भाकृअनुप
ICAR

2016-17

वार्षिक प्रतिवेदन
Annual Report

ndri

भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान
(मान्य विश्वविद्यालय) करनाल – 132 001 भारत

ICAR-NATIONAL DAIRY RESEARCH INSTITUTE
(Deemed University) Karnal - 132 001 India

MILESTONES

1923 Established in Bangalore as Imperial Institute of Animal Husbandry and Dairying.

1936 Renamed "Imperial Dairy Institute".

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.

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.

1962 Western Regional Station established at Bombay.

1964 Eastern Regional Station established at Kalyani (W.B.).

1966 Institute brought under the aegis of ICAR.

1975 Operational Research Project initiated.

1976 Department of Human Nutrition and Dietetics established at NDRI, Karnal.

1979 M.Sc., Ph.D. Programme in Dairy Engineering commenced at Karnal.

1983 IDD (DH) started at Bangalore.

1985 "Farm Advisory Bureau" and "Industrial Consultancy Cell" set up. The Institute recognised as Centre of Excellence in Animal Biotechnology.

1987 Embryo Biotechnology Centre established.

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.

National Agricultural Research Project (NARP) funded through World Bank.

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 commissioned for providing practical training to the students of NDRI University and to serve as an interface between Institute and Industry.

1998 A Modern Cafeteria with a seating capacity of 150 constructed in front of the Institute Hostels at the cost of 29 lakhs.

1999 Total no. of 9 NATP Projects with financial outlay of 266.25 lakhs initiated.

2000 NDRI bagged the Best Annual Report Award second time in succession for the years 1996-97 and 1997-98 in the category of large ICAR Institutes.

A Guest House with two suites named as "Kamdhenu" was constructed at SRS, Bangalore.

Platinum Jubilee of the Institute celebrated on 7th - 8th April 2000 at SRS, Bangalore.

Web-site of NDRI was created and launched by the Hon'ble Union Minister for Agriculture on 23rd December 2000.

2001 Foundation stone of the Agricultural Technology Information Centre laid on 1st August, 2001 under NATP project at NDRI, Karnal.

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.

2003 State-of-the-art milking parlour system introduced in cattle section.

2004 First IVF goat kid born at NDRI.

ATIC centre at NDRI made functional.

2006 New Animal Biotechnology Centre commissioned.

2007 Creation of Video Conferencing Lab and Mini Auditorium.

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.

2010 8th Convocation of NDRI, Deemed University held in presence of Dr. A. P. J. Abdul Kalam, Former President of India.

2011 M.Sc. in Forage Production Introduced at NDRI, Karnal.

National Academy of Dairy Sciences Launched at NDRI, Karnal.

NDRI Recognised as Centre of Advanced Faculty Training (CAFT) in the Disciplines of Dairy Production and Dairy Processing.

2012 Sahiwal Calf "Holi" through Ovum Pick up (OPU-IVF) technique born on 7th March, 2012.

NRC on Milk Quality and Safety established at NDRI, Karnal.

Business Planing and Development (BPD) Unit established at NDRI, Karnal.

2013 First female calf named 'Mahima' was born to a cloned buffalo on 25th January 2013.

A male cloned buffalo calf named 'Swarn' was born on 18th March 2013. Donor somatic cell used was isolated from the seminal plasma of an elite bull.

2013 A Diploma in Dairy Technology started at Southern Regional Station, Bangalore.

2014 NDRI bagged the Sardar Patel Outstanding ICAR Institution Award presented by Hon'ble Prime Minister of India, Sh. Narendra Modi Ji.

A female cloned calf named "Lalima" was born 2nd May, 2014.

NDRI signed a MoU with Riddet Institute, New Zealand to promote research and academic collaborations.

A male cloned calf named "Rajat" was born on 23rd July, 2014.

NDRI produced a clone of endangered wild buffalo of Chhattisgarh named "Deepasha" on 12th December, 2014.

Garima, a cloned buffalo, earlier born at NDRI produced second female calf named "Karishma" on 27th December, 2014.

A new educational approach "Farmers' Farm School" of NDRI was started at village Gorgarh, Karnal.

NDRI got ISO 9001: 2008 certification.

NDRI implemented MIS/FMS to carryout administrative and financial activity of the Institute.

2015 A female cloned calf named 'Swarupa' - a clone of 'Karan-Kirti', the highest milk producing Murrah buffalo was born on August 1, 2015.

2016 Two service centres established at Lalukheri, Mazzafarnagar (UP) and Piprakothi East Champaran (Bihar).

2017 Additional KVK established at Eastern Campus, Kalyani.

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.

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.

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 contribute towards manpower development programmes.

MANDATE

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

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Publisher

Dr. R. R. B. Singh
Director, NDRI

Chief Editor

Dr. Bimlesh Mann
Acting JDR, NDRI

Editors

Dr. Meena Malik
Professor (English), NDRI

Mr. Braj Kishor
Assistant Chief Technical Officer, PME

Layout Design, Word Processing and Cover Design

Mr. Sunil Sharma
Technical Officer, PME

Hindi Translation

Mr. Rakesh Kumar Kushwaha
Assistant Director (OL)

Mrs. Kanchan Choudhary
Assistant Chief Technical Officer (Translator)

Secretarial Operations

Mr. Ram Dhari
Assistant, PME

Mrs. Ranjana
PS to JDR

Photography
Communication Centre, NDRI

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A Group photograph of 15th Convocation of NDRI Deemed University held on 4th March, 2017

PREFACE

NDRI Annual Report 2016-17 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 initiated to strengthen these programmes during the last one year. The information has been so arranged that it provides a holistic view of this premier dairy Institute of the country and its functioning.

The research and development activities of NDRI were pursued through its mandate oriented and well-structured research programmes comprising 76 in-house and 63 externally funded research projects, which also included four International collaborative research projects. NDRI has been successful in getting external funding from almost all leading national funding agencies i.e. Department of Biotechnology (DBT), Department of Science and Technology (DST), Science and Engineering Research Board (SERB), Ministry of Food Processing Industries (MOFPI), Food Safety and Standards Authority of India (FSSAI), Indian Council of Medical Research (ICMR), Niche Area of Excellence (NAE,ICAR), National Agriculture Innovation Fund (NAIF, ICAR) and Application of Micro-organisms in Agriculture and Allied Sectors (AMAAS), ICAR.

In the area of dairy production, the Institute has already made a mark in the area of cloning by producing many cloned calves one after the other. Subsequent to this, global transcriptome and miRNA profiling has been carried out in buffalo blastocyst-stage embryos produced by cloning and *in vitro* fertilization techniques to identify the shortcomings in cloned embryos. This would help in making strategies for improving the success rate of producing cloned calves in cattle and buffaloes. The Institute has also developed a proteomics-based method for detection of A1/A2 milk. A method for the estrus synchronization has been developed for use in fertility management of dairy cattle. A methodology has also been developed for prediction of lifetime milk potential of Tharparkar cows.

In the area of dairy processing, some of the significant research achievements include an effective 'Synbiotic formula' and 'Synbiotic lactose free fermented dairy beverage' to combat enterotoxigenic *Escherichia coli* (ETEC) mediated diarrhea; a suitable encapsulation system for long term survival of probiotic organisms at ambient storage under tropical (Indian) climatic conditions; direct vat starter for Greek style yoghurt; process optimization for the preparation of enzyme modified cheese (EMC) from Cheddar cheese; characterization of alpha-glucosidase and dipeptidyl peptidase-IV inhibitory milk bioactive peptides using *Lactobacillus* spp.; technologies for lemongrass incorporated paneer and freeze dried paneer; enzyme modified cheese paste to enhance the cheese-flavour in dairy or non-dairy products; process for manufacture of Surati paneer and cottage scale prototype module for its preparation and optimization of a green technology process for texture modification in ghee with reduced cost. To address the growing concern for presence of contaminants in milk, paper strip assays have been developed for rapid detection of organophosphorous, carbamate, herbicide, fungicide groups of pesticide within regulatory limits with great degree of repeatability and selectivity. A TLC based method for detection of vanaspati addition in ghee has been standardized. It is significant to note that

during the preceding year three patents have been granted and two new patent applications have been filed.

In the area of mechanization, a eutectic module containing secondary refrigerants and nanofluids has been developed for fast cooling of raw milk at farm level. A sub-baric unit for frying and soaking of gulabjamun has been developed and tested. The unit reduces the frying time and soaking time of gulabjamun considerably. Rice pre-cooking system for production of kheer; microprocessor based paneer pressing unit for small scale paneer processors; weight based metering and filling system for kheer and rabri are a few other innovations made in the area of process engineering.

The Institute also developed Web based Decision Support System for establishing commercial dairy farm and generating bankable techno-economic project feasibility report. Cost-effective and intelligent classification Neural Network (NN) model has been developed to classify healthy and mastitic Murrah buffaloes. An exclusive Need-Based 'Web- enabled Interactive Information Delivery System' for Dairy Stakeholders has been developed and hosted on institute website. A 'Dairy Progressiveness Index' has been developed using quantitative data on 20 indicators for 16 states for the temporal analysis and forecasting of dairy scenarios in India.

NDRI is pragmatic in adopting changes to keep its activities aligned to the trends in global institutions of higher learning. The Institute has embarked on digitization of the entire activities in the Deemed University so as to make it paperless in near future. It is implementing automation of the entire academic activities starting from registration, payment of fees and regulation of progress of academic and research work of the students. The entire admission process including conduct of admission test for Ph. D program has been now made online. The Institute has created Internal Quality Assessment Cell and Student Grievance Redressal Cell to make our activities more participative, transparent and responsive. A new Student Empowerment Unit has been established to realize the vision of NDRI to produce excellent and accomplished human resource by helping students pursue both their professional and personal goals with greater self-awareness, self-esteem, understanding and focus. Adjunct Faculty Scheme has been initiated under which outstanding professionals selected from across the globe are visiting the Institute to teach and mentor the students every year. The Institute also plans to initiate Foundation Program for the freshers at the start of the semester and before commencement of regular course work to tap the innate talents of the students and nurture them to develop into outstanding professionals and accomplished human beings.

Another landmark has been the creation of a Dairy Processing Unit under the aegis of Krishi evam Dairy Vikas Kendra at *Piprakothi*, *Motihari (Bihar)*. The Kendra works for the benefit of farmers by imparting extensive training on *dairy processing with backward and forward integration* to the dairy farmers. Mera Gaaon Mera Gaurav (MGMG) programme is in existence since August 2015. As of now, 29 teams comprising 4 scientists from each discipline have been involved in carrying out the MGMG programme in 145 villages in the vicinity of the Institute. Some of the new initiatives also included construction of University Examination Hall having 600 seating capacity at the main campus and Fodder Museum as a demonstration unit at the Southern Campus, Bengaluru.

I am happy to inform that all our endeavours have resulted in increasing number of Awards/ Recognitions/ Appreciations for the Institute. NDRI was bestowed with a number of Prestigious Awards such as ICAR Best Annual Report Award; Rafi Ahmad Kidwai Award for Outstanding Research and ICAR Best Teacher Award to its faculty; and Jawahar Lal Nehru Award for the Best Doctoral Research to two of its students.

All this could be achieved by the Institute with the dedication, hard work, cooperation and understanding of the NDRI fraternity. The Institute is committed to provide an enabling and vibrant environment to its faculty and the students to be creative, exuberant, professionally & academically accomplished and socially responsive to take up future challenges for fulfilling the nation's dairy dreams.

I sincerely hope that the Annual Report 2016-17 would serve as valuable source of information to the professionals of the other Dairy Development Organizations in the country.

(R. R. B. Singh)

EXECUTIVE SUMMARY

National Dairy Research Institute is a premier research organization of the nation dedicated for providing Research and Development (R&D) and Human Resource Development (HRD) support towards dairy development programmes in the country. Established in 1923 at Bengaluru, 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. The Institute has the distinction of being a Deemed University for implementing its academic programmes.

ORGANISATIONAL STRUCTURE

In consonance with the administrative pattern of the Deemed University System of the ICAR, the Institute is managed through various policy and 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 Genetics & Breeding, Livestock Production and Management, Animal Nutrition, Forage Research and Management Center, Animal Physiology, Animal Biochemistry, Animal Biotechnology, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, Dairy Extension and Dairy Economics, Statistics & Management at the main station and its two regional stations. The Institute also has an Agricultural Technology Information Centre (ATIC), Krishi Vigyan Kendra & Dairy Training Centre, Artificial Breeding Research Centre, Krishi & 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 Production Section, Animal Health Complex, Model Dairy Plant, Technology Business Incubator, Business Planning and Development Unit, National Referral Center 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 section is under the administrative control of Comptroller (Finance). The Institute presently has strength of 159 scientists, 202 technicians, 127 administrative and 433 skilled supporting staff.

BUDGET OUTLAY

The budget and expenditure including Plan and Non-plan for the year 2016-2017 was ₹16978.59 lakhs and ₹ 17230.35 lakhs, respectively for the Institute and its Regional Stations.

SIGNIFICANT ACHIEVEMENTS OF THE INSTITUTE IN THE FIELD OF RESEARCH, TEACHING AND EXTENSION ARE:

RESEARCH

A total number of 76 in-house and 75 externally funded research projects were in operation during the year 2016-17. In order to strengthen basic and strategic research, funding from extra-mural research projects has touched approximately ₹ 110 crores. NDRI has been successful in getting external funding from almost all leading national funding agencies i.e. Department of Biotechnology (DBT), Department of Science and Technology (DST), National Bank for Agriculture and Rural Development (NABARD), National Dairy Development Board (NDDB), National Agriculture Science Funds (NASF), Ministry of Food Processing Industries (MoFPI), Food Safety and Standards Authority of India (FSSAI), Indian Council of Medical Research (ICMR), Niche Area of Excellence (NAE,ICAR), National and Application of Micro-organisms in Agriculture and Allied Sectors (AMAAS), ICAR.

The support from funding agencies has encouraged scientists to work on contemporary areas of research viz., stem cell, buffalo cloning, transcriptone, embryogenesis, biosensor, nanotechnology, abiotic stress in farm animals, nutraceuticals and functional foods. The grants from funding agencies has helped students to opt for modern tools and techniques in their dissertation.

- Global transcriptome and miRNA profiling was carried out in buffalo blastocyst-stage embryos produced by cloning and *in vitro* fertilization techniques to identify the shortcomings with cloned embryos.
- Transgenic buffalo spermatogonial stem cells were produced and used for homologous transplantation.
- Mammary lineage cells were produced by directed differentiation of buffalo embryonic stem cells.
- Novel non-coding RNAs were discovered in buffalo oocytes, which may influence their development competence.
- Recombinant bovine lukemia inhibitory factor was produced successfully. Its use as a supplement for culture of bovine stem cells may help in improving efficiency and reducing the cost.
- Direct application of mesenchymal stem cells isolated from adipocyte tissue was demonstrated in management of chronic hoof wounds in cattle and buffaloes.
- Treatment of human intestinal cells with recombinantly produced lactobacilli surface layer proteins could prevent pathogen binding to the extent of as high as 76%.
- A proteomics-based method was developed for detection of A1 and A2 milk.
- Proteins differentially expressed in milk whey of A1 and A2 milk were identified for analyzing their health implications.
- New definition of precious pashmina fibers was established with its unique proteomic compositions.
- Genetic marker in SCD gene was identified for selection of Murrah buffaloes for higher milk and fat yield at early stage.
- Genetic marker of STAT5A gene related to higher 305 days first lactation milk yield and fat yield was identified. The marker could be used for developing Marker Assisted Selection Strategy for Murrah buffaloes at early stage.
- Genetic markers of BSP5, ODF1 PPP1R11 genes were identified, which could be used for selection of improved semen quality traits, higher conception rate and sire conception rate in Murrah bulls.
- Genetic markers of MAP1B1 and PPP1R11 gene related to seminal quality parameters and higher fertility (conception rate, pregnancy rate and sire conception rate) were identified. Genetic markers could be used for developing Marker Assisted Selection Strategy for Karan Fries cattle at early stage.
- A methodology was developed for prediction potential of lifetime milk production of Tharparkar cows.
- Optimum birth weight and age at first use of Murrah bulls was standardized for better conception rate. In organized herd, Murrah bulls should be used prior to 3.5 years, which is expected to result in 5.08% better Conception Rate (CR) based on first A.I, in comparison to Murrah bulls used after 4.5 years of age.
- Prediction models were developed with high accuracy for energy value of milk (kcal/kg) of Murrah buffaloes. The models could be used as one of the selection criteria of Murrah buffaloes for high energy value of milk, sire evaluation for high energy value of milk under PT Programme and by the dairy industry to judge the milk quality of Murrah buffaloes.
- A new THI model (THI_D= 40.34 + 1.23 db + 0.0027 RH) was developed to assess the impact of heat stress on Daily Milk Yield (DMY) using 2,91,416 DMY records of 471 Murrah buffaloes scattered over 20 years (1994-2013).

- New THI Model (THI_{DMKF} = 39.3 + 3 × T_{WB} – 1.16 × T_{DB}) was developed for Karan Fries cattle to assess the impact of heat stress.
- Optimum levels of various first lactation traits for higher lifetime productivity in Karan Fries cows were found to be 800-900 days for age at first calving, 4000-4500 kg for 305-days first lactation milk yield, 4500-5000 kg for first lactation total milk yield, 91-115 days for first service period, 300-400 days for first lactation length, 60-90 days for first dry period and 300-400 days for first calving interval.
- Intelligent predictive models were developed for modeling fertility of Murrah bulls using various emerging machine learning algorithms such as Neural Networks (NN), Support Vector Regression (SVR), Decision Trees (DT), Random Forests (RF) and Linear Model (LM) for regression.
- A sandwich ELISA method was developed for quantification of BSP-1 in semen of crossbred bulls.
- An *in vitro* model was developed for studying sperm-oviduct binding in buffalos. The study suggested that baseline thermographic information on body and USST could be useful in developing thermographic signature for individual animal and predictive model for early detection of mastitis.
- Automatic herringbone parlour was found for milking of crossbred dairy cows in view of appropriate milkability, normal udder health, milk quality and milking behaviour.
- The study on genotype and THI interaction revealed that the cows bearing genetic composition of 50% exotic (either Jersey or HF) and 50% indigenous (either Red Sindhi or Tharparkar) inheritance exhibited better milk production potential at higher THI zones than cows with 75% or more exotic inheritance.
- Method for the estrus synchronization using kisspeptin-10 was developed which could be used in fertility management of dairy cattle.
- Inclusion of dried powder of Kamela (*Mallotus philippensis*) or Ficus hookeri tree leaves as herbal feed additives @ 4% in the concentrate mixture for growing calves improved their growth performance.
- Feeding of Azolla supplement to Alpine x Beetal goats during post partum showed positive effect on milk production, profit, DM intake and blood metabolites.
- Administration of cows with Vitamin E and Se during peripartum period showed beneficial effect on uterine health.
- A knowledge based bilingual information retrieval system was developed entirely for reproductive management of dairy animals.
- Acetic acid, 2-butanone and oleic acid were found to be effective for better sexual preparation of Sahiwal bulls and total sperm output.
- Rice Condensed Distillers Syrup (RCDS) could replace a part of concentrate mixture in growing as well as lactating crossbred cattle up to 15% (DM basis) level without any adverse effect on milk yield, milk composition, TDMI, growth performance, nutrient intake, nutrients utilization and blood parameters.
- Ammonia treated pellets prepared by Amonia Fibre Expension (AFEX) technology showed no detrimental health effects on cows and buffaloes, but milk from cattle fed with AFEX and control diets showed significant difference in acetamide levels.
- Dietary vanadium supplementation @ 0, 2, 4 and 8 ppm had no effect on feed consumption, growth performance and nutrient utilization. Plasma triglyceride and cholesterol levels were decreased; however, APL and GPx actvities were significantly increased by vanadium supplementation.
- Somatic cell count (SCC) reduced significantly (P>0.05) in animals treated with diet containing ca propionate and CLA in comparison to control.
- ME requirements during summer and winter seasons for maintenance (139.57 and 130.78 Kcal/kg $BW^{0.75}$) and growth (4.87 and 5.03 Kcal./kg $BW^{0.75}$) were calculated and was found higher in Summers. However, DCP requirement during summer and winter seasons for maintenance (4.25 and 4.16 g /kg $BW^{0.75}$) and growth (0.27 and 0.25 g/kg $BW^{0.75}$) were comparable.

- A robust model for determining water requirements of growing buffalo heifers was developed DWI (L/d) = 14.39 +1.56 DMI (kg/day) + 0.68 Tmax. (^{0}C) – 0.057 RH (%) + 0.016 BW (kg).
- I*n vivo* methane emission was 11.7% and 7.76% lower in high energy fed group as compared to low energy groups during summer and winter, respectively. However, no variation was observed on enteric methane emission among the experimental groups during different seasons.
- CP, DCP, TDN and ME maintenance requirements for breeding buffalo bulls were 6.76, 4.17, 34.79 g/kg $W^{0.75}$ and 524.10 KJ/kg $W^{0.75}$, respectively.
- Sorghum forage varieties and their nutritive value under different nutrient management regimen were evaluated.
- Yield and quality of forage maize were improved through management of plant density and nutrients in different cultivars.
- Supplementation of zinc and sodium bicarbonate effectively mitigated the heat stress while astaxanthin feeding increased reproductive performance of cattle under heat stress.
- Supplementation of bicarbonate in transition Murrah buffaloes restored blood gas and acid base balance to normal and consequently ameliorated negative effects on milk production during heat stress.
- Neutrophils decreased ability to perform phagocytosis & chemotaxis functions in cows, which attained peak lactation in hot humid season leading to suppression of pro-inflammatory cytokines secretion.
- The purification method of waste water was developed with a solution of alum, charcoal and sodium hypochlorite (1%).
- Bioavailability studies carried on two peptides (hexa peptide: C and tri peptide: G) on the intestinal cell line (Caco-2 cells) showed their sufficient transport of 0.95% and 1.72% across the epithelial membrane in their intact form through transcytosis and PepT1 mediated mechanisms, respectively.
- The hormetic effect of buffalo casein derived antioxidative and osteogenic peptide was established. The peptide also exhibited anti-aging effect in fibroblasts that were mediated via activating Nrf2 and downregulating NF-kB pathway through p38 MAPK dependent signaling mechanism.
- Cow, buffalo and goat milk administration to mice partially suppressed glucocorticoid-induced bone loss through improvement of BMD and trabecular bone histomorphometric parameters. Among different kinds of milk, goat milk offers better protection against glucocorticoid-induced bone loss.
- The incorporation of oryzanol and ferulic acid in diet prevented the increase in body weight due to the feeding of High Fat Diet and also prevented the fat deposition during feeding of fat rich diet.
- The positive effects of dietary incorporation of locust bean galactomannan and diosgenin on aberrant energy metabolism under high- fat diet fed conditions in C57BL/6 mice were evinced by activities of certain key enzymes in liver tissue, and the mRNA expression of selected genes in liver and adipose tissue.
- Mesoporous Silica nanoparticles (MSN) were found to be comparatively less toxic as compared to NanoZinc and Multiwalled carbon Nanotubes (MWCNT).
- Minimalistic morphologic changes were observed with MSN Nanoparticles while NanoZinc caused visible and profound cellular and ultra structural damage.
- Membrane integrity values were severely depressed in the germ cells used as a unique model system treated with the IC_{50} dose of silver NPs and MWCNTs.
- Feeding of mixture of vitamin C and electrolytes reduced transportation stress of goats in summer season while individual feeding of these was less effective.

- Metabolic heat production and energy loss as methane (K cal) per unit metabolic weight was found higher in crossbred than the zebu cattle.
- Manufacturing protocols were developed for several products such as Functional cream cheese, Functional Yoghurt cheese, Low sodium Cheddar, Mozzarella and Processed cheese, Low sodium and low fat Cheddar cheese, Milk protein concentrates (i.e. MPC55, MPC60 and MPC70), Aloe Vera Supplemented Probiotic Lassi, Dietetic Sandesh with 30% reduction in calorie, Cheese dip and Ready-to-Serve Breakfast Smoothie.
- Shelf life enhancement of milk-coconut sweet was accomplished.
- Studies were carried out on technology and shelf life of herb incorporated *burfi.*
- Phytosterol fortified *lassi* was developed.
- Rice Pre-cooking system was developed for production of kheer.
- Semi-automatic weight based filling system was developed for viscous dairy products.
- Combined LPG and Electric based heating system for rasogolla cooking was standardized.
- Prototype of ohmic milk heating system (5 litre capacity) was developed.
- Microprocessor based automated instrumentation system for pneumatic paneer hoop-cum-press unit was designed and developed.
- Effect of pomegranate peel extract was studied on antioxidant attributes and shelf life of *dahi.*
- Technology of spiced cheese rolls from an admixture of goat-buffalo milk was developed.
- Indigenous probiotic *lactobacillus* strains in synbiotic oat-milk based fermented products were evaluated.
- Milk protein-starch-nanocellulose based biodegradable packaging material was developed and evaluated.
- Quality of goat milk yoghurt using ultrafiltration was improved.
- Milk protein enriched pearl millet malt based complementary food was developed.
- Technology was standardised for gluten-free pasta from a composite dairy-millet base.
- Studies were conducted to evaluate the effect of extrusion processing induced changes on quality characteristics of milk protein-maize composite based extrudates.
- Dahi supplemented with probiotic strain *L. rhamnosus* CRD9 exhibited ameliorative effect in prevention and treatment of non- alcoholic fatty liver diseases in mouse model as it down regulated *de novo* fatty acid synthesis and uptake genes (*FAS, ACC, SREBP1c* and *ADRP)*.
- Live and heat killed preparations of probiotic *lactobacilli* exhibited anti-inflammatory potential.
- Probiotic *Lactobacillus* strain SG27 exhibited maximum adherence potential in Caco-2 cells.
- The encapsulated probiotic strain, *Lactobacillus reuteri* LR6 (prepared at Riddet Institute, New Zealand) showed one and two log reduction of *lactobacilli* counts during storage at 4 and 35°C, respectively.
- An effective 'Synbiotic formula' and 'Synbiotic lactose free fermented dairy beverage' to combat enterotoxigenic *Escherichia coli* (ETEC) mediated diarrhea were developed.
- Alpha-glucosidase and dipeptidyl peptidase-IV inhibitory milk bioactive peptides were produced using *Lactobacillus* spp. and characterized.
- North Indian vegetarians have diversified bacterial community compared to non-vegetarians. However, no significant difference in *Bifidobacterium* spp. was observed between the two different dietary regimens. *Fusobacterium* and *Akkermansia* were found to be absent in the North Indian gut microbiota. Decrease in *F. prausnitzii* and butyrate was observed in diabetic hosts.
- Direct vat starter for Greek style yoghurt was developed.
- A process was optimized for the preparation of enzyme modified cheese (EMC) from Cheddar cheese.

- Nanofluid based portable type milk cooling module was developed with unique design of extended surface for rapid heat transfer suitable for current milk production and procurement system in developing countries like India.
- An automated microprocessor based paneer press was designed and developed for small scale paneer processors.
- A wide variation in pH, acidity and total lactic counts in traditionally prepared fermented milk samples collected from cold desert region of Himachal Pradesh were observed. Besides, fermented milk samples had higher yeast and molds as well as coliforms.
- Out of the 272 DEPs, based on the fold change (≥1.5), 48 up-regulated and 110 down regulated DEPs were obtained in *L. fermentum* NCDC 400 under acid stress conditions.
- *Lactobacillus reuteri* LR28 showed maximum folate production in skim milk and possessed probiotic attributes. LR28 produced enhanced concentration of folate (35.12 ± 0.92 µg/l) by the addition of 3% lactose, 5.5 mg/l PABA and 300 µl melon juices in skim milk and showed significant improvement in diarrhea control *in-vivo.*
- '*hsp*60' with HaeIII and '*clpC*' with MspI could be used as single restriction RFLP markers for species level differentiation of Bifidobacteria. A combined application of rpoB RFLP (HhaI and HinfI) and clpC (MspI and TaiI) might be applied thereof for sub-species level identification and differentiation.
- *L. fermentum* SR4 and *L. fermentum* KF3A were found to be the two most prolific Zn uptaking cultures and the former showed highest ability to accumulate Zn (1.947 ± 0.31mg/g d.w.) under optimised conditions.
- Sheep milk 10 kDa fraction showed maximum antimicrobial activity against *Bacillus cereus* ATCC1306 and 5 kDa fraction showed higher antioxidant and antihypertensive activity followed by cow and buffalo milks.
- Synbiotic blueberry yoghurt and 10 kDa bioactive peptide fraction from it exhibited significant (p<0.05) reduction in the oxidative stress biomarker enzymes and significant (p<0.05) increase in antioxidant enzymes in oxidative stress induced mice.
- Fermentation with adapted *Kluyveromyces marxianus* MTCC 1389 strain in 3L bioreactor using lactose rich whey resulted in final ethanol titer of 79.33 ± 0.82 g/l which was nearly 17.5% more than parent strain (65.66 ± 0.12 g/l).
- The genetically engineered *Kluyveromyces marxianus* 6C17 using Cre-LoxP system was examined for the production of ethanol under controlled batch cultivation on concentrated whey (100 g/l lactose) which resulted into 19% higher ethanol yield than the parental strain.
- Methods for detection of antibiotic residues in milk employing spores as bio-recognition molecules, were developed based on two different approaches i.e. enzyme substrate reaction on paper strip and change of colour indicator based on release of DPA during spore germination.
- Maximum bacteriocin production (12.8 × 10^3 AU/ml) of *S. bovis* RLA was obtained at optimal conditions of temperature (40°C) and initial pH 6.5 at 24 h of incubation.
- Distinct branched chain fatty acids 4-methylnonanoate and 4, 8-dimethylnonanoate were detected in goat milk and 2-methoxypropanoate was detected in cow milk using GC-MS.
- Retinol and tocopherol contents were found highest in goat milk fat. β-carotene was found highest in indigenous bovine breeds (445 to 616 µg/100 g fat) and was absent in buffalo as well as in goat milk fat.
- Cholesterol concentration was found highest in summer and lowest in winter in cow, buffalo and goat milk. Cholesterol content was found highest in goat milk fat.
- An electrochemical aptasensor for detection of trace amounts of aflatoxin M1 (AFM1) was designed and developed.

- A TLC based method was standardized to resolve sesamol, sesamolin and sesamin on TLC plate. Adulteration of ghee with vanaspati to the minimum level of 5% could be detected using the standardized TLC method.
- Whey protein hydrolysates-iron and caseinophorphopeptides-Ca/zn/Fe complexes showed better bioavailability of these elements as compared to their irongemic salt in cell line (Caco-2 cell line) and animal model.
- Conditions were optimized for microencapsulation of stable grape seed extracts (GSE) using gum arabic and whey protein concentrate with high retention of antioxidant activity with low release of phenolic compounds under simulated gastric conditions.
- The feasibility of different preservatives like Kathon, Bronopol, Sodium Azide, Sodium Omadine, Dowicil, Triclosan, Hydrogen Peroxide, and Methyl and propyl parabenas as alternative preservative to formalin for milk stored for analytical purposes was assessed. Bronopol (0.05-0.1%) and kathon (0.20-0.40%) showed better antimicrobial activity.
- Database was developed to provide empirical support to Govt. initiative of doubling farmers' income.
- Web based Decision Support System (TEAM-CD version 1.0) was developed for establishing commercial dairy farm and generating bankable techno-economic project feasibility report.
- Studies were carried out on strengthening database on cost and returns in value addition to milk in the organized sector, cost of milk production in Haryana, Karnataka, Odisha and cost elasticity of milk production.
- Studies were carried out on impact analysis of technologies, institutional arrangements and development programmes related to dairying.

EDUCATION

- A new Student Empowerment Unit was established to realise the vision of NDRI to produce excellent and accomplished human resource by helping students to become healthy, informed, aware and committed scholars. This Unit would provide a platform for students to pursue both their professional and personal goals with greater self-awareness, self-esteem, understanding and focus. The programme entails imparting 'knowledge with ethics' to enable the students to fully utilize vocational and occupational services in the best possible manner to achieve social and economic self-sufficiency.
- The CAFT training entitled " Probiotics: The Therapeutics of 21st Century" sponsored by HRD-ICAR (Indian Council of Agricultural Research) was organized by the Division of Dairy Microbiology during the period from November 8-28, 2016.

The participants of the CAFT programme with the Director, NDRI

- A six day international training programme on "Advances in Reproductive Biotechnology" for the officials of SAARC Countries was organised from 25th to 30th July 2016.
- The Animal Genetic & Breeding Division conducted 33rd National Training Programme on "Skill Development for Sustainable Livestock Productivity in the Genomic Era" from 6th – 26th March, 2017 under the aegis of CAFT (Animal Genetics and Breeding).
- A six day basic training on "Routine Chemical Analysis" from 18th – 23rd July, 2016 for technical staff of ICAR institutes was conducted in Division of Dairy Chemistry.
- Ms. Gantuya Khasbaatar, Laboratory of Microbiology, General and Experimental Biology, Mongolian Academy of Sciences (MAS), Mongolia was awarded Research Training Fellowship for Developing Country Scientists (RTF-DCS)-2016 for a period of six months from February - August, 2016 to carry out project entitled "Techno-functional Characterization of Lactic Acid Bacteria (LAB) of Mongolian and Indian Origin" at Molecular Biology Unit, ICAR-NDRI, Karnal.
- Internal Quality Assurance Cell and student Grievance Redressal Cell created to make the academic activities more participative, transparent and responsive.
- Fifteenth Convocation of NDRI was held on 4th March 2017. Dr Sanjay Rajaram, Formar Director, Wheat Programme CIMMYT and World Food Prize Laureate was the Chief guest and Prof. (Dr.) A. K. Srivastava, Member ASRB New Delhi presided over the Convocation.

EXTENSION

- Three patents were granted and two patents were filed during 2016-17.
- Under the Entrepreneurship Development Programmes of the Business Planning & Development Unit and the Agri-Business Programme, fourteen training programmes were conducted for varying periods for the benefit of milk producers and farmers. They established firm linkages with the stakeholders for the technologies developed at the Institute.
- A total of 100 local resource persons (LRPs) of 100 villages of the Muzaffarnagar district (UP) were trained about the ration balancing programme. Nearly 4000 animals were covered under the project and ration balancing advice was given to 7600 famers by the selected LRPs. Overall, many dairy farmers were benefited from the programme in terms of enhanced livestock productivity and health.
- During the period (2016-17), fourteen technologies were developed and nine technologies were transferred to dairy industry. Besides this, prices of fourteen technologies were fixed. These technologies are ready for commercialization to dairy stakeholders.
- A total of 3713 AIs were performed using semen of Karan Fries bulls and as a result 50.46 % conception rate was obtained under field conditions. Test day milk yield of 143 daughters was recorded in the field.
- A total of 3916 AIs were performed using semen of Murrah bulls and as a result 50.40 % conception rate was obtained under field conditions. Test day milk yield of 138 daughters was recorded in the field. The records of daughters under field conditions could be used for the genetic evaluation of Murrah breeding bulls.
- The Artificial Breeding Research Center screened sexually transmitted bacterial, viral and protozoan diseases viz., TB, JD, Brucellosis, IBR, Campylobacteriosis, and Trichomoniasis of all breeding bulls.
- Four Murrah breeding bulls were selected under Network Project on Buffalo Improvement for the 17th set of progeny testing programme and 10 Sahiwal bulls were selected under AICRP on 'Genetic improvement of Sahiwal cattle'.
- During 2016-17, frozen semen of eight Murrah bulls under 'Network project on Buffalo improvement', seventeen Sahiwal bulls under AICRP on 'Genetic improvement of Sahiwal cattle' and sixteen Karan Fries crossbred bulls under Progeny Testing of KF bulls were preserved for distribution to different participatory center.
- Thirty three Infertility and Veterinary Aid Camps were ogranised in Kulwaheri, Budhakhera, Deepo, Dugro and Dhamanheri villages. A total of 741 animals were treated for reproductive disorders and various veterinary ailments.

- Thirty one Kisan Sangoshthies were organised for the benefit of dairy farmers in the adopted villages.
- KVK of NDRI organised 177 on–campus and off–campus training programmes on different aspectes of dairying and alliled field of agriculture such as crop production, horticulture, bee keeping and fisheries apart from home science for the benefit of 6034 farmers and farm women, rural youth and entrepreneurs.
- ATIC of NDRI provided 4152 services to 5120 persons from different states through video shows, lectures, personal discussions etc.

INFRASTRUCTURE

- Established 'Bull Mother Farm' for Sahiwal and Karan Fries cattle and Murrah buffaloes at Livestock Research Centre, NDRI.
- A Dairy Processing Unit under the aegis of Krishi evam Dairy Vikas Kendra established at *Piprakothi*, *Motihari (Bihar)*. The Kendra works for the benefit of farmers by imparting extensive training on *dairy processing with backward and forward integration* to the dairy farmers.
- A fully functional Computer Aided Designing (CAD) lab was developed with four i7 computers, Hi end colour plotter, Auto Cad 2017 Academic license, Nanocad Academic license.
- Construction of Krishna Wing of Girls Hostel.
- Initiatives were taken for utilizing the under-utilized marshy land for growing of animal friendly tree saplings and fodder production by deep bed and furrow system.
- Construction of 33 Nos. Garbage –bins at ICAR-NDRI, Karnal.
- Strengthened DNA Bank for Cattle and Buffalo.
- Digitalization of pedigree and performance records of cattle and buffaloes initiated.
- Renovation of Divisional Library and Livestock Record Cell of Animal Genetics & Breeding Division.
- Renovation of Traditional Dairy Products Laboratory of the Dairy Technology Division.
- Renovation of Buffalo Shed of Livestock Research Centre at ICAR-NDRI, Karnal.
- Renovation of Electric Work of Ration Balancing lab at Animal Nutrition Division.
- Underground Storage Tank of capacity 6.20 Lakhs litres for drinking water supply in campus including connections to the existing OHSR at ICAR-NDRI, Karnal.
- Renovation of Satluj Hostel at NDRI.
- Renovation of PG Lab Semen Quality Control Lab, Semen Processing Lab, Semen Storage Lab, at Artificial Breeding Research Centre and Main Building at NDRI, Karnal.
- Providing of shed to cover the cold storage & dispatch dock of B.P.D., Building at NDRI, Karnal.
- Renovation of UG Lab of Dairy Microbiology Division,
- Renovation of Brahamputra Hostel.
- Renovation of Hostels Boundary wall (Boys & Girls).
- New laboratory in the Engineering section and proteomics laboratory in Production Section developed at Southern Campus, Bengaluru.
- Laying of BSNL Optical Fiber Cable (OFC) for internet connectivity and installation of networking and firewall software (Cyberoam).
- Aadhar based Biometric Attendance Systems was installed.
- National Knowledge Network (NKN) of Ministry of Communications and Information Technology, GoI successfully laid and installed at Southern Campus, Bengaluru.

- Dairy cattle and agricultural waste management through Vermi-composting -as a source of revenue generation started at Southern Campus, Bengaluru.
- Fodder Museum as a demonstration unit started at Southern Campus, Bengaluru.
- Renovation of Protein laboratory of Dairy Chemistry Division.
- The foundation stone of University Examination Hall at NDRI, Karnal was laid.
- An additional KVK established at ERS, Kalyani.

Sh. Sudarshan Bhagat, Hon'ble Union Minister of State for Agriculture and Farmers Welfare laying foundation stone of the University Examination Building at NDRI, Karnal

Dr. A. K. Srivastava, Director, NDRI inaugurated the additional KVK at Eastern Campus, Kalyani

कार्यकारी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित संगठन है जो कि देश में डेरी विकास कार्यक्रमों के लिए अनुसंधान एवं 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 कर दिया गया। इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो कि बंगलौर तथा कल्याणी में स्थित है। दक्षिण व पूर्वी क्षेत्रीय केन्द्र स्थानीय क्षेत्र में कृषि वातावरण के अनुरूप डेरी विकास के लिए अनुसंधान एवं सहयोग प्रदान करने में लगे हुए हैं। शैक्षणिक कार्यक्रमों के संचालन हेतु संस्थान को मान्य विश्वविद्यालय का दर्जा प्राप्त है।

संगठनात्मक स्वरूप

संस्थान की प्रबंध प्रणाली भारतीय कृषि अनुसंधान परिषद के मान्य 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, विद्या परिषद समितियों को सौंपा गया है। संस्थान के निदेशक इसके मुख्य कार्यकारी अधिकारी हैं तथा प्रबंधन, अनुसंधान, शैक्षणिक एवं विस्तार 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 एवं विस्तार कार्यक्रम संस्थान के मुख्यालय तथा इसके दो क्षेत्रीय केन्द्रों पर संस्थान के तेरह प्रभागों/अनुभागों–पशु प्रजनन, पशुधन उत्पादन एवं प्रबंधन, पशुपोषण, चारा अनुसंधान, पशु शरीर क्रिया विज्ञान, पशु जीव रसायन, पशु जैव प्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी अभियांत्रिकी, डेरी रसायन, डेरी सूक्ष्म जीव विज्ञान, 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, है। पीपराकोठी, पूर्वी चंपारन, मोतीहारी, बिहार पर कृषि विज्ञान केन्द्र के अन्तर्गत कृषि तथा डेरी विकास केन्द्र तथा मुजफरनगर (उ.प्र.) में लालूखेड़ी में माडल 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, टैक्नोलोजी बिजनस इनक्यूबेटर, व्यवसाय नियोजन एवं विकास एकक, दुग्ध गुणवता एवं सुरक्षा के लिए नैशनल रैफरल प्रयोगशाला, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय तथा राष्ट्रीय जैव सूचना केन्द्र, कंप्यूटर केंद्र, संपदा अनुभाग, राजभाषा अनुभाग एवं अनुरक्षण अभियांत्रिकी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे क्रय, भंडार, एवं सुरक्षा संयुक्त निदेशक (प्रशासन) एवं कुलसचिव के नियंत्रण में है जबकि वित्त विभाग वित्त नियंत्रक (कंप्ट्रोलर) के प्रशासनिक नियंत्रण में है। संस्थान में इस समय 159 वैज्ञानिक, 202 तकनीशियन, 127 प्रशासनिक एवं 433 निपुण सहायक कर्मचारी हैं।

बजट परिव्यय

संस्थान का वर्ष 2016–17 के लिए योजना तथा गैर योजना शीर्ष में वास्तविक व्यय बजट 16978.59 लाख रूपए था तथा वर्ष 2016–17 के लिए योजना एवं गैर योजना के लिए स्वीकृत बजट 17230.35 लाख रूपए था। इस में क्षेत्रीय केन्द्रों का बजट भी शामिल है।

अनुसंधान

वर्ष 2016–17 के दौरान कुल 76 अन्तः संस्थानीय तथा 75 बाह्य अनुसंधान परियोजनाओं का कार्य चल रहा था। मूल एवं महत्वपूर्ण अनुसंधान कार्यो को सुदृढ़ करने के अतिरिक्त वितीय अनुसंधान परियोजनाओं से फंडिग लगभग 110 करोड़ रूपए तक पहुंच गई है राष्ट्रीय डेरी अनुसंधान संस्थान लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेन्सियों जैसे जैव प्रौद्योगिकी विभाग(डी.बी.टी.), विज्ञान एवं प्रौद्योगिकी विभाग(डी.एस.टी.) कृषि एवं ग्रामीण विकास के लिए राष्ट्रीय बैंक (नाबार्ड), राष्ट्रीय डेरी विकास बोर्ड(एन.डी.डी.बी.)राष्ट्रीय कृषि विज्ञान फंड(एन.ए.एस.एफ.), खाद्य प्रसंस्करण उद्योग मंत्रालय(एम.ओ.एफ.पी.आई) से बाह्य वित्तीय सहायता प्राप्त करने में सफल रहा है।

फंडिंग एजेन्सियों से प्राप्त सहायता ने वैज्ञानिकों को स्टैम कोशिका, भैंस की क्लोनिंग, ट्रांसक्रिप्टोन, एम्ब्रयोजेनेसिस, बायोसैंसर, नैनोप्रौद्योगिकी, फार्म पशुओं में एबायोटिक दाब, न्यूट्रासियूटिकलस तथा क्रियात्मक आहारों पर कार्य करने के लिए प्रोत्साहित किया है। फंडिंग एजेन्सियों से प्राप्त अनुदान ने छात्रों को अपने शोध–निबंधों में आधुनिक उपकरण एवं तकनीकियों के चयन के लिए भी सहायता प्रदान की है।

- क्लोनड भ्रूणों में कमियों की जांच के लिए क्लोनिंग तथा परख नली निषेचन तकनीकियों द्वारा उत्पन्न भैंस के ब्लास्टोसिस्ट–स्टेज भ्रूणों में ग्लोबल ट्रांसक्रिप्टोम तथा एम आई आर एन ए प्रोफाइलिंग की गई। इससे गायों तथा भैंसों में क्लोनड बछड़े पैदा करने की सफलता दर में सुधार के लिए रणनीतियां बनाने में सहायता मिलेगी।

- ट्रांसजीनिक भैंस शुक्राणुजन स्टेम कोशिकाएं उत्पन्न की गई तथा होमोलोंगस प्रत्यारोपण के लिए उनका प्रयोग किया गया।
- भैंस की भ्रूणीय स्टैम कोशिकाओं के निदेशित विभेदीकरण द्वारा स्तनीय वंशावली कोशिकाएं उत्पन्न की गई।
- भैंस के डिम्बाणुजन कोशिकाओं में विलक्षण नान–कोडिंग आर.एन.ए.की खोज की गई जो कि उनकी विकासात्मक क्षमता को प्रभावित कर सकेंगें।
- पुनर्संयोजन गोपशु ल्यूकीमिया निरोधक तत्वों को सफलतापूर्वक उत्पन्न किया गया। गोपशुओं की स्टैम कोशिकाओं के संवर्धन के लिए एक संपूरक के रूप में इसके प्रयोग से उनकी क्षमता सुधार में सहायता होगी तथा इससे लागत में भी कमी आएगी।
- एडिपोसाइट ऊतकों से वियोजित भिसेनकाइमल स्टैम कोशिकाओं का सीधा अनुप्रयोग गोपशुओं तथा भैंसों में खुरों के पुराने घावों के प्रबंधन में लाभकारी हो सकता है।
- पुनर्संयोजन द्वारा उत्पन्न लेक्टोबेसिलि सतहीय प्रोटीन के साथ मानव आन्त्र कोशिकाओं के उपचार से पेथोजन बांइडिंग से 76% तक बचा जा सकता है।
- गोपशुओं तथा भैंसों के ए 1/ए 2 दूध की जांच के लिए एक प्रोटिओमिक्स आधारित विधि विकसित की गई।
- ए 1/ए 2 दूध के दुग्ध व्हे में अभिव्यंजित प्रोटीन की उनके स्वास्थ्य विश्लेषण के लिए जांच की गई।
- बहुमूल्य रेशों की इसके सर्वश्रेष्ठ प्रोटिओमिक संरचना के साथ नई पहचान संस्थापित की गई।
- प्रारंभिक अवस्था पर उच्च दुग्ध एवं वसा के लिए मुर्राह भैंसों के चयन के लिए एस.एस.डी. जीन में आनुवांशिक मार्कर की जांच की गई। प्रदर्शन विशेषकों पर आनुवांशिक मार्कर का प्रभाव प्रदर्शित करता है कि लगभग 263 ग्राम परीक्षण दिवस दुग्ध उत्पादन, 0.15% परीक्षण दिवस वसा प्रतिशत तथा 13.8 ग्राम परीक्षण दिवस वसा उत्पादन एस.सी.डी जीन में एस.एन.पी. (जी21146196ए) परिवर्तित होने पर बढ़े हुए पाए गए।
- 305 दिन के उच्चतम प्रथम दुग्ध स्त्रवण दुग्ध उत्पादन तथा वसा उत्पादन से संबंधित स्टैट 5 ए. जीन के आनुवांशिक मार्कर की जांच की गई। प्रांरभिक अवस्था में मुर्राह भैंसों के चयन के लिए मार्कर सहायक चयन रणनीति के विकास के लिए मार्कर का प्रयोग किया जा सकता है।
- बी.एस.पी 5, ओ.डी.एफ 1 पी पी पी 1 आर 11 जीनों के आनुवांशिक मार्करों की जांच की गई जिनका प्रयोग मुर्राह भैंसों में संशोधित वीर्य गुणवत्ता विशेषकों के चयन, उच्च गर्भाधान दर तथा प्रजनक गर्भाधान दर के चयन के लिए प्रयोग किया जा सकता है।
- वीर्य गुणवत्ता पैरामीटरों तथा उच्चतर जनन क्षमता (गर्भाधान दर, तथा प्रजनक गर्भाधान दर) संबंधी एम.एपी 1 बी 1 तथा पी पी पी 1 आर 11 जीन के आनुवांशिक मार्करों की पहचान की गई। प्रारम्भिक अवस्था में करन फ्रीज गोपशुओं के चयन के लिए मार्कर सहायक चयन रणनीति के विकास के लिए आनुवांशिक मार्करों का प्रयोग किया जा सकता है।
- थारपरकर गायों के जीवनपर्यन्त दुग्ध उत्पादन के पूर्वानुमान के लिए एक प्रणाली विकसित की गई।
- श्रेष्ठ गर्भाधान दर के मुर्राह सांडों के प्रथम प्रयोग के समय आयु तथा अनुकूलतम जन्म भार का मानकीकरण किया गया। संगठित पशु समूहों में मुर्राह झोटों को 3.5 वर्ष की आयु से पहले प्रयोग किया जाना चाहिए, जो कि 4.5 वर्ष की आयु के बाद प्रयोग किए जाने वाले मुर्राह सांडों की तुलना में परिणामस्वरूप प्रथम कृत्रिम गर्भाधान पर आधारित 5.08% अधिक सी.आर.आधारित परिणाम की संभावना रहती है।
- मुर्राह भैंसों की दुग्ध की ऊर्जामान (के.सी.ए.एल/कि.ग्रा.) के लिए उच्च परिशुद्धि के साथ पूर्वानुमानित माडलों का विकास किया गया। मुर्राह भैंसों की दुग्ध गुणवत्ता की जांच के लिए डेरी उद्योग द्वारा पी.टी.कार्यक्रम के अर्न्तगत उच्च ऊर्जा मान के लिए मुर्राह भैंसो की चयन मापदण्डों में से एक मानदण्ड के रूप में माडलों का प्रयोग किया जा सकता है।
- 20 वर्षो (1994–2013) से अधिक समय से फैले 471 मुर्राह भैंसों के दैनिक दुग्ध उत्पादन (डी एम वाई) वाले 2, 91 ,416 दैनिक दुग्ध उत्पादन रिकार्ड पर ऊर्जा दाब के प्रभाव को मूल्यांकित करने के लिए एक नवीन टी. एच आई माडल (टी.एच आई डी) = 40.34 + 1.23 डीबी+ 0.0027 आर.एच.) का विकास किया गया। नाजुक मदकाल दाब के दौरान टी.एच आई में दैनिक दुग्ध उत्पादन यूनिट वृद्वि में लगभग 80 ग्रा. कमी विकसित टी एच आई डी मूल्यांकित की गई। मुर्राह भैंसों में नाजुक मदकाल दाब तथा मदकाल दाब के दौरान दैनिक दुग्ध उत्पादन के लिए अनुमानित प्रजनन मान 1.6 कि.ग्रा से 1.9 कि.ग्रा. तक कम पाया गया।

- करनफ्रीज गायों में उच्चतम जीवनपर्यन्त उत्पादकता के लिए विभिन्न प्रथम दुग्ध स्त्रवण विशेषकों के अनुकूलतम स्तर प्रथम ब्याँत के समय आयु के लिए 800–900 दिन, 305 दिन के प्रथम दुग्ध स्त्रवण दुग्ध उत्पादन 4000 से 4500 कि.ग्रा., प्रथम ब्याँत कुल दुग्ध उत्पादन, 4500–5000 कि.ग्रा, प्रथम गर्भस्थापन अवधि के लिए 91–115 दिन, प्रथम ब्याँत अवधि 300–400 दिन, प्रथम शुष्क काल अवधि 60–90 दिन तथा प्रथम ब्याँत अन्तराल 300–400 दिन पाए गए।
- प्रतिक्रमण के लिए न्यूरल नेटवर्कस (एन.एन), सपोर्ट वेक्टर रिग्रेशन(एस.वी.आर.) डिसिजन ट्री (डी.टी), रेंडम फारेस्ट (आर.एफ) तथा लीनियर माडल (एल एम) जैसे विभिन्न उभरते हुए मशीनी शिक्षण एल्गोरिदम का प्रयोग करके मुर्राह झोटों की आदर्श जननक्षमता के लिए सूचनाप्रद भविष्यसूचक माडल विकसित किए गए।
- संकर सांडों के वीर्य में बी.एस.पी.1 के निर्धारण के लिए एक सैंडविच एलिसा विधि विकसित की गई।
- भैंसों में शुकाणु–डिम्बवाहिनी बांइडिंग पर अध्ययन के लिए एक परखनली माडल विकसित किया गया। अध्ययन सुझाता है कि शरीर पर बेसलाइन थर्मोग्राफिक जानकारी तथा यू.एस.एस.टी, थनैला रोग से पीड़ित पशुओं की प्रारंभिक जांच के लिए पूर्वानुमानित माडलों के लिए थर्मोग्राफिक संकेत विकसित करने में लाभकारी हो सकता है।
- मदकाल दाब के प्रभाव को मूल्यांकित करने के लिए करन फ्रीज गोपशुओं के लिए नवीन टी.एच आई माडल(टी एच आई डी एम के एफ = 39.3+3X टी डब्ल्यू बी 1.16 X टी डी बी.) विकसित की गई। मदकाल तनाव के दौरान करन फ्रीज गोपशुओं में टी.एच.आई मान में यूनिट वृद्धि सहित लगभग 82.जी, 87 जी तथा 144 जी प्रतिदिन दुग्ध उत्पादन कम होता पाया गया तथा 50%, > 50%, से 62.5% तथा > 62.5% विदेशी वंशानुक्रम पाया गया। मदकाल तनाव के दौरान दैनिक दुग्ध उत्पादन के लिए औसत ई.बी.बी, वसा तथा एस.एन.एफ. प्रतिशतता एवं गर्भस्थापन दर में कमी पाई गई।
- अध्ययन दर्शाते हैं कि उपयुक्त दुग्ध क्षमता, सामान्य अयन स्वास्थ्य, दुग्ध गुणवत्ता तथा दोहन व्यवहार को देखते हुए संकर डेरी पशुओं के दुग्ध दोहन के लिए स्वचालित आड़ा पार्लर उपयुक्त पाया गया। भारतीय परिस्थितियों के अन्तर्गत संकर गायों के दोहन के लिए 0.2 कि.ग्रा./मिनट के ए.सी आर.तथा 42 के पी ए. के निर्वात स्तर तथा 65:35/60:40(पी.< 0.05) के स्पंदन अनुपात दुग्ध दोहने वाली मशीन की सैटिंग के लिए सबसे अधिक उपयुक्त पाए गए।
- अध्ययन दर्शाते हैं कि दुग्ध उत्पादन, लाभ, शुष्क पदार्थ अन्तर्ग्रहण तथा रक्त चयपचयता पर प्रसव पश्चात अल्पाइन X बीटल बकरियों को अजोला संपूरण आहार खिलाने से सकरात्मक प्रभाव पड़ता है।
- प्रसव पूर्व अवधि के दौरान विटामिन ई–तथा एस ई. के साथ गायों का प्रबंधन संशोधित गर्भाश्य स्वास्थ्य पर लाभप्रद प्रभाव प्रदर्शित करता है क्योंकि इस वर्ग में अधिकतम गायों (73%) का सामान्य प्रसव हुआ तथा नियंत्रित वर्ग (30%), पी जी एफ 2ए (33%) तथा संयुक्त वर्ग (42%) की तुलना में गर्भाश्य संक्रमण नहीं हुआ।
- डेरी पशुओं की प्रजनन व्यवस्था पर एक ज्ञान आधारित द्विभाषी सूचना सुधार प्रणाली पूर्ण रूप से विकसित की गई।
- अध्ययन दर्शाते हैं कि साहीवाल सांडों के श्रेष्ठ यौन तैयारी तथा कुल शुक्राणु उत्पादकता के लिए एसीटिक अम्ल, 2 ब्यूटानोन तथा ओलिक अम्ल प्रभावी है।
- अध्ययन दर्शाते है कि चावल संधानित आसवक सिरप (आर.सी डी एस) 15% तक (शुष्क पदार्थ पर दुधारू संकर गायों एवं बढ़ते हुए गायों में सान्द्रित मिश्रण के एक अंश के रूप में प्रतिस्थापित किया जा सकता है तथा इसका दुग्ध उत्पादन, दुग्ध संरचना, टी.डी.एम आई, विकास प्रदर्शन, पोषक अन्तर्ग्रहण, पोषक पदार्थों की उपयोगिता एवं रक्त पैरामीटरों पर कोई प्रतिकूल प्रभाव नहीं पड़ता है।
- अमोनिया फाइबर एक्सपैंशन (ए एफ ई एक्स.) प्रौद्योगिकी द्वारा तैयार अमोनिया उपचारित गोलियां डेरी पशुओं के हरे चारे के स्थान पर प्रतिस्थापित की जा सकती है। इस आहार पर रखी जाने वाले गायों तथा भैंसों के स्वास्थ्य पर कोई हानिकारक प्रभाव नहीं देखे गए। यह आहार तथा नियंत्रित आहार पर रखे गए गो पशुओं के दूध में एसीटामाइड स्तरों में महत्वपूर्ण अन्तर पाया गया।
- चारा उपभोग, विकास प्रदर्शन तथा पौषणिक उपयोगिता पर 0,2,4 तथा 8 पी पी एम की दर से आहारीय वैनेडियम सम्पूरण का कोई प्रभाव नहीं था वैनेडियम तथा जिंक संतुलन एवं उनके प्लाज्मा स्तरों पर वैनेडियम संपूरण का सकारात्मक प्रभाव था। प्लाज्मा ट्रिग्लाइकराइड तथा कोलस्ट्रोल स्तर कम पाए गए, जबकि ए.पीएल तथा जी पी एक्स गतिविधि वैनेडियम संपूरण द्वारा महत्वपूर्ण रूप से वृद्धि करती पाई गई।

- आहारीय सी ए प्रोपायोनेट, नियंत्रित पशुओं की अपेक्षा सी.एल ए वर्गों में सोमेटिक कोशिका काऊन्ट (एस.सी. सी.)में महत्वपूर्ण कमी (पी>0.05) पाई गई।
- अनुरक्षण के लिए ग्रीष्म तथा शीत ऋतु के दौरान एम.ई. की अपेक्षाओं की (139.57 तथा 130.78 के सी ए एल/कि.ग्रा. बीडब्ल्यू 0.75) का विकास (4.87 तथा 5.03 के सी ए एल/कि.ग्रा.बी.डब्ल्यू 0.75) कर आकलन किया गया तथा यह ग्रीष्म ऋतु में अधिक पाया गया। तथापि ग्रीष्म तथा शीत ऋतुओं के दौरान पाच्य अपरिष्कृत प्रोटीन (डी.सी.पी) की आवश्यकता अनुरक्षण के लिए (4.25 तथा 4.16 ग्रा./क्रि.ग्रा.बी डब्ल्यू 0.75) तथा विकास (0.27 तथा 0.25 ग्रा./क्रि.ग्रा.बी डब्ल्यू 0.75) तुलनात्मक पाए गए।
- भैंस के बढ़ते हुए ओसरों की जल आवश्यकता के लिए एक रोबस्ट माडल विकसित किया गया जो कि निम्नानुसार है: डी.डब्ल्यू 1(एल./डी.) = 14.39+1.56 शुष्क पदार्थ अन्तर्ग्रहण डी.एम.आई(कि.ग्रा./दिन)+0.68 टी मैक्स (0^{o} सें.)–0.057 आर एच(%)+0.016 बी.डब्ल्यू (कि ग्रा.)
- ग्रीष्म एवं शीत ऋतु के दौरान अल्प ऊर्जा वर्गों की तुलना में उच्च ऊर्जा आहार वर्ग में इन – विवो मिथेन उत्सर्जन क्रमशः 11.7% तथा 7.76% कम था। जबकि विभिन्न ऋतुओं के दौरान प्रयोगात्मक वर्गों में आन्त्र मिथेन उत्सर्जन पर कोई अन्तर नहीं पाया गया।
- विभिन्न पौषणिक प्रबंधन के अन्तर्गत ज्वार चारे की किस्मों तथा उनके पौषणिक मान का मूल्यांकन किया गया।
- विभिन्न कल्टीवरों में पौषक पदार्थो एवं पादप सघनता के प्रबंधन के द्वारा मक्का चारा के उत्पादन एवं गुणवत्ता में सुधार किया गया।
- जिंक एवं सोडियम बाइकार्बोनेट के संपूरण ने मदकाल तनाव को महत्वपूर्ण रूप से कम किया जबकि मदकाल तनाव के अन्तर्गत गोपशुओं के एस्टाक्सेन्थिन आहार से प्रजनन क्षमता में वृद्धि हुई।
- मदकाल तनाव के दौरान, दुग्ध उत्पादन पर मुर्राह भैंसों के संक्रमण में बायोकार्बोनेट के संपूरण से रक्त में गैस तथा अम्ल आधारित संतुलन पर सामान्य तथा संगत सुधार पर नकारात्मक प्रभाव पड़ता है।
- गायों में फेगोसाइटोसिस, केमोटेक्सिस कार्यों को पूरा करने के लिए न्यूट्रोफिलस कम योग्यता प्रदर्शित करते है जो कि गर्म आर्द्र मौसम में सबसे अधिक ब्याँतकाल को प्राप्त करते है
- बेकार पानी को विशुद्ध करने के लिए एलम, चारकोल तथा सोडियम हाइपोक्लोराइड (1%) के घोल के साथ एक विधि विकसित की गई।
- आन्त्र कोशिक लाइन (केको–2 कोशिकाएं) पर दो पेप्टाइडों (हेक्सा पेप्टाइड : सी तथा ट्राइ पेप्टाइड : जी) पर जैव उपलब्धता अध्ययन किए गए जो कि ट्रांससाइटोसिस तथा पेप टी 1 मीडिएटिड विधियों के द्वारा उनके सम्पूर्ण रूप में एपीथिलियल मेम्ब्रेन पर 0.95% तथा 1.72% संतोषजनक परिवहन प्रदर्शित करते हैं।
- भैंस की केसीन के हार्मेटिक प्रभाव से प्रति आक्सीकर उत्पन्न हुए आस्टीओजेनिक पेप्टाइड संस्थापित हुए। पेप्टाइड ने फाइब्रोब्लास्ट पर एंटी एजिगं प्रभाव भी प्रदर्शित किए जो कि पी 38 एम ए पी के डिपैंडेंट सिगनलिंग प्रक्रिया द्वारा डाऊनरेगुलेटिंग एन एफ–के.बी मार्ग तथा एन आर एफ2 को सक्रिय करने का माध्यम था।
- चूहों पर गाय, भैंस तथा बकरी के दूध के उपयोग से ट्रेबिक्युलर बोन हिस्टोमारफोमीट्रिक तथा बी.एम डी के सुधार द्वारा ग्लूकोकारटिकाइड प्रवृत हड्डियों को क्षति आंशिक रूप से रूक गई।
- विभिन्न प्रकार के दूध में से बकरी का दूध ग्लूकोकारटिकाइड प्रवृत्त क्षति को अधिक संरक्षण प्रदान करता है।
- आहार में आरिजेनोल तथा फेरूलिक अम्ल के समावेशन से उच्च वसा वाले आहार के कारण शरीर भार में वृद्धि से बचाव होता है तथा वसा भरपूर खुराक खाने के दौरान वसा निक्षेपण से भी बचाव होता है।
- उच्च वसा युक्त आहार परिस्थितियों के अन्तर्गत से 57 बी.एल/6 चूहों में असामान्य ऊर्जा चयापचय पर लोकस्ट बीन ग्लेक्टोमैनन के आहारीय समावेशन का सार्थक प्रभाव होता है इससे जिगर तथा एडीपोज ऊतकों में चयनित जीनों की एम आर एन ए अभिव्यंजना तथा जिगर ऊतक में कुछ मुख्य किण्वकों की क्रिया द्वारा प्रदर्शित की गई।
- नेनो जिंक तथा मल्टीवाल्ड कार्बन नेनोटयूबस(एम डब्ल्यू सी एन टी) की तुलना में मेसोपोरस सिलिका नेनोपार्टिकलस (एम.एस एन) तुलनात्मक रूप से कम विषाक्त पाए गए।
- एम एस एन नेनोपार्टिकलस के साथ मिनिमलिस्टिक मार्फोलोजिक परिवर्तन अवलोकित किए गए जबकि नेनो जिंक स्पष्ट पाए गए तथा कोशिकीय एवं अल्ट्रा संरचनात्मक क्षति गहरी थी।

- यह पाया गया कि मेम्ब्रेन सम्पूरणता मान श्रेष्ठ माडल प्रणाली के रूप में प्रयुक्त कीटाणु कोशिकाओं में दबे हुए पाए गए तथा एम.डब्ल्यू सी.एन.टी तथा ए.जी.एन पी. की आई.सी 50 डोज के साथ उपचारित पाए गए।
- विटामिन सी.+इलेक्ट्रोलाइट का मिश्रण खिलाने से ग्रीष्म ऋतु में बकरियों का संप्रेषण तनाव कम हो गया जबकि इनका अलग अलग आहार कम प्रभावी था।
- जेबू गोपशुओं की तुलना में संकर गोपशुओं में चयापचय ऊष्मा उत्पादन तथा मीथेन(के सी ए एल) प्रति यूनिट चयापचय भार के रूप में ऊष्मा क्षति अधिक पाई गई।
- क्रियात्मक क्रीम चीज़, क्रियात्मक योघर्ट चीज़, अल्प सोडियम चेड्डार चीज़, मोजरेला तथा प्रोसैसड चीज, अल्प सोडियम तथा अल्पवसीय चेड्डार चीज, दुग्ध प्रोटीन सान्द्रण (अर्थात् एम.पी.सी 55, एम.पी.सी.60 तथा एम.पी.सी.70) एलोवीरा सम्पूरित प्रोबायोटिक लस्सी, आहारीय सन्देशः कैलोरी में 30% कमी वाला, चीज़ डिप, रेडी टू सर्व ब्रेकफास्ट समूदी जैसे कई उत्पादों की संरचना के लिए प्रक्रियाएं विकसित की गई।
- दूध–नारियल से तैयार मिठाई की शेल्फ लाइफ बढ़ाने की विधि विकसित की गई।
- जड़ी–बूटियों युक्त बरफी की शेल्फ लाइफ तथा प्रौद्योगिकी पर अध्ययन किए गए।
- फाइटोस्टीराल पुष्टिकर लस्सी विकसित की गई।
- खीर बनाने के लिए राइस–प्री कुकिंग प्रणाली विकसित की गई।
- विस्कोस(चिपचिपे) डेरी उत्पादों के लिए अर्द्ध स्वचालित भार आधारित फिलिंग प्रणाली विकसित की गई।
- रसगुल्ला बनाने के लिए संयुक्त एल.पी.जी तथा विद्युत आधारित तापन प्रणाली का मानकीकरण किया गया।
- ओहमिक दुग्ध तापन प्रणाली (5 लीटर क्षमता) की प्रोटोटाइप विकसित की गई।
- वायवीय पनीर हूप–कम–प्रेस यूनिट के लिए माइक्रोप्रोसैसर आधारित आटोमेटिड इन्सटरयूमेंटेशन प्रणाली विकसित की गई।
- दही की शेल्फ लाइफ तथा प्रति आक्सीकर गुणों पर अनार के छिलकों के सत्रव का प्रभाव पर अध्ययन किया गया।
- बकरी–भैंस के दूध के मिश्रण से मसालेदार चीज रोल बनाने की प्रौद्योगिकी विकसित की गई।
- सिनबायोटिक जई–के दूध पर आधारित किण्वित उत्पादों में स्वदेशी प्रोबायोटिक लेक्टोबेसिलस प्रजातियों का मूल्यांकन किया गया।
- दुग्ध प्रोटीन–स्टार्च–नेनोसेल्यूलोज आधारित बायोडिग्रेडेबल पैकिंग सामग्री का विकास एवं मूल्यांकन किया गया।
- अति सूक्ष्मछानन प्रक्रिया का प्रयोग कर बकरी के दूध की योघर्ट की गुणवत्ता में सुधार किया गया।
- दुग्ध प्रोटीन से भरपूर बाजरा यव्य(माल्ट) आधारित सम्पूरक आहार विकसित किया गया।
- सम्मिश्रित डेरी–मिलेट आधार से ग्लूटन रहित पास्ता के लिए प्रौद्योगिकी का मानकीकरण किया गया।
- दुग्ध प्रोटीन–मक्का सम्मिश्रण आधारित एक्सटरयूडेटस के गुणवत्ता विश्लेषण पर निष्कासन प्रसंस्करण प्रवृत्त परिवर्तनों के प्रभाव पर अध्ययन आयोजित किए गए।
- प्रोबायोटिक प्रजाति एल.रेहमनोसस सी आर डी 9 के साथ सम्पूरित दही ने चूहों के माडल में नानअल्कोहलिक फैटी लिवर रोगों के उपचार तथा बचाव में सुधारजनक प्रभाव प्रदर्शित किए जो कि डी.नोवो वसीय अम्ल संश्लेषण को नियमित करता है तथा जीनस (एफ.ए.एस, ए.सी सी, एस आर ई बी पी 1 सी तथा ए डी आर पी.) को उन्नत करता है।
- प्रोबायोटिक लेक्टोबेसिलि की क्रियाशील एवं ऊष्मारोधी तैयारियां प्रति उत्तेजक संभाव्यता प्रदर्शित करती है।
- एस जी 27 प्रजाति ने काको–2 कक्षों के अन्तर्गत अधिकतम अनुपालनात्मक संभावना को प्रदर्शित किया।
- सम्पुटित प्रोबायटिक प्रजाति, लैक्टोबैसिलस रेउटेरी एल.आर.6 (रिडेट संस्थान, न्यूजीलैण्ड में तैयार) ने क्रमशः 4 एवं 35 डिग्री सेल्सियस पर भण्डारण के दौरान एक एवं दो लॉग लैक्टोबेसिलि काउंट्स की कमी दर्शाई।
- एन्टरोटॉक्सीजेनिक एस्चेरिचिया कॉली(ई.टी.ई.सी.) मीडिएटेड डायरिये से मुकाबले के लिए एक प्रभावी 'सिनबायोटिक फॉमूला' एवं 'सिनबायोटिक लेक्टोस मुक्त किण्वित डेरी पेय पदार्थ' विकसित किए गए।

- लैक्टोबैसिलस एसपीपी के प्रयोग से अल्फा ग्लूकोसाइडेस एवं डाइपेप्टाइडिल पेप्टीडेस–चार निरोधात्मक दूध बायो–एक्टिव पेप्टाइड्स उत्पादित किये गए एवं चिन्हित किये गए।
- उत्तर भारतीय शाकाहारियों में मॉसाहारियों के बजाय बैक्टीरियल कम्यूनिटी की विविधता पाई गई। बहरहाल, दो भिन्न आहार ग्रहण करने वालों में बाइफाइडोबैक्टीरियम एसपीपी में कोई विशेष अंतर दृष्टिगत नहीं हुआ। उत्तर भारतीयों की माइक्रोबायोटा ऑतों में फ्यूजोबैक्टीरियम एवं एक्करमानसिया अनुपस्थित पाए गए। डायबिटिक मेजबानों में एफ.प्राउज्नीट्जील एवं ब्यूटाइरेट की कमी पाई गई।
- ग्रीक स्टाइल योघर्ट के लिए प्रत्यक्ष वाट स्टार्टर विकसित की गई।
- चेद्दर पनीर से एंजाइम रूपांतरित पनीर (ई.एम.सी.–एंजाइम मॉडिफाइड चीज) को तैयार करने के लिए एक प्रक्रिया विकसित की गई।
- भारत जैसे विकासशील देशों में वर्तमान दुग्ध उत्पादन एवं खरीद व्यवस्था के लिए उपयुक्त द्रुत हीट स्थानांतरण के लिए नैनोफ्लुइड आधारित पोर्टेबल टाइप दुग्ध कूलिंग मॉड्यूल को विस्तृत सतही अनूठी डिजाइन के साथ विकसित किया गया
- एक स्वचालित माइक्रोप्रोसेसर आधारित पनीर प्रेस को डिजाइन किया गया एवं छोटे स्तर के पनीर प्रोसेसरों के लिए विकसित किया गया।
- जीनोटाइप एवं टी.एच.आई. इन्टरेक्शन के अध्ययन से यह ज्ञात हुआ कि 50 प्रतिशत एक्जोटिक (जर्सी या एच.एफ.) आनुवांशिक संरचना वाली एवं 50 प्रतिशत स्वदेशी (लाल सिन्धी या थारपारकर) विरासत वाली गायों ने 75 प्रतिशत या अधिक एक्जोटिक विरासत वाली गायों के बजाय उच्चतर टी.एच.आई. क्षेत्रों में बेहतर दुग्ध उत्पादन क्षमता को प्रदर्शित किया।
- किस्पेप्टीन–10 का प्रयोग करते हुए ऐस्ट्रस सिंक्रोनाइजेशन के लिए विधि विकसित की गई, जिसे डेरी मवेशियों की प्रजनन क्षमता के प्रबंधन में प्रयोग में लाया जा सकता है।
- यह निष्कर्ष प्राप्त हुआ कि कामेला(मालोटस फिलिप्पेनसिस) या फाइकस हुकेरी वृक्ष की पत्तियों के सूखे पाउडर को बढ़ती हुई 4 प्रतिशत गाढ़े मिक्सचर को हर्बल फीड योजक(एडिटिव) के रूप में मिलाने से बढ़ती हुई बछड़ी की वृद्धि प्रदर्शन(ग्रोथ परफॉरमैंस) में सुधार हुआ।
- हिमाचल प्रदेश के ठण्डे मरूस्थली क्षेत्र से पारंपरिक रूप से तैयार किये गये किण्वित दुग्ध सैम्पलों में पी.एच., अम्लता एवं कुल लैक्टिक काउंट में ज्यादा अंतर दृष्टिगत् हुआ। इसके अलावा, किण्वित दुग्ध सैंपलों में ज्यादा खमीर एवं सॉचों के साथ–साथ कॉलिफॉर्म भी पाए गए।
- 272 डी.ई.पी. में से, एल. फरमेंटम एनसीडीसी 400 में एसिड स्ट्रेस्ड परिस्थितियों के अन्तर्गत फोल्ड चेंज(≥1.5), 48 अप–रेग्यूलेटेड एवं 110 डाउन–रेग्युलेटेड डी.ई.पी. प्राप्त किए गए।
- लैक्टोबैसिलस रेयूटेरी एल.आर.28 ने स्किम दुग्ध में अधिकतम फोलेट उत्पादन को प्रदर्शित किया एवं प्रोबायोटिक गुणों को धारित रखा। एल.आर.28 ने स्किम दुग्ध में 3 प्रतिशत लैक्टोज, 5.5 मिलीग्राम/लीटर पी.ए.बी.ए.एवं 300 µl तरबूज के रस की वृद्धि सहित फोलेट के परिवर्द्धित कंसन्ट्रेशन (35.12 ± 0.92 µg/l) को उत्पादित किया एवं डायरिया नियंत्रित इन्वाइवो में महत्वपूर्ण सुधार प्रदर्शित किए।
- एचएईतीन एवं 'सीएलपीसी' के साथ एवं एमएसपीआई के साथ 'एच.एस.पी.60' को, बाइफाइडोबैक्टीरिया के स्पीशीज लेवल डिफरेंशियेशन के लिए एकल प्रतिबंध आरएफएलपी मार्कर के रूप में प्रयोग में लाया जा सकता है। आरपीओबी आरएफएलपी (एचएचए1 एवं एचआईएनएफ1) एवं सीएलपीसी(एमएसपीआई एवं टीएआईएल) के एक संयुक्त अनुप्रयोग को तदनुसार उप–प्रजाति लेवल पहचान एवं विभेद के लिए प्रयोग में लाया जा सकता है।
- एल.फरमेंटम एस.आर.4 एवं एल.फरमेंटम के.एफ.3.ए, दो अत्यंत प्रोलिफिक जेड.एन. अपटेकिंग कल्चर्स के रूप में पाये गए थे एवं पहले ने अनुकूलित दशाओं में जेड.एन.(1.947 ± 0.31 मिलीग्राम/ग्राम डी.डब्ल्यू.) के एकत्रण हेतु उच्चतम क्षमता प्रदर्शित की।
- 10 केडीए फ्रेक्शन भेड़ के दूध ने बैसिलस सेरेयस एटीसीसी1306 एवं 5केडीए फ्रेक्शन उच्चतर एंटीऑक्सीडेंट एवं एंटीहाइपरटेंसिव गतिविधि के विरूद्ध अधिकतम एंटी–माइक्रोबायल गतिविधि प्रदर्शित की एवं इसके बाद गाय व भैंस के दूध ने इसे प्रदर्शित किया।

- सिन्बायोटिक ब्लूबेरी योघर्ट एवं 10 केडीए बायोएक्टिव पेप्टाइड फ्रेक्शन ने ऑक्सीडेटिव स्ट्रेस बायोमार्कर एंजाइम्स में महत्वपूर्ण (पी<0.05) की कमी को तथा ऑक्सीडेटिव स्ट्रेस इन्ड्यूस्ड चूहों में एंटीऑक्सीडेंट एंजाइम्स के अंतर्गत महत्वपूर्ण (पी<0.05) वृद्धि को प्रदर्शित किया।
- लैक्टोस रिच व्हे के उपयोग के साथ 3 लीटर बायोरियेक्टर में अनुकूलित के.मारक्सीनस एमटीसीसी 1389 स्ट्रेन फरमेंटेशन से परिणामतः 79.33 ± 0.82 ग्राम/लीटर के फाइनल एथेनॉल टाइटर प्राप्त हुआ जोकि पैरेन्ट स्ट्रेन के (65.66 ± 0.12 ग्राम/लीटर) 17.5 प्रतिशत के करीब था।
- क्री–लॉक्सपी सिस्टम का प्रयोग करते हुए आनुवांशिक रूप से तैयार किए गए क्लूव्वेरॉमाइसेस मारक्सींनस 6सी17 का गाढ़े व्हे (100 ग्राम/लीटर लैक्टोस) पर नियंत्रित बैच कल्टीवेशन के अन्तर्गत एथेनॉल उत्पादन के लिए परीक्षण किया गया जिसके परिणामस्वरूप पैरेन्टल स्टैन के बजाय 19 प्रतिशत उच्चतर एथेनॉल उपज(47 ग्राम/लीटर) प्राप्त हुआ।
- जैव–पहचानजन्य अणुओं के रूप में दुग्ध नियोजक बीजाणुओं के एंटीबायटिक अवशेषों के लिए अन्वेषण की विधियॉ दो भिन्न धारणाओं यथा पेपर स्ट्रिप पर एंजाइम सब्ट्रेट रियेक्शन एवं बीजाणु अंकुरण के दौरान डी. पी.ए. मुक्तक आधारित रंग सूचक परिवर्तन के आधार पर विकसित की गई थीं।
- एस.बोविस आर.एल.ए. का अधिकतम बैक्टीरियोसिन उत्पादन (12.8×10^3 ए.यू./मिलीलीटर) (40 डिग्री सेंटीग्रेड) पर इष्टतम परिस्थितियों में एवं 24 एच के ऊष्मायन पर प्रारम्भिक 6.5 पी.एच. पर प्राप्त किया गया।
- ब्रांच चेन्ड वसीय अम्ल 4–मिथाइलनोननोएट तथा 4,8–डाई मिथाइलनोनेनाएट बकरी के दूध में पाए गए तथा 2 मिथोक्सीप्रोपेनोएट जी.सी.–एम.एस. का प्रयोग कर गाय के दूध में पाए गए।
- रेटीनोल एवं टोकोफेरल अंष बकरी के दूध वसा में अधिकतम पाए गए। बी–केरोटीन स्वदेशी गोपशुओं की नस्लों में (445 से 616 मिग्री/100 ग्राम वसा) अधिकतम पाया गया तथा भैंस एवं बकरी के दूध वसा में अनुपस्थित था।
- अफलाटाक्सिन एम1 (ए.एफ.एम.1) की अल्पमात्रा की जॉच के लिए एक विद्युत रासायनिक एप्टासेंसर का डिजाइन तैयार किया गया एवं विकसित किया गया।
- टीएलसी प्लेट पर सीसामल, सीसमोलिन तथा सीसामिन का निराकरण करने के लिए एक टी.एल.सी. आधारित विधि मानकीकृत की गई। मानकीकृत टीत्र.एल.सी. विधि का प्रयोग करके घी में वनस्पति की मिलावट का 5 प्रतिशत के न्यूनतम स्तर तक जॉच की जा सकती है।
- व्हे प्रोटीन हाइड्रोलाइसेटस–लौह तथा केसीफारफो पेप्टाइडटस–सी.ए./जिंक/एफ.ई. सम्मिश्रण पशु माडल तथा कोशिका लाइन (केको–2 सेल लाइन) में आयरनजैनिक लवण की तुलना में इन तत्वों की श्रेष्ठ जैव उपलब्धता प्रदर्शित की।
- अनुरूप अमाशयी परिस्थितियों के अन्तर्गत फिनोलिक सम्मिश्रण की अल्प त्याग के साथ प्रतिऑक्सीकर क्रिया के उच्च अवधारणा के साथ व्हे प्रोटीन सान्द्रण तथा गमअरेबिक का प्रयोग करके संतुलित अंगूर के बीजों के सत्व(जी.एस.ई.) के सूक्ष्म इनकेप्सुलेशन के लिए परिस्थितियॉ अनुकूल बनाई गई।
- विश्लेषणात्मक उद्देश्यों के लिए संग्रहित दूध के लिए फार्मोलिनको वैकल्पिक परिरक्षक के रूप में केथोन, ब्रोनोपाल, सोडियम एजाइड, सोडियम ओमाडाइन, डाउसिल, ट्रिक्लोसन, हाइड्रोजन परऑक्साइड तथा मिथाइल एवं प्रोपाइल पैराबीनस जैसे विभिन्न परिरक्षकों की संभाव्यता का मूल्यांकन किया गया। ब्रोनोपाल (0.05–0.1 प्रतिशत) तथा केथोन(0.20–0.40 प्रतिशत) ने श्रेष्ठ सूक्ष्मजैवीय क्रिया प्रदर्शित की।
- कृषकों की आय को दुगुना करने के लिए सरकार की पहल को अनुभवी सहयोग प्रदान करने के लिए एक डैटाबेस विकसित किया गया।
- वाणिज्यिक डेरी फॉर्म को स्थापित करने एवं बैंकयोग्य तकनीकी–आर्थिक परियोजना व्यवहार्यता रिपोर्ट के सृजन के लिए वैब आधारित निर्णय समर्थन प्रणाली(टीम–सीडी वर्जन 1.0) विकसित की गई।
- संगठित क्षेत्र में दूध के मूल्य संवर्द्धन और लागत व रिटर्न्स संबंधी डाटाबैस को मजबूत करने, हरियाणा, कर्नाटक, ओडिशा में दुग्ध उत्पादन की लागत एवं दुग्ध उत्पादन में लागत–लोच विषयों पर अध्ययन किए गए।
- डेरी व्यवसाय से जुड़े प्रौद्योगिकियों, सांस्थानिक व्यवस्थाओं व विकास कार्यक्रमों की प्रभाव विष्लेषण पर अध्ययन किए गए।

