य शत-प्रतिशत हिन्दी में निष्पादित करने के लिए विनिर्दिष्ट किया जा चुका है।
- » संस्थान में निदेशक महोदय की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति का गठन किया गया है। समिति की प्रत्येक तिमाही में एक बैठक आयोजित की जाती है तथा इन बैठकों में संस्थान व इसके क्षेत्रीय केन्द्रों में राजभाषा हिन्दी के प्रचार, प्रसार व कार्यान्वयन की स्थिति की समीक्षा की जाती है तथा भावी कार्यक्रमों हेतु कार्ययोजना तैयार कर उन्हें कार्यान्वित किया जाता है। रिपोर्टाधीन अवधि में 29.03.2019, 29.6.2019, 16.10.2019 व 16.12.2019 को तिमाही बैठकों का आयोजन किया गया व बैठकों के कार्यवृत्त परिषद मुख्यालय व सर्वसंबंधितों को जारी कर सभी निर्णित बिन्दुओं पर समय पर कार्रवाई की गई।
- » राजभाषा हिन्दी के प्रगामी प्रयोग से संबंधित सभी रिपोर्टें एवं बैठकों के कार्यवृत्त परिषद मुख्यालय को भी प्रेषित किए जाते हैं। तिमाही हिन्दी बैठकों के कार्यवृत्तों एवं तिमाही प्रगति रिपोर्टों पर परिषद मुख्यालय से प्राप्त हुई अभ्युक्तियों एवं मार्गदर्शन के अनुसार अक्षरशः अनुपालना भी की जाती है तथा इंगित की गई कमियों का निराकरण किया जाता है।
- » संस्थान के दक्षिणी क्षेत्रीय केन्द्र, बेंगलूरु व पूर्वी क्षेत्रीय केन्द्र, कल्याणी में भी संस्थान राजभाषा कार्यान्वयन समितियां गठित की गई हैं। दोनों केन्द्रों में भी प्रत्येक तिमाही में हिन्दी बैठक का आयोजन करके तिमाही प्रगति रिपोर्ट के साथ

बैठक का कार्यवृत्त संस्थान मुख्यालय करनाल को प्राप्त होते ही उसकी समीक्षा कर आवश्यक निर्देश जारी किये जाते हैं।

- » राजभाषा विभाग, गृह मंत्रालय, भारत सरकार को समय पर ऑनलाइन तिमाही प्रगति रिपोर्टें भेजी जाती हैं।
- » संस्थान के निदेशक महोदय व सहायक निदेशक (राजभाषा) नगर राजभाषा कार्यान्वयन समिति की की छमाही समीक्षा बैठकों व अन्य कार्यक्रमों में नियमित रूप से प्रतिभागिता करते हैं।
- » वर्ष 2018-19 की "सरकारी कामकाज में मूल हिन्दी टिप्पण/आलेखन योजना" के 10 विजेताओं को नियमानुसार नकद पुरस्कार स्वीकृत किए गए व प्रमाणपत्रों से सम्मानित किया गया।
- » वर्ष 2018-19 की "वैज्ञानिक तथा तकनीकी वार्षिक मूल हिन्दी टिप्पण एवं आलेखन प्रतियोगिता के 19 विजेताओं को नकद पुरस्कार एवं प्रमाण पत्रों से पुरस्कृत किया गया।
- » संस्थान में वैज्ञानिकों व विद्यार्थियों के द्वारा हिन्दी में शोधपत्र व पोस्टर बनाने के लिए उन्हें प्रोत्साहित करने के लिए दि. 30.9.2019 को "हिन्दी शोधपत्र व पोस्टर प्रदर्शन" प्रतियोगिता का आयोजन किया गया और सभी प्रतिभागियों को प्रतिभागिता प्रमाणपत्र व विजेताओं को नकद पुरस्कार व प्रशस्ति प्रमाणपत्र से सम्मानित किया गया।
- » संस्थान के डेरी कैलेण्डर को विगत वर्षों की भाँति कृषकों व पशुपालकों के हित को ध्यान में रखकर उनसे संबंधित उपयोगी जानकारी को संक्षिप्त रूप में केवल हिन्दी में तैयार कर प्रकाशित किया गया।
- » संस्थान के विभिन्न प्रभागों द्वारा किसानों व जनसामान्य के लिए आयोजित किए जाने वाले सभी कार्यक्रमों में हिन्दी भाषा में प्रशिक्षण प्रदान किया जा रहा है। सभी प्रचार-सामग्री प्रशिक्षण सामग्री भी हिन्दी अथवा द्विभाषी में प्रकाशित करवाई जाती है।
- » संस्थान के निदेशक, नगरस्तरीय नगर राजभाषा कार्यान्वयन समिति, करनाल के पदेन अध्यक्ष भी हैं। उनकी अध्यक्षता में समिति की दो बैठकें, प्रथम बैठक दिनांक 20.6.2019 को एवं दूसरी बैठक दिनांक 15.11.2019 को संपन्न हुई हैं। नराकास की छमाही बैठकों में करनाल में स्थित 51 केन्द्र सरकार के सभी सदस्य कार्यालयों के प्रशासनिक प्रमुख व भारत सरकार, राजभाषा विभाग के प्रतिनिधि अधिकारी शामिल होते हैं।
- » संस्थान के शोधरत छात्र-छात्राओं के शोधपत्रों के सारांश को हिन्दी में अनुवाद कर प्रस्तुतीकरण की व्यवस्था की जाती है। इसी प्रकार संस्थान के परास्नातक और शोध छात्र-छात्राओं के लिए हिन्दी नॉन क्रेडिट कोर्स की कक्षाओं का पाठ्यक्रमानुसार नियमित रूप से संचालन किया जा रहा है।
- » संस्थान के वैज्ञानिकों से प्राप्त वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, वार्षिक प्रतिवेदन, प्रशासनिक पत्र, परिपत्र, ज्ञापन, विभिन्न समारोहों की प्रेस विज्ञप्ति, गणमान्य अतिथियों, मंत्रियों आदि के संबोधन, व्याख्यान एवं अन्य सामग्री का अनुवाद कार्य संस्थान के राजभाषा एकक द्वारा किया जा रहा है।