शिक्षण

- पशु आनुवांशिकी एवं प्रजनन प्रभाग ने सी.ए.एफ.टी. (पशु आनुवांशिकी एवं प्रजनन) के तत्वावधान में सतत् पशुधन उत्पादकता के लिए कौशल विकास पर 33वॉ राष्ट्रीय कार्यक्रम आयोजित किया।
- छात्रों को स्वस्थ, सूचनाप्रद, जागरूक एवं वचनबद्ध छात्र बनाने में सहायता करने के लिए श्रेष्ठ एवं मानव संसाधन पैदा करने के लिए रा.डे.अनु.सं. में एक नया स्टूडेंट इम्पावरमेंट यूनिट संस्थापित किया गया। यह यूनिट छात्रों को स्वजागरूक, समझदार एवं ध्यान केन्द्रित करने के साथ व्यावसायिक एवं निजी लच्यों को पूरा करने के लिए एक मंच प्रदान करता है। अतः यह कार्यक्रम छात्रों को सामाजिक एवं आर्थिक आत्मनिर्भरता प्रदान करने के लिए व्यावसायिक सेवाओं का पूर्ण रूप से सही ढ़ंग से प्राप्त करने के लिए ज्ञान प्रदान करता है।
- भारतीय कृषि अनुसंधान परिषद के संस्थानों के तकनीकी कर्मचारियों के लिए 18–23 जुलाई, 2016 तक नित्यप्रति के रासायनिक विश्लेषण पर एक छह दिवसीय मूल प्रशिक्षण आयोजित किया गया।

हिन्दी चेतना मास उद्घाटन समारोह का दृश्य

- आण्विक जीवविज्ञान यूनिट, भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल में 'मंगोलिया एवं भारतीय मूल के लेक्टिक एसिड बैक्टीरिया(एल.ए.बी.) के तकनीकी क्रियात्मक विशिष्टता' शीर्षक परियोजना, फरवरी से अगस्त, 2016 की अवधि के लिए चलाया गया। इस कार्यक्रम द्वारा विकसित देशों के वैज्ञानिकों(आर.टी.एफ.–डी.सी.एस.) 2016 के लिए अनुसंधान प्रशिक्षण फैलोशिप मैसर्ज गंतव्य खसबतार, सूक्ष्मजीव विज्ञान प्रयोगशाला, सामान्य एवं प्रयोगात्मक जीवविज्ञान मंगोलियन एकेडमी ऑफ साइंस(एम.ए.एस.) मंगोलिया को प्रदान किया गया।
- डेरी सूक्ष्मजीवविज्ञान प्रभाग द्वारा 8–28, नवंबर, 2016 की अवधि के लिए एच.आर.डी.––भा.कृ.अनु.प.(भारतीय कृषि अनुसंधान परिषद) द्वारा 'प्रोबायोटिक' 21 वीं शताब्दी का रोगोपचार शीर्षक पर सी.ए.एफ.टी. प्रशिक्षण प्रवर्तित किया गया।
- दक्षेस(सार्क) देशों के अधिकारियों के लिए एक छह दिवसीय अंतर्राष्ट्रीय प्रशिक्षण कार्यक्रम का 25 से 30 जुलाई, 2016 तक आयोजन किया गया।
- शैक्षणिक गतिविधियों को अधिक सहभागिता–उन्मुखी, पारदर्शी एवं उत्तरदायी बनाने के लिए आन्तरिक गुणवत्ता, आश्वासन प्रकोष्ठ एवं छात्र शिकायत निवारण प्रकोष्ठ का सृजन किया गया।
- रा.डे.अनु.सं. के पन्द्रहवें दीक्षांत समारोह का 4 मार्च, 2017 को आयोजन किया गया। डा. संजय राजाराम, पूर्व निदेशक, गेहूँ कार्यक्रम सी.आई.एम.एम.वाई.टी. एवं विश्व खाद्य पुरस्कार विजेता इस समारोह के मुख्य अतिथि एवं प्रोफेसर (डा.) ए. के. श्रीवास्तव, सदस्य कृषि वैज्ञानिक चयन मंडल, नई दिल्ली ने दीक्षांत समारोह की अध्यक्षता की थी।

प्रसार कार्यकलाप

- मुजफ्फरनगर जिले(उत्तरप्रदेश) के 100 गॉवों के 100 स्थानीय स्त्रोत व्यक्तियों(एल.आर.पी.) को राशन संतुलन कार्यक्रम के बारे में प्रशिक्षित किया गया। परियोजना के अन्तर्गत लगभग 4000 पशुओं को लिया गया तथा चयनित एल.आर.पी. द्वारा किसानों को राशन संतुलन पर 7600 से भी अधिक परामर्श दिए गए। कुल मिलाकर पशुधन उत्पादकता में वृद्धि तथा स्वास्थ्य पर इस कार्यक्रम से कई डेरी कृषकों को इससे लाभ हुआ।

- व्यवसाय नियोजन एवं विकास यूनिट तथा कृषि–व्यवसाय कार्यक्रम के उद्यमिता विकास कार्यक्रमों के अन्तर्गत दुग्ध उत्पादकों एवं कृषकों के लाभ के लिए विभिन्न अवधियों के लिए कई प्रशिक्षण कार्यक्रम आयोजित किये गए। संस्थान में विकसित प्रौद्योगिकियों के लिए उन्होंने स्टेकहोल्डरों के साथ फर्म लिंक स्थापित किए।
- इस अवधि (2016–17) के दौरान चौदह प्रौद्योगिकियॉ विकसित की गई तथा नौ प्रौद्योगिकियॉ डेरी उद्योग को हस्तांतरित की गईं। इसके अतिरिक्त चौदह प्रौद्योगिकियों का मूल्य निर्धारित किया जा चुका है जोकि डेरी स्टॉक होल्डरों को व्यवसायीकरण के लिए तैयार हैं।
- वर्ष 2016–17 के दौरान तीन पेटेंट प्रदान किए गए, दस पेटेंटों के लिए आवेदनों की जॉच की गई तथा दो पेटेंट फाइल किए गए।
- क्षेत्रीय परिस्थितियों के अन्तर्गत करन फ्रीज सांडों का वीर्य प्रयोग करके कुल 3713 पशुओं का कृत्रिम गर्भाधान किया गया, जिसके परिणामस्वरूप 50.46 प्रतिशत गर्भस्थापन दर प्राप्त की गई। क्षेत्र में 143 बछड़ियों का परीक्षण दिवस दुग्ध उत्पादन रिकॉर्ड किया गया।
- क्षेत्रीय परिस्थितियों के अन्तर्गत मुर्राह सांडों के वीर्य का प्रयोग करके कुल 3916 पशुओं का कृत्रिम गर्भाधान किया गया। क्षेत्र में 138 बछड़ियों का परीक्षण दिवस दुग्ध उत्पादन रिकॉर्ड किया गया। मुर्राह प्रजनन सांडों के आनुवांशिक मूल्यांकन के लिए क्षेत्रीय परिस्थितियों के अन्तर्गत बछड़ियों के रिकॉर्ड का प्रयोग किया जा सकता है।
- पशु प्रजनन अनुसंधान केन्द्र ने सभी प्रजनित सांडों की जीवाणुओं, वायरल तथा प्रोटोजोआ से फलने वाले यौन रोगों जैसे टी.बी., जे.डी. ब्यूरोलोसिस, आई.बी.आर., कैंपीलोबैक्टीरियोसिस तथा ट्राइकोमोनोसिस की जॉच की।
- सन्तति परीक्षण कार्यक्रम के 17 वें सैट के लिए भैंस सुधार पर नेटवर्क परियोजना के अन्तर्गत चार मुर्राह प्रजनन सांडों का चयन किया गया तथा साहीवाल गोपशुओं का आनुवांशिक सुधार पर ए.आई.सी.आर.पी. के अन्तर्गत 10 साहीवाल सांडों का चयन किया गया।
- वर्ष 2016–17 के दौरान विभिन्न पार्टिसिपेटरी केन्द्रों पर वितरण के लिए करनफ्रीज सांडों के सन्तति परीक्षण के अन्तर्गत सोलह करन फ्रीज संकर सांडों तथा 'साहीवाल गोपशुओं के आनुवांशिक सुधार' पर ए.आई.सी. आर.पी. के अन्तर्गत 17 साहीवाल सांडों तथा ''भैंस सुधार पर नेटवर्क परियोजना' के अन्तर्गत आठ मुर्राह सांडों का प्रशीतित वीर्य परिरक्षित किया गया।
- कुल्वाहेरी, बूढ़ाखेरा, दीपो, डुग्रो एवं धमनहेरी गाँवों में 33 बाँझपन और पशु चिकित्सा सहायता शिविर आयोजित किए गए। कुल 741 पशुओं का विभिन्न प्रजनन विकारों एवं पशुओं की अन्य बीमारियों का इलाज किया गया।
- गोद लिए गए गाँवों में संस्थान द्वारा विकसित प्रौद्योगिकियों के हस्तांतरण के लिए डेरी कृषकों एवं खेतीहर महिलाओं के लिए 31 किसान संगोष्ठियाँ आयोजित की गईं।
- रा.डे.अनु.सं. के कृषि विज्ञान केन्द्र ने 6034 किसानों और खेतिहर महिलाओं, ग्रामीण युवाओं एवं उद्यमियों के लाभ के लिए गृह विज्ञान के साथ–साथ डेयरी एवं कृषि संबद्ध क्षेत्रों जैसे फसल उत्पादल, बागवानी, मधुमक्खी–पालन एवं मत्स्य पालन 177 कैंप के भीतर एवं बाहर प्रशिक्षण कार्यक्रमों का आयोजन किया।
- रा.डे.अनु.सं. के कृषि प्रौद्योगिकी सूचना केन्द्र(ऐटिक) ने विभिन्न राज्यों के 5120 व्यक्तियों को वीडियो शो, व्याख्यानों, व्यक्तिगत चर्चाओं आदि के माध्यम से 4152 सेवाएं प्रदान की हैं।

आधारभूत संरचना

- पशुधन अनुसंधान केन्द्र, रा.डे.अनु.सं. में करन फ्रीज गोपशुओं तथा मुर्राह भैंसों के लिए 'बुल मदर फॉर्म' की संस्थापना की गई।
- गोपशुओं तथा भैंसों के लिए डी.एन.ए. बैंक का सुदृढ़ीकरण किया गया।
- गोपशुओं एवं भैंसों के वंशावली एवं प्रदर्शन रिकॉर्डों का डिजिटलीकरण प्रारंभ किया गया।
- पशु आनुवांशिकी एवं प्रजनन प्रभाग के विभागीय पुस्तकालय तथा पशुधन रिकॉर्ड कक्ष का नवीकरण।
- डेरी प्रौद्योगिकी प्रभाग की परम्परागत डेरी उत्पाद प्रयोगशाला का नवीकरण।
- पूर्वस्नातक एवं स्नातकोत्तर कक्षाओं की मरम्मत का कार्य किया गया।
- पीपराकोठी, मोतीहारी(बिहार) में संस्थापित कृषि एवं डेरी विकास केन्द्र के तत्वावधान में एक डेरी प्रसंस्करण केन्द्र संस्थापित किया गया। यह केन्द्र डेरी कृषकों को पिछड़े एवं उन्नत इंटीग्रेशन के साथ डेरी प्रसंस्करण पर गहन प्रशिक्षण प्रदान करके किसानों के हित के लिए काम करता है।

- एक पूर्ण रूप से क्रियाशील कंप्यूटर एडिड डिजाइनिंग(सी.ए.डी.) प्रयोगशाला विकसित की गई जिसमें चार आई 7 कंप्यूटरों, हाई एंड कलर प्लाटर, ऑटोकैड 2017, अकैडमिक लाइसेंस, नैनोकार्ड अकैडमिक लाइसेंस की सुविधाएं उपलब्ध थीं।
- छात्राओं के कृष्णा विंग छात्रावास का निर्माण कार्य पूर्ण होने के अंतिम चरण में है।
- डीप बैड तथा फरो प्रणाली द्वारा एनीमल फ्रेंडली ट्री सेंपलिंग के विकास तथा चारा उत्पादन के लिए उपयोगाधीन मर्शी लैंड के उपयोग के लिए कदम उठाए गए हैं।
- भा.कृ.अनु.प.–रा.डे.अनु.सं. करनाल पर 33 कूड़ादान का निर्माण
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल में पशुधन अनुसंधान केन्द्र के भैंसों के शैड का नवीकरण।
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल में रेफरीजरेटर तथा उपकरण प्रयोगशाला के लिए केन्द्रीय विभागीय सुविधा तथा डेरी पोशण के लिए राशन संतुलन प्रयोगशाला के विद्युत कार्य का नवीकरण।
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल में मौजूदा एचएसआर को कनैक्शन देने के लिए सहिल परिसर में पीने के पानी की आपूर्ति के लिए फ्री बोर्ड + 6.20 लाख लीटर क्षमता वाला भूमिगत संग्रहण टैंक का निर्माण कार्य किया गया।
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल के पशु जैव प्रौद्योगिकी केन्द्र के भवन के कॉरीडोर में फर्श की रगड़ाई एवं सफेदी का कार्य।
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल के सतलुज छात्रावास में वाशरूमों की मरम्मत कार्य एवं सुदृढ़ीकरण।
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल के कृत्रिम प्रजनन अनुसंधान केन्द्र, मुख्य भवन के स्नातकोत्तर प्रयोगशाला वीर्य गुणवत्ता नियंत्रण प्रयोगशाला, वीर्य प्रसंस्करण प्रयोगशाला, वीर्य संग्रहण प्रयोगशाला एवं शोचालयों का नवीकरण।
- भा.कृ.अनु.प.–रा.डे.अनु.सं., करनाल में पी.पी.डी. भवन के शीत भंडारगृह (कोल्ड स्टोरेज) तथा डिस्पैच डॉक को ढ़कने के लिए शैड प्रदान किए गए।
- डेरी सूक्ष्मजीवविज्ञान प्रभाग की पूर्वस्नातक प्रयोगशाला का नवीकरण।
- ब्रहमपुत्र छात्रावास का नवीकरण।
- डेरी रसायन प्रभाग में प्रोटीन प्रयोगशाला का नवीकरण।
- मान्य विश्वविद्यालय के परीक्षाकक्ष की आधारशिला रखी गई।
- लड़कों तथा लड़कियों के छात्रावासों की चारदीवारी की मरम्मत।
- दक्षिणी क्षेत्रीय परिसर, बंगलुरू में उत्पाद अनुभाग में अभियांत्रिकी अनुभाग तथा प्रोटिऑमिक्स प्रयोगशाला में नई प्रयोगशाला का विकास।
- इन्टरनेट कनैक्शन तथा नैटवर्किंग स्थापित करने एवं फायरवाल सॉफ्टवेयर(साइब्रोम) के लिए बी.एस.एन.एल. ऑप्टीकल फाइबर केबल(ओ.एफ.सी.) डालना।
- आधार कार्ड आधारित बायोमीट्रिक उपस्थिति प्रणाली स्थापित की गई एवं उनका प्रयोग किया जा रहा है।
- संचार एवं सूचना प्रौद्योगिकी मंत्रालय का राष्ट्र ज्ञान नेटवर्क(एन.के.एन.) दक्षिण परिसर, बंगलुरू में सफलतापूर्वक संस्थापित किया गया।
- राजस्व अर्जित करने के स्त्रोत के रूप में वर्मी कम्पोस्टिंग द्वारा डेरी गोपशुओं तथा कृषि के अपशिष्ट प्रबंधनद क्षिणी परिसर, बंगलुरू में प्रारंभ किया गया।
- दक्षिण क्षेत्रीय परिसर, बंगलुरू में एक प्रदर्शन यूनिट के रूप में चारा संग्रहालय प्रारंभ किया गया।
- राष्ट्रीय डेरी अनुसंधान संस्थान के कृत्रिम प्रजनन अनुसंधान केन्द्र में एक सुसज्जित वीर्य प्रसंस्करण प्रयोगशाला स्थापित की गई।
- राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र, कल्याणी (प.ब.) में एक अतिरिक्त कृषि विज्ञान केन्द्र की स्थापना की गई।

INTRODUCTION



ICAR-National Dairy Research Institute (NDRI) at Karnal, Haryana is one of the premier Institutes in dairy sector which has contributed a lot in the growth of 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 Bengaluru in 1923 as a center for dairy education. In 1955, it was shifted to its present site in Karnal 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. In 1970, NDRI was brought under Indian Council of Agricultural Research. Since, 1989, the Institute has the distinction of being a Deemed University for implementing its academic programmes.

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 dairy industry and upliftment of dairy profession leading to socio-economic and environmental benefits to the nation as well as contribute 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. It is a place of study in the heart of a charming landscape with lots of greenery. Modern laboratories are available for education and research. 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 Campus 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 and also research in different fields of dairy production and processing in India.

Eastern Campus, Kalyani

The Eastern Campus of the Institute was established at the Central Dairy in Kolkata in 1964 and was shifted to Kalyani, Nadia district, during 1966, about 50 km north of Kolkata. The main objective of establishing the Eastern Campus 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 trials for perfection.

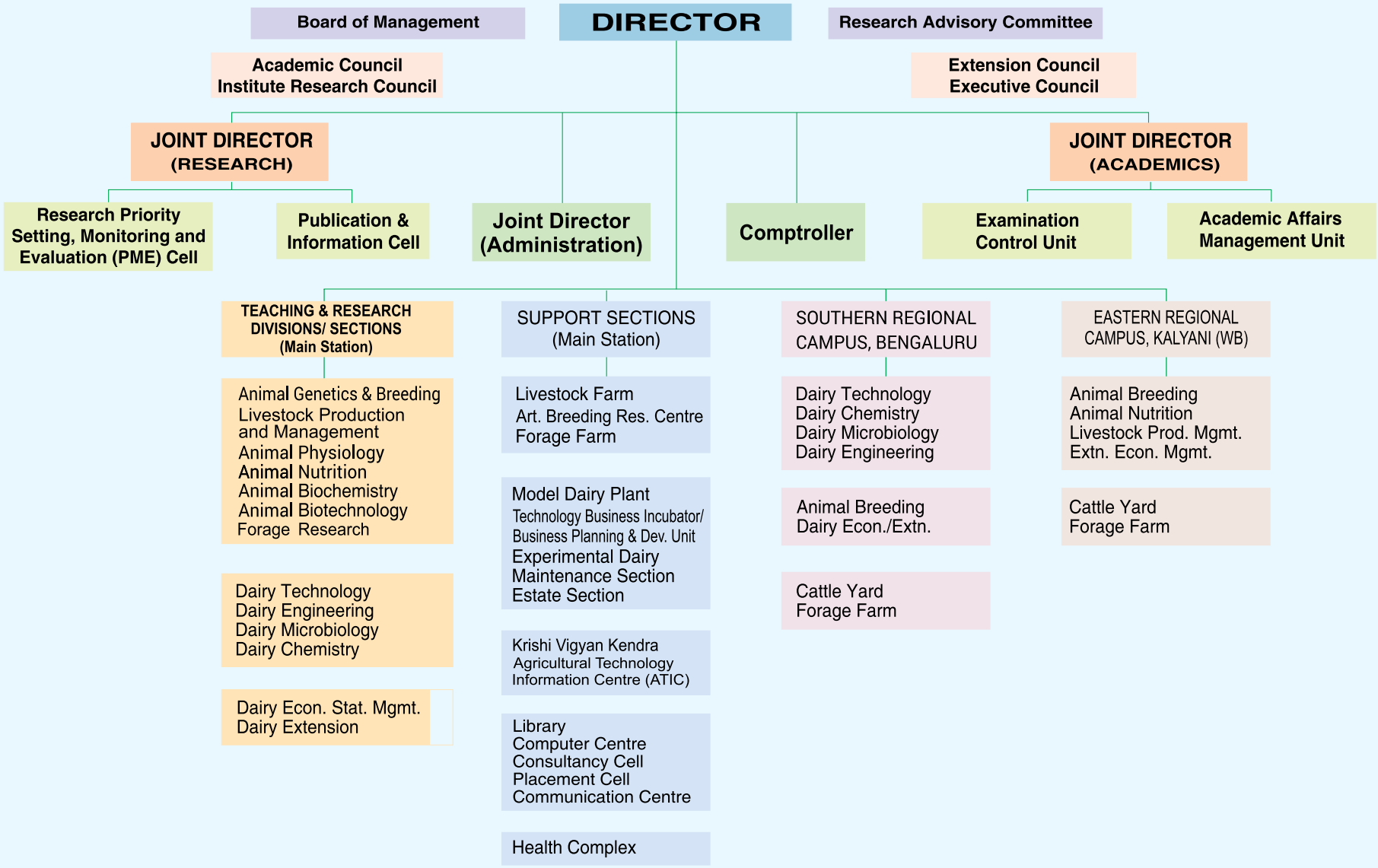
Krishi and Dairy Vikas Kendra, Piprakothi - Motihari

ICAR-NDRI established Krishi and Dairy Vikas Kendra (KDVK) at KVK, Piprakothi, East Charparan (Bihar) in the premises of Krishi Vigyan Kendra 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 Ji on 10th July, 2016.

Model Dairy Centre, Lalukheri - Muzzafarnagar

It 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 organisational 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. The Director NDRI, is the Chairman of this Board. The Research Advisory Committee is responsible for all round progress of 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.

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 areas 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 station is conducted through 16 subject-matter disciplines.

Board of Management

Chairman	**Director, NDRI**
Member	**Joint Director (Research),** NDRI
Member	**Joint Director (Academic),** NDRI
Members (Head of Divisions/ Principal Scientists nominated by President of ICAR)	**Dr. M. S. Chauhan,** Director CIRG, Makhdoom
	Dr. A. K. Puniya, Dean GADVASU, Ludhiana
	Dr. C. S. Prasad, Former Director NIANP, Bengaluru
	Dr. Indrajit Singh, Director CIRB, Hisar
	Dr. R. K. Pundir, Principal Scientist NBAGR, Karnal
	Dr. Ranbir Singh, Principal Scientist, IVRI, Izatnagar

Members Two Members of Governing Body Nominated by the President, ICAR)	**Dr. A. K. Singh,** Vice Chancellor Raj Mata Vijayaraje Scindia, Krishi Vishwsavidyalaya, Gwalior **Dr. Arvind Kumar,** Vice Chancellor, Rani Lakshmi Bai CAU, Jhansi **Dr. Ashok Kumar,** ADG (AH) ICAR, New Delhi
Member (VC of Agricultural University Nominated by the President, ICAR)	To be nominated
Member (Nominee of the DG, ICAR)	**DDG (AS), ICAR**
Member (Director IVRI/IARI)	**Director, IVRI, Izatnagar**
Member (Jt. Director, Ext. Edu.)	**Head, Extension Division**
Member (Animal Husbandry Commissioner, Deptt. of Animal Husbandry & Dairying Ministry of Agriculture)	**Dr. Suresh S. Honnappagol** Animal Husbandry Commissioner, DAHD&F, Ministry of Agriculture, Govt. of India,Krishi Bhawan, New Delhi
Member (One Eminent Scientist in the Field of Research done in Institute but not employed by ICAR, Nominated by President, ICAR)	**Prof Dr. Veer Singh** Head, Dept. of Veterinary Parasitology, COVSc. & AH, SDAU, Sardar Krushinagar, Gujarat
Member (One Eminent Agril. Educationist Concerned with the Research work of the Institute but not employed by ICAR, Nominated by President, ICAR)	**Prof Dr. Ram Swarup** Department of Veterinary Pathology, COVSc., Govind Valabh Pant Agricultural Vishwavidyalaya, Pantnagar
Member (Non Official Persons Representing Agriculture Interest to be Nominated by President, ICAR)	**Sh. Jagdish Singh** Village-Arainpura, Tehsil-Gharonda., District-Karnal **Sh. Dharmveer, Mirzapur** Village-Mirzapur, P.O.- Gurukul District-Kurukshetra
Member (FA, ICAR or his Nominee)	Director (F) DARE
Member (Commissioner, Rohtak Division, Rohtak)	**Commissioner,** Rohtak Division, Rohtak
Member Secretary	**Sh. Susanta Saha** Joint Director (Admn. & Registrar)

Academic Council

Chairman	**Director, NDRI, Karnal**
Vice-Chairman	**Dr. R. R. B. Singh**, **Joint Director (Academic), NDRI, Karnal**
Member	**Joint Director (Research), NDRI, Karnal**
Members (Five Eminent Scientists from outside the NDRI)	**Dr. Kusumakar Sharma** Ex-Asstt.Director General, ICAR
	Dr. J. B. Prajapati, Dean, College of Dairy Science, AAU, Anand-388001 (Guj)
	Dr. Pankaj Sood, Professor & Head Animal Reproduction Gynaecology & Obstetrics College of Vety. Science, HPKVV, Palampur (HP)
	Dr. N. S. Sharma Professor & Controller of Examinations, Guru Angad Dev University of Animal Sciences, Ludhiana (Panjab),
	Dr. P. S. Pandey, ADG (EP &HS) KAB-II, Pusa, New Delhi-110012
Member (DDG Education or his nominee)	DDG (Edn.), ICAR KAB-II, New Delhi
Members (One Senior Scientist from each Division)	**Dr. Bimlesh Mann,** Head, DC Division **Dr. Latha Sabikhi,** Head, DT Division **Dr. Sunita Grover,** Head, DM Division **Dr. A. K. Singh,** Head, DE Division **Dr. Dheer Singh,** Head, ABC Division **Dr. A. K. Tyagi,** Head, AN Division **Dr. Mahendra Singh,** Head, AP Division **Dr. A. K. Chakraavarty,** Head, AG & B Divn. **Dr. Smita Sirohi,** Head, DES & M Division **Dr. K.S. Kadian,** Head, Dairy Extn. Division **Dr. Pawan Singh,** I/c LPM **Dr. Magan Singh,** I/c FRMC, NDRI, Karnal **Dr. P. Palta,** I/c ABTC, NDRI, Karnal **Dr. S. K. Tomar,** Academic Coordinator **Dr. T. K. Datta,** PS, ABTC **Dr. A. Kumaresan,** Sr. Scientist, ARGO **Dr. Sumit Arora,** PS, DC Division & Controller of Examinations **Dr. K. P. Ramesha,** Head, SRS, Bengaluru **Dr. T. K. Datta,** Head, ERS, Kalyani
Students Member	**Ms. Indu Devi,** Ph.D. 2nd Year LPM
	Ms. Mitasha Mehta, 2nd Yr DC Topper M.Sc. student
Member Secretary	**Joint Director Admn. & Registrar,** NDRI Deemed University

Research Advisory Committee

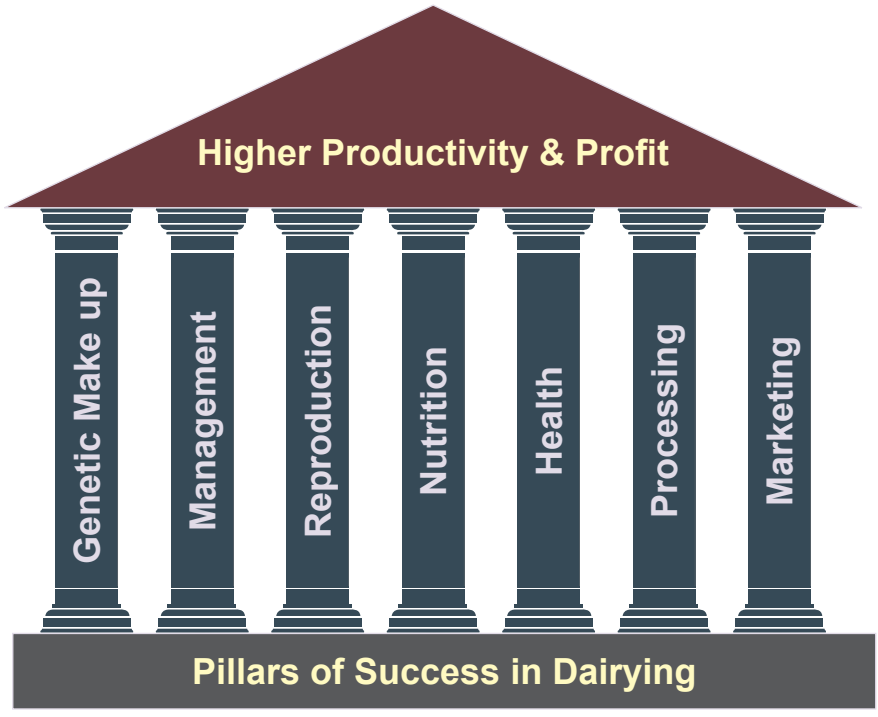
Chairman (An Eminent Scientist from outside ICAR system, nominated by DG, ICAR	**Dr. M. L. Madan,** Ex-DDG (AS), ICAR
Member	**Deputy Director General (AS),** ICAR, New Delhi
Member	**Director, NDRI, Karnal**
Member	**Dr. P. S. Birthal,** Director, Institute of Development Studies, Jaipur
Member	**Dr. O. P. Dhanda,** Ex-ADG (AN&P), ICAR
Member	**Dr. Kamlesh R. Trivedi,** Advisor, NDDB, Anand
Member	**Dr. F. A. Masoodi,** Prof. Department of Food Science & Technology, University of Kashmir, Hazratbal, Srinagar
Member	**Dr. Satish Kulkarni,** Former Head, SRS, Bengaluru
Member	**Sh. Jagdish Rana,** Village-Arainpura, Tehsil-Gharonda, District-Karnal
Member Secretary	**Joint Director (Res.)**

Extension Council

Chairman	**Director, NDRI, Karnal**
Members	**Dr. R. R. B. Singh,** Joint Director (Academic)
	Dr. Bimlesh Mann, Acting Joint Director (Res.)
	DDG (Extn. Education), ICAR, New Delhi or nominee
	Dr. S. S. Lathwal, I/c, LRC
	Dr. S. K. Tomer, PS, DM
	Dr. B. S. Chandel, PS, DES&M
	Dr. Ashutosh, I/c, Forage Production Section
	Dr. T. K. Mohanty, PS & I/c, ABRC
	Dr. P. S. Oberoi, PS & I/c, ATIC
	Dr. A. K. Tyagi, Head, AN
	Dr. A. K. Singh, PS & I/c, BPD Unit, DT **Head, ERS** of NDRI, Kalyani **Agriculture Commissioner**, Govt. of India, Ministry of Agriculture, Department of Agriculture & Cooperation, Krishi Bhawan, New Delhi
	Director General, Department of Animal Husbandry & Dairying, Govt. of Haryana Pashudhan Bhawan, Sector- 2, Panchkula
	Director (Farm Information) Directorate of Extension, Govt. of India, New Delhi
Member Secretary	**Dr. K. S. Kadian,** Head, Dairy Extension Division

RESEARCH ACHIEVEMENTS

- BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY
- GENETIC IMPROVEMENT OF DAIRY ANIMALS
- ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS
- FEED, FODDER AND PRODUCTIVITY
- INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS
- NOVEL APPROACHES IN VALUE ADDITION AND PROCESS ENGINEERING
- DEVELOPMENT AND VALIDATION OF HEALTH PROMOTING DAIRY FOODS
- MILK PROTEINS DERIVED BIOACTIVE PEPTIDES
- RISK ASSESSMENT : CONTAMINANTS IN DAIRY FOODS
- NEW GENERATION METHODS TO ASSESS QUALITY AND SAFETY OF MILK AND MILK PRODUCTS
- DAIRY DEVELOPMENT : POLICY ANALYSIS, STRENGTHENING DATABASE AND IMPACT ASSESSMENT
- EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING
- ICT TOOLS AND SOFT COMPUTING APPLICATIONS IN DAIRYING



BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY

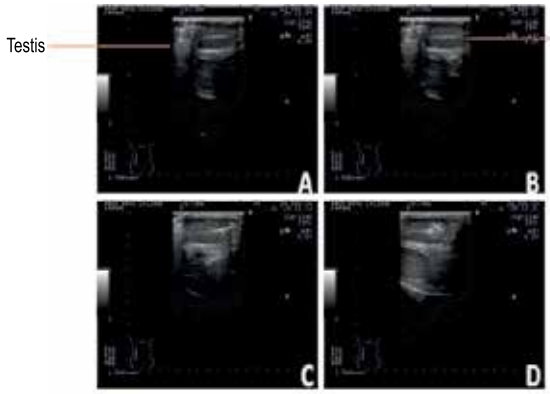
Global Transcriptome and miRNA Profiles of Cloned Buffalo Embryos

The live birth rate with cloned embryos is <2% in several species including buffalo. It is necessary to increase it substantially to enable wide application of cloning technology. Global transcriptome and miRNA profiling was carried out by Illumina-based Next Generation Sequencing (NGS) in buffalo blastocyst-stage embryos produced by cloning and IVF techniques to identify the shortcomings with cloned embryos. It was found that the global transcriptome profile of cloned blastocysts was very different from that of their IVF counterparts. Many genes affecting pluripotency, trophectoderm development and epigenetic modifications were up-regulated in cloned embryos than in IVF ones. WNT pathway expression was high in cloned embryos and might be one of the possible reasons for low cloning efficiency. *RPS15, HPRT1* and *GAPDH* was found to be the best suitable combination of internal control genes for qPCR data analysis of cloned and IVF blastocysts.

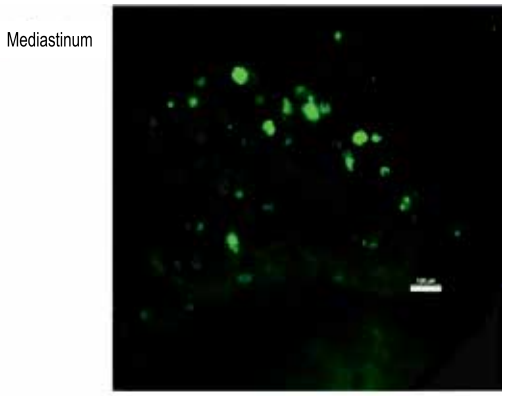
The miRNA expression profiles of IVF and cloned buffalo blastocysts were also found to be quite different from each other. The expression of four genes, *DROSHA*, *DGCR8*, *DICER* and *AGO2* involved in miRNA biogenesis was also found to be up-regulated in cloned, relative to IVF blastocysts suggesting that the biogenesis of miRNAs may also be altered in cloned embryos. Gene Ontology results of the NGS data showed that 47 categories under Biological processes, 28 under Cellular components and 22 under Molecular functions were enriched. For pathway analysis study, target genes of the differentially expressed miRNAs were predicted using TargetScan and these targets were investigated for their involvement in different pathways using KEGG database. Eight pathways that were affected the most (based on their role in preimplantation development) were cell cycle, apoptosis, signaling pathways regulating pluripotency of stem cells, MAPK signaling pathway, Notch signaling pathway, WNT signaling pathway, TGF-β signaling pathway, and JAK-STAT signaling pathway. The results showed that there is a dysregulation of miRNAs in cloned blastocysts compared to IVF blastocysts, which may be responsible for the abnormalities in cloned embryos. The information generated in the present study can be used to lay a foundation for miRNA-therapy in cloned embryos to improve their quality and hence the success rate in terms of live births.

Transgenic Buffalo Spermatogonial Stem Cells (SSCs) Produced and Used for Homologous Transplantation

SSCs are unipotent adult stem cells of the testis, which are responsible for the maintenance of the spermatogenesis throughout the entire life of the male. SSC research offers various



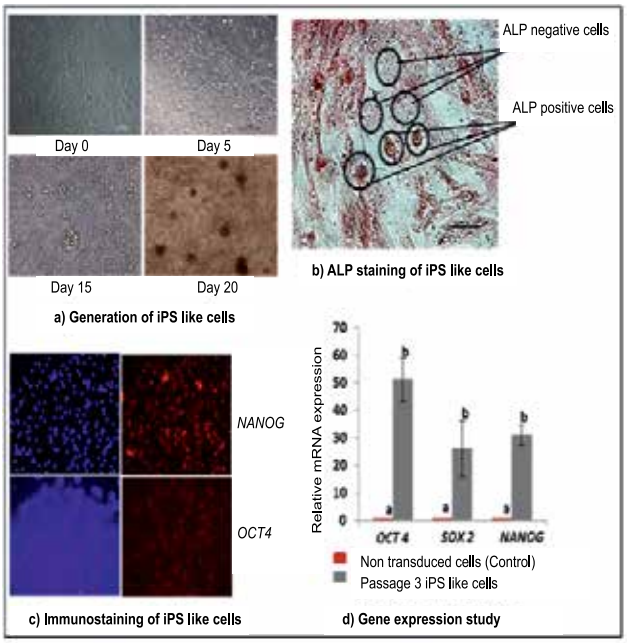
Ultrasound-guided SSC transplantation



Detection of transgenic donor SSCs in seminiferous tubules after 45 days

applications including infertility treatment, contraception, generation of transgenic animals, *in vitro* spermatogenesis and preservation of fertility of oncological patients. SSC transplantation is a technique which involves isolation of SSCs from a fertile donor and their transplantation into the seminiferous tubules of infertile recipients, resulting in restoration of fertility and donor SSCs derived spermatogenesis. Transgenic buffalo SSCs were produced and used for homologous transplantation. This was the first successful homologous transplantation of transgenic SSCs in any farm animal species in India. This technique may play a crucial role for infertility treatment in crossbred bulls and as an alternative method for production of transgenic animals with high efficiency, less time and capital requirement.

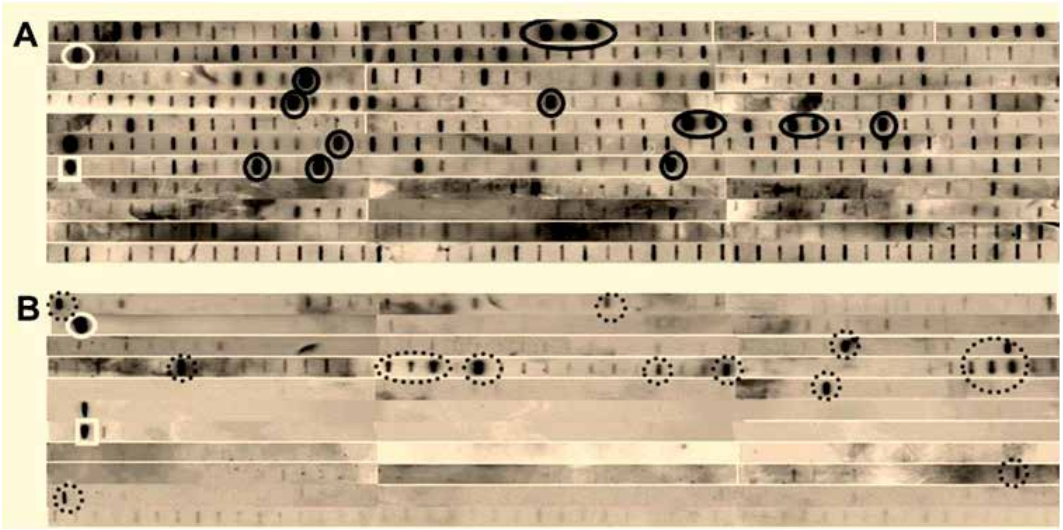
Buffalo Embryonic Stem (ES) Cells Directed to Differentiate to Mammary Lineage Cells



Mammary lineage epithelial cells are the main indicates of milk production and defense against intra-mammary infections. ES cells, having potential to be differentiated into any cell line, could be used for obtaining such compatible cells that could produce milk and replace the damaged cells. Two approaches were attempted for the directed differentiation of buffalo ES cells to mammary lineage cells. In the first approach, ES were cultured in nutrient medium supplemented with all-trans retinoic acid whereas, in the second approach, ES cells were transfected with pIRES2-AcGFP1 expression vector with integrated *WNT10B* gene. Cells of mammary lineage could be successfully produced using both the approaches. These compatible cells if transplanted into mammary gland could replace the damaged cells by their self renewal property and if transfected with the gene, whose enzymatic product destroys the mastitis causing bacteria, could reduce or diminish the infection resulting into prolonged lactation period.

Novel Genes Discovered in Buffalo Oocytes with Potential Development Control Ability

The composition and dynamics of the oocyte-expressed genes ultimately define their future fertilizing ability. Construction of a buffalo oocyte-specific subtracted cDNA library has raised fresh challenge to define the importance of a battery of oocyte-expressed transcripts whose identity

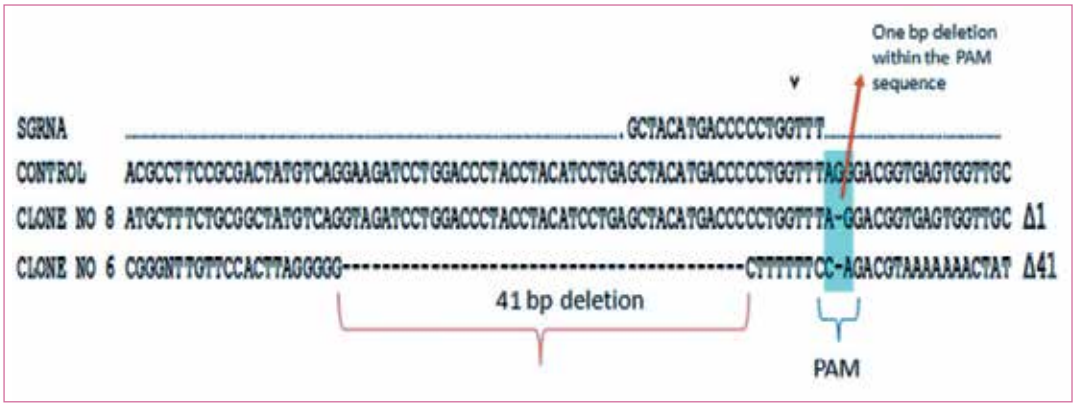


Genes isolated from buffalo oocytes were confirmed for their expression in oocytes (A) vis-à-vis other tissues (B). The genes in circle are expressed exclusively in oocytes and not in any somatic tissues.

and function are still unknown. These hitherto unknown oocyte transcripts were characterized and their expression dynamics was assessed in buffalo oocytes of different development competence. In addition, their protein binding characteristics were explored to delineate their possible mechanism of function. Six transcripts were selected from the buffalo oocyte EST library based on their exclusive oocyte presence and subjected to 5' and 3' RACE for generating full length sequences. Constructed full length sequences were validated by amplifying them in oocytes and their genomic locations were analyzed across the species. Further, these sequences were analyzed for their coding potential and possible role using coding potential calculator and miRNA database. Evidences were generated to establish their significantly different expression trajectory in 'good' vs. 'poor' oocytes. Four of these studied sequences were found to be long inter-genic non-coding RNAs and two of them could be acting as potential miRNA precursors, revealing their protein binding ability as assessed by RNA electrophoretic mobility shift assay. Findings generated very novel information on the existence of valid long inter-genic non-coding RNAs in the buffalo oocytes with their possible role in imparting development ability of buffalo oocytes.

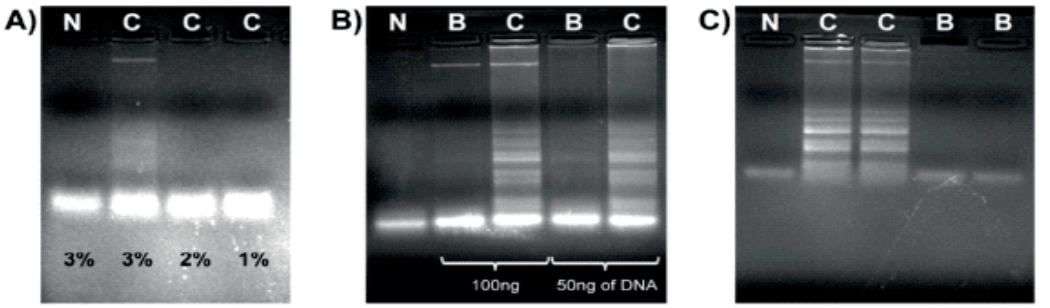
Genomic Deletion of Rig-1 Gene in Goat Primary Cell Culture System Using CRISPR/Cas Genome Editing Tool

The CRISPR/Cas9 system has recently emerged as a powerful tool for functional genomics studies in mammals. A precise CRISPR/cas9-based genome editing tools was successfully used to knock down one innate immune gene in goat fibroblast cells. Goat *rig-I* (retinoic acid-inducible gene-1) gene was taken as a model gene to study the efficiency of CRISPR/*Cas9* system-induced gene deletion in primary goat fibroblast cell. *Rig-I* gene is involved in sensing of intracellular viral RNA and thereafter, generation of innate immune response. A suitable plasmid expression vector containing sgRNA (single guide RNA) and cas9 gene (the enzyme for the gene deletion) was transfected to goat cells for deletion of first exon of *rig1* gene. The gene deletion was achieved by NHEJ (non-homologous end joining)- based gene inactivation pathway. The sequence analysis showed that two clones out of 30 were found to be positive for deletion in RIG-I (Exon-I) gene. This CRISPR/Cas9 based gene deletion could be applied precisely to inactivate the function of any deleterious gene in mammalian cell culture system.



Loop-mediated Isothermal Amplification (LAMP)-Based Identification of Cattle DNA

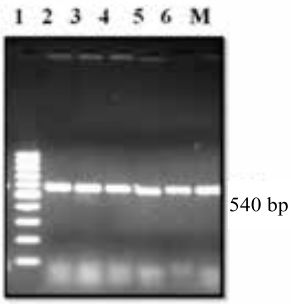
LAMP, a novel promising technique, could be used for amplification of DNA at a constant temperature (isothermal) by using a single enzyme, without the requirement of a thermal cycling apparatus (PCR machine). A LAMP reaction was optimised for the detection of cattle-specific DNA in the presence or absence of buffalo DNA. Six different specific types of LAMP primers were designed using bovine mitochondrial DNA sequence obtained from GenBank database. The reaction was performed at uniform temperature of 63°C for 1h with the help of Bst DNA polymerase enzyme. The specificity of LAMP assay was checked by using cattle-specific primers and taking into account the DNA samples from different but related species such as buffalo, cattle, pig and goat. The optimized reaction conditions including additives (glycerol) could selectively amplify the cattle DNA without any non-specific amplification from buffalo, pig and goat DNA samples. LAMP has the potential to be used as a simple DNA-based screening assay in the field or at the point of care by clinicians. It may be a particularly useful method for infectious disease diagnosis in low and middle income countries.



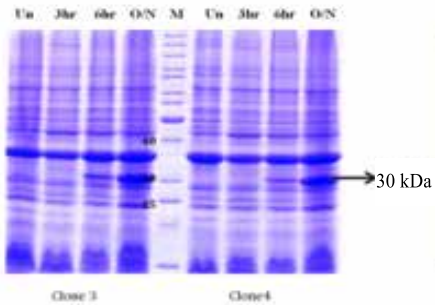
Agarose (2%) gel electrophoresis of LAMP product. (a) Different concentrations of glycerol were used and 3% glycerol gave good amount of amplification. (b) Reaction condition set up at 3% glycerol, 2nd and 3rd lane DNA amount 100 ng. 4th and 5th lane DNA amount 50 ng.(c) Reactions performed after optimization of LAMP assay protocol.

Recombinant Buffalo Leukemia Inhibitory Factor (BuLIF) Produced in Bacterial Host

LIF is a cytokine essentially required in the production of stem cells since it plays a pivotal role in the maintenance of pluripotency. Bovine stem cell research is currently dependent on using murine recombinant LIF. BuLIF was produced in *E. coli* host to explore the possibility of substituting murine LIF with buffalo LIF. It was purified to homogeneity using tandem chromatographic procedures and its applicability tests are underway. Three vectors were used to clone BuLIF, namely pJET1.2 (cloning vector) pET22b, pMALc2x, pGEX6P1 (expression vectors). These vectors were transformed and grown in different host including (TOP10, BL21, and Lemo cells). The confirmation of rBuLIF protein on SDS-PAGE was followed by western Blot against his tag in BuLIF with secondary HRP conjugated antibody. Subsequently, purification strategies were optimized with different chromatographic techniques. The purified protein was >95% pure after affinity chromatography in tandem to ion exchange chromatography. The purity and homogeneity was further confirmed by Western Blot and protein sequence was determed by mass spectrometry.



Recombinant clones of pET22b_BuLIF confirmed by PCR



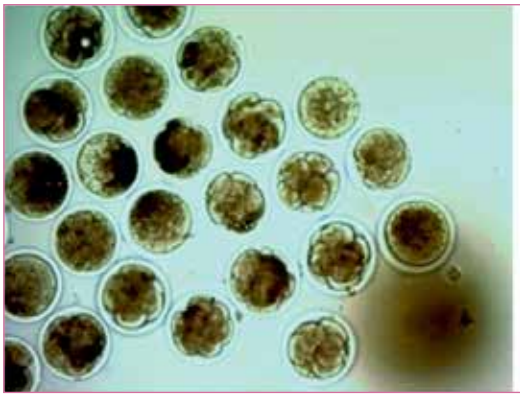
Expression of rBuLIF at 37C under lmM IPTG. The recombinant rBuLIF visible as intense band at 30 kDa region.

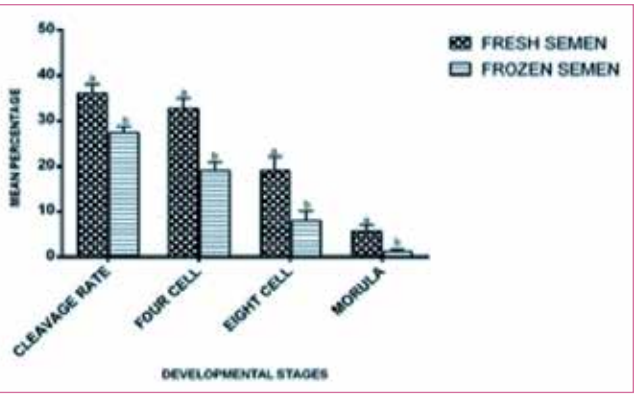
Purification of rBuLIF by affinity and ion exchange chromatography.

Western Blot image showing purified rBuLIF with anti-his antibody.

In Vitro Development of Caprine Embryo using Cryopreserved Black Bengal Buck Semen

The present study was conducted to check the competence of cryopreserved black Bengal buck semen to produce goat embryo through *in vitro* fertilization technique. Cumulus oocyte complexes were collected from slaughterhouse ovaries, washed 5-6 times and cultured in maturation media for 27 h. in 5% CO_2 incubator at 38.5°C with maximum humidity. Cryopreserved semen straws were thawed and sperms were capacitated *in vitro*. After 27 h of culture cumulus cells were separated



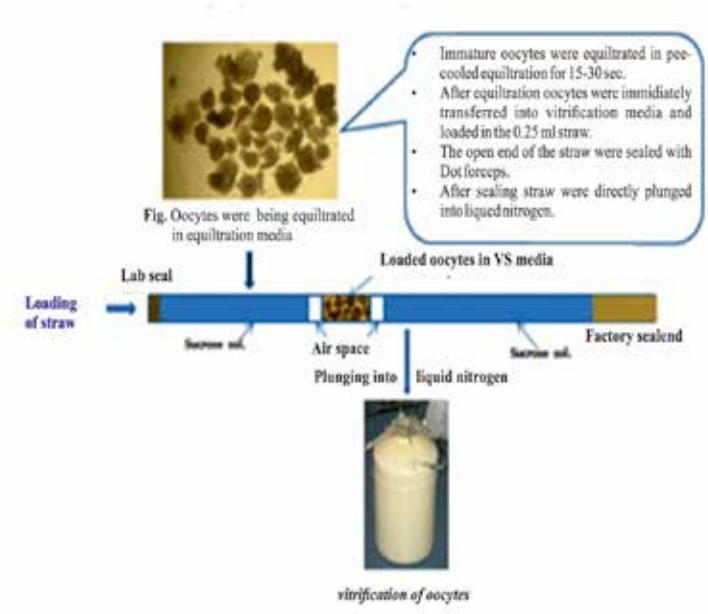


from matured oocytes. Denuded oocytes were transferred to acidified Tyrode's medium for zona thinning and were co-incubated with capacitated sperms for fertilization in Fert-BO media at 38.5°C in 5% CO_2 in air with maximum humidity. After 5 h of co-incubation, presumptive zygotes were washed and cultured in embryo development media for cleavage. After 40-42 h. embryos were co-incubated with oviductal cells in replacement media for further development.

In fresh group overall cleavage rate (%) was 36.05 ± 2.09 and morula formation (%) was 5.65 ± 1.32. However, in frozen group the overall cleavage rate (%) was 27.39 ±1.37 and morula formation (%) was 1.23 ± 0.52. These results indicate that cryopreserved black Bengal buck semen have competence to produce embryos and could be used for embryo development through *in vitro* fertilization.

Cryopreservation of Cattle Oocytes and their Post Thawing Embryo Development through *In Vitro* Techniques

Cattle ovaries were collected from Kolkata slaughterhouse in a thermo flask containing normal saline supplemented with penicillin (50 IU/ml) and streptomycin (50 µg/ml) maintaining 30-32°C. Surrounding tissues were trimmed by using sterilized surgical scissors and washed thoroughly with prewarmed normal saline. Cumulus oocyte complexes (COCs) were collected in aspiration medium (HEPES modified TCM 199 + DPBS + 0.3% BSA + 50 µg/ml Gentamycin) using sterile 19 gauge hypodermic needle from visible surface follicles 3-5 mm in diameter. COCs were washed thoroughly with prewarmed washing media and a group of 10-15 oocytes suspended in equilibration media (pre-cooled) for 1-2 min. followed by in cryopreservation/vitrification media. Three different cryopreservation media (I, II & III) were formulated for preserving immature cattle oocytes. The loaded straws were directly plunged in liquid nitrogen for preservation. For *in vitro* maturation and fertilization the cryopreserved oocytes were collected from the straw after thawing and expelled in sucrose medium. After thorough washing ooccytes were *in vitro* matured in maturation media for 24 h in 5% CO_2 incubator at 38.5°C with maximum humidity. After maturation oocytes were fertilized with *in vitro* processed sperms and presumptive embryos were cultured in embryo development media for embryo development. No. of oocytes cryopreserved in Cryopreservation Media-I (VM-I), Cryopreservation Media-II (VM-II), Cryopreservation Media-III (VM-III) are 141, 159 and 166, respectively. No. of Cleavage % in Cryopreservation Media-II (VM-II), Cryopreservation Media-III (VM-III) are 11.95% and 18.67%, respectively. Four-cell stages in Cryopreservation Media-II (VM-II), Cryopreservation Media-III (VM-III) are 8.80% and 14.46%, respectively. Eight-cell stages in Cryopreservation Media-II (VM-II), Cryopreservation Media-III (VM-III) are 7.55% and 12.65% respectively. Sixteen-cell stages in Cryopreservation Media-II (VM-II), Cryopreservation Media-III (VM-III) are 5.66% and 9.04%, respectively.



GENETIC IMPROVEMENT OF DAIRY ANIMALS

Crossbred Cattle and Bulls

In crossbred cattle improvement programme, the bull mother farm was established by maintaining 37 elite Karan Fries cows (22.98%) for nominated mating with an average 305-day milk yield as 4596 kg and average EPA as 4189 kg which were 28.81% and 20.04% higher than the herd average (3568 kg) and average EPA (3490 kg). A total of 13 males were reserved for breeding. Average dam's best lactation milk yield and EPD of males reserved for breeding was 5437 kg (5014 to 7360 kg) and 2.54 % (0.67 to 11.03 %).

The performance records on 1237 Karan Fries cows, over a period of 36 years (1979-2014) revealed that the animals which having age at first calving nearly the mean were found with better lifetime performances. The better performance of milk constituent traits was observed in winter months.

Optimum levels of various first lactation traits of Karan Fries cows were found to be 800-900 days for age at first calving, 4000-4500 kg for first lactation 305-days milk yield, 4500-5000 kg for first lactation total milk yield, 91-115 days for first service period, 300-400 days for first lactation length, 60-90 days for first dry period and 300-400 days for first calving interval.

A New THI Model ($THI_{DMKF} = 39.3 + 3 \times T_{WB} - 1.16 \times T_{DB}$) was developed for Karan Fries cattle to assess the impact of heat stress on daily milk yield. During heat stress, about 82 g, 87g and 144 g daily milk yield were found to be decreased with per unit increase in THI value in HF crossbred cattle with 50%, >50% to 62.5% and >62.5% exotic Inheritances. Average Expected Breeding Value (EBV) for daily milk yield, fat and SNF percentage and conception rate was found to be declined during heat stress.

A total of 21 adult breeding bulls are being maintained at the Institute for frozen semen production. During the year, a total of 24,259 doses of frozen semen were produced and 11,484 doses of frozen semen were supplied to the farmers and developmental agencies.

In Field Progeny testing for KF cattle a total of 3713 AI were performed under field conditions and as a result 50.46 % conception rate was obtained. Across the villages, the highest conception rate was observed in Rindal (55.38%) and lowest was observed in the Darar centre (47.25%). A total of 1336 (707 males and 629 females) calves were born in the farmers' herds. Test day milk yield of 143 daughters were recorded in the field. As many as 8 bulls of 14th Set were used for AI during the year.

Indigenous Cattle and Bulls

Improvement of Sahiwal cattle is aimed to monitor the production performance traits along with genetic improvement with progeny testing and incorporation of new germplasm and dissemination of good quality germplasm to different centers located in different agro climatic conditions.

The bull mother farm of Sahiwal breed was established and presently maintaining 42 (26.92 %) elite Sahiwal cows with average lactation milk yield and EPA was 2937 kg and 2591kg which was 33.86 and 18.31% superior to average lactation yield (2194 kg) and EPA (2190 kg) of the herd.

Six Male calves were selected as young future breeding bulls. Dam's best lactation milk yield and EPD of males reserved for breeding was varied from 3004 to 3831 kg and 6.18 to 10.58 % above herd average. The test and nominated mating of third set of 10 Sahiwal bulls is continuing since 2016.

A total of 34 Sahiwal breeding bulls are being maintained at the Institute. During the year, a total number of 31,771 doses of semen were frozen and out of that 15,307 doses of frozen semen

were supplied to the farmers and developmental agencies. About 5675 doses of frozen semen were also supplied to DRU units at GLF Hisar, GADVASU, Ludhiana, GBPUA&T, Pantnagar and Shri Gaushala Trust, Bhiwani for AI at those centers.

Genetic base of Tharparkar cattle has widened and a methodology was developed for prediction of lifetime milk production of Tharparkar cows. The study conducted on 232 Tharparkar cows revealed the least squares mean of lifetime traits including Herd life (HL), Number of calving (NC) and Breeding efficiency (BE) (%) as 2884.86 ± 49.67 days, 4.63 ± 0.20, 87.07 ± 0.6%, respectively.

Lifetime milk yield up to four lactations (LTMY-4L), Lifetime milk yield up to 6 years (LTMY-6Y), up to 8 years (LTMY-8Y) and up to 10 years of age (LTMY-10Y) of Tharparkar cows were computed as 8595.55 ± 220.68 kg, 5337.27 ± 148.48 kg, 9366.257 ± 226.15 kg, 13105.12 ± 448.40 kg, respectively.

Lifetime milk fat yield up to 6 years (LTFY-6Y), up to 8 years (LTFY-8Y), up to 10 years of age (LTFY-10Y) were found as 272.08 ± 17.57 kg, 435.99 ± 24.10 kg, 617.71 ± 51.48 kg whereas, Lifetime SNF yield up to 6 years (LTSNFY-6Y), up to 8 years (LTSNFY-8Y) and up to 10 years of age (LTSNFY-10Y) of Tharparkar cows were computed as 479.35 ± 30.19 kg, 767.05 ± 41.32 kg and 1093.61 ± 91.41 kg, respectively.

Murrah Buffaloes

The breeding programme in the Murrah herd was followed for test mating of XVIth set of bulls. Sixteenth set had 15 bulls of which 12 bulls test mating continued up to March, 2017. The dams' best lactation 305 day or less milk yield of 12 test bulls had ranged from 3053 to 4636 kg.

Bulls for Elite Mating at the Institute Herd

The breeding programme in the herd was followed for nominated mating using semen of three Proven Murrah Bulls. About 54 Murrah buffaloes were identified as elite animals. The average lactation milk yield of elite Murrah buffaloes increased to 2777 kg which was 25.26% higher than the herd average. The best lactational milk yield of elite Murrah buffaloes ranged between 2813 kg in first lactation to 4341 kg. Sixty eight daughters and seventy one male calves were born in the herd of which 13 and 9 were elite female and male calves, respectively.

Herd Performance

The herd strength was reduced during the period. Average age at first service and age at first calving of buffaloes were 31.01 and 43.21 month. Average age for initiating training and age at first collection of the young Murrah bulls was reduced to 26 and 29 months. The average service

period of buffaloes was estimated as 132.20 days. The overall female conception rate in the herd was 43.29 %. The female calf (0-3 month) mortality was reduced to 4.66 %. The wet and herd average were 8.39 kg and 4.52 kg, respectively. The average milk Fat, SNF and Total solid were estimated as 7.99 %, 9.55 %, and 17.54 %, respectively.

Selection of Young Murrah bull

A total of eight elite Murrah male calves were reserved during the period (2016-17) on the basis of Expected Predicted Difference and dam's best 305 days or less lactation milk yield, breed characteristics and physical conformity for selection of young male calves for future breeding. The dam's best 305 days lactation milk yield of reserved males ranged from 2997 kg in first lactation to 3533 kg. The superiority of reserved Murrah male calves ranged from 2.84 to 8.08%, respectively. The center proposed nine Murrah bulls out of which four breeding bulls were selected for test mating under XVIIth Set. The dam's best 305 days milk yield of selected bulls ranged from 3068 to 4187 kg.

Progeny Test Evaluation – Set-wise

The information on 305 days milk yield of daughters were collected, compiled and supplied to Nodal institute for genetic evaluation of XIIth set of Murrah bulls. The NDRI Centre contributed about 30.41% test bulls since inception of the project.

New THI Model for Murrah Buffalo

A new THI model (THI_D= 40.34 + 1.23 db + 0.0027 RH) was developed to assess the impact of heat stress on daily milk yield (DMY) using 2, 91,416 DMY records of 471 Murrah buffaloes scattered over 20 years (1994-2013). During critical heat stress, the developed model (THI_D) assessed about 80 g declines in daily milk yield per unit increase of THI. The expected breeding value for daily milk yield was found to be decreased by 1.6 kg and 1.9 kg during heat stress and critical heat stress in Murrah buffaloes.

Developed Models for Prediction and Optimization of Traits

Developed prediction models with high accuracy for energy value of milk (kcal/kg) of Murrah buffaloes. The models can be used as one of the selection criteria of Murrah buffaloes for high energy value of milk, sire evaluation for high energy value of milk under PT Programme and by the dairy industry to judge the milk quality of Murrah buffaloes.

Optimum birth weight and age at first use of Murrah bulls was standardized for better conception rate. In organized herd, Murrah bulls should be used prior to 3.5 years, which is expected to result in 5.08 % better conception rate based on first A.I, in comparison to Murrah bulls used after 4.5 years of age.

Germplasm Production and Dissemination

The NDRI centre has produced 31,798 doses of frozen semen during the period. The centre has supplied 8375 doses of frozen semen to other centers. In addition 5740 doses of semen were supplied to NDRI Field Unit, 2197 doses of semen were supplied for research purpose in the Institute and 10,621 doses of frozen semen to farmers and other dairy development organizations during the period.

The germplasm of genetically superior progeny tested proven bulls are being used on elite cows in organized herds for production of high-pedigreed bulls for further multiplication and production of superior germplasm and establishment of elite herds. Superior semen of proven and high-pedigreed bulls of NDRI center are being used by various dairy development agencies and dairy farmers for bringing genetic improvement of Murrah buffaloes.

Field Progeny Testing Programme for Buffaloes

A total of 3916 A.I was performed using semen of Murrah bulls under field conditions and as a result 50.40 % conception rate was obtained. As many as 18 breeding bulls belonging to the 15th and 16th set were used for AI during the year. Across the villages, the highest conception rate was observed in Rindal (53.94%) and lowest was observed in the Drar (46.92%) village. A total of 1524 (802 males and 722 females) Murrah buffalo calves were born in the farmers' herds and

performance data on 138 daughters was recorded. The records of daughters under field condition would be used for the genetic evaluation of Murrah breeding bulls.

» The major success is the enhancement of adoption of A.I practice in buffaloes. A.I is presently practiced in 100% households and played a very important role in upgrading the Murrah breed in the area under the project.

» There are many good qualities Murrah buffaloes produced under NWP using high pedigree germplasm, giving 22-24 liters milk per day. Under the project area, large number of farmers are being benefitted with production of very good quality Murrah buffaloes as they are getting 25-40% higher milk production.

Evaluation of Single Nucleotide Polymorphisms in Candidate Genes Associated with Semen Quality in Murrah Buffaloes and Khillar Cattle

Genetic variation in aquaporin 7 (AQP7) and PRNP genes were assesed by PCR-SSCP and sequencing methods in Murrah buffalo and Khillar bulls. In AQP7 gene, exon 1, 4, 5, 7 and 8 were found to be polymorphic and 20 SNPs (8 in exons and 12 in intron region) were found in Murrah bulls while in Khillar cattle exons 4, 2 and 6 were polymorphic with 2, 3 and 4 unique SSCP patterns, respectively.Sequence analysis indicated a total of 11 SNPs in the entire coding region of AQP 7 gene in Khillar cattle. In AQP7 gene, a significant association of SSCP variants of exon 1 with volume, exon 4 with volume and concentration and exon 8 with volume, motility and post thaw motility were observed in Murrah bulls. Sperm viability and hypo osmotic swelling reactivity were found to be significantly associated with exon 5 and exon 1, respectively in Murrah bulls. PCR-SSCP analysis of Prion protein gene revealed that only Exon 2 and 4 was found to be polymorphic in both Murrah and Khillar bulls with 5 SNPs. The variations in exonic region of PRNP were found to have no significant association with semen quality parameters. The study indicated high degree of genetic variability in aquaporin 7 gene and indicated the association of certain genetic variants of AQP7 gene with semen parameters. The PRNP gene was found to be less polymorphic as compared to AQP7 gene in Khillar cattle and Murrah buffaloes. The present study indicated the possibility of using genetic variants of exon 1, exon 4 exon 5 and exon 8 as genetic markers for semen quality traits in Murrah bulls.

Expression of CRH, a Stress Regulator Gene and Estimation of Breeding Value in Deoni *(Bos Indicus)* Cattle

CRH gene, primarily being a stress regulator, was found to be highly conserved in the Deoni breed of *Bos indicus* cattle as it exhibited lack of polymorphism. However, expression study of CRH mRNA revealed higher level of stress in Deoni animals during the parturition than the lactation. A positive correlation was found among the relative quantitaion values of expression and the daily milk yield of Deoni animals, in which both of them revealed a declining trend from the day of calving to day 60 post calving. In most of animals, highest yields were observed after 10 days of calving followed by a gradual declining trend upto 60 day post calving except one animal. Heritability of the first lactation milk yield (FLMY) was estimated to be 0.24 ± 0.20 which was used for calculations of breeding values both in lactating cows and breeding bulls of Deoni cattle. Breeding values of FLMY in Deoni cows calculated only on adjusted phenotype records, ranged from 139.32 to 1520.20 kg with a mean value of 610.90 ± 58.07 kg. Based on least squares analysis of FLMY of the daughters, mean breeding value of Deoni bulls estimated was 598.47 ± 21.43 kg with the highest value of 693.53 ± 64.18.

Development of Genetic Model for Improving the Selection Efficiency of Crossbred Cattle at ERS NDRI, Kalyani

Data on 1097 records which comprises of first to thirteen lactations of 354 Jersey crossbred animals, maintained at the Eastern Regional Station of NDRI, Kalyani for a period of 35 years (1980-2014) were used to determine the effect of important environmental factors on test day milk yields and their genetic control. A total of 10 classes of Test-Day Milk Yields (TDMY1 – TDMY10) recorded at an interval of 30 days for all available animals. A total of 6 univariate models were applied for genetic parameter estimation of test day milk yields of crossbred animals and the best model were chosen for these traits. The least squares means of different test milk yields (TDMY1-TDMY10) were 10.48, 10.19, 9.30, 8.54, 7.99, 7.26, 6.67, 6.17, 5.45 and 4.72 kg, respectively. Co-efficient of variations for all the TDMYs (TDMY1-TDMY10) ranged from 32.5-43.6%. The present

study revealed that the random effects of sire had significant influence on all the TDMY of animals. Period of calving had significant influence only TDMY6, TDMY7, TDMY9, TDMY10 in the present study. Season of calving had highly significant (P<0.01) effect on TDMY1-TDMY9 and significant (P<0.05) effect on TDMY10. The lactation number and genetic group of animals significantly (P<0.01) affected most of the test day milk yields in this study.

Estimates of direct heritabilities for different test day milk yields (TDMY1-TDMY10) varied from 0.28-0.36, 0.35-0.46, 0.29-0.40, 0.32-0.46, 0.35-0.47, 0.35-0.48, 0.37-0.57, 0.41-0.50, 0.39-0.46 and 0.31-0.38, respectively. For these traits, ignoring maternal effects yielded higher estimates of h^2 for most of the applied models. Comparison among different models in different test day milk yields of Jersey crossbred cattle revealed that maternal heritabilities (m^2) varied from 0.06-0.10, 0.05-0.08, 0.02-0.08, 0.00-0.04, 0.00-0.04, 0.00-0.04, 0.00-0.07, 0.00-0.05, 0.00-0.05 and 0.00-0.05, respectively in different models for different TDMYs (TDMY1 to TDMY10). Similarly, permanent maternal environment effect (c^2) ranged from 0.00-0.02, 0.00-0.04, 0.000.05, 0.01-0.05, 0.00-0.03, 0.00-0.03, 0.04-0.08, 0.03-0.05, 0.00-0.06 and 0.03-0.04 for all the traits (TDMY1-TDMY10), respectively in different models. The model which included the additive direct, additive maternal effects, and also includes the additive direct–maternal covariance (Model 4) was the best fitted model for test day yields (TDMY1-TDMY7) in the present study. For description of other test day yields (TDMY8, TDMY9 and TDMY10), the model with direct genetic effects (Model 1) was considered the most suitable model in the present data set.

Genetic Evaluation of Productive Efficiency of Crossbred Cattle in Relation to Heat Stress

A total of 12708 monthly milk yield records (January 1994 – December, 2015) of crossbred cows maintained at ICAR- NDRI, ERS, Kalyani herd descended from 55 sires and 209 dams were used for studying the effect of genotype environment interaction (GxE interaction) in relation to the impact of heat stress on production traits. Climatological data (maximum temperature, minimum temperature and relative humidity) for the corresponding periods were recorded from institute records and Temperature Humidity Index (THI) was computed. The THI thus obtained were classified into 5 zones (below 65, 65 to 70, 70 to75, 75 to 80, above 80). It was observed that during the months April to September, the monthly average THI remained above 80 imparting higher thermal load on the animals. The crossbred cattle according to their breed composition were classified into different genetic groups viz; HF crosses with 50% HF inheritance, HF crosses with 75% HF inheritance, Jersey (50%), Jersey crosses (>50%< 75% Jersey inheritance), Jersey crosses (75% Jersey inheritance), Pure Tharparkar, 50% Jersey and 50% Tharparker,/Red Sindhi. The non-genetic factors like parity, period of calving, stage of lactation, THI (P<0.01) and age group at first calving (P<0.05), significantly influenced the milk production traits (total monthly milk yield and average monthly milk yield). The genotype and THI interaction study also revealed that the cows bearing genetic composition of 50% exotic (either Jersey or HF) and 50% indigenous (either Red Sindhi or Tharparkar) inheritance exhibited better milk production potential at higher THI zones than cows with 75% or more exotic inheritance.

Genetic Markers for Reproductive Traits and Productivity

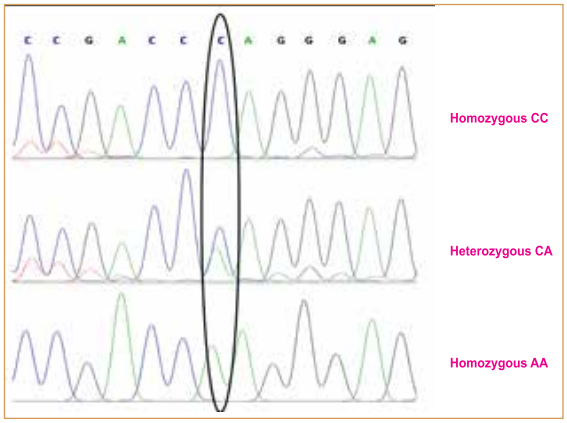
Two SNPs (T28707402G and T28708860C) related to daughter pregnancy rate and one SNP (T28708860C) related to sire conception rate in PPP1R11 gene could be used as potential genetic markers for higher fertility in Karan Fries bulls.

Genetic markers of MAP1B1 and PPP1R11 genes in relation to seminal quality parameters and reproductive traits were identified in HF crossbred bulls. MAP1B1_c SNP591 A>C genotype (CC) were found to have highest CR (53.59%) and SCR (14.47%) whereas, PPP1R11_a SNP285 C>T genotype (TT) had highest motility (45.11%), acrosome integrity (68.45%) and membrane integrity (55.99) in HF crossbred bulls.

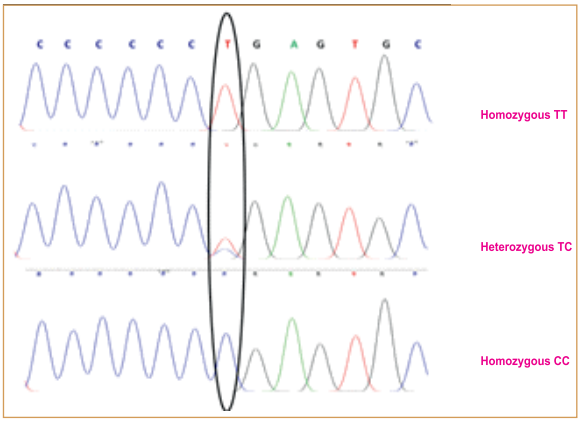
The presence of SNP (G21146196A) in SCD gene could be used as potential genetic marker for selection of Murrah buffaloes for higher milk and fat yield. The effect of genetic markers showed that about 263 gm TDMY, 0.15% TDF and 13.8 gm TDFY were found increased on changing SNP (G21146196A) in SCD gene.

Association analysis between semen quality parameters and genotypes of BSP5 showed that SNPs at g.C151T, g.C180T, g.G396A and g.C69A, g.G133C, g.C337A had significant (P<0.01) effect on acrosome integrity and tail abnormality, respectively. BSP5 genes at SNPs g.G260C, g.C1358T; g.C69A, g.G133C, g.G260C, g.C337A and g.C1358T, g.T2298C also revealed significant effect (P<0.05)

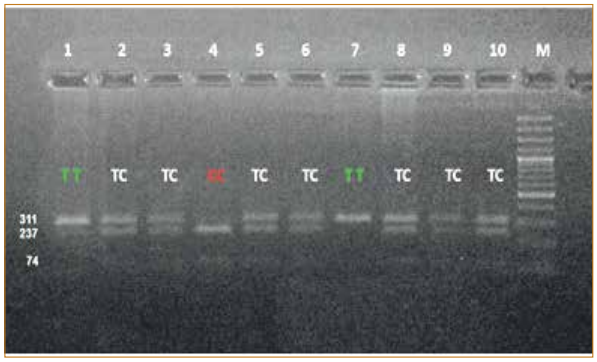
Chromatogram of SNP at g. C337A of BSP5 gene in Murrah bulls



Chromatogram of SNP at g. T95C of ODF1 gene in Murrah bulls



PCR-RFLP of primer 3 of BSP5 gene using BbvI Restriction Enzyme



Lane 1,7 : TT (311bp)
Lane 4 : CC (237 and 74bp)
Lane 2,3,5,6,8-10 : TC (311, 237 and 74bp)
M : 100 bp DNA ladder

PCR-RFLP of primer 2 of ODF1 gene using BsoBI Restriction Enzyme

Lane 1-4,6,7 : TT (653bp)
Lane 8 : CC (444 and 209bp)
Lane 5 : TC (653, 444 and 209bp)
M : 100 bp DNA ladder

on PTM, acrosome integrity and HOST, respectively. Association analysis between conception rate and genotypes revealed that genotypes of BSP5 gene at SNPs g.C69A, g.G133C, g.C151T, g.C337A and g.G396A had significant (P<0.05) effect on conception rate in Murrah bulls.

In ODF1 gene, four Murrah specific SNPs (g.T95C, g.G194A, g.C8941T and g.C9019T) were found where seven haplotypes were generated from these SNPs of ODF1 gene. Association analysis between semen quality parameters and genotypes of ODF1 gene showed that genotype at SNP at g.T95C locus had significant (P<0.05) effect on PTM and HOST while SNP at g.C8941T had significant (P<0.05) effect on HOST. Association analysis between conception rate and ODF1 Haplotypes revealed that Hap1, Hap2 and Hap4 were found to have significant (P<0.01) effect on conception rate of Murrah buffalo bulls.

The presence of SNP (G43051121A locus) in STAT5A gene could be used as potential genetic marker for higher 305 days first lactation milk, fat and protein yield in Murrah buffaloes.

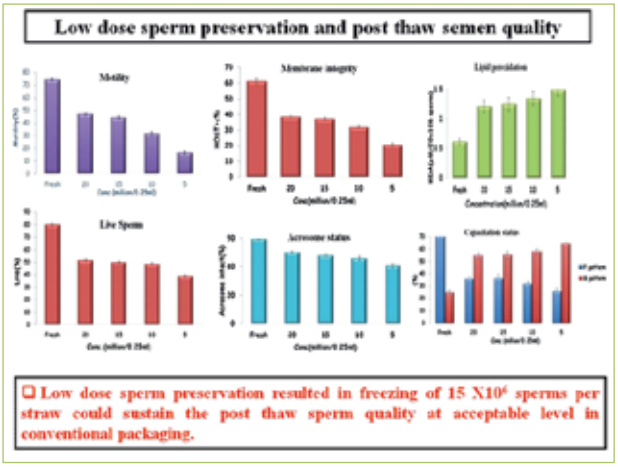
Genetic markers of MAP1B1 and PPP1R11 genes in relation to seminal quality parameters and reproductive traits were identified in Murrah bulls. PPP1R11_a SNP216 C>T genotype (CC) was found to have highest CR (44.25%) and SCR (5.66%) whereas, PPP1R11_a SNP 458 C>G genotype (CC) had highest HOST (70.69%), acrosome integrity (69.13%), Commat assay (8.17%) and membrane integrity (58.77%) in Murrah bulls.

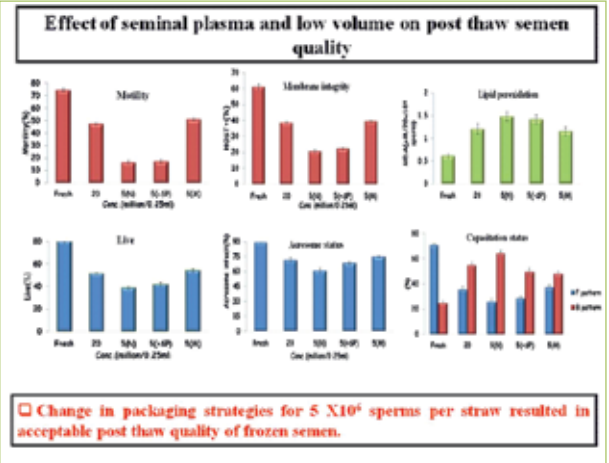
ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS

Low Volume Sperm Packaging: An Alternative of Low Dose Sperm Cryopreservation

The success of low dose sperm cryopreservation with acceptable quality and fertility can fulfill the gap between demand and production of frozen semen to achieve the national target of artificial insemination. It was revealed that progressive motility and HOST was significantly ($p<0.01$) lower in 10 and 5 million as compared to 20 million sperm per straw. Live percent and intact acrosome were significantly ($P<0.01$) lower in 5 million as compared to 20 million. Lipid peroxidation and capacitation status (F and B pattern) was more with an increase in dilution and highest were in 5 million. No significant ($p> 0.05$) differences were observed between 15 and 20 million doses for all quality parameters, but below 15 million sperm quality get reduced. To overcome the problem, an another study showed that inclusions of seminal plasma were not effective to improve the post-thaw semen quality in 5 million concentrations. Post-thaw motility, viability, membrane integrity, acrosome status and capacitation status were comparable ($P<0.01$) in cryopreserved spermatozoa of 5 million sperm concentration straw with modified packaging with 20 million sperm dose with conventional packaging. No significant difference ($P>0.01$) were found in post-thaw sperm quality between 20 million sperm dose with conventional packaging and 5 million with modified packaging. It can be concluded that modified packaging is an effective method for low dose sperm cryopreservation with acceptable post-thaw semen quality.

The study was further planned with lowering the dose of Karan Fries, Sahiwal and Murrah up to 10 million. No significant difference was observed in semen quality and CASA parameters of 20 million, 15 million and 10 million in all the three breeds.

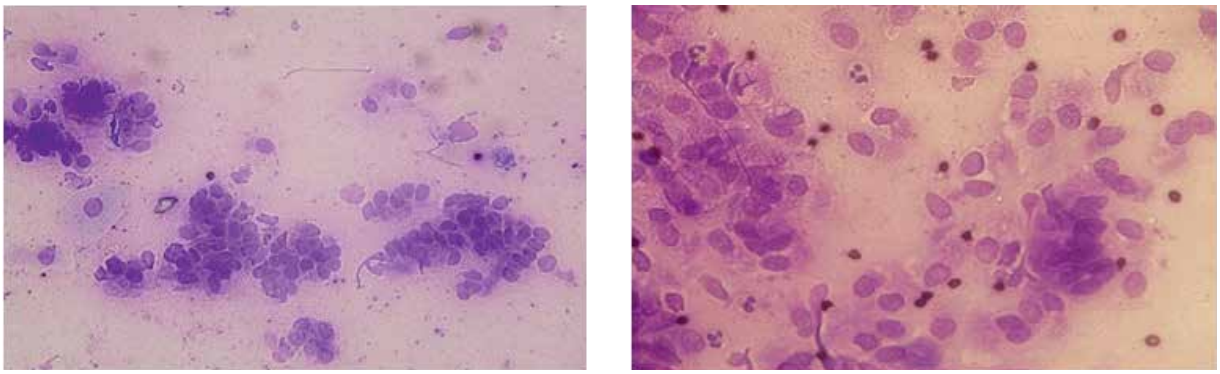




Uterine Fluid Cytology as a Tool for the Diagnosis of Sub-Clinical Endometritis in Buffaloes

At field conditions, it is difficult to diagnose sub-clinical endometritis (SE) in buffaloes. Endometrial cytology is considered the reference method while endometrial biopsy is considered as definitive diagnosis for SE. However, restlessness temperament and comparatively thinner and coiled uterus in buffaloes pose problems in using endometrial biopsy and cytobrush techniques. A simple endometrial cytology based tool for diagnosis of SE in the buffalo was developed. Uterine fluid samples and endometrial samples were collected from estrus buffaloes and the smears were

stained with Field stain for 3 minutes. A minimum of 400 cells were counted in each smear for determination of the percentage of polymorphonuclear cells (PMN). The relationship of cytobrush cytology with uterine fluid cytology was positive and significant. The ratio of PMN in cytobrush cytology to uterine fluid cytology was 1:2.4. ROC analysis revealed that the threshold value of 6.16% PMN in uterine fluid cytology had higher specificity and sensitivity (100%) in differentiating normal from SE affected buffaloes. In conclusion, collection of uterine fluid was easier compared to collection of endometrial samples using cytobrush and the percentage of PMN in uterine fluid cytology can be used as a tool for diagnosis of SE in buffaloes.



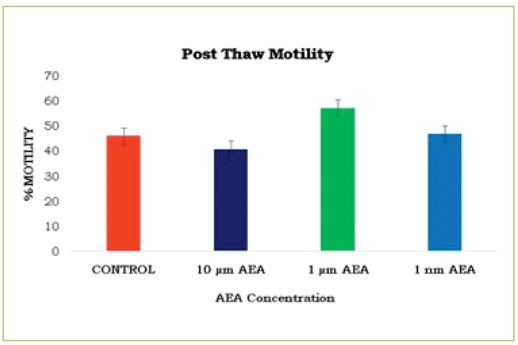
Uterine cytology of normal (left) and subclinical uterine infection (right) affected buffaloes

In-Vitro Oviduct Epithelial Explants Model for Studying Sperm-Oviduct Binding in Buffaloes

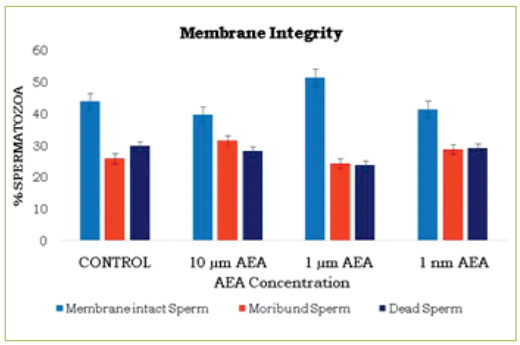
To understand the sperm-oviduct binding, a quantitative and reproducible in vitro model is required; however, such model is not available for buffalo. Therefore, an in vitro model was developed for studying sperm-oviduct binding in buffalos. Oviduct explants were prepared by overnight culture of epithelial cells in TCM- 199 medium under 5% CO2 at 38.5oC. Cryopreserved spermatozoa from buffalo bulls (n=4) were incubated with the oviduct explants and the sperm-oviduct explants complex were stained with JC-1. The effect of sperm concentration (2, 3 and 4 million), size of the oviduct explants (<0.2, 0.2-0.3, 0.3-0.4 and >0.4 mm2) and time of incubation (1 h and 4 h) on binding index (BI-number of sperm bound to unit area of explants) was studied. No significant difference was observed in the BI among <0.2, 0.2-0.3 and 0.3-0.4 mm2 size of explants, however the BI decreased significantly ($p < 0.05$) when the size of explants exceeded 0.4 mm2. The BI decreased significantly ($p < 0.05$) when the sperm concentration was increased to 4 million while the duration of incubation did not have any significant effect on the BI. The interaction of bulls with explants size, sperm concentration and incubation time was not significant. The developed assay has the potential to be used as an in vitro model for studying sperm-oviduct binding in buffaloes.

Effect of Anandamide on Cryocapacitation and Sperm Functions in Murrah Buffalo Bulls

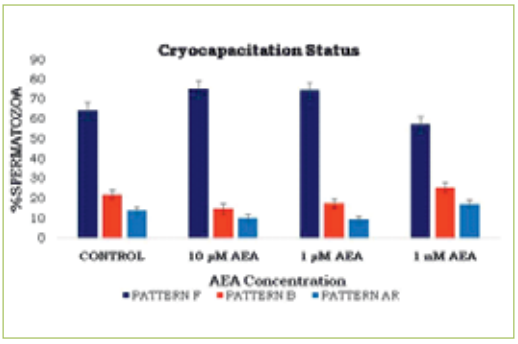
Cryopreservation leads to lethal and sub-lethal damages to spermatozoa. Anandamide (AEA) an endocannabinoid, which maintains the sperm in decapacitated state before the sperm reaches the actual site of fertilization, at the same time conserving the energy for future fertilization events has been identified. The present study was undertaken to assess the effect of Anandamide incorporation in the extender at three different levels on post-thaw sperm functions, especially the cryocapacitation status, in Murrah buffaloes. Also, the expression of the endocannabinoid system (receptor for Anandamide – CB1 receptor and Anandamide degrading enzyme – FAAH) in the spermatozoa in relation to the cryotolerant status of buffalo bull. The relative expression of FAAH gene differed significantly (P=0.04) with cryotolerant, fold change (30.8) times in cryo-susceptible spermatozoa.The relative expression of FAAH protein in cryo-susceptible and cryo-tolerant spermatozoa was not significantly different. The expression of TRPV1 protein differed significantly (P=0.01) with cryotolerant, fold change (13.1) times in cryo-susceptible spermatozoa. It was inferred that the protective role of AEA on cryopreservation of buffalo spermatozoa is dose dependent. TRPV1 receptor and FAAH enzyme might be associated with sperm cryo-susceptibility in the buffalo spermatozoa and can be used as tools for prediction of cryo-tolerance along with other existing methods.



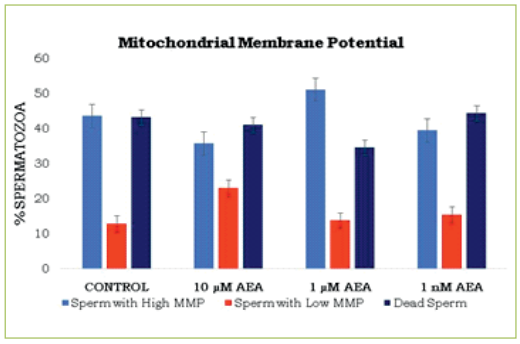
Effect of Anandamide Supplementation on Post Thaw motility in Murrah buffalo bulls



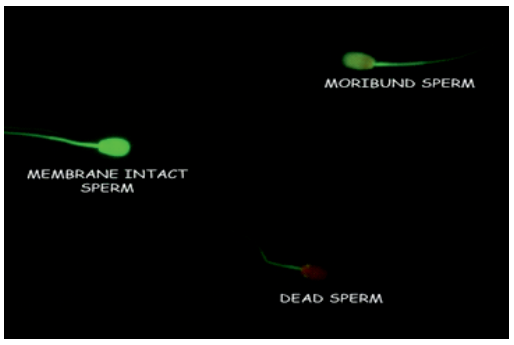
Effect of Anandamide Supplementation on Post Thaw Membrane integrity in Murrah buffalo bulls



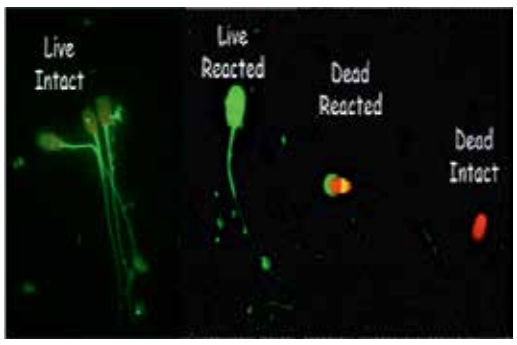
Effect of Anandamide Supplementation on Post Thaw cryocapacitation status in Murrah buffalo bulls



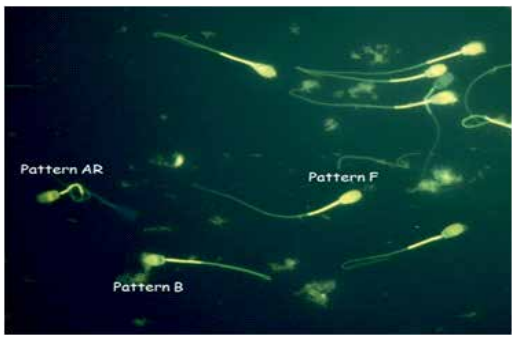
Effect of Anandamide Supplementation on Post Thaw Mitochondrial membrane potential in Murrah buffalo bulls



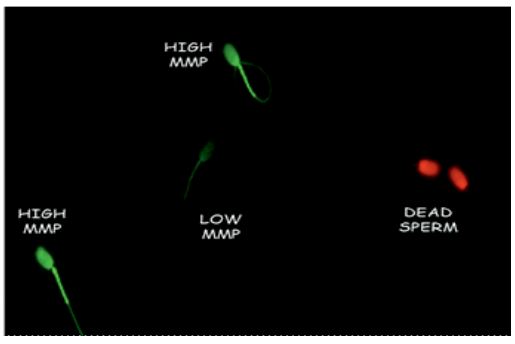
CFDA - PI staining of Spermatozoa for Membrane Integrity Status in post-thaw spermatozoa of buffalo bulls



FITC-PNA staining of Spermatozoa for Acrosome Reaction Status post-thaw spermatozoa of buffalo bulls



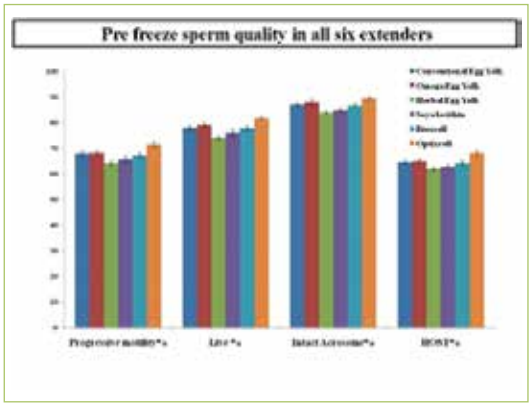
CTC staining of Spermatozoa for Cryocapacitation Status post-thaw spermatozoa of buffalo bulls

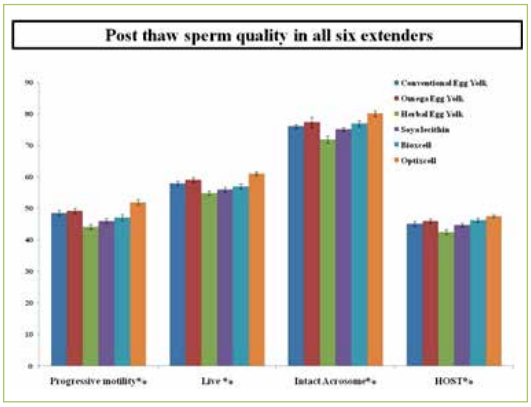


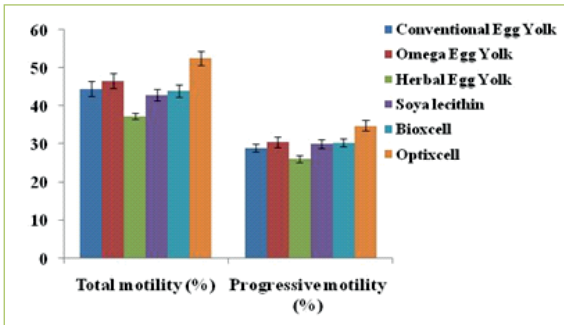
JC1 staining of Spermatozoa for Mitochondrial Membrane Potential Status post-thaw spermatozoa of buffalo bulls

Comparative Efficacy of Egg Yolk, Liposome and Soya Lecithin Based Extenders for Cryopreservation of Sahiwal Bull Semen

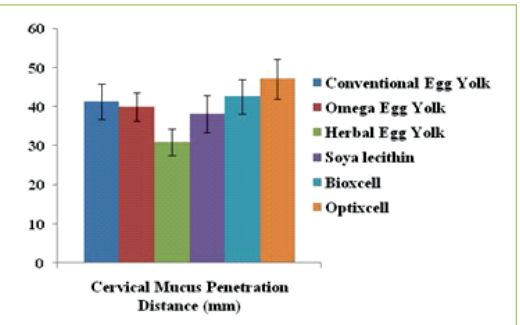
The extender is playing an important role in sperm cryopreservation and maintenance of sperm quality. Therefore, to find out suitable extender for cryopreservation of Sahiwal bull semen, effects of egg yolk, soya lecithin and liposome-based extenders were compared. Semen quality parameters were significantly ($p<0.05$) different among different extenders at both pre and post-freeze stages. Semen extended in liposome-based extender showed significantly higher progressive motility at both stages as compared to all other extenders. However, herbal egg yolk and soya based extenders were significantly lower as compared to Optixcell extender at post-thaw only. There was a significant difference between Optixcell and herbal egg yolk extenders for live percent and non-significant with all other extenders at pre-freeze. However, at post-thaw stage semen diluted in Optixcell extender was significantly differing from all others extenders except omega egg yolk based extender for live percent. The semen diluted in Optixcell extender showed significantly higher for HOST percent as compared to all other extenders during pre-freeze and post-thaw condition except Bioxcell extender during post-thaw condition. Semen extended in Optixcell showed significantly higher values for intact acrosome percent as compared to herbal and soya lecithin based extenders at both pre-freeze and post-thaw stage. The sperm abnormalities in semen diluted in Optixcell extender were significantly lower as compared to herbal and conventional egg yolk extender except for Omega and Bioxcell extender. Progressive motility (%) and total motility (%) were recorded significantly higher in liposome-based extender



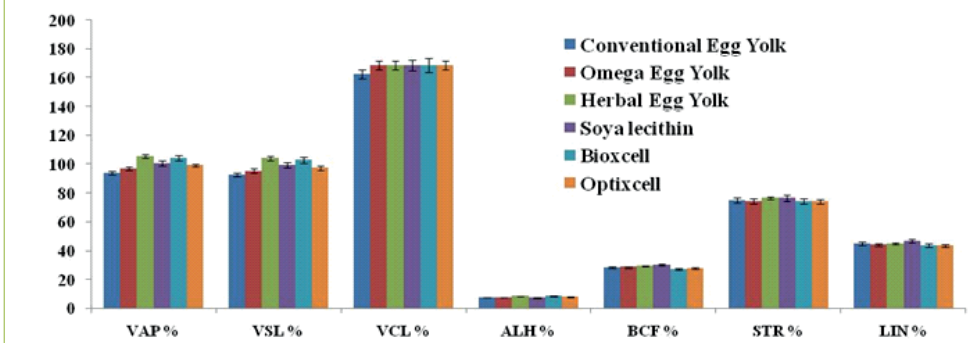




Post thaw sperm motility (CASA)



Post thaw cervical mucous penetration test

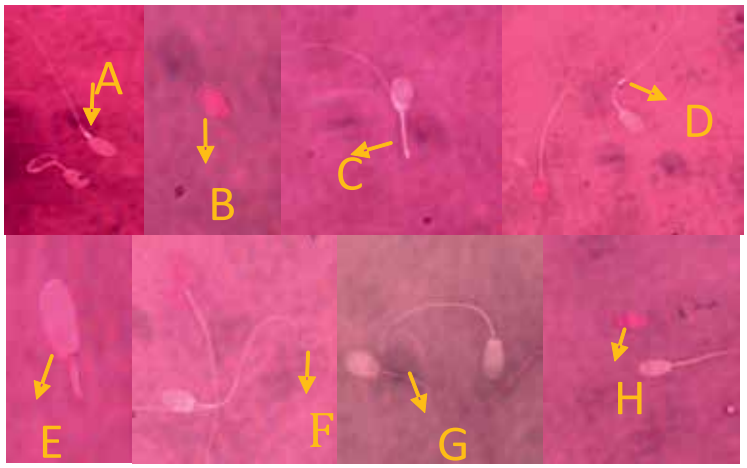


Post thaw sperm kinetic parameters (CASA)

as compared to the conventional egg yolk and Herbal egg yolk based extender during post freeze period. There were non-significant differences were observed for progressive motility (%) and total motility (%) between conventional egg yolk, omega egg yolk, soya-lecithin and Bioxcell extenders. The sperm kinetic parameters such as average path velocity (VAP), straight line velocity (VSL), curvi linear velocity (VCL), the amplitude of lateral head displacement (ALH) and beat cross frequency (BCF) significantly differed among different extenders of post-thawed semen samples. While non-significant ($p<0.05$) difference was recorded for straightness (STR) and linearity (LIN) among different extenders. It can be concluded that omega egg yolk and Bioxcell extenders are comparable with a conventional egg yolk based extenders for cryopreservation of Sahiwal bull semen and can be used as an alternative. Overall liposome-based extender showed better cryopreservation ability of Sahiwal bull semen.

Sperm Abnormalities in Murrah Bulls

Significant variations were observed between mass activities with regard to percentage of spermatozoa progressive motility, viability, sperm concentration, HOST positive sperms and acrosome integrity. However percentage of abnormal sperms did not differ in two groups. The mean values for progressive motility of spermatozoa (%) from mass activity of +1 and +3 increased from 45 ± 0.91 to 65 ± 1.2; percent viability from 72 ± 1.5 to 78 ± 1.1, concentration from 510 ± 127.3 to 990 ± 131.90; percent HOST positive sperms from 69 ± 2.4 to 79 ± 2; and percent acrosome integrity increased from 70 ± 2.1 to 78 ± 1.2.



Abnormalities encountered in the morphology of buffalo spermatozoa; A= Proximal cytoplasmic droplet, B= Pyriform heads, C=Foldedtails and D=Distal cytoplamic droplets, E = Tailless normal heads, F = Terminally coiled tail G = Simple bend and H= narrow, small heads; Magnification = 100x

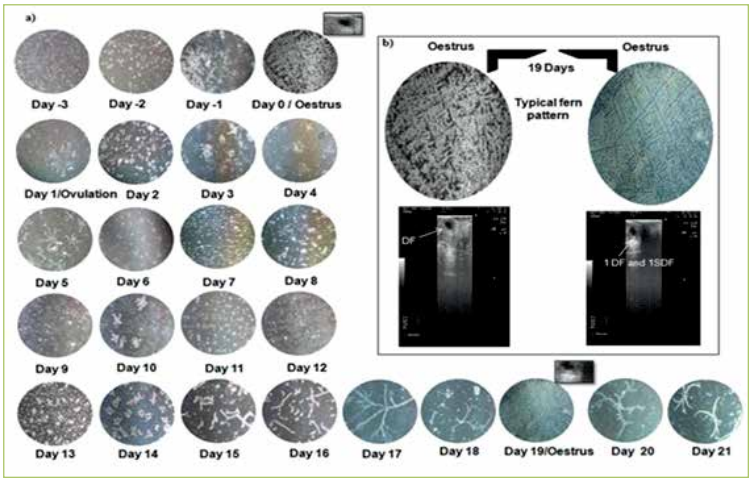
Up-regulation of Milk Secretion through Manipulating the PG-PL System in Murrah Buffaloes during Hot Dry Season

The role of plasminogen-plasmin (PG-PL) system of milk and plasma hormones during hot dry season (42.4°C) under two different management systems was elucidated in buffaloes subjected to benefit of mist and fan cooling from 9:30 a.m. to 5:00 p.m. vis-a vis control. Buffaloes of treatment group experienced better comfort by alleviating environmental stress as their physiological responses such as rectal temperature, respiration rate, pulse rate, and forehead and mid-dorsal temperatures were significantly ($p<0.05$) reduced compared to control, which subsequently resulted in higher milk yield by 5 % ($p<0.01$). Analysis of milk samples revealed higher concentration of milk plasminogen (7.99 vs 6.27 µg/ml) and β-casein (1.09 vs 0.92 g/dl) and lower plasmin level (0.178 vs 0.194µg/ml) in treatment buffaloes. Plasma glucose level was higher whereas cortisol, norepinephrine, and NEFA levels decreased by 19.19, 15.38 and 11.41%, respectively, in treatment animals without changing the milk calcium, GH, and epinephrine levels. The lower ratio of plasmin: plasminogen suggested role of PG-PL system in up-regulation of milk secretion during summer season in buffaloes.

Saliva Ferning, an Unconventional Estrus Determination Method in Buffaloes

The saliva, being available regularly and showing crystallization patterns like cervicovaginal fluid, is considered as an alternative biofluid for estrus determination in buffaloes. Five female nonpregnant Murrah buffaloes (Bubalus bubalis) in summer and three animals in rainy season were considered in this study. Estrus was determined by the estrus symptoms, ovarian ultrasonography, and salivary estradiol (E2) to progesterone (P4) ratio. A total of 450 saliva samples

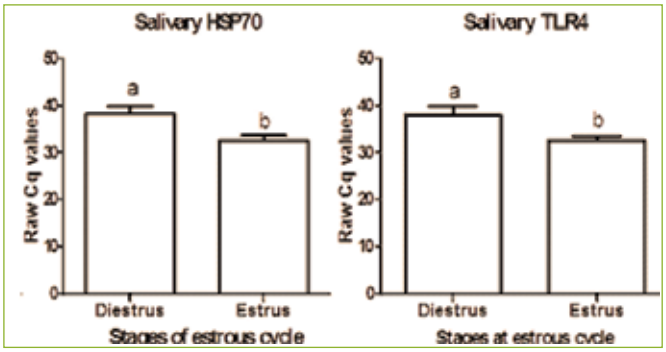
were collected from these animals on the daily basis. The salivary smear was prepared with 20 µL of the cell-free saliva on a clean glass slide, and its microscopic images were captured at a magnification of × 200. The images were used for fractal analysis as the salivary crystallization or fern patterns follow the fractal geometry. Saliva at estrus showed a typical symmetrical fern-like crystallization patterns with lower ($P < 0.05$) fractal dimension values. Salivary estradiol levels and E2/P4 ratio were higher ($P < 0.05$) at the estrus stage than those at the diestrus stage. An average period of an estrous cycle was 21.7 ± 2.7 days (n = 18 estrous cycles) in buffaloes on the basis of distinct salivary crystallization patterns. The proportion of estrus detection by the salivary fern patterns was higher ($P < 0.01$) (0.84) than the proportion of estrus detection (0.5) in the field conditions. Altogether, salivary fern patterns alongwith the current methods can help reduce estrus detection problem in buffaloes (Ravinder et al., 2016. Theriogenology 86: 1147-1155)



Salivary fern patterns in an estrous cycle of buffaloes (a) and at two consecutive estrus stages (b)

Direct Saliva Transcript Analysis as a Novel Estrus Marker Detection Method in Buffaloes

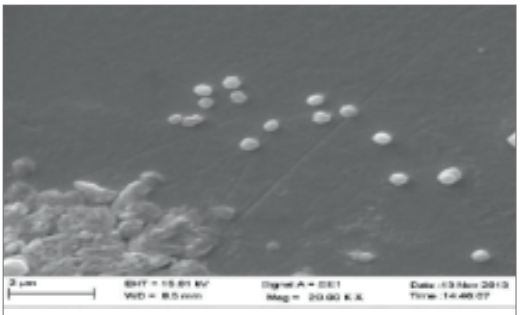
Direct saliva transcript analysis without RNA isolation showed suggestively higher levels of TLR4 and HSP90 at estrus stage (Day 0) than the diestrus stage (Day 10) in buffaloes. In addition, miRNA (circulatory novel biomarkers) was identified novel for estrus detection. (Onteru et al., 2015. Biomarkers 4: 1-3)



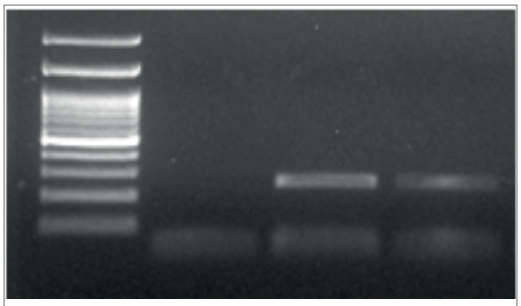
Direct saliva transcript analysis of HSP70 and TLR4 genes at estrus and diestrus stages of buffaloes

Development of a Novel PCR Method for *Ureaplasma Diversum* Detection in Vaginal Swabs of Buffaloes

Through metagenomic study, a strain of *Ureaplasma diversum* was identified to be predominant in uterine samples of buffaloes suffering from endometritis. This is the first report in India indicating the presence of *Ureaplasma diversum* strain in farm animals. The culture conditions of *Ureaplasma diversum* were characterized in more than 10 days. A rapid PCR detection method was developed for *Ureaplasma diversum* strain T95 by designing strain-specific primers. The developed PCR test could be useful for easy diagnosis and early treatment of reproductive infections in buffaloes. Interestingly, 70% of buffaloes tested with reproductive infections were found to be positive for *Ureaplasma diversum* strain T95. (Patent application Number: 806/DEL/2015).



Scanning electron microscopy of Ureaplasma diversum



Rapid PCR test for U.diversum

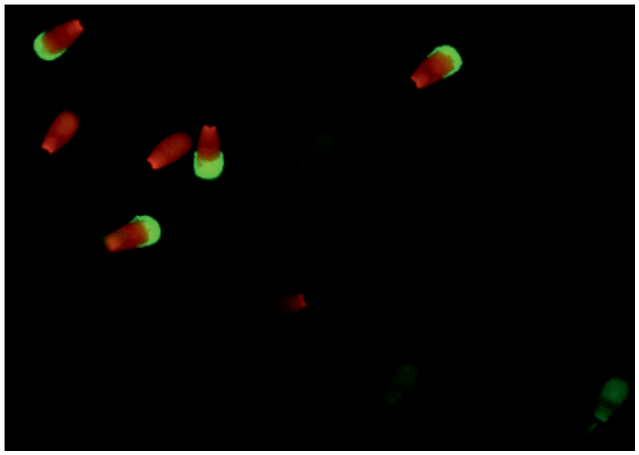
Elucidated molecular and cellular mechanism of ovarian dysfunction underlying postpartum infection in buffaloes and proposed a novel strategy to attenuate and treat infection through nutritional intervention and HDAC inhibitors as potential therapeutics to treat postpartum uterine infection in buffaloes and cows

Putative Fertility Markers in the Spermatozoa of Crossbred Bulls

Earlier, using 2-D DIGE, it was identified that 21 sperm proteins were differentially expressed between high- and low-fertile crossbred bulls, among which 17 were over expressed in high-fertile bulls and 4 were over expressed in low-fertile bulls. After identifying the differentially expressed proteins and their functional classification, four proteins viz. ENO1, MDH2, ATP5D and BSP-1 were selected for further validation. To find out the correlation between their expression levels with fertility in crossbred bulls, these proteins were quantified using western blotting and ELISA methods in frozen-thawed spermatozoa of 56 crossbred bulls with known fertility. The relative expression of ENO1 and BSP-1 proteins were found to be significantly correlated with the conception rate in crossbred bulls. To confirm further, expression of these proteins were studied at mRNA level. It was observed that the relative expression of ENO1 was 2.4 times higher in the spermatozoa from high fertile bulls as compared to low fertile bulls. The correlation between expression of ENO 1 gene and crossbred bull fertility was positive and significant ($r=0.65$; $P<0.05$). It was concluded that sperm expression of ENO1 may serve as a positive fertility marker while the expression of BSP-1 may serve as a negative fertility marker in crossbred bulls.

Functional Assay for Selection of Sperm Doses with High Fertilizing Potential

The clinical value of different sperm functional assays were assessed to predict the fertility. Five important sperm functions were assessed in cryopreserved spermatozoa from crossbred bulls (n=52) with known fertility and identified a suitable combination of sperm function tests that could fairly predict fertility. The proportion of spermatozoa with intact membrane was significantly ($P<0.05$) higher in high fertile bulls as compared to either medium or low fertile bulls. The proportion of moribund spermatozoa was significantly ($P<0.05$) higher in low fertile bulls and medium fertile bulls as compared to high fertile bulls. The proportion of live acrosome intact (LAI) spermatozoa was significantly ($P<0.05$) higher in high fertile bulls compared to either medium or low fertile bulls. The proportion of uncapacitated spermatozoa was significantly ($P<0.05$) higher in high and medium fertile bulls as compared to low fertile bulls. The relationship between the proportion of membrane intact spermatozoa and bull fertility was positive and significant ($r = 0.62$; $P<0.001$). On the other hand, the relationship between the proportion of moribund spermatozoa and bull fertility was negative and significant ($r = -0.54$; $P<0.001$). The relationship between LAI spermatozoa and fertility was positive and significant ($r = 0.71$; $P<0.001$) while the relationship between DAR spermatozoa and fertility was negative and significant ($r = -0.59$; $P<0.001$). Among all, the combination of tests estimating LAI, moribund and uncapacitated status of spermatozoa had high accuracy of prediction (adjusted $R2 = 0.65$) along with lowest C(p) value.



FITC-PNA assay for assessment of sperm acrosome reaction

Age Related Changes and Seasonal Influence on Testicular Cytology and Semen Production in Crossbred Goats

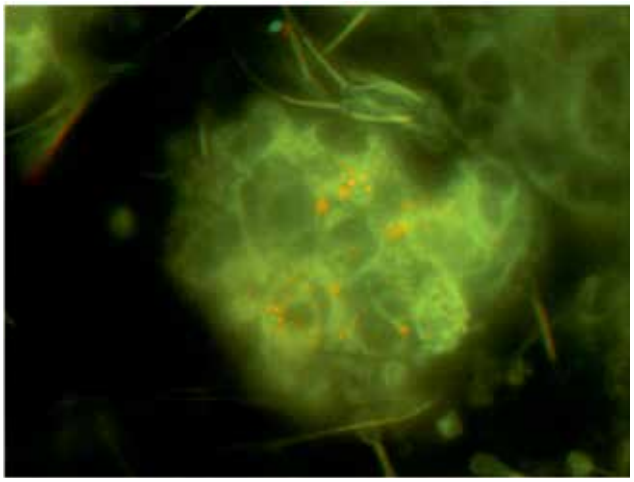
Age related changes in testicular biometry, seminiferoustubule, testicular cell indices , peripheral blood testosterone concentration, the influence of season on testicular cytology and semen quality was studied in crossbred (Alpine X Beetal) goats. A positive linear relationship among age, body weight and the testicular biometry parameters was observed as the age advanced from 2 to 14 months. Testosterone concentration showed a steady increase from 2 (0.25 ng/ml) to 6 months (0.4 ng/ml) of age and then declined over a period and reached plateau from 10 months (0.22-0.27 ng/ml) indicating that puberty occurs at 6 months of age in Alpine X Beetal crossbred goats. Melatonin concentrations showed a negative correlation with the day length. There were no significant differences in the proportion of spermatogonia, spermatocytes and spermatids in the testicular cytology of bucks during different seasons. The mass activity, individual motility, viability and sperm concentration was higher during rainy and autumn season while sperm functional parameters did not differ among seasons. The intra- buck and inter-buck variations were high compared to the seasonal influence on semen quality. Collectively, all these findings indicate that seasonal variations are less evident in terms of spermatogenesis and semen quality in Alpine X Beetal crossbred bucks under the given location and climatic conditions.

Sperm Functional Differences between Oviduct-Explant Bound and Unbound Spermatozoa

Although it is understood that spermatozoa are subjected to selection processes to form a functional sperm reservoir in the oviduct, the mechanism remains obscure. In order to understand the sperm selection process in the oviduct, mitochondrial membrane potential and tyrosine phosphorylation status in oviduct-explants bound and unbound spermatozoa was analysed. Frozen semen from Murrah buffalo bulls were utilized for the study. Oviduct explants were prepared by overnight culture of epithelial cells in TCM- 199 and washed spermatozoa were added to the oviduct explants and incubated for 4 h under 5% CO2, 38.5oC with 95% relative humidity. Mitochondrial membrane potential (MMP) and tyrosine phosphorylation status of bound and unbound spermatozoa were assessed at 1h and 4h of incubation. The proportion of spermatozoa with high MMP was significantly higher ($P< 0.001$) among the bound spermatozoa (range 84.67 to 96.56%) compared to unbound (range 8.70 to 21.03%) spermatozoa. The proportion of tyrosine phosphorylated spermatozoa was significantly higher ($P< 0.001$) among unbound population as compared to bound population. The proportion of spermatozoa displaying tyrosine phosphorylation at acrosomal area was significantly ($P<0.05$) lower in bound sperm population compared to unbound population. It was inferred that spermatozoa with high MMP and low tyrosine phosphorylation were preferred to oviduct-explants binding in buffaloes.

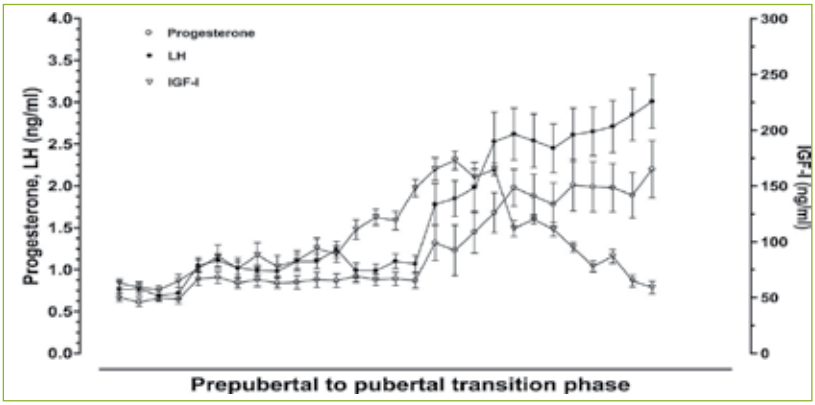
Induction of Puberty Using Kisspeptin (kp-10) in Crossbred Heifers

A total of 18 healthy prepubertal crossbred heifers (Jersey cross) with body weight between 180 to 200 kg (mean ± SEM: 188.9 ± 11.8 kg) and aged between 17 to 19 months were selected and divided randomly in to two groups; control (n=9) and treatment (n=9). To standardize counting of follicles, each ovary was scanned from end to end to identify the positions of the antral follicles. Video images for different ovarian sections were captured on a computer monitor and the locations of each antral follicle 3 mm or greater in diameter in each section were drawn on an ovarian map. Animals were administered either with kisspeptin-10 (Kp-10) @ 50 µg KP-10/ animal (treatment group; n=9) or with equal volume of normal saline (Control group; n=9) twice-a-week till the onset of puberty. Dosage of KP-10 as used herein was standardized for crossbred cows during the last year of the project. Onset of puberty was determined by observing the follicular growth patterns, plasma progesterone values and occurrence of first estrum.



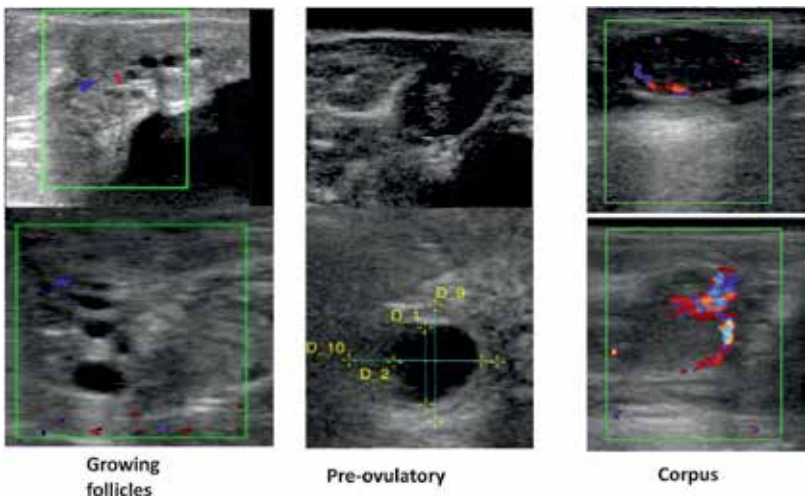
Tyrosine phosphorylation status of unbound spermatozoa

Changes in plasma progesterone, LH and IGF-1 estimated in twice-a-week samples collected from KP-10 administered animals during the transitional phases from pre-pubertal to pubertal stages are presented in Fig. 1. Plasma progesterone concentrations exhibited increasing trend (P<0.05) with advancing age. Abrupt pre-pubertal increase in plasma IGF-I concentrations were recorded in heifers approaching puberty. Plasma LH exhibited increasing trend (P<0.05) in concentrations for crossbred heifers as puberty advances.



Changes of hormonal profiles during transition from prepubertal to pubertal stages in crossbred heifers treated with KP-10.

Results of the experiments on follicular dynamics using transrectal ultrasonography revealed that exogenous administration of kp-10 enhanced the growth of follicles in all animals of treatment group than those of control animals. Higher number of medium and large follicles was recorded in the ovaries of kp-10 treated animals than controls. Though a large number of small follicles of <4mm in diameter were observed in control animals, no medium (<8mm) or large (<10mm) follicles were found.



Follicles of small and large size, and corpus luteum in the ovaries of KP-10 treated animals

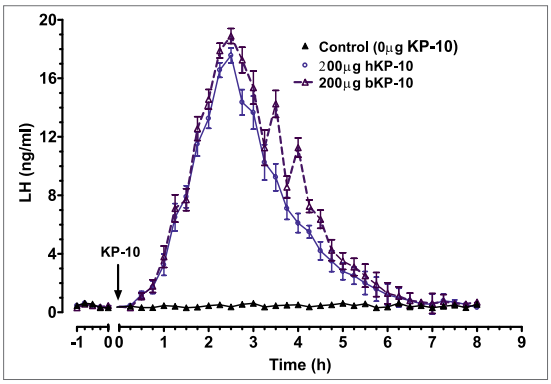
Age and body weight of experimental crossbred heifers at puberty has been shown in Table. Kisspeptin-10 administration was found to enhance pubertal process in the animals of treatment group than those of controls. KP-10 administered heifers came in to first estrum at around 60 days ahead than control animals. Two of nine animals of treatment group exhibited their first estrus at 197 and 198 kg body weight, respectively.

Groups	Age at first estrus (months)	Body weight (kg)
Control	23.96 ± 1.21 [a]	245.46 ± 9.83[c]
Treatment	21.92 ± 1.79 [b]	221.63 ± 10.51[d]

(Treatment group of animals were treated with KP-10 @ 50µg /animal (n=9) or with equal volume of normal saline (Control group; n=9) twice-a-week till the onset of puberty.)

Response of bKP-10 vis-à-vis hKP-10 on Plasma LH release in Crossbred Heifers

The efficacy of bovine specific kisspeptin-10 (bKP-10) that was designed and synthesized during the last year was tested in terms of endogenous LH release post-administration and also compared with commercially available human specific kisspeptin-10 (hKP-10). It was inferred that bKP-10 was at par with the commercial hKP-10 (Figure 3). Hence, it can be used instead of hKP-10 for reproduction augmentation in bovine species. The findings showed that synthesized bovine kisspeptin-10 based on amino acid sequence was found cheaper and equally potent as that of commercially available kisspeptin-10.



Effect of exogenous administration (i.v.) of bovine specific kisspeptin-10 (bKP-10) and human kisspeptin-10 (hKP-10) on blood LH release in prepubertal crossbred heifers. Blood samples were collected at every 15 min intervals one hour prior to and 8-h post administration

Effect of Trehalose Supplementation on Cryopreservation of Black Bengal Buck Semen

Various membrane-permeable cryoprotectants such as glycerol, dimethyl sulfoxide, ethylene glycol, and propylene glycol and their combinations, were tested with buck sperm, but glycerol is the most frequently used penetrating cryoprotectant. Glycerol is commonly used at concentrations of 4% to 8%. The toxicity of glycerol limits the use of high concentration of glycerol in cryoprotective media. Trehalose is a non-penetrating disaccharide that seems to protect cells both by increasing the tonicity of the extender and by stabilizing the plasma membrane, possibly due to direct interaction with phospholipid polar head groups of membrane phospholipids. Trehalose seems to be more efficient than other sugars for protection of spermatozoa in cryopreservation media, and many authors have reported its beneficial effect for semen cryopreservation indifferent species, such as ram, bull and boar. This study was carried out to observe the effect of supplementation of trehalose on the in vitro sperm characters of Black Bengal buck semen during cryopreservation. Treatment group was supplemented with trehalose @ 50, 100 1nd 150 mM to the cryoprotectant media containing glycerol (5%v/v), while the control group had no trehalose. Results revealed that the supplementation of trehalose did not improve the post thaw recovery of Black Bengal buck semen and the semen samples preserved in media containing only glycerol (5% v/v) had better in vitro sperm characters.

Post Thaw *In-Vitro* Sperm Characters of Black Bengal Buck Semen Preserved in Trehalose Supplemented Media

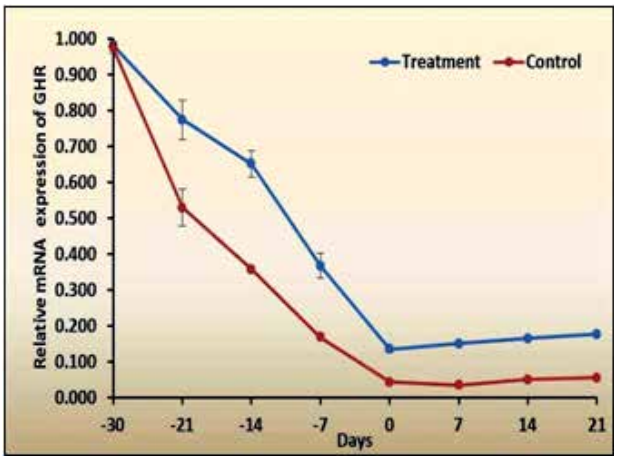
Treatment	Sperm motility (%)	Viable count (%)	Functional membrane integrity (%)	Abnormal count (%)	Concentration of malondialdehyde (µmol/ml)
Glycerol	30.77 ± 0.02 ^{P}	36.94 ± 0.03^{P}	27.33 ± 0.07^{P}	39.06 ± 0.02 ^{P}	0.27 ± 0.02 ^{P}
Glycerol + 50mM trehalose	15.18 ± 0.02 ^{Q}	17.83 ± 0.03^{Q}	3.89 ± 0.07 ^{Q}	32.20 ± 0.02 ^{Q}	0.40 ± 0.02 ^{Q}
Glycerol + 100mM trehalose	8.10 ± 0.02 ^{R}	10.49 ± 0.03^{R}	2.29 ± 0.07 ^{QR}	36.47 ± 0.02 ^{P}	0.55 ± 0.02 ^{R}
Glycerol + 150mM trehalose	1.45 ± 0.02 ^{S}	2.45 ± 0.03^{S}	0.67 ±0.07 ^{R}	46.01 ± 0.02 ^{R}	0.65 ± 0.02 ^{S}

Data shown all mean ± SEM (n = 24)

Means with different superscripts P, Q, R, S in a column differ significantly (P<0.05).

FEED, FODDER AND PRODUCTIVITY

Prilled Fat Supplementation in Transition Period Augments Animal Productivity



GHR mRNA expression during transition period in KF cwos

Periparturient physiological and metabolic adaption in terms of normal energy metabolites, hormone and body condition changes was achieved by prilled fat(@100g/d) and *Saccharomyces cerevisiae* (25g/d) feeding in an experiment on rural Murrah buffaloes. Feeding not only enhanced GH associated rise in milk production (2.5kg/d), fat content and conception rate but also led to additional income of ₹ 117/day to the rural dairy farmers. The feeding of similar dose during transition period in KF cows declined metabolic marker-NEFA level and increased triglycerides, glucose level thereby indicating significant check on mobilization of body fat reserves. Supplementation improved birth weight of calf, induced early uterine involution leading to onset of early postpartum estrus and was economical (₹ 87/day). However feeding of 25g fermented yeast culture (FYC) alone in transition buffaloes enhanced milk production by 13% with high fat content (7.5%) without changing DMI, NEFA, triglycerides and cholesterol levels. FYC feeding resulted in early onset of first postpartum heat (47 vs. 69 days), decreased service period (30 days) and higher conception rate. The higher expression of GHR and IGF-1 receptors were related to higher milk yield and plasma GH.

Evaluation of Sorghum Forage Varieties and their Nutritive Value Under Different Nutrient Management

The field study was laid out in split-plot design with eight varieties of forage sorghum *viz.*V1 (MP Chari), V2 (PC-615)-local check, V3 (CSV 30F), V4 (CSV20), V5 (CSV 27), V6 (CSV 21F), V7 (UPMC 503), V8 (CSV 15) in main plots and four Nutrient Management: Control, N:P:K (150:80:40), N:P:K (100:60:30), N:P:K (50:40:20) in sub plots with three replications in total 96 numbers of plots. Green fodder yield was significantly differed by sorghum varieties. Highest GFY was obtained in UPMC 503 and lowest in CSV 27 variety. The higher dose of NM gave highest yield among other doses of nutrients. Green fodder yield increased 42.99% over to check variety (PC 615) followed by CSV 15 variety of sorghum. Interaction effect was found between sorghum cultivars and nutrient management for GFY. Dry matter, dry matter yield, crude protein and ash content were significantly influenced by variety and nutrient management. Dry matter yield differed significantly in varieties and nutrient uptake and recorded highest in UPMC 503. While NM practices gave higher DMY and N uptake with higher dose of nutrients. Maximum CP was estimated in variety CSV 21 F and lowest in PC 615 (check variety). Highest dry matter (%) was recorded by UPMC 503 and at par with CSV 20 & M P Chari. Lowest dry matter (%) was estimated in CSV 30 F. However, Ash (%) was found highest in CSV 21 F but it was on par with all varieties except M P Chari and CSV 20. Highest dose of NM gave higher value in such quality parameters. NDF and ADF were influenced significantly. The NDF & ADF (%) were estimated higher in MP Chari variety and lowest in control treatment. The economics were worked out and highest monetary returns were obtained by UPMC 503 with NPK (150:80:40) kg/ha of nutrient management practices followed CSV 27 variety of sorghum. The gross return,

net return and benefit cost ratio were the highest in variety UPMC-503 followed by CSV-15 with the application of N-150, P-80, and K-60 kg/ha.

Improvement in Yield and Quality of Forage Maize through Management of Plant Density and Nutrients in Different Cultivars

The study was conducted to evaluate the effect of different planting densities and fertility levels on nutritive yields and quality of fodder maize. Results indicated that plant population, Plant height and number of leaves/plant increased with increase in seed rate. Green and dry fodder yield, leaf: stem ratio, leaf length and width decreased with increase in seed rate, however differences were not significant. The decrease in stem girth was significant with successive increment in seed rate from 60 to 90 kg/ha. Interaction effect between plant density and fertility levels was found significant. Higher seed rate not showed response to applied fertilizer at more than 75% RDF level. These results suggested that, for obtaining good quality fodder in good tonnage, it is suggested to use 60 kg/ ha seed rate alongwith 125% RDF. This combination also obtained significant maximum CP (1542.1 kg/ha), EE (367.4 kg/ha) and ash yield (1280.0 kg/ha). Therefore, to realize higher productivity with enhanced quality of fodder maize with optimum density with seed rate 60 kg/ha and use of 125% of RDF.

Further study was conducted in split plot arrangement with two main-plot treatments consisting of verities (African tall and J-1006) and six sub-plot treatments of zinc fertilization (Zn_0-No zinc sulphate; Zn_1-10 kg/ha $ZnSO_4$ as basal dose ; Zn_2 -20 kg/ha $ZnSO_4$ as basal dose ; Zn_3 -0.5% one foliar spray of $ZnSO_4$ at 30 DAS ; Zn_4 -0.5% two foliar spray of $ZnSO_4$ at 30 and 45 DAS and Zn_5 -10 kg/ha $ZnSO_4$ as basal dose +0.5% one foliar spray at 30 DAS). Results showed that both the verities tested were found statistically at par for all the tested parameters except CP content, in which J-1006 accumulated higher CP over African tall. Application of zinc either as basal or foliar spray improved all growth and yield parameters and yield as well over no zinc. The highest green and dry fodder yield were recorded with Zn_2 (60.16 and 14.15 t/ha), not statistically different from Zn_5 (59.71 and 13.50 t/ha) and Zn_4 (59.32 and 13.14 t/ha) while lowest with Zn_0 (46.69 and 10.25 t/ha), respectively. Results suggested that zinc fertilization of maize through soil and/or foliar spray could enhance not only fodder productivity and quality but also improve nutrient uptake of fodder maize.

Another study was conducted to study the performance of quality protein maize (QPM) cultivars in différent planting windows. August 15th sowing recorded maximum plant height, leaf length, leaf width, number of leaves per plant, green fodder yield (53.49 and 56.17 t/ha) and dry matter yield (11.39 and 12.03 t/ha) during 2014 and 2015, respectively. The performance of 15th August sown maize in post monsoon season was at par with September 5th sowing, however further delay in sowing led to significant reduction in growth parameters and fodder yield. Among different cultivars African tall gave maximum yield, however, the cultivars J-1006, HQPM-1 and HQPM-4 were at par with African tall while HM-10 was significantly substandard to all cultivars tested.

The study was conducted on dual purpose baby corn production under varying crop establishment methods and nitrogen management. The results revealed that significantly higher yield (baby corn and fodder yield) was recorded under raised bed (RB) and zero tillage (ZT) as compared to conventional tillage (CT). However, ZT and RB were on par with each other. Among the nitrogen levels increasing nitrogen levels up to 100% with Azotobactor gave significant higher baby corn as well as fodder yield as compared to control and 75% N with and without Azotobactor. Among the growth and yield attributing characteristics crop establishment method was not affected up to level of significance excepts plant height at harvest which was significantly higher under RB and on par with ZT as compared to CT. Increasing levels of nitrogen increased plant height, no. of leaves and leaf length up to 125% N, which was on par with rest of treatments except control.

Influence of Vanadium Supplementation on Growth, Nutrient Utilisation and Blood Parameters in Sahiwal Calves

Twenty male Sahiwal calves of similar age (6 ± 0.82 months) and body weight (71 ± 8.06 kg) were divided into 4 groups of 5 animals each. All the animals were fed to meet their nutrient requirements (ICAR, 2013), however, the animals in groups T_1, T_2, T_3 and T_4 were also supplemented with 0, 2, 4 and 8 ppm of vanadium, respectively. It was found that the level of vanadium in the diet did not influence feed consumption, nutrient intake, digestibility of nutrients (DM, OM,

CP, EE, NDF and ADF), growth performance (BW and ADG), nitrogen balance and growth rate. Vanadium supplementation at the levels of 2, 4 and 8 ppm of dietary DM did not show any significant effect on excretion and absorption patterns of Ca, P, Cu and Fe and their levels in plasma were also similar in different groups. However, absorption of vanadium and Zn and their levels in plasma were higher ($P<0.05$) in vanadium supplemented groups. Plasma glucose, total protein, aspartate amino transferase and alanine amino transferase levels were not affected by vanadium supplementation. Plasma triglyceride level was ($P<0.05$) decreased by 17.37% and 16.64% in 4 and 8 ppm supplemented groups and cholesterol level showed a declining ($P<0.05$) trend with increase in vanadium concentration in the diet. The alkaline phosphatase activity was higher ($P<0.05$) in groups T_3 and T_4 compared to group T_1 and T_2. The IGF-1 levels were similar in all treatment groups. Blood glutathione peroxidase activity was higher ($P<0.05$) in groups T_3 and T_4 as compared to T_1 and T_2, whereas SOD and catalase activity was similar in all the groups. In conclusion, dietary vanadium supplementation upto 8 ppm had no effect on growth performance and nutrient utilisation. Vanadium and Zn balance and their plasma levels were positively affected. Plasma triglyceride and cholesterol levels decreased; however, APL and GPx activity was significantly increased.

Use of Maize Gluten Meal in Animal Feed

Eighteen early lactating Murrah buffaloes (Mean BW: 589 kg; parity 2.1 and 69.7 days in milk) were allocated to 3 dietary regimens. Control group (C) was offered with concentrate mixture containing GNC as major protein source, while it was replaced isonitrogenously at 50% each by Rice Gluten Meal and Maize Gluten Meal in T_1 and T_2, respectively for 120 days. Results revealed that there was no effect of treatments on nutrient intake, however, milk yield ($P<0.05$), 6% fat-corrected milk yield ($P<0.01$) and milk component (fat, protein, lactose, SNF and total solids) yield were higher in group T_2 than C with no difference between groups T_1 and T_2. Composition of milk, fatty acid profile and renneting properties remained unaltered due to various treatments. Milk urea nitrogen concentration was lower ($P<0.01$) in both the groups T_1 and T_2 than C. Nevertheless, animals in groups T_1 and T_2 were found to be more efficient as reflected by their higher efficiency of conversion of DM ($P<0.05$) and N ($P<0.01$) for milk production. Human-edible feed conversion efficiency was higher ($P<0.01$) in treatment groups than C. N balance increased ($P<0.01$) only in group T_2 with similar microbial protein synthesis and its efficiency. Furthermore, except plasma urea N which decreased ($P<0.05$) in treatments, none of the blood metabolites differed among the groups. Feed cost (₹) per kg 6% FCM lowered by 1.15 and 1.50 in T_1 and T_2 over C. It was concluded that RGM can be used as an alternative protein source isonitrogenously replacing 50% of GNC in lactation rations; however, 50% MGM based diets produced higher milk yield than GNC based diets.

Growth and Nutrient Utilization in Calves Fed Rice Dry Distillers Grains with Solubles (RDDGS) Replacing Oilcake in Concentrate Mixture of Buffalo Heifers

Eighteen female calves of 9-18 months of age (around 176 kg BW) were divided into three experimental groups of 6 animals each on the basis of body weight and age. The control group calves were fed on a diet containing concentrate mixture 1 containing 25 parts of GNC, 10 parts mustard cake and without rice gluten meal, the second group animals were fed on a diet containing concentrate mixture 2 in which GNC and Mustard cake were replaced with RDDGS at 50% level on crude protein basis (T1) whereas, the third group were offered the diet containing concentrate mixture 3 in which GNC and mustard cake were replaced with RDDGS at 75% level on CP basis (T2). Body weight gain for 90 days was 7.98, 8.71 and 8.45 kg and ADG was 532.02,580.33 and 563.72 g/day in control, T1 and T2, respectively, which was similar. There was no effect on overall feed efficiency, digestibility of nutrients, nitrogen metabolism and Plasma glucose, BUN, total protein, ALT and AST levels.

It was concluded that the replacement of ground nut cake with 50% and 75% levels of RDDGS on crude protein basis in the ration of buffalo heifers did not have any adverse effect on nutrient utilization and growth performance and thus rice DDGS can replace ground nut cake and mustard cake upto 75% in concentrate mixture of buffalo heifers.

Supplementation of *Leucaena Leucocephala* Leaves to Impro ve the Nutrient Utilization and Methane Mitigation from Straw Based Diet in Male Murrah Buffalo Calves

Fifteen Murrah male buffalo calves were selected for 90 days of study period, and a 7 days metabolism trial was conducted at the end of the feeding trial. The animals were divided into three treatment groups-T_1, T_2 and T_3. T_1 was fed a diet of wheat straw (WS) and concentrate(C)

(90:10), T_2 was fed a diet of WS, C and *Leucaena leucocephala* leaves (80:10:10) and T_3 with same ingredients as T_2 in the ratio of (65:10:25). Body weight (kg) of the animals increased during 90 days trial with a percent change of 10.99, 20.84 and 19.28% in T_1, T_2 and T_3 respectively. However it was non significant (P>0.05) among the groups in each fortnight. ADG (kg/d) and FCE were significantly higher (P<0.05) in T_2 and T_3 than T_1. DMI was (kg/d) was not higher significantly (P>0.05) in T_2 than in T_3 and T_1 upto 4th but at 5th and 6th fortnight a significant (P<0.05) change was observed among the groups. Difference in digestibility coefficients (%) for all nutrients were statistically non significant (P>0.05). Emission of CH_4 (g/kg DMI) was reduced to 6.3% in T_3 and 3.5% in T_2 than in T_1, though the difference was not significant (P>0.05). CH_4 (g/kg DDMI) reduced to 1.16% in T_2 and 12.04% in T_3 as compared to T_1 however this was not significant (P>0.05). Further, methane loss as percentage of energy intake (GE, DE and ME) in all groups was non-significantly different from each other. Dung of calves was stored for 24 h and gas produced was analyzed. Total gas produced (ml/kg DM) was significantly (P<0.05) higher in T_2 than T_3 and T_1. In T_2 methane production (ml/kg DM), mg/kg DM, percent methane mg/kg DM was significantly higher (P<0.05) than T_3 and T_1. There was significant difference (P<0.05) among the groups.

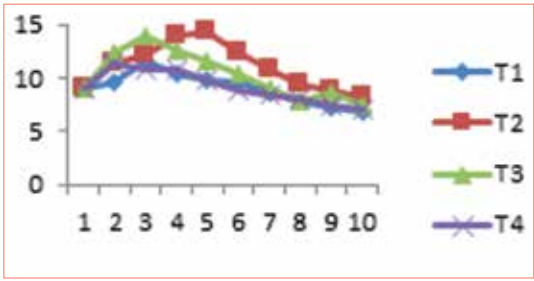
Supplementation of Fibrolytic Enzymes alongwith H_2 Sinks in Stover Based Diet Feeding

Body weight of animals in group C increased from 148.74 ± 19.21 to 151.99 ± 19.27, in T_1 (fumaric acid+enzyme level I) from 149.60 ± 15.88 to 153.11 ± 16.00 and in T_2 (fomaric acid+enzyme level II) from 143.66 ± 14.05 to 147.04 ± 14.33, having total body weight gain of 3.25 ± 0.24, 3.51 ± 0.26 and 3.38 ± 0.35 kg in C, T_1 and T_2, respectively. ADG observed during this period for C, T_1 and T_2, was 463.89 ± 34.09, 501.85 ± 36.76 and 482.41 ± 49.35 g/d, respectively, higher in group T_1 and T_2 group compared to group C however, the difference was not significant (p>0.05). Average DMI (kg/d) did not differ among the groups. CPI (kg/d) was found to be 0.42 ± 0.05, 0.42 ± 0.04 and 0.40 ± 0.03 (kg/d) in the groups C, T_1 and T_2, respectively. CPI and TDN requirements according to ICAR (2013) were fulfilled. The average FCE (g weight gain/kg DMI) in groups C, T_1 and T_2 were 95.63 **±** 2.87, 90.69 ± 3.24 and 89.53 ± 5.73, respectively (P>0.05). DCP was significantly higher in T_1 group followed by T_2 and group C, while there was no difference for the other nutrients. Microbial N (g/d) at intestine level had no significant difference in group C, T_1 and T_2 and average values were 28.73, 29.00 and 28.68. ADG was found to be higher in group T_1 and T_2 compared to group C however, the difference was not significant (p>0.05). CH_4 (g/d) was 74.33, in group C while it decreased to 63.03 in T_2 and 64.58 in T_1 and the differences were nonsignificant (p>0.05).

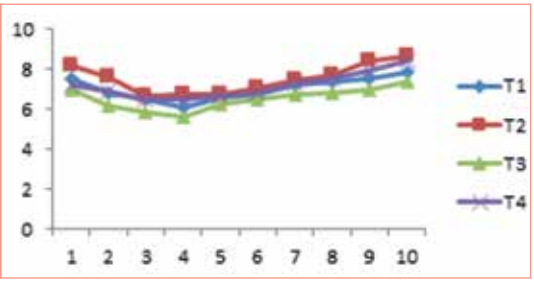
Effects of Calcium Propionate (Ca-Pro), Conjugated Linoleic Acid (CLA) and Mycotoxin Binder (MB) on Lactation

Twenty apparently healthy lactating Murrah buffaloes at parturition were selected and divided into four groups of five animals each on the basis of their milk yield. Animals in the control group (T_1) were fed on chopped sugargraze (cross of sugarcane and sorghum) and sorghum green, wheat straw and concentrate mixture as basal diet while animals in T_2 were fed basal diet with 150g of Ca-Pro + 40 g MB per day per animal mixed with concentrate mixture, while animals in T_3 were fed basal diet with 50 g of CLA + 40 g MB per day per animal and animals in T_4 group animals were fed basal diet with 40 g MB mixed with concentrate mixture. Results revealed that there was no difference (P>0.05) in dry matter intake Findings suggested that there was significant increase (P<0.05) in DM, OM, CP, NDF digestibility due to treatments with various additives i.e. Ca Pro, CLA and MB in various combinations. There was no significant difference (P>0.05) of DM OM, EE, ADF and NDF intake among the groups. There was significant increase (P<0.05) in average milk yield (22% and 13% in T_2 and T_3, respectively than control), 6% fat corrected milk (FCM) in T_2 and T_3 than T_1 and T_4 groups. But, milk fat content was significantly decreased (P<0.05) in T_3 than any other groups due to CLA supplementation (7.0 to 6.5%). Somatic cell count (SCC) was significantly (P>0.05) reduced in T_2, $T_3$and T_4 groups than T_1 group. Mono unsaturated fatty acid (MUFA) and polyunsaturated fatty acid (PUFA) were increased with decreased saturated fatty acid in milk in CLA supplemented group than other groups. Ratio of unsaturated to saturated fatty acid in milk was improved in CLA supplemented group (T_3) which is also beneficial to the consumers. First observed estrous in treatment groups varied from 65 to 91 days and conception rate was also 100% in all the groups. Service period varied from 86 to 125 days in different groups

with the average of 121 days in T_1 and reduced to 103 days in all other supplemented groups (T_2, T_3 and T_4). Reproductive performance was better in supplemented groups.



Fortnightly milk yield of various groups



Fortnightly fat level in various treatment groups

Refinement of Energy and Protein Requirements for Cattle and Buffaloes for Different Seasons

Three TMRs were formulated during two different seasons considering maize as green fodder during high THI (summer) season and oat fodder during low THI (winter) season. The control ration (T_1) was having energy according to ICAR, 2013, in T_2 energy content was15%higher T_3 it was 15% lower than ICAR, 2013 recommendation. Two growth trials of 120 days duration each during summer and winter season were carried out. At the middle of the studies metabolism trials were conducted during two periods. Two *in vivo* SF_6 trials were conducted during high THI (summer) and low THI (winter) periods to evaluate seasonal variation of methane emissions at different levels of dietary metabolizable energy treatment groups. The results showed significantly higher DMI, MEI, TDNI, CPI and DCPI / 100kg BW during winter than summer season and among the treatment groups and significantly lower DMI was observed in low ME group in both the seasons. It was revealed that the animals consumed more nutrients during winter season as compared with summer season. The average ME intake was higher in high energy groups compared to low energy groups. There was significant ($P<0.001$) variation in digestibility of DM, OM, CP and ADF in between both the seasons and treatments. Digestibility was higher during summer season and was significantly higher in high ME group. The N intake was similar in all the three groups in both the seasons thus energy levels had no significant effect on N intake. The absorbed N was improved linearly with increased level of dietary ME whereas the N retention was similar among all the groups. There was no significant variation in the enteric methane emission (g/d) between high THI (summer) and low THI (winter) period. Among the groups, there was significantly ($P<0.05$) higher CH_4 release in T_3 group having low ME than groups T_1 and T_2 in both high and low THI period. ME requirement for maintenance during summer and winter periods were 139.57 kcal and 130.78 kcal per kg $BW^{0.75}$, or 584.35 KJ and 547.54 KJ per kg $BW^{0.75}$ respectively, which was 36.81 KJ higher in summer. In addition, ME requirement for growth were 4.87 and 5.03 kcal per kg $BW^{0.75}$ during summer and winter periods, respectively which was comparable between both periods. CP requirements for maintenance were 5.83 g and 5.97 g per kg $BW^{0.75}$ during summer and winter periods respectively. Energy levels in the ration had no influence on total water intake but it varied between high and low THI conditions. Water requirement of buffalo heifers can be predicted for summer and winter periods from the following equation DWI (L/d) = -14.39+1.56 DMI (kg/d) +0.68 T_{max}(°C) -0.057 RH(%)+0.016 BW(kg).

In another study, Murrah buffalo bulls fed on different levels of energy and protein. Animals were divided as per 2×2 factorial design into four different groups based on body weight viz. HEHP (high energy high protein), HELP (high energy low protein), LEHP (low energy high protein) and LELP (low energy low protein) having 5 animals each and fed different rations having around 15% higher and lower energy than the ICAR (2013). Results showed CP and TDN intakes were significantly higher in higher energy and protein group (1.12 ± 0.05 and 5.17 ± 0.14) as compared to lower energy and protein groups (0.96 ± 0.02 and 4.8 ± 0.1). No significant ($P>0.05$) effect of energy and protein levels on DMI intake, body weight and digestibility of OM, ADF and hemicelluloses was observed. Apparent DM, EE, and NDF digestibility was ($P>0.05$) higher in higher energy fed groups (61.84 ± 1.21, 70.81 ± 1.69 and 56.54 ± 1.03) as compared to lower energy fed group (60.29 ± 1.59, 68.93 ± 1.02 and 55.62 ± 1.97), respectively. In case of testicular and seminal attributes, there was no significant difference except sperm concentration showed significantly ($P<0.05$) higher values in low energy (1355.13 ± 65.49) fed group as compared to higher energy (1172.09 ± 46.18) fed groups. The CP, DCP, TDN and ME maintenance requirements for breeding buffalo bulls were

6.76, 4.17, 34.79 g/kg $W^{0.75}$ and 524.10 KJ/kg $W^{0.75}$, respectively. The requirements for unit body weight change of bulls in terms of CP, DCP, TDN and ME intake per day were 0.281, 0.169, 1.07 g/g BWC and 16.11 kJ/kg BWC/day, respectively.

Dietary Manipulation of Rumen Fermentation using Tree Leaves of North-Eastern India for Improving Growth Performance in Calves

Kamela tree leaves

Attempts was made for using north-eastern Himalayan forest tree leaves as a herbal feed additives in the animals diet to improve its growth performances. Twelve growing Jersey crossbred male calves of about 7-8 months age were divided into 3 groups (G1, G2 and G3) of 4 animals each. They were maintained on roughage (paddy straw) and concentrate based ration for 140 days. Roughage and concentrate mixture was offered separately and their ratio was maintained at 50:50. Three types of iso-nitrogenous concentrate mixtures (C1, C2 and C3) were prepared in which, C1 concentrate mixture contained @ 4% dried leaves (in powder form) of Kamela (*Mallotus philippensis*) while C2 concentrate mixture contained @ 4% dried leaves (in powder form) of *Ficus hookeri* tree. Growth rate, nutrient digestibility, rumen fermentation pattern and feed conversion efficiency were studied in these animals. Kamela (*Mallotus philippensis*) tree leaves were collected from Tripura, while *Ficus hookeri* tree leaves were collected from Meghalaya.

Initial body weight was similar among the calves of three experimental groups while finishing body weight was lower ($P<0.01$) in the calves of G3 than G2 and G1group. Similarly total body weight gain and average daily gain were also lower ($P<0.01$) in the calves of G3 group. Average daily body weight gain of the calves in G1, G2 and G3 groups were 597.1, 557.8 and 525.7 g, respectively. Feed conversion efficiency in terms of DM intake per kg body weight gain were also better ($P<0.05$) in the calves of G1 and G2 groups than G3 group. The DMI/kg body weight gain was 6.3, 6.8 and 7.2 kg in the calves of G1, G2 and G3 groups, respectively.

On the basis of the results obtained in the present study, it may be concluded that inclusion of dried powder of Kamela (*Mallotus philippensis*) or Ficus hookeri tree leaves as herbal feed additives @ 4% in the concentrate mixture of growing calve improve its growth performances.

Utilization of Dried Rice Distillers Grain with Solubles (RDGS) as Major Protein Source in the Diet of Growing and Lactating Jersey Crossbred Cattle

Rice Distillers Grain with Solubles (RDGS) is an important agro-industrial by-product of the distillers industries in Asian countries. The chemical composition of RDGS in terms of OM, CP, EE, NDF, Total Ash and AIA (% DM) were 94.7, 48.4, 5.31, 35.5, 5.3 and 1.23, respectively. The data on chemical composition of RDGS indicated that it could be a very promising alternative feed resource for ruminants. It is an excellent source of crude protein with CP content more than MOC and GNC and similar to SBM. RDGS is also a good source of ether extract which is rich in oleic and lenoleic acid. It's a fair source of minerals. Low crude fiber content further enhances its nutritive value. Incorporation of RDGS replacing SBM significantly improved the digestibility of DM, CP and EE without any adverse effect on DM and nutrient intake. The growth rate improved significantly in RDGS fed group without any adverse effect on blood parameters and the feed conversion efficiency also improved by around 18%. There was no adverse effect of RDGS supplementation replacing SBM on milk yield, feed conversion efficiency and milk composition. The increase in milk yield and FCM yield by around 5.6 and 4.1%, respectively in RDGS fed group as well as the much lower cost of RDGS than SBM resulted in improvement in net profit margin in RDGS fed group by around 16%. RDGS could replace SBM fully in concentrate mixture (@ 25%) of growing calves and lactating cattle without any adverse effect and thus economized the ration and enhanced the net profit.

Utilization of Dried Rice Condensed Distillers Syrup (RCDS) as Major Protein Source in the Diet of Growing and Lactating Jersey Crossbred Cattle

Rice Condensed Distillery Syrup (RCDS) is another important Agro-industrial by-product of the distillers industries in Asian countries. This huge volume of wet Distillery Syrup produced as a

byproduct may create a serious environmental problem if it is spread onto fields. The RCDS required for the present study was provided by IFB Agro Industries Limited, Kolkata. The DM content of RCDS was around 33%. The chemical composition of RCDS in terms of OM, CP, EE, NDF, Total Ash and AIA (% DM) were 89.5, 24.8, 1.24, 10.9, 10.5 and 0.99, respectively. Chemical analysis indicated that it is a fair source of protein very good source of soluble carbohydrate. It is also a good source of some fatty acids (palmitic acid, oleic acid and linoleic acid) and minerals (P, mg, Zn and Fe). Feeding of RCDS (@ 15% of concentrate mixture) to growing crossbred calves resulted no adverse effect on voluntary intake, growth performance, nutrient digestibility, a vailability of nutrients and blood parameters. There was no significant difference in DM Intake and milk composition in crossbred cattle when 15% (DM basis) of concentrate mixture was replaced by RCDS. The milk yield, 4% FCM yield and feed conversion efficiency (kg DMI/kg FCM yield) were also unaffected by replacement of conventional concentrate mixture with RCDS (@15% of conc. Mix.) in the diet of crossbred lactating cows. Thus, it can be concluded that RCDS can replace a part of concentrate mixture in growing as well as lactating crossbred cattle up to 15% (DM basis) level without any adverse effect on milk yield, milk composition, TDMI, growth performance, nutrient intake, nutrients utilization and blood parameters.

Effect of Supplementation of Area-Specific Mineral Mixture (KALMIN) on Productive and Reproductive Performance in Dairy Animals

Studies were conducted to find out the effects of "KALMIN ERS" supplementation on enhancement of pubertal process of growing crossbred heifers in physiological, nutritional and cellular/ molecular terms and on various productive & reproductive performances during pregnancy to lactation transition phases in crossbred cows and goats. The study was conducted to investigate the effects of supplementation of area specific mineral mixture on productive and reproductive performance (first post-partum estrus, conception rate, birth weight of calves, milk yield and its constituents, blood metabolites (glucose, NEFA, AAN, urea, total protein, albumin and globulin), enzymes (SGOT/AST and SGPT/ALT), hormones (progesterone and estrogen) and mineral in pregnant crossbred cows. Eighteen growing crossbred heifers were divided into two groups viz Control (T_0) group (N=9) without area specific mineral mixture and treatment (T_1) group (N=9) with 30g/animal/day area specific mineral mixture .In another study the above parameters for goats were divided into three groups viz. Group I: Control with no mineral mixture; Group II: With 2% commercial mineral mixture; Group III with 2% KALMIN-ERS. It was found that in case of cows supplemented with KALMIN-ERS @ 30g/animal/day decreased the time interval of postpartum estrus and enhanced conception rate first post-partum estrus and in case of goats area specific mineral supplementation significantly improved average daily gain during pregnancy and body weight at kidding in goat.

Effect of Azolla Supplementation on Milk Production, Composition and Blood Metabolites of Alpine x Beetal Goats

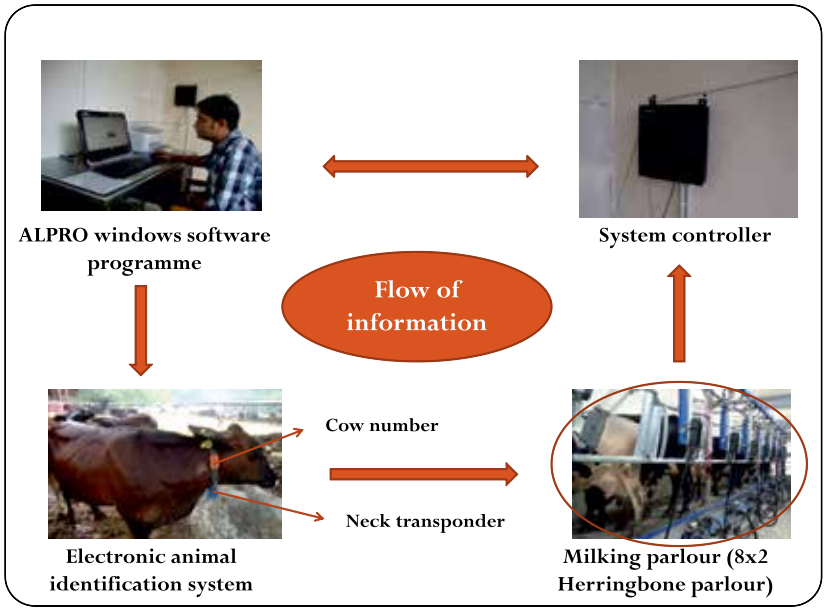
The effect of Azolla supplementation was studied on 30 lactating Alpine x Beetal goats. The experimental goats were randomly divided into three groups of 10 each. T_1 served as control, T_2 animals were fed 25% Azolla of normal concentrated mixture and T_3 were fed 50% Azolla of concentrate mixture. The milk production was significantly (P 0.05) higher in T_2 (1.89 ± 0.58 kg) and T_3 (1.71 ± 0.42 kg) as compared to control (1.57 ± 0.32 kg). The milk production during 210 days study period averaged 329.7, 396.9 and 359.1 kg in T_1, T_2 and T_3, respectively giving additional yields of 8.92% and 20.28%, respectively in T_3 and T_2 over control group. The income from milk was significantly (P 0.05) higher in T_2 (₹ 11907.00) as compared to T_3 (₹ 10773.00) and T_1 (₹ 9891.00), respectively giving additional income of ₹ 2016.00 and ₹ 882.00, respectively in T_2 and T_3 over control. DM intake was significantly (P 0.05) higher in T_2 (1280.74 ± 6 0.96 g) and T_3 (1207.85 ± 40.41 g) as compared to control (1161.29 ± 65.31g). Milk composition was not affected by Azolla supplementation. The ALT was significantly higher in T_2 (81.72 ± 2.69 u/l) and T_3 (72.28 ± 2.66 u/l) as compared to control (68.03 ±1.37 u/l). The similar pattern was also recorded in AST (u/l) and BUN (mg/dl). It was concluded that feeding of Azolla supplement to Alpine x Beetal goats during post partum had positive effect on milk production, profit, DM intake and blood metabolites.

INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS

Performance, Udder Health and Milk Quality of Crossbred Dairy Cows Milked in Automated Herringbone Milking System

A study was carried out to assess the effect of automated milking system on milkability, udder health, behaviour and milk quality of dairy cows in automated herringbone milking system.

For this study, in the first phase an average number of 69 crossbred cows in different parity, stages of lactation and udder types were milked in 8 x 2 low-line automated herringbone milking parlour having automatic cluster remover settings. The milkability traits were studied for a period of 3 months based on observations generated automatically in Herd Management Software of the automated milking system. In second phase, 56 crossbred dairy cows with apparently normal udder and teat conformation were selected and milked in the automatic milking parlour using nine combinations comprising five vacuum levels, two pulsation ratio and four automatic cluster removal settings.



Flow of information in automated herd management system

It was concluded that automatic herringbone parlour was suitable for milking of crossbred dairy cows in view of appropriate milkability, normal udder health, milk quality and milking behaviour. A vacuum level of 42 kPa with ACR of 0.2 kg/min and pulsation ratio of 65:35/60: 40 ($P<0.05$) was found to be the most appropriate milking machine settings for milking crossbred cows under Indian conditions.