राजभाषा के क्षेत्र में सम्मान/पुरस्कार

1. नगर राजभाषा कार्यान्वयन समिति, करनाल के द्वारा राजभाषा के क्षेत्र में उत्कृष्ट कार्य के लिए नराकास करनाल वार्षिक पुरस्कार (2018-19) के अंतर्गत "प्रथम पुरस्कार" के रूप में राजभाषा ट्राफी व प्रशस्ति पत्र।
2. नगर राजभाषा कार्यान्वयन समिति, करनाल के द्वारा उत्कृष्ट पत्रिका पुरस्कार प्रतियोगिता में संस्थान की गृह पत्रिका "दुग्ध गंगा (2017-18) को "द्वितीय पुरस्कार" व ट्राफी का सम्मान प्राप्त हुआ।
3. नराकास करनाल के द्वारा संस्थान के श्री राकेश कुमार कुशवाहा, सहायक निदेशक(राजभाषा) को राजभाषा गौरव अवॉर्ड 2018-19 से सम्मानित किया गया।



SWACHCHH BHARAT ABHIYAN: CLEAN & GREEN NDRI

Swachchh Bharat Abhiyan is a mission led by the Government of India to make a clean India. To realize Gandhiji's dream of a Clean India, ICAR-NDRI, Karnal is supporting this drive of the Government of India by organizing cleanliness campaigns, talks on cleanliness, awareness camps, etc. in the Institute campus and in the adopted villages. The Institute focuses on spreading awareness about better sanitation and hygiene practices and disseminating information about the importance of cleanliness, through various programmes. The residents of the Institute's campus and the villagers were also educated to make the campaign effective and successful. All the scientists, students and staff of the Institute made a massive sanitation drive not only inside the campus, but also in nearby villages of the Institute. Further, in order to inculcate the value of maintaining health and hygiene at household-level, especially among the residents of the campus of the Institute, several environment-friendly dustbins were kept at many locations inside the premises of the Institute.

Awareness Campaigns

A team of extension scientists also organized awareness campaigns in the adopted villages of the Institute. The team sensitized the villagers about the importance of cleanliness and to keep the villages neat and clean. Emphasis was given for wider adoption of the bio-waste management towards processing of bio-wastes into clean and environment-friendly bio-fuels and organic manures. Further, scientists, technical officers, staff and students of the Institute visited the nearby villages for programmes like Dairy Education at Farmers' Doors, Farmers' Farm School and *Mera Gaaon Mera Gaurav*. They educated the villagers about significance of *Swachchh Bharat Abhiyan*, thereby inculcating a sense of cleanliness among them. Similarly, the farmers coming to attend the training programmes, organized by *Krishi Vigyan Kendra* and Women Empowerment Lab of the Institute were also made aware about significance of maintaining health and hygiene at the household levels and the vicinity of their respective localities. The farmers were advised to follow the practices associated with clean milk production.