Development of Dairy Cattle Welfare Assessment Scale

The resource availability, husbandry practices and performance levels of dairy animals have a great impact on animal welfare. There is lack of information on dairy cattle welfare problems and methodology for assessing welfare level under different production systems in India. Therefore, a dairy cattle welfare measurement scale was developed for assessing the level of dairy cattle welfare in different types of dairy farms.

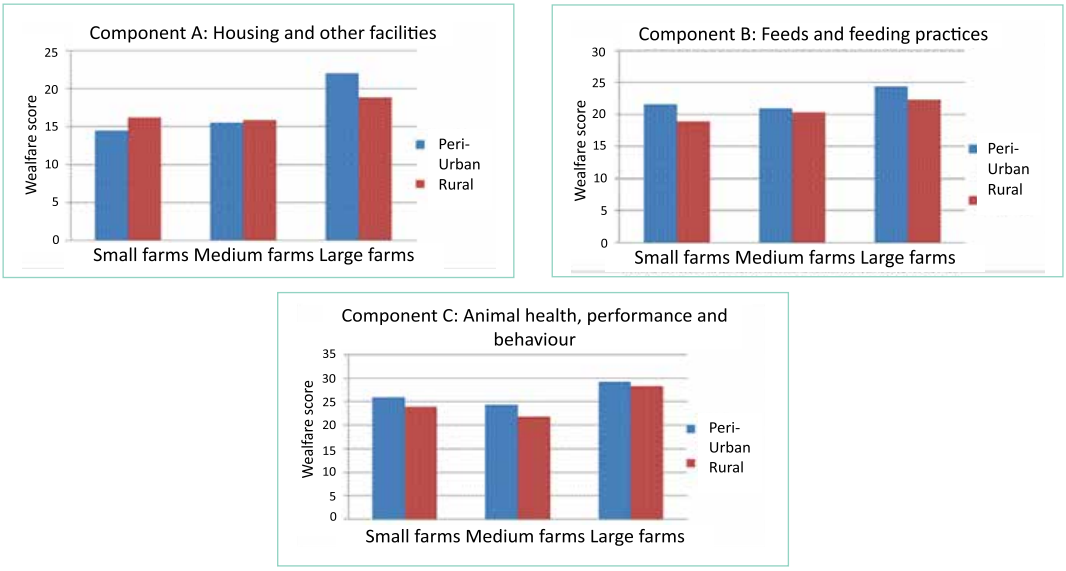
The fundamental basis for the development of the scale was adopted from Calamari and Bertoni (2009) and was modified as per Indian dairy farming conditions. For the development of dairy cattle welfare assessment scale 3 major components viz. housing and other facilities (Component 'A'), feeds and feeding practices (Component 'B'), and animal health, physiology and behaviour (Component 'C') were selected and assigned welfare score of 30, 30 and 40, respectively out of an overall welfare score of 100. From these 3 components, 20 welfare indicators were identified having 6, 4 and 10 indicators in each component, respectively. The scale was tested for its reliability and validity using Cronbach's alpha and opinion of experts, respectively. Principle component analysis was performed to delineate the welfare indicators which affected most the overall welfare score.

Assessment of Dairy Cattle Welfare Status in Haryana

Dairy cattle welfare assessment scale developed was applied for the assessment of welfare level of dairy farms in Haryana. For this purpose, 50 commercial dairy farms were purposely selected and categorized into small (10-20 cows), medium (21-50 cows) and large (>50 cows) based on adult herd size.

- The mean value of welfare scores in Component A was 15.35 ± 0.74, 15.65 ± 0.66 and 20.40 ± 0.78 in small, medium and large dairy farms, respectively. The mean welfare score of the large dairy farms was significantly ($P<0.05$) higher than the mean score obtained in other two categories of farms.
- The mean value of welfare scores in Component B was 20.30 ± 1.12, 20.70 ± 1.12 and 23.40 ± 1.18 in small, medium and large dairy farms, respectively with the mean of large dairy farms was significantly ($P<0.05$) higher than the other two categories.
- The mean values of welfare score of Component 'C' were 24.85 ± 0.40, 23.00 ± 0.40 and 24.30 ± 0.38 in small, medium and large dairy farms were, respectively.
- The overall mean welfare scores in all components out of a total score 100 by small, medium and large dairy farms were 60.5 ± 2.74, 59.35 ± 2.17 and 68.1 ± 1.18, respectively.
- The overall mean welfare score of small, medium and large dairy farms in peri-urban area were 62.00 ± 3.32, 60.80 ± 2.57 and 75.60 ± 2.12 and in rural area were 59.00 ± 2.22, 57.90 ± 1.79 and 69.40 ± 2.74, respectively.
- The overall mean welfare score of large dairy farms in all components was significantly ($P<0.05$) higher than small and medium dairy farms.

It was concluded that the overall welfare status of large and small commercial dairy farms in Haryana was found to be 'very good' and the welfare status of medium dairy farms was in 'average' category. The welfare ranking of peri-urban large commercial dairy farms was the highest with welfare score of 75.60 and a rural medium dairy farms was the lowest with a welfare score of 57.90. Feeding space, feeding and watering system with frequency; mastitis incidence; cow comfort and reproductive efficiency were the most compromised welfare indicators in case of small and medium dairy farms, whereas human-animal relationship, mastitis incidence and reproductive efficiency were the most compromised welfare indicators in case of large commercial dairy farms.



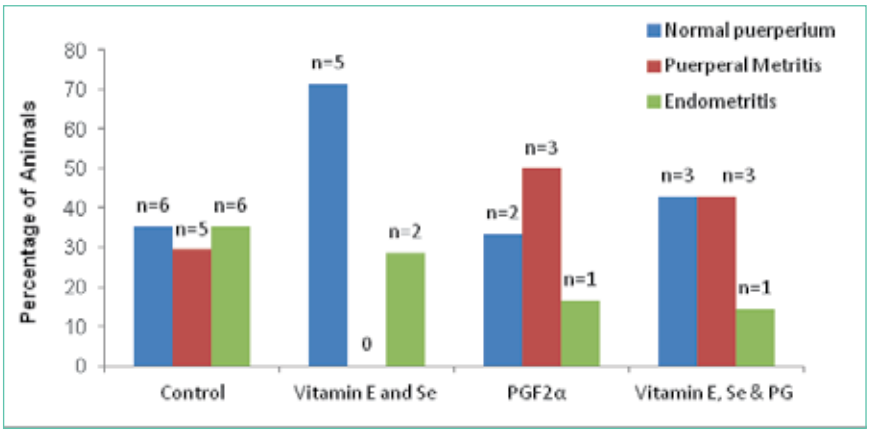
Welfare scores at dairy farms in component A, B and C

Transcriptional Abundance of Antioxidant Enzymes in Endometrium and Circulating Levels of TAC, MDA and NO in Sahiwal Cows in Relation to Postpartum Uterine Health

Alterations in oxidative and antioxidative molecules in peripheral circulation may influence the antioxidative defense mechanism in uterine endometrium and contributes to development of uterine infection during postpartum period in cows. Peripheral blood concentrations of total antioxidant capacity (TAC), malondialdehyde (MDA) and nitric oxide (NO) were estimated (day −21, −7, on the day of calving and day +7, +21, +35) in normal (healthy) (n = 11), puerperal metritic (n = 7) and clinical endometritic (n = 6) cows. Transcriptional abundance of CAT, GPx4 and SOD2 genes in endometrial biopsy tissue was studied. Significantly lower ($P < 0.05$) TAC and higher ($P < 0.05$) MDA and NO concentrations during peripartum period and lower ($P < 0.05$) expression of CAT, GPx4 genes and higher expression of SOD2 gene was observed in endometrium of cows that developed uterine infection than normal (healthy) cows. It may be inferred that the low serum TAC level and high level of lipid peroxidation and NO production during peripartum period influence the endometrial expression of anitioxidative genes that compromise the uterine health during postpartum period.

Modulation of Postpartum Uterine Health by Administration of Vitamin E and Se during Peripartum Period in Sahiwal Cows

A total number of 37 Sahiwal cows during peripartum period were divided into 4 groups, control (n=17), Vitamin E and Se group (n=7), $PGF_{2\alpha}$ (n=6) and Vitamin E, Se, $PGF_{2\alpha}$ (n=7) group. Cows in Vitamin E and Se group were administered with 5 doses of E Care SE (1000 IU Vitamin E and 10 mg of Se) 30 days, 15 days prepartum and on the day of calving and 15 and 30 days postpartum. Cows with PG group were administered with one dose of cloprostenol (250 µg) on the day of calving and combined group were administered with both vitamin E, Se and $PGF_{2\alpha}$. Uterine health was monitored for these cows on the basis of uterine discharge scoring, USG and clinical signs. Administration of cows with Vitamin E and Se during peripartum period has shown beneficial effect on improving uterine health since highest number of the cows (73%) in this group undergone normal puerperium and didn't develop uterine infection compared to control (30%), $PGF_{2\alpha}$ (33%) and combined group (42%).



Effect of Vitamin E and Se and $PGF_{2\alpha}$ administration on uterine health in Sahiwal cows.

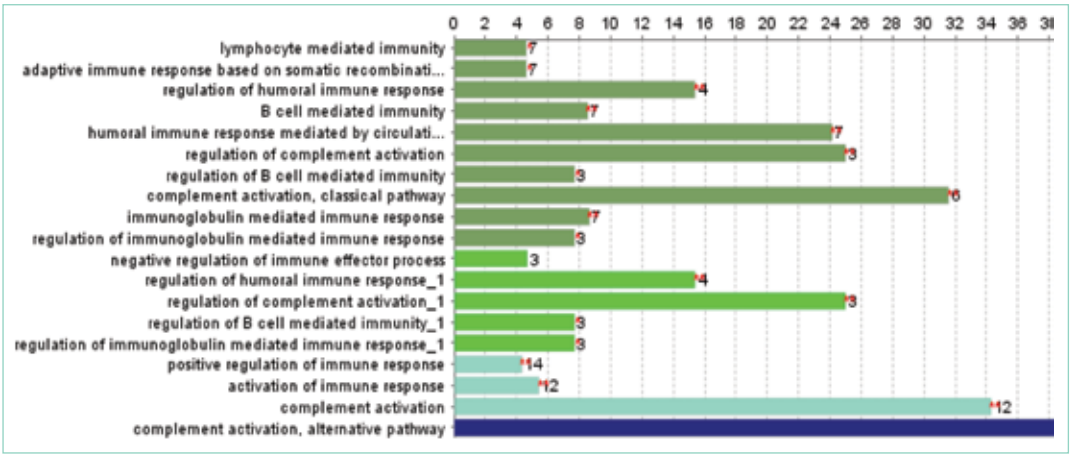
Differential Expression of Proteins in Endometrial Tissue of Sahiwal Cows

Uterine immunity during peri-calving period play key role in elimination of pathogens and to maintain uterine health and subsequent fertility. Therefore, it is important to understand the uterine physiology immediate to parturition and to explore the mechanism of uterine susceptibility to infections in order to develop suitable preventive strategies and predict future reproductive health status. Endometrial biopsy samples were collected on the day of calving from sahiwal cows and differential expression of proteins were studied using iTRAQ and nLC-MS/MS technique. A total of 819 non-redundant proteins were identified and out of these 389 proteins were up-regulated (>1.5 fold) in cows that developed puerperal metritis than normal cows. Cows that developed clinical endometritis had shown 74 differentially expressed proteins than normal cows and out of these 24 proteins were up-regulated (>1.5 fold) and 50 proteins were down-regulated (<0.6 fold). These differentially expressed proteins were associated with several immune signaling

processes such as focal adhesion, PI3K-Akt signaling, apoptosis process, antigen presentation and processing, oxytocin signaling pathway, leucocyte transendothelial migration, bacterial invasion of epithelial cells, estrogen signaling pathway, RAGE receptor binding pathway, Fc gamma R-mediated phagocytosis, response to reactive oxygen species. Out of the differentially expressed proteins, seven (07) proteins were selected for early identification of susceptibility of cows towards postpartum uterine infection and for further validation.

Identification of Candidate Proteins in Serum of Sahiwal Cows as Predictive Markers of Uterine Infection

Postpartum uterine infection is one of the important conditions in dairy cattle that compromise their fertility and productivity. Immune system of animals play important role in clearing off the infection and making uterus sterile, hence, studying the changes in expression of proteins in serum during period immediate to calving may give an clue to understand the susceptibility of animals to postpartum uterine infection. Serum samples were collected on the day of calving from sahiwal cows (n=24) and their uterine health was monitored during postpartum period based on uterine discharge scoring, USG and clinical signs. Differential expression of proteins was studied between puerperal metritic (n=3), clinical endometritic (n=3) and control (healthy) cows (n=3) using label free quantification (LFQ) and LC-MS/MS. A total of 150 and 226 proteins were differentially expressed in puerperal metritic and clinical endometritic cows vs. normal (healthy) cows. Out of which, 09 proteins were up-regulated (>1.5 fold) and 52 proteins were down regulated (<0.6 fold) in puerperal metritic vs. control cows and 13 proteins were up-regulated and 89 proteins were down-regulated in clinical endometritic vs. control cows. These differentially expressed proteins were associated with several immune signaling processes such as regulation of innate and humoral immune response and regulation of immunoglobulin mediated immune response. Out of the differentially expressed proteins, three (03) proteins were selected as predictive markers of postpartum uterine infection and for further validation.

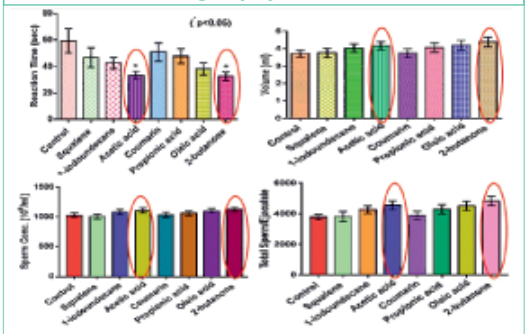


Gene Ontology based classification of differentially expressed proteins on the basis of their involvement in immune system using Cytoscape software with ClueGO plug-in

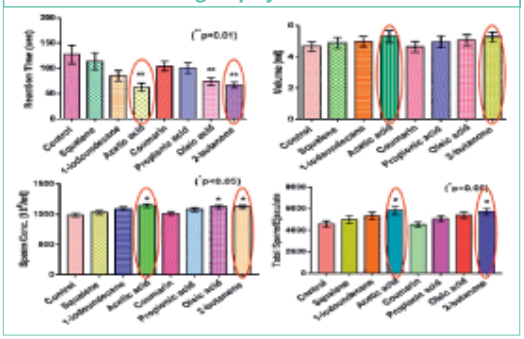
Strategies to Improve Semen Production Performance in Indigenous Dairy Bulls

Zebu bulls are shy breeder and they exhibit optimum libido in presence of female with estrus phase only, but semen collection with use of male dummy leads to lack of adequate sexual stimulation and more time taking for semen collection. Therefore, the present study was designed to test the effect of estrus specific molecule(s) for effective sexual preparation of donor bulls. For this, based on sexual behaviour score, bulls were classified into weak and strong libido groups. Seven synthetic estrus specific molecules i.e. coumarin, squalene, oleic acid, 2-butanone, acetic acid, propionic acid, 1-iodoundecane were used on ten breeding Sahiwal bulls. Same bulls were used as control and exposed to each molecule one by one by giving a refractory period of 14 days. Individual nasal spray of acetic acid or 2-butanone to strong libido bulls reduced reaction time and Total Time Taken to Ejaculate (TTTE), and increased Libido Score (LS), Mating Ability Score (MAS), Sexual behaviour Score (SBS), but no change was observed in overall semen production. With the exposure of acetic acid, oleic acid and 2- butanone in weak libido group, RT and TTTE were decreased and LS, SBS, MAS as well as sperm concentration were increased. However, the

Sexual behaviour and semen quality of strong libido group of bulls



Sexual behaviour and semen quality of weak libido group of bulls



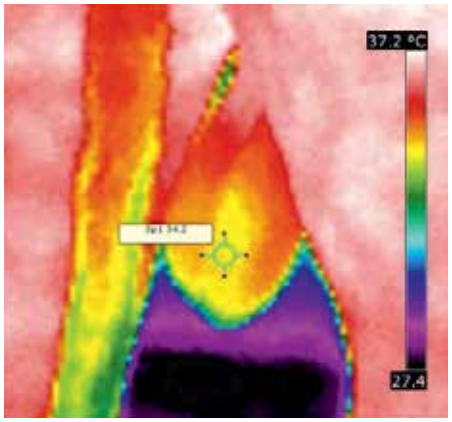
bulls of libido independent group of showed significantly higher (p<0.01) output of total sperm per ejaculate and exhibited better RT, TTTE, LS, MAS and SBS with acetic acid, oleic acid and 2-butanone exposure. Thus, it was concluded that acetic acid, 2-butanone and oleic acid were found to be effective for better sexual preparation of Sahiwal bulls and total sperm output.

Infrared Thermal Imaging: A Potential Technology for Early Detection of Mastitis in Cows

Infrared image of udder skin surface

Early diagnosis of mastitis is most important in order to reduce the economic losses to the dairy farmers and dairy sector. In this study, the relationship of udder skin surface temperature (USST) assessed using IRT camera with milk somatic cell count (SCC), electrical conductivity (EC) and California Mastitis Test (CMT) and assessed the usefulness of USST in detecting sub-clinical mastitis in crossbred (Karan Fries) and Zebu (Deoni) cattle was established. The mean body and USST of non-mastitis crossbred and Deoni cows did not differ significantly. The body and USST of both the breeds were significantly higher by 0.9 to 1.0 °C during evening milking than morning milking. The stage of lactation, milk yield and parity did not show any influence over body and USST. Deoni cows had 1.0 °C lesser body and USST than crossbred cows. USST of sub-clinical and clinical mastitis-affected quarter was higher than unaffected quarter by 0.8 and 1.0°C, respectively in crossbred cows. Similarly, subclinical mastitis affected Deoni cows showed 1.42 °C higher USST. The USST was positively correlated with EC and SCC in both crossbred and Deoni cows. The ROC curve analysis revealed a higher sensitivity for USST in early prediction of SCM with a cut-off value of >37.56 and >36.75 °C in crossbred and Deoni cows, respectively. It was concluded that baseline thermographic information on body and USST would be useful in developing thermographic signature for individual animal and predictive model for early detection of mastitis.

Effect of Climatic Variations on Scrotal Thermal Profile of Murrah Bulls



Infrared thermography image of scrotal surface

The scrotal thermal profile of proximal pole (PPT), mid pole (MPT) and distal pole (DPT) of the scrotal surface (SST) and ocular temperature (OcT) of 109 Murrah bulls maintained at commercial semen production stations were recorded by FLIR i5 infrared thermal camera and analysed by Quick Report 1.2 SP2 software. Microclimatic factors were measured using standard techniques and Temperature Humidity Index (THI) was calculated and classified as high (>80.88), medium (70.06 to 80.88) and low (<70.06). Data were analysed by ANOVA and Tukey test. The THI had significant (P<0.05) effect on SST and OcT, whereas PPT (°C), MPT (°C), DPT (°C) and OcT (°C) values during high THI period were 34.51 ± 0.07, 33.76 ± 0.08, 32.89 ± 0.10 and 36.85 ± 0.06, respectively which was found to be significantly (P<0.05) higher as compared to corresponding values obtained during medium and low THI periods. The temperature gradient (TG, difference between the PPT and DPT) of the

testes was significantly (P<0.05) higher during low THI period (4.50 ± 0.06 °C) as compared to medium THI (2.38 ± 0.03 °C) and high THI (1.61 ± 0.05 °C). The findings indicated that the scrotal TG decreased during high THI period as compared to medium and low THI periods. The recording of microclimatic variables in conjunction with the infrared thermography could be used for assessing the effects thermal stress on physiology and health of buffalo bulls.

National Innovations on Climate Resilient Agriculture-Deoni Breed

Effect of chromium propionate, an antioxidant, supplementation on physiology and growth of Zebu calves was studied. Deoni female calves (n=18; Age- 374.22 ± 25.66 days, Body weight- 121.67 ± 6.50 kg) were divided into three groups. In one group calves were supplemented with chromium propionate @ 3 mg/day; in the other group, it was supplemented at 5 mg/day while the calves in the remaining group were treated as control. Physiological, haematological parameters, dry matter intake and weight gain were recorded at fortnightly interval. The dry matter intake did not differ significantly among the groups while the average daily weight gain was significantly (P < 0.05) higher in 3 mg/day (182.05 ± 28.21 gm/day) and in 5 mg/day (171.79 ± 16.58 gm/day) chromium propionate supplemented group as compared to the control group (84.60 ± 18.33 gm/day). It was concluded that supplementation of chromium propionate @ 3 mg/day improved the growth rate in Deoni female calves during winter season.

Vermicomposting for Utilization of Dairy, Fodder and Tree Leaves Waste Biomass

Vermicomposting Fig. ***A.*** *Cattle dung ,****B.*** *Ragi straw waste,* ***C.*** *Dried fallen leaves,* ***D.*** *Vermicompost pit,* ***E.*** *Earth worms* ***F.*** *Vermicompost product*

In the dairy farms, a lot of biomass goes as waste, which otherwise could be converted into valuable manure. Vermicomposting is the process by which earth worms are used to convert organic materials into a humus-like material known as vermicompost. To develop a model for demonstration of conversion of waste biomass into valuable bio-manure, SRS of ICAR-NDRI, Bengaluru has recently started utilization of bio-waste (the unwanted bushes/weeds/fallen leaves available in the farm area/institute campus, and dung & urine) utilizing vermicomposting technology, by using earthworms *viz. Eisenia foetida &Eudrilus eugeniae* whichconsumes organic wastes and reduce the volume by 40–60 per cent and converts into high quality organic manure for the plant and horticultural crops. In the unit, a wide range of agricultural residues, such as ragi/paddy straw, dried leaves, weeds etc, and dairy cattle wastes viz. dung, urine and biogas slurry are converted into vermicompost. This eco-friendly waste management system is efficient in handling the dairy animals and agricultural waste. At this station, since September 2016, vermicomposting has been initiated which is serving as a source of revenue generation. Hands on practical trainings on dairy cattle waste management and vermicomposting technology are provided to farmers/ entrepreneurs and interested parties.

Impact of Climatic Stress on Milk Production in Crossbred Jersey Herd in Lower Gangetic Region

Environmental factors like temperature, humidity, rainfall etc. are some of important constrains that influence the production and reproduction in domestic animals. Due to rise in environmental temperature and humidity, stress increases and there by cardinal physiological responses are altered. Thermal humidity index (THI) is a combined indicator of environmental variables that gives better precession in judging the alteration in physiological response, voluntary feed intake, body growth and changes in milk production of lactating cows. Impact of THI on production performance of whole herd of Jersey crossbred cows at ERS-NDRI, Kalyani was investigated. Based on THI environment was classified as slight to moderate (THI<80) and high stressful conditions (≥80). When THI exceeded 80, the morning milk yield (kg) and overall herd average (kg/day) were decreased. On overall basis, 66.6% days of the year was low to moderate stressful and rests 33.4% severe stressful. The daily herd average (kg/cow) and percentage of lactating cows in herd

between two environmental stress conditions were 4.61 ± 0.01 vs 4.44 ± 0.02, and 72.92 ± 0.17 vs 69.95 ± 0.21, respectively. The study revealed that there was reduction of 170 gm milk per cow per day in the herd under high stressful conditions. However, milk fat percentage and solids not fat percentage remained unchanged.

Influence of Some Managemental Practices on Incidence of Subclinical Mastitis and Milk Quality in Dairy Cows

Farm study was carried out in 30 Jersey crossbred cows comprising of 3 groups viz: in control group (T_0) fodder was offered 1 hour after milking (as usual) but in T_1 group fodder was provided immediately after milking and T_2 group was supplemented with Vit-E @ 1000 IU / day/ animal during 30 days pre-partum and 60 days postpartum and fodder offering as usual one hour after milking. The analyzed data revealed that effect of treatments were significantly ($P<0.01$) varied for Log_{10} SCC, MCMT, pH and MBRT. The overall higher Log_{10}SCC (cells / ml) was recorded in T_0 group (5.67 ± 0.10) but it was lowest in T_1 (5.15 ± 0.06) and lower in T_2 group (5.34 ± 0.06). The overall higher MCMT (grade) was observed in T_0 group (3.11 ± 0.17) as compared to T_1 (1.41± 0.10) and T_2 (1.54 ± 0.08). The overall higher pH was recorded in T_0 group (6.81 ± 0.01) but it was lowest in T_1 (6.65 ± 0.02) and lower in T_2 group (6.67 ± 0.02). The management practice of offering fodder immediately after milking (T_1) showed significant ($P<0.01$) effect on PMSP and Vit-E supplementation (T_2) showed significant ($P<0.01$) effect on udder health status. The overall MBRT (minute) was higher in T_1 group (402.42 ± 12.54) but it was lowest in T_0 (172.71 ± 18.91) and lower in T_2 (382.00 ± 41.67). The effect of treatments were non-significant for Fat and SNF content in milk. The study can be concluded that Vit-E (feed grade) supplementation (@ 1000 IU/ day/cows, during 30 days pre-partum to 60 days post-partum) can improve udder health status without major changes in milk composition. The management practice like regular fodder offering immediate after completion of each milking session can increase standing behavioural time and decrease SCM cases without altering milk quantity and composition in Jersey crossbred cows. Comparatively, the practice of higher PMSP is better over the practice of Vit-E supplementation to maintain udder health status in Jersey crossbred cows. These management practice can improve milk quality by keeping milk SCC to minimal levels.

Evaluation of the Improved Feeders on the overall Feed Wastage and Performance of the early Growing Crossbred Calves

The study was carried out in NDRI- ERS, Kalyani with eight Jersey crossbred calves. *Ad libitum* amount of feed and fodders were offered in conventional aluminum bowls and improved feeders designed for the calves, respectively. The average body weight of the calves were better when offered feed and fodders in improved feeder with significantly ($p<0.05$) high dry matter intake (Kg/animal/ day). The conventional aluminum bowls were sufficient for 3 small sized calves while 9-10 calves could feed comfortably in the improved feeder. Another major problem of aluminum bowls were that the calves inserted their legs in the feeder bowls, contaminating the feeds with dung and urine. In such a condition, feed became unpalatable which was often refused by the animal leading to wastage. The investigatory behavior of weaker calves in the group when fed in aluminum bowls were often suppressed as the healthier calves pushed them at times while feeding. The average residue in aluminum bowls was significantly ($p<0.05$) higher than the improved feeders. The FCR in conventional aluminum bowls and improved feeder was 1.96 and 1.84, respectively. Therefore it was concluded that feeding the young calves in improved feeders was better than the conventional aluminum bowls.

Improved feeders for the Calves

Effect of Housing Management on the Health and Performance of Early Growing Crossbred Calves before Weaning at the Lower Gangetic Plains of West Bengal

The calves are reared in two different types of housing management where they are housed in groups of more than four in semi covered housing while the other group was managed in pairs in enclosures. Rectal temperature was significantly higher ($P<0.05$) in group housing (101.32 ± 0.10) to those in pair (100.06 ± 0.72) while THI was significantly higher ($P<0.05$) in pair housing (74.65 ± 0.05) than group housing (72.95 ± 0.45). Both the rectal temperature and THI was recorded higher during rainy season of June to October when compared to the mild winters of West Bengal. During the rainy season the body weight did not differ in both the housing types but, during the winter of Nov to Feb the body weight was significantly higher in animals that were housed in pair with higher DMI. Simultaneously, behavioral observations recorded by scan sampling method for 30 minutes daily showed that the animal in groups spend significantly higher ($P<0.05$) time standing (21.24 ± 2.98 min) while animal in pair spend longer time ($P<0.01$) lying. It was observed that the animals in pairs took significantly ($P<0.01$) longer time to suckle the milk when bottle fed. More oral behaviour like licking, biting and suckling was observed in pair housing than in groups. Diarrhoea and respiratory diseases were comparatively few ($P<0.5$) in calves housed in groups. Therefore, group housing is better for rearing calves in the Lower Gangetic plains of West Bengal. However, during winter months of Nov to Feb make shift arrangement to protect the animals from cold drafts using gunny bags and plastic sheets must be used.

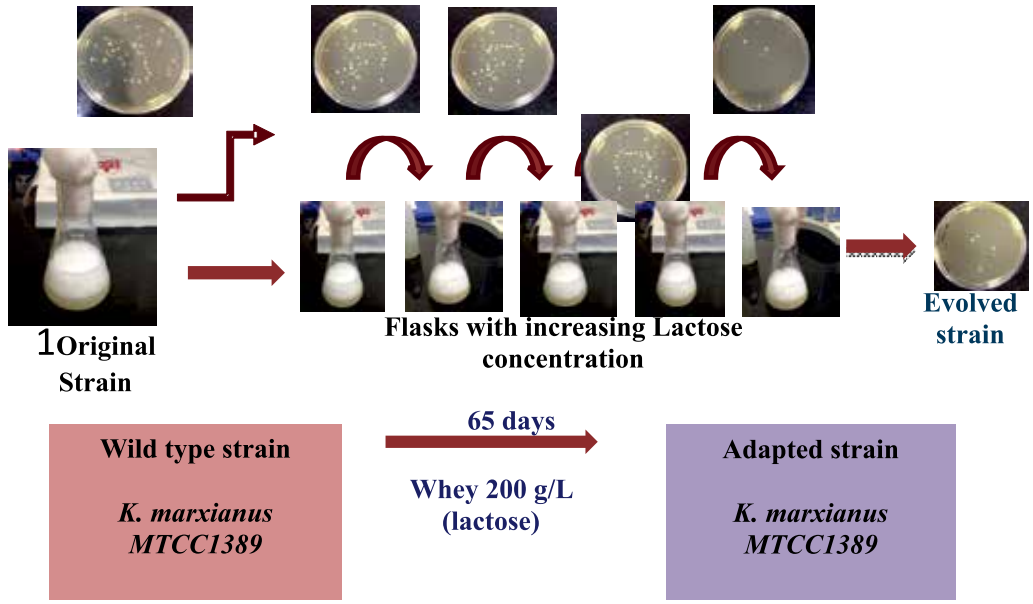
Biochemical and Molecular Characterization of Bovicin from *Streptococcus Bovis* Having Anti-Methanogenic activity

Bacteriocin-like inhibitory substance (BLIS) was detected in rumen *streptococci*. The rumen liquor isolate RLA recovered from rumen liquor samples showed higher bacteriocin production (1.28×10^4 AU/mL) as compared to the other bovicin gene positive RLV (6.4×10^3 AU/ml) using spot on lawn assay. The result of API 20 Strep system for the species identification also showed the close identity of RLA (98.3%) with *Streptococcus gallolyticus* formerly *Streptococcus bovis*. The selected isolate RLA was subjected to different culture conditions to optimize conditions for maximal bacteriocin production. The maximum bacteriocin production (12.8×10^3 AU/ml) of *S. bovis* RLA could be achieved in basal medium broth at optimal conditions of temperature 40°C and initial pH 6.5 at 24 h of incubation. The antibacterial substance produced by RLA was protease sensitive, remained active in a pH range from 2.0 to 12.0, and was found to be heat stable since it did not lose activity after heating at 100°C for 15 min.

NOVEL APPROACHES IN VALUE ADDITION AND PROCESS ENGINEERING

Lactose Utilization from Whey by Evolutionary Engineering of *Kluyveromyces Marxianus*

Seven strains of *Kluyveromyces marxianus* (MTCC1389, MTCC1388, MTCC188, MTCC4059, MTCC4136, MTCC242, and MTCC4139) were screened for the sugar tolerance, ethanol tolerance and thermotolerance. Selected strain MTCC 1389 tolerates sugar (lactose) upto 200 g/l, ethanol upto 6% and thermotolerant upto 45°C. Ethanol production was similar in 150 g/l and 200 g/l lactose in MTCC 1389. The study was designed to develop a multi-stress tolerant strain of *K. marxianus* for the production of ethanol from lactose rich whey. Therefore, *K. marxianus* MTCC1389 was selected to adapt in concentrated whey (200 g/l lactose). Fermentation with adapted *K. marxianus* MTCC 1389 strain in 3l bioreactor resulted in final ethanol titer of 79.33 ± 0.82 g/l which was nearly 17.5% more than parental strain 65.66 ± 0.12 g/l. Adapted strain was found stable even after 10 cycles of fermentation in whey (50g/l). Moreover, expression of stress responsive genes was analyzed in both parental and adapted strain. The experimental analyses suggested that the MTCC 1389 adapted strain was able to valorize lactose to ethanol at a faster rate than the parental strain. Evolutionary engineering was found to be an efficient strategy to obtain a superior biofuel yeast strain, which efficiently fermented four-fold concentrated cheese whey.



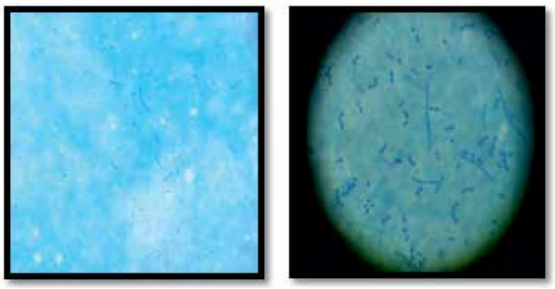
Evolution of Kluyveromyces marxianus 1389 cultures with concentrated whey

Exopolysaccharides Producing Lactic Cultures for Low-fat Shrikhand

Six EPS producing strains that comprised of ropy and non-ropy were selected for the study. The selected cultures were investigated for EPS production in deproteinized whey (DPW) supplemented with glucose (7 g/l) and yeast extract (3.5 g/l). Streptococci produced higher amount of EPS than Lactobacilli. The highest EPS production of 257.17 ± 1.69 mg/l was observed for *S. thermophilus*

1, whereas, *L. delbrueckii* subsp*. bulgaricus* 2 (78.67 ± 1.94 mg/l) showed lowest EPS production. Shrikhand prepared from high and medium EPS producing cultures had high moisture retention and body and textural defects. EPS producing cultures was found to be better option for preparation of low fat Shrikhand than non- EPS producing cultures. However, before use, careful screening is required for various technological properties since not all EPS producing cultures gives desirable attributes to low fat products. Highly ropy cultures were not found suitable for making low fat Shrikhand, as they hold more moisture and create problem in dewatering of curd, which is essential aspect during Shrikhand making process. Nevertheless, EPS producing cultures selected in this study (*S. thermophilus* 3 + *L. delbrueckii* subsp. *bulgaricus* 3) could be used to produce low fat Shrikhand.

Production of Direct Vat Set (DVS) Greek-Style Yoghurt Culture

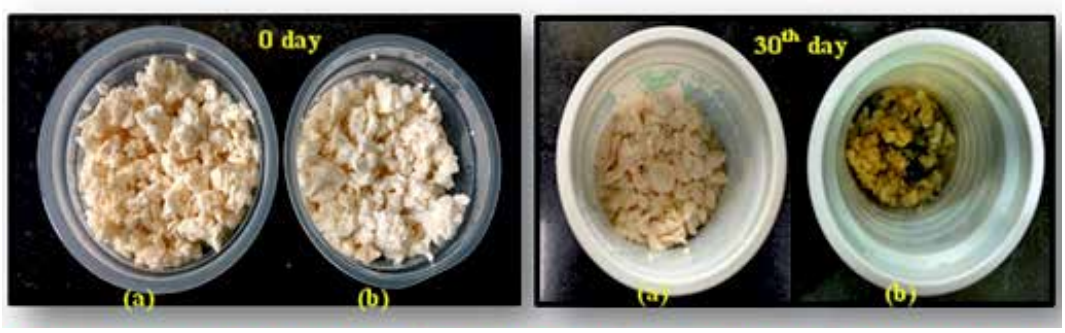


Yoghurt Culture

Greek-style yoghurt is a semisolid fermented dairy product characterised by thick creamy texture, heavier mouth-feel and high nutritive value. Two yoghurt cultures (*S. thermophilus* NCDC 526 (ST 526); *L. delbrueckii* subsp*. bulgaricus* I15 (LB I15) and (*S. thermophilus* NCDC 455 (ST 455) and *L. delbrueckii* subsp*. bulgaricus* I15) were selected on the basis of previous studies carried out earlier in starter culture Lab. Based on sensory, physicochemical and microbiological attributes of Greek-style yoghurt, ST 526+LB I15 combination was selected for DVS formulation. Cell biomass production in whey based medium was optimized by batch fermentation followed by harvesting of cell biomass and its suspension in cryoprotective medium before subjecting to freeze drying. Viable counts of freeze dried cultures so produced were observed to be 12.41 and 12.21 log cfu/g for ST 526 and LB I15, respectively. Prepared DVS cultures were packed in cryo-vials and stored at -20°C for 75 days. The cultures during storage were analysed for viable counts and evaluated for preparation of Greek-style yoghurt. The viable counts of DVS cultures were more than 11.00 log cfu/g with a curd setting time of 4.5 h after 75 days. Microbiological, physicochemical and sensory qualities of Greek-style yoghurt prepared with DVS cultures were acceptable till 30 days of storage at 7 ± 1°C. Therefore, the freeze dried concentrated cultures could be used as DVS starter for production of good quality Greek-style yoghurt.

Lactobacilli as Protectants for Cottage Cheese

Lactobacillus plantarum NCDC-769 was found to exhibit highest inhibition invariably against *Staphylococcus aureus*, *Listeria monocytogenes*, *Bacillus cereus*, *Pseudomonas fluorescens*, *Rhodotorula glutinis* and *Penicillium roqueforti* as indicated by zones of inhibition of sizes 29.25, 30, 21.25, 31.75, 30.75 and 52 mm, respectively. *L. plantarum* NCDC-769 was also observed to be the most potent against all the target microorganisms with MIC as 16, 14, 14, 18, 10, and 8 mg/ml against *S. aureus*, *L. monocytogenes, B. cereus*, *Ps. fluorescens*, *Rhodotorula glutinis* and *Penicillium roqueforti,* respectively. The potent protectant was found to exhibit antimicrobial effect significantly different from untreated supernatant as compared to supernatant subjected to temperature treatments of 60, 70, 80 and 90°C. However, antagonistic effect was not completely suppressed at various levels of temperatures. The study also demonstrated that there was no significant effect of pH



Cottage cheese at start and end of storage study of 30 days (a) control: cottage cheese without protectant and (b) sample: cottage cheese with protectant

(P > 0.05) upto pH level of 5.0 unlike other test microorganisms. The cottage Cheese culture was found to be compatible with the selected protectant establishing their possible use as adjunct culture. Significant decline in count of target microorganisms using protectant as adjunct culture *in situ* was observed in developed Cottage Cheese during 30 days of shelf stable storage.

Antifungal Potential of *Lactobacilli* for Extending the Shelf-life of Fermented Milks

As many as 200 lactobacilli were screened for their antifungal activity; out of which, 21 most prolific cultures were selected to evaluate their inhibition spectrum against 18 indicator fungi. *L. plantarum* KF2B, *L. plantarum* NCDC 378, and *L. fermentum* C-14 showing broad inhibition spectrum were found to be effective against as many as 15, 13, and 12 fungal cultures, respectively. The antifungal cell free supernatants (CFS) of all three lactobacilli were found to be stable at high temperature (121°C for 15 min) and showed activity at only low pH (not above 4). *In vitro* tests showed that the CFS of NCDC 378 and KF2B showed sporicidal activity and completely suppressed the conidia germination of *Penicllium roqueforti* NCDC 170 in PDA, while CFS of C-14 showed delayed conidia germination. The CFS of all the three cultures caused distortion or damage of *Penicillium* sp. hyphae; the antifungal substance in the CFS of NCDC 378 induced pore formation in fungal hyphae. The antifungal substance was identified as Phenyllactate (PLA) and quantified by UFLC. C-14 showed highest PLA production of approximately 55 ± 1.7 mg L^{-1} which could further be enhanced to 64.2 ± 2.4 mg L^{-1} in optimized whey based medium. Two antifungal cultures *L. plantarum* NCDC 378 and KF2B used as adjunct culture exhibited fungicidal property in dahi and totally inhibited the growth of *Candida paraslopsis* NCDC 279 and *Rhodotorula glutinis* NCDC51 at prevailing storage conditions.

Development of Equipments for Mechanized Production of Traditional Indian Dairy Products (*Rabria and Kheer*)

Conventionally, *kheer* is prepared by concentrating milk with simultaneous cooking of rice and addition of sugar towards the end of cooking. As *kheer* is prepared in an open pan i.e. at atmospheric pressure, it becomes a batch process, limiting its mechanized production. Prolonged cooking time is the main problem associated with the *kheer* manufacture which is usually 1 hour in conventional open-pan process. So, for mechanized production of *kheer*, it is necessary to reduce the total cooking time which may be achieved by pre-cooking of rice. Temperature dependent hydration kinetics during pre-cooking of rice (Pusa 1121 and Pusa 1509) was studied. Effect of different temperature soaking time treatments on the physical properties was determined. Soaking temperature had significant effect on physical properties pre-cooked rice. The data were tested on the standard hydration equations to determine the model parameters and correlation coefficient (R^2). Effective diffusivity was computed for different precooking temperatures. Trials helped to determine time-temperature combination to get desired hardness of pre cooked rice for production of *kheer*. Trials were conducted on heat and mass transfer during production of kheer with traditional methods and properties were assessed in terms of physical, optical and sensory characteristics. The trials were carried out with the controlled condition with heating plate and steam kettle and the process parameters with heat and mass transfer during the experiment was assessed. The product was analyzed with the regular interval of time during the production of *kheer*. The physical, optical, sensory, heat and mass transfer characteristics showed significant effect on process parameters. The *rabri* was prepared using tradition method to analyse the process parameters (machine and product) for design and development of equipment. The rate of clotted cream layer with total solids of milk on regular interval of time was observed using the steam kettle and LPG stove with heat and mass transfer characteristics of *rabri* production. The temperature and weight loss profile with respect to time at different location during *rabri* production process was also assessed.

Design and Development of Microprocessor Based Automated Instrumentation System for Pneumatic Paneer Hoop-Cum-Press Unit

Design of the microprocessor controlled automated press was completed. Design of a microprocessor controlled automated press for paneer was also completed and as shown in the block diagram (Figure). Microprocessor controlled automated press consists of following main units: Paneer pressing unit, Automatic process control unit, FRL unit, Air compressor and Support stand/frame and other minor accessories/components

Front panel and internal circuit of microprocessor controlled automated press for paneer

Block diagram of microprocessor controlled automated press for paneer

Automation in paneer making will help in reducing the labour requirement as well as save the time and energy consumption. Automated microprocessor based instrumentation system for the preparation of paneer was developed to minimize the human interventions, consequently improving the microbial quality of the dairy product. It consists of the following main units, such as paneer pressing unit, automatic process control unit, FRL unit, oil-free dentist type air compressor and support stand/frame and other minor accessories/components. The air compressor supplies the compressed air via FRL (Filtering-Regulating-Lubricating) unit to the pneumatic cylinder (air operated cylinder) to operate the main pressing unit. Air leaving a compressor is hot, dirty, and wet, which can damage and shorten the life of downstream equipment, such as valves and cylinders. Before air can be used it needs to be filtered, regulated and lubricated. The connecting shaft connects pneumatic cylinder and detachable plate. The main pressing unit consists of pneumatic cylinder, connecting shaft and detachable plate is be operated by supplying air from the air compressor via FRL. Applying and releasing pressure is controlled automatically by automatic control unit. Pressure, time and rate of pressing are controlled automatically by automatic control unit. Since the duration of press is highly influencing the hardness, textural and physico-chemical properties of paneer, optimization of pressure and pressing duration over the coagulum by preparing any quantity of paneer varying from 0.25 kg to 12.5 kg using the microprocessor based automated paneer press unit can be achieved within 4-5 trials.

Incorporation of Whey and Hydrolysed Whey Proteins in Processed Cheese to Enhance Functional Attributes

Processed cheese was prepared by using Cheddar cheese whey. Addition of water in cheese during processing was totally replaced with the whey. Emulsifying salts of 3% and 1% sodium chloride were added during heat processing. Cheese was processed at 80-83°C /5-8 min. It was cooled slowly to room temperature, packed in aluminium foil and stored in refrigerator for further analysis. Cheese whey was used heated at 70 – 75°C for 4-5 min to inactivate residual coagulating enzymes and starter organisms. The whey was cooled to 50°C and the pH was adjusted to 7.0 for whey protein hydrolysis. Flavourzyme was added to the whey for hydrolysis of whey proteins at 50°C. Whey was hydrolysed for about 30 min and 75 min to obtain degree of hydrolysis (DH) 3 and 5%, respectively with 1:25 ratio of enzyme to substrate. The hydrolysed whey was used to prepare processed cheese. Attempts were made to keep identical conditions during processing. Moisture variation was minimum (42.80 – 43.46%). However, the lowest pH of 5.71 was observed in cheese made with whey. The pH of cheese made with hydrolysed whey of DH 3 and DH 5 were 5.76 and 5.80, respectively which were slightly more than those made with whey. There was no noticeable difference observed in sensory characteristics among control cheese. It was observed

that whey incorporation showed some brown colouration when the moisture content in processed cheese was below 40%. Highest hardness was observed in cheese made with whey as compared to other samples. Cheese made with hydrolysed whey of DH 5 became slightly gummy. Maximum meltability of 4.55 was observed in control cheese followed by the cheese made with whey of DH 5%. Antihypertensive activity was measured *in vitro* and more inhibition activity of ACE (38%) was observed in the hydrolysed whey with DH 5%.

Technological Studies on Surati Paneer, an Indian Variety of Soft Cheese

Surati paneer, a variety of soft cheese, is originated from India. It contains around 15% fat, which is much less compared to other products such as paneer, cream and butter spreads, making Surati paneer as a select commodity of consumers in the era of obesity and health consciousness. In order to optimise process, considering traditional method of Surati paneer, processing parameters viz. casein/ fat ratio of cheese milk, level of calcium chloride addition, selection and rate of addition for starter culture, incubation temperature and rate of addition for rennet, rate of salt addition, soaking medium and soaking duration were studied in terms of sensory analysis, textural analysis and yield parameters. Based on these analyses, most suitable parameters were selected for optimised process of Surati paneer. Surati paneer was prepared from the optimized procedure and subjected to various physico-chemical and compositional analyses. The average TS, moisture, fat, lactose, protein, ash and salt contents were: 28.74%, 71.26%, 11.66%, 0.40%, 14.28%, 2.21% and 1.32% respectively. Surati paneer making module was designed and fabricated after considering all the steps associated with preparation protocol. All the steps involved in the optimized procedure of Surati paneer were facilitated by fabricated module and an optimized product was produced using the module. Selected parameters were studied for comparison with control product. Surati paneer prepared from fabricated module was stored at refrigerated temperature (<10°C). Polypropylene cups were selected as most suitable packaging material for Surati paneer. It was acceptable by sensory panel up to 5 days. Freshly prepared Surati paneer was suggested to be used along with vegetable salad. It can also be made into a homogeneous mass and used as bread spread as well as with potato chips and potato fitz. Sensory panel was served Surati paneer alongwith various food products and encouraging remarks were obtained from sensory panel.

Process Optimization for Preparation of Enzyme Modified Cheese Paste for Enhancement of Flavour in Processed Foods

A process was optimised for the preparation of enzyme modified cheese (EMC) from Cheddar cheese. The optimized process parameters were: 45% TS in cheese slurry, 3% emulsifier, enzyme combination of lipase "MER", "AY" and protease "A" in 1:1:1 ratio, incubation time 2 hours, temperature 40°C and heat treatment of 100°C / 5 min. Gas Chromatography revealed that concentration of fatty acids in Cheddar EMC was 20000 mg / kg which was 20 times higher than natural cheese. Regarding shelf life, it was observed that the developed Cheddar EMC with potassium sorbate kept well up to 6 and 20 days in pouch at 30°C and refrigeration temperature, respectively. The Cheddar EMC was found useful as flavor ingredient for the preparation of processed cheese, pasta products and cheese dip. Addition of 10% EMC was recommended for pasta preparation, whereas 5% addition was found to be optimum for processed cheese and cheese dip preparations.

Development of Technology for Preparation of Freeze Dried *Paneer*

The present investigation was taken up to develop freeze drying process to extend the shelf life of *paneer* to commercially viable level. *Paneer* was prepared by applying 0.049 kg/cm^{2}pressure for 10, 20 and 35 minutes which gave a *paneer* having approximately 55, 50 and 46% moisture, respectively. 1cm^3*paneer* pieces were frozen by employing different freezing methods like deep

freezing for 16 hours, LN2 immersion for one minute, LN2 vapour contact for 20 minutes and acetone bath freezing for 1 hour. Among the different freezing methods employed, rehydrated freeze dried paneer (FDP) prepared from deep frozen *paneer* had greater acceptability when compared to other freezing methods. Different cube size (1cm^3 and 1cm×1cm×2cm) were tried for freeze drying and observed that increase in cube size lead to increase moisture retention in final dried product. It was observed that dipping in brine solution (5% NaCl) resulted in retention of more moisture in FDP. Two stage drying retained more moisture compared to single stage drying. No significant difference was observed in final moisture content, per cent rehydration and sensory characteristics of FDP prepared from 2.5 hours and 16 hours of deep frozen *paneer*. FDP prepared by applying 0.049 kg/cm^2 pressure for 10 minutes gave faster and complete rehydration within 3 minutes in boiling water. Proximate composition of FDP: moisture, fat, protein, lactose, ash, acidity and FFA % were 4.12, 46.21, 41.29, 4.58, 3.79, 0.67 and 0.259 respectively. The bulk density of FDP (0.561 g/cm^3) was reduced to almost half of that of fresh *paneer* (1.192 g/cm^3). FDP packed under normal condition had shelf life of 105 days in both metallised polyester (MPE) and nylon pouches, whereas, it was 90 days in vacuum packing. The FDP packed with O_2 scavenger had acceptable sensory attributes even after 120 days in both MPE and nylon pouches. TBA value, stress relaxation time, hardness, cohesiveness, springiness and resilience of FDP increased with storage time. Highest TBA value was observed in FDP packed under vacuum.

Lemongrass Flavoured Paneer - Process Optimization, Utilization and Evaluation of Shelf- life

Lemongrass is an aromatic perennial tall tropical grass and yields an aromatic oil with citral as its major component in a 70–85% concentration. To prepare lemeongrass flavoured paneer, lemongrass flavour was incorporated in the following ways during *paneer* preparation: 1) Cut and crushed form of lemongrass leaves added @ 2, 4 and 6% by the weight of milk and at a level of 20% (v/v) of the coagulant solution and extracted by heat treatment; 2) Extraction in potable water which was then heat concentrated and chilled which was used for dipping *paneer* blocks; 3) Addition of freshly extracted lemongrass oil into milk as well as coagulant solution at various levels (0.015%, 0.02%, 0.025%) was attempted. The samples incorporated with lemongrass as extract as well as oil obtained satisfactory sensory scores. The textural and physico-chemical properties of *paneer* remained unaffected by lemongrass flavour incorporation, but an increase in acidity and decrease in pH, with increased level of addition of lemongrass into *paneer*. *Paneer* attained greenish tinge by the extraction of lemongrass flavour into milk. It was observed that, the addition of cut lemongrass leaf (4% w/v) into milk, obtained the highest sensory score compared to all other samples. The studies on anti-oxidant characteristics as evaluated by DPPH and FC assays revealed that, among all the experimental samples, RSA activity was the highest for *paneer* added with lemongrass oil (8.77% inhibition), and the total phenolic compounds found to be the maximum in *paneer* incorporated with lemongrass leaf in crushed form (0.0056 mg/g GAE). In the gas chromatographic analysis, both isomers of citral, neral and geranial, were eluted out. It was observed that the optimized product stored at ambient conditions, got spoiled at the first day of storage, while the refrigerated samples had a shelf life of 23 days. Lemongrass flavoured *paneer* was well accepted as fried *paneer* for direct consumption, as toppings in Pizza, addition to pickles and culinary dishes including *paneer* curry.

Analysis of Energy and Exergetic Performance of Spray Drying System for Milk-Malted Millet Food

The laboratory scale spray-dryer performance was experimentally evaluated for thermal efficiency, evaporative capacity, theoretical and actual drying time. The performance parameters were investigated under optimized inlet and outlet air temperatures and blending ratio for drying of milk-millet wort blends. The powder yield increased from 64.74 to 80.06%, with increase in inlet and outlet temperatures from 180 to 200°C and 70 to 80°C, respectively, keeping milk-wort blending ratio as 1:1. The results for thermal efficiency showed that increase in the inlet temperature from 180 to 200°C and outlet temperature from 70 to 80°C increased the thermal efficiency from 64.3 to 78.0% at the blending ratio of 1:1. Thermal efficiency was significantly influenced by inlet air temperature, outlet air temperature and blending ratio. The response surface model for thermal efficiency during of spray-dried milk-barnyard millet powder (MBMP) in terms of independent variables was derived. The exergy efficiency of MBMP was slightly higher at 9.38 to 11.79%. This exergy efficiency of producing milk-malted barnyard millet powder was relatively higher than that of spray drying of buffalo milk and cow milk powders.

Design and Development of Microcontroller Based Sub-Baric Thermal Processor for Manufacture of Fried and Soaked Dairy Products

A sub-baric thermal processor (SBTP) was conceptualized, designed and fabricated as per c-GMP and 3-A hygiene fabrication standards. The fully automatic, microcontroller based, skid mounted unit comprised two parallel units for independent frying and soaking of the product integrated on a single platform. The fabricated SBTP was fine-tuned and optimised for deep frying and sugar soaking of *Gulabjamun* under sub-baric conditions. The process was found to be faster with total time for preparation for a batch of *Gulabjamun* (frying and soaking) observed to be 45 min as against 4-6 h in the conventional process.

Development of Infrared Assisted Baking Oven and Evaluation of Baking Characteristics of *Chhana Podo*

An infrared-assisted baking oven was developed and the baking characteristics of chhana podo were studied. The heat transfer coefficient calculated based on horizontal enclosure approach was found to be 3.8446 W/m^{2}K. The Nusselt number was found to be 92.0885. The convective heat transfer coefficient calculated using this method was found to be 7.1996 W/m^{2}K. The convective heat transfer coefficient was also calculated by the empirical method for forced convection in smooth rectangular duct shapes. The Nusselt number was calculated as 111.467. The convective heat transfer coefficient calculated using this method was found to be 7.168 W/m^{2}K. The parameter Gr/Re^2 was 0.257, which meant both natural and forced convection parameters must be considered. Using the combined forced and free convection method, the $Nu_{combined}$ was found to be 127.8949 and the convective coefficient was 10W/m^{2}K. The mean heat transfer coefficient of this oven in forced convection mode for baking of chhana podo was calculated as 7.05 W/m^{2}K. A potential energy saving of 15-20% and a reduction in baking time of 15% were realized. Computational fluid dynamics (CFD) was used to map baking of chhana podo. The temperature profile and moisture loss were modelled. This CFD modeling could be used to improve the product quality, design better ovens and achieve energy savings.

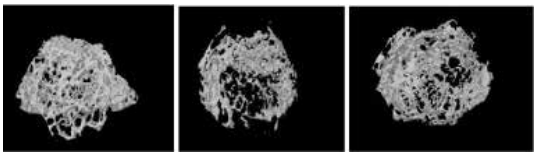
DEVELOPMENT AND VALIDATION OF HEALTH PROMOTING DAIRY FOODS

Comparative Profiling of Differentially Expressed Proteins in A1/A2 Milk

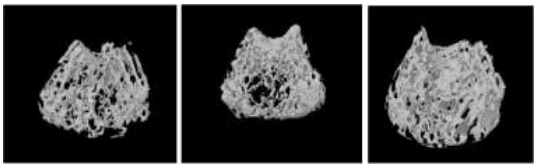
β-casein is the second most abundant protein and crucial for casein micelle structure. A1 and A2 variants are reported to be the most common allelic variants of β-casein in dairy animals. Digestion of A1 β-casein milk releases a 7 amino acid bioactive peptide called BCM 7 in small intestine, which may be associated with various diseases such as type 1 diabetes, heart disease, schizophrenia and autism. Advanced isobaric tag for relative and absolute quantification (iTRAQ) proteomic approach was used to identify whey proteins differentially expressed in A1, A2 and A1A2 type of milk. A total of 1049 proteins were identified, out of which 117 proteins were differentially expressed in A1A1, A2A2 and A1A2 β-casein variants. The molecular pathways associated with the differentially expressed proteins were analyzed using Cluego Pathway analysis plug-in of cytoscape module. Preliminary results revealed the involvement of some of the proteins such as AHSG, LBP, ORMI, ANG, GSN, CSN1, CSN2, CSN1S2 in various pathways which are responsible for acute inflammatory response, hormone secretion and some are responsible for milk production. These results may provide a better understanding of their significance in human health on consumption of milk having A1A1, A1A2 and A2A2 beta casein variants.

Protective Effect of Cow, Buffalo and Goat Milk in Glucocorticoid - Induced Bone Alterations in Mice

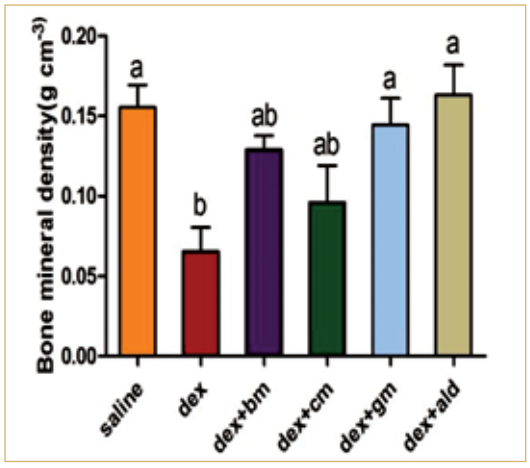
An investigation was carried out to study the effect of milk from different species in ameliorating the detrimental effect of dexamethasone (dex), a glucocorticoid on bone health in mice. It was observed that body weight of mice decreased in dex treatment. Moreover, dex treatment caused a decrease in bone mineral density (BMD) when compared to control. Interestingly, feeding goat, buffalo and cow milk partially reverse the glucocorticoid-induced bone loss. In addition, bone formation markers like serum alkaline phosphatase activity and osteocalcin level improved to some extent on feeding milk compared to the dex-treated group. The results revealed that administration of goat, buffalo and cow milk improved bone



Control Dex Dex+ Buffalo milk



Dex+Cow milk Dex+ goat milk Dex+alendronate



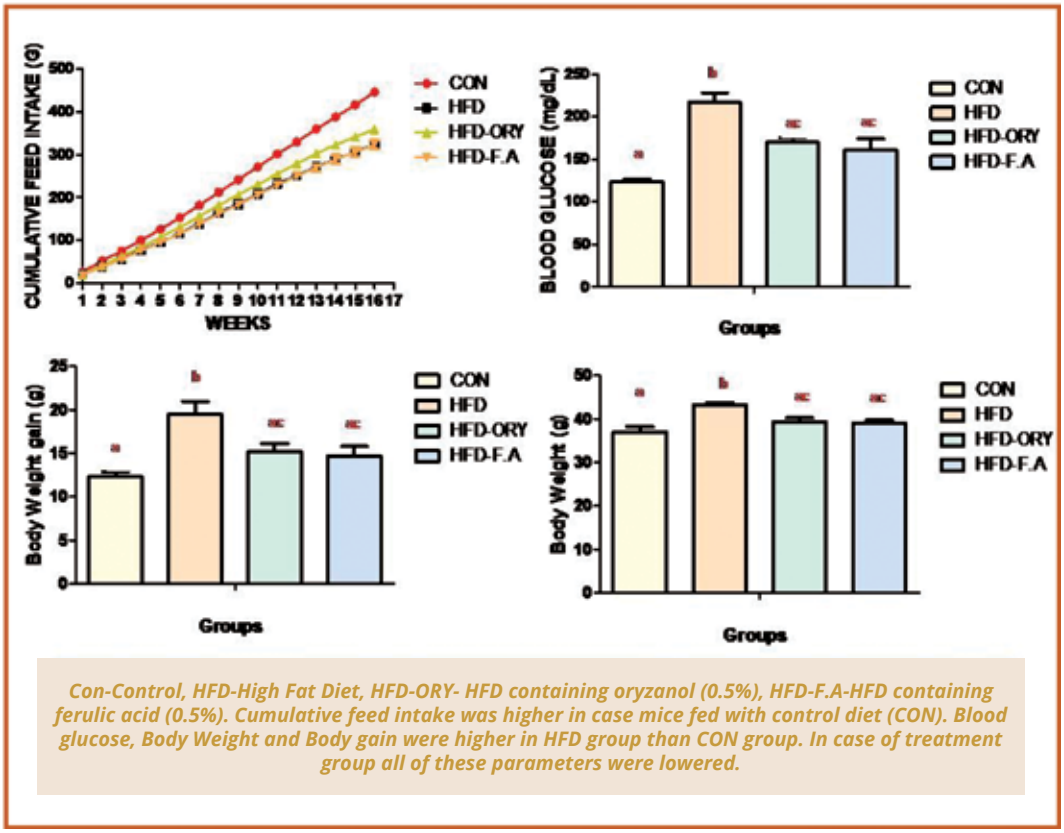
(a) *(b)*

(a) 3D reconstructions of trabecular bone on the distal femoral side of the growth plate in after feeding milk from different species in dexamethasone (Dex) treated mice (b) Bone mineral density of distal femoral growth plate. Data are shown as mean ±SEM (n=6). Values with different letters are statistically significant (P < 0.05)

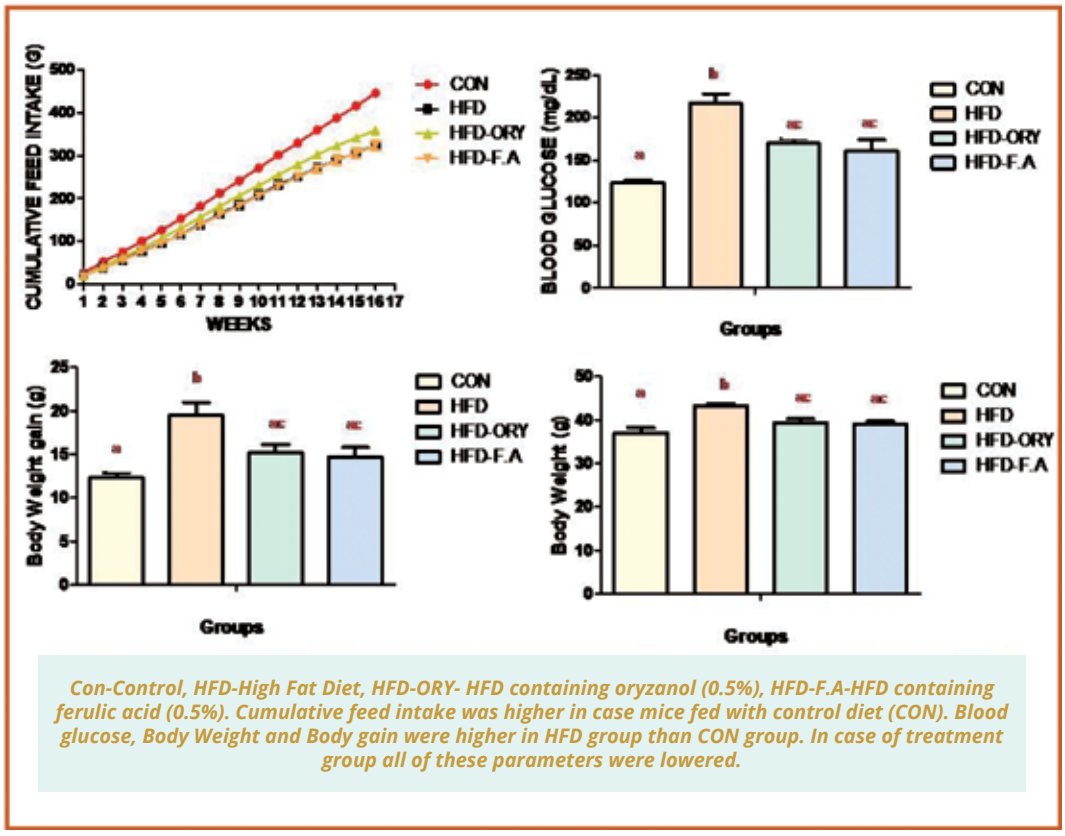
health against glucocorticoid-induced bone loss in mice, and among all the milk investigated, goat milk was found to more effective in mitigating the detrimental effects of dex on femoral BMD and microarchitecture.

Influence of Dietary Supplementation of Oryzanol and Ferulic Acid on Body Weight, Organ Weight, Blood Glucose and Antioxidative Enzymes in Mice Fed with High Fat Diet

The study was conducted by incorporation of Oryzanol (0.5 %) and Ferulic acid (0.5 %) in the diet. The study was also conducted on four groups of C57BL/6 mice according to different diet i.e. Control group (CON) fed on normal control diet, a High fat diet group (HFD) fed with fat rich diet, High fat diet containing oryzanol (HFD-ORY), and High fat diet containing ferulic acid (HFD-F.A). The feeding was for 16 weeks and all the mice were free to access the food and drinking water during the experiment. Daily feed intake was recorded and body weight was measured weekly. After 16 weeks all the mice were anaesthetized and sacrificed. Blood samples were collected and organs weight (liver, kidney, spleen, adipose tissue) was measured at the end of experiment. The feed intake was higher in control group as compared to other dietary groups. The body weight was significantly higher in the high fat diet fed group than control group. While body weight was lower in both HFD-ORY and HFD-F.A group. The same trend was observed for liver weight and adipose tissue weight. Blood glucose level was elevated in case of HFD group as compared to Control group while it was significantly lower in the case of HFD-ORY and HFD-F.A group than HFD group. The activity of the enzymes Catalase and Superoxide dismutase was lower in case of HFD group then Control group. In case of HFD-ORY and HFD-F.A the enzyme activity was higher than HFD group. Same kind of pattern was observed in case of the enzyme glutathione peroxidase activity. It revealed that the incorporation of oryzanol and ferulic acid in diet prevented the increase in body weight due to the feeding of High Fat Diet and also prevented the fat deposition during feeding of fat rich diet. It controlled the enhancement of blood glucose due to feeding of Fat rich diet. Both of these also upregulates the activities of antioxidative enzymes which get reduced due to the intake of High Fat Diet. It can be concluded that both of these phytochemicals have a great impact on the progression of obesity and associated disorder when included in the diet.



Con-Control, HFD-High Fat Diet, HFD-ORY- HFD containing oryzanol (0.5%), HFD-F.A-HFD containing ferulic acid (0.5%). Cumulative feed intake was higher in case mice fed with control diet (CON). Blood glucose, Body Weight and Body gain were higher in HFD group than CON group. In case of treatment group all of these parameters were lowered.



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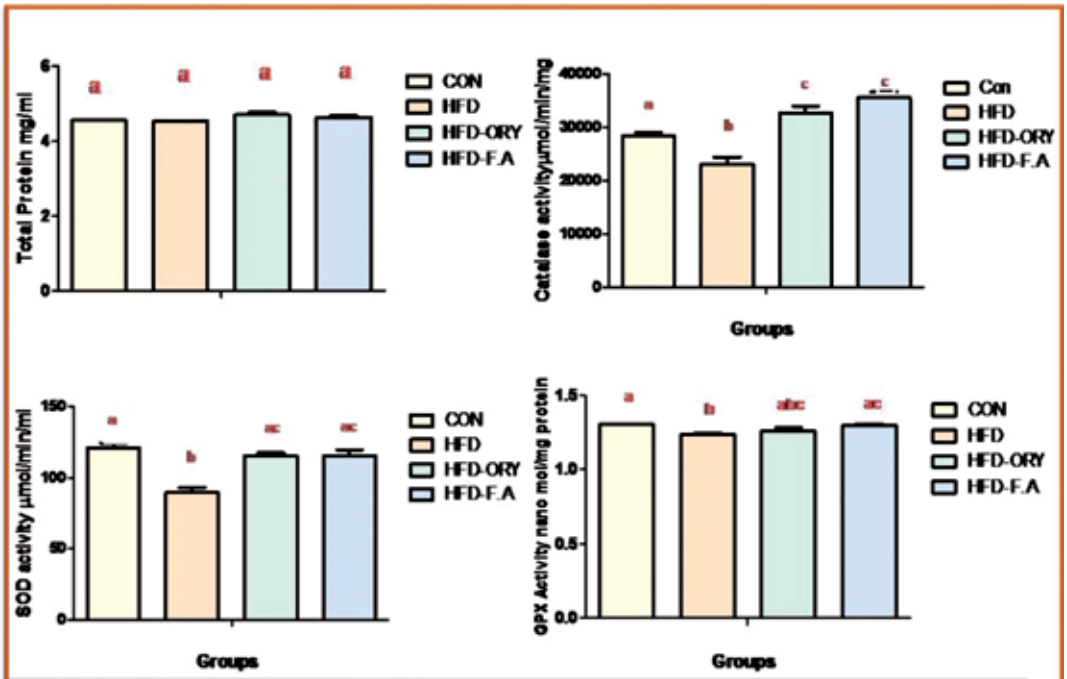


CON- Control, HFD-High Fat Diet , HFD-ORY- HFD containing oryzanol (0.5 %), HFD-F.A- HFD containing ferulic acid (0.5%). Columns with different latter differ significantly. Total protein content was not different in any group. The activity of the enzymes Catalase and Superoxide dismutase was lower in case of HFD group then Control group. In case of HFD-ORY and HFD-F.A the enzymes activity was higher than HFD group. Same trend was observed in case of Glutathione peroxidase enzyme activity

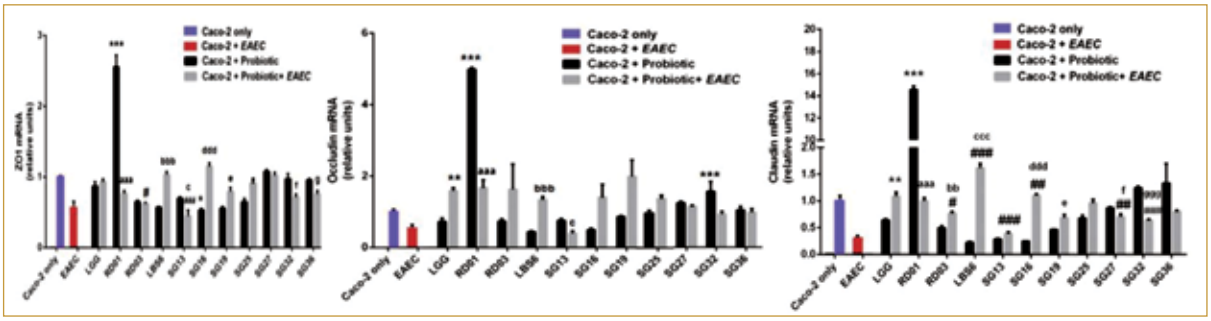
Galactomannan and Diosgenin Exhibit Potential to Ameliorate Aberrant Energy Metabolism under High-Fat Diet Fed Conditions in Mice Model

Effects of dietary incorporation of locust bean galactomannan (LGM) and diosgenin on activities of regulatory enzymes of glycolysis & gluconeogenesis, and mRNA expression of selected genes in liver and adipose tissue were evaluated in C57BL/6 mice fed high fat diet (60 % kcal from fat) for 18 weeks. Hepatic phosphofructokinase (PFK-1), pyruvate kinase (PK) and glucokinase

(GK) activities were found to be lowered in high fat diet (HFD) group as compared to the control group. The resistance to decrease in activity of three kinases (PFK-1, PK & GK) could be observed in LGM/diosgenin fed groups, however, it reached to statistically significant level in case of PK as a consequence of LGM feeding. PEP carboxykinase (PEPCK, the most important regulator of gluconeogenesis) activity in liver tissue was found to increase significantly in animals fed HFD while the dietary incorporation of galactomannan/ diosgenin exhibited a protective effect. The mRNA expression of selected genes related to regulation of fatty acid oxidation (Cpt1, PPARα) and lipogenesis (SREBP-1c) in liver tissue suggested the effectiveness of locust bean galactomannan and diosgenin in counteracting the effects of high fat diet. The mRNA expression of adiponectin and leptin in epididymal fat tissue also suggested the efficacy of galactomannan & diosgenin in maintenance of energy homeostasis. Further, the expression of MCP-1 & TNFα genes also indicated protective effect of two functional components against inflammatory responses under high fat diet fed conditions.

Study of Mechanism of Probiotic Action in Persistent Diarrhea in Children Caused by Enteroaggregative *E.Coli* – Using a Mouse Model

A total of 10 putative probiotic lactobacilli strains that included five *L. plantarum* RD01, RD03, SG-13, SG-25 and SG-36 strains, one *L. casei* Lbs6, two *L. rhamnosus* SG-16 and SG-32 along with two *L. fermentum* SG-19 and SG-27 as well as standard probiotic strain *L. rhamnosus* GG were selected based on their antimicrobial/antagonistic activity against enteroaggregative *E. coli* (EAEC). The probiotic strains SG25, Lbs6 and SG27 exhibited anti-inflammatory activity and SG27maximum adherence (30%) in Caco-2 cell line. The Principal Component Analysis (PCA) of probiotic functional properties such as adhesion and the interference properties i.e. ability to exclude pathogens either by exclusion, competition and displacement indicated SG25 and SG19 as candidate probiotic strains with excellent interference properties. RD01, RD03, SG32 and SG36 showed the protective effect by strengthening the integrity of epithelial cells (epithelial barrier) as indicated by decreased permeability of FITC-Dextran. In addition, the PCA analysis of expression of tight junction genes (Zonaoccludens 1, Occludin and Claudin-1) in both HT-29 and Caco-2 cells, indicated RDO1 and SG-25 as candidate prophylactic probiotic strains in the maintenance of gut barrier function. Based on all the probiotic functional properties, RD01, LbS6, SG25 and SG13 were finally selected for further studies at NICED. The study showed that probiotic functional properties varies from strain to strain.

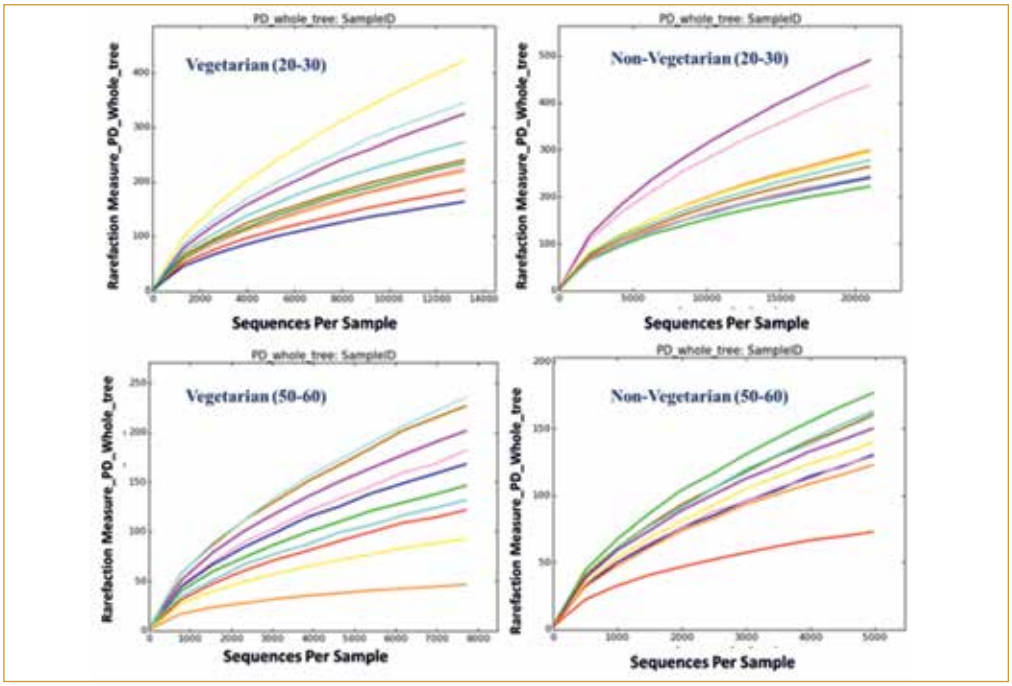


Transcript levels of Zona occludens -1 (ZO-1), Occludin and claudin in CaCo-2 cells challenged with probiotic strains only or with EAEC only or with co-culture of probiotics and EAEC

Comparative Metagenome of Human Gut of North and North-Eastern Regions of India

A total of 982 Mb of data was generated from all the subject groups using standard 454 GS-FLX (Roche) protocols and the GS Junior device. The data obtained from the above NGS run was analyzed for gut microbial diversity studies using QIIME (Quantitative Insights Into Microbial Ecology). The analysis of microbial diversity data of North Indian population of different age (20-30 and 50-60) and diet (vegetarian and non-vegetarian) groups revealed that "Gut microbial richness decreases with age in both Vegetarian and Non-Vegetarian population" and "Vegetarian population harbours highly diversified gut microbiota compared to Non- Vegetarian population". Further, the decrease in *Bacteroidetes* composition with age was also observed with simultaneous increase in *Firmicutes* on taxonomic analysis. Overall, the decrease in *Bacteroidetes* to *Firmicutes* ratio with age was reported in the gut microbiota of North Indian population. In addition, the increase in composition of *Enterobacteriaceae* was also observed with age. However, no significant difference in *Bifidobacterium* composition was observed between subjects with vegetarian and

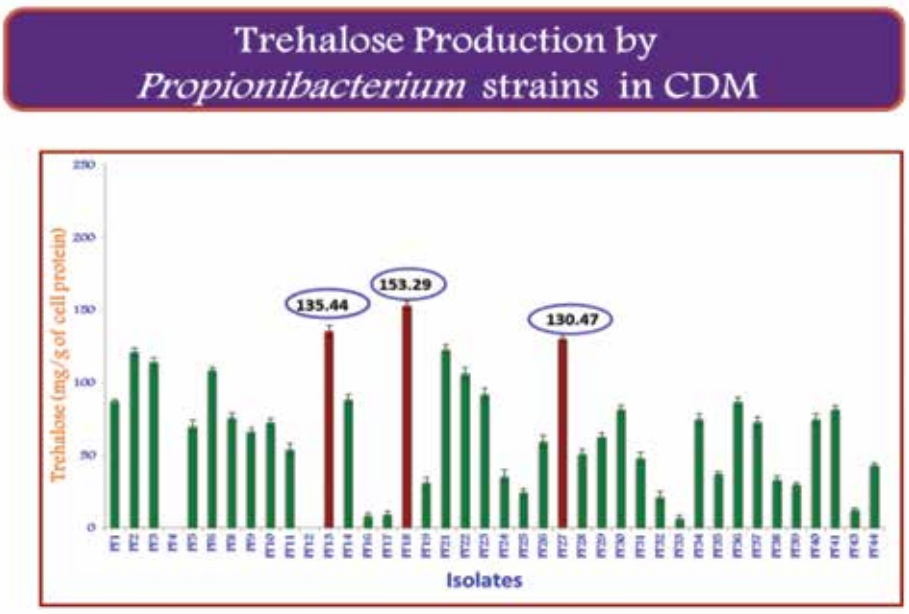
non-vegetarian diets. Besides, the absence of *Fusobacterium* and *Akkermansia* in the North Indian gut microbiota was also observed in the study. No significant difference was observed in the faecal metabolite composition of acetate, propionate and butyrate between vegetarian and non-vegetarian diets of same and different age groups.

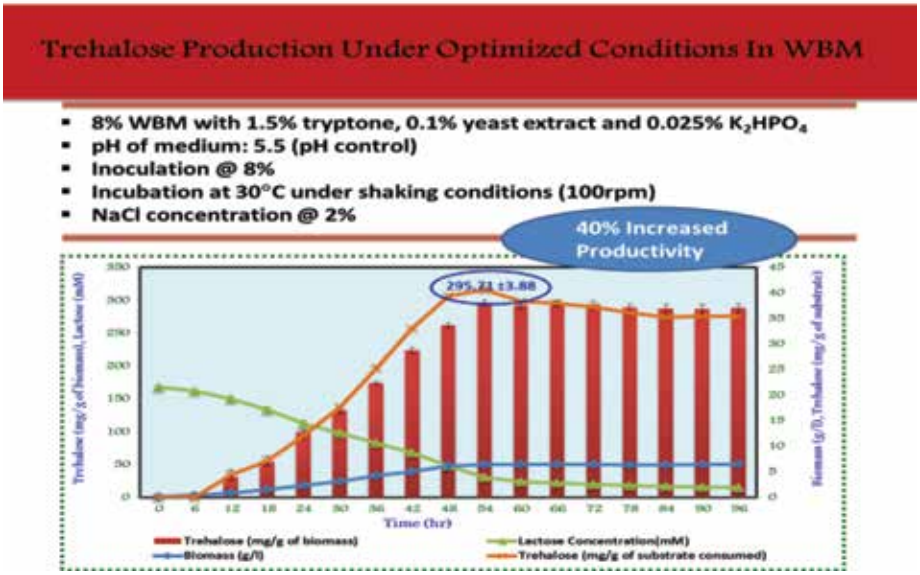


Alpha diversity curves based on 16S rDNA sequence data of vegetarian and non-vegetarian population of different age groups (20-30 and 50-60) captures both the organismal richness of a sample and the evenness of the organisms' abundance distribution

Production of Trehalose by *Propionibacterium freudenreichii*

Forty strains of *Propionibacterium freudenreichii* previously isolated from different dairy products were screened for their trehalose production potential as a functional attribute and various methods of trehalose extraction and estimation were compared in order to assess their efficiency. Trehalose production from two most prolific producer strains was optimized by application of response surface methodology (RSM). Screening for trehalose production in CDM showed that trehalose production was a strain dependent phenomenon. Thirty eight isolates were found to be trehalose positive that included 34.2% low producers (6.6-50 mg/g cell protein), 44.7 % moderate producers (50-100 mg/g cell protein) and 21% high trehalose producer (100-200 mg/g cell protein). PF18 was the highest trehalose producer (153.29 mg/g cell protein) followed by PF13

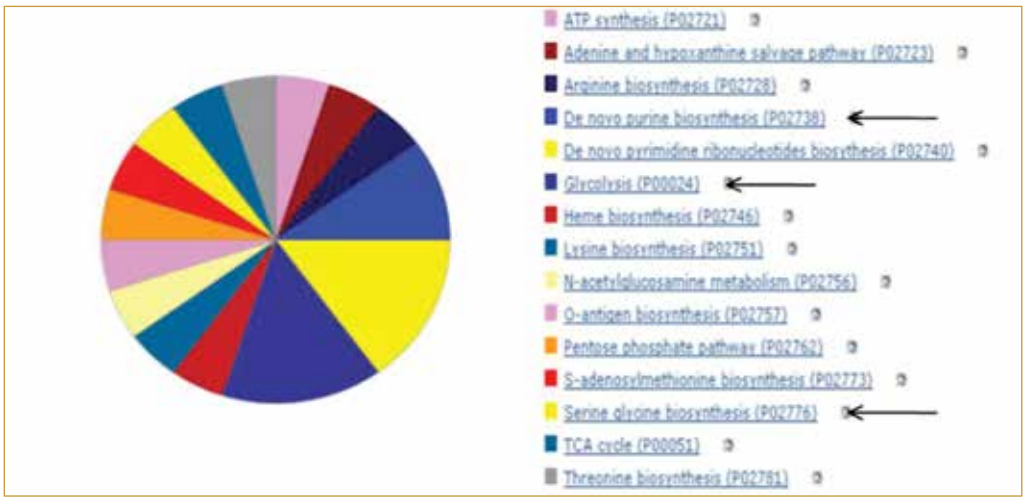




(135.44mg/g cell protein). Among the five cell disruption methods, lysozyme treatment was found to be the most effective followed by the microfludizer and glass bead method. Comparison of enzymatic and HPLC methods for trehalose estimation showed no significant difference among their efficiency. The trehalose production by PF18 and PF13 was observed to be the maximum (203 and 188 mg/g cell protein respectively) at 3% glucose, 5 pH and 72h incubation time. Under optimized conditions, PF18 and PF13 showed 1.33 and 1.4 fold increase in their trehalose production respectively.

Proteome Analysis of *Lactobacillus fermentum* Strains in Response to Acid Stress

L. fermentum strains (NCDC400, NCDC605 Bif18, and Bif19); *L. rhamnosus* (NCDC 347) and *L. helveticus* (NCDC 599) were evaluated for pH tolerance (1.5, 2.0, 2.5, 3.0, 3.5 and 6.5). Among the test cultures, *L. fermentum* (NCDC400) tolerated pH 2.0 up to 2 hrs while *L. rhamnosus* (NCDC 347) and *L. helveticus* (NCDC 599) up to 1 hr. In terms of log reduction in pH 2, NCDC 400 and NCDC 347 showed 4 log reductions while NCDC 599 showed 7 log reductions up to 1 hr. *L. rhamnosus* (NCDC 347) and *L. helveticus* (NCDC 599) were unable to grow after 1 hr. The order of tolerance to pH 2 was NCDC 400 > NCDC 347>NCDC 599>BIF 19>BIF 18> NCDC 605. The growth phase especially early stationary phase was established for NCDC 400, which was found to be 10 h. For extraction of proteins from NCDC 400, different methods were used. Cell lysis using lytic buffer and sonication gave protein concentration of 941 and 982 µg/ ml at pH 2.0 and 6.5, respectively. The isolated proteins were subjected to tryptic digestion and directly subjected to LC-MS/MS which led to identification of a total of 655 proteins. LFQ revealed 272 differentially expressed

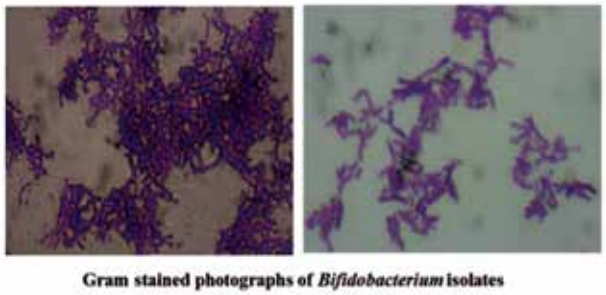


Involvement of acid responsive DEPs in metabolic pathways of NCDC 400

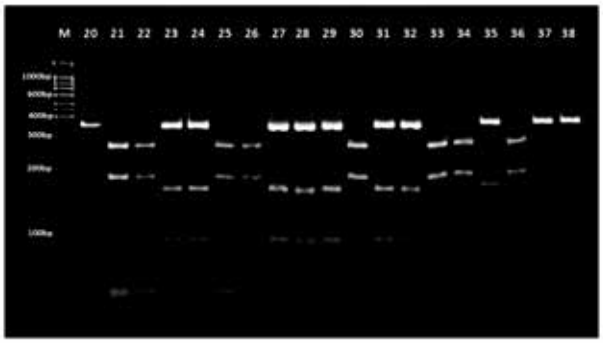
proteins (DEPs). Based on the fold change (≥1.5), there are 48 up-regulated and 110 down regulated DEPs. PANTHER GO-Slimand enrichment analysis indicated that the majority of DEPs were involved in metabolic, cell part and catalytic activity of NCDC 400 while others were involved in glycine biosynthesis, glycolysis and purine biosynthesis.

Development of RFLP Based Molecular Markers for Differentiation of *Bifidobacterium* Species

RFLP fingerprinting patterns of PCR amplified partial gene fragments of hsp60, tuf, clpC, 16S rDNA and rpoB, were used to differentiate *Bifidobacterium* species. Based on phosphoketolase assay, 93 out of 336 isolates from milk samples and faeces of human and animal origin recovered using anaerobic conditions were presumptively identified as *Bifidobacterium* which were further confirmed by biochemical and molecular approaches. The confirmed isolates alongwith 12 reference *Bifidobacterium* strains were PCR amplified for five different taxonomic markers (hsp60, tuf, clpC, 16S rDNA and rpoB) and three restriction enzymes were used for each gene separately. Dendrograms were constructed from the fingerprints using UPGMA method for each gene and enzymes separately and group wise band patterns were estimated for analysis. Genotyping based on hsp60 restriction patterns yielded 9 different genotypes while tuf, clpC, 16S rDNA, and rpoB genes yielded 10. Composite genotyping grouped all the isolates with different reference strains at species level to *B. breve* (11*), B. animalis* (9), *B. catenulatum* (3*), B. adolescentis* (13), *B. bifidum* (13), *B. merycicum* (8), *B. pullorum* (5) and at sub species level in between *B. longum* subsp. *longum* (4) and *B. longum* subsp. infantis (15) except one group (12) for which no placement was obtained. It was concluded that hsp60 with HaeIII and clpC with MspI could be used as single restriction marker for species level differentiation. Additionally, a combined application of rpoB RFLP (HhaI and HinfI) and clpC (MspI and TaiI) could be applied thereof for sub-species level identification and differentiation.



Gram stained photographs of *Bifidobacterium* isolates



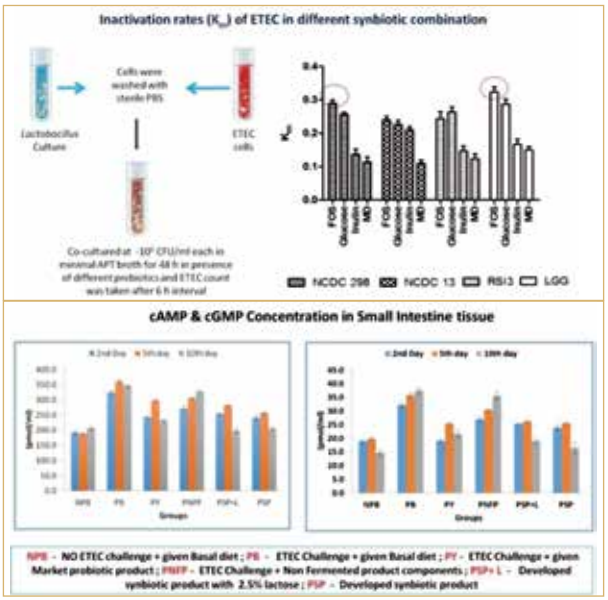
RFLP fingerprinting of *hsp60* gene with HaeIII of bifidobacterial isolates

Dendrogram showing banding pattern similarity among different isolates with referral strains constructed from the data of Hsp60 PCR-RFLP

Efficacy of Synbiotic Fermented Dairy Beverage against Enterotoxigenic *Escherichia coli* (ETEC) Mediated Diarrhea

Three probiotic *Lactobacillus* cultures viz. *L. rhamnosus* NCDC 298, *L. rhamnosus* RSI3, *L. acidophilus* NCDC 13 along with *L. rhamnosus* GG (standard strain) and prebiotics fructo-oligosaccharide (FOS), inulin and maltodextrins were included in this study. *L. rhamnosus* NCDC 298 showed higher antimicrobial activity against Enterotoxigenic *Escherichia coli* MTCC 723 (ETEC-MTCC 723). FOS rendered highest prebiotic activity score (0.55), auto-aggregation (32.6%) and co-aggregation with

ETEC-MTCC 723 (24.2%). Deactivation rate of ETEC-MTCC 723 (K_m =0.29) and down regulation of *LT-I* (74.16%) and *ST-I* (48%) toxin genes were maximum in co-culturing with *L. rhamnosus* NCDC 298 in presence of FOS. Combination was also effective in mitigation of cAMP and cGMP levels in ETEC infected HT-29 cell lines. *Lactobacillus* counts, pH and titratable acidity of developed synbiotic fermented dairy beverage were ~10^9 CFU/ml, 3.5 and 0.65% lactic acid, respectively with a shelf life of 35 days at 7°C. After induction of diarrhea, mice were fed with synbiotic beverage without or with lactose (2.5%), and a market probiotic fermented beverage on *ad libitum* for 10 days. Treatments decreased ETEC, cAMP and cGMP as well as IgA and increased intestinal and faecal lactobacilli. Shrinked and apical damaged internal villi structures were ameliorated on treatment. Efficacy of developed product was found comparable with that of market beverage.



Efficacy of Probiotic Dahi on Biochemical and Genetic Markers of Non-Alcoholic Fatty Liver Diseases in Mouse Model

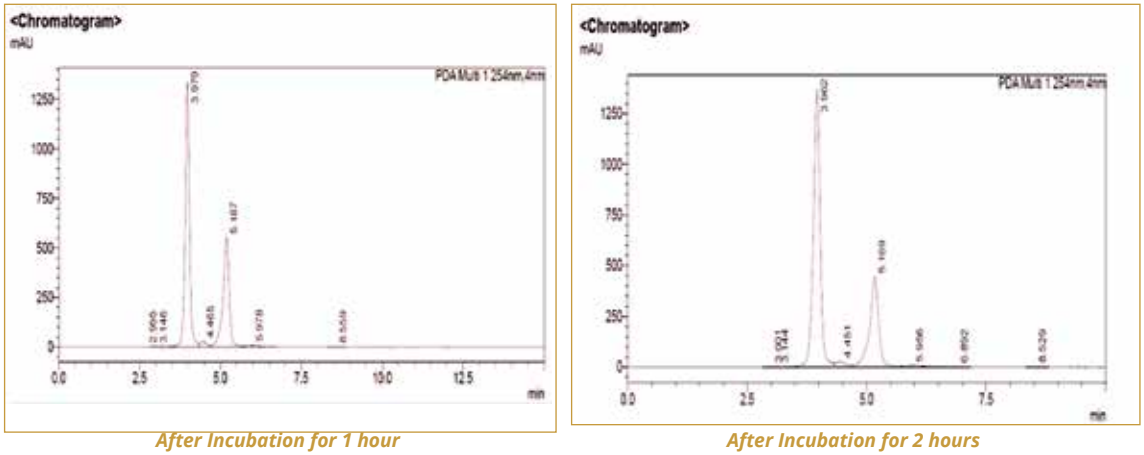
Lactobacillus rhamnosus CRD 9 exhibited highest cholesterol assimilation of 61.86 ± 0.31% and antioxidative activity of 328.40 ± 2.37 and 400.09 ± 2.89 µM TEAC as estimated by ABTS and DPPH technique out of the ten test probiotic lactobacilli. Feeding of *L. rhamnosus* CRD9 probiotic dahi to 120 C57BL/6 mice for 7 (16^{th}-23^{rd}) weeks showed significant improvement in physical and biochemical parameters. Total cholesterol and liver enzymes (AST, ALT and GGT) were observed to be elevated among CP, TCD, TPD and TPC groups on 16^{th} week indicative of liver injury. Expression of *de novo* fatty acid synthesis and uptake genes *FAS, ACC 1*, *SREBP 1c,* and *ADRP* were up-regulated in CP, TCD, TPD and TPC groups on 16^{th} week. Feeding of probiotic dahi, led to significant down regulation of *FAS, ACC, SREBP 1c* and *ADRP*, which contributed to decreased synthesis of new fatty acid in hepatocytes as well as reduced influx of serum fatty acid to hepatocytes. Expression of fatty acid oxidation and triglyceride uptake genes *(ACOX, CYP2E1,PPAR*∝and *DGAT1*&*PPARγ*) were up regulated while lipolytic gene *HSL* was down-regulated under diseased condition. The administration of probiotic *dahi* down regulated fatty acid oxidation and triglyceride uptake genes, while enhanced expression of *HSL* gene, indicative of its ameliorative effect against NAFLD due to its hypocholesterolemic and anti-oxidative property which reduces excess fat deposition as well as scavenge free radicals generated during inflammation of liver thereby improving liver health.

Preparation of Folate Rich Fermented Milk and its Role in Diarrhea Control

L reuteri LR28 and LR22 produced maximum folate i.e.19.39 **±** 0.5 and17.32 **±** 0.6 µg/l**.** The cultures possessed probiotic properties besides exhibiting antimicrobial activity against several pathogens. LR28 showed maximum folate production at 2% inoculum level at 100 rpm in 48 hrs (23.03 **±** 2.0 µg/l). The conditions for production of folate were standardized that included lactose, maltose, 5mg/l PABA, glutamic acid, cobalt chloride, yeast extract besides melon, tomato and cucumber juices. The production of folate increased from 19.39 **±** 0.5 µg/l to 35.12 **±** 0.92 µg/l by using optimized conditions in skim milk i.e. 3% lactose, 5.5 mg/l PABA and 300 µl/ml melon juices. Immunomodulatory activity of different cultures i.e. non folate producing probiotics (NFP), folate producing non-probiotic (FPN) and folate producing probiotic (FP) were studied for specific immune response in *in vivo* mouse model challenged with *S. dysentriae.* On the 15^{th} day, significant increase in IgA concentration of 4.86 ng/ml, 4.73 ng/ml by FP and NFP followed by FNP (4.73 ng/ml) was recorded . FP group had shown significant colonization of *Lactobacillus* in gut of 7.18 log cfu/ml followed by NFP group of 6.78 log cfu/ml and FPN of 5.95 log cfu/ml. FP had shown significant reduction of *S. dysentraie* of 4.94 log cfu/ml followed by NFP group of 5 log cfu/ml and FPN group of 4.95 log cfu/ml. FP and FPN had shown significant increase in haemoglobin followed by NFP.

Screening of Purine Nucleosides Degrading Lactic Acid Bacteria as a Novel Approach for Treating Hyperuricemia

Hyperuricemia is one of the most common and extensive metabolic diseases in populations, characterized by high uric acid level in the blood, causing deposition of urate crystals in the joints and kidneys, and is well known as important risk factor for gouty arthritis, uric acid nephrolithiasis, cardiovascular and renal disease, especially hypertension. LAB can be effectively used for preventing or treating hyperuricemia as some of the LAB has purine nucleosides degrading ability. Out of 20 different dahi and fecal samples, 76 Gram positive and catalase negative rods were isolated. HPLC method (Shimadzu LC-20 AD) was used to evaluate the ability of these isolates to degrade inosine and guanosine, the two key intermediates in purine metabolism. The degradation of purine compounds was evaluated in cell-free extracts of LAB. The cells were sonicated for 30'X3 (pulse rate- 5sec on/ 5 sec off) and activity evaluated through HPLC. Eleven isolates were screened as positive for purine nucleoside degradation ability. The identity of these isolates was confirmed through PCR with universal primers 27F/1492R and subsequently sequenced.

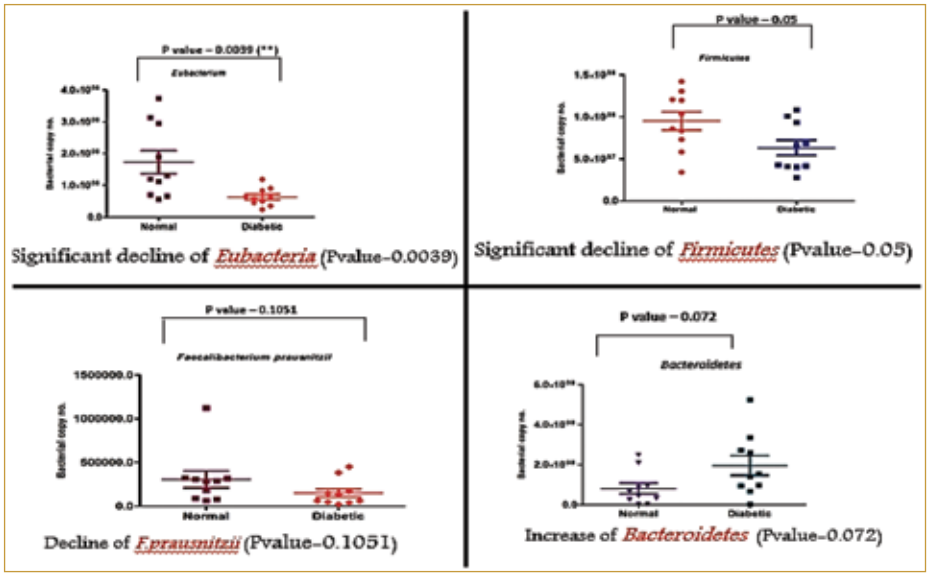


After Incubation for 1 hour *After Incubation for 2 hours*

Purine nucleoside degradation ability of Isolate D3D

Comparative Abundance of *Faecalibacterium Prausnitzii* in the Gut Microbiota of Healthy versus Diabetics

The study was conducted to compare the abundance of *Faecalibacterium prausnitzii (F. prausnitzii*), one of the key metabolically active commensal bacterium linked with Diabetes Mellitus (T2D), besides other major gut microbial enterotypes viz. *Firmicutes* and *Bacteroidetes* in the gut microbiota of healthy and diabetic hosts by their respective Real Time PCR (qPCR) assays. Population size of 20 subjects which included 10 healthy and 10 diabetic subjects with mean age 54.3 ± 2.55 and 52.4 ± 2.82, respectively was selected. Both in relative and absolute qPCR assays, no significant



Absolute quantification of Eubacteria, F. prausnitzii, Firmicutes, Bacteroidetes from the gut microbiota of gut Healthy versus Diabetics

differences (P>0.05) were observed in the relative and absolute quantification of *F. prausnitzii* and *Bacteroidetes*, which might be attributed to the small sample size (N=10) and large interindividual variations. However, in absolute quantification, a significant decrease (P=0.0039) in gut microbial diversity was recorded with significant concomitant decrease in *Firmicutes*. In addition, the SCFA analysis using GC revealed a significant decline (P=0.0036) in butyrate concentration (0.98 ± 0.18mM) in diabetic subjects relative to healthy subjects (1.9 ± 0.21). The study indicated that it might be possible to manage diabetes effectively by either modulating the abundance of *F. prausnitzii* through probiotic or dietary interventions or directly exploring the same itself as the probiotic. However, more in depth and extensive clinical studies are required at molecular level with the inclusion of large number of human subjects to be statistically more relevant.

Zinc Enrichment of Lactic Acid Bacteria and its Bioavailability Evaluation

Lactobacilli (37) and Leuconostoc (2) strains recovered from human, dairy and non-dairy sources were screened for their Zinc (Zn) tolerance at different levels. Nine cultures were found to be able to grow on MRS-cysteine agar containing 50mM Zinc sulphate. Selected strains were screened for quantitative Zn uptake in liquid media (MRS-cysteine) containing 100 and 200 ppm of Zn. Two most prolific Zn uptaking cultures viz. SR4 and KF3A (1.293 and 1.095 mg/g d.w. respectively) and *L. rhamnosus* LGG were selected. Media conditions with 200 ppm of Zn, 48 h incubation at 37°C and pH 5.5 were observed to be suitable for the maximum Zn uptake. *L. fermentum* SR4 showed highest ability to accumulate Zn (1.947 ± 0.31mg/g d.w.) Further *in-vivo* Zn bioavailability study was carried out in male albino wistar rats using Zn enriched cell lysate of SR4 upto 4 weeks. Groups fed with B-Zn gained significantly higher body weight in comparison to Zn depleted group and groups fed with inorganic and organic Zn. Liver Malonaldehyde levels were significantly lower in group fed with Zn depleted diet and serum Metallothione in levels were significantly higher in BZ-30. Scanning electron microscopy of hairs revealed marked difference in hair characteristics and size of group fed with Zn depleted diet as compared to other groups. Immune cellular response and Liver Zn level was significantly higher in BZ-30 group.

Morphological characterization of Zn Enriched Biomass By SEM

SR4, Control
(Cells grown in media without $ZnSO_4$)

SR4
(Cells grown in media with $ZnSO_4$)

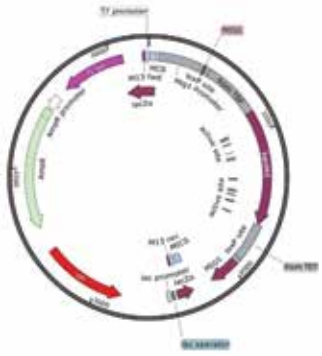
Zn Enriched Biomass Production by Batch Fermentation Under Optimized Conditions

Culture	Qty of biomass per lit MRS medium	Zn mg/g (d.w)
SR4 Biomass	2.238 g	1.94±0.369

Enhancing Galactose Metabolism by Genetically Engineered Thermotolerant *Kluyveromyces Marxianus*

Among eleven *K. marxianus* strains (lab isolates), *K. marxianus* 6C17, 6C18 and 6C8 were found to be the more sugar tolerant (150 g/l galactose) than other strains. However, ethanol production was maximum in 150 g/l galactose and lactose by 6C17 strain. Since, the GAL genes are tightly regulated, being repressed by glucose and induced by galactose up to 1,000-fold, the strategy of targeting two regulatory genes was employed. The deletion of the two regulatory genes was done in *K. marxianus* using the Cre-LoxP system for the efficient utilization of both glucose and galactose by preventing the catabolite repression. The disruptant (regulatory gene mutant) obtained could grow in the medium containing G418. The Cre-loxP system is a very versatile tool that allows for gene marker rescue, resulting in mutant strains free of exogenous

selective markers, a very important aspect for industrial application. The mutant strain was examined for the production of ethanol under controlled batch cultivation on concentrated whey and 47 g/l of ethanol yield was obtained during fermentation of concentrated whey containing 100 g/l of lactose which is 19% higher than the parental strain. The findings of the present study have the potential to pave way to develop a future industrial strain for bioethanol production from whey.

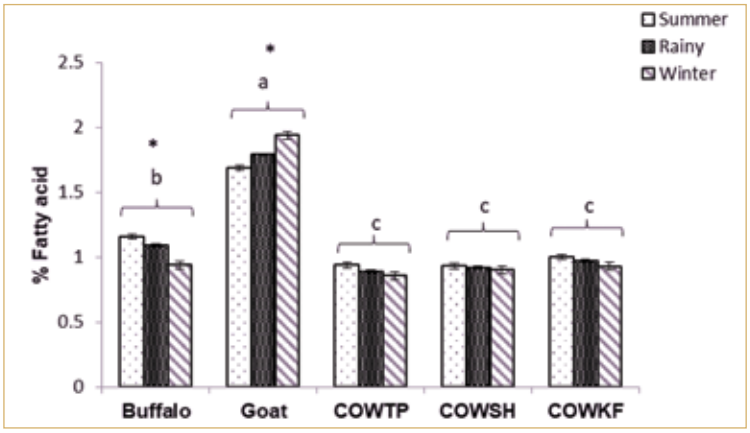


Deletion cassette of 2242 bp

Picture represents the assembled deletion cassette

Profiling of Milk Fat of Indigenous Milch Species

Milk fat of indigenous species of bovine (Tharparkar and Sahiwal) and buffalo (Murrah) was characterized and compared with goat (alpine x beetle). The season had an impact on fatty composition of milk with concentration of short chain fatty acids being highest in winter and lowest during summer amongst all the species and breeds studied. Conversely, the milk produced in summer had elevated levels of total poly unsaturated fatty acids, trans fatty acids and conjugated linoleic acid (CLA) contents in comparison to winter milk. The major isomer of CLA in milk fat of all species was found to be C18:2 (c9, t11) and was highest in cow milk fat. All milk fat samples invariably contained odd chain fatty acids up to C25 with chain length varying from C9-C25. Among the trace fatty acids detected, branched chain fatty acids were identified in all the species, with goat milk demonstrating the highest levels.



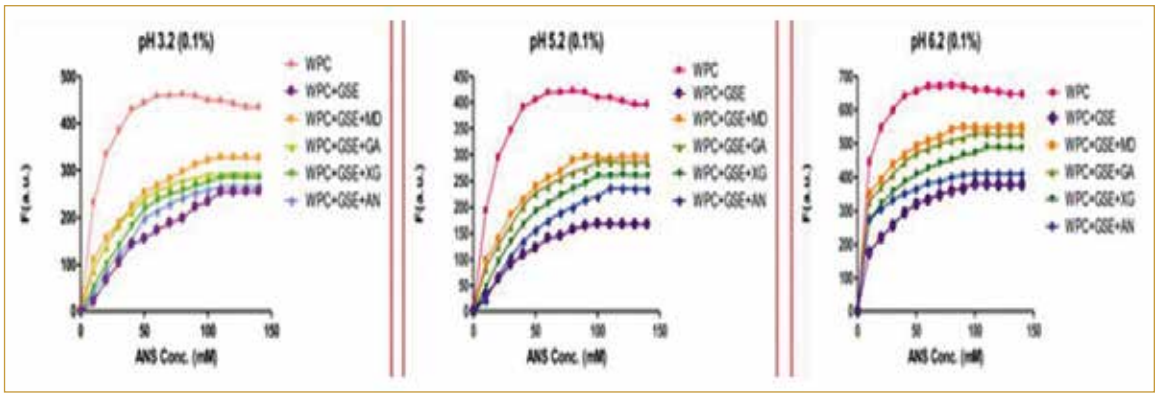
*Total Branch Chain Fatty Acids (%) Concentration in Summer, Rainy and Winter Season for Milk Fat Derived from Different Milk Animals: Bars represents mean of six determinations and error bar indicates standard error. Significance between seasons *P<0.05; a,b,c,d- represents difference between species/breeds. (COWTP: Tharparkar breed of cow; COWSH: Sahiwal breed of cow; COWKF: Karan Fries breed of cow).*

Some distinct branched chain fatty acids were detected in present study. 4-methyloctanoate, 4, 6-dimethyloctanoate, 4-methylnonanoate and 4, 8-dimethylnonanoate branched chain fatty acids were detected only in goat milk. Phytanic acid (tetramethyl 3, 7, 11, 15 hexadecanoic acid) was not observed in goat milk. 2-tridecyl propenoic acid was detected in buffalo and cow milk but not in goat milk. Further, 3-methoxypropanoate was found only in cow breeds. Cholesterol concentration was found highest in summer and lowest in winter in all samples. Cholesterol content was found highest in goat milk fat (324 to 340 mg/100 g fat) among all the species studied. The other identified minor sterol fractions viz., desmosterol, lanosterol and lathosterol on the other hand did not show much variation in content with respect to season. Fat soluble vitamins (retinol, β-carotene and tocopherol) were analyzed using RP-HPLC and were estimated highest in

summer and lowest in winter. Retinol and tocopherol contents were found highest in goat milk fat. β-carotene was found highest in indigenous bovine breeds (445 to 616 µg/100 g fat) and was absent in buffalo as well as in goat milk fat.

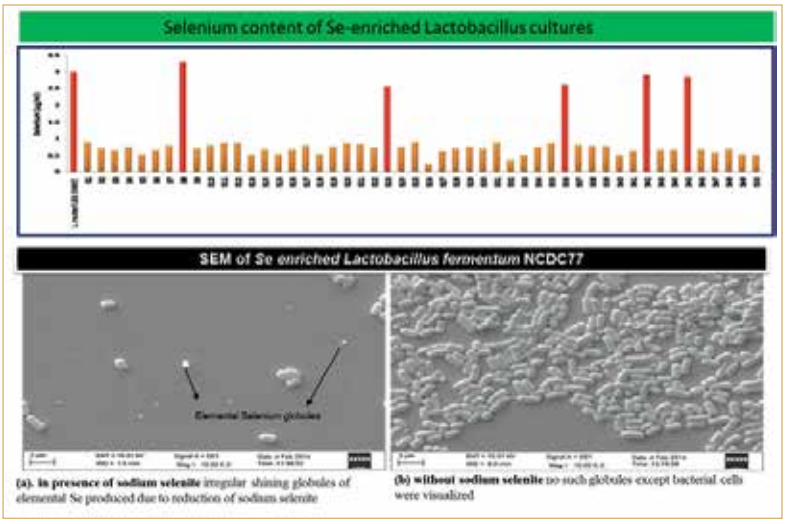
Microencapsulation of Grape Seed Extracts Phenolics

Conditions optimized for stable grape seed extracts (GSE) microcapsules using gum arabic and whey protein concentrate with high retention of antioxidant activity. The interaction of grape seed extract (GSE) polyphenols with whey proteins with or without polysaccharides including xanthan gum (XG), alginate (AN), gum-arabic (GA) and maltodextrin (MD) was determined under different pH conditions (3.2, 5.2 and 6.2) based on fluorescent probe binding method using fluorescence spectroscopy.The results suggested that GA and MD were shown to be the most effective in the inhibition of WPC–GSE polyphenols complexation.



Development of Seleno-Probiotic Biomass and Functional Food using Native Strains of Lactic Acid Bacteria

Fifty native strains of Lactobacilli were screened qualitatively for Se uptake and biotransformation by plate count method and total Se accumulation by ICPE (quantitative method) with *L. reuteri* LB2 DSMZ culture as a reference strain. *L fermentum* NCDC77 (S8), was found to be the most efficient to uptake Se from the medium, and accumulated higher amount of Se (3.28 µg/ml) than *L. reuteri* LB2 DSMZ (2.97 µg/ml). Scanning electron microscopy of highest Se-accumulating culture (S8) indicated the presence of elemental Se produced as a result of reduction of sodium selenite when the culture was grown in media supplemented with higher concentration of Se and also possessed probiotic attributes. The maximum biomass yield (3.98 mg/ml) and Se-accumulation (297.48 µg/gd.w.) were observed at a concentration of 3.36 µg/ml of sodium selenite, inoculum level of 3% for 20hrs. Selenium enriched biomass of S8 was produced in laboratory fermentor using the optimal conditions and lyophilized (freeze dried) in skim milk using sodium glutamate as protective agent. Selenium content of freeze dried biomass was 89.2 µg/g with bacterial load of biomass 11.68 log cfu/g. Finally, "Stirred Dahi' enriched with Se", with appreciable sensorial and microbiological quality was prepared using *L. lactis* NCDC97 at the inoculum rate of 2% and Se-enriched biomass was added after breaking of coagulum to give final Se content of 28 µg per 100 g.



MILK PROTEINS DERIVED BIOACTIVE PEPTIDES

Recombinant Proteolytic Enzymes PepL and PepP Aminopeptidases of Lactic Acid Bacteria to Selective Remove Specific Amino Acids to Design Bioactive Peptides

Caseins and whey proteins are broken down to oligopeptides, which are internalized to be broken down further by aminopeptidases in the cytoplasm. Recombinant leucyl aminopeptidase (PepL) and peptidyl aminopeptidase (PepP) of lactobacilli origin were produced in *E. coli*. The *pepL* genes of *L. casei* and *L. rhamnosus* GG were successfully cloned and expressed in *E. coli* as inclusion bodies and refolded into biologically active form. Various physicochemical properties like thermal stability, requirement of cobalt metal ions, substrate specificity and enzyme kinetics were studied for both the enzymes. These enzymes were active against small synthetic peptides (3-5 amino acids long) with leucine at N-terminus. PepL preferred tri-peptide as compared to tetra-peptides and penta-peptides. Hydrolyzed peptides showed enhanced anti-oxidative activity as compared to un-hydrolyzed peptides, e.g., LHLPL showed ~19% inhibition of free-radicals before hydrolysis and ~63% inhibition after hydrolysis by PepL. Likewise, Anti-hypertensive activity of hydrolyzed peptides was also enhanced significantly. Proteolytic system of LAB plays a crucial role in imparting flavour, debittering, texture and organoleptic effects in cheese. The recombinant peptidases could be helpful in the designing of bioactive peptides as well as in protein hydrolysis industries for the generation of free amino acids. Hydrophobic residues like leucine are responsible for bitterness in cheese and hence can be treated with PepL enzyme to improve organoleptic properties and enhance activities of bioactive peptides

Milk Casein Derived Peptides Mediates Overlapping Anti-inflammatory and Anti-oxidative Effects

A study was conducted on buffalo casein- derived peptides for their overlapping antioxidative and immunomodulatory potential under cellular milieu. Ten peptides (A to J) were selected from bovine milk casein and modified wherever required according to buffalo sequence. The selected peptides were screened for their free radical scavenging and immunomodulatory properties by using chemical and *ex vivo* murine tissues, respectively.

On the basis of the above screening, four peptides (B, C, F, and G) having overlapping free radical scavenging and immunomodulatory properties were selected for further evaluation under cellular conditions using human intestinal epithelial Caco-2 cells or mouse splenocytes. Treatment of Caco-2 cells with the four selected peptides (B, C, F, and G) for 24 h at different concentrations (10 ng to 1 mg/ml) did not affect the cell viability and membrane integrity. In addition, the increased ROS generation in response to H_2O_2 induced oxidative stress was also inhibited by these peptides. Moreover, pre-treatment with peptides C and G (100 µg to 1 mg/ml) protected ($P < 0.05$) the cell viability against H_2O_2 induced oxidative cell death. Further, treatment with peptides B, C, F, and G regardless of their concentration reduced ($P < 0.01$) the formation of oxidative products such as MDA. The assessment of antioxidative enzymes (catalase: CAT, superoxide dismutase: SOD and glutathione peroxidase: GPx) activities additionally supplemented the antioxidative potential of peptides where increase ($P < 0.05$) in catalase activity was recorded with the addition of selected peptides. But GPx has higher activities ($P < 0.01$) with peptide C and F. These results were also confirmed by studying the mRNA expression and western blotting analysis of Nrf-2.

Under evaluation of the immunomodulatory potential of peptides, all the four selected peptides (B, C, F, and G), on one hand reduced the secretion of IFN-γ while on the other increased the levels of IL-10 in the supernatant of cultured spleen cells regardless of their amount used. Moreover, peptide-C at 1 µg to 1 mg/ml also increased the release of IL-4 where other peptides did not show such response. Additionally peptides F and G showed an increase ($P < 0.05$) secretion of TGF-β at various concentrations used (10 ng to 1 mg/ml).

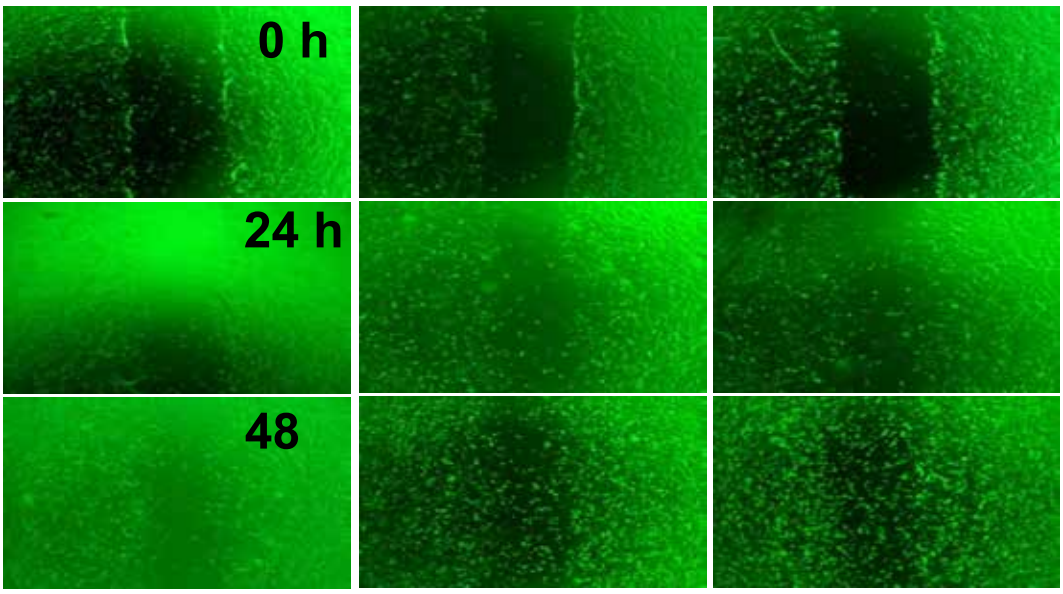
Bioavailability and transport route studies conducted on two peptides (C and G) showed their sufficient transport of 0.95 % and 1.72 % across the epithelial membrane in their intact form through transcytosis and PepT1 mediated transport mechanisms, respectively.

Besides, these peptides (C and G) displayed strong antioxidative and anti-inflammatory potential under *in vivo* conditions in mice against ethanol-induced oxidative stress by considerably elevating ($P < 0.01$) liver GSH content and by decreasing ($P < 0.01$) the activities of antioxidative enzymes, MDA alongwith reduced expression of CYP2E1, PPAR-α, TNF-α and COX-2 genes than ethanol control.

Thus present study established the overlapping antioxidative and immunomodulatory potential of four peptides (B, C, F, and G) to a varying extent using different approaches with sufficient bioavailability of the two of the peptides (C and G) studied across the human intestinal epithelial cells.

Anti-aging Effect of Hormetic Bioactive Peptide in Aged Fibroblasts

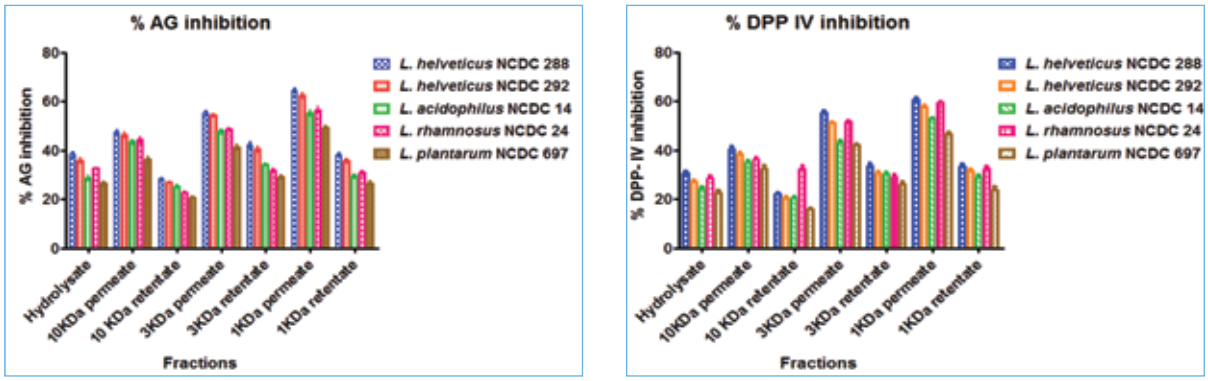
The effect of milk- derived bioactive peptide (VLPVPQK) on hormesis related anti-aging signaling mechanism was investigated. Skin fibroblast cells from rats were cultured under serum starved conditions till late passage, and the anti-aging effect of the peptide on fibroblasts studied by assessing cell viability, malonodialdehyde and free radical production. In addition, the apoptotic activity of caspases, the extent of DNA damage and SA-β gal activity also evaluated. Concurrently, the qPCR analysis of senescence markers, p21 and p16 levels and expression level of p38 MAPK, p-p38MAPK, Nrf2, NF-(p65) kB, Bax and Bcl-x L by western blot assessed. The results demonstrated that peptide established the hormetic response at 30ng/ml, and was found to have potential in wound healing of cultured fibroblast cells via down-regulating caspases. Amazingly, peptide reversed the senescent related dysfunctions by stimulating Nrf2 mediated antioxidative defense system via inhibiting NFkB/p38MAPK signaling. Therefore, peptide can serve as a valuable anti-aging/anti-inflammatory therapeutic remedy and as a medication for prolonged wound by maintaining protein homeostasis via activating Nrf2 and downregulating NF-kB pathway through p38MAPK dependent signaling mechanism.



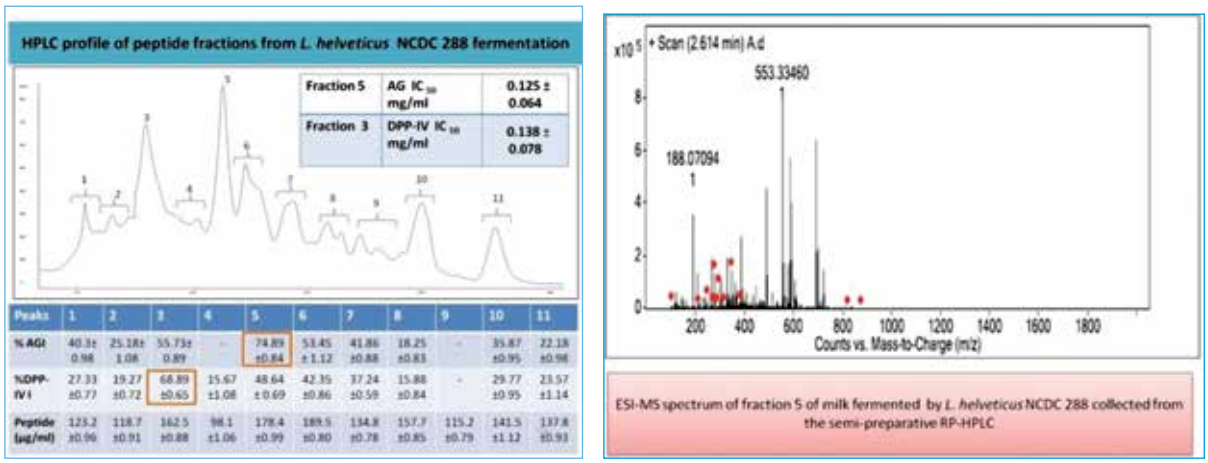
Effect of peptide with and without p38 inhibitor on scratch healing

Production and Characterization of Alpha-Glucosidase and Dipeptidyl Peptidase-IV Inhibitory Milk Bioactive Peptides using *Lactobacillus* spp.

Fermented buffalo skim milk prepared by as many 21 strains of *Lactobacillus* as a single culture was analyzed for peptide content, alpha-glucosidase and DPP-IV enzymes inhibition profiles. Peptide contents (measured by OPA method) ranged between 2.30 to 4.63 mg of leucine equivalent/ml of skim milk fermentate. Alpha-glucosidase and DPP-IV inhibitory activities were found highest in skim milk fermented with *L. helveticus* NCDC 288. On the basis of higher enzyme inhibition, cultures namely *L. helveticus* NCDC 288, *L. helveticus* NCDC 292, *L. acidophilus* NCDC 14, *L. rhamnosus* NCDC 24 and *L. plantarum* NCDC 697 were selected. Peptides in skim milk fermentate were fractionated by ultrafiltration (10, 3 and 1 kDa ultrafiltration membranes) and higher alpha-glucosidase and DPP-IV inhibitions were observed in 1 kDa permeates. Peptides in 1 kDa permeate were further fractionated by RP-HPLC. Two fractions from *L. helveticus* NCDC 288 and one fraction from *L. rhamnosus* NCDC 24 showing maximum enzyme inhibitory activities were sequenced by LC-MS/MS and 14 different peptides originated from caseins and whey proteins were identified. Most of the sequenced peptides were structurally similar with previously reported alpha-glucosidase and DPP-IV inhibitory peptides (VLPVPQK).



Alpha-glucosidase and DPP-IV inhibitions by ultra-filtered fractions of skim milk fermentate



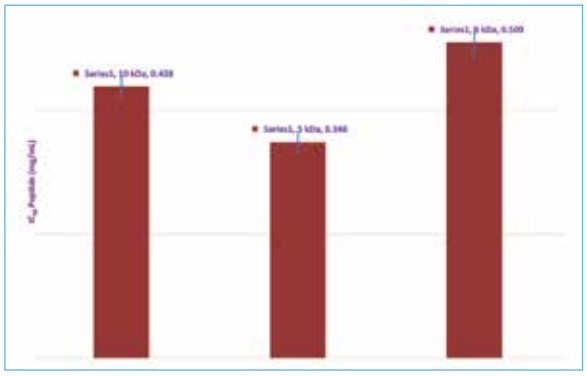
Biofunctional Properties of Synbiotic Fruit Yoghurt and their Bioactive Peptides

Biofunctional synbiotic fruit yoghurt (SFY) was prepared using probiotic yoghurt bacteria ST 144 and LB 144, prebiotic inulin and fruit pulp (mango, blueberry, strawberry raspberry) by using Response Surface Methodology (RSM) for antioxidant activity. Among all the yoghurt preparations, SFY blueberry showed highest polyphenol contents (713.45 ± 0.20 mg GAE/100 ml), antioxidant activity (2148.90 ± 1.10 µmol/l TEAC), ACE inhibitory activity (67.49 ± 0.30%) and flavonoid contents (2.14 ± 0.00 quercetin equivalent/ml). The 10 kDa bioactive peptide fraction of SFY (blueberry) showed significantly (p<0.005) higher antioxidant activity (2076.02 ± 25.25 µmol/l TEAC), ACE-Inhibitory activity (87.58 ± 0.26% inhibition) and the antimicrobial activity (zone of inhibition which ranged from 15.53 ± 0.12 to 25.10 ± 0.35 mm). LC-MS/MS-MS sequencing of 10 kDa bioactive

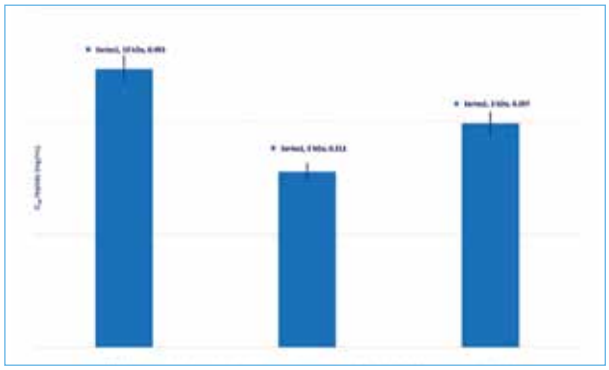
peptide fractions showed many peptide sequences like antioxidant peptides VPYPQ, AVPYPQR, KVLPVPE, VLPVPQKKVLPVPQK, GVRGPFPII, GPVRGPFPII, IPIQY, IPIQYVL, KVLPVPQ, VKEAMAPK and GVSKVKEAMAPK. ACE-Inhibitory peptides, antimicrobial peptides, immuno-modulatory peptides, anti-cancerous peptides and anti-thrombotic peptides were also identified. *In vivo* study was conducted in the oxidative stress induced mice model and it was found that oxidative stress biomarker enzymes significantly (p<0.05) decreased in SFY and 10 kDa peptide fed group of animals, whereas, the antioxidant enzymes were increased significantly (p<0.05) in these groups. The synbiotic blueberry yoghurt and its bioactive peptides showed significant antioxidative properties alongwith other biofunctional properties.

Production of Bioactive Peptides through Fermentation of Soy Aqueous Extract by *Lactobacilli*

All the cultures demonstrated ability to produce α–Galactosidase, which is important for utilization of soy complex oligosaccharides and *L. plantarum* C2 (LP C2) exhibited highest activity (23.9 ± 0.24 U/mg) after 30h of fermentation. Highest proteolytic activity was shown by *L. rhamnosus*C34 (684.358 ± 2.85) and NCDC 288 (617.948 ± 3.39) µg serine/ml. The 10, 5 and 3 kDa fractions of bioactive peptides showed inhibition against foodborne pathogens, highest inhibition was observed by 10 kDa (12 mm) against *L. monocytogenes* followed by 5 kDa (12 mm) and 3 kDa (11 mm) against *E. coli.* 10 kDa fractions showed highest antioxidative activity (1830.64 TEAC µM and 50.737% DPPH inhibition. In addition, highest ACE-inhibition was observed (79.467 ± 1.15%) in 3 kDa fractions. About 136 peptides were identified using LC/MS/MS from 9 precursor soy proteins, majority by β-conglycinin, glycinin and lectin, with their reported bioactivities. KP, VLP, DA, EG, SY, PQ, KE, QK, IE, FY, FR, VR, GR, VPP, PP, TF, YG, IAK, LAA, HHL, LA and VVPP were some common sequences found, which are well accepted as ACE-Inhibitors. In addition, peptides KHH, HH, HL, LY, LHE, IR, PHA, SWN, PHI, KP, EL and LK were found in sequences were identified as antioxidative. Thermal stability of bioactive peptides observed up to 100°C peptides were stable in the presence of digestive enzymes besides being stable at room as well as refrigeration temperatures for upto two weeks.



Antioxidant activity of Soy derived bioactive peptides with their Half maximal inhibitory concentration (IC50),



ACE-Inhibitory activity of soy derived bioactive peptides with their Half maximal inhibitory concentration (IC50)

Bioactive Peptides from Camel and Goat Milk by Fermentation with *L. rhamnosus* C25

Camel and goat milk procured from NRCC, Bikaner and Livestock Research Centre of NDRI, Karnal, respectively were fermented with seven proteolytic *Lactobacillus* cultures for 48h at 37°C for the production of bioactive peptides. Maximum antimicrobial activity by *L. rhamnosus* C25 was observed under the optimized conditions (37°C for 48 h using 2 % inoculum level and without agitation) for fermentation of milk samples. 10 kDa, 5 kDa and 3 kDa fractions of goat and camel milk fermentate showed antimicrobial activity against all the pathogens. However, 3 kDa fractions of camel milk fermentate exhibited maximum activity as compared to 5 kDa and 10 kDa fractions. On the other hand, 5 kDa fractions of goat milk fermentate showed maximum activity. 5 kDa peptide fractions of goat whey fermentate and sodium caseinate exhibited higher antimicrobial activity than 3 kDa and 10 kDa fractions. In fermented camel milk, whey fermented and sodium caseinate fermented, 3 kDa fractions showed better antimicrobial activity than 10 kDa and 5 kDa

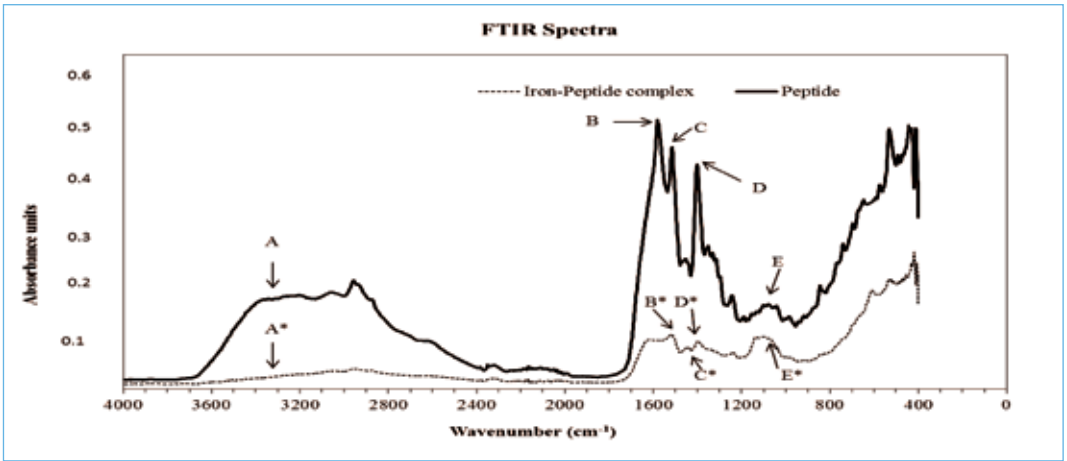
fractions. However, the maximum antimicrobial activity was found in goat milk (5 kDa) and camel milk (3 kDa) fermentate. The HPLC chromatogram of the fermented fractions showed different peaks indicating that bioactive peptides have been generated during fermentation process. During purification, six fractions of each sample of peptides were collected and they exhibited antimicrobial activity against *E.coli*. LC-MS/MS analysis revealed many peptide sequences related to ACE-inhibitory activity and few sequences similar to antimicrobial peptides.

Enrichment of Cheese Dip and Cheese Sauce with Bioactive Peptides by Incorporation of Proteolysed Whey

Cheese sauces and dips are consistent, flavourful and functional cheese ingredients that add value to prepared foods. These were enriched with bioactive peptides by incorporation of proteolysed whey. Cheese sauces and dips were prepared using whey which was adjusted to 3% protein and hydrolysed to 3% DH that was achieved in 20 min using enzyme to substrate ratio of 1:15. The hydrolysed whey samples exhibited Angiotensin-I-Converting Enzyme (ACE) inhibition activity *in vitro* and also anti-*E.coli* activity. The protein hydrolysates could be incorporated at 100% v/v level during the preparation of cheese sauce and dip without causing significant changes to the sensory attributes of these propducts. The enriched sauce and dip showed 39% ACE inhibitory activity and 26 min growth inhibition against *E. coli*. Storage studies revealed that shelf life of enriched cheese sauce and dip was 6 – 7 days at 30°C in multilayer pouch.

Evaluation of Iron Binding Peptides Derived from Buffalo Casein

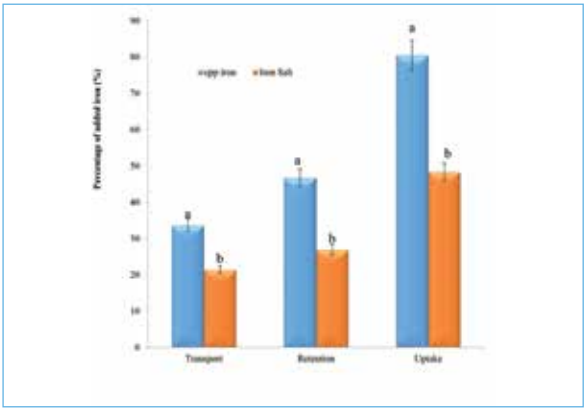
Complexation reaction of buffalo casein hydrolysate (BCH) with iron evaluated using attenuated total reflectance- Fourier transform infrared spectroscopy and assessed for survivability under *in-vitro* gastrointestinal (GI) digestion.



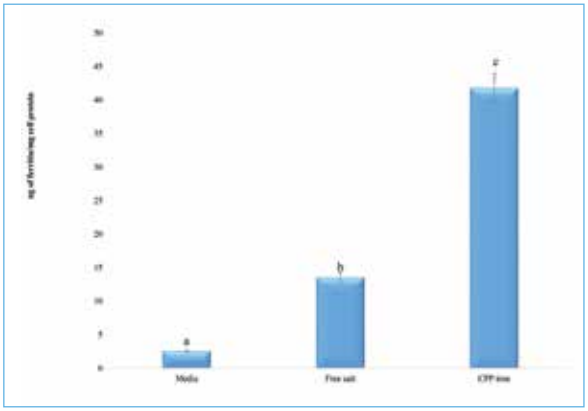
Amide I, amide II and phosphorylated regions in FTIR spectra of BCH were major iron binding sites. 93.88% BCH-iron complex survived from degradative action under gastric digestion and 98.69% iron solubility after intestinal digestion. Animal feeding trials showed an increase in iron absorption by 70%.

Preparation and Characterization of Caseinophosphopeptides-minerals Complexes

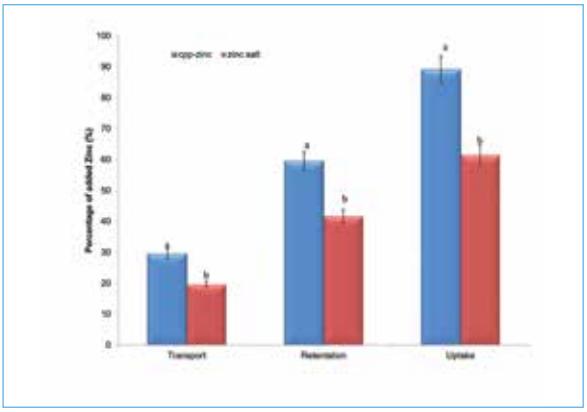
Caseinophosphopeptides (CPPs) are multifunctional bioactive peptides derived from milk casein. In the present study, a new method for enrichment of CPPs alongwith mineral (Iron and Zinc) was developed by using ultrafiltration after enzymatic hydrolysis of caseinate. FTIR spectroscopy and UV-Vis spectroscopy confirmed the structural modification upon mineral binding with CPPs. The particle size analysis also showed these CPP-mineral complexes stable at different



Iron transport, retention and uptake in Caco-2 cells from CPP – iron complexes with comparison to inorganic iron salt.



Ferritin synthesis in Caco – 2 cells



Zinc transport, retention and uptake in Caco-2 cells from CPP – zinc complex in comparison to inorganic zinc salt

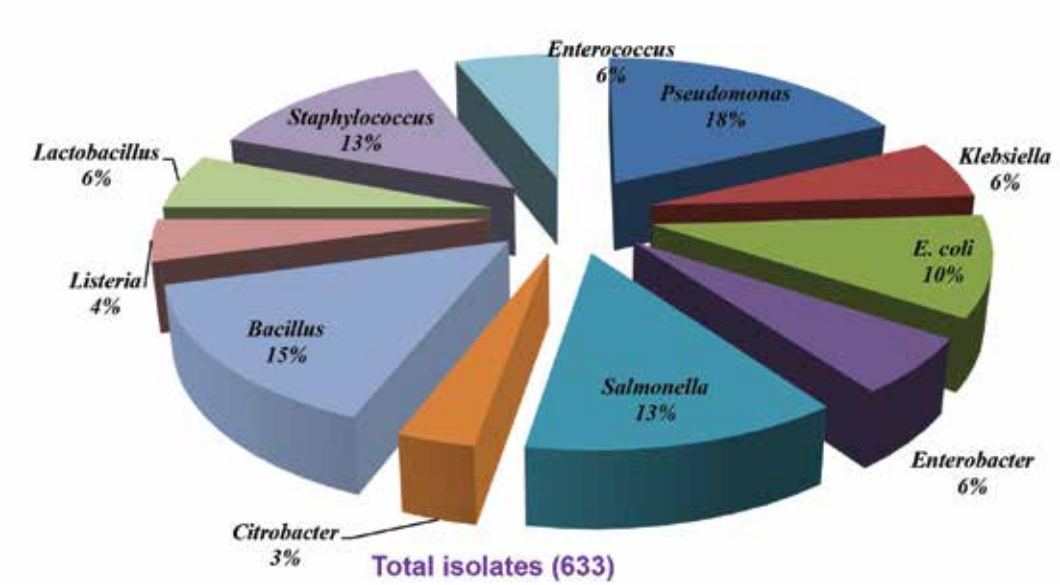
Effect of Zinc on Dermatological characteristics of rat

processing conditions. These samples were purified by RP-HLPC on C18 Column and fractions having higher protein: phosphate ratio were subjected to LC-MS/MS, nine peptides were identified both from CPP-Fe complex and CPP-Zn complex. Bioavailability of CPP-Fe & CPP-Zn complexes were investigated by *in-vitro* and *in-vivo* studies. The *in-vitro* caco-2 cell model established the effectiveness of these complexes to increase the bioavailability of mineral as compared to mineral salt. CPP-Fe complex showed 80.47% uptake significantly higher than inorganic iron salt (48.26%) and inorganic zinc salt showed 61.46% uptake much lower than CPP-Zn complex (89.12%). The CPP-Fe complex significantly increased ferritin synthesis (41.82 ± 0.79 ng of ferritin/mg cell protein) in caco-2 cell as compared to iron salt (13.54 ± 0.32 ng of ferritin/mg cell protein). These samples were also able to increase serum mineral level in rat model during replanishment in CPP mineral fed group as compared to their respective inorganic salts fed group. The antioxidative enzymes (AOE) viz. catalase, superoxide dismutase (SOD) activities in liver homogenate increased significantly in CPP-Fe and CPP-Zn complex fed groups as compared to their inorganic salts fed group.

RISK ASSESSMENT : CONTAMINANTS IN DAIRY FOODS

Microbial Diversity of Biofilms in Dairy Niche

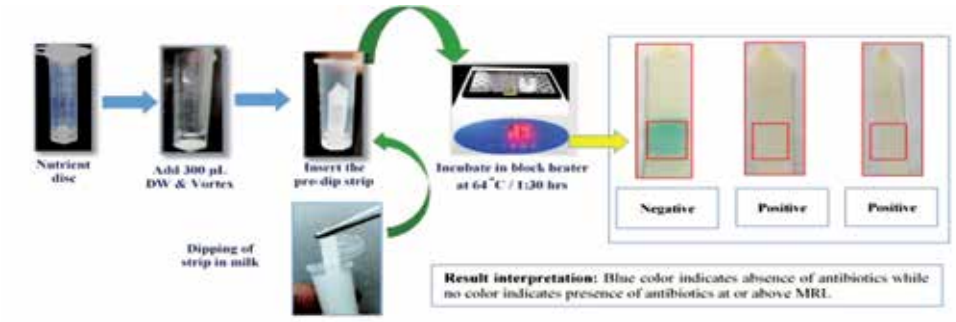
One hundred and seventy four bio-film samples were collected after cleaning-in-place system from different segments of processing lines. The sampling points included Balance and Storage tanks, Chilling and Pasteurization lines, Homogenizer, Cream separator, Ice-cream processing unit, Powder processing unit, Curd and Paneer vats. Bio-film samples were analysed on selective media and morphological examination of 633 representative colonies revealed predominance of Gram – ve rods (354) and Gram + ve rods (157) followed by Gram + ve cocci (122). On the basis of biochemical (API kit) and molecular tools, the isolates were found to belong to *Pseudomonas*, *Bacillus*, *Escherichia coli*, *Enterobacter*, *Staphylococcus* (*S. aureus*, *S. epidermidis* & *S. capitis*), *Enterococcus faecalis* and *E. faecium*. Forty five presumptive colonies of Gram +ve rods from PEMBA showed presence of endospore on spore staining as well as could utilize glucose and mannitol anaerobically and thus, were designated as *Bacillus*. Biochemical observations of API 20E kit of Gram -ve rods led to identification of 4, 11 and 15 isolates as *Citrobacter freundii*, *Enterobacter* and *Klebsiella pneumoniae*. A total of 15, 3, 3 cultures were identified as *Ps. aeruginosa*, *Salmonella* and *E. coli* by genetic methods as these could amplify 618, 285 and 348bp products, respectively. Benzalkonium chloride was found to the most effective biocide against biofilm producer strains of *Pseudomonas* and *Staphylococcus* species.



Microbial diversity of biofilms of dairy niche

Monitoring of Drug Residues and Environmental Pollutants

Technologies for detection of antibiotic residues in milk employing spores as bio-recognition molecules were developed based on two different approaches i.e. enzyme substrate reaction on paper strip and change of color indicator based on released of DPA during spore germination. Both the technologies i.e. Spore based kit for detection of antibiotic residues in milk and Paper strip based assay for antibiotics detection in milk, were validated by third party through an open tender and M/s. Dove Research And Analytics, Panchkula (A unit of Dove Chemicals) validated the claims of the technology, in terms of working test procedure, sensitivity against various groups of antibiotics as per Limits of Detection (LODs).



Assessment of Antimicrobial Residues and Resistance in Dairy Animals in India

A total of 753 samples of raw milk were collected from three districts of Assam (329) and Haryana (424) representing Urban /rural block of three districts i.e. Karnal (168); Kaithal (118); Bhiwani (138). Milk samples were collected directly from the household respondents. Forty eight samples (6.38%) were found positive for antibiotic residues during preliminary screening with Spore based kit on paper strip/DPA kit developed at NDRI. The remaining 93.63% samples were found negative. Forty eight positive samples were further screened for presence of specific group of antibiotics i.e. Novobiocin and macrolides using CHARM 6602 and β-lactam, chloramphenicol, enrofloxacin, gentamycin, quinolone, streptomycin, sulfa-drug and tetracycline groups using Charm ROSA. Assam state samples showed the presence of β-lactam in 0.30%, quinolone and Enrofloxacin in 0.91% each, Macrolide 2.74% and Novobiocin 4.26% and multiple drugs in 2.12%. In Haryana state, samples were found positive with tetracycline in 1.18%, Sulfa-drugs 2.12% β-lactam and quinolone 0.47% each, Macrolide 1.89%, Novobiocin 4.48% and multiple drugs in 4.71%. Three groups of antibiotics namely chloramphenicol, gentamycin, streptomycin could not be detected in any of the samples.

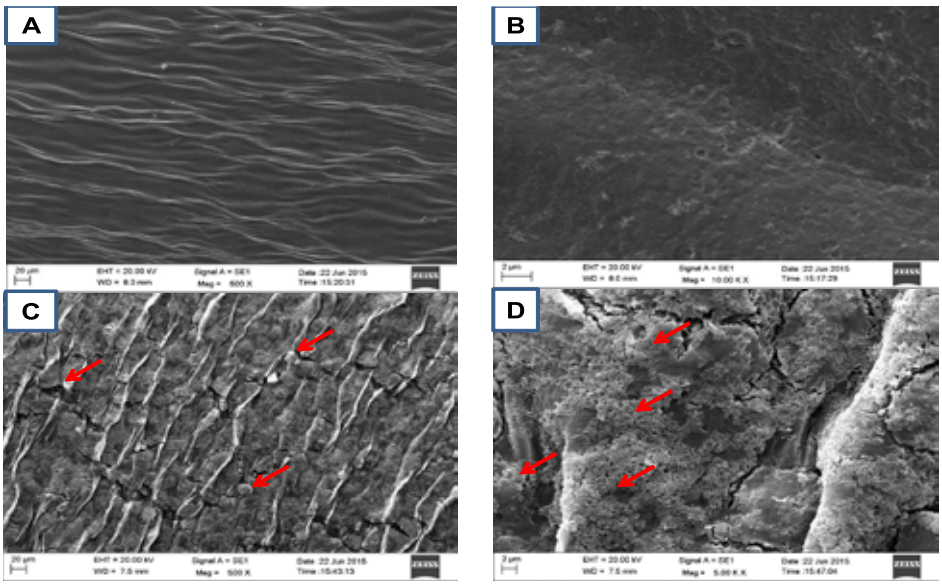
Physico-chemical, Sensory, Textural and Microbiological Quality of Paneer Sold in Bengaluru City

Eight brands of paneer (80 samples) were collected from Bengaluru city and analyzed for various physico-chemical (pH, acidity, fat, moisture, protein, ash and lactose%), sensory (colour and appearance, flavour, body and texture and overall acceptance scores), textural (hardness, cohesiveness, adhesiveness, gumminess, springiness, chewiness and resilience) and microbiological (total bacterial count, yeast and mold, coli forms, *Staph. aureus* and Salmonella) parameters. It was observed that only two of the eight brands studied conformed to all the labeling requirements. In rest of the brands, the requirements like FSSAI license display, ingredients' display, proper naming of the product were not met. Almost all the brands of packets collected conformed to ingredients declaration, permitted additive declaration, best before date, manufacturing date and address. The textural characteristics as measured by Texture Analyzer were found to vary widely from brand to brand and even within a brand and batch to batch. The fat and moisture contents of paneer samples ranged from 13.65 – 24.90% and 49.92 – 64.29%, respectively indicating a wide variation. About 37 % brands showed fat content (on dry matter basis) less than FSSAI standards and all the brands conformed to moisture % standards. None of the paneer samples was found to be adulterated with starch or carbonates or sodium chloride or urea. Almost all the paneer samples were of acceptable quality, the overall acceptance score ranging from 6.3 – 7.6. The TBC counts ranged from 27.4×10^4-43.10×10^4 per g; YMC from 13.75×10^1 – 20.90×10^1 per g; coli forms 3.65×10^1 – 7.65×10^1 per g; *Staph. aureus* was detected in almost all the brands. Presence of *E. coli* and Salmonella was not detected in any of the brands studied. Correlations were studied among sensory, physic-chemical, textural and microbiological parameters of paneer samples. Most of these showed poor correlations, r value being less than 0.70. However, some good correlations were noted like: body and texture score versus fat content (r=0.879), flavour score versus body and texture score (r=0.931). Regression analyses indicated good fit of some univariate and multiple linear models. Based on tabular analysis, the characteristics of all those paneer samples which were scored higher than 7.5 (which was arbitrarily taken as a cut off score for best acceptance of paneer) have been given. Among all these parameters, notable ones are those of moisture content varying from 49.52 – 58.87% and fat varying from 21 – 25.4%.

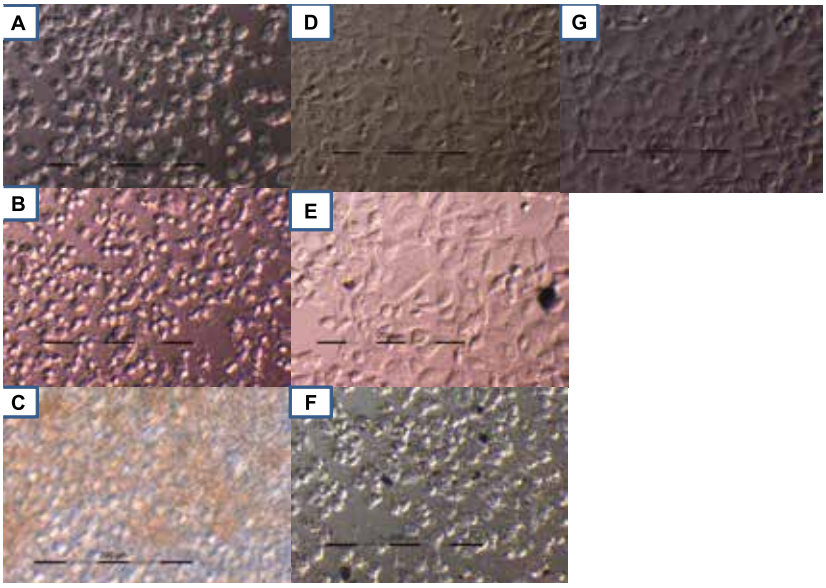
Nanosafety of Mesoporous Silica Nanoparticles via a Controlled Release Nanodispensers for the Delivery of Semiochemicals

The present study was undertaken with the aim to investigate the effect of MSN NPs on pregnant mice, including the reproductive system of prenatally exposed mature male mice. ZnO NP's were taken as a positive control throughout the studies. The level of male sex hormone testosterone, histopathological changes in the testis and relative gene expression levels of steroidogenesis

related genes involved in testosterone production were examined, which are the possible markers involved in the effected reproductive functions in prenatally exposed mature male mice. Additionally, steroidogenesis in the corpus luteum of pregnant mice and liver and kidney injury marker enzymes were also analysed. *In vitro* studies were also carried out in TM3 cells to assess the safety of the MSN NPs and it was also ascertained as to how MSN NPs compare in causing noxious effects with ZnO NP. Pregnant albino mice were exposed to MSN and ZnO NPs for two days on alternate days during GD (Gestation Day) 15 to 19. Only in the case of ZnO-treated animals hepatic injury marker enzymes increased in the higher concentration of NMs exposed mother mice, but histological examination revealed no changes in the placenta of pregnant mice, whereas testis of male offsprings showed gross pathological changes. The expression pattern of progesterone biosynthesis related genes was also altered in the corpus luteum of NPs exposed pregnant mice for ZnO NP but no effect whatsoever with MSN. *In utero* exposure of ZnO NPs increased the relative expression of StAR in 100 mg/kg BW ZnO NP and bulk ZnO-treated group and P450scc in 50 mg/kg BW ZnO NP and 100 mg/kg of bulk ZnO treated male offsprings and there was no statistically significant effect caused by MSN was noticed. Serum testosterone concentration significantly increased in the 100 mg/kg of bulk ZnO and decreased in the 250 mg/kg of MSN treated groups and a single dose of 300 mg/kg BW of ZnO NPs caused miscarriages and adversely affected the developing fetus in mice only in ZnO NPs treated, with no mortality in the MSN treated group. TM3 cells were obtained and *in vitro,* they were exposed to doses of MSN and ZnO NP in the micromolar range. Results demonstrated minimalistic effect on morphological changes on the cell line as caused by MSN. However on the other hand, even low *in vitro* doses of ZnO NP caused the substantial effect on the morphology of the cells. Oral exposure of ZnO NPs and MSN to the mice during pregnancy affects steroidogenesis taking place in the corpus luteum of pregnant mice (via progesterone biosynthesis), and the testis of male offspring (via testosterone biosynthesis) exposed in utero during fetus through a shift in the steroidogenesis related gene expression profile (StAR and P450scc). Fetal nanoparticle exposure of ZnO NP (even at a very low 50 mg/kg BW) and MSN at abnormally high concentrations (> 350 mg/kg BW) disturbs the reproductive functions of the male by causing gross pathological changes in testis, like prominent epithelial vacuolization, decrease in the seminiferous tubule diameter, seminiferous epithelium height and altered spermatogenesis. Moreover, oral intake of 300 mg/kg BW or above of ZnO NPs by pregnant mice is lethal to the developing fetus. The results obtained in this work in addition to contributing to an increase in the knowledge of the effect of prenatal exposure of ZnO NPs and MSN on the corpus luteum of pregnant mice and the testis of prenatally exposed male mice also clearly demonstrate that MSN is far better than ZnO NP in so far as their nanosafety assessment is concerned.



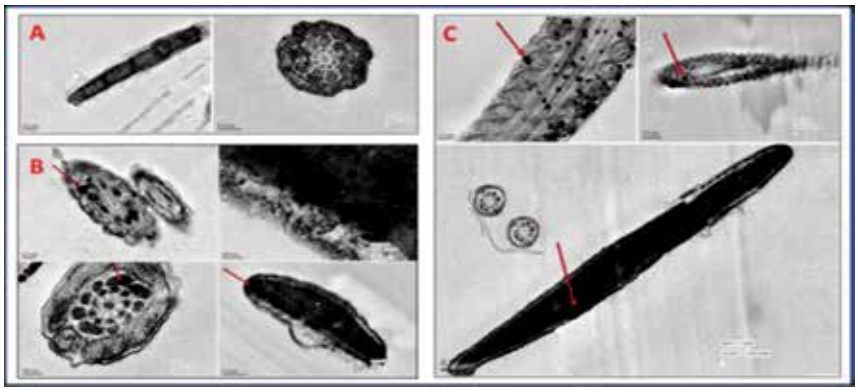
SEM images of TM3 cells after 2 h exposure to the MSN NPs. A and B showing control TM3 cells not treated with NPs and C or D treated with 50 μg/ml of MSN NPs. Control TM3 cells were healthy, flat and well spread (A or B). In A, the TM3 cells not treated with MSN or ZnO NPs are flat and well spread



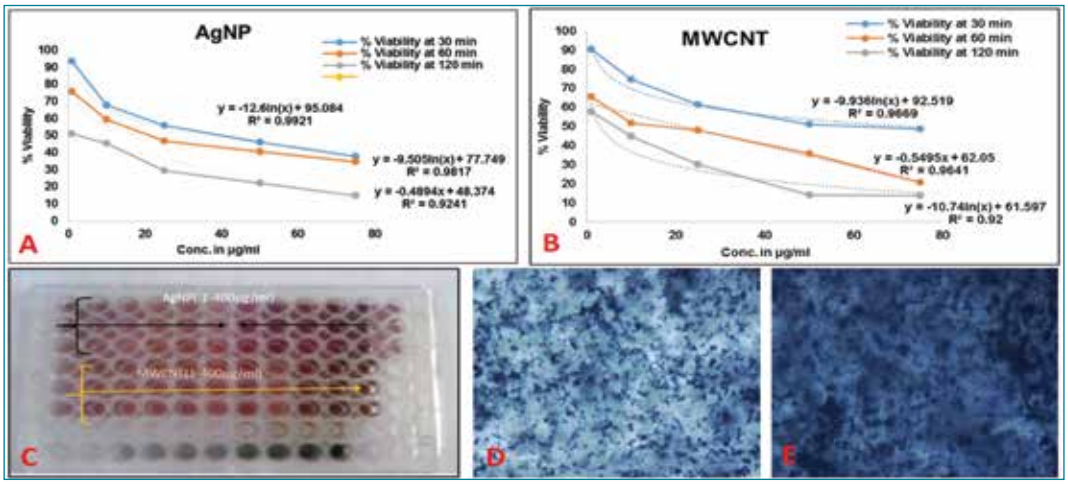
The visible morphological changes in TM3 cells induced by ZnO NPs and MSN were compared after 4 h incubation with (A) 5 μg/ml ZnO NPs (B) 5 μg/ml MSN (C) 10 μg/ml of ZnO NPs (D) 10 μg/ml of MSN (E) 50 μg/ml of ZnO (F) 50 μg/ml of MSN. G representing the control TM3 cells. Optical micrograph indicated that compared to MSN NP, ZnO NP was causing alteration in normal cell morphology

Biosafety of Anthropogenic Nanomaterials: *In Vitro* Assessment of Half Maximum Inhibitory Concentration of Silver Nanoparticles and Multiwalled Carbon Nanotubes in Germ Cell Model System

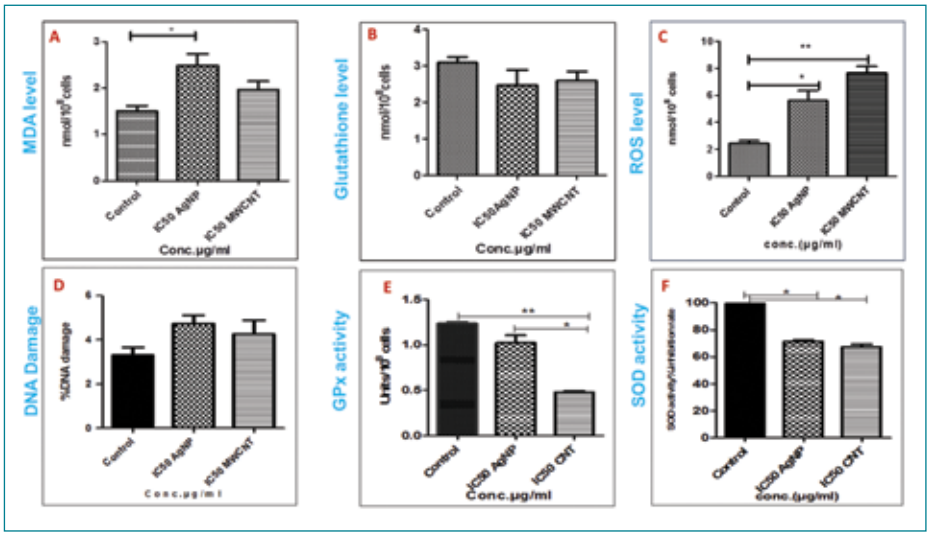
The area of nanotechnology has pretty much exploded with hundreds if not thousands of new products available in the market. Silver nanoparticles (Ag NPs) and Multi-walled carbon nanotubes (MWCNTs) are the class of nanomaterials which have high demand in the consumer product industry. Ag NPs are consumed in clothing, food industry, paints, cosmetics, electronics, coating application and medical products. MWCNTs are usually used due to their excellent mechanical, electrical, magnetic and hollow nanostructure properties. However, the ability of Ag NPs to cross the blood testis-barrier laid them feasible for use in contraceptive devices and other products predestined for reproductive hygiene. Despite their immense usage, these nanomaterials have also been observed to induce cytotoxicity mainly by disrupting the mitochondrial functions and also by inducing oxidative stress resulting in membrane damage and apoptosis. There is a dearth of credible information regarding the safety of silver nanoparticles (Ag NPs) and multi-walled carbon nanotubes (MWCNTs). Buffalo bull spermatozoa have low cholesterol to phospholipid ratio in the plasma membrane which increases their sensitivity to chemical damage and oxidative attack. The aim of the current study was to determine the half maximum inhibitory concentration (IC_{50}) of Ag NPs and MWCNTs by employing different doses and time interval combinations. Typical experiments had 100 million spermatozoa temporally incubated with increasing concentrations of Ag NPs and MWCNTs. Spermatozoa viability was monitored by MTT assay and Eosin-Nigrosin staining followed by estimation of IC50 values by regression analysis. IC50 values for Ag NPs were significantly lower than MWCNTs. Spermatozoa treated with IC50 doses of Ag NPs and MWCNTs were also assessed for other sperm functionality parameters including oxidative stress and membrane integrity. It was observed that in both Ag NPs and MWCNTs treated group, oxidative stress indicators and membrane integrity was significantly affected. Buffalo bull spermatozoa may be a suitable *in vitro* cell model for nanomaterial safety testing and it can further replace costly and time consuming animal testing models by providing a reduction and replacement system. The present study was conceived with the primary objective of determining the IC50 of two different nanomaterials viz. Ag NPs and MWCNTs in buffalo bull spermatozoa. This question was remained consistent for many years since different types of cells in the body behave differently towards external chemicals or substances act upon by them. Germ cells harbour and carry the fertility characteristics of animals from one generation to next generation; hence, determining the safe doses of these nanomaterials on germ cell becomes necessary. Buffalo bull spermatozoa can serve as a representative germ cell in vitro model for the assessment of nanomaterials safety on human/animal health and environment.