Swachchhta Hi Sewa

A campaign exclusively focused on eradication of *Plastic Waste* was undertaken at the Institute-level, under the *Swachchhta Hi Sewa* programme of Govt. of India from September 11 to October 2, 2019. In this context, sensitization of all the Staff and Students was done by the Hon'ble Director of ICAR-NDRI, Karnal *vis-à-vis* Community Mobilization for Plastic Waste *Shram-Daan* and Banning of *Single Use Plastics*. Accordingly, one *Cleanliness Drive vis-à-vis Shram-Daan for Plastic waste-collection & Segregation* in the households and common/shared spaces, was carried out inside the Campus of the Institute.



Swachchhta Pakhwada

ICAR-NDRI, Karnal celebrated *Swachchhta Pakhwada* under "*Swachchh Bharat Abhiyaan*" programme of the Institute during December 16-31, 2019 at ICAR-NDRI, Karnal. All the scientists, technical officers, administrative, financial, supporting staff and students of the Institute participated in this cleanliness drive and cleaned up premises of ICAR-NDRI, Karnal and nearby places of the Institute. In addition to this, ICAR-NDRI, Karnal organized a cleaning campaign on massive scale in the campus and adopted villages of ICAR-NDRI, Karnal. The employees and students of ICAR-NDRI, Karnal took the task of cleaning every nook and corner of the Institute. Residents of the campus of the Institute were also sensitized for the making their surroundings clean. The employees of ICAR-NDRI, Karnal launched several campaigns, jointly with villagers, in order to implement the *Swachchh Bharat Abhiyaan* in the district.



Tree Plantation Campaign

Tree plantation campaign at KVK alongwith IFFCO was organized in which 500 fruit plants were distributed to 150 farmers and farmwomen on September 17, 2019 to encourage planting trees in their household premises. Joint Director (Research) Dr. Latha Sabikhi was the chief guest of the event.



MEGA GAON MERA GAURAV (MGMG)

This flagship programme has been initiated at the Institute level since August-September 2015 as per the directives of the ICAR. At present, 29 teams comprising of 4 Scientists each from different disciplines of the Institute involved in carrying out the programme (MGMG) in 145 villages @ 5 Villages per team in the vicinity of the Institute. The major objective of this innovative initiative is to promote the 'Direct Interface' of Scientists with the farmers to hasten the lab-to-land process, while providing the farmers with the required information, knowledge and advisory services on a regular basis via adoption of villages. A total of 169 field activities were conducted in 50 villages and 6800 farmers were benefited.

In accordance with the main objective of MGMG, the scientists of the Institute are contributing towards the scheme of *Mera Gaaon Mera Gaurav* (MGMG). During the regular interactions with the villagers, at the field-level, it has been realized, of late, that the villagers of the locality, being the significant 'Stakeholders' in this mission, wished to have certain specific 'Interventions', as pertaining to the domain of 'Dairying'. Subsequently, based on the feedback given by the villagers, including those engaged in the field of *Dairying*, coupled with their involvement in the process of selection of the concerned *Interventions*, some *Dairy-centric Interventions* were finalized, in a participatory approach for the purpose of implementation in the adopted villages under the scheme of MGMG.

In view of this, an effective strategy was developed to make this programme more meaningful, especially from the perspective of stakeholders involved at the grassroots. Accordingly, a plan was chalked out, wherein identification of the *Dairy-centric Interventions* was done. Further, the *Groups* were formed on the basis of *Interventions* being selected and from March 2018 onwards, the outreach of the programme was focused on the villages selected in a 'Cluster Approach'.

Activities Organised under MGMG

Sr. No.	Name of Activity	No. of Activities Conducted	No. of Farmers Participated & Benefitted
1.	Visit to village by teams	38	1900
2.	Interface meeting/goshthies/training	38	1900
4.	Demonstrations conducted	19	380
5.	Mobile based advisories (No.)	-	-
6.	Literature support provided	24	480
7.	Awareness created	38	1900
8.	Input support provided	-	-
	Total	157	6560