Transmission electron micrographs of buffalo bull spermatozoa (head and mid piece region). (A) Longitudinal section of sperm head incubated for 6 h without nanoparticles (control) at 5000x magnification (B) Photographs showing attached and internalized nanoparticles in the head after 6 h of incubation with Ag Np at 5000x magnification. (C) Internalized CNT in cross section of sperm (Red arrow shows internalized NM in different cross section area of head and mid-piece region)



Determination of IC_{50} via MTT assay. Dose dependent effect of A) Ag NPs and B) MWCNTs on viability of sperm cells. IC_{50} values were calculated by sperm viability percentage (%) = a-b/a ×100, where a is OD value of control and b is OD value of treatment group. Percentage viability values plotted against concentration of NM. By regression analysis (y = 50), IC_{50} values were calculated. C) 96 well plate showing MTT crystals in D) Ag NPs and E) MWCNTs

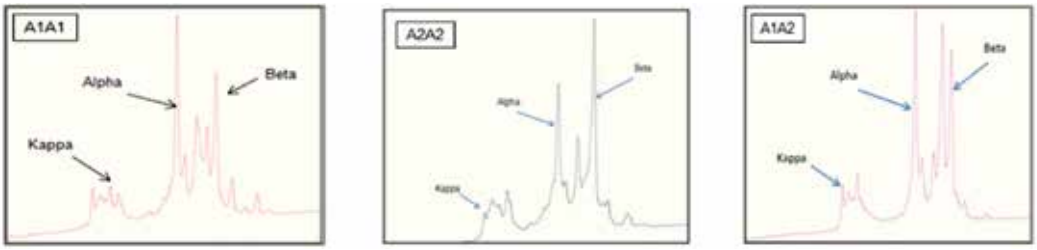


*Ag NP and MWCNT induced oxidative stress in buffalo bull spermatozoa. Fresh spermatozoa with > 80 % motility were treated with Ag NP and MWCNTs at concentrations of IC50 i.e. 34 μgml^{-1} and 45 μgml^{-1} respectively. After 30 min incubation time, level of MDA, GSH and ROS along with antioxidant enzyme level was determined. (A) MDA level, (B) GSH level, (C) ROS level (D) DNA damage (E) GPx and (F) SOD activity. GPx activity was significantly decreased in MWCNT treated cells as compared to the control and silver nanoparticle treated cells. Each data set mean value is composite of three independent experiments with SD shown. *Statistically significant difference as compared to the controls. Bars with * subscripts are significantly different (P < 0.05)*

NEW GENERATION METHODS TO ASSESS QUALITY AND SAFETY OF MILK AND MILK PRODUCTS

A UHPLC-coupled LC-MS-MS Based Method Developed for Detection of A1/ A2 β-casein Variants in Milk

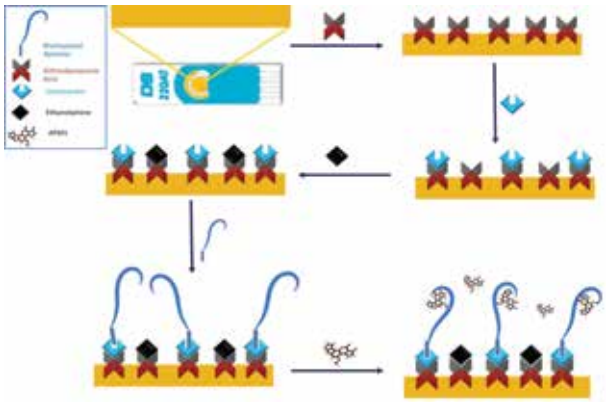
A mass spectrometry-based method was developed to identify A1 and A2 β-casein variants from different genotypes (A1A1, A2A2 and A1A2). For intact mass analysis, proteins were extracted from milk by the addition of a two-fold volume of an aqueous denaturing solution containing 8 M urea, 165 mM TRIS, 44 mM sodium citrate and 0.3% (v/v) mercaptoethanol, followed by filtration. Protein (20µg) was loaded to UHPLC coupled with QTOF for data acquisition and data was further analyzed for mass calculation using compass data analysis software. β-casein variants of A2A2 and A1A1 milk types could be successfully differentiated using this method. The method developed could be used to identify and quantify β-casein variants in whole milk.



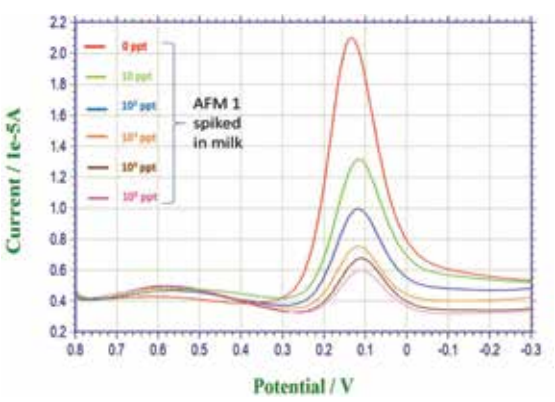
Comparison between A1A1, A2A2 and A1A2 UHPLC Chromatogram

Detection of Aflatoxin M1 using Electrochemical Aptasensor

An electrochemical aptasensor for detection of trace amounts of aflatoxin M1 **(**AFM1) was designed and developed. An AFM1 binding ssDNA aptamer (AFAS3, Kd – 35.6 nM) was modified at 3′-end by biotin. The sequence of aptamer used is $^{5'}$ ATCCGTCACACCTGCTCTGACGCTGGGGTCGACCCGGAGAAATGCATTCCCCTGTGGTGTTGGCTCCCGTAT- TEG-Biotin$^{3'}$. Biotinylated aptamer was immobilized on screen printed gold electrode (SPGE) comprising of working electrode, counter electrode and reference electrode and was achieved by sequentially layering dithiodipropionic acid, streptavidin and biotinylated-tetraethylene glycol-aptamer. Aptamer 'AFAS3' was selected from random oligonucleotide library using SELEX. Immobilization of aptamer was monitored by cyclic voltammetry. Peak current in square wave voltammogram was inversely related to logarithmic concentration of AFM1. Dynamic range of sensor was 1 ppt



Scheme for the immobilization of aflatoxin M1 specific aptamer on screen printed gold electrode

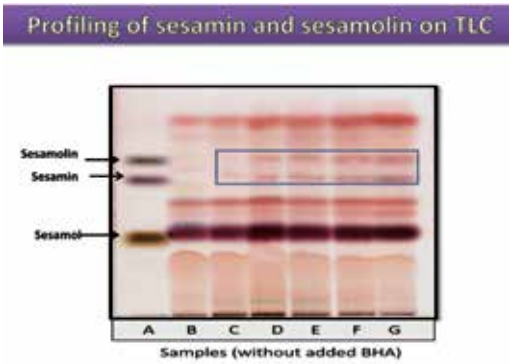


Square wave voltammetry of aptamer immobilized on screen printed gold electrode at variable concentration of aflatoxin M1.

to 10^5 ppt AFM1. Sensor can be regenerated by treating electrode with 10 % SDS or 40 mM tris HCl (pH 8.0) containing 10 mM EDTA and 0.02 % tween-20. Developed sensor offers great promise for easy and sensitive detection of AFM1.

Efficacy of Baudouin and Sesamin Tests to Detect Vanaspati/Hydrogenated Vegetable Oil in Ghee during Storage

A protocol was standardized to isolate sesamin/ sesamol from the vanaspati and found that saponification approach was more appropriate. A TLC based method was standardized to resolve sesamol, sesamolin and sesamin on TLC plate. Adulteration of ghee with vanaspati to the minimum level of 5% could be detected using the standardized TLC method. TLC based method remained efficient even in stored samples, indicating that both the active components i.e. remained intact as a result of storage.



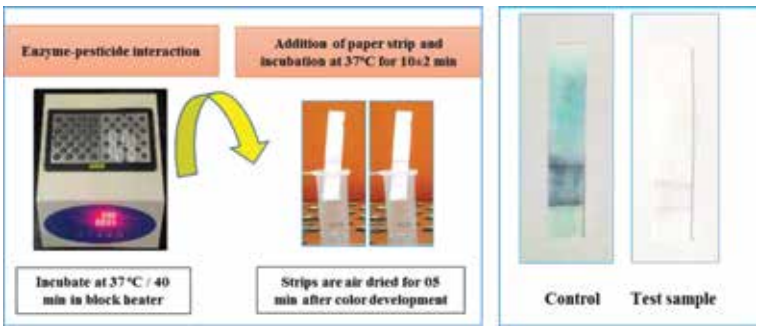
A) Mixed standard, B) pure ghee, C)1% adulterated, D) 5% adulterated, E) 10% adulterated, F) 20% adulterated, G)30 % adulterated

Formulation of new Preservative as an Alternative to Formalin for Chemical Analysis of Milk and Milk Products

The feasibility of different preservatives like Kathon, Bronopol, Sodium Azide, Sodium Omadine, Dowicil, Triclosan, Hydrogen Peroxide, and Methyl and propyl parabenas as alternative preservative to formalin for milk stored for analytical purposes was assessed. Milk samples added with various concentrations of different preseravtives were stored at 37°C for 24 hrs. The preservatives were screened on the basis of their antimicrobial activity against various group of microorganisms by using Total plate count, Lactic acid bacterial count, Coliform count, Yeast and mould count. The results showed that the Dowicil (0.02-0.20%), Methyl Paraben (0.05-0.20%), Propyl Paraben (0.05-0.20%), Triclosan (0.07-0.30%) and Hydrogen peroxide (0.05-0.20%) were having poor antimicrobial activity against all groups of microorganisms. However, Sodium Omadine (0.02-0.08%), and Sodium Azide (0.02-0.10%) were effective against coliform and yeast and mould count but having poor antimicrobial activity against Total plate count, Lactic acid bacterial count. Bronopol (0.05-0.10%) and Kathon (0.20-0.40%) showed good antimicrobial activity against all groups of microorganisms.

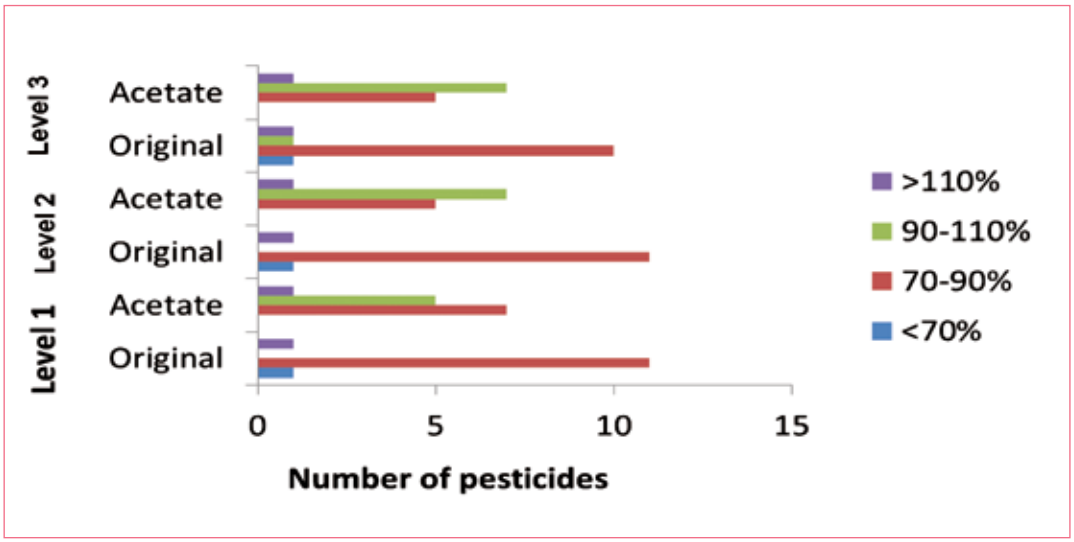
Development and Evaluation of Spore Based Biosensors for Monitoring of Pesticide Residues in Milk

Spore enzyme based sensor on paper strip was evaluated with milk samples (spiked / or under field condition) and LODs of 30 pesticides of different groups were established. The marker enzyme associated with spores was highly specific for wide range of pesticide groups and could provide semi-quantitative detection well within regulatory limits.



Spore-enzyme sensor on paper strip for detection of pesticides in milk

The developed assay was used for screening 451 raw milk, 56 pasteurized milk and 20 dried milk samples procured from Haryana wherein 25 raw milk and 6 pasteurized milk samples were found positive for pesticides residues. Shelf-stability study of functionalized paper-strips with substrate was carried out. The functionalized paper-strips were vacuum packed and stored at 25 ± 5, 4 and -20°C. The strips stored at 4°C and -20°C were found to work well up to 7 months. Transitions of individual eleven pesticides (four OC and seven OP group) were obtained and studied at the concentration of 5 ppm in pesticide mix in solvent and the fragmentation spectra of analyte molecules were matched with reference spectra in NIST (National Institute of Standard & Technology) library pre-registered in GC-MS/MS TQ 8030. The percent recovery of pesticides was estimated using two different extraction procedures (original and acetate QuEChERS method) and compared against the standardized conditions of GC-MS/MS and estimated maximum recovery. It was observed that acetate method gives better efficiency i.e. maximum pesticides showed recovery in the range of 90-110%, whereas original method showed recovery in the range of 70-90%.



Comparison of original and acetate methods for pesticide extraction from milk; Level 1-10 ng mL^{-1} Level 2-100 ng mL^{-1} and Level 3-250 ng mL^{-1}

Evaluation and Validation of Paper-Strip Sensor for Detection of Pesticide Residues in Milk

Paper based sensors are new alternative technology for fabricating simple, low-cost, portable and disposable analytical devices for many application areas including clinical diagnosis, food quality control and environment monitoring. For routine monitoring of pesticides under field application, a spore-enzyme-sensor was miniaturised on paper strip. IP created in the development of assay is unique based on novel marker enzyme from prokaryotic source which otherwise is exploited from eukaryotic system as acetylcholine esterase in existing prior art.The developed assay was evaluated for LODs for different groups of pesticides and were found invariably within regulatory limits for organophosphorous, carbamate, organochlorine, fungicides and herbicides group. An alternative use of sugars for phase separation was achieved with better recovery of pesticides from spiked reconstituted milk and cleanup reagents were replaced by specialized filter tips.The efficacy of optimized extraction protocol was evaluated with one pesticide from each group spiked in reconstituted milk and detection was achieved successfully using miniaturized spore based sensor on paper strip. The assay was evaluated with 139 milk samples and positive samples were analyzed for confirmation using GC. The preliminary results obtained with GC and strip sensor revealed a positive correlation wherein out of random 15 samples , four were found negative and eleven were positive for different group of pesticides namely Heptachlor: 2.2-10.5ppm, Aldrin: 0.46-2.2 ppm) and Chlropyrifos: 87-225 ppb.

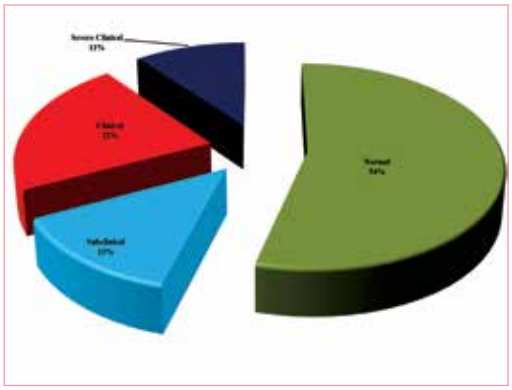
Spore based Paper-Strip Assay for Detection of Antibiotic Residues in Milk

The concept based on spore germination inhibition was attempted and detection of antibiotics in milk was achieved successfully by functionalizing spores and marker enzyme substrates on paper strip. Spores on paper strip were allowed to germinate in the presence of germinant

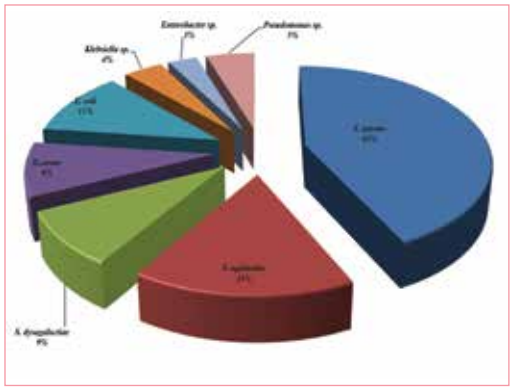
medium lyophilized in eppendorf tube and by addition of milk. In the development of strip based assay, initially, the release of marker enzyme was established during spore germination. Employing marker enzyme, different papers were evaluated. Spores and enzyme substrate were lyophilized on selected paper strip using easy printer and process was optimized. The optimized assay on paper strip was evaluated for different groups of antibiotics for their limit of detection. LODs achieved were 2-100 ppb for β-lactams group;100-1500 ppb for aminoglycosides, 0.1 ppb chloramphenicol, 100 ppb bacitracin, 50 ppb each for trimethoprim and sulphadimidine. The optimized assay was subsequently, evaluated with 72 raw milk and 28 pasteurized milk samples wherein five samples were found positive with strip assay. These contaminated samples were further, tested with Charm 6602/ROSA assay and showed the presence of β-lactam, tetracycline, chloramphenicol, and gentamycin group. The results obtained so far exhibited good correlation with AOAC approved system.

Development of Enzyme Substrate Based Assay for Detection of Mastitic Milk

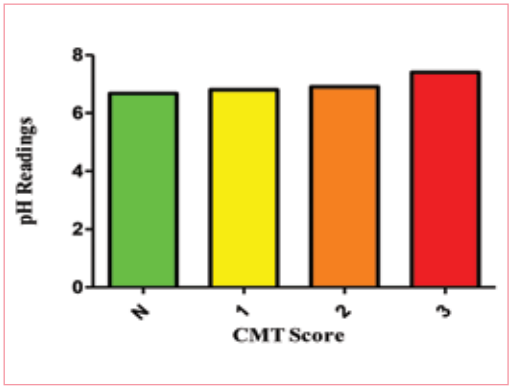
Screening of 160 milk samples from 40 selected high yielding animals for mastitis infection by conventional tests *viz.,* california mastitis test (CMT), somatic cell counts (SCC), pH & chloride conten) revealed mastitis infection in 46% (22, 13 and 11% clinical, subclinical and severe clinical mastitis) quarters. Pathogen analysis of mastitic milk revealed predominance of *S. aureus* (43%), followed by *Streptococcus agalactiae* (16%). Screening of predominant mastitis causing microorganisms for six marker enzymes (I, II, III, IV, V, & VI) showed their presence except enzyme-III. The same was present in milk of infected quarters and thus, selected for development of test. The developed assay was validated in laboratory using normal and mastitic milk samples and was compared with results of well established methods (CMT, SCC, pH and chloride content). The test was quantified by CIELAB based on colour intensity. The colour intensity correlated with results of CMT, SCC, pH, chloride content. The test was evaluated under field conditions with 60 mastitic milk samples which demonstrated positive reaction by color change from white to yellow after 10 minutes. Activity of target enzyme was also checked in 50 urine samples, which were found negative.

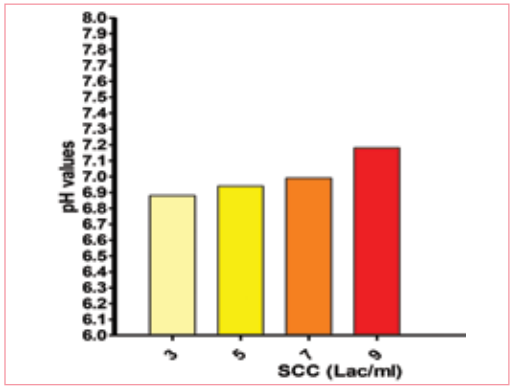


Quarter wise percent distribution of mastitis



Distribution Pattern of Pathogens in Mastitic Milk





Correlation between pH & CMT scores. *Correlation between pH & somatic cell counts*

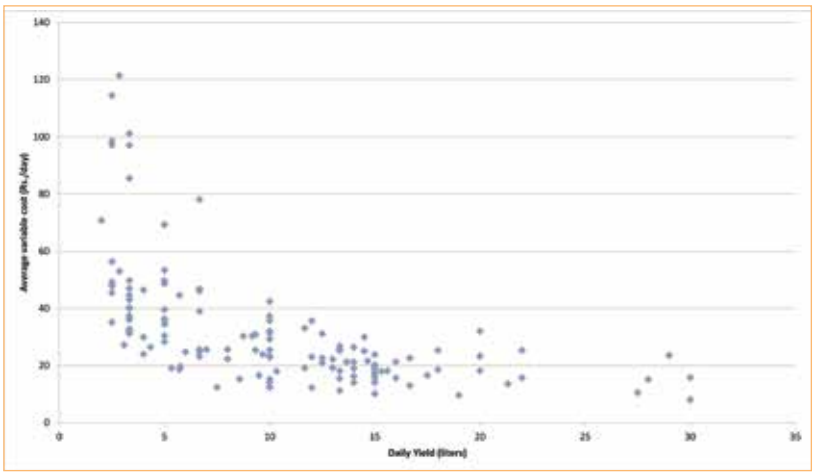
DAIRY DEVELOPMENT: POLICY ANALYSIS, STRENGTHENING DATABASE AND IMPACT ASSESSMENT

Economics of Milk Production

Studies are undertaken in various parts of the country to work out the economics of milk production. In the milk-shed area of Dhenkanal Co-operative Milk Producers' Union (Odisha), the daily gross maintenance cost of crossbred, buffalo and local cow, was ₹ 136, ₹ 91 and ₹ 80, respectively. The crossbred cows were the most profitable for the dairy farmers earning a net return of ₹ 3 per litre of milk production.

In Belgavi district of Karnataka also, crossbred rearing was profitable with net return from crossbred cow slightly higher than ₹ 3 per litre. The cost of milk production was about ₹ 21/ litre for crossbreds, about ₹ 27/litre for buffaloes and ₹ 29/litre for local cows. The buffalo milk production was also profitable in the region, the net returns were about ₹ 2/litre.

In the Sirsa Cooperative milk shed area of Haryana, the cost of milk production of local cos and buffaloes is about ₹ 32.50-33.50/litre and that of crossbreds much lower (₹ 21/litre). The net margin in milk production of local cows is as the costs are high due to low productivity of animals. For buffaloes, as the price of milk is much higher than that of cow milk, the dairy farmers get a net return of ₹ 3.50/litre. Similarly in crossbred animals, the net returns are reasonably good (₹ 5/litre) as the cost of milk production is on the lower side. The inverse relationship between the milk yield and average variable cost emphasise on the need to enhance milk yield for higher profit margins. The cost elasticity of milk production of average herd size category was found to be -0.59, which implies that with one per cent increase in yield, the average cost will decrease by more than half per cent.



Relationship between Cost and Milk Productivity: Micro Evidence from Sirsa, Haryana

Cost of Milk Procurement, Marketing and Processing

The procurement cost of milk that comprised of transportation, collection, chilling and reception cost was ₹ 1.83 per litre of milk for the Sirsa Cooperative milk plant located in western Haryana. Cost of steam production, water pumping and refrigeration in the dairy plant was found to be ₹ 1.35 per kg, ₹ 9.43 per kilo litres and ₹ 9.37 per tones, respectively. Cost of manufacturing various products was ₹ 205/kg (paneer), ₹ 333/kg (ghee), ₹ 10.35 /200 ml, (dahi), ₹ 29/litre (lassi), ₹ 221/ kg (Kaju pinni), ₹ 224/kg (SMP), ₹ 29.30/litre (Standardised Milk), ₹ 36.48/litre (Double Toned

Milk) and ₹ 43.12/litre (Full Cream Milk). There was scope in the plant to improve the water use efficiency and shift the resource from low profitable products such as Standardised Milk (4.70%) to high profitable products such as Dahi (23.29%).

Bulk of milk produced in India is marketed through unorganised sector comprising of milk vendors, halwaies etc. Even in the milk shed area of a cooperative milk plant (Dhenkanal Co-operative Milk Producers' Union, Odisha), where the marketed suplus was 78.5%, only 27.7% of the marketed surplus was sold to the cooperative plant and rest to the unorganised sector. Interestingly, the small holder dairy farmers sold more milk to the organised sector (44%), while farmers with larger herd relied more (89%) on the market agents in the unorganised sector. Among various milk marketing agencies, the halwais were making the highest profit in liquid milk marketing (₹ 3.10/ litre). The producer's share in consumer's rupee was highest (84.66%) in case of producer-milk vendor-consumer channel.

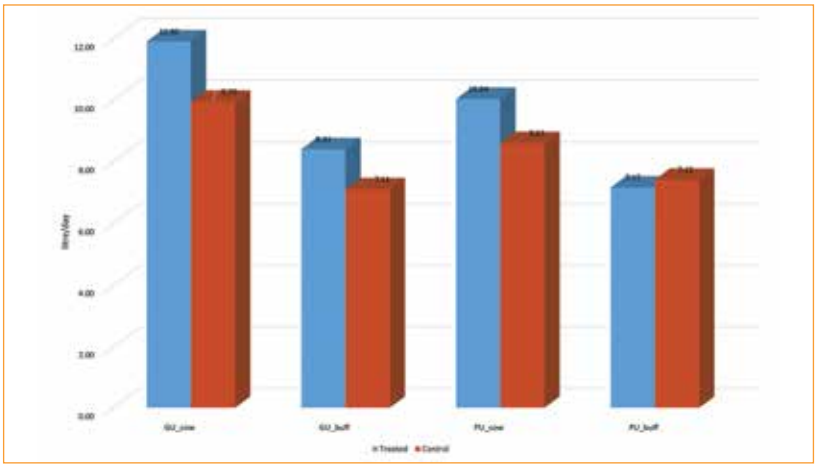
Improving Efficiency and Reducing Cost of Milk Production

Inefficiency in milk production can reduce by better utilisation of existing resources and/or technological interventions. However, as in case of crop production, there are evidences of technology fatigue in dairy farming as well. The estimates of total factor productivity (TFP), which is an indicator of contribution of technology, worked out to be very low in Sirsa co-operative milk shed area. TFP was the highest on large category of households (0.2202) and for crossbred cow (0.2346). Although TFP increased with the increase of herd size; and it was higher for high yielding animals, *i.e.*, crossbred cattle and buffaloes yet its value closer to zero revealed higher share of inputs in explaining the milk productivity than that of technology. In this area, the technical efficiency of the farmers in milk production was generally high in all herd size categories (> 80 per cent) implying that < 20 percent improvement can be made by better utilisation of existing resources by the farmers, while for a higher increase, technological intervention would be required.

As feed and fodder cost account for 60-70% of the total variable cost, to examine the scope of reducing the cost of milk production, a study in Mandya district of Karnataka, developed minimum cost feed (MCF) plans for the existing and the recommended practices. For the existing practices, the following of MCF plan can reduce ration cost from 9 to 15%. The MCF plan for recommended practices increased the feed cost marginally from 0.9% to 7% but the nutrient intake was considerably higher than the existing one. The decrease in feed and fodder cost by following the MCF plans increased the profitability in milk production from 27 to 41% in case of crossbred and buffalo. Also the local cows can earn positive net returns by following the minimum cost ration.

Impact of Ration Balancing Advisory Services

Realizing the ardent need to promote adoption of balanced animal ration for enhancing the productive, reproductive and economic performance of the dairy animals, Ration Balancing Program (RBP) was made a key component in the National Dairy Plan I (NDP I), a Central Sector Scheme for promoting dairy development in the country. Impact assessment on the three outcome variables, milk productivity, feed cost and milk-feed ratio indicated very encouraging influence of the program. In case of Gujarat, the RBP has increased the milk productivity of both, cows and buffaloes by about 19.5 and 18%, respectively. In Punjab, similar results were discernible for cows but, in buffaloes the effect of RBP could not be established based on the field survey. RBP had a clear impact in reducing the feed cost per liter of milk by about 18-19% in case of cows in both the states and about 2.6% for buffaloes in Gujarat. The unit cost of feed declined significantly ($p<0.10$) in case of buffaloes also in Punjab,



Effect of RBP on Milk Productivity

although the productivity differences between RBP and non RBP animals were not significant. The decrease in feed cost and significant increase or non-significant change (Punjab buffaloes) in milk productivity has led to improvement in milk-feed ratio, i.e. the ratio of gross returns from milk output per unit of feed cost.

Potential Impact of Semen Sexing Technology

Semen sexing is a promising technology to deal with the problem of growing number of animals of unwanted sex that are male animals in Indian context. An ex-ante evaluation of the technology, wherein under the alternative animal management scenarios, the quantification of benefit of sexed semen was done in terms of more milk production due to larger female herd, worked out that the net present value of the benefits from semen sexing technology to be ₹ 24.10 lakhs per 100 heifers under best management practices. Given the difference in cost of sexed semen and its lower conception rate compared to the unsorted semen, the economic viability is discernible only on the farms that have ideal management practices. The unviability in case of good and moderate practices gives a clear message that the focus of the Government on promoting sexed semen in India should be backed by efforts to improve estrus detection and conception rate at field level without which there would be no economic rationale for its adoption.

Assessment of Technological Needs and Manpower Requirements of Dairy Production and Processing

The study encompassed distinct regions of Karnataka practising dairy farming and milk processing**.** The improved farm practices of the organised farm units included azolla culture, hi-tech animal housing, silage pits, hydroponic green fodder, vermi-compost, liquid manure, machine-milking with instant storage at farm-level chilling unit. The milk yield per day in the farms varied from 125-175 litres/day with 90- 98% of milk disposal at Dairy Co-operative society under the KMF and private dairy, Akshaya Kalpa. The profile study in the selected thirty farm units indicated that farming with dairying as primary occupation (60%) with a herd size of 2-3 dairy animals by majority (60%) of the respondents and 4-5 dairy animals by 30%. The milk production per day in the sample farm units ranged from up to 15 litres /day in 57% of the farms and 16 to 30 litres / day in 32% of farms. The constraints in dairy production units as expressed by the respondents included, high cost of inputs-Cattle Feed (86%), severe water scarcity (82%), low milk procurement price (80%), limited veterinary services (68%), recurring FMD and mastitis problem 65% and repeat breeding (54%). Assessment of the technology and manpower needs of dairy production units in the study area indicated need for good quality cost-effective feed utilizing local agro-by products (62%), drought resistant green fodder varieties to cope-up fodder scarcity (56%), small-scale cost-effective dairy machinery and equipments for small farms and processing units (42%), farm-level kits for testing milk quality and disease diagnosis (40%) and skilled field level manpower for effective breeding and health care services (52%).

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

In the project items for resilience scale were developed and rating from judges was registered by using 'Google form'. Items for construction of 'Resilience scale' were selected and 29 items were sent to different judges who were professionals belongs to ICAR Deemed University (NDRI, IVRI, IARI),Central Agricultural University, State Agricultural University, State Veterinary and Animal Husbandry University, Krishi Vigyan Kendras, Rama Krishna Mission Vivekananda University etc. All the items were fulfilling the Edward's criteria for formulation of statement. Responses of the judges were recorded by using 'Google form'. Response from 36 judges was retained for final item analysis and 14 statements have been retained. The statements were retained on the basis of t-value (more than 1.75). By using 'Google form' collection and analysis of responses from judges took less time and facilitated the item analysis process for scale development. Final selection of the statement for 'Resilience Scale' was completed and one interview schedule was developed and the schedule was pretested. The final schedule was translated in Bengali and data collection was started. The collection of data from one block in the 'Red and lateritic soil zone' was completed.

EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING

Ration Balancing Programme

A total of 100 local resource persons (LRPs) of 100 villages of the Muzaffarnagar district (UP) were trained about the ration balancing and all of them were working in their respective villages. Nearly 4000 animals were covered under the project area and more than 7600 ration balancing advices were given to the famers by the selected LRPs. More than 50 farmer meetings are undertaken to assess the progress of the plan. Overall, many dairy farmers were benefited from the programme in terms of enhanced livestock productivity and health.

Vulnerability to Climate Change among the Tribal Dairy Farmers of Himachal Pradesh

The live on this earth are increasingly endangered by the adverse effects of the current climatic conditions because the activities of human beings are gradually degrading the environment, thereby affecting its aptness for habitation for natural creatures. The present study was conducted to assess status of vulnerability to climate change among the tribal dairy farmers of Himachal Pradesh. An Agro-ecosystem characterization of the study area was assessed and found that the prevalent cropping system was rice/maize-wheat and the major crop of the study area was found to be wheat, maize, rice, barley, chickpea etc. with the dominated livestock mainly buffalo, cattle, goat and sheep. The major soil types in the study area were deep loam to sandy loam soil. Majority of the tribal dairy farmers (58.75%) were moderately vulnerable to climate change while 37.50% of them were highly vulnerable, having vulnerability index value less than zero. Among eight studied villages, three were highly vulnerable while five villages were moderately vulnerable. Among selected villages, Khairi village (-0.24) of Sirmaur District was highly vulnerable to climate change followed by Naurangabad (-0.23) and Dhaulakuan (-0.03). Village Dhargujaran (0.69), Sanghnai(0.61), Ambota (0.48), Wasuni (0.47), Ogali (0.04) had positive value of vulnerability index representing less vulnerability to climate change.

Dairying in Sustainable Livelihood among the Rural Farm Family of Nadia District of West Bengal

Ex-post-facto cause to effect research design was applied in this study to trace out the impact of extension interventions in improving knowledge, attitude, adoption towards scientific dairy farming practices and improvement in milk production of dairy animal and income from dairying which resulted into improved livelihood of rural poor in Nadia district of West Bengal, India. Therefore, 60 dairy farmers of 2 experimental villages (Muratipur and DakkhinChandamari) who were considered as beneficiaries and 60 dairy farmers of 2 control villages (Alaypur and Iswaripur) who were considered as non-beneficiaries were selected as sample for the study covering, pre-assumed effect, *i.e.* knowledge, attitude and adoption of scientific dairy farming practices, milk production and monthly income from dairying, is due to cause various type extension interventions arranged by the Eastern Regional station. Overall knowledge regarding scientific dairy farming practices possessed by the dairy farmers, adoption of scientific dairy farming practices, milk production, monthly income from dairying of experimental villages was significantly ($p<0.01$) higher than the dairy farmers of non-experimental villages. It was revealed that there was a significant difference between the beneficiaries (who received facilities through extension interventions for dairy farming) and non beneficiaries (dairy farmers of control villages) in all aspects of scientific dairy farming practices. It may be concluded that systematic extension intervention may improve livelihood of millions of rural masses.

Unraveling the Innovation System in Evolving Dairy Value Chains in Kerala

The Agricultural Innovation System (AIS) perspective has gained popularity owing to its systems approach acknowledging the multitude of actors and their independent as well as interdependent activities, crucial for the functioning of a sector. The present study was designed with an objective to analyze the dairy value chains of Kerala with an innovation system perspective. The role of private sector was found to be at its infancy and their convergence with the other actors and the farmers were found to be abysmal, which needs more deliberation. Overall the dairy innovation system was found to be performing less than its actual potential in terms of networking and convergence among various actors. Farmers of SBMSCS (35.65) had the highest mean learning scores followed by Farm Fresh (31.49), Imasree (30.68) and PDDP (27.46). The scores are reflective of the learning of the farmers on a technological innovation (Calcium Supplement) much relevant to the dairy sector of the State. The results suggested that social participation significantly influenced the farmer to be a medium or high social learners. Further an analysis of the constraints faced by the dairy farmers in various dairy value chains of focus made it clear that the major problems were spiraling of the price of cattle feed, non remunerative price of milk, high cost of credit, shortage of manpower for cattle health care, unavailability of dry and green fodder etc. which demand varied strategic interventions.

Dynamics of Coordination among Different Aagencies with ATMA in Andhra Pradesh

Agricultural Technology Management Agency (ATMA) is one of the huge public sector extension systems in India. Present study was conducted to investigate the extent of coordination among different agencies for convergence of extension activities at district level, to analyse the Group Dynamics and its effect on Farmers empowerment. It was found that the coordination in Phase 1 was significantly more (179.66) in comparison to Phase 3 (167.84) followed by Phase 2 (140.58) with 0.7, 0.62 and 0.46 scores on ACI. Most of the ATMA professionals (29.85%) expressed that there was a high coordination of ATMA followed by Medium (25.37%). It was also found from this study that group dynamics of the six common interest groups from the three selected districts were significantly not equal. Group dynamics score of members of CIGs under ATMA in phase 1 was more than phase 3 followed by phase 2 and their GDI scores were 0.76, 0.66 and 0.57, respectively. It was found that most of the members (39.67%) represented for high group dynamics. Three factors affecting group dynamics were identified as "Teamwork for success", "Obey the rules" and "responsibilities and Communication among roles". Out of five empowerment dimensions perceived, highest empowerment happened in technical knowledge dimension (23.67%). Extension functionaries are facing inadequate conveyance allowances; salary as the more serious constraint and sporadic visits of the extension functionaries made foremost constraints faced by the farmers.

Facilitation in Disseminating Improved Indigenous Technical Knowledge (ITKs) among Livestock Rearers of Telangana

Blending of indigenous knowledge practices with scientific knowledge will help in their protection, preservation and wide spread utilization. Improved Indigenous Technical Knowledges (i-ITK) were operationalised as products, practices or innovations based on indigenous knowledge system which were scientifically validated, standardized and improved for their ease of utilisation. The present study was designed with an objective to analyze 'knowledge gain' and 'perceived effectiveness' of livestock rearers. A list of thirty five i-ITK practises which help in healing eight common ailments viz. diarrhoea, bloat, retention of placenta, anoestrus, mastitis, foot and mouth disease, ecto-parasites and wounds were catalogued, alongwith the information of their source, formulation, validation, administration procedure, rationale and cost of treatment. The information was disseminated among farmers by framing it into four extension modules viz. lecture + literature (EM-1); lecture + visual aids + Q & A forum (EM-2); lecture + demonstration + focused group discussion (EM-3) & literature + demonstration + focused group discussion (EM-4). It was observed that there is a significant increase in pre-exposure & post-exposure mean knowledge scores of farmers exposed to the extension modules with knowledge gain. Maximum gain was observed through EM-3 i.e. 24.00%. It can be concluded that there was a significant increase in knowledge of farmers exposed to all four extension modules on i-ITK practices.

Preparedness of Livestock Rearers among the Tribal in Disaster Prone Areas of Uttarakhand

To overcome the problems in animal health improvement, a total number of 40 educated farmers were trained on field and 10 farmers in each village were provided animal health kit and continuous supply of improved essential feed additive, supplements and general veterinary medicines. The calves borne have better growth rate compared to calves produced from traditional management practices. In overall 4.66% of calf mortality was reduced in dairy animal. To prevent mastitis in dairy animal; farmers were advised to provide feed-fodder/ concentration feeds just after the milking of animal and insure that animal should not be sit on the floor atleast 30 minutes after the milking. This practice showed very good results and there were reduction of mastitis case around 45%. Mass vaccination, popularized amongst the farmers resulted in almost insignificant morbidity and mortality in bovines. Periodic deworming and introduction of high yielding perennial grasses as Napier (IGFRI-10) & Guinea (Hamil) increased the availability of green fodder round the year. Farmers' perceived lack of knowledge about scientific dairy farming practices.

Production and Disposal Pattern of Feed and Fodder for Dairy Animals in Peri-Urban Areas of Haryana

First-hand information on feed and fodder for dairy animals was collected from 120 respondents of Haryana. It was calculated that the area under cropped grain crops and fodder crops was 76.17 and 12.94% of total cropped land in peri-urban areas. It was found that quantity of seeds and nitrogenous fertilizers were used more than recommendation in fodder production. Most of the respondents (50.83 %) were using homemade concentrates to their dairy animals and only 27.17% of the respondents fed mineral mixture @ 29.28 g/day to each lactating animals. It was observed that 46.67 and 27.5% of farmers were involved in purchasing and selling of the dry fodder whereas, 34.17 and 43.33% farmers were engaged in purchasing and selling of green fodder. Study revealed that major problem perceived by the respondents was found high cost of input in fodder production, non-availability quality seeds, seasonal fluctuation in forage market prices, most serious problem in study area. Farmers were less aware about fodder production practices. Hence, mass awareness or training programme can be organized to update the farmers' knowledge regarding the recommended package of practices. Farmer's organization for creating fodder bank may be promoted in the study area to help the producers to maintain the availability of green fodder round the year.

Market-led Extension Approach for Livelihood Security of Dairy Farmers in Bihar

It was found that most of the farmers (59.16%) narrated that, Sudha dairy were the main promoting agency for collection centre. About half (50.83%) of the respondents having low awareness on breeding practices. Apart from selling of raw milk less than one fifth (15.42%) of the respondents sell their milk in the processed form of paneer and peda, respectively. More than four fifth (82.92%) of the respondents had medium to high level of livelihood security, whereas, the overall average livelihood security index value was 0.61. The Progressive farmers have the strong linkage with the dairy farmers in the transfer of important information regarding not only marketing of milk and milk products but also about the different aspects of agriculture. The most important limiting factors were the "low price of milk offered by the purchasing agency" whereas "well-developed cooperative structure for marketing of the milk" were the topmost conducive factor. Till now, the market led extension system were the peripheral issue, and, this is the opportune time considering it as the main line extension system.

A Study on Sustainability of Sugarcane based Dairy Farming in Uttar Pradesh

Average net profit from dairy farming/household/annum was ₹ 21292.30, majority of the farmers (55.42%) had low net profit, low farmers' margin (50.42%) and low (<1:1.21) input–output ratio (45.42%). The average economic, social and environmental sustainability indices were 0.36, 0.35 and 0.44, respectively. The composite sustainability of sugarcane based dairy farming was 0.38 and majority (44.58%) of the farmers appeared in the category of medium. The composite sustainability of sugarcane based dairy farming for different categories of farmers' *viz*.; large, medium, semi-medium, small, marginal and landless was found to be 0.63, 0.53, 0.46, 0.40, 0.35 and 0.30, respectively. Animal Husbandry Department of UP was the main source of dairy farming technologies. Majority (43.33% & 43.33%) of the farmers utilized sugarcane and dairy

farming technologies to a medium extent. Absence of sugarcane varieties having appropriate proportion of sugarcane top with good nutritive value, controlling the menace of blue bull and irregular payment of sugarcane dues to the farmers were the major issues raised by the farmers. To develop sugarcane varieties having more digestible crude protein (DCP), trace elements and less or no oxalic acid, to educate farmers regarding mineral deficiency arising out due to continued sugarcane tops feeding and educating farmers for improving fodder quality of sugarcane tops were the major issues as envisaged by officials.

Roles and Issues of Marginalized Dairy Holders in Urban and Peri Urban Areas of National Capital Region

Majority (77.50%) of the dairy farmers had medium level of total annual income, majority (70.83%) of dairy farmers are landless farmers. Majority (60.00%) of the farmers gave shelter for the animals in compound of the house and Ground floor of the house and knowledge of proper space for animals was very less. Majority (45.00%) of the dairy farmers purchased green fodder from fodder market. Most (43.33%) of the dairy farmers following manure disposal mechanism in the form of both preparation of dung cake and sold to agriculturist and 67.50% of the dairy farmers following water disposal mechanism by discharging to municipality sewage line. Average herd size of animal which were in milking stage was 7.39. Most (32.50%) of the dairy farmers sold dry animals to other farmer, while 30% of the dairy farmer were used to transfer dry animals in the nearby rural areas to rear till the animals calves. Average monthly milk production is 2923.58 litres/household. Most (36.67%) of the dairy holders were used to milking the animals in front of the consumer by taking them to their residential area. No space for waste disposal, no grazing land, no availability of space for shelter of animals, increasing incident of disease in animals, contamination of animal waste to water bodies, foul smell of residential area, blocking of storm drains and traffic hazards were the main issues of urban and peri urban dairy farming.

Social Perspective of Deagrarianization and its Effect on Livelihood Security of Farming Community in Punjab

There were 14 pull factors responsible for deagrarianization of farming community in Punjab. However, top three factors were 'Higher Education leads to Deagrarianization (92.33%), 'easily and adequate access to bank, cooperative loans etc. and 'Assured income from own business (shopkeeper, kiryan sore, general store)' (91.67%). Mechanisation of agriculture encourages the deagrarianizationand 'Sustained economic growth, rising per capita income'(91.33%). The important push factors were 'Seasonality of agricultural activities (93.00%)', 'Availability of less family labour (89.00%) and 'Uncertainty of crop production due to attack of pest and diseases' were experienced by the farming community to switch over to non- agriculture activities in Punjab. During the focused group-discussion, it was highlighted that land less and marginal farmers were shifting their occupation from agriculture to non-agriculture in Punjab.

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

In the light of rising costs of inputs and reducing farm profitability, emphasis will have to be an efficient and judicious use of improved seeds, integrated nutrition management, integrated weed management and integrated pest management to accelerate agriculture growth. Farmers need awareness regarding balanced fertilizer use, potash use and micronutrients to enhance productivity and quality of the product without depleting soil health. As far as utilization of dairy farming technologies are concerned a considerable gap is existing due to low level of adoption. However, a lot of potential is there for improving the existing productivity of animals. Further it was observed that need of sustainable development of dairy farming enterprise. To overcome all these obstacles under this study scientist –farmers interaction, exposure visit of farmers, kisan sanghoshthies and training programs on different topics like value addition in milk and milk products; vegetable based cropping system; scientific crop farming; animal health practices and scientific dairy farming practices were organized. SMS Web portal was launched to provide the timely and useful information in form of SMS to the farmers. For saving of critical inputs in rice crop direct seeded rice intervention was carried out at farmers' field and to overcome the scarcity of fodder at lean period round the fodder production interventions was also carried out.

Socio-economic Assessment of Indigenous Dairy Cattle Holders in Southern India

Productivity and economic returns of two Zebu cattle breeds (Hallikar and Kangeyam) under smallholder production system was studied in their respective tracts. Among the two breeds, the milk productivity and economic returns were higher in Kangeyam breed. The reported milk productivity per animal per day was 2-4 litres and 4-6 litres for Hallikar and Kangeyam, respectively. On an average, the income generated per month from a single animal ranged from ₹ 2000-3000 in both the breeds. The major advantage, as expressed by the farmers of maintaining these breed of cattle included, their unique suitability to low external input system with grazing, resistance to diseases & adverse climatic conditions. A majority of the farmers preferred indigenous cattle milk for domestic consumption and crossbred animals were exclusively kept for economic returns. A majority of the farmers practiced AI for breeding their animals, however, in the case of Hallikar breed, the availability of frozen semen is very much limited and the farmers had to use semen of any indigenous breed available. However, the farmers maintaining Kangeyam cattle, did not report this as a problem as the frozen semen doses for this breed was available with the Animal Husbandry Department. At present, the milk of Kangeyam cattle fetches good price ranging from ₹ 80 - 100 per litre, however, its availability is limited as majority of the farmers utilized the milk for domestic consumption.

TSP Activities: Upliftment of Socio-Economic Condition of Tribal People through Integrated Livestock Farming in Eastern part of India

A total of 6 vaccinations cum animal health camps were organized in the tribal villages. Three on-campus training programmes were organized in the institute for uplifting the knowledge of tribal dairy farmers about 'scientific dairy farming practices'. Seven scientists-farmers interaction sessions were also organized. In the interaction sessions, a team of scientists and experts of NDRI-ERS, Kalyani interacted with the farmers (with dairy/goat and other animals) on the following areas: scientific animals rearing practices, mastitis management and control measures, vaccination and deworming protocol, fodder production and feed resource development, breeding strategies, infertility/aneastrous/repeat breeding management and calf rearing and heifer management. Experts also delivered lectures/opinion on various aspects of animal husbandry practices through Santiniketan Doordarsan and All India Radio (AIR) for mass communication during the camp period. Apart from that fodder seeds and planting materials of maize, cowpea, sorghum, ricebean, H. Napier, Guinea grass etc were distributed among farmers. Chicks were also distributed to the tribal women.

Krishi-Cum-Dairy Mela and Technology Demonstration organized at Ghoshaldanga Village near Shantiniketan, Birbhum

On 28th January, 2017 one 'Krishi-Cum-Dairy Mela and Technology Demonstration' was organized at Ghoshaldanga village near Shantiniketan, Birbhum District in collaboration with KVK, BiswaBharati, Shantiniketan. In the programme, 153 farmers participated. Veterinary medicines and other inputs were distributed among the farmers who possessed a total of 416 number of cattle, 46 Calves, 18 buffaloes, 412 goats, 99 sheep and 606 no. of poultry birds. A cattle show and competition programme was organized and prizes were distributed among farmers. Similarly,

for agricultural crops, a competition was also organised and winners were given suitable prizes. One scientists-farmers interaction session was also organized on this occasion. Mineral mixture for dairy animals was distributed among farmers. All the participating tribal farmers got some utensils for help in dairy farming.

NEH Activities : Improving the Livelihood through Dairy Farming in North Eastern Hill Region of India

During the period under report, four North Eastern States were covered. Extension interventions which were made in those states are given in the following paragraphs.

Animal husbandry/dairy development programme in Arunachal Pradesh: Team of scientists and technical officer from ERS of ICAR-NDRI, Kalyani visited Arunachal Pradesh and by collaborating with ICAR-NRC on Yak, Dirang, organized animal (piglet) distribution camp, distributed supplements/medicines, concentrate mixture for livestock, interaction-cum-demonstration session with tribal farmers in Yewang village, Dirang (26-27/9/2016). Both ERS of ICAR-NDRI, Kalyani and ICAR-NRC on Yak, Dirang distributed 150 piglets (4 female + 1 male/per farmer) to 30 farmers in the same village. Discussions and interactions were carried out on various topics viz: health management, various livestock production system and its constraints, solutions etc. in depth during the interaction session.

Team from ERS of ICAR-NDRI, participated in 'Yak Mela' at Lubrang village, West Kameng, Arunachal Pradesh on 13.11.16 and distributed 5000 kg concentrate mixture and 596 Kg mineral mixture, which benefitted 124 Yak farmers.

Training of farmers in progress at eastern regional campus, Kalyani

Animal husbandry/dairy development programme in Meghalaya: Two days programmes on awareness about rearing of dairy cattle, demonstrations of use of various inputs alongwith distribution of various inputs and animal health camps in two remote villages of Meghalaya namely Mawmuthoh (Mawrynkneng Block) and Tanglei (Mawkynrew Block) were jointly organized by ICAR-National Dairy Research Institute (NDRI), Eastern Regional Station (ERS), Kalyani, West Bengal and ICAR Research Complex for NEH Region, Umiam, Meghalaya on 11.01.17 and 12.01.17. The team of Scientists/experts from ICAR-NDRI, ERS, Kalyani, West Bengal participated in this programme. All scientists trained the farmers about scientific animal rearing practices and encouraged the farmers to take dairy farming as a profitable entrepreneurship. In this regard, detailed interactions between scientists and farmers were held and farmers of both villages were benefited.

In the state of Meghalaya, four sessions of scientists' interaction with farmers were organized. In those sessions, several inputs were distributed among the farmers. Farmers were exposed to the knowledge of different facets of scientific dairy farming. From the interaction session, 293 farmers were benefitted. Inputs like mineral mixture, cattle feed, veterinary medicines, fodder seeds, extension literatures were distributed among farmers. Method of demonstration of azolla production was also organized.

Animal husbandry/dairy development programme in Tripura: Two visits were organized in the state of Tripura during this period. Scientists-farmers interaction sessions cum veterinary heath camp were organized in those visit as a part of awareness in relation to the scientific dairy animal production. A total of 193 farmers and 2244 animals were benefitted from the camp. Several inputs were also distributed among farmers. Apart from that regular SMS in Bengali language pertaining to various aspects of scientific dairy farming was also send to the registered farmers from Tripura.

Animal husbandry/dairy development programme in Sikkim: One visit in the state of Sikkim was organized in which veterinary health camp-cum-scientists-farmers interaction session was organized in collaboration with ICAR-National Organic Farming Research Institute, Gangtok, Sikkim. A total of 71 farmers were benefitted from the visit. Inputs like mineral mixture, veterinary medicines, cattle feed and extension literatures were distributed among the farmers.

Hundred farmers from various states of North Eastern India visited the Institute at Kalyani on 29.11.2016. Farmers were acquainted with various scientific practices for dairy development and interacted with the scientists/officials for enhancement of their knowledge about scientific practices pertaining to dairy farming.

Dairy farmers interecting with scientist at ERS, Kalyani

ICT TOOLS AND SOFT COMPUTING APPLICATIONS IN DAIRYING

Development of Web Module on Reproduction Management of Dairy Animals

Animal reproduction is a very important subject for students and an area of great concern for dairy farmers. The objective of study was were to develop a web module on reproductive management of dairy animals and to validate the developed web module through participatory assessment approach and expert opinion. Major outcome of this study was development of web portal (www.ndrionline.com) and Mobile App for students, farmers, teachers, veterinarians, extension functionaries etc. It consists of student domain, farmer's domain, general domain, gallery, FAQ etc. Student domain consists of information based on syllabus of ARS NET. In farmer's domain, practical and applied aspect of reproductive management has been covered in hindi language. Gallery consisted of high quality digitalized images and videos pertaining to animal reproduction. Frequently asked questions of farmers and their solutions has been presented in question answer format. Developed module has been validated by expert opinion and participatory assessment approach. A knowledge based bilingual information retrieval system entirely on reproductive management of dairy animals has been developed which will be very useful for students, farmers, extension functionaries, teachers etc.

Decision Support System for Establishing Commercial Dairy Farms

A web based app TEAM-CD (Techno Economic AssessMent-Commercial Dairy farm) was developed for the prospective entrepreneurs of commercial dairy farming using ASP.Net.4.0 as front end and MS-SQL server as back end. It is a decision support system based on the scientific principles of animal husbandry and economics. The software developed is robust to accommodate the regional specificities and user specific requirement in dairy farming. The app provides for generating project report for commercial dairy herd of 10 to 500 adult females. This app has 16 modules, in which 6 are input modules and 10 are output modules. It has a provision for customising the project parameters in accordance with the user requirement. The pre-feasibility project report is generated in the pdf format, giving complete financial analysis of the project for 5 year period including the repayment schedule.

Geospatial Database, Data Mining and Information Dissemination for Dairy Development

Thirty districts of Karnataka state were grouped into three regions: North, South and Coastal & Malnad. Region specific trends in milk production, dynamics of cattle and population of Karnataka State were undertaken. The endogenous and exogenous factors affecting milk production were determined using correlation and regression analysis. HTML programs were developed to create a website to disseminate the data and analysed information according to different thematic areas envisaged in the database, in the form of maps, graphs, excel files, tables and write-ups.

The R-program developed imports data from excel file and aggregate and present the trend analysis for different variables. In case, the data are not available for intermittent time points, linear interpolation sub-routine is used and missing values were estimated. The program also includes ratio and percentage analysis and graphs. Sub-routine for computing annual growth rate and compound annual growth rate (CAGR) are also included. Future projection based on CAGR can also be carried out using a sub-routine included for the purpose. Yet another future of the program is that it has *ggplot* which is a very powerful graphical tool providing aesthetic feel and look to the graphs. An illustrative program is made available for the district level data of milk production, animal population and average milk yield.

Machine Learning Approach to Predict the Fertility of Murrah Bulls

Intelligent predictive models were developed for modelling fertility of Murrah bulls using various emerging machine learning algorithms such as Neural Networks (NN), Support Vector Regression (SVR), Decision Trees (DT), Random Forests (RF) and Linear Model (LM) for regression. These models were based on birth weight, 3rd, 6th, 9th, 12th and 24th month's body weights (kg); age at maturity (years), post-thaw motility (%) and conception rate (%). Data comprised 3200 female buffaloes' and 55 breeding bulls' records pertaining to the Livestock Research Centre, ICARI-NDRI Karnal. A comparison between machine learning models *vis-à-vis* classical regression model was carried out using the accuracy metrics, *i.e.*, mean absolute error (MAE), root mean square error (RMSE) and Akaike's Information Criterion (AIC). In the light of experimental results, it is deduced that machine learning approach (especially Random Forest paradigm) was capable of efficiently predicting fertility of Murrah bulls; which was generally found better than conventional linear models.

Improving Knowledge in Preparation of Traditional Milk Products through Multimedia

Six bi-lingual multimedia on 'Traditional Milk Products' on viz. dahi, lassi, khoa, gulabjamun, paneer and ghee were developed which can act as a guide to the farmers for preparing the products in their household with locally available resources. One 'Knowledge Test' for measuring the knowledge of dairy farmers regarding production of 'Traditional Milk Products' was also developed.

Effectiveness of Mobile Advisory Services in Dairy Farming

Adoption of dairy farming practices can be increased through mobile based advisory services. Results of the study indicated that practices wise adoption were increased as breeding (16.73%), feeding (17.74%), healthcare (14.16%), management (21.12%), fodder production (17.49%), and marketing (23.73%), increased whereas overall adoption of dairy farming was increased around 18.50%. Majority (87%) of the respondents indicated that mobile advisory services on farming should be provided by the government free of cost. When hypothetically bidding processing was performed to estimate the willingness to pay for mobile advisory services, it was found that 60-72% of the farmers were willing to pay one rupee per day for mobile based advisory services.

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, 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 the RAC of NDRI, Karnal was held on 19th-21st September, 2016 under the chairmanship of Dr. M. L. Madan, Former DDG (AS), ICAR.

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 meeting to evaluate the outcome of the completed research projects and to consider new research projects proposals was held during 1st April, 2nd April, and 4th April, 2016 at NDRI, Karnal; 8th May,2016 at ERS, Kalyani and 22nd April, 2016 at SRS, Bengaluru. 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 during 20th, 22nd and 24th October, 2016 at NDRI, Karnal, 18th October, 2016 at SRS, Bengaluru and 26th October, 2016 at ERS, Kalyani, respectively. IRC meetings were chaired by Dr. A. K. Srivastava, Director and convened by Dr. Bimlesh Mann, 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.

Evaluation of Contract/Consultancy Projects

PME Cell also screened and evaluated contract/consultancy research proposals received from time to time. PME cell meetings were held on 6th June, 21st July, 7th November, 2016 and 4th January, 2017 to consider contract /consultancy research projects proposals sponsored by Naandi foundation, Chem., Process System Pvt. Ahmedabad, Pioneer Dupont Hyderabad and Centre for MicroFinance.

Research Projects Database Management

A database through PIMS package of research projects was updated for all the projects in operation during the year 2016. 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 as 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. During the period, three meetings of Technical Screening Committee were held on 22nd February, 10th March and 17th March, 2017 to screen, scrutinize and evaluate the manuscripts.

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 2015-2016.
- Four issues of "NDRI News Letter" - a quarterly newsletter in English.
- 15th Convocation Director's Report.
- Research Projects (2016).
- IRC Proceedings under the research programmmes identified by Research Advisory Committee for NDRI, Karnal (2 No).
- Information on research achievements of NDRI for inclusion in ICAR/DARE Annual Report 2016-2017 and ARIS Newsletter.
- Information on NDRI for inclusion in ICAR/IAUA/VCI Newsletters.

Best Annual Report Award Winning Team NDRI with Dr. R. R. B. Singh Director NDRI & Vice Chancellor and Senior Officers of ICAR-NDRI

Annual Report of NDRI was adjudged as **"ICAR Best Annual Report (2015-16)"** under large Institute category for its excellent quality of content, originality and innovativeness in the presentation. Dr. R. R. B. Singh, Director, NDRI received the award from Hon'ble Radha Mohan Singh Ji, Union Minister of Agriculture & Welfare, Govt. of India in presence of Dr. Trilochan Mohapatra, Secretary (DARE) & DG, ICAR during the ICAR Director's meeting held on 14th February, 2017.

Research Information Management

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

- RAC agenda items covering ATRs of last RAC meeting, proceedings of IRC meetings, QRT recommendations etc. for detailed discussion in RAC meeting.
- Proceedings of the RAC Meeting held on 19th -21st September, 2016 and communicated the same to the members of RAC after obtaining the approval from the Chairman, RAC.
- Counter comments of the Director of the Institute on the recommendations of RAC emerged during the last RAC Meeting held on 19th -21st September, 2016.
- Additional information with respect to NDRI, Karnal for inclusion in the ICAR/DARE Annual Report (2017-2018).
- Information related to on-going research projects wise achievements alongwith allocated budget and time frame.
- Information on major technologies developed/ transferred/ commercialized by NDRI through (ITMU/IPR) Unit of the Institute.
- Information regarding the research achievements of the Institute for the period 2015-2016.
- Information regarding significant events for the period April to June, 2016.
- Information on skill development trainings imparted to rural youth and farmers during- 2016.
- Consolidation of information on agricultural research products including varieties/hybrids/ breeds/species etc. and technologies that have been developed and commercialized by the Institute in the field alogwith a few lines of description for each technology.
- Report on NDRI by highlighting the significant achievements and technologies developed by the Institute.
- Initiatives taken by the Institute for the welfare, development and empowerment of women and other gender related issues.
- Information on development of research technologies for the farming community and dairy industry.
- Information on transfer of technology in the area of animal sciences.
- Quarterly Progress Reports containing the achievements of research, finance, purchase and civil works and targets of the next quarter.
- Monthly Progress Reports consisting significant events.
- Six Monthly Progress Reports of the research achievements with targets of next six months.
- Information on important conferences, seminars, workshops and meetings for publication in Directory of Events of ICAR.

Follow up for XII Plan EFC Memo Document

PME Cell prepared the information as follow up action related to various activities duly reflected in XII Plan EFC Memo Document of the Institute (2012-2017) as per the directives of the Council:

- A brief write- up on the XII Plan research accomplishments that have impacted the society.
- Consolidation of information regarding monitoring the financial implications/research activities of TSP Scheme being carried out during XII Plan at Eastern Regional Station, Kalyani.
- Consolidation of information with respect to NDRI Karnal and its regional stations on important salient research achievements, current research projects (in- house/ externally foreign aided), recent areas of development in Animal Science Division.
- Write-up on initiatives taken by ICAR for the welfare development and empowerment of women and other gender related issues.

- Information on skill development programme conducted during XII plan and future proposed programmes.
- Consolidation of information with respect to research activities carried out at Eastern Regional Station, Kalyani under Tribal Sub Plan (TSP) and North-Eastern Hill (NEH) Region.
- Consolidation of Quarterly, Six monthly and Annual progress report with respect to implementation of Tribal Sub Plan (TSP) and North-Eastern Hill (NEH) in the e Animal Science Division of the Council.
- Consolidation of information on agricultural research products including varieties/hybrids/ breeds/species and technologies that have been developed and commercialized by the Institute in the field alongwith a few lines of description for each technology.

Formulation of XIII Plan (2017-20) EFC Memo Document

- Formulation of SFC/EFC Memo XIII Plan Document of NDRI and its Regional Stations for the period (2017-20) covering TSP/ NEH Schemes for Eastern Region of the Country and other schemes for strengthening dairy development through need based interventions: An action research at Krishi and Dairy Vikash Kendra, Piprakothi, Champaran, (Bihar).
- The overall fund provisions (Plan & Non Plan) amounting to ₹ **9031.76 lakhs** have been allocated to NDRI, Karnal and its Regional Stations including TSP/NEH activities.

Research Co-ordination

Action Taken Reports

- Action Taken Report on the recommendations emerged during ICAR DADH Interface meeting pertaining to NDRI.
- Action Taken Report against recommendations of working group on consumers affairs (Modi Report) pertaining to NDRI.
- Action Taken Report against recommendations emerged during ICAR Regional Committee (RC) No. V held at PAU, Ludhiana from 14th -15th November, 2015.
- Brief note on techniques/ technologies mention in the ATR against the recommendations no. 16th &18th emerged during ICAR Regional Committee (RC) No. V held at PAU, Ludhiana from 14th -15th November, 2015.
- Action Taken Report (ATR) on the points related to NDRI emerged out during the meeting of Heads of Subject matter Division and Associated Sections held under the Chairmanship of DG, ICAR on 22nd April 2016.
- Action Taken Report (ATR) on the recommendation No. 34 emerged during the 24th meeting of ICAR Regional Committee No. VII held at Goa under the Chairmanship of the DG, ICAR on 8th -9th September, 2016.

Status Reports

- Status Reports of the Institute on the agenda items discussed during the Divisional meeting of Animal Science Division of ICAR.
- Status Report on RAC Proceedings/Proceedings of QRT Report finalization/ Monthly Cabinet Report/ Quarterly Report/ Status of Institute's in-house and externally funded research projects.
- Status Report on the agenda items set for the meeting of Directors/ Joint Directors of Animal Science Institutes held under the Chairmanship of DG, ICAR.

Collation

- Information on NDRI, Karnal for inclusion in the ICAR/DARE Annual Report (2017-2018).
- Consolidated requisite information with respect to TSP activities carried out at ERS, Kalyani.
- Consolidated information on International collaboration with details of projects/trainings/ delegation (to & fro) etc. for the period from (2012-16).
- Consolidated information on year wise programmes/ new initiatives taken by NDRI during (2012-16).

- Information for PMO regarding "Specific Steps taken by the Institute for Utilization of Space Technology Based Tools and Applications in Governance and Development".
- Consolidated information related to technologies that could be shared with farmers of different states.
- Information on salient research achievements after June, 2015 to October, 2016.
- Information on achievements on for the period (2012-13 to 2015-16) of the Institute.
- Information for 4th Meeting of SAARC Cabinet Secretaries held on 9-10 June, 2016 in Kathmandu, Nepal (Preparatory meeting)
- Information on various points pertaining to NDRI asked by Dr. Satyapal Singh, M.P.
- Consolidated year wise information with respect to new technologies generated (verities/ breeds/products/processes and validated/commercialized/ licensed by the Institute during 2014-15 and 2015-16 alongwith a brief para about each technology.
- Information sought by the Council with respect to research programmes/training programmes for the Inter- ministerial meeting in MEA on VVIP visit to Mozambique .
- Information on research achievements (2012-13, 2013-14, and 2015-16) on new machinery and prototypes production and dissemination of superior male germplasm/ technologies developed/ technologies commercialized/ patents filed/patents granted to ICAR-NDRI, Karnal.
- Information on role of NDRI for dairying in Haryana.
- Consolidated revised information on year wise programmes/ new initiatives taken by NDRI during (2012-16).
- Consolidated information on 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; state wise beneficiaries of KVK training programmes (2014-15); production and dissemination of superior male germplasm/ technologies transferred to the farming community.
- Information on applied cutting edge research undertaken during the past three years and research proposed to be taken up for the next three years.
- Additional information on the slides sent to DDG (AS) regarding the major achievements of NDRI during 2016.
- Information on technologies transferred during (2013-2016) by NDRI.
- Information on multiplication of elite indigenous cattle through cloning.
- Up-dated information on white revolution for Honorable Union Minister for Agriculture and Farmers Welfare.
- Information on NEH Project for inclusion in XIII Plan (2017-20).
- Information for Parliamentary Standing Committee (PSC) on Science & Technology, Environment & Forest consisting detailed back ground note on "Status of Technological Interventions" to combat adulteration of food with respect to NDRI, Karnal.
- Information on NDRI, Karnal in prescribed format to avail the custom duty and central excise duty exemptions for goods imported.
- Revised information on applied cutting edge research undertaken at NDRI, Karnal.
- Information with respect to NDRI for inclusion in IAUA News Letter Vol. 16 No. 03 for the quarter ending September, 2016.
- Consolidated information on TSP activities being carried out at ERS, Kalyani.
- Power point presentation (slides) on NDRI with respect to Technologies/models on waste management.
- Information pertaining to research achievements of the Institute between (November, 2015 to October, 2016) alongwith suitable photographs for inclusion in DARE/ICAR Annual Report (2016-17).
- Information on 13 point references with respect to NDRI Karnal for inclusion in the presentation before Hon'ble Mos (a) Minister of State for Agriculture & Farmers Welfare (PR).
- Information on past performance and projected outcomes during current financial year (2015-16) of the Institute on action points (1-10) and covering AICRP/Net Work Programme, Outreach Programme and Mega Seed Projects.

- Information for DARE/ICAR Annual Report (2016-17) on Intellectual Property and Technology Management (IP&TM) issues from (November, 2015 to October, 2016) with respect to NDRI, Karnal.
- Information on "Direct Benefit Transfer" to students/ scientists/farmers under various scheme ie. TSP/NEH/Fellowships with respect to NDRI, Karnal.
- Information on most significant achievements of NDRI having impact on society and farming community.

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 61 parliament questions (Lok Sabha & Rajya Sabha) were attended. In addition, this unit also prepared Information consisting of detailed background note on "Status of Technological Interventions" to combat adulteration of food with respect to NDRI, Karnal for Parliamentary Standing Committee (PSC) on Science & Technology, Environment & Forest.

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.

Summary of Major Activities of PME Unit

In-house Research Projects	76
Completed Research Projects	25
New Research Projects	23
Externally Funded Projects (National)	71
Externally Funded Projects (International)	04
Contract/ Consultancy Projects Proposals Screened	06
IRC Meetings Convened and Co-ordinated	02
RAC Meeting Convened and Co-ordinated	01
Manuscripts of Technical Bulletins/Books Scrutinized/ Evaluated	10
NDRI- Annual Report (2015-2016)	01
Quarterly NDRI News Letter (4 Issues)	04
Proceedings of IRC	02
Various Write-ups on NDRI	36
Action Taken Reports/Status Reports	10
Six Monthly Reports	02
Parliament Questions Attended	61
Monthly Reports	12
Monitoring of TSP Scheme - Reports	07
Six Monthly Reports/Annual Progress Reports	02
Retention Cases of Scientists Handled	20
Assessment Cases of Scientists Handled	06
Visits Co-ordinated	16

Research Projects-2016-17
(In-house)

SL. No.	Project Title	PI
1	Multi-trait evaluation of Karan Fries cattle for higher productivity and fertility (Lead Division: Dairy Cattle Breeding)	Avtar Singh
2	Identification of stage-specific small, non coding RNAs in buffalo oocytes and pre-implantation embryos (Lead Division: Animal Biotechnology Centre)	Rakesh Kumar
3	Production of buffalo recombinant interferon-tau and evaluation of its biological activity (Lead Division: Animal Biotechnology Centre)	D. Malakar
4	Generation of induced pluripotent stem (iPS)-like cells from buffalo fibroblasts (Lead Division: Animal Biotechnology Centre)	M. K. Singh
5	Diagnostic potential of salivary fern patterns, steroids and miRNA for buffalo estrus detection (Lead Division: Animal Biochemistry)	Suneel Kumar Onteru
6	Cryopreservation of cattle oocytes and their post thawing embryo development through *in vitro* techniques (Lead Station: ERS-Kalyani)	S. K. Das
7	Development of genetic model for improving the selection efficiency of crossbred cattle at ERS NDRI, Kalyani (Lead Station: ERS-Kalyani)	A. Mandal
8	Development of suitable protocol for semen preservation and artificial insemination of Bengal goat (Lead Station: ERS-Kalyani)	M. Karunakaran
9	Application of kisspeptin, a noble GnRH secretagogue for augmentation of reproduction in crossbred cows (Lead Station: ERS-Kalyani)	M. Mondal
10	Evaluation of single nucleotide polymorphism in candidate genes associated with semen quality in Murrah buffaloes and Khillar cattle (Lead Station: SRS, Bengaluru)	K. P. Ramesha
11	Investigation on QTL and non-genetic factors regulating postpartum productive and reproductive performances in Deoni Cattle (Lead Division: SRS, Bengaluru)	D. N. Das
12	Genomic selection for improvement of reproduction and roduction performance in dairy animals (Lead Division: Dairy Cattle Breeding)	A. K. Chakravarty
13	Mass spectrometry based targeted quantitation and validation of urine-based early pregnancy biomarkers in cattle (Lead Division: Animal Biotechnology Centre)	A. K. Mohanty
14	Identification and targeted validation of unique proteins expressed during subclinical mastitis in Sahiwal and Karan Fries cattle (Lead Division: Animal Biotechnology Centre)	Sudarshan Kumar
15	Exploring the use of mesenchymal stem cells for treatment of hoof wound of bovine (Lead Division: Animal Biotechnology Centre)	D. Malakar
16	Genetic evaluation of reproductive and productive efficiency of crossbred cattle in relation to heat stress under tropical climate (Lead Station: ERS-Kalyani)	Rajalaxmi Behera
17	Influence of some managemental practices on incidence of sub clinical mastitis and milk quality in dairy cows (Lead Station: ERS, Kalyani)	Champak Bhakat
18	Modulation of uterine immunity to prevent postpartum uterine infections in Dairy Cows (Lead Division: LPM)	Rubina K. Baithalu
19	Effect of Azolla supplementation on growth, reproductive and productive performance of Alpine x Beetal goats (Lead Division: LPM)	Ramesh Chandra
20	An investigation on factors affecting semen quality and freezability in Deoni and Malnad Gidda cattle (Lead Station: SRS, Bengaluru)	Mukund A. Kataktalware
21	Development of suitable housing for dairy cows in lower Gangetic regions of West Bengal (Lead Station: ERS-Kalyani)	D. K. Mandal
22	Evaluation of bovine major acute phase proteins as a predictive biomarker of postpartum performance in Deoni Cows (Lead Station: (Lead Station: SRS-Bengaluru)	A. Manimaran
23	Studies on seminal plasma reactive nitrogen species as biomarkers of semen quality in crossbred cattle and buffaloes and its association with seminal hormones and sperm functions- (Lead Division: Dairy Cattle Physiology)	Sujata Pandita
24	Strategies to improve semen production performance in indigenous dairy bulls - (Lead Division: LPM)	Mukesh Bhakat

SL. No.	Project Title	PI
25	An investigation on anti-mullerian hormone as a predictive biomarker of fertility in HF crossbred & indigenous Deoni cows - (Lead Station: SRS, Bengaluru)	S. Jeyakumar
26	Diversity in bio-chemical quality of fodder influenced by weather and soil fertility forcing variables - (Lead Station: SRS, Bengaluru)	B. Srinivas
27	Comparative nutritional evaluation and utilization of some newer feed resources in Dairy Cattle Ration (Lead Station: ERS-Kalyani)	A. Chatterjee
28	Dietary manipulation of rumen fermentation using tree leaves of north eastern India for improving growth performances in calves (Lead Station: ERS-Kalyani)	A. Santra
29	Effect of supplementation of area-specific mineral mixture (KALMIN) on productive and reproductive performance in dairy animals (Lead Station: ERS-Kalyani)	M. K. Gosh
30	Improvement in yield and quality of forage maize through management of plant density and nutrients in different cultivars (Lead Division: Dairy Cattle Nutrition)	Rakesh Kumar
31	Refinement of energy and protein requirements for cattle and buffaloes during different seasons (Lead Division: Dairy Cattle Nutrition)	S. S. Kundu
32	Development of calf starter for higher growth in Sahiwal calves (Lead Division: Dairy Cattle Nutrition)	S. K. Tomar
33	Studies on vanadium and boron for their role in immuno-endocrine functions, bioavailability of minerals and production performance in dairy animals (Lead Division: Dairy Cattle Nutrition)	Veena Mani
34	Evaluation of sorghum forage varieties and their nutritive value under different nutrient management (Lead Division: Dairy Cattle Nutrition).	Magan Singh
35	Dietary supplementation of prebiotics, probiotics and synbiotics to augment health of calves (Lead Division: Dairy Cattle Nutrition)	Sachin Kumar
36	Role of certain trace minerals on semen quality of cattle and buffalo (Lead Division: Dairy Cattle Nutrition)	Gautam Mondal
37	Development of feeding module to reduce the age at first conception in Murrah buffaloe (Lead Division: Dairy Cattle Nutrition)	Raman Malik
38	Dual purpose baby corn production under varying crop establishment methods and nitrogen management (Lead Division: Dairy Cattle Nutrition)	Hardev Ram
39	Optimizing the performance of crossbred calves by synbiotic feeding in existing farm conditions (Lead Station: ERS-Kalyani)	Saroj Rai
40	Evaluation of osteogenic peptides from buffalo milk (Lead Division: Animal Biochemistry)	Suman Kapila
41	Post processing interventions to improve quality and shelf- life of curd rice (Lead Station: SRS, Bengaluru)	Menon Rekha Ravindra
42	Comparison of effects of soluble fiber and phytosterol on glucose homeostasis and insulin resistance in high fat diet fed mice (Lead Division: Animal Biochemistry)	R. K. Sharma
43	Evaluation of antioxidative potential of goat milk in controlling hypercholesterolemia (Lead Division: Animal Biochemistry)	Sunita Meena
44	Size dependent variations in lipid fractions of fat globules in milk from different species (Lead Division: Dairy Chemistry)	K. P. Indumathi
45	Aflatoxin M_1 mitigation by probiotic *lactobacillus* species (Lead Division: Dairy Microbiology)	Chand Ram
46	Production of antimicrobial bioactive peptides from bovine and non-bovine milk by microbial fermentation and simulated gastrointestinal digestion for development of functional ingredients (Lead Division: Dairy Microbiology)	Shilpa Vij
47	Proteome analysis of *Lactobacillus fermentum* strains in response to acid stress (Lead Division: Dairy Microbiology)	Pradip Behare
48	Incorporation of whey and hydrolysed whey proteins in processed cheese to enhance functional attributes (Lead Station: SRS, Bengaluru)	Bikash Chandra Ghosh
49	Design and development of universal turbo disperser for dairy products (Lead Station: SRS, Bengaluru)	M. Manjunatha
50	Development of weight based metering and filling system for viscous dairy products (Lead Division: Dairy Engineering)	P. Barnwal

SL. No.	Project Title	PI
51	Evaluation of dairy conjugates as effective emulsifiers for the delivery of herbal bioactives (Lead Division: Dairy Technology)	Latha Sabikhi
52	Development of low sodium cheese varieties (Lead Division: Dairy Technology)	Yogesh Khetra
53	Shelf life extension of *Aloe vera* supplemented probiotic *lassi* by non-thermal intervensions (Lead Division: Dairy Technology)	Shaik Abdul Hussain
54	Analysis of energy and exergetic performance of spray drying system for milk-malted millet food (Lead Station: SRS, Bengaluru)	P. Heartwin Amala Dhas
55	Design and development of micro-processor based automated instrumentation system for pneumatic paneer hoop cum-press unit (Lead Station: SRS, Bengaluru)	Chitranayak
56	Development of infrared assisted baking oven and evaluation of baking characteristics of *Chhana Podo* (Lead Station: SRS- Bengaluru)	F. Magdaline Eljeeva Emerald
57	Preparation and characterization of micro/nano delivery system for 'green' carotenoids (Lead Division: Dairy Technology)	Neelam Upadhyay
58	Technology development for the production of milk protein concentrate (MPC60) from buffalo milk (Lead Division: Dairy Technology)	Ganga Sahay Meena
59	Omega-3 fatty acids fortified functional butter and curd (Lead Station: SRS, Bengaluru)	Monika Sharma
60	Effect of storage on baudouin test, sesamin test and RP-TLC test to detect adulteration of vanaspati and vegetable oils in ghee (Lead Division: Dairy Chemistry)	Vivek Sharma
61	Studies on investigation of the changes on fat and solids not fat (SNF) contents during the milk collection stages (Lead Division: Dairy Chemistry)	Vivek Sharma
62	Monitoring milk urea level as potential tool for milk quality (Lead Division: Dairy Chemistry)	Raman Seth
63	Formulation of new preservative as an alternative to formalin for chemical analysis of milk and milk products (Lead Divison: Dairy Chemistry)	Richa Singh
64	Preparation and characterization of panchgavya from indigenous cow (Lead Divison: Dairy Chemistry)	Priyanka Singh Rao
65	Effectiveness of mobile advisory services in dairy farming (Lead Division: Dairy Extension)	H. R. Meena
66	Geo-spatial databank and data mining for strategic planning and development of dairying in Karnataka state (Lead Station: SRS, Bengaluru)	M. Sivaram
67	Dairying in sustainable livelihood among the rural farm family of Nadia District of West Bengal (Lead Station: ERS-Kalyani)	S. Garai
68	Technological needs and manpower requirement of dairy production and processing units in Karnataka (Lead Station: SRS, Bengaluru)	M. C. A. Devi
69	Socio-economic assessment of indigenous dairy cattle holders in Southern India (Lead Station: SRS, Bengaluru)	S. Subhash
70	Machine learning approach to predict the fertility of Murrah bulls (Lead Division: DES&M)	A. K. Sharma
71	Assessment of climate-led vulnerability and resilience strategies of tribal dairy farmers (Lead Division: Dairy Extension)	Sanjit Maiti
72	Improving knowledge in preparation of traditional milk products through multimedia (Lead Division: Dairy Extension)	S. K. Jha
73	Development & application of multi-market model for policy analysis in Indian Dairy Sector (Lead Division: DES&M)	B. S. Chandel
74	A Study on sustainability of Gaushalas in Haryana (Lead Division: DES&M)	Ajmer Singh
75	Career dynamics of dairy graduates in India: A stakeholders analysis (Lead Division: D. Extn.)	Sanjit Maiti
76	Livelihood security vis-à-vis resilience to adverse weather events among tribal and non-tribal livestock farmers (Lead Station: ERS-Kalyani)	Asif Mohammad

EXTRA-MURAL FUNDING AND COLLABORATIONS

The scientists of the Institute maintained close liaison with various organizations to exchange information and acquired 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	Development of resilient probiotic foods designed for the Indian Market conditions.	S. K. Tomar	Surajit Mandal and A. K. Singh	DST (Indo Newzealand)	2013-2016
2	Development and application of lactic acid bacteria as designer products.	S. K. Tomar	-	BBSRC Funded Joint India-UK Collaboration Project.	2014-2017
3	Nanotechnology research on buffalo milk-Characterization of nanostructure of buffalo milk.	Bimlesh Mann	Rajesh Bajaj and Rajan Sharma	Australian – Indian Council Collaborative Project between NDRI and University of Queensland, Australia	2015-2016
4	Strengthening simulation approaches for understanding, projecting and managing climate risks in stress-prone environments across the Central and Eastern Indo-Gangetic Plains.	S. V. Singh	-	ICRISAT	2014-2016
National Collaborations					
5	Network project on buffalo Improvement-Field Unit (CIRB Hisar).	Avtar Singh	A. K. Chakravarty and A. K. Gupta	ICAR	2012-2017
6	Monitoring of drug residues and other environmental pollutants-outreach project of ICAR.	N. K. Goel	Raghu H. V	ICAR	2012-2017
7	Indigenous breed program (Sahiwal Cattle).	A. K. Gupta	Avtar Singh, A. K. Chakravarty, T. K. Mohanty, S. S. Lathwal and Anupma Mukherjee	ICAR	2012-2017
8	National initiative on climate resilient Agriculture.	S. V. Singh	O. K. Hooda, Anjali Aggarwal, S. S. Kundu, Chander Datt, A. K. Mohanty, S. De, Smita Sirohi, Dheer Singh, Ritu Chakravarty, Vivek Sharma,K. Ponnusamy and P.S. Minz	CRIDA (ICAR)	2012-2017

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
9	Infertility in crossbred bulls:Search for spermatogenic cell markers for early prediction on fertility.	A. Kumaresan	J. K. Kaushik and T. K. Mohanty	NFBSFARA	2012-2017
10	Network programme on veterinary type culture (VTC)-Rumen Microbes.	A. K. Tyagi	-	ICAR	2010-2017
11	Scheme on dairy microbes under Network Mode	S. K. Tomar	Surajit Mandal and and P.V. Behare	Network	2010-2017
12	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	P. K. Roy, M. K. Ghosh, S. K. Das, Lotan Singh, A Mandal, A. Chatterjee, S. Bandopadhyay and S. Naskar	ICAR	2012-2017
13	Development of parthenogenetic goat from embryonic stem cells.	M. K. Singh	M. S. Chauhan and R. S. Manik	NFBSFARA	2013-2017
14	Recombinant expression of lactobacilli aminopeptidases for the production of bioactive peptides.	J. K. Kaushik	Rejesh Kumar	DBT	2013-2016
15	Preparedness of livestock rearers among the tribal in Disaster Prone Areas of Uttarakhand.	H. R. Meena	Gopal Sankhala, B. S, Meena and K. Ponnusamy	ICSSR	2014-2016
16	Onset of Puberty and Induction of Estrus: Role of Kisspeptin (Kiss1) in bovine species (Mithun and Cattle).	Mohan Mandal	Chatterjee	DBT	2014-2017
17	Niche Area of Excellence (NAE) Scheme entitled “Development and evaluation of spore based biosensors for monitoring of pesticides residues in milk”.	N. K. Goel	Raghu H. V., A. K. Mohanty and Rajan Sharma	ICAR	2014-2018
18	Microbial diversity of industrial waste polluted sites of Punjab: Biogeochemical interactions for recycling of metals and degradation of pollutants.	Chand Ram	-	DBT	2014-2017
19	Manipulation of partitioning of nutrients and energy balance to augment milk production and reproductive performance in dairy animals.	Mahendra Singh	S. S. Thakur, A. K. Roy and Anand Laxmi	BRNS	2014-2017
20	Microbial diversity of bio-films in dairy niche.	R. K. Malik	Chand Ram, S. K. Tomar, Surajit Mandal and Diwas Pradhan	AMAAS	2014-2017
21	Comparative metagenome of human gut of North and North-Eastern region of India”	Sunita Grover	Rashmi H. M.	DBT	2014-2017
22	Development of aptamer based detection system for aflatoxin M1 in Milk.	Rajan Sharma	-	DBT	2014-2017
23	Controlled release dispensers for delivery of semiochemicals.	Gautam Kaul	-	DBT	2014-2017
24	Study of mechanism of probiotic action in persistent diarrhea in children caused by enter aggregative *E. coli* using a mouse model.	Sunita Grover	Rashmi H. M	ICMR	2015-2017

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
25	Incentivizing research in agriculture-Project-V semen sexing in cattle.	S. K. Singla	P. Palta, R. S. Manik and M. K. Singh	ICAR	2014-2017
26	Development of mammalian cell based biosensor prototypes for toxins in commercial milk.	Suneel Kumar Onteru	Dheer Singh and A. K.Singh	DBT	2014-2018
27	Elucidating the mechanism of pashmina fibre development: An OMICS approach.	J. K. Kaushik	-	NASF	2015-2018
28	Leukemia inhibitory factor: pluripotency in buffalo stem cells.	Sudarshan Kumar	A. K. Mohanty, J. K. Kaushik and D. Malakar	NASF	2015-2018
29	Optimization of procedures for improving cloning efficiency in buffalo.	S. K. Singla	M. S. Chauhan, P. Palta and R. S. Manik	DBT	2014-2017
30	Delineating Beta Casein variants in Indian cows and potential health implications of A1A2 Milk.	A. K. Mohanty	Sudarshan Kumar	NASF	2015-2018
31	Water budgeting and improving water productivity livestock based farming.	Ashutosh	O. K. Hooda and Manju Ashutosh	ICAR	2015-2017
32	Incentivizing research in agriculture - Project-V semen sexing in cattle.	T. K. Mohanty	A. K. Chakravarty, Mukesh Bhagat, A. Kumaresan, A. K. Gupta and Pawan Singh	ICAR	2014-2017
33	Bio-prospecting of lactic acid cultures from cold dessert region to develop functional fermented milk products with potential health benefits 1-330/SM.	Surajit Mandal	S. K. Tomar and Pradip V. Behare	DST	2015-2018
34	Impact assessment of agricultural research and development.	Smita Sirohi	B. S. Chandel, T. K. Mohanty and A. K. Singh	ICAR	2015-2017
35	Impact assessment and evaluation of ration balancing program in northern and western regions.	Smita Sirohi	B. S. Chandel	NDDB	2015-2016
36	Whole genome based SNP mining and development of breed signatures for dairy and dual-purpose indigenous cattle.	A. K. Dang	Avtar Singh	DBT	2014-2017
37	Assessment of early pregnancy by analysis of neutrophil dynamics and gene expression in dairy cattle.	A. K. Dang	K. Mohanty, Rajeev Kapila	DBT	2014-2017
38	Empowerment of farm women through livestock technologies.	K. Ponnusamy	P. S. Oberoi	ICAR	2015-2017
39	Livestock methane reduction through immunization based approaches.	Dheer Singh	Suneel Kumar Onteru, G. Mandal and A. K. Puniya	DBT	2014-2017
40	Structural and functional characterization of exosome nanoparticle of buffalo milk as a model for potential application as biomarkers and for developing new cell delivery system.1-339/DS.	Dheer Singh	Suneel Kumar Onteru	CRP Nanotechnology (ICAR)	2015-2017

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
41	Lactation stress associated postpartum anestrus SNP array in buffaloes.	Suneel Kumar Onteru	Dheer Singh,	NFBSFARA	2015-2018
42	Biosafety of Nanomaterials.	Gautam Kaul	Bimlesh Mann	Consortia of Research platform on Nanotechnology	2014-2017
43	Electrospun Smart O_2 Sensor for Modified Atmosphere Packaged Dairy Products.	P. N. Raju	A. K. Singh and P. S. Minz	ICAR	2016-2018
44	Technology of heart friendly herbal-milk smoothie with prophylactic effects against CVD and associated risks.	S. A. Hussain	Latha Sabikhi, A.K. Singh, Sathish Kumar M. H., Rajan Sharma and Suman Kapila	MFPI	2016-2017
45	Social perspective of deagrarianization and its effect on livelihood security of farming community in Punjab.	B. S. Meena	H. R. Meena, Gopal Sankhala, and Rakesh Kumar	ICSSR	2016-2017
46	Development of web module on reproduction management of dairy animals.	Nishant Kumar	Kumaresan, A. P. Ruhil, S. S. Lathwal, Pawan Singh, M. L. Kamboj, S. K. Jha and Sanjit Maity	ICAR	2016-2017
47	Ration balancing programme under National Dairy Plan-1 at Muzaffarnagar (U.P.).	A. K. Tyagi	Nitin Tyagi, Sachin Kumar	NDDB	2016-2018
48	Veterinary type culture collection-Rumen component.	A. K. Tyagi	Nitin Tyagi, Sachin Kumar	ICAR (NRC Equines)	2016-2017
49	Urban and Peri urban Dairies among marginalized dairy holders and its effect on society.	Gopal Sankhala	H. R. Meena, B. S. Meena, K. S. Kadian and S. S. Lathwal	ICSSR, New Delhi	2016-2017
50	Establishment of Agri-Business Incubation (ABI).	A. K. Singh	S. K. Tomar, Sumit Arora, Gopal Sankhala, P. N. Raju, Yogesh Khetra and Sanket Borad	NAIF, ICAR	2016-2017
51	Documentation of traditional knowledge of livestock keepers of Karnataka state.	K. P. Ramesha (SRS)	S. Subash, S. Jeyakumar, Mukund A. Kataktalware	Karnataka Biodeversity Board, Karnataka	6 Months (April-October. 16)
52	Dynamics of major acute phase proteins in relation to energy status during peri-partum period productive and reproductive performance in cows.	A. Manimaran (SRS)	S. Jeyakumar, K. P. Ramesha, M. Sivaram, V. Sejiyan (NIANP) and M.Bagath (NIANP)	ICAR	2016-2017
53	National innovations on climate resilient agriculture.	M. A. Kataktalware (SRS)	K. P. Ramesha	ICAR	2013-2017
54	Risk and vulnerability analysis of rural farm households in drought prone and coastal regions of India.	Smita Sirohi	S. Chandel and Sanjit Maiti	ICSSR	2015-2018
55	Kappaphygus alvarezii and red sea weed based formulations for improving productivity of dairy animals and poultry.	Chander Dutt	Veena Mani, Neelam Kewalramani and A. K. Tyagi	CSIR, New Delhi	2016-2017

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
56	Agrowaste Utilization: Separation of nutraceutic β-cryptoxanthin from kinnow peels and its conversion to aqueous dispersible nanoemulsions for value addition of foods.	Rajan Sharma	-	DST	2014-2017
57	Study of fodder crop assessment for dairy industry and potential areas of intensification of state level.	Magan Singh	Rajesh Kumar Meena, Rakesh Kumar and V. K. Meena	Space Application Centre, Ahmedabad	2016-2018
58	Standardization of seed rate of berseem with rye grass under mixed cropping system.	Magan Singh	S. S. Thakur, Rakesh Kumar, Hardev Ram, Rajesh Kumar and V. K. Meena	AICRP-IGFRI, Jhansi	2016-2018
59	Development of equipment for mechanized production of traditional Indian dairy products (rabri and kheer).	P. S. Minz	Chitranayak and P. N. Raju	ICAR	2014-2017
60	Nano encapsulation of functional ingredients for their delivery in dairy foods.	Bimlesh Mann	Rajan Sharma, Rajesh Bajaj, Gutam Kaul and Richa Singh	CRP on Nanotechnology-ICAR	2014-2017
61	Development of fertility prediction tools using specific sperm function tests in cattle and buffalo bulls.	A. Kumaresan	-	ICAR	2016-2018
62	Upgradation of methane emission factors for Indian Livestock and preparation of inventory of GHGs emissions from Indian livestock.	Madhu Mohini	-	MoE&F Through Inspire Network for Environment.	2016-2017
63	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	2012-2017
64	Role of probiotic *lactobacilli* in modulation of intestinal epithelium mediated barrier functions and immune signals.	Rajiv Kapila	Suman Kapila, Ajay Dang	DBT	2016-2019
65	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
66	Technological change in dairy farming and its effect on rural employment in Trans-Gangetic Plains Region–ICAR.	B. S. Meena	Pawan Singh, H. R. Meena, Rakesh Kumar and Sanchita Garai	ICAR	2016-2017

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
67	Validation and standardization of the GC analysis method given in ISO 17678: 2010 for determination of milk fat purity in bovine milk othr than cow's milk.	Vivek Sharma	Sumit Arora and Priyanka Singh Rao	FSSAI	2016-2018
68	Capacity building of resource for farmers in paddy-wheat cum dairy production system through Farmer First Programme.	Gopal Sankhala	K. Singh, Sanket Borad, Heena Sharma, Sangita Ganguly, B. S. Meena, Ajmer Singh, S. S. Lathwal, Rakesh Kumar, H. R. Meena, Nitin Tyagi and V. K. Pandita (IARI)	ICAR	2016-2018
69	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	2017-2019
70	Conservation of indigenous pig of Assam through Handmade Cloning technique.	M. K. Singh	-	DBT	2017-2019
71	Synthetic endometrium: A novel model to study early embryonic development and uterine health in ruminants.	Rubina K. Baithalu	M. K. Singh	NASF	2017-2019
72	Whey protein-iron complexes: Preparation,characterization and application in biscuits, milk and dahi.	Kamal Gandhi	-	DST	2017-2019
73	Bile responsive proteo-transcriptomics investigation of native probiotic strain lactobacillus helveticus MTCC 5463".	Pradip Vishnu Behare	K. Mohanty and Sudarshan Kumar	SERB-DST	2017-2019
74	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 and D. N. Dass	DAHVS	2017-2020
75	Development of phytopharmaceutical product for bovine mastitis.	K. Dang	T. K. Mohanty	DBT	2017-2019

NDRI Team with Professor Neal Menzies, Head, School of Agriculture and Food Science), University of Queensland (UQ), Australia

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. The composition of ITMC is as follows:

1.	Director, ICAR-NDRI, Karnal	Chairman
2.	Joint Director (Research) & I/C SRC ICAR-NDRI, Karnal	Member
3.	Joint Director (Academics), ICAR-NDRI, Karnal	Member
4.	Dr. A. K. Singh, PS, DT Division & In-charge, BPD, ICAR-NDRI, Karnal	Member
5.	Dr. P. K. Singh, Nodal Officer (IPR), ICAR-NBAGR, Karnal	External Member
6.	Dr. Naresh Kumar, PS, DM Division, ICAR-NDRI, Karnal	Member
7.	Dr. Sumit Arora, PS, DC Division, ICAR-NDRI, Karnal	Member
8.	Dr. Rajan Sharma, PS, DC Division, ICAR-NDRI, Karnal	Member Secretary

During the year 2016-17, three ITMC meetings were held. At these meetings, pricing of technologies and examination of patent applications for their novelty and commercial applicability before filing patent applications were taken-up and MoUs were exchanged between NDRI and firms for Technology Transfer.

During the year 2016-17, a total of 09 technologies developed at the Institute were transferred to 08 commercial houses through 10 different MoUs thereby earning a total of ₹ 30,00,000 (excluding Service Tax) for the Institute through technology transfer fee and fee for additional freeze dried cultures for previously sold technologies. One technology was transferred on more than one occasions. The list of technologies transferred is prevented overleaf.

Technologies Ready for Commercialization

In the year 2016-17 pricing of the following technologies was fixed.

1. Technology for low fat *Shrikhand* with exopolysaccharides (EPS) producing lactic cultures.
2. Fast acidifying yoghurt culture for Greek Style Yoghurt.
3. Universal cell lysis solution for direct PCR from animal, plant and bacterial cells.
4. Technology of sour dahi using prolific acidifying lactic cultures.
5. Probiotic bacterial culture for preparation of fermented milk products with immunomodulatory attributes for aging subjects / suckling mothers and newborns.
6. Prototype improved butter melting system.
7. Cooling system for viscous dairy products.
8. Pilot plant in-line system for manufacture of traditional Indian dairy products.
9. Single stage scraped surface heat exchanger.
10. Design of conical process vat (CPV).

11. A device for dialysis of samples in microlitre volume.
12. A multipurpose device for dialysis, concentration and buffer exchange of samples in microlitre volume.
13. Aptamers for Aflatoxin M1.
14. Aptamers for Betacasomorphin-7.

Technologies Transferred during (2016-17)

S. No.	Name of the Technology	Inventors	Date of Signing of MoU	Revenue Received *(₹)
1.	A Process for Preparation of Low Cholesterol Ghee	Darshan Lal, Vivek Sharma, Raman Seth, Manoj Kumar and Amit Kumar (Dairy Chemistry)	06.04.2016	6,00,000
2.	Arjuna Herbal Ghee	Rajani Kant, G.R. Patil, R. R. B. Singh and A. A. Patel (Dairy Technology)	23.05.2016	1,50,000
3.	A Process for Preparation of Low Cholesterol Ghee	Darshan Lal, Vivek Sharma, Raman Seth, Manoj Kumar and Amit Kumar (Dairy Chemistry)	07.06.2016	6,00,000
4.	Exopolysaccharides Producing Lactic Cultures for Preparation of Low-Fat Lassi	Pradip V. Behare, S.K. Tomar and Surajit Mandal (Dairy Microbiology)	08.06.2016	1,00,000
5.	Spore Based Kit for Detection of Antibiotic Residues in Milk at Dairy Farm	Naresh Kumar, A. Khan, S. Arora , Raghu H. V., M. Balhara, P. K. Sharma and S. Shaikh (Dairy Microbiology)	17.12.2016	3,00,000
6.	Paper Strip Assay for Rapid Detection of Pesticide Residues	Naresh Kumar, N. Tehri, R. Gopaul, P. K. Sharma, Kumar, Morab S. and Raghu H. V. (Dairy Microbiology)	17.12.2016	5,00,000
7.	Fast Acidifying Yoghurt Culture for Greek Style Yoghurt	Surajit Mandal, S. K. Tomar, Pradip V. Behare, Jyoti, Ravi S. Wankhede (Dairy Microbiology)	30.12.2016	3,00,000
8.	Strip Based Test for Detection of Maltodextrin in Milk	Rajan Sharma, Y. S. Rajput, Bimlesh Mann and Panchal Bhavesh Kumar R (Dairy Chemistry)	13.02.2017	1,50,000
9.	Anionic Mineral Mixture for Prepartum Dairy Animals	Harjit Kaur and Veena Mani (Animal Nutrition)	29-03-2017	2,50,000
10.	Sugar Tolerating Lactic Culture for Preparation of Misti Doi (for additional freeze dried culture)	Surajit Mandal, S. K. Tomar and Pradip V. Behare (Dairy Microbiology)	27.12.2016	50,000

Request for Examination of Patents Filed (2016-17)

1. A strip for detection of added urea in milk and process for the same. Application No. 3472/DEL/2013.
2. Aptamers specific for betacasomorphin 7 (BCM7). Application No. 3703/DEL/2013.
3. A strip for detection of maltodextrin in milk and process for the same. Application No. 2097/DEL/2014.
4. A peptide with osteoanabolic and antiresorptive activity. Application No. 2778/DEL/2013.

5. Antimicrobial nanoemulsion of clove oil stabilized with milk protein and a process thereof. Application No. 913/DEL/2015.
6. A strip based test for detection of detergent in milk. Application No. 750/DEL/2015.
7. Development of Enzyme-spore based assay for monitoring antibiotic residues in milk. Application No. 2213/DEL/2014.
8. Marker enzymes and spore germination based assay *E. coli* in milk and milk products. Application No. 2214/DEL/2014.
9. A PCR based method for detection of a field strain of *Ureaplasma diversum.* Application No. 806/DEL/2015.
10. *Mangifera indica* flower panicles' extract stabilized gold nanoparticles and method for making the same. Application No. 807/DEL/2015.

Patent Filed (2016-17)

1. Oil in water curcumin nanoemulsion and method of preparation thereof. **Application No.** 201611018434 (Date of filing 30.05.2016). **Inventors:** Bimlesh Mann, Pooja, Ramesh Pothuraju, Rajan Sharma and Rajesh Kumar.
2. Caseinophosphopeptides-divalent metal (iron/zinc) nanocomplexes and method of preparation thereof. **Application No.** 201711010975 (Date of filing: 28.03.2017). **Inventors:** Bimlesh Mann, Prabin Sarkar, Rajan Sharma, Rajesh Kumar and Munmun Sen.

Patent Granted (2016-17)

01 Spore Germination Based Detection Kit for ß-Lactam group in milk. (**Patent Grant No**. 273160, Grant date: 20.05.2016). **Inventors**: Naresh Kumar, Sougata Das and Manju G.

02 A Kit for Detection of Adulteration of Milk with Soymilk. (**Patent Grant No.** 275521, Grant date: 08.09.2016). **Inventors:** Y. S. Rajput, Rajan Sharma and Poonam.

03 A multipurpose device for concentration, dialysis and buffer exchange of protein solution and a process for the same. (**Patent Grant No.** 276077, Grant date: 29.09.2016). **Inventors:** Y.S. Rajput and M. P. Divya.V

Patent Workshop organized

Zonal Agro-Technology Management Centre (ZTMC) of ICAR-NDRI organized one day Patent Workshop on December 16, 2016 at NDRI, Karnal. The resource persons (Mr. Amit Jain and Dr. Indira Banerjee) for this workshop were invited from LS Davar Company, New Delhi. Dr. R. R. B. Singh, Joint Director (Academic), NDRI chaired the workshop. The Patent Workshop was attended by the Scientist of NDRI, students and Member Secretaries of various ITMC of ZTMC of NDRI Zone.

Dr. R. R. B. Singh, Joint Director (Academic) NDRI addressing the participants of National Workshop on Patent Filing Procedure

Zonal Agro-Technology Management Centre (ZTMC) Meeting

ZTMC Meeting was held at ICAR-NDRI, on December 17, 2016 to discuss the progress of Zone. The meeting was chaired by Director NDRI and Chairman of Zonal Institute Technology management Committee (ZITMC). Dr. Inderjeet Singh, Director ICAR-CIRB and Co-Chairman of ZTMC alongwith other members representing ICAR-NBAGR, ICAR-CIRB, ICAR-NRCE, ICAR-NRCC, ICAR-NRCY attended the meeting.

ZTMC Meeting in progress

The composition of ZTMC

1.	Director, ICAR-National Dairy Research Institute, Karnal	Chairman
2.	Director, ICAR-Central Institute for Research on Buffaloes, Hisar	Co-Chairman
3.	Director/His representative, National Research Center on Camel, Bikaner	Member
4.	Joint Director (Res.), ICAR-National Dairy Research Institute, Karnal	Technical Expert
5.	Dr. P. K. Singh, PS, ICAR-NBAGR, Karnal	Technical Expert
6.	Comptroller, ICAR-NDRI, Karnal	Member
7.	Representative of ATMC/ICAR Headquarters	Member
8.	Dr. A. K. Singh, PS & In-charge, BPD, ICAR-NDRI, Karnal	Expert Member
9.	Ms. Purwa Rathi, Patent & Trademark Agent, New Delhi	Expert Member
10.	Dr. Rajan Sharma, PS, ICAR-NDRI, Karnal	Member Secretary

Institute-Industry Meet

Zonal Agro-Technology Management Centre (ZTMC) of NDRI organized One Day, **"Institute-Industry Meet"** on **December 17, 2016** at the National Dairy Research Institute, Karnal. At this meet, technologies developed at NDRI and other Institutes of ZTMC were presented, demonstrated and commercialized to entrepreneurs /Industries. A total 130 number of technologies were presented to Industries. Apart from NDRI, 8 other member Institutes of the ZTMC also participated in this meet (i.e. ICAR-NBAGR, ICAR-CIRB, ICAR-CIRC, ICAR-CIRG, ICAR-NRCC, ICAR-NRCE, ICAR-NRCM and ICAR-NRCY).

A technology being commercialized during Institute-Industry Meet

Overview of Intellectual Property Management Activities

Sl.	Particulars	No.
1.	Technologies Developed	07
2.	Technologies Transferred	08
3.	Technologies Ready for Commercialization	14
4.	Prices for Technologies Fixed	14
5.	Patents Filed	02
6.	Patents Granted	03
7.	Patent Applications Examined	10
8.	MoU Signed with Different Firms	09
9.	Institute Technology Management Meetings	03
9.	Institute-Industry Meet	01
10.	Patent Workshop	01
11.	Revenue Generation through Commercialization of Technologies	₹ 30.00 lakhs

ENTREPRENEURSHIP DEVELOPMENT AND CONSULTANCY SERVICES

Business Planning and Development (BPD) Unit

Business Planning and Development (BPD) Unit in ICAR-National Dairy Research Institute was established under the aegis of National Agricultural Innovation Project (NAIP) to harness the scientific knowledge and innovation available at the institute for the benefit of farming community, entrepreneurs, students and industry. BPD Unit acts as the nodal point for stakeholders willing to work with NDRI for the growth and development of Indian dairy sector. NDRI is committed for commercialization of existing technologies and products, evaluation and development of business potential of existing technologies and products, promotion of entrepreneurship in the field of dairying, capacity building of stakeholders and development of linkages among beneficiaries. The unit supports industry as well as entrepreneurs with existing technologies, consultancy and business planning for dairy and food sector.

Training Programmes

- BPD and SINED (TBI) organized ten Entrepreneurship Development Programme (EDP) on "Commercial Dairy Farming" to promote scientific dairy farming practice, enhance milk productivity and provide excellent quality milk. The programmes were attended by 250 participants comprising progressive farmers, unemployed rural youth, IT professionals, engineers, retired officials and women entrepreneurs.
- BPD organized four Entrepreneurship Development Programme (EDP) on "Milk and Milk Product Processing" with the objective to promote value addition at the farm/producer's level and improve the profitability of milk producers for 70 participants from various part of the country. BPD Unit also organised training programme on "Cheese & Fermented Dairy Products" and two trainings under Unnat Bharat Abhiyan.

Training of Self Help Groups through Village Level Milk Processing Unit

Village level small scale milk processing units were strengthened by the establishment of quality testing and milk processing facility by procuring the processing equipments. The unit has now facility of bulk milk cooler (BMC), khoa making machine, steam jacketed kettles, paneer press, curd incubator, deep freezers and milk testing equipments. The women collect about 250 l of milk daily and process into value added products. The average income of these women SHG member is about ₹ 10000/- per month/per member. The intervention has also enabled minimization of stakeholders in milk value chain and milk producers are getting remunerative price (₹ 34-40/l).

SUCCESS STORY

Mohak Khabaria ventured into Health Drink Market

After, undergoing an EDP programme on "Milk & Milk Product Processing" at BPD Unit of NDRI, Mohak enrolled for incubation programme of SINED (TBI). Under the mentorship of faculty of Dairy Technology Division, Mohak has developed 3 types of whey protein-enriched and initiated test marketing under the Reset brand in selected cities of northern India and Gujarat. Success of the product motivated him further to launch the product on large scale. Mohak has changed the packaging and registered beverages under the brand name of "Mocktale". Mohak has received Innovation awards and cash prize from the Gujarat State Govt. in 2016. The whey protein fortified natural fruit based beverages were developed with 3 different flavours namely lemon, *Imli* (tamarind) and *Jaljeera* (spices mixture used to address digestion problems – very much acceptable traditional drink by Indians). The product is available in the PET bottle having 250 ml volume and packaging material explaining the health benefits. Now, it is reintroduced in attractive flexible laminates. Mohak has implanted the project in two phases and first phase was related to prototype development and test marketing of the product. Second stage is for the refinement, upgradation of the technology and commercial launching. Currently, Mohak is marketing the product through various channels. The Govt. of Gujarat provided the Grant of ₹ 10 Lakhs under the Start-Up policy for the project. The innovative product developed in collaboration with NDRI, Karnal could be attractive fusion product based on whey proteins and fruit juices. It will add new dimensions to rapid growing beverage market in India. The company will introduce innovative health drinks/beverages based on dairy, fruits & vegetables and even cereal/millet extracts.

SUCCESS STORY

Mr. Dharam Pal Established Commercial Dairy Farming

After participating in EDP programme on **"Commercial Dairy Farming"** in BPD Unit of ICAR-National Dairy Research Institute, Karnal; Mr. Dharam Pal decided to set up a Modern dairy farm based on indigenous breeds of Cows. Under the continuous mentoring of scientists of NDRI, Karnal; Mr. Dharampal procured the Gir cows from Gujarat and established his dairy farm in Ajeetpura near Jaipur. Milk produced under hygienic conditions is chilled immediately, packaged in Table top packing which is a biodegradable paper. Milk (A2) is marketed in Jaipur, Gurugram, Noida, Delhi and even to customers located in Mumbai. Farm fresh chilled milk under the brand name of "Olitia Dairy" fetches very high price in market and looking at the growing demand for milk products, they have introduced cow milk ghee prepared by traditional method. Farm waste is utilized for biogas production and thus, it is green project. Mr. Dharmapal is also establishing the farm as Research & Breed Development Centre.

Harnessing the Nutrition of Indigenous Cows

Professional Service Functions

Under Professional service functions, 5 new contract research projects worth ₹ 47,76,662/ were initiated during 2016-17. Through contract services, 35 companies, entrepreneurs, government organizations were benefitted.

Training Programme for the Students

A total number of 69 students from 28 Universities, Colleges were imparted training and guidance for their short-term project works.

Training Programmes for Business Incubation

In order to provide technical assistance, mentoring, information related to detailed project report and support in getting the financial support from various funding agencies, 15 incubates were enrolled under the mentorship of scientists of NDRI, Karnal and graduated to start their business ventures. Seven entrepreneurs initiated their ventures with the technologies sourced from ICAR-NDRI, Karnal under business incubation through SINED (TBI) during the year 2016-17 and some of the brands established as a result of these programmes are Mishti Whey Drink, Cookies, Milky Joy Natural Kulfi, Shuddh Paneer, etc.

SUCCESS STORY

NDRI Graduates turned Entrepreneurs

Two NDRI graduates after working in dairy industry for almost 6 years, decided to start their own business venture. By observing alarming rise in milk adulteration, they interacted with the faculty of Dairy Chemistry Division of the Institute and learnt about the rapid diagnostic kits & strips developed for detection of adulterants in milk at collection point itself. After brief baseline survey, Babbar Singh and Manoj Maurya purchased the technology of paper strip based detection of Maltodextrin in milk and registered their venture as "Delmos Research Pvt Ltd.". Joined as Incubatee Company with BPD Unit, NDRI, Karnal and started the commercial production. The buyers of the strips include companies like Amul, Mother Dairy, Milk cooperative federations and private dairies. Their future plan includes expansion of rapid diagnostic kits and strips for detection of adulterants, contaminants and micro-organisms.

एनडीआरआई ने दूध में माल्टोडेक्सट्रिन जांचने की तकनीक सौंपी

अब मिलावटी दूध से मुक्ति

दूध उपभोक्ताओं को अक्सर कम गुणवत्ता और मिलावटी दूध का सामना करना पड़ रहा है। जिसकी वजह से आर्थिक और शारीरिक नुकसान हो रहा है।

हरिभूमि न्यूज . करनाल

करनाल। डेलमो कंपनी के संयोजकों को समझौता ज्ञापन देते हुए एनडीआरआई के वैज्ञानिक व अन्य।

दूध मानव पोषण के आहार में एक महत्वपूर्ण भूमिका निभाता है, लेकिन दूध उपभोक्ताओं को अक्सर कम गुणवत्ता और मिलावटी दूध का सामना करना पड़ रहा है। जिसकी वजह से आर्थिक और शारीरिक नुकसान हो रहा है। अधिकतर दूध उद्योग मिलावट की समस्या से जूझ रहे है, हालांकि विज्ञान ने ऐसे कई टेस्ट बनाए हैं जिससे दूध की गुणवत्ता का पता लगाया जा सके, लेकिन ये सब टेस्ट आम जनता की पहुंच से बाहर थे, लेकिन अब आम उपभोक्ता भी मिलावटी दूध की पहचान आसानी से कर सकेगा, क्योंकि एनडीआरआई के वैज्ञानिकों द्वारा विकसित की गई दूध में माल्टोडेक्सट्रिन की जांच करने की टेक्नोलोजी को गुड़गांव की डेलमो रिसर्च प्राइवेट कंपनी को ट्रांसफर कर दिया है। कंपनी के संयोजक मनोज कुमार मौर्य तथा बब्बर सिंह ने बताया कि वे जल्द ही इसे मार्केट में उतारेंगे। जिससे अब घर में आम उपभोक्ता भी दूध में माल्टोडेक्सट्रिन की मिलावट का पता लगा सकेगा। खास बात ये है कि ये दोनों एनडीआरआई से ही चीटेक की पढ़ाई कर चुके हैं, इन्होंने किसी दूसरी कंपनी में काम करने की बजाए खुद का बिजनेस शुरू किया है, ताकि आम जनता को मिलावट की समस्या छुटकारा दिला सकें।

10 तकनीक हस्तांतरित की

एनडीआरआई के निदेशक डा. आरआरबी सिंह ने उन्हें बधाई दी और कहा कि साधनों की कमी के चलते आम लोग मिलावटी दूध की जांच कर पाने में असमर्थ हैं। एनडीआरआई की कोशिश रही है कि कुछ ऐसे टेस्ट बनाए जाएं जिन्हें साधारण लोगों तक पहुंचाया जाए। इस दिशा में डेयरी रसायन प्रभाग के वैज्ञानिकों को द्वारा तैयार की गई इस कीट को डेरी उद्यियों को हस्तांतरित किया गया है। उन्होंने आगे बताया कि इस वर्ष संस्थान ने कुल 10 टेक्नोलोजीज को डेरी उद्योगों को हस्तांतरित की हैं।

अधिक संवेदनशील

डा. राजन शर्मा ने बताया कि भारतीय खाद्य सुरक्षा एवं मानक प्राधिकरण एफ एसएसएआई के नियमानुसार दूध में धोखे से माल्टोडैकसट्रिन मिलावट करने की अनुमति नहीं है। दूध में माल्टोडैकसट्रिन की उपस्थिति का शीघ्रता से पता लगाने के लिए एक पेपर आधारित स्ट्रीप विकसित की गई है। यह कीट किलो दूध में 150 मिली ग्राम तक माल्टोडैकसट्रिन की मिलावट की जांच करने में सक्षम है। यह टेस्ट मौजूदा तरल आधारित परीक्षण की तुलना में अधिक संवेदनशील है। इस परीक्षण पेपर स्ट्रीप को दूध में कुछ देर के लिए डुबोया जाता है, जिससे स्ट्रीप का रंग एकदम से बदल जाता है। पोजिटिव सैंपल में स्ट्रीप का रंग पीला हो जाता है। इस परीक्षण के द्वारा दूध से बनने वाले पदार्थ खोया एवं दही, में भी माल्टोडैकसट्रिन की उपस्थिति का पता लगाया जा सकता है।

मिलावटी दूध से बीमारियां खतरा

संयुक्त निदेशक डा. विमलेश मान ने बताया कि दूध में माल्टोडैकसट्रिन नामक एक कैमिकल्स को मिला कर दूध के सोलिड नॉट फैट एसएनएफ को कृत्रिम रूप से बढ़ा दिया जाता है। मिलावट होने पर दूध में पौष्टिक गुणों की कमी हो जाती है। मिलावट के धंधे पर अंकुश लगाने के लिए सबसे पहले हमें जागरूक होना होगा। इसके अलावा साधारण सरल और कम लागत के तरीकों टेस्ट के विकास के द्वारा ही मिलावट की समस्या का समाधान किया जा सकता है।

DAIRY EDUCATION

EDUCATION AND TRAINING

National Dairy Research Institute is the premier Institution of International repute in Human Resource Development for the growing dairy industry in India. 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 2016-17.

B.Tech. (Dairy Technology)

B.Tech. (Dairy Technology) is a 4 Year degree programme offering intensive training in processing and quality control of milk and milk products; and engineering aspects of milk processing plants.

Masters' and Doctoral Degree Programmes

The Institute offers Masters' degree programme in the following disciplines: i) Dairy Microbiology; ii) Food Safety and Quality Assurance iii) Dairy Chemistry; iv) Dairy Technology; v) Food Science & Nutrition vi) Dairy Engineering; vii) Animal Biochemistry; viii) Animal Biotechnology; ix) Animal Genetics and Breeding; x) Livestock Production and Management; xi) Animal Nutrition; xii) Animal Physiology; xiii) Agricultural Economics; xiv) Agricultural Extension Education, xv) Agronomy, and xvi) Veterinary, Gynaecology and Obstetrics. The Institute offers Doctoral degree programme in all the above disciplines except Food Science and Nutrition.

Diploma in Dairy Technology and Animal Husbandry

The Diploma in Dairy Technology being offered at Southern Campus, Bengaluru offers intensive training in dairy processing and quality control of milk and dairy products, engineering aspects of dairy processing equipments and dairy business management. The Diploma in Animal Husbandry and Dairying being offered at Eastern Campus of NDRI, Kalyani, offers intensive training in Animal Husbandry and Dairying.

Scholarship and Fellowships

Masters in Dairying and Ph.D. students are awarded Institute scholarship at the following rates in accordance with the prescribed rules and regulations of ICAR:

Institute Scholarships

Master's degree	₹ 7560/- P.M. for two years plus ₹ 6000/- per annum as contingency.
Ph.D.	₹13125/- P.M. for three years and ₹10,000/- per annum as contingency.
Ph.D. (In-service)	₹3000/-P.M. for three years and ₹ 10000/- per annum as contingency.

ICAR Junior Research Fellowship

Master's degree	₹ 8640/- P.M. (For Non Veterinarians) and ₹ 12,000/- P.M. (For veterinarians) for two years and ₹ 6000/- per annum as contingency.

ICAR Senior Research Fellowship

Ph.D.	₹ 15000/- P.M. (For Non Veterinarians) for 1st and 2nd year and ₹ 17,500/- for 3rd year; and ₹10000/- per annum as contingency.
Ph.D.	₹ 17,500/- P.M. (For Veterinarians) for 1st and 2nd year and ₹ 18,700/- for 3rd year; and ₹ 10000/- per annum as contingency.

National Talent Scholarship

The National Talent Scholarship (NTS) @ ₹ 2000/- per month is awarded by ICAR on merit provided that the university/institute is located outside the state of his/her domicile.

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. Passed out students of NDRI are getting employment in Dairy/ Food Industry (Govt./Cooperative/Multinationals). Salary ranges from ₹ 30,000 to 83,000/- per month. In addition to employment a number of students also opt for higher studies in India and abroad. The major functions of the Cell are as follows:

- To counsel the undergraduate and post graduate students in career planning.
- To compile a directory of corporate and academic bodies at the National and International level engaged in the area of Dairying and Food Processing.
- To prepare a compendia of resume of the final year students for facilitating placement/ screening with prospective employers.
- To evolve mechanism for placement of Graduate/Postgraduate students from various disciplines by arranging campus interviews.
- To arrange seminars/workshops/presentations to maintain closer liaison between student community and industry.

Counselling for Admissions

Counselling for admission to PG programme was held by the Education Division of ICAR at NASC Complex, New Delhi. Counselling for admission to B. Tech. (DT) and Ph.D. progamme was held by NDRI at Karnal campus.

Entrance Examination

An all India Competitive entrance examination for admission to Ph.D. and B. Tech.(Dairy Technology) programme for the session 2016-17 was conducted by NDRI on 13.5.2016 and 15.5.2016, respectively at three centers i.e. Karnal , Bengaluru and Kalyani.

Admissions

Admissions for the academic session 2016-17 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. A total of 11 students joined Diploma in Dairy Technology, 5 students joined Diploma in Animal Husbandry & Dairying, 48 students joined B.Tech. (Dairy Technology), 160 students joined Masters' programme, 122 students including one foreign nationals joined the Ph.D. Programme.

Meetings

- 82nd, 83rd and 84th meetings of the Standing Committee on Course Curricula and Academic Affairs were held on 15.4.2016, 8.9.2016 & 18.2.2017, respectively.
- 61st and 62nd meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 7.9.2016 and 18.2.2017, respectively.
- 41st meeting of Academic Council was held on 27.9.2016
- 42nd meeting of Academic Council was held on 2.3.2017.

Fifteenth Convocation of NDRI Deemed University

Fifteenth Convocation of NDRI Deemed University was held on 4th March, 2017. Professor (Dr.) A. K. Srivastava, Former Director & Vice Chancellor, NDRI and presently the Member of Agricultural Scientists Recruitment Board, New Delhi presided over the Function and Padamshree Dr. Sanjaya Rajaram, Former Director, Wheat Programme, CIMMYT; Former Director, Biodiversity & Integrated Gene Management Program, ICARDA and World Food Prize Laureate, 2014 delivered the Convocation Address. Dr. R. R. B. Singh, Director & Vice Chancellor, NDRI Deemed University presented the Convocation Report. **A total of 262 students (including 75 girls) were conferred different degrees i.e. B.Tech. (Dairy Technology) - 22, Master's -148 and Doctoral – 92.** Besides, Best Division Award for academic achievements and innovations in teaching and Two Best Teacher Awards for undergraduate teaching and post graduate teaching were also given to recoginze and promote teaching excellence and motivate the faculty.

In his Convocation address, Dr. Rajaram emphasized that agriculture including dairy science and animal husbandry, forestry would decide the balance in future of abundance of nutritious foods, and preservation of natural resources including water, soil and biodiversity. Students were also Awarded Medals in B.Tech. (Dairy Technology)/M.Sc./M.V.Sc/M.Tech./Ph.D. A galaxy of eminent guests including Dr. H. Rahman, Deputy Director General (Animal Sciences), and others graced the occasion.

Three topper students each in B.Tech. (DT), Master's and Doctoral programmes were awarded Director's Gold, Silver and Bronze Medals for overall performance in Course work. Best thesis

A student receiving degree during 15th Convocation held at NDRI

awards for Master/Ph.D. programmes (one each in Production, Processing and Management group) were also given to the students.

Name of the Student	Discipline	Medal
B.Tech. (Dairy Technology)		
Varun Arora	Dairy Technology	Gold
Naincy Saini	Dairy Technology	Silver
Shivam Panwar	Dairy Technology	Bronze
M.Sc./M.V.Sc/M.Tech.		
Priyanka	Dairy Engineering	Gold
Sangeeta Bhattacharyya	Agricultural Extension Education	Silver
Prabha Karan	Veterinary Gynaecology & Obstetrics	Bronze
Ph.D.		
Neethu K.C.	Dairy Engineering	Gold
Tapas Kumar Patbandha	Livestock Production Management	Silver
Rajalaxmi Behra	Ph.D. (Animal Genetics & Breeding)	Bronze

Best Thesis Awards

Best Thesis Awards for Masters' theses (one each in Production, Processing and Management Groups) carrying a citation, a certificate and ₹ 5000 were awarded.

Best Masters' Thesis Awards

Group	Name of the student	Discipline
Production	Mr. Saraf Kaustubh Kishor	Veterinary, Gynaecology and Obstetrics
Processing	Mr. Surya Kant Verma	Animal Biochemistry
Social Science & Management	Ms. Sangeeta Bhattacharya	Agricultural Extension Education

Gold Medals for best thesis research work in Ph.D. Programme of Production, Processing and Management Group were awarded. The award carries Gold Medal, Citation and Certificate.

Group	Name of the student	Discipline
Production	Ms. Uttarani Maibum	Animal Physiology
Processing	Mr. Mahesh Kumar G.	Dairy Engineering
Social Science & Management	Mr. Kale Rajiv Baliram	Agricultural Extension Education

Dr. D. Sundaresan Memorial Oration Award-2017 was bestowed on Dr. Trilochan Mohapatra, Secretary, DARE & Director General, ICAR, New Delhi. Dr. Mohapatra delivered the lecture on the topic "**The GM Future: Bright or Gloomy"** at NDRI Karnal on 18th March, 2017. The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. Trilochan Mohapatra, Secretary DARE & DG, ICAR, New Delhi receiving Dr. D. Sundaresan Memorial Oration Award-2017

Dr. N. N. Dastur Memorial Oration Award-2017 was bestowed on Dr. Subeer Mazumdar, Director, National Institute of Animal Biotechnology, Hyderabad. Dr. Mazumdar delivered the oration on the topic **"Future of Transgenic Farmed Animals and Milk as a Source of Therapeutic Proteins"** at NDRI Karnal on 21st February, 2017. The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. K. K. Iya Oration Award-2017 was bestowed on Dr. Narendra Singh Rathore, Deputy Director General, (Agril. Education), Indian Council of Agricultural Research, New Delhi. Dr. Rathore delivered the lecture on the topic "**Innovations in Agriculture Education in India"** at NDRI Karnal on 23rd February, 2017. The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. Subeer Mazumdar, Director, National Institute of Animal Biotechnology, Hyderabad receiving Dr. N. N. Dastur Memorial Oration Award-2017

Dr. Narendra Singh Rathore, Deputy Director General, (Agril. Education), ICAR, New Delhi receiving Dr. K. K. Iya Oration Award-2017

Cultural Activities

Literary and cultural activities prove a valuable lens to view the inner world of students and thereby enable their holistic development. Institute provided several opportunities to the students to showcase their talent. The Institute organised several cultural and literary activities through "Inter-University Festival Reverie" Vasantotsav, Freshers' Day for all-round development of the students.

Dr. Trilochan Mohapatra, Secretary (DARE) and DG, ICAR inaugurating Inter-University Youth Festival (Reverie 2016) at NDRI

Literary Events

» The NDRI Team of B. Tech. (DT) third year students (Namely: Messrs. **Sandeep Baruah, Saurabh Rai** and **Nabil Alam)** won the **First** Prize at the *Zonal level Quiz Competition* conducted by *Haryana State Council for Science & Technology, Haryana*. The award carried a cash prize of ₹ 40,000/- and a **Merit Certificate**.

» The NDRI Team of B. Tech. (DT) third year students (Namely: Messrs. **Sandeep Baruah, Saurabh Rai** and **Nabil Alam)** also participated in the *State Level Quiz Competition,* held at **Arya P. G. College, G. T. Road, Panipat** on **31st January 2017;** and secured Fifth position.

» Six students of the B. Tech. (DT) Degree programme (Namely: Messrs. Ravinder Parmar, Saurabh Rai, Gautam Modi, Sagar Anand, Chandramauli and Priyam Agrawal) secured 2nd, 3rd, 3rd, 4th, 5th and 6th rank, respectively in the *IAS Scholarship Test*, conducted by DC Classes, Karnal, in September 2016.

» The NDRI Team of Mr. Saurabh Rai and Mr. Shoban Deb secured **Third** position in the **Dairy and Food Quiz**, organized on the occasion of *National Milk Day 2016.*

» The NDRI Team (Represented by Messrs. Saurabh Rai and Chandramauli) participated in the ***Quiz*** event in the 17th All India Agricultural Universities Youth Festival, held at RAJUVAS, Bikaner (Rajasthan).

» Mr. Vikas Gruwa, B.Tech. (DT) 4th Yr. got the First Prize in extempore completion during 17th All India Agricultural University Youth Festival, held at Rajasthan University of Veterinary and Animal Sciences (RAJUVAS), Bikaner (Rajasthan), during 22nd - 25th February, 2017.

» Mr. Krishna Arora (B.Tech. DT 3rd Yr.) won **Third** Prize in the **Debate** competition, organised by YPARD.

» Mr. Krishna Arora (B.Tech. DT 3rd Yr.) won the **Debate** Competition, held in Delhi University on the occasion of *World Food Day*.

» Mr. Shrey Agrawal (B.Tech. DT 1st Yr.) won **Third** Prize in the ***Inter-college Debate Competition***, organized at Satyawati College, Delhi University, Delhi.

» During All India Inter-University Youth Festival 2017, held at ICAR-NDRI Deemed University, Karnal (Haryana), following students got prizes:

» **Essay Writing (Hindi)**: Mr. Saurabh Rai, B.Tech. (DT) 3rd Yr. got the First Prize.

» **Extempore**: Mr. Anand, Ph.D. Scholar of ICAR-NDRI, Karnal got the First Prize.

» **Elocution**: Mr. Shrey Aggarwal, B.Tech. (DT) 1st Yr. got the First Prize.

» **Quiz**: NDRI Team (Mr. Saurabh Rai, Ms. Sakshi and Mr. Rajesh Panwar) got the Third Prize.

» **Dumb Charades**: NDRI Team (Ms. Sakshi, Ms. Rashika and Mr. Simran) got the Third Prize.

» **Shipwreck**: Mr. Krishna Arora, B.Tech.(DT) 3rd Yr. got the Second Prize.

TECHNOLOGY DISSEMINATION AND EXTENSION PROGRAMMES

DAIRY EXTENSION

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: Dungro, Deepo and Dhamnheri.

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 (2016-2017)

Sr. No	Activities Conducted	Nos. of Cases
1	A.I. in Cows	244
2	Conception Rate (%) in Cows	38.10
3	A.I. in Buffaloes	163
4	Conception Rate (%) in Buffaloes	30.80
5	No. of Cross-breed Calves Born	95
6	No. of Buffalo Calves Born	115
7	General Treatment	215
8	Dehorning	74
9	Deworming	596
10	Tick control	196
11	Infertility	130
12	Pregnancy diagnosis	368

Infertility and Veterinary Aid Camps.

A total of 33 camps were organized in Kulwaheri, Budhakhera, Deepo, Dugro and Dhamanheri villages. During the Camps, a total number of 741 cases were treated for reproductive disorders and various veterinary ailments. Ectoparasitic control campaign and Deworming programmes for control of endoparasites were conducted. Special attention was given to improve the productive and reproductive cause of animals by diagnosis and proper treatment.

Kissan Sanghosthies

Thirty one Kisan Sangosthies were organized and large number of farmers attended these sangosthies. The following topics were discussed in detail as:

- Awareness on ecto-parasite infestation
- Correct Time of Breeding of females
- Deworming animals and tick control,
- Management of inter-calving period in lactating animals,
- Management of transition period in dairy animals
- Preparation of value added milk products.
- Preventive measure against contagious disease
- Role of mineral mixture in animal diet

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.

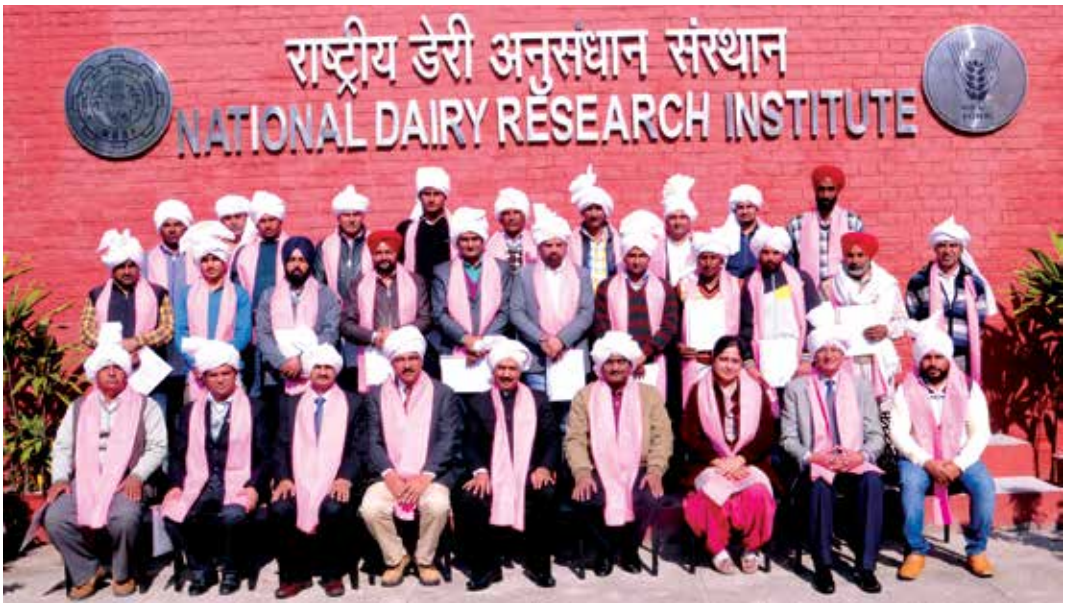
Dairy Education at Farmers' Door (DEFD)

Extension Education Programme "Dairy Education at Farmers' Door" 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 various villages on 2nd Saturday of every Month. Scientists also obtained the feedback from the participating farmers. At the outset, arrangement for discussion with a group of farmers was made at the local common entrance of the village and discussion on farmers' problems related to scientific dairy farming, crop husbandry practices and also to give veterinary advice to the farmers.

The farming community expressed happiness on this new Extension initiative of the Institute where the NDRI scientists devote their holiday for dairy farmers.

Farmers' Farm School

NDRI 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 second batch of the Farmers Farm School has passed out in the month of July 2016 and they were awarded certificate by the Director of the Institute on 13th January, 2017. The course curriculum also includes the visit to various agricultural institutes and progressive farms. The third batch is in progress and classes were started from 05/08/2016. This batch is especially reserved for farmwomen and currently 20 women were enrolled as a student of 3rd batch of farmers farm school.



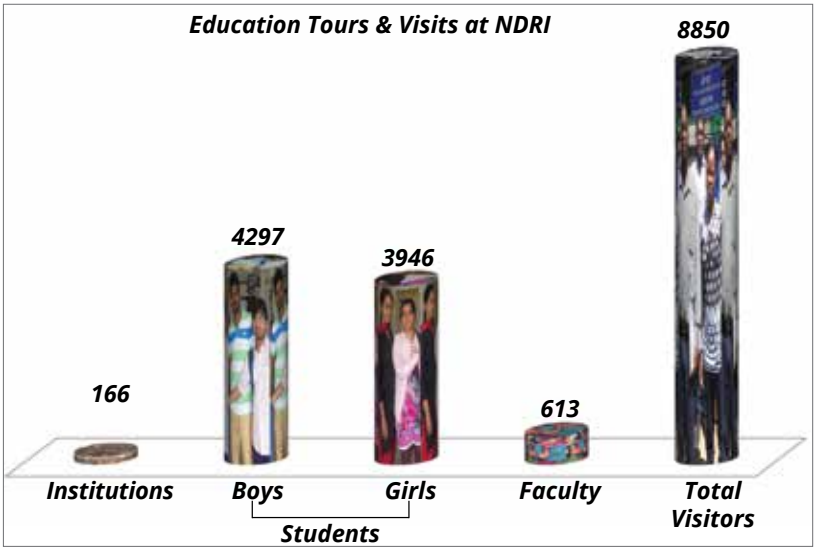
Second batch of farmers of Farmers' Farm School with the Director, NDRI Karnal

Dairy Samachar

Quarterly Dairy Samachar was published by Division Dairy Extension, NDRI, Karnal and to make them well aware of newly developed dairy technologies of the Institute, dairy entrepreneurs in different states throughout the country.

Educational Visits at NDRI

A total of 8856 visitors (students & Faculty) of 166 colleges/Institutions/Universities visited the Institute which were coordinated by the Division. The groups were sensitized about the different research, teaching and extension achievements and facilities available in the Institute. The details of educational tour is as follow:



KRISHI VIGYAN KENDRA (KVK)

Krishi Vigyan Kendra (KVK) at NDRI, Karnal became operational in July 1976. Subsequently, this Kendra has developed infrastructure to run the need based skill oriented training programmes through "Learning by Doing". Three fundamental principles viz., (i) agricultural production – the prime goal, (ii) work experience – the main method of imparting training and (iii) weaker section of the society – the main target group, are always kept in mind.

The main aim of KVK is to accelerate agricultural production and allied activities for improving economic status of farmers and create job opportunities for the poor amongst the poorest in the rural areas.

Training Programmes organized by KVK (April 2016 to March, 2017)

Title of the Course	Duration (days)	No. of Courses	No. of Beneficiaries	Mandays Trained
On Campus				
Dairy Production				
At KVK	5-26	20	1773	9285
Sponsored	5-9	10	288	1468
Dairy Processing				
At KVK	5	6	118	590
Sponsored	3-5	2	52	188
Crop Production	1-4	4	112	352
Vermiculture	3-26	3	91	733
Bee-keeping	4	3	172	688
Fish Farming	4	2	133	532
Home Science	1-15	7	135	694
Total (A)		57	2874	14530
Short Integrated Training Programmes (**B**)	1-3	97	2737	3307
Total (A+B)		**154**	**5611**	**17837**

Off Campus				
Dairy Processing	1	5	71	71
Crop Production	1	10	130	130
Vermiculture	1	4	65	65
Home Science	1	4	157	157
Total (C)		23	423	423
Grand Total (A) + (B) +(C)		**177**	**6034**	**18260**

Skill Development Trainings

Krishi Vigyan Kendra organized two skill development trainings of 200 hours each sponsored by Ministry of Skill Development, Govt. of India on A.I. Technician and Vemi-compost Producers for 20 participants each. The trainings were organized during 6th – 31st March, 2017 and participants were assessed by Agriculture Skill Council of India, New Delhi on 31st March, 2017.

State-wise Beneficiaries of on Campus KVK Training Programmes (April 2016 to March, 2017)

Sr. No	State	No. of Beneficiaries
1.	Haryana	3079
2.	Uttar Pradesh	923
3.	Himachal Pradesh	801
4.	Jammu & Kashmir	213
5.	Gujarat	192
6.	Odisha	175
7.	Rajasthan	140
8.	Bihar	109
9.	Punjab	109
10.	Uttrakhand	87
11.	Madhya Pradesh	76
12.	Manipur	70
13.	Chhatisgarh	13
14.	Delhi	11
15.	Chandigarh	2
16.	Jharkhand	2
Total		**6034**

Front Line Demonstrations (2016-17)

Front Line Demonstration (FLD) is a National Programme to promote and popularize the production of the oilseed and pulse crops apart from latest varieties in fodder and cereal crops in this region. One of the prime mandates of KVK is to conduct FLD in various crops to generate production data and feedback information and to study the factors, which enhance the optimum yield, and also to prove the production potential of newly developed crop production technology.

Results of F.L.D 2016-17

S. No	Crop		Varierty	Total No. of Demo.	Area (ha.)	Av. yield
1.	Oilseeds	Mustard	RH-749	15	6.0	18.52
2.	Pulses	Gram	HC-1	53	20.0	18
		Summer Moong	SML-668	100	40.0	2.70
4.	Fodder	Berseem	BL-42 BL-10 HB-2	12 11 4	1.62 1.72 0.80	1315 1105 939
		Cowpea	CL-367	8	1.0	292
		Maize	J-1006	16	4.75	457

Promotion of Moong cultivation

KVK concentrated its efforts in increasing the Moong cultivation area in the district. Moong varieties SML-668 and MH-421 were promoted and the farmers having different categories of land holding were encouraged to grow summer Moong for getting pulse as well as to increase the soil fertility.

Meeting of Scientific Advisory committee

Scientific Advisory committee of KVK was held on 18th November, 2016 under the Chairmanship of Director NDRI Karnal in which the progress report of the KVK was presented and activities of KVK were proposed. In this meeting officials of the line departments and the local ICAR Institutes also participated.

Extension Activities

- KVK celebrated "Women Empowerment Day" on 27th April, 2016 in which 35 women from different villages of Karnal district and 32 women from district Kangra (Himachal Pradesh) participated. During this event lectures were delivered by subject matter specialists of KVK and progressive women.
- A Partheniunm awareness week was organized at NDRI from 16th - 22nd August, 2016 to apprise the farmers, farm women and school children on ill effects of weed
- KVK organized Soil Health Day on 5th December, 2016 in which 95 farmers 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 the crop production.
- A "Kisan Ghoshti" was organized by KVK in village Daha Jagir on 14th December, 2016 in which more than 50 farmers and farm women participated.
- KVK celebrated 23rd - 29th December, 2016 as "Jai Kisan Jai Vigyan" week to sensitize the farmers to adopt scientific practices in agriculture. During this, various activities were organized at KVK and in the villages of Karnal district.
- A group of 20 farmers from Panipat and Karnal district were taken to Rabi Kisan Mela organized by CSSRI Karnal on 8th March, 2017
- KVK participated in a fisheries conservation programme organized in village Vazidpur, Kunda Ghat at Yamuna River wherein 70 fish farmers of the district Karnal and Kurukshetra participated. Lectures were delivered by the KVK staff.
- KVK organized five exposure visits of the farmers of Karnal district to Farmers Scientist Interface and agriculture fares organized in IARI, New Delhi, KVK Kaithal Manoli district Sonipat, Muzzafar Nagar, KVK, Damla, Yamuna Nagar.
- KVK organized the exhibitions depicting its activities and achievements on 17th October, 2016 DWR, Karnal and on 5th December, 2016 at KVK, NDRI, Karnal.

Revenue Generated

Total revenue generated at KVK through various activities during **April 2016 to March, 2017** was **₹ 34,73,148/-**

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 with other research stations of ICAR and state institutions located at Karnal is utilized by this centre for the farmers and other stake holder 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 of ATIC

- 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 for the 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 by Agricultural Technology Information Centre (April 2016 to March 2017)

Sr. No.	Details of Services	No. of Services	No. of Persons
1.	Dairy/Agriculture Related Information through Video Shows and Lectures	25	926
2.	Personal Discussion with Subject-Matter-Specialists on Dairy Farming	47	114
3.	Information through Dairy/Agriculture Literature	101	101
4.	Information on Agriculture (Seed/Fertilizer/ Compost etc)	1502	1502
5.	Information through telephone (Toll-free) on Agriculture & Dairying etc.	2404	2404
6.	Information through e-mail on Agriculture & Dairying etc.	73	73
Total		**4152**	**5120**

KRISHI AND DAIRY VIKAS KENDRA (KDVK), IN KVK, PIPRAKOTHI

ICAR-NDRI established Krishi and Dairy Vikas Kendra (KDVK), in KVK, Piprakothi, East Champaran, Bihar in the premises of Dr. Rajendra Prasad Central Agriculture University, Pusa. The center was inaugurated at KVK, East Champaran District by Hon'ble Union Agriculture and Farmers Welfare Minister Shri Radha Mohan Singh Ji on 10th July 2016. A Veterinary camp was organized in Kotwa, Village on 13.06.2016 and around 70 animals were treated. Indigenous Cattle, Buffaloes and Crossbred bull semen doses were distributed regularly to the AI technicians of the region for breed improvement programme and 650 doses of semen were sold from this unit during this period.

Training Programmes Organized at Krishi and Dairy Vikash Kendra (KDVK) KVK, Piprakothi, East Champaran, Bihar (August 2016 to March 2017)

Sl. No.	Date	Topic	No. of Participants
1	2.8.2016 to 4.8.2016	Commercial Dairy Farming	80
2	19.8.2016 to 21.8.2016	Dairy and Food Processing	21
3	6.9.2016 to 8.9.2016	Commercial Goat Farming	54
4	3.10.2016 to 4.10.2016	Refresher training on Artificial Insemination and Pregnancy Diagnosis	27
5	28.11.2016 to 30.11.2016	Dairy Pasu Prajanan Abam Chara Prabandhan	45
6	15.12.2016 to 17.12.2016	Dairy and Food Processing	17
7	22.12.2016 to 24.12.2016	Commercial Goat Farming	63 Male -42 and Female -21
8	11.01.2017 to 13.01.2017	Commercial Dairy Farming and Feed Formulation	88 Male -86 Female-2
9	23.02.2017 to 25.02.2017	Commercial Dairy Farming and Reproduction Management	50 Male -49 Female-1
10	6.03.2017 to 8.03.2017	Feed Formulation and Balance Ration for Dairy Animals	35
11	15.03.2016 to 17.03.2016	Dairy Animal Housing and Feeding Management for Better Milk Production	55
Total			**598**

Exposure visit cum Training Programmes organized at NDRI for Motihari Farmers and Entrepreneurs

Sl. No.	Date	Place	No. of Participants	Particulars
1	1.6.2016 to 8.06.2016	LRC, AI Section and ABRC, DT Davison	7	Dairy entrepreneur and AI technician
2	17.10.16 to 22.10.2016	Training in AI, semen lab and DT lab	1	Appointed as casual worker at Motihari center
3	17.11.2016 to 19.11.2016	Exposure visit AI, semen Lab and DT lab	1	Dairy entrepreneur
		Total	**9**	

Training Programmes at Lalukheri Centre

Three training programmes on Milk and Milk Product Processing were organized at Lalukheri Centre of NDRI participated by 52 farmers, entrepreneurs and rural unemployed youth. The training was imparted for testing of milk quality, basic unit operations related to milk processing and manufacturing of value added dairy products.

WOMEN EMPOWERMENT AND MAINSTREAMING OF GENDER ISSUES

DAIRY EXTENSION DIVISION

Fifty-two women empowerment-training courses and campaigns were organized for farm women to create awareness in the field of dairying and home science, also impart skills in these areas so that they could generate more income from dairying, and maintain healthy atmosphere in their respective families. A total number of 815 farmwomen were trained in these training programmes.

Name of Programme	Village/On-campus	No. of Courses	No. of Participants
Preparation of Value Added Milk Products for Farm Women.	Kulwahri, Pinjor, Pingli, Jundla, (NICRA villages) and Churni	18	315
Capacity Building in Value Added Milk Products for Farm Women.	Pinjor Circle, Gumto, Gorgarh and Dungro	8	151
Capacity Building of Farm-women in Scientific Dairy Farming (Supplementation of Mineral Mixture, Balancing of Rations, Vaccination Schedule, Ecto-endo Parasites Control, Clean Milk Production Practices, Care of Animals during Summer and Winters).	Bazidpur, Kulwahri, Subri and Gumto	7	106
Preservation of Fruits & Vegetables (Tomato Paste and Chutney, Amlaachar, Lemon Achar, Mixed Vegetable Achar & Guava Jam)	Kulwahri, Bazidpur, Dungro, Subri and Gorgarh	11	137
Awareness Campaign on Health and Hygiene (Vaccination Schedule for Children, Tips for Personal Hygiene, Tips for House Cleanliness and Surroundings)	Kulwahri, Gumto, Dungro, Subri	8	106
Total		**52**	**815**

Empowerment of Farm Women through Livestock Technologies

The study was undertaken for introducing the technological interventions for empowering the women belonging to landless, and resource poor farm families in the livestock enterprise after identifying the major issues affecting the technology transfer. Farmwomen were able to reduce 30% production cost by adopting the feed preparation at their farm levels. They saved the money ranged from ₹ 500 to 2000 per month depending upon the number of animals, kept by them. The improved fodder variety BL 42 enhanced the income from 10-15% due to more number of cuts and higher yield. Veterinary camps and interaction meets in both the villages enhanced the greater understanding of the scientific technologies in dairy farming among the farmwomen. After the exposure visit to NDRI and later the training on preparation of milk products, farm women were found to adopt the same in their households especially paneer making regularly and burfi, lassi, flavoured milk making occasionally.

Impact of Women Dairy Self Help Groups

The membership of Self Help Groups, helped the women dairy farmers in the Belagavi district of Karnataka to enhance their savings and therefore, positively influencing their repayment status. There was increase in employment and income of the SHG members, the average man-days of employment in a year worked out for member households (212.46 man-days) was more than that of non-member households (175.84 man-days) and the overall monthly net income for member group (₹ 1805) was more than that of non-member (₹ 1395) groups. The membership of SHGs also empowered the women as is evident from higher value of dairy empowerment score of member group (0.73) vis-a-vis the non-member group (0.62).

Training Programme for Tribal Women (ERS-NDRI)

Krishi Vigyan Kendra (KVK)

Sixteen different programmes were organized on scientific dairy farming, milk product making, preservation of fruits and vegetables, preparation methods of sauces, jam, pickle etc. and stitching and embroidery by the KVK in rural areas. A total of 187 women participated in these programmes.

The Krishi Vigyan Kendra empowered the farm women through skill and capacity building in different vocations for the 450 farm women of Gujrat, Manipur, Jammu & Kashmir, Himachal Pradesh and Uttar Pradesh states.

International Women Day: KVK in association with CSSRI organized a programme in village Bastara on International Women Day (8th March, 2017) in which 70 farm women participated.

Farm-women taking class in Farmers' Farm School

HONOURS AND AWARDS

- **Education Leadership Award** was given to NDRI, Karnal during World **"Education Congress"** organised on 23rd June, 2016 in Mumbai.
- **ICAR Best Annual Report Award (2015-16)** was given to ICAR-NDRI under large Institute Category for its excellent quality of content, originality and innovativeness in the presentation. **Dr. R. R. B. Singh,** Director NDRI, Karnal received the award from **"Hon'ble Radha Mohan Singh Ji,** Union Minister of Agriculture & Farmers Welfare, Govt. of India in presence of **Dr. Trilochan Mohapatra,** Secretary DARE & DG, ICAR during ICAR Directors' meeting held on 14th February, 2017.
- **ICAR-National Dairy Research Institute** got a certificate of appreciation from Indian Council Agricultural Research, New Delhi for outstanding achievements in digitization of more than 1,600 Ph.D./Master theses of the Institute in the digital repository KrishiKosh of the Council during the workshop on "Exploring KrishiKosh Repository to Disseminate Agricultural Knowledge" held from 6th - 7th December, 2016 jointly organized by CCS Haryana Agricultural University, Hisar, Haryana and ICAR, New Delhi.
- **Dr. A. K. Srivastava,** Director and Vice Chancellor, NDRI was conferred **"Dewang Mehta Education Award"** for Outstanding Contribution in recognition of leadership, development, innovation and industry interface on 25th November, 2016 at Raj Lands End., Mumbai.
- **Dr. S. K. Singla, Dr. M. S. Chauhan, Dr. R. S. Manik, Dr. P. Palta** and **Dr. Shiv Prasad** received **"ICAR Award"** for Outstanding Interdisciplinary Team Research in Agricultural and Allied Sciences 2013-14 on 16th July, 2016 at Vigyan Bhawan, New Delhi.

- **Dr. M. S. Chauhan** was awarded **"Rafi Ahmed Kidwai Award"** for Outstanding Research in Agricultural Sciences 2015 on 16th July, 2016 at Vigyan Bhawan, New Delhi.

- **Dr. A. K. Singh,** Principal Scientist, Dairy Technology Division received **"Bhart Ratna Dr. C. Subramaniam Award"** for Outstanding Teacher-2015 for Natural Resource Management and Agricultural Engineering on 16th July, 2016.

- **Sh. Sandeep Khokhar,** Technical Assistant, Animal Genetic & Breeding Division and **Sh. Ram Pal Saini,** Skilled Supporting Staff, Dairy Technology Division bagged **"Best Employee Award"** under cash award scheme for technical and supporting category employees of ICAR, respectively on 16th July 2016.
- **Dr. Selokar Naresh Lalaji**, Ph.D. (Animal Biotechnology) student of Dr. S. K. Singla, Principal Scientist, ABTC, received **"Jawaharlal Nehru Award"** for Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences 2015 for Animal Sciences on 16th July, 2016 at Vigyan Bhawan, New Delhi.
- **Dr. Monika Saini**, Ph.D. (Animal Biotechnology) student of Dr. P. Palta, Principal Scientist and Incharge, ABTC, received **"Jawaharlal Nehru Award"** for Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences 2015 for Animal Biotechnology on 16th July, 2016 at Vigyan Bhawan, New Delhi.

- **"Best Division Award"** for 2015-2016 was presented to **Animal Biotechnology Centre** for academic achievements and innovations in teaching during 15th Convocation of NDRI on 4th March, 2017.
- **Dr. Sudhir Kumar Tomar**, Principal Scientist, Dairy Microbiology Division was conferred **"Best Teacher (PG)"** award for the year 2015-2016 during 15th Convocation held on 4th March, 2017 at NDRI, Karnal.

- **Dr. Yogesh Khetra,** Scientist, Dairy Technology Division was awarded the "**Best Teacher Award"** for the academic session 2015-16 during 15th Convocation of National Dairy Research Institute, Karnal on 4th March, 2017.
- **Dr. A. K. Srivastava,** Director NDRI was awarded "**100 Most Influential Directors of India (Education) Award"** by World Education Congress 2016 held on 23rd June, 2016 at Hotel Taj Land End, Mumbai.
- **Dr. Dhruba Malakar,** Principal Scientist was awarded **"Distinguished Scientist Award",** Prof. M. A. Akbarsha and Prof. M. Michael Aruldhas Gold Medal Oration 2016.
- **Dr. I. K. Sawhney,** Emeritus Scientist was awarded **"Life Time Achievement Award"** by the Indian Dairy Engineers Association (IDEA) for significant contribution to Dairy Engineering Profession, at 10th National Convention of Indian Dairy Engineers, held at AAU Anand on 29th - 30th September, 2016.
- **Dr. K. S. Kadian** conferred **"Best Extension Professional Award"** for outstanding contributions in the field of Extension Education by the Society of Extension Education, Agra at 8th National Extension Education Congress- 2017 held at National Academy of Agricultural Research Management, Hyderabad during 28th - 31st January, 2017.
- **Dr. K. Ponnusamy** and **Dr. B. S. Meena** received **"Reviewer Excellence Award"** of Indian Journal of Animal Research and Asian Journal of Dairy and Food Research from Agricultural Research Communication Centre, Karnal in November 2016.
- **Mr. Gajanan P. Deshmukh** received the **"Indian Foods Research Award"** of ₹ 50,000 from the Ph.D. Research Promotion programme organised by **F1rst (**Business Associate of Giract, Geneva).
- **Dr. Dalip K. Gosain** was awarded **"Srestha Nagrik Purushkar"** by Pahla Kadam Organization of Kurukshetra on 11th July, 2016.
- **Dr. Sunita Grover,** Head, Dairy Microbiology Division was awarded **"Fellow of National Academy of Agricultural Sciences"** in January, 2017.
- **Mr. Umamageswari M** received **"Bir Singh Aasi Memorial All India Best Publication Awards 2016"** for the paper entitled "Technical efficiency of dairy farmers in Tamil Nadu- an application of stochastic frontier production function. International Journal of Farm Sciences 6 (2): 214-224" by SADHNA (Society for Advancement of Human and Nature).
- **Dr. Sumit Arora,** Principal Scientist, Dairy Chemistry Division and **Dr. A. K. Singh**, Principal Scientist, Dairy Technology Division were awarded the **"Fellowship of Indian Dairy Association"** during 16th - 18th February, 2017 at 45th Dairy Industry Conference, Mumbai.
- **Dr. T. K. Mohanty,** Principal Scientist was awarded **"Fellow of National Academy of Dairy Science India"** in 4th Convocation of NADS (I) on the 6th April, 2016 at National Dairy Research Institute, Karnal.
- **Dr. Magan Singh,** Principal Scientist awarded as "**Associate Fellowship of the National Academy of Dairy Science"** (India) on 6th April 2016 at NDRI, Karnal and Reviewer Excellence Award by ARCC, Karnal, 2016.
- **Dr. Veena Mani,** Principal Scientist received **"National Academy of Dairy Science India – Award**" of Fellow of National Academy of Dairy Science India conferred for 2016.
- **Dr. Goutam Mondal,** Principal Scientist and **Dr. Nitin Tyagi,** Scientist received **"Associate Fellowship Conferred by National Academy of Dairy Science (India)"** for the year 2016,
- **Dr. Yogesh Khetra**, Scientist, Dairy Technology Division was awarded with **"Associateship of National Academy of Dairy Sciences, India**".
- **Dr. A. K. Tyagi,** Head, Dairy Cattle Nutrition Division received **"Life Time Achievement Award"** of CLFMA India.
- **Dr Kamal Gandhi,** Scientist received **"Early Career Research (Project for three years) Award"** from Science and Engineering Research Board, Department of Science and Technology, Government of India.
- **Dr. Chand Ram Grover** received **"Reviewer Excellence Award"** for reviewing research papers for publications in **"Asian Journal of Dairy and Food Research".** The award was conferred upon by Editors of Agricultural Research Communication Centre, Karnal (28th December, 2016).
- **Dr. A. Kumaresan** received **"Fellowship Award"** by Indian Society for Study of Animal Reproduction on 6th December, 2016 at Tirupati.

- **Dr. Ashish Kumar Singh**, Principal Scientist, Dairy Technology Division was awarded with **"Chellapa Memorial Oration"** during XVI Annual Conference of Indian Society of Veterinary Pharmacology and Toxicology (ISVPT-2016) by the Indian Society of Veterinary Pharmacology and Toxicology at Navsari Agricultural University, Navsari (Gujarat).
- **Mr. B. P. Singh**, Assistant Chief Technical Officer (Library) received a certificate of appreciation from Indian Council Agricultural Research, New Delhi for his commendable contribution in "Strengthening and Sustainability of e-Granth (Strengthening Digital Library and Information Management under NARES)" during the workshop.
- **Dr. Ramendra Das, Dr. I. D. Gupta,** Principal Scientist, **Dr. Archana Verma,** Principal Scientist, **Dr. Avtar Singh,** Principal Scientist, **Dr. Mahesh V Chaudhari, Dr. Lalrengpuii Sailo, Dr. R. C. Upadhyay,** Ex-Head and **Dr. J. Goswami** were awarded **"Best Paper Award"** award in 45th IDA Meet for Published Research Article entitled: Genetic polymorphisms in ATP1A1 gene and their association with heat tolerance in Jersey crossbred cows.
- **Dr. Apurva Sharma Dr. Syama M. A.** and **Dr. Sumit Arora,** Principal Scientist received **"Best Paper Award"** for the oral presentation on "**Preparation, of ferritin core - A novel iron fortificant"** in the second National Conference on "New Horizons in Human Health and Nutrition-2017", 2nd – 3rd March, 2017 at School of Bioengineering & Food Technology, Shoolini University, Solan (HP).
- **Dr Kamal Gandhi,** Scientist received "**Best Paper Award"** for the article **entitled "Iodine value integrated with solvent fractionation technique as a tool for detecting palm olein and sheep body fat adulteration in ghee (clarified milk fat)"** published in the "Dairy Processing Area" in the Indian Journal of Dairy Science in the Conference on Climate change and dairying held during 16th – 18th February, 2017.
- **Dr. Ashish Kumar Singh,** Principal Scientist, Dairy Technology Division, was awarded with **"Best Paper Award"** for his article published in Indian Journal of Dairy Science, 2015 at 45th Dairy Industry Conference, Mumbai during 16th – 18th February, 2017.
- **Er. Chitranayak** bagged "**Best Paper Award"** at International Conference, ICCCN-2017 at NITTTR (National Institute of Technical Teachers' Training and Research), Chandigarh.
- **Dr. B. S. Chandel** and **Dr. Rishikanta Singh** received **"Best Paper Award"** for their paper entitled "Policy interventions for mainstreaming of small milk producers in contemporary production system - A value chain analysis of Indian dairy sector" published in the *Indian Journal of Dairy Science 68(*2015): 73-80; by the Indian Dairy Association under "Dairy Economics, Extension and Management Area".
- **Dr. Ajmer Singh** conferred **"Best Paper Award"** for his paper entitled "Demand and supply analysis of livestock products in Andaman and Nicobar islands" published in Indian Journal of Economics and Development 11 (2015): 801-814 by The Society of Economics and Development.
- **Ms. Anu Kumari**, **Dr. F. Magdaline Eljeeva Emerald, Dr. H.V. Dr. Vikram Simha** and **Dr. Heartwin A. Pushpadass** received "**Best Research Paper Award"** for the paper entitled 'Effects of baking conditions on colour, texture and crumb grain characteristics of Chhana Podo, International Journal of Dairy Technology, 68 (2): 270-280, by Warner School of Food & Dairy Technology, SHIATS on the occasion of Founder's Day on 27th October, 2016.
- **Dr. Sanchita Garai** received "**Best Presentation Award"** for the paper entitled " Group Dynamic Effectiveness and its determinants among the Women Self Help Group members of Nadia District of West Bengal,India " in international Conference on Women Studies & Social Sciences 2017 at Chandigarh during 9th – 11th March, 2017.
- **Dr. Kamal Gandhi,** Scientist received "**Best Oral Presentation Award"** on the topic "**Detection of sheep body fat and palm olein adulteration in Ghee using Gas Liquid Chromatography Technique"** in the Second National Conference on New Horizons in Human Health and Nutrition (With Special Emphasis on Himalayan and Indigenous Foods) held on 2nd – 3rd March, 2017 at Shoolini University, Solan (HP).
- **Dr. Priyanka Singh Rao,** Scientist **Dr. Rajesh Bajaj**, Principal Scientist, **Dr. Bimlesh Mann**, Head, **Dr. Sumit Arora**, Principal Scientist **Dr. Richa Singh,** Scientist received "**Best Oral Presentation Award"** on **"Chitosan for encapsulation of papain hydrolysed sodium caseinate"** in National Conference on Advances in Food Science and Technology on 24th -25th March, 2017 at Eternal University Baru Sahib (HP).
- **Dr. H. R. Meena** received **"Best Oral Presentation Award"** for the Paper presented entitled "Mobile Advisory services in dairy farming" in the 8th National Extension Education

Congress-2017 on "Nutrition-Sensitive Agriculture: Changing Role of Extension" Organized by Society of Extension Education, Agra at ICAR-NAARM, Hyderabad during 28th – 31st January, 2017.