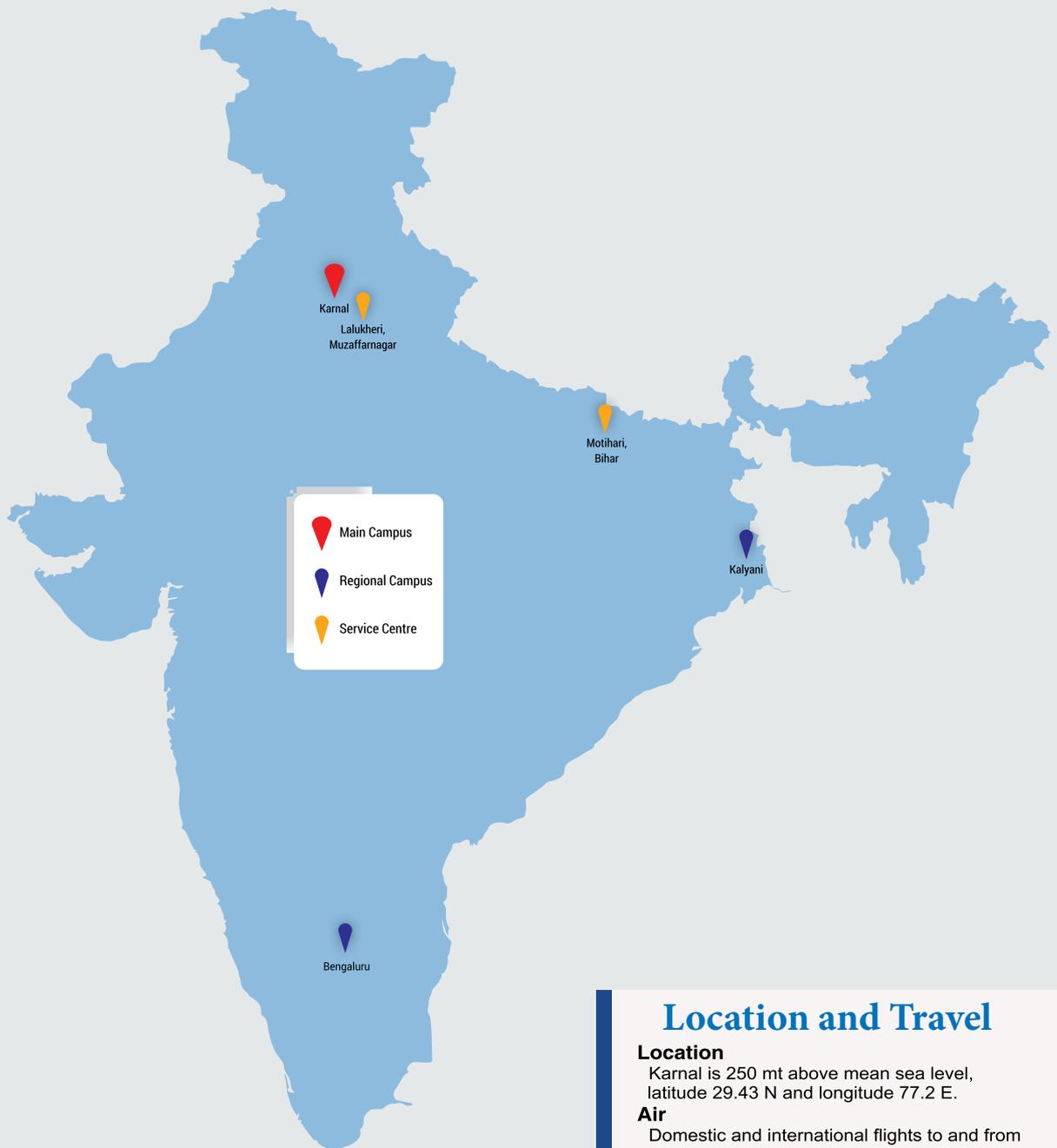
Other Activities Organised under MGMG

Sr. No.	Name of Activity	No. of Agencies/ Farmers Benefitted
1.	Linkages developed with other agencies (No. of agency)	The farmers were provided information about other potential Institutions/ organizations for the purpose of developing linkages with such agencies. 12
2.	Facilitation for new varieties, seeds, technology, etc. (including feeding of <i>Mineral Mixture</i> to enhance milk production)	In addition to it, the farmers were provided information about improved and/or good farming/ dairying practices, including the significance of value-addition in their farm/dairy produces. 240

Mera Gaon Mera Gourav (MGMG) Programme at ERS, Kalyani

ERS of ICAR-NDRI is implementing the "***Mera Gaon Mera Gourav***" programme in fifteen selected villages. All the scientists are actively involved in implementation of this programme. A total number of 22 village visits were organized to update the knowledge of dairy farmers about scientific dairy farming and solve the problems of the farmers at their doorstep and 164 farmers were benefitted. A total number of 428 animals were treated. Several inputs like veterinary medicines, mineral mixture, fodder seeds, extension literatures etc. were distributed among farmers. Through these interventions, farmers were sensitized about the scientific management of livestock at their household.





Location and Travel

Location

Karnal is 250 mt above mean sea level, latitude 29.43 N and longitude 77.2 E.

Air

Domestic and international flights to and from Indira Gandhi Airport, Delhi are available.

Rail/Bus

Karnal is 133 km from Delhi and Institute is 1 km from Railway Station/Bus Stand

Climatic Information

Min. Temperature in winter : 10°C
Max. Temperature in summer : 45°C
Annual Rainfall : 70 cm

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