- **Mr. Kausthub Kishore Saraf** received "**Young Scientist Best Presentation Award"** by Indian Society for Study of Animal Reproduction on 6th December 2016 at Tirupati.
- **Ms. Jagrani Minj** and **Dr. Shilpa Vij** were awarded "**Second Prize in Oral Presentation"** on "Comparative analysis of biofunctional properties of synbiotic fruit yoghurt having different berry fruits" in the proceeding of National Conference on "advances in food science and technology current trends and future perspectives (AFST-2017)" held at Department of Food Technology, Akal College of Agriculture Eternal University, Baru Sahib, Himachal Pradesh (India), 24th – 25th March, 2017.
- **Dr. S. Choudhary, Dr. A. Santra, Dr. N. Muwel** and **Dr. S. K. Das** received **"Second Best Paper (Oral Presentation) Award"** for the paper entitled '*Effect of Forest Tree Leaves Containing Plant Secondary Metabolites as Feed Additives on In vitro Rumen Methanogenesis, Protozoal Population and Microbial Biomass Production in Cattle'* at X Biennial Conference of Animal Nutrition Association (ANACON-2016) held at College of Veterinary Science, Sri Venkateswara Veterinary University, Tirupati on 9th – 11th November, 2016.
- **Mr. Naveen Kumar** got "**Second Prize in Young Scientist Presentation"** in Second National Conference on new horizons in Human health and Nutrition held from 2nd – 3rd March, 2017 at Shoolini University for the paper entitled, 'Hormetic bioactive peptide: an innovative nutraceutical approach to rejuvenate aged fibroblast cells' authored by Naveen Kumar, Savita Devi, Srinu Reddi, SB Mada, Radha Yadav, Rishika Vij, Suman Kapila and Rajeev Kapila.
- **Ms. Savita Devi** got **"Second Prize in Young Scientist Presentation"** in Second National Conference on new horizons in Human health and Nutrition held from 2nd – 3rd March, 2017 at Shoolini University for the paper entitled, 'Cytoprotective effect of novel buffalo casein derived bioactive peptide in oxidative stress' authored by Savita Devi, Naveen Kumar, Suman Kapila and Rajeev Kapila.
- **Ms. Jasmine Kaur** and **Dr. S. S. Thakur** received **"Best Poster Presentation Award"** for their poster paper entitled *"In vitro* fermentation pattern of concentrate mixtures of cows containing varying levels of novel feedstuff-Phalaris minor seeds", in the Convocation of the National Academy of Veterinary Sciences (NAVS) and National Symposium on" Sustainable Livestock Development for Food and Nutritional Security: Way Forward, held at Khalsa College of Veterinary and Animal Sciences, Amritsar on 22nd - 23rd October, 2016.
- **Mr. Bilal, A. Malla, Mr. Len, T.V., Mr. A. N. Sharma, Mr. Sachin Kumar** and **Dr. A. K. Tyagi** received **"Best Poster Presentation Award"** of ISSGPU, India.
- **Mr. Ravi Prajapati, Mr. P. S. Minz, Mr. Piyush Lanzewar, Mr. B. Kumar** and **I. K. Sawahney** received **"Best Poster Award"** in 10th Convention of IDEA and National Seminar on "Engineering For Innovative Dairy Products And Process Development" on topic of "Effect of vapour ejection system on performance parameter of scraped surface heat exchanger" 29th – 30th September, 2016 Organized by AAU Anand, Gujarat.
- **Mr. M. Makwana, Mr. C. Ram, Mr. N. Kumar** and **Mr. S. Singh** (2017) received **"Best Poster Award"** on research paper entitled "Characterization of biofilm forming microbes and their control" presented in National Seminar "Dynamism in Dairy Industry and consumer Demand" organized by SASNET and Alumni Association, SMC College of Dairy Technology, Anand Agricultural University, Anand (Gujarat) from 4th - 5th February 2017.
- **Mr. Arvind Kumawat, Mr. P. S. Minz, Mr. P. Subramani** and **Ms. Priyanka** received **"Best Poster Award"** for poster presentation on topic "Energy Conservation Opportunities in dairy industry" in 44th Dairy Industry Conference on "Make in India : Dairying 2030" organized by ICAR-National Dairy Research Institute, Karnal on 18th – 20th February, 2016.
- **Ms. Priyanka Saini, Mr.Arun Beniwal, Ms. Anusha Kokkiligadda** and **Dr. Shilpa Vij** received **"Best Poster Award (2nd position)"** on Utilization of paneer whey for ethanol production using lactose adapted *Kluyveromyces marxianus* strain. In National conference on Advances in Food Science and Technology (AFST-2017) held at Eternal University, Baru Sahib, and Himachal Pradesh. (24th – 25th March, 2017).
- **Mr. Atanu Das,** Ph.D. (Dairy Technology) III Yr (Major Advisor: Dr. A.K. Singh) received "**Second Prize in Poster Presentation"** in National Seminar on Improvement of Small Ruminant Production System for Livelihood Security organized by ICAR- CWSRI, Avikanagar during March 9-10, 2017.

- **Dr. Syama M. A., Dr. Apurva Sharma** and **Dr. Sumit Arora,** Principal Scientist received **"Second Best Poster Award"** for the poster entitled **Preparation, characterization and application of reassembled sodium caseinate-vitamin D nanocomplex"** in the second National Conference on "New Horizons in Human Health and Nutrition-2017", 2nd – 3rd March, 2017 at School of Bioengineering & Food Technology, Shoolini University, Solan (HP).
- **Mr. M. Mahajan, Mr. D. Nagoorvali, Mr. N. Rawat, Dr. M. S. Chauhan,** Principal Scientist **Dr. R. S. Manik,** Principal Scientist **Dr. S. K. Singla,** Principal Scientist **Dr. P. Palta,** Principal Scientist and **M. K. Singh,** Scientist were given **"Second Best Poster Award"** for their poster entitled 'Effect of thimerosal on methylation and apoptosis related gene expression in goat (*Capra hircus*) parthenogenetic blastocysts' in 'National Seminar on Improvement of Small Ruminant Production System for Livelihood Security' held at Avikanagar, Rajasthan from 9th – 10th March, 2017.
- **Mr. Ravi Prajapati** received **"Best Thesis Award"** for masters in dairy engineering in 10th Convention of IDEA and National Seminar on " Engineering For Innovative Dairy Products And Process Development" on topic "Studies on intensification of heat transfer employing mechanical vapour ejector system on scraped surface heat exchanger" 29th – 30th September, 2016 Organized by AAU Anand, Gujarat.
- **Mr. Gaurav Kumar Deshwal**, M.Tech. (Dairy Technology) II Yr (Major Advisor: Dr. P. Narender Raju) received "**First Best Project Award"** under Engineering & Technology category at North Zone Student Research Convention held at Chitkara University, Rajpura, Punjab held during 19th – 20th January, 2017.
- **Mr. Gaurav Kumar Deshwal**, M.Tech. (Dairy Technology) II Yr (Major Advisor: Dr. P. Narender Raju) received "**Third Best Project Award"** with a Cash Prize of ₹ 25,000/- under *Engineering & Technology* category at National Student Research Convention (ANVESHAN) held at Annamali University, Chidambaram, Tamil Nadu held during 27th – 29th March, 2017.
- **Ms. Tanya Tyagi,** M.Tech (Dairy Technology) II Yr (Major Advisor: Dr. A. K. Singh) received **"Second Prize"** in All India Inter-University Elocution Competition organized in January, 2017 by Shiksha Mandal Wardha, Maharashtra.
- **Er. Chitranayak** bagged **"First Prize"** for essay writing on the topic "Rajbhasha Banam Swachchh Bharat", Hindi Essay competition, ICAR-NDRI, (news was published in 8 hindi local news paper).
- **Ms. Bulbul G. Nagrale,** Ph.D. scholar of DES&M Division bagged **"Second Prize"** at National Student Research Convention under Social Sciences category, held at Sardar Patel University, Anand, Gujarat during 28th – 30th March, 2016.
- Cooling Module for milk & other fluids presented by Mr. Darshan has been selected as Top 10 innovation among Top 50 innovators in the DST-Lokheed Martin Indian Innovation Growth Programme (IIGP) **2016** (IIGP301292 http://www.indiainnovates.in).
- **Dr. Mohan Mondal** awarded with **"Dr. S. K. Sirohi Memorial Outstanding Young Researcher Award 2017".**
- **Mr. Sanket Borad,** Scientist, Dairy Technology Division was awarded "**Appreciation Certificate"** for Under-graduate teaching for the year 2015-2016.
- **Mr. Writdhama Prasad,** Scientist, Dairy Technology Division was awarded **"Appreciation Certificate"** for Under-graduate teaching for the year 2015-2016.
- **Ms. Pallavi** and **Ms. Neha Yadav**, students of final year B. Tech (Dairy Technology) won the Championship in the team event, while Ms. Pallavi secured first position in individual category during the 13th National Dairy Product Judging Contest organised by SMC College of Dairy Science, Anand Agricultural University (Gujarat) during 16th – 17th September, 2016.
- **Dr. B. S. Meena** received **"Certificate of Excellence Award (2016-17)"** as a member of scientific advisory board of International Journal of Livestock Research from Agricultural Research Communication Center, Karnal

- **Dr. S. Jeyakumar** received "**Certificate of Award for Breed Registration"** by Hon'ble Dr. Trilochan Mohapatra, Secretary DARE & DG, ICAR for registration of two indigenous breeds viz. Teressa Goat and Nicobari Pig of Andaman and Nicobar Islands during Award Ceremony held at Krishi Bhawan, New Delhi on 23rd August, 2016.
- **Dr. S. Jeyakumar** received **"Fellow of Andaman Science Association"** by the Andaman Science Association on the occasion of its Pearl Jubilee Celebration during ASA: ICCB- 2016 held on 8th – 10th December 2016 at ICAR-CIARI, Port Blair.

NDRI Students Excel in Thirteenth National Dairy Products Judging Contest and Ninth National Dairy and Food Quiz Contest

PUBLICATIONS

Research Papers

Aarif, O. and Aggarwal, A. (2015). Evaporative cooling in late-gestation Murrah buffaloes potentiates immunity around transition period and overcomes reproductive disorders. *Theriogen.*, 84 : 1197–1205.

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Singh, D., Onteru, S. K. and Meena S. (2016) Compendium of a Short Course on *Advances in Functional Genomics and Proteomics for Farm Animal Biology* sponsored by Department of Biotechnology, Ministry of Science and Technology, Government of India.

Singh, M. K., Palta, P. Manik, R. S. Singla, S. K. and Chauhan, M. S. (Eds) *Hands-on Training on In Vitro Fertilization Technology,* pp: 75.

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Sivaram M., Heartwin, A. and Magdalene, F. E. (2016) *Statistical Techniques in Dairy Research – A Practical Manual using SPSS and Design Expert.*

Srivastava, A. K. and Kumaresan, A. (2016*) Status Paper on Uterine Infection in Dairy Animals.* NDRI Publication No. 142/2016, pp: 28.

Srivastava, A. K., Onteru, Suneel and Singh, Dheer (2016) *Status Paper on Diadetes and Milk* (Ed.) Meena Malik, NDRI Publication No. 247/2016.

Thompkinson, D. K., Sabikhi, L. and Kumar, M. H. S. (2017) *Laboratory Manual – Market Milk*. (3rd Edition) March. NDRI Publication No. 24/2006. pp: 59.

NAAS Rating (2017) and ISI Thomson Reuters Impact Factor (2016) of Research Publications (Research Papers/ Review Articles)

Sr. No.	NAAS Rating	No. of paper Published	ISI Thomson Reuters Impact Factor	No. of paper Published
1.	>10.0	7	>4.0	10
2.	>9.0	29	>3.0	29
3.	>8.0	58	>2.0	54
4.	>7.0	122	>1.0	119
5.	>6.0	264	<1.0	130
6.	<6.0	155	-	-
7.	Others	50	Others	220
	Total	**469**		**469**

Publications/ scientist =3.13; No. of publications/100 scientists with >6.00 NAAS Rating= 176

TRAINING AND CAPACITY BUILDING

In accordance with 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 coordination and effectively 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.

Deputations Abroad

- **Dr. T. K. Datta,** Principal Scientist, Animal Biotechnology Centre was deputed to attend **"Livegene Program Strategic Review and Planning Meeting"** at ILRI, Nairobi, Kenya from 16th – 17th May, 2016.
- **Mr. Vaibhao Lule Patil** presented paper entitled **"Zinc Enrichment of** Lactobacillus pp. **and Assessment of its Bioavailability in Caco-2 Cell Culture Model: New Biological Approach with Improved Bioavailability"** at International Conference on "Beneficial Microbes: Microbes for the Benefit of Mankind" from 31st May - 2nd June 2016, Heldin Phuket, Thailand.
- **Dr. Bimlesh Mann,** Head, **Dr. Rajesh Kumar,** Principal Scientist and **Dr. Rajan Sharma,** Principal Scientist, Dairy Chemistry Division visited UQ, Australia during 26th September to 1st October, 2016 to facilitate the discussion about future research collaborations and also for the current research project entitled "Milk-Characterization of Nanostructure of Buffalo Milk", under Australian - Indian Council Collaborative Project between NDRI and University of Queensland, Australia
- **Dr. T. K. Datta,** Principal Scientist, Animal Biotechnology Centre visited Bangkok, Thailand from 8th - 9th November, 2016 to participate in the meeting on Genetic Improvement of Livestock in Asian Countries organized by **"Dairy Asia"** which works under the mentorship of FAO for visioning and building a sustainable dairy sector in Asia and the Pacific region.
- **Dr. A. K. Tyagi,** Head, Animal Nutrition Division visited University of Ghent, Ghent, Belgium from 13th - 20th November, 2016 to deliver lecture in the International Training Programme Dairy Nutrition.
- **Dr. A. Kumaresan,** Senior Scientist, ARGO underwent International training in the area of "Flow Cytometry **Based Semen Evaluation in Relation to Male Fertility"** from 15th September to 30th November, 2016 at Division of Reproduction, Department of Clinical Sciences, Swedish Agricultural University, Uppsala, Sweden. This training was a part of post award grant under Lal Bahadur Shastri Outstanding Young Scientist Award 2014 received by him in the year 2015.

Trainings/ Workshops (Category-wise)

Scientists

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Dr. Kamal Gandhi, Sci.	Professional Attachment Training on "Subcritical CO_2 Extraction of the Flavors from Different Types of Ghee, Supercritical CO_2 Extraction of Ginger (Zingiber officinale) and Turmeric (Curcuma Longa) followed by their Characterization and Application in Preservation of Ghee and Extraction of Rosemary Essential Oil by Water Distillation and Checking its Antioxidant Activity in Ghee".	1st May to 30th August, 2016	Indian Institute of Technology, Delhi

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Er. Ankit Deep, Sci.	Three Months Professional Attachment Training.	11th May to 10th August, 2016	ICAR-CIAE, Bhopal
Dr. Sangita Ganguly, Sci. Dr. Heena Sharma, Sci.	Three Months Professional Attachment Training.	16th May –15th August, 2016	Panjab University, Chandigarh
Mr. Manoj Kumar, Sci.	Three Months Professional Attachment Training.	23rd May -23rd August, 2016	DFRL, DRDO, Mysore
Dr. Dheer Singh, Head Dr. S. K. Onteru, SS Dr. Sunita Meena, Sci.	Short Course on "Advances in Functional Genomics and Proteomics for Farm Animal Biology".	1st - 21st July, 2016	Department of Biotechnology, Ministry of Science and Technology, Government of India
Dr. Ajmer Singh, PS	Short Course-cum-Training Programme on "Personality Development and Self-motivation for Enhanced Performance of Agriculture Scientists and Teachers".	11th – 21st July, 2016	NAARM, Hyderabad
Dr. Veena Mani, PS Dr. Neelam Kewalramani, PS	Training Programme on "Stress Management".	6th – 9th September, 2016	NAARM, Hyderabad
Dr. Asif Mohammad, Sci.	New Age Extension Strategy for Communication Proficiency and Managerial Skill for Extension Professionals: Concept, Approach, Methodology and Application.	7th -27th September, 2016	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia.
Dr. Dheer Singh, Head Dr. S. K. Onteru, SS	Training Program on "Handling and Care of Laboratory Animals".	19th – 24th September, 2016	Human Resource Management, ICAR
Dr. Kamal Gandhi, Sci.	Training Programme on "Developing Winning Research Proposals in Agricultural Research".	20th – 24th September, 2016	NAARM, Hyderabad
Dr. K. Ponnusamy, PS	Training Programme on "Financial Management & Scientific Organization".	3rd – 10th October 2016	IIPA, New Delhi
Er. Khushbu Kumari, Sci.	Professional Attachment Training.	28th November, 2016 to 10th March, 2017	ICAR-CIPHET, Ludhiana
Dr. K. Ponnusamy, PS	Fifth NICRA Annual Review Workshop.	9th - 10th December, 2016	NASC, New Delhi
Mr. Sanket Borad, Sci.	National Faculty Development Programme in Entrepreneurship.	19th – 30th December, 2016	EDII, Gandhinagar, Gujarat
Dr. Dheer Singh, Head Dr. T. K. Datta, PS	Management Development Programme (MDP) on "Leadership Development".	19th - 30th December, 2016	NAARM Hyderabad,
Dr. K. S. Kadian, Head Dr. B. S. Meena, PS Dr. H. R. Meena, Sci.	8thNational Extension Education Congress-2017.	28th - 31st January, 2017	NAARM, Hyderabad
Dr. P.N. Raju, Sci.	IP Protection and Technology Transfer in Indian Perspective.	30th - 31st January, 2017	NBAGR, Karnal
Dr. Anjali Aggarwal, PS	Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR.	16th - 18th February, 2017	NAARM, Hyderabad.

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Er. Amita Vairat, Sci.	Training Programme on "Science and Technology for Rural Societies".	20th - 24th February, 2017	Indian Institute of Public Administration, New Delhi
Dr. Neelam Upadhyay, Sci. Dr. Writdhama Prasad, Sci.	Training Programme on "Analysis of Experimental Data".	20th - 25th February, 2017	NAARM, Hyderabad
Dr. Nitin Tyagi, Sr. Sci. Dr Sachin Kumar, Sci.	Feed Formulation and Balanced Ration for Dairy Animals.	6th - 8th March, 2017	Motihari, Bihar
Mr. P.S. Minz. Sci.	Training programme on Scilab for Engineers Applications.	13th - 17th March, 2017	NITTTR, Chandigarh
Dr. K. Ponnusamy, PS	Policy Workshop on "Strategies in Adopting Technology Enhanced Learning in Agricultural Education".	14th - 15th March 2017	NAARM, Hyderabad
Dr. Surajit Mandal, Sr. Sci.	Training Programme Related to "CODER Network APP and the Software" of the Project entitled "Bioprospecting of Lactic Cultures from "Cold Desert Regions" to Develop Functional Fermented Milk Products with Potential Health Benefits" under "CODER Programme" by SEED Division, DST, New Delhi.	20th – 21st March, 2017.	SKUAST, Jammu

Administrative Staff

Mrs. Prem Kumari, Private Secretary	Training Programme on Enhancing Efficiency and Behavior Skills for Stenographers Grade III, PAs, PSs and PPSs.	28th July – 3rd August, 2016	NAARM, Hyderabad
Mrs. Nirmala Kumari, Private Secretary Mrs. S. Deb Roy, Private Secretary	Training Programme on Enhancing Efficiency and Behavior Skills for Stenographers Grade III, PAs, PSs and PPSs.	24th – 30th November, 2016	NAARM, Hyderabad
Mr. Avnish Kumar Private Secretary	Training Programme on Enhancing Efficiency and Behavior Skills for Stenographers Grade III, PAs, PSs and PPSs.	4th – 10th January - 2017	NAARM, Hyderabad

Technical Staff

Mr. Deepak Yadav, Technician	Training Programme on "Payroll and HR Modules of ICAR-ERP under MIS/FMS".	23rd - 24th May 2016	IASRI, New Delhi
Dr. Uttam Kumar, CTO	Winter School Training Programme on "Recent Innovation in Management of Organic Production System".	5th - 25th August 2016	IARI, New Delhi
Dr. J. K. Dabas, ACTO	Improving Productivity and Profitability in Dairy Sector by Effective Energy Management Practices.	7th - 9th September, 2016	Dr. Ambedkar Institute of Productivity, Chennai
Dr. J. K. Dabas, ACTO Mr. Sunil Kumar, ACTO Mr. Pawan Kumar, TO Mr. Parveen Kumar, TO Mr. Pardeep, STA	10th Convention of Indian Dairy Engineers Association and National Seminar on "Engineering for Innovative Dairy Products and Process Development".	29th - 30th September, 2016	AAU, Anand
Dr. Uttam Kumar, CTO Mr. Vijender Kumar Meena, ACTO	4th International Agronomy Congress Performance of Quality Protein Maize under Different Planting Date to Provide Fodder during Winter Lean period.	22nd - 26th November, 2016	New Delhi

Mr. B.P. Singh, ACTO Mr. Anil Kumar Dagar, ACTO Mr. Ravi Rawat, STO Mr. Rakesh Kumar Tank, STO Mr. Sunil Naryan, STO Mr. Gain Singh, STO	Competency Enhancement for Technical Officers at ICAR Hyderabad.	30th November to 9th December, 2016	NAARM, Hyderabad
Sh. Alokes Goswami, CTO	Competency Enhancement Programme for Technical Officers at ICAR.	1th - 7th December, 2016	ICAR
Sh. S. K. Choudhary, CTO Sh. Omprakash, CTO Smt. Maju Bala, TO	Short Term Course (60 Hours) on AutoCAD (Regular Session).	2nd - 13th January, 2017	MSME Tool Room – Ludhiana (GOI Society, under MSME) at its extension centre at Karnal
Mr. Pawan Kumar, TO Mr. Sourav Rana, TA	Handling & Maintenance of Lab and Field Equipment.	17th - 30th January 2017	ICAR- CIFE, Mumbai

Participation in Conferences/Seminars within India

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. A. K. Chakravarty, Head	Seminar on "Strategies for Improving Dairy Production in Tripura' at Agartala, Tripura.	30th – 31st May, 2016
Dr. Ganga Sahay Meena, Sci.	Animal Fair-cum-Farmers'-Scientist Interaction, Motihari, Bihar.	27th March – 1st April 2016
Dr. P. Barnwal, Sr. Sci. Dr.Neelam Upadhyay, Sci.	International Conference on "Recent Advances in Food Processing and Biotechnology" at BHU, Varanasi.	5th – 6th April, 2016
Dr. Ajmer Singh, PS	Seminar on "Market Imperfections, Farmers' Distress and Agraian Crisis in India" at PAU Ludhiana.	7th April, 2016
Dr. S. Jeyakumar, PS	International Conference on "Recent Trends in Biosciences, Organized by Alagappa University, Karaikudi, Tamil Nadu.	7th - 9th April, 2016
Dr. Sumit Arora, PS	Presented Paper on "Safety and Stability of Artificial Sweeteners in Dairy Products" on the occasion of World Health Day at RPIIT Technical and Medical Campus, Karnal.	8th April, 2016
Dr. A.K. Sharma, PS	Workshop on "Fuzzy Sets, Fuzzy Logic and its Applications in Big Data Analytics", Thapar University, Patiala.	12th – 15th April, 2016
Sh. S. S. Meena, AAO	Training Programme on Payroll and HR Modules of ICAR-ERP under MIS/FMS Project at ICAR-IASRI, New Delhi.	18th -19th April, 2016
Dr. Rajan Sharma, PS	Institute-Industry Meet at SRS of NDRI, Bengaluru. The Meet was organized to showcase NDRI technologies and the theme was 'Composite Dairy Foods'.	21st April, 2016.
Dr. A. K. Gupta, PS	XV Annual Review Meet of AICRP on Cattle at BAIF, Pune.	7th May, 2016
Dr. A. K. Chakravarty, Head Dr. A. Kumaresan, Sci.	Seminar on "Strategies for Improving Dairy Production in Tripura" at Agartala, Tripura.	30th – 31st May, 2016
Dr. Jancy Gupta, PS	National Seminar on "Newer Approaches in Cow Comfort Systems for Better Productivity" organized by IDA, Kerala State Chapter and Indian Veterinary Association at Hotel Pearl Regency, Thrissur..	25th June, 2016
Dr. M.C.A. Devi, PS Dr. S. Subash, PS	Brain Storming Session on "Scope of Indigenous Breeds of Cattle Towards Sustainable Production and Livelihood in the Current Climate Change Scenario" held at SRS of ICAR-NDRI, Bengaluru.	1st July, 2016

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. A. K. Chakravarty, Head	Workshop on "Network Project on Buffalo Improvement" at GADVASU, Ludhiana, Punjab.	4th – 5th July, 2016
Dr. Chand Ram, Sci.	Workshop on "Extremophiles - Agricultural Microorganisms for Agriculture & Allied Sector". at National Agriculture Science Exhibition Complex, New Delhi.	7th - 8th July, 2016
Dr. Ajmer Singh, PS	Training Programme on "Personality Development and Self Motivation for Enhanced Performance of Agriculture Scientists and Teachers at NAARM, Hyderabad.	11th - 21th July, 2016
Ms. Rashmi H M. Sci.	National Workshop on "Use of WHONET for Surveillance of AMR at New Delhi.	27th - 29th July, 2016
Dr. Latha Sabikhi, Head Dr. Vivek Sharma, PS	Conference on "Emerging Trends in Bovine and Non Bovine Dairy Sector" at Chandigarh.	29th July, 2016
Dr. Chand Ram, PS Mr. Diwas Pradhan, Sci.	"AMR Workshop for Veterinarian Microbiologists" at Microbiology Division, Postgraduate Institute of Medical Education and Research (PGIMER), Chandigarh.	5th - 6th August, 2016
Dr. D. K. Mandal, PS Dr. M. Karunakaran, PS Dr. A. Mohammad Saroj Rai, PS Dr. M. Mondal, Sr. Sci. Dr. C. Bhakat, Sci. Dr. Asif Mohammad, Sci.	International Conference on "Agriculture, Food Science, Natural Resource Management and Environmental Dynamics: The Technology, People and Sustainable Development" organized by BCKV, Mohanpur, West Bengal.	13th to 14th August, 2016
Dr. Sumit Arora, PS	International Conference on "Food and Beverage Analysis" at New Delhi.	21st August, 2016
Ms. F. Magdaline Eljeeva Emeald, PS Dr. Menon Rekha Ravindra, PS	International Conference on "Agricultural Sciences and Food Technologies for Sustainable Productivity and Nutritional Security" at GKVK Bengaluru.	25th -27th August, 2016
Dr. A. K. Gupta, PS	Meeting of Indigenous Breeds Project of AICRP on Cattle at ICAR-CIRC, Meerut.	2nd September, 2016
Dr. A. K. Sharma, PS	Outreach Programme for Future Readiness, Techno-Foresight session on "Food without Open Agriculture", CSIR-NISTADS, New Delhi.	15th September, 2016
Dr. I. K. Sawhney, Emeritus Sci. Dr. Menon Rekha Ravindra, PS Er. Chitranayak, Sr. Sci. Dr. P. Barnwal, Sr. Sci. Er. P.S. Minz, Sci. (SS) Er. Amita Vairat, Sci. Er. Ankit Deep, Sci. Dr. J. K. Dabas, ACTO Er. Sunil Kumar, ACTO Mr. Pawan Kumar, TO Sh. Parveen Kumar, TO Mr. Sourav Singh, TA	10th Convention of Indian Dairy Engineers Association & National Seminar on "Engineering for Innovative Dairy Products and Process Development" at SMC college of Dairy Science, Anand.	29th – 30th September, 2016
Dr. K. Ponnuswamy, PS	Training Programme on "Financial Management & Scientific Organization" at New Delhi.	3rd - 7th October, 2016
Dr. Sumit Arora, PS	National Summit on "Fortification of Food" at Vigyan Bhawan, New Delhi.	16th - 17th October, 2016
Dr. K. P. Ramesha, Head	National Conference-cum-workshop on "Making Indian Food Clean and Safe" at College of Food and Dairy Technology, Chennai.	17th - 18th October, 2016
Dr. S. Jeyakumar, PS	Seminar on "Advancement in Bovine Reproduction Biotechnologies to increase Breeding Efficiencies" organized by IMV at Bengaluru.	21st October, 2016

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. Sohan Vir Singh, PS Dr. A.K. Mohanty, PS	Brainstorming meeting on "Identification of Indicators of Resilience to Climate Change" at ICAR-CRIDA, Hyderabad.	26th October, 2016
Dr. Ganga Sahay Meena, Sci.	Wealth from Waste, KVK Sikohpur Guruguram, Haryana.	27th October, 2016
LPM	Brain Storming Session on "Talent Search and Retention in Scientific Technical and Administrative Cadres of ICAR at ICAR-CSSRI, Karnal.	3rd – 4th November, 2016
Dr. A. K. Tyagi, Head Dr. S.S. Kundu, PS Dr. Bandla Srinivas, PS Dr. Chander Dutt, Sr. Sci. Dr. Sachin Kumar, Sci.	X Biennial Conference of Animal Nutrition Association on "Newer Perspectives in Animal Nutrition Research for Augmenting Animal Production" at Tirupathi, Andhra Pradesh.	9th - 11th November 2016
Dr. A. K. Chakravarty, Head	National Conference on "Stakeholders Dairying" at New Delhi.	15th November, 2016
Dr. Gautum Mondal, Sr. Sci.	Training Programme for "Newly Recruited Sr. Scientists to Principal Scientist at NAARM, Hyderabad.	15th – 26th November, 2016
Dr. Rajan Sharma, PS Dr. Y. S. Rajput, Emeritius Sci.	85th Annual Meeting of Society of Biological Chemists (India) along with Symposium (Theme: Innovations in Biological Research on Health and Disease) held at CSIR-CFTRI Mysore.	21st - 24th November, 2016
Mr. Parveen Kumar, TO	Post Harvest Management of Agriculture Produce at PAU, Ludhiana.	21st - 28th November, 2016
Dr. Magan Singh, PS Dr. Rajesh Kumar Meena, Sci. Dr. Hardev Ram, Sci.	4th International Agronomy Congress on "Agronomy for Sustainable Management ..... Challenges" at Indian Society of Agronomy, New Delhi.	22nd - 26th November, 2016
Dr. Ashish Kumar Singh, PS	XVI Annual Conference of "Indian Society of Veterinary Pharmacology and Toxicology" and National Symposium on "Animal Health and Production: Challenges and Opportunities in Veterinary Pharmacology and Toxicology", College of Animal & Veterinary Sciences, Navsari, Gujarat.	23rd – 25th November, 2016
Dr. Naresh Kumar Goel, PS	ICAR-ILRI Collaborative Project Workshop at Guwahati.	27th November 2016
Mr. Uttam Kumar, CTO	Good Laboratory Practices for Technical Staff of ICAR at CIFE, Mumbai.	28th November - 3rd December, 2016
Dr. Menon Rekha Ravindra, PS	National Seminar "Milk Value Chain" on at St.Teresa's College, Ernakulam.	29th November 2016
Ms. Rashmi, H.H. Sci. Mr. Diwas Pradhan, Sci.	8th India Probiotic Symposium of "Gut Microbiota and Probiotic Science Foundation (India)" entitled "Probiotics In Health – Emerging Opportunities" at ITC Grand Chola, Chennai, India.	3rd - 4th December, 2016
Dr. S. S. Kundu, PS	National Symposium on "Agro Forestry for Environment Challenges, Sustainable Land Use, Biodiversity Conservation and Rural Livelihood Options" at ICAR-CARI, Jhani.	3rd - 5th December, 2016
Mr. Narender Singh, TO	Exploring Krishi Kosh Repository to Disseminate Agricultural Knowledge, CCS, HAU, Hissar.	6th – 7th December, 2016
Dr. Yogesh Khetra, Sci.	International Conference on "Nutraceuticals and Functional Foods: The Challenges and Opportunities". AAU, Anand, Gujarat.	6th – 8th December, 2016
Dr. T. K. Mohanty, PS Dr. A. Kumaresan, Sr. Sci. Dr. Mukesh Bhakat, Sci.	Animal Fertility and Fecundity at Crossroads: Addressing the Issues Through Conventional and Advanced Reproductive Technologies College of Veterinary Science, SVVU, Tirupati.	6th -8th December, 2016
Dr. T. K. Dutta, Head Dr. M. K. Ghosh, PS Dr. A. Mondal, PS Dr. M. Mondal, PS Dr. M. Karunakaran, PS	International Conference on "Climate Change Adaption and Biodiversity: Ecological Sustainability and Resource Management for Livelihood Security" organized at ICAR-CIARI, Port Blair.	8th -10th December, 2016
Dr. Sudarshan Kumar, Sr. Sci.	Workshop on "Targeted Proteomics and Big Data Analysis" at New Delhi.	9th - 13th December, 2016

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. A. K. Mohanty, PS	Indo-US Bitateral Workshop-cum-Symposium at NIPGR New Delhi.	12th - 13th December, 2016
Dr. Sudarshan Kumar, Sr. Sci.	2nd International Conference on "Functional and Interaction Proteomics: Application in Food and Health" at New Delhi.	14th - 17th December, 2016
Dr. S. Jeyakumar, PS	Workshop on "Control of Mastitis – A Way Forward", organized by NDDB and Alumni Association of SRS of ICAR-NDRI, Bengaluru.	15th December, 2016
Dr. S. Jeyakumar, PS	Seminar on "FLIR Thermal Imaging for Diagnostic Application".	16th December, 2016
Dr. T. K. Mohanty, PS	National Seminar on "Biotechnology Approaches in Management of Health & Reproductive Disorders in Livestock for Sustainable Productive and IV Annual Convention of SVSBT" at Anand.	16th – 17th December, 2016
Dr. Sohan Vir Singh, PS	XXV Annual Conference. of "Society of Animal. Physiologist of India & National Symposium" at College of Vet. Science & Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Mhow (MP).	21st - 23rd December, 2016
Dr. K. Ponnusamy, PS	National Conference at Sher-e-Kashmir University of Agricultural Science & Technology, Jammu.	21st - 23rd December, 2016
Dr. K. P. Ramesha, Head Dr. B.C. Ghosh, PS Dr. Surendranath, PS Dr. Balasubramayam, PS Dr. Bandla Srinivas, PS Dr. P. K. Dixit, PS Dr. K.Jayaraj Rao, PS Dr. M.C.A. Devi, PS Dr. Sivaram, PS Sr. S. Jeyskuma, PS Dr. S. Subash, PS Dr. Sathish Kumar, M.H. , PS Dr. Laxmana Naik, N., PS	National Consultation "Small Farmer Production Systems: Way Forward" organized by NABARD Chair Professor held at SRS of ICAR-NDRI, Bengaluru.	22nd - 23rd December, 2016
Dr. V. K. Gupta, Emeritus Sci.	International Conference on "Emerging Engineering at IIT, Kharagpur.	27th - 30th December, 2016
Dr. A. Santra, PS Dr. A. P. Ruhil, PS	104th Indian Science Congress at Tirupati, Andhra Pradesh.	3rd - 7th January, 2017
Dr. M.C.A. Devi, PS	Eighth GCRA International Conference on "Innovative Digital Applications for Sustainable Development" during at UAS, GKVK, Bengaluru.	5th - 7th January, 2017
Dr. I. K. Swhney, Emeritus Sci.	Permit dor meeting and discussion with the concerned teachers and collecting the relevant course materials at Raipur.	9th - 13th January, 2017
Dr. M.C.A. Devi, PS Dr. S. Subash, PS	"Regional Horticultural Fair 2017" at IIHR, Bengaluru.	15th - 17th January, 2017
Mr. Pawan Kumar, TO Mr. Saurav Singh, STA	Handling, Maintenance of Lab and Field Equipments for Technical Staff at CIFE, Mumbai.	17th – 30th January, 2017
Dr. Rajan Sharma, PS Dr. Chand Ram, PS	National Conference cum Workshop on "Making Indian Food Clean and Safe" at Tamil Nadu Veterinary and Animal Sciences University, Chennai.	20th – 21st January, 2017
Dr. Latha Sabikhi, Head	Round Table Group Discussion on "Composite Dairy Foods", SMC College of Dairy Science, Anand (Gujarat).	21st January, 2017
Dr. Dheer Singh, Head	International Conference on "Reproductive Health with Emphasis on Strategies for Infertility Assisted Reproduction and Family Planning" and to deliver the lecture entitled "Genomics and Proteomics in Reproductive Health" All India Institute of Medical Sciences (AIIMS), New Delhi.	23rd - 25th January, 2016
Dr. Mukund Kataktalware, PS	National Seminar on 'Quality- A tool for Value Addition of Dairy Foods' organized by Alumni Association, Southern Regional Station, ICAR-NDRI, Bengaluru at Bengaluru.	23rd - 24th January, 2016

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. M.C.A. Devi, PS Dr. S. Subash, PS	Two day International Conference on "Conservation Science and Sustainable Development" organized by ATREE (Ashoka Trust for Research in Ecology and the Environment) at IISC, Bengaluru.	24th - 25th January 2017
Mr. N.K. Dahiya, ACTO	2nd Workshop of Nodal Officers of ICAR Research Data Repositor for Knowledge Management, Initiative, IASRI, New Delhi.	24th - 25th January, 2017
Dr. Mukund Kataktalware, PS	International Conference on "INDIGENOUS" held at College of Veterinary Science, Rajendra Nagar, Hyderabad.	28th-31st January, 2016
Dr. K. S. Kadian, PS Dr. B. S. Meena, PS Dr. H. R. Meena, Sr. Sci.	8th National Extension Education Congress-2017 on "Nutrition-Sensitive Agriculture Changing Role of Extension Education" at NAARM, Hyderabad.	28th-31st January, 2016.
Dr. Sohan Vir Singh, PS	Consultancy Meeting for Developing the Basic and Strategic Research Framework for Bridging in the Gaps in Technologies and Knowledge Aiming to Enhance Livelihood and Profit for Farmers as well as Agro Ecosystems in Abiotically Challenged Areas at ICAR-NIASM, Baramati.	30th – 31st January, 2017
Dr. A. K. Sharma, PS	"Industry Academia Conclave: Technothan-I", University Institute of Engineering & Technology, Kurukshetra University, Kurukshetra.	2nd – 4th February, 2017
Dr. Anupam Chatterjee, PS Dr. Champak Bhakat, PS	International Conference on "Recent Trends on Agriculture, Veterinary & Life Sciences-2017" at Margao, Goa.	2nd – 4th February, 2017
Dr.(Mrs.) Bimlesh Mann, Joint Director (Res.)	National Seminar on "Dynamic in Dairy Industry and Consumer Demands and 12th Alumni Convention" at Anand, Gujarat.	4th – 5th February, 2017
Dr. K. P. Ramesha, Head	XIV Annual Convention and National Symposium on "Biodynamic Animal Farming For Management of Livestock Diversity" under the Changing Global Scenario College of Veterinary and Animal Sciences, Thrissur, Kerala.	8th – 10th February, 2017
Dr. Sachin Kumar, Sci.	XIV Annual Convention of Indian Society for Advancement of Canine Practice on Newer Approaches in Management of Canine Health and Rewarding Clinical Practices as well as Trade at Pantnagar, Uttrakhand.	9th – 11th February, 2017
Dr. D. Malakar, PS.	International Conference & Receive Prof. M.A. Akbarsha Aruldhas Gold Medal from Hyderabad.	9th – 11th February, 2017
Mr. Uttam Kumar, CTO Mr. Vijender Kumar Meena, ACTO	Advance in Variety Maintenance and Quality Seed Production or Entrepreneurship, at IARI, Regional Station, Karnal.	14th – 23rd February, 2017
Dr. Sumit Arora, PS Dr. A. K. Singh, PS Dr. Parveen Kumar, PS Dr. Meena Malik Professor (English) Dr. I. D. Gupta, PS Er. Chitranayak, Sr. Sci Dr. Kaushik Khamrui, Sr. Sci.	45th Dairy Industry Conference on "Climate Change and Dairying in Association with KoeInmesse YA Trade Fair Pvt. Ltd. Concurrent to their International Exhibition India International Dairy Expo focussing on Dairy Farming, Processing, Packaging, Distribution & Products, Bombay Exhibition Centre, Mumbai.	16th – 18th February, 2017
Dr. A. K. Mohanty, PS	20th Annual Convention of "Association for Promotion of DNA Fingerprinting" at KIIT University, Bhubaneswar.	16th – 18th February, 2017
Dr. M. K. Singh, Sci.	International Symposium on "Genome Editing Technology" at ADNAT, Hyderabad.	16th – 18th February, 2017
Dr. Sohan Vir Singh, PS	"XIII ASC 2017" at University of Agriculture Sciences, GKVK, Bengaluru.	21st - 22nd February, 2017
Dr. Sujeet K. Jha, PS Dr. K. Ponnusamy, PS	2nd National Conference on "Technological Interventions for Sustainable Livestock Production" at SKUAS&T, Jammu.	21st – 23rd February, 2017

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. K. P. Ramesha, PS Dr. P.K. Dixit, PS Dr. B.V. Balasubramanyam, PS Dr. B.C. Ghosh, PS Dr. K. Jayaraj Rao, PS Dr. M.C.A. Devi, PS Dr. Sivaram, PS Dr. Rekha Menon Ravindra, PS Dr. Sathish Kumar, M.H., PS Dr. Laxmana Naik, N,, PS Dr. P. Heartwin Amaladhas, PS Dr. S. Subash, PS	"XIII Agricultural Science Congress" held at University of Agricultural Sciences, Bengaluru, Karnataka.	21st - 24th February 2017
Dr. A. Kumaresan, Sr. Sci.	"Annual Review Meeting of NASF" at NAAS Complex, New Delhi.	23rd February, 2017
Dr. Sachinandan De, PS	To deliver a lecture on the seminar A2 milk detection process and milk certification related issues on "Availability, Necessity and Typing of A2 Milk" at Chhattisgarh.	23rd February, 2017
Dr. (Mrs) Smita Sirohi, Head Dr. A. K. Mohanty, PS Dr. S. S. Kundu, PS Dr. K. Ponnusamy, PS Dr. SohanVir Singh, PS	Brain Storming Session on "Future Climate Change Research in Agriculture" at NASC, New Delhi.	23rd February, 2017
Dr. Archana Verma, PS	Workshop on "Genes to Genomics: The Current Status" at BHU, Varanasi.	1st – 7th March, 2017
Dr Kamal Gandhi, Sci. Dr. P.N. Raju, Sci.	Second National Conference on "New Horizons in Human Health and Nutrition (With Special Emphasis on Himalayan and Indigenous Foods)" at Shoolini University, Solan (HP).	2nd – 3rd March, 2017
Dr. A. P. Ruhil, PS Dr. Ashok Santra, PS	"104th Indian Science Congress" at SV University, Tirupati.	3st – 7th March, 2017
Dr. A. P. Ruhil, PS	19th Annual National Conference on "Statistics and Informatics in Agricultural and Allied Sciences" at Sher-e-Kashmir University of Agricultural Sciences, Jammu.	6st – 8th March, 2017
Dr. A. K. Tyagi, Head Dr. S.S. Kundu, PS Dr. Sohan Vir Singh, PS Dr. Pawan Singh, PS Dr. D. Malakar, PS Dr. Nitin Tyagi, PS Dr. Goutam Mondal, Sr. Sci. Dr. Ashutosh, Sr. Sci. Dr. Heena Sharma, Sci. Dr. M. K. Singh, Sci.	National Seminar on "Improvement of Small Ruminant Production System for Livelihood Security" at ICAR-Central Sheep and Wool Research Institute (CSWRI), Avikanagar.	9th -10th March, 2017
Dr. A. K. Chauhan, PS Dr. Ajmer Singh, PS	29th National Conference of "Haryana Economics Association" at HAU, Hisar.	9th -10th March, 2017
Dr. (Mrs.) Sanchita Garai, Sci.	International Conference on "Women Studies and Social Sciences-2017" at International Multidisciplinary Research Foundation Vijayawada, Chandigarh.	9th – 11th March, 2017
Dr. Sachin Kumar, Sci.	Advance Short Course on "Clinical Nutrition Approaches for Gut Health of Animals" at IVRI, Izatnagar.	16th – 25th March, 2017

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. Latha Sabikhi, Head Dr. A.K. Sharma, PS	Workshop on "Co-operative Learning for Producing High Quality Dairy Professionals", College of Dairy Science and Technology, Guru Angad Dev Veterinary & Animal Sciences University, Ludhiana.	17th March, 2017
Mr. Uttam Kumar, CTO Mr. Vijender Kumar Meena, ACTO	Layout and Maintenance of Field Experiments and Recording Observation at IARI, New Delhi.	18th – 27th March, 2017
Er. Chitranayak, Sr. Sci. Er. P. S. Minz, Sci.	International Conference on "Communication, Computing and Networking (ICCCN 2017)" at National Institute of Technical Teachers Training & Research (NITTTR), Chandigarh.	23rd – 24th March, 2017
Dr. Sumit Arora, PS Dr. Priyanka Singh Rao, Sci.	National Conference on "Advances in Food Science and Technology" at Eternal University, Baru Sahib, Sirmour (HP).	24th – 25th March, 2017
Dr. I. K. Sawhney, Emeritus Sci.	National Conference on "Sustainable Mechanical Engineering: Today and Beyond" organized by Department of Mechanical Engineering, Tezpur. University and Department of Science & Technology, Govt. of India at Tezpur.	26th March, 2017
Dr. (Mrs) Archana Verma	International Conference on "Agriculture Biotechnology Science and Engineering" at Kanpur.	26th March, 2017
Dr. Narender Raju. P	Training –cum-Awareness Workshop at NBAGR, Karnal.	30th – 31st March, 2017

A compendium of lectures being released

MAJOR EVENTS

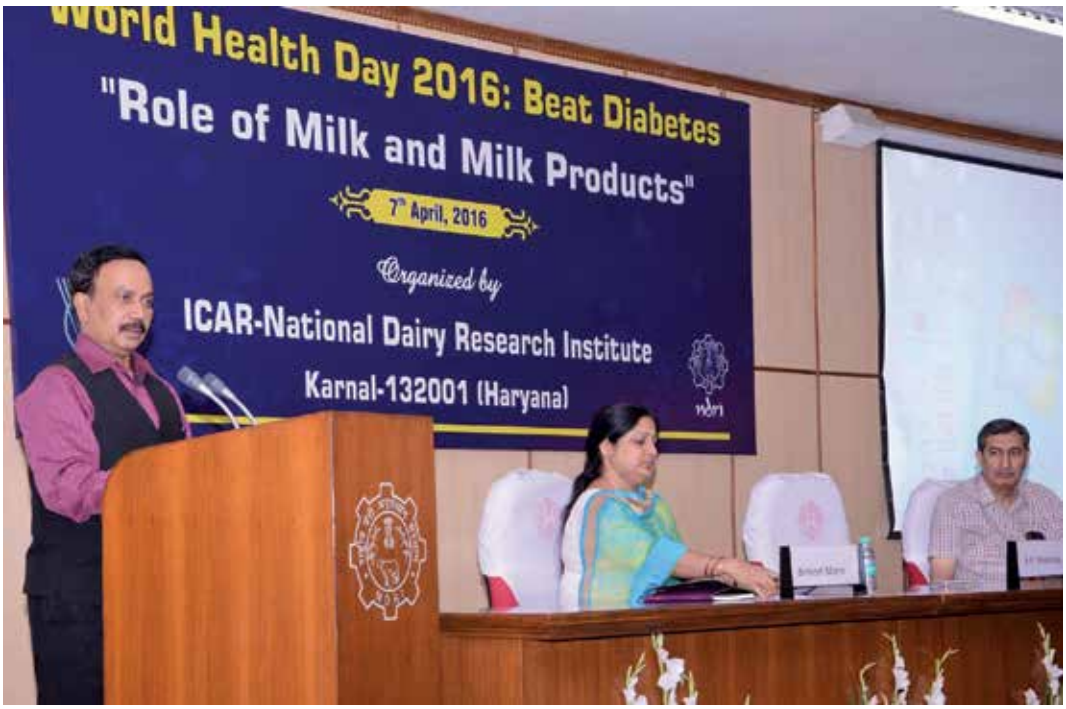
Training Programmes/Workshops/Seminars/ Symposia Organized

(April 2016 to March 2017)

Seminar on Nutritional Security through Dairying	6th April, 2016
Inter-University Youth Festival (Reverie - 2K16)	11th – 13th April, 2016
ICAR-Inter-Institutional Sports Tournament – 2016	16th - 19th April, 2016
Industry Meet (SRS-NDRI)	21st April, 2016
A Brain Storming Session on Physio – Nutritional Approaches for Enhancing Reproduction in Dairy Animals (ERS – NDRI)	9th May, 2016
An Awareness Programme on Pulse Production for Nutritional Security	24th June, 2016
Training Programme on Project Formulation on Climate Change Mitigation and Adaptation	27th June to 1st July 2016
Basic Training on Routine Chemical Analysis	18th – 23rd July, 2016
Training Programme on Advances in Reproductive Biotechnology	25th July, 2016
SAC Regional Training Programme on Advances in Reproductive Biotechnology sponsored by SAARC Agriculture Centre Dhaka, Bangladesh	25th – 30th July, 2016
Training-cum-workshop on Inter-Personal Skills & Stress Management	3rd August, 2016
All India Animal Husbandry Officers Workshop-cum-Training	22nd – 25th August, 2016
Training Programme on R & D Strategies and Interventions for Effective Agribusiness and Entrepreneurship Development in Dairy and Food Sector	16th September to 6th October, 2016
8th National Seminar on Indian Dairy & Food Sector: Way Forward to Meet Future Challenges	23rd - 24th September, 2016
Training Programme on Probiotics: The Therapeutics of 21st Century	8th – 28th November, 2016
An International Workshop on Milk: Naturally Nanostructured Food	30th November, 2016
Training Programme on Scientific Dairy Farming and Practices for Tribal Women (ERS – NDRI)	7th – 9th December, 2016
Workshop on Mastitis Control-Way Forward (SRS-NDRI)	15th December, 2016
Training on Milk and Milk Products Processing	15th -24th December, 2016
Training Programme on Scientific Dairy Farming for Tribal Unemployed Youths	20th – 22nd December, 2016
Patent Workshop	16th December, 2016
Institute Industry Meet	17th December, 2016
National Consultation on Small Farmer Production Systems: Way Forward (SRS-NDRI)	22nd – 23rd December, 2016
Training Programme on Commercial Dairy Production	9th - 14th January, 2017
Second Convocation of Farmers Farm School	13th January, 2017
North Zone Students Research Convention (ANVESHAN-2017)	20th – 21st January 2017
Krishi-cum-Dairy Mela and Technology Demonstration	28th January, 2017
Training Programme on Farm Business Management	31st January to 3rd February, 2017

Training Programme on Artificial Insemination and First Aid (ERS-NDRI)	31st January to 3rd March, 2017
Training Programme on Milk and Milk Products Processing	20th February to 1st March, 2017
Training Programme on Dairy Farm and Milk Processing Plant Management	22nd February to 3rd March, 2017
Training Programme on Commercial Milk Production	27th February to 4th March, 2017
15th Convocation of NDRI Deemed University	4th March, 2017
33rd National Training Programme on Skill Development for Sustainable Livestock Productivity in Genomic Era	6th – 26th March, 2017
National Training Programme on Technology Management and Business Planning for Entrepreneurship Development	13th - 18th March 2017
Training Programme on Ultra Pasteurized Milk	20th – 23rd March, 2017
Training Programme on Value Addition in Milk and Milk Products	27th – 31st March, 2017

Specific Day(s) Celebrated (April, 2016 – March, 2017)	
World Health Day	7th April, 2016
World Veterinary Week	23rd- 30th April, 2016
94th Foundation Day Celebrations (SRS - NDRI)	1st July 2016
International Youth Day	12th August, 2016
6th Blood Donation Camp	16th September, 2006
World Food Day (SRS - NDRI)	17th October, 2016
National Milk Day (SRS - NDRI)	26th October, 2016
Agricultural Education Day (SRS - NDRI)	3rd December, 2016
Veterinary Health Camp	24th January, 2017
Annual Sports Meet	2nd March, 2017



Special Lectures on the occasion of World Health Day at ICAR-NDRI, Karnal on 07.04.2016

DISTINGUISHED VISITORS

19.05.2016	Dr. Trilochan Mohapatra, Hon'ble Secretary (DARE) and Director General (ICAR), New Delhi laid Foundation Stone for the proposed 'Krishna Wing of Hostel' at the premises of the Students Hostel in the presence of Dr H. Rahman, Deputy Director General (Animal Sciences) ICAR, New Delhi .
06.06.2016	A high level 12 member delegation from Ethopia led by HE Dr. Mebrahtu Meles Gebru, State Minister, Ministry of Industry, Government of Ethiopia.
17.06.2016	A delegation of Nepal Agriculture Research Council, Nepal.
25.06.2016	Sh. Devendra Chaudhry, IAS and Secretary, Animal Husbandry, Dairying & Fisheries, Ministry of Agriculture & Farmers Welfare.
14.07.2016	Dr. Isabelle Baltenweck, Program Leader, Livestock Value Chain Programme and Dr. Johanna Lindhal, Scientist, Food Safety and Zoonoses from International Livestock Research Institute.
13.08.2016	Assistant Secretaries (IAS Officers of 2014 batch) accompanied by Director (Marketing), Department of Agriculture, Cooperation and Farmers Welfare, New Delhi.
09.09.2016	A High Level 9 Member delegation from Nepal.
27.09.2016	Hon'ble Union Minister of State for Agriculture and Farmers Welfare, Sh. Sudarshan Bhagat visited on 17.09.2017.

03.10.2016	Drs. Marie Hasket and Fritha Langford and Prof. Cathy Dwyer from University of Edinburgh, UK.
15.10.2016	Sh. Dushyant Chautala, Hon'ble Member of Parliament.
19.10.2016	Prof. Mike VanderHaar, MSU-MICHIGAN and Dr. Bobby Birangi, President & CEO, MBI with their team from USA.
03.11.2016	Dr. Trilochan Mohapatra, Secretary (DARE) & DG, ICAR, New Delhi.

Dr. Trilochan Mohapatra, Secretary DARE & DG ICAR visited NDRI Karnal on 3rd November, 2016

18.11.2016	Ms. Alina Gumpert, the Director of the German Agribusiness Alliance and Mr. Ulrich Lossie, Director Agriculture and Bioenergy, Federal Association of German Training Centres.
29-30.11.2016	Dr. Nidhi Bansal senior lecturer and Dr. Sangeeta Prakash Senior lecturer from University of Queensland, Australia.
11.01.2017	Twenty Five Member delegation of Washington AgForestory Class 38 led by Mathew Kloes, Programme Director, U.S.A.
18.1.2017	Newly recruited Faculty Members (22Nos.) of Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar.
16.03. 2017	Ten Student participants of Colorado FFA Class, USA accompanied by advisor Ryen Allen Hudson.
29.3.2017	Sh. Mohan Singh Ahluwalia, Hon'ble Member, Animal Welfare Board.

Dr. Nidhi Bansal from University of Queensland, Australia sharing her research experience at NDRI

PERSONNEL

INSTITUTE STAFF
(As on 31st March, 2017)

Director's Cell

R. R. B. Singh, PhD	Director
Nirmala Kumari, BA	Private Secretary

Research Prioritization, Monitoring and Evaluation Cell

Bimlesh Mann, PhD	Acting Joint Director (Research)
Meena Malik, M Phil, PhD	Professor (English)
Braj Kishor, MA, B Lib Sci	Assistant Chief Technical Officer
Sunil Sharma, MSc	Technical Officer
Ranjana, BA	Private Secretary

Academic Affairs Cell

R. R. B. Singh, PhD	Joint Director (Academics)
S. K. Tomar, PhD	Academic Coordinator
Sumit Arora, PhD	Controller of Examinations
Bhagwan Das, BA	Asstt. Admn. Officer
Parvesh Lata, BA	Private Secretary

Administrative Wing

Susanta Saha, MSc, MBA	Joint Director (Admn.) & Registrar
K. P.S. Gautam, M Com, B Ed	Chief Administrative Officer
R. C. Meena, M Com	Sr. Admn. Officer
Ashok Mallick, B Com	Sr. Admn. Officer
Ram Niwas, BA	Admn. Officer
Agnivesh, B Sc	Admn. Officer
Ritu Dalal, B Tech	Admn. Officer
Chiranjee Lal, M.Lib.	Asstt. Admn. Officer (DDO)
S. S. Meena, BA	Asstt. Admn. Officer (Purchase)
Rajbir, BA	Asstt. Admn. Officer (E-II)
Dharam Singh Meena, BA	Asstt. Admn. Officer (Stores)
Nirmal Kumar Jain, BA	Asstt. Admn. Officer (E- V)
Subhash Chand, BA	Asstt. Admn. Officer
Ajit Singh, BA	Asstt. Admn. Officer (E- IV)
Mukesh Dua	Asstt. Admn. Officer (C&B-III)
Anita Rani, BA	Private Secretary

Finance Section

D. D. Verma, M Com, PGDFM	Comptroller
Mithlesh Kumar, MSc, PGDFM	Sr. Fin. & Account Officer
Kunal Kalra, B Com, PGDM	Finance & Accounts Officer
Vishal Acharya, MA	Asstt. Fin. & Account Officer

Animal Genetics & Breeding Division

A. K. Chakravarty, PhD	Head
A. K. Gupta, PhD	Principal Scientist
Archana Verma, PhD	Principal Scientist
I. D. Gupta, PhD	Principal Scientist
Anupama Mukherjee, PhD	Principal Scientist
Om Vir Singh, PhD	Chief Technical Officer
Vinod Kumar, BSc	Sr. Technical Officer
Y. K. Panwar, MA	Sr. Technical Officer

Livestock Production & Management Section

Pawan Singh, PhD	Head
P. S. Oberoi, PhD	Principal Scientist
T. K. Mohanty, PhD	Principal Scientist
M. L. Kamboj, PhD	Principal Scientist
S. S. Lathwal, PhD	Principal Scientist
Ramesh Chandra, PhD	Sr. Scientist
Mukesh Bhakat, PhD	Sr. Scientist
Nishant Kumar, MSc	Scientist
Rubina Baithalu, MVSc	Scientist
Shiv Kumar, MSc	Assistant Chief Technical Officer
R. K. Tonk, PhD	Sr. Technical Officer

Animal Nutrition Division

A. K. Tyagi, PhD	Head
Neelam Kewalramani, PhD	Principal Scientist
S. S. Kundu, PhD	Principal Scientist
S. S. Thakur, PhD	Principal Scientist
Madhu Mohini, PhD	Principal Scientist
Veena Mani, PhD	Principal Scientist
Raman Malik, PhD	Principal Scientist
Chander Datt, PhD	Principal Scientist
Nitin Tyagi, PhD	Sr. Scientist
Goutam Mondal, PhD	Sr. Scientist
Sachin Kumar. PhD	Scientist
Gian Singh, MSc	Sr. Technical Officer
Sumit Narayan, MSc	Technical Officer

Animal Physiology Division

Mahendra Singh, PhD	Head
O. K. Hooda, PhD	Principal Scientist
Sujata Pandita, PhD	Principal Scientist
Parveen Kumar, PhD	Principal Scientist
Sohanvir Singh, PhD	Principal Scientist

A. K. Dang, PhD	Principal Scientist
Anjali Aggarwal, PhD	Principal Scientist
A. K. Roy, PhD	Sr. Scientist
Manju Ashutosh, PhD	Sr. Scientist
Ashutosh, PhD	Sr. Scientist
Y. P. Singh, BSc	Technical Officer

Animal Biotechnology Centre

Dr. P. Palta, PhD	Principal Scientist and In-Charge
Dr. R. S. Manik, PhD	Principal Scientist
Dr. S. K. Singla, PhD	Principal Scientist
Dr. T. K. Datta, PhD	Principal Scientist
Dr. S. De, PhD	Principal Scientist
Dr. J. K. Kaushik, PhD	Principal Scientist
Dr. A. K. Mohanty, PhD	Principal Scientist
Dr. D. Malakar, PhD	Principal Scientist
Dr. Rakesh Kumar, PhD	Senior Scientist
Dr. M. K. Singh, PhD	Scientist
Dr. S. Kumar, PhD	Scientist

Animal Biochemistry Division

Dheer Singh, PhD	Head
Dr. Y. S. Rajput, PhD	Emeritus Scientist
R. K. Sharma, PhD	Principal Scientist
Gautam Kaul, PhD	Principal Scientist
Rajeev Kapila, PhD	Principal Scientist
Suman Kapila PhD	Principal Scientist
S. K. Sood, PhD	Sr. Scientist
Sunil Kumar Onteru, PhD	Sr. Scientist
Ms. Suneeta Meena, MSc	Scientist
Sateesh E. M., PhD	Scientist
Vedamurthy G. V., PhD	Scientist
Ravi Kant, PhD	Asstt. Chief Technical Officer

Dairy Technology Division

Latha Sabikhi, PhD	Head
Vijay Kumar, PhD	Emeritus Scientist
S. K. Kanawjia, PhD	Emeritus Scientist
A. K. Singh, PhD	Principal Scientist
Kaushik Khamrui, PhD	Principal Scientist
Narender Raju Panjagari, PhD	Scientist
Ganga Sahay Meena, PhD	Scientist
Yogesh Khetra, PhD	Scientist
Prateek Sharma, PhD	Scientist
Shaik Abdul Hussain, PhD	Scientist
Gunvantsinh Rathod, M Tech	Scientist
Neelam Upadhayay, PhD	Scientist
Wridhama Prasad, M Tech	Scientist
Sanket G. Borad, M Tech	Scientist
Sangita Ganguly, PhD	Scientist
Heena Sharma, PhD	Scientist
Manoj Kumar, CT, MTech	Scientist
Prem Kumari, B.A.	Private Secretary

Experimental Dairy

Hari Ram Gupta, PhD	Chief Technical Officer (In-Charge)
Lehri Singh, MSc (Chemistry)	Chief Technical Officer
A. K. Kohli, Dip. (Mech. Engg.)	Asstt. Chief Technical Officer
Sanjeev Kumar, MA (Economics)	Asstt. Chief Technical Officer
Probir Mondal, IDD	Sr. Technical Officer
Prathvi Raj, Higher Secondary	Technical Officer
Prabha Sharma, Intermediate LT	Technical Officer
Gurpartap Singh, M Tech (Mech. Engg.)	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 Kumar, PhD	Principal Scientist
Richa Singh, PhD	Scientist
Priyanka Singh Rao, MSc	Scientist
K. P. Indumati, MSc	Scientist
Kamal Gandhi, PhD	Scientist
P. C. Singh, MSc	Asstt. Chief Technical Officer
Shakuntla Rani, BA	Private Secretary

Dairy Microbiology Division

Sunita Grover, PhD	Head
R.K. Malik, PhD	Emeritus Scientist
S. K. Tomar, PhD	Principal Scientist
Naresh Kumar, PhD	Principal Scientist
Shilpa Vij, PhD	Principal Scientist
Chand Ram, PhD	Principal Scientist
Surajit Mandal, PhD	Senior Scientist
Raghu H.V., MSc	Scientist (SS)
P. V. Behare, PhD	Scientist (SS)
Rashmi H. M., M Tech	Scientist
Diwas Pradhan, M Tech	Scientist

Dairy Engineering Division

A. K. Singh, PhD	Head
I. K. Sawhney, PhD	Emeritus Scientist
Chitranayak, PhD	Sr. Scientist
P. Barnwal, 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
Om Prakash, Dip. (Agri. Engg.)	Chief Technical Officer
S. K. Chaudhary, AMIE	Chief Technical Officer
J. K. Dabas, PhD	Asstt. Chief Technical Officer
Sunil Kumar, M Tech	Asstt. Chief Technical Officer
Pawan Kumar, Dip. (Machinist)	Technical Officer
Sh. Parveen Kumar, Dip. (Machinist)	Technical Officer
Ms. Manju Bala, Dip Arch	Technical Officer

Dairy Economics, Statistics & Management Division

Smita Sirohi, PhD	Head
B. S. Chandel, PhD	Principal Scientist
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
Udita Chaudhary, MSc	Scientist
Tara Chand, BSc	Asstt. Chief Technical Officer
Sunita Chaudhary	Private Secretary

Dairy Extension Division

K. S. Kadian, PhD	Head
Jancy Gupta, PhD	Principal Scientist
K. Ponnusamy, PhD	Principal Scientist
S. K. Jha, PhD	Principal Scientist
Gopal Sankhala, PhD	Principal Scientist
B. S. Meena, PhD	Principal Scientist
H. R. Meena, PhD	Sr. Scientist
Ritu Chakravarty, MSc	Scientist (SG)
Sanchit Maiti, PhD	Scientist
Sanchita Garai, PhD	Scientist
Parvinder Sharma, PhD	Chief Technical Officer

Forage Research & Management Centre

Magan Singh, PhD	Sr. Scientist & I/c FR&MC
Rakesh Kumar, PhD	Sr. Scientist
Hardev Ram, PhD	Scientist
Rajesh Kumar Meena, PhD	Scientist
Uttam Kumar, PhD	Chief Technical Officer
V. K. Meena, PhD	Sr. Technical Officer

Agricultural Technology Information Centre (ATIC)

P. S. Oberoi, PhD	Principal Scientist & Incharge
J. K. Pundir, BVSc	Assistant Chief Technical Officer
Kumar Bharat, MA	Assistant Chief Technical Officer
Jitendra Rana, PhD	Assistant Chief Technical Officer

Krishi Vigyan Kendra/Trainers' Training Centre

Dalip K. Gosain, PhD	Program Coordinator
Surender Gupta, PhD	Chief Technical Officer
Satya Pal, MVSc	Asstt. Chief Technical Officer
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, MSc (Horti.)	Chief Technical Officer
Anil Kumar Dagar, MSc	Assistant Chief Technical Officer

Ravi Rawat, MSc (Entomology)	Sr. Technical Officer
Sukhdev Singh	Technical Officer
Mahender Pal	Technical Officer
Sh. Ashok Kumar	Technical Officer

Livestock Research Centre

S. S. Lathwal PhD	Principal Scientist & Incharge
Ramesh Chandra, PhD	Sr. Scientist
Nishant Kumar, MVSc	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

S. Raju, MVSc	Chief Technical Officer
Sahdev Singh, MSc	Sr. Technical Officer

Artificial Breeding Research Centre

T. K. Mohanty, PhD	Principal Scientist & Incharge
A. K. Gupta, PhD	Principal Scientist
Mukesh Bhakat, PhD	Sr. Scientist
Subhash Chand, BVSc	Sr. Technical Officer

Library Services

S. S. Thakur, PhD	Head
B. P. Singh, MA, M Lib	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
Jai Pal, BA, PGDCA	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

K. P. S Gautam, M Com, BEd	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. M. Chayal, Dip.Civil Engg.	Chief Technical Officer, Incharge
R. K. Bansal, BE (Civil)	Asstt. Chief Technical Officer
S. K. Saini, B Tech (Mechnical)	Technical Officer
Tek Chand, ITI (Electrical)	Technical Officer
Sohan Lal, MA (Eco.) ITI (Electrical)	Technical Officer
Khem Chand, ITI (Electrical)	Technical Officer
Naresh Kanyana, ITI (Electrical)	Technical Officer
Balbir Singh, ITI (Electrical)	Technical Officer
Sarvan Kumar Munjal, ITI (Electrical)	Technical Officer
M. P. Sharma, ITI (Electrical)	Technical Officer
Arun Kumar, ITI (Electrical)	Technical Officer
Ishwar Singh Nagar	Technical Officer

Printing Press

G.S. Meena, PhD	Incharge
Krishan Kumar Poria	TO

Health Complex

Smita Sirohi, PhD	Incharge
Rekha Sharma, MBBS/DMCH	Chief Medical Officer
Manoj Kumar, MBBS	Chief Medical Officer
Shish Pal Gupta	Sr. Technical Officer
Richa Walia, Diploma Nursing	Technical Officer
Saroj Kathuria, Diploma Nursing	Technical Officer
K. S. Khanna	Technical Officer
Shashi Bhushan, D Pharma	Technical Officer
Sarroj Bala, D Pharma	Technical Officer

Hospitality Cell

Vinod Kumar	Technical Officer (Liaison Officer)
R. S. Dhull	Technical Officer

Sports Section

A. K. Singh, PhD	Incharge
G. S. Meena, PhD	Coordinator
Sandeep Deswal	Sports Instructor

Estate Section

Sushil Kumar Kamboj, MSc	Chief Technical Officer, Incharge
Prem Singh, MA	Asstt. Chief Technical Officer
P. M. Meena, MSc	Asstt. Chief Technical Officer

Southern Campus, Bengaluru

K. P. Ramesha, PhD	Head
B. Surendra Nath, PhD	Principal Scientist
Bikash Chandra Ghosh, PhD	Principal Scientist
B.V. Balasubramanyam, 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	Sr. Scientist

M. Sivaram, PhD	Sr. Scientist
S. Jeyakumar, PhD	Sr. Scientist
A.Kumaresan, PhD	Sr. Scientist
P. Heartwin Amala Dhas, PhD	Sr. Scientist
Menon Rekha Ravindra, PhD	Sr. Scientist
Mukund .A. Kataktalware, PhD	Sr. Scientist
F. Magdaline Eljeeva Emerald PhD	Sr. Scientist
S. Varalakshmi, PhD	Scientist
M. Manjunath, 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. Rajashekaraiah, BSc (Agri.)	Asstt. Chief Technical Officer
Veeraju, BE (Civil)	Asstt. Chief Technical Officer
K. L. Sampath, BSc	Asstt. Chief Technical Officer
P. G. Satish, BVSc	Asstt. Chief Technical Officer
T. R. Thivijakumari, MA	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. Geethakumari, MA	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
Sreekanta, Dip.	Technical Officer
Vimala, BSc	Technical Officer
K. Ramakrishna Prasad, MSc	Technical Officer
S. Shashi Kala	Asstt. Admn. Officer

Eastern Campus, 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. Mondal, PhD	Sr. Scientist
M. Karunakaran, 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	Asstt. Chief Technical Officer
Sukhdev Singh, BA	Asstt. Admn. Officer
Simita Roy, BA	Private Secretary

PERSONALIA

Appointments/Joining

» Dr. K. P. Ramesha, Principal Scientist was appointed to the post of Head, Southern Campus of NDRI, Bengaluru w.e.f. 12.4.2016.

» Dr. Brajendra Singh Meena, Sr. Scientist, Dairy Extension promoted to the post of Principal Scientist w.e.f. 19.11.2014.

» Sh. Kamal Gandhi joined his duties as Scientist (Dairy Chemistry) on 01.4.2016.

» Sh. Ankit Deep joined his duties as Scientist (Agricultrual Process Engineering) on 11.4.2016.

» Sh. Manoj Kumar C.T. joined his duties as Scientist (Dairy Technology) on 11.4.2016.

» Dr. (Ms) Sangita Ganguly joined her duites as Scientist, (Dairy Technology) on 11.4.2016.

» Dr. (Ms) Heena Sharma joined her duties as Scientist (Livestock Products Technology) on 11.4.2016.

» Sh. D. D. Verma joined his duties as Comptroller at ICAR-NDRI Karnal after his transfer from NAARM Hyderabad on13.6.2016.

» Dr. Mahendra Singh, Principal Scientist, Animal Physiology Division was appointed as Head, NDRI, Karnal w.e.f. 19.09.2016.

» Dr. Bimlesh Mann, Head, Dairy Chemistry Division given the additional charge of Acting Joint Director (Res.), NDRI, Karnal w.e.f 1.10.2016.

» Ms. Khushbu Kumari joined as Scientist at NDRI, Karnal w.e.f. 17.10.2016.

» Sh. Kunal Kalra joined as Finance & Accounts Officer at NDRI, Karnal w.e.f. 17.11.2016.

» Sh. Agnivesh joined as Administrative Officer at NDRI, Karnal w.e.f. 16.11.2016.

» Ms. Ritu Dalal joined as Administrative Officer at NDRI, Karnal w.e.f. 17.11.2016.

» Dr. R. R. B. Singh, Joint Director (Academic) took over the charge of Acting Director, NDRI, Karnal w.e.f. 30.01.2017.

» Dr. T. K. Datta, Principal Scientist entrusted with the responsibility of Acting Head, ERS of NDRI, Kalyani w.e.f. 01.02.2017 as a stop gap arrangement.

Promotions

» Dr. Mukund A. Kataktalware, Sr. Scientist, Southern Campus, Bengaluru promoted and given ₹ 9000 Grade Pay w.e.f. 26.02.2016.

» Dr. Sathish Kumar, M. H., Scientist, Southern Campus, Bengaluru promoted and given ₹ 7000 Grade Pay, w.e.f. 11.5.2015.

» Mr. H. C. Devaraju, Scientist, Southern Campus, Bengaluru promoted and given ₹ 7000 Grade Pay, w.e.f. 11.5.2015.

» Dr. K. P. S. Tomar, Chief Technical Officer, Livestock Research Centre awarded an advance increment w.e.f. 1.1.2016.

» Mr. R. K. Mittal, Chief Technical Officer, Vehicle Maintenance Section awarded an advance increment w.e.f. 1.7.2016.

» Mr. R. K. Bansal, Assistant Chief Technical Officer, Maintenance Section promoted to the post of Chief Technical Officer w.e.f. 1.7.2016.

» Mr. Prabir Shah, Assistant Chief Technical Officer, Eastern Campus, Kalyani promoted to the post of Chief Technical Officer w.e.f. 1.1.2016.

» Mr. Lehri Singh, Assistant Chief Tech. Officer, Experimental Dairy promoted to the post of Chief Technical Officer w.e.f. 10.12.2015.

» Mr. Sunil Kumar, Senior Technical Officer, Dairy Engineering promoted to the post of Assistant Chief Technical Officer w.e.f. 2.8.2015.

» Mr. B. P. Singh, Senior Technical Officer, Library promoted to the post of Assistant Chief Technical Officer w.e.f. 31.10.2015.

» Mr. Naresh Kumar Dahiya, Senior Technical Officer, Computer Centre promoted to the post of Assistant Chief Technical Officer w.e.f. 12.11.2015.

- Mr. Sanjiv Kumar, Senior Technical Officer, Experimental Dairy promoted to the post of Assistant Chief Technical Officer w.e.f. 19.1.2016.
- Mr. Shiv Kumar, Senior Technical Officer, Livestock Production & Management Section promoted to the post of Assistant Chief Technical Officer w.e.f. 27.1.2016.
- Mr. Anil Kumar Dagar, Senior Technical Officer, Farm Section promoted to the post of Assistant Chief Technical Officer w.e.f. 19.2.2016.
- Mr. Pooran Mal Meena, Senior Technical Officer, Estate Section promoted to the post of Assistant Chief Technical Officer w.e.f. 27.4.2016.
- Mr. Jitender Singh Rana, Senior Technical Officer, Livestock Research Centre promoted to the post of Assistant Chief Technical Officer w.e.f. 1.5.2016.
- Mr. Braj Kishor, Senior Technical Officer, PME Unit promoted to the post of Assistant Chief Technical Officer w.e.f. 4.5.2016.
- Mr. Parmod Kumar, Senior Technical Officer, ATIC promoted to the post of Assistant Chief Technical Officer w.e.f. 24.5.2016.
- Ms. Kanchan Choudhary, Senior Technical Officer, Official Language Unit promoted to the post of Assistant Chief Technical Officer w.e.f. 29.06.2016.
- Ms. T. R. Thivijaya Kumari, Senior Technical Officer, Southern Campus, Bengaluru promoted to the post of Assistant Chief Technical Officer w.e.f. 29.6.2016.
- Mr. M.S. Nagarajaiah, Technical Officer, Southern Campus, Bengaluru promoted to the post of Senior Technical Officer w.e.f. 20.5.2016.
- Mr. Narendra Singh, Senior Technical Assistant, Library promoted to the post of Technical Officer w.e.f. 19.9.2015.
- Sh. Ishwar Singh Nagar, Senior Technical Assistant, Maintenance Section promoted to the post of Technical Officer w.e.f. 31.8.2015.
- Mr. Rup Kumar Pal, Senior Technical Assistant, Vehicle Pool promoted to the post of Technical Officer w.e.f. 29.6.2016.
- Mr. Sudesh Kumar, Senior Technical Assistant, Vehicle Pool promoted to the post of Technical Officer w.e.f. 29.6.2016.
- Ms. Anuradha, Senior Technical Assistant, Human Health Complex promoted to the post of Technical Officer w.e.f. 29.6.2016.
- Mr. K. Ramakrishna Prasad, Senior Technical Assistant, Southern Campus, Bengaluru promoted to the post of Technical Officer w.e.f. 10.7.2016.
- Mr. Om Kumar, Assistant, promoted as Assistant Administrative Officer w.e.f. 02.01.2017.

Transfers/Retirements

- Dr. A. K. Srivastava, Director NDRI Karnal appointed as Member, ASRB, New Delhi and relieved from NDRI, Karnal on 30.01.2017.
- Sh. S. George, Comptroller, relieved from NDRI to join at ICAR-National Academy of Agricultural Research Management, Hyderabad on 13.6.2016.
- Dr. Khajan Singh, Principal Scientist and Head Dairy Extension retired from the Council's services w.e.f. 30.6.2016.
- Sh. R. K. Bansal, Admn. Officer retired from the Council's services w.e.f. 30.6.2016.
- Dr. R. K. Mehla, Principal Scientist, Livestock Production & Management retired from the Council's services w.e.f. 31.07.2016.
- Dr. Avtar Singh, Principal Scientist, Animal Genetic & Breeding retired from the Council's services w.e.f. 16.08.2016.
- Dr. R. K. Malik, Joint Director (Research) retired from the Council's services w.e.f. 30.09.2016.
- Dr. S. K. Kanawija, Principal Scientist, Dairy Technology Division retired from the Council's services w.e.f. 31.10.2016
- Mr. Karan Singh, Chief Technical Officer, Dairy Cattle Nutrition Division retired from the Council's services w.e.f. 31.12.2016.

- Mr. Ramkishan Singh Dhull, Technical Officer, Hospitality Section retired from the Council's services w.e.f. 31.12.2016.
- Mr. N. K. Verma, Assistant Administrative Officer, Purchase Section retired from the Council's services w.e.f. 31.12.2016.
- Sh. Ishwar Dayal, Assistant Administrative Officer promoted as Administrative Officer and relieved from NDRI, Karnal to join at CSSRI, Karnal w.e.f 15.10.2016.
- Dr. A. Kumarsean, Sr. Scientist transferred from NDRI Karnal to SRS of NDRI, Bengaluru and relieved on dated 17.01.2017.
- Dr. S. K. Tomar, Principal Scientist, Animal Nutrition Division retired from the Council's services w.e.f. 31.01.2017.
- Dr. R. K. Sharma, Principal Scientist, Animal Biochemistry Division retired from the Council's services w.e.f. 31.03.2017
- Mr. Vikrma, Technical Officer, Animal Genetics & Breeding retired from the Council's services w.e.f. 31.01.2017.
- Mr. Rup Kumar Pal, Technical Officer, Vehicle Pool retired from the Council's services w.e.f. 28.02.2017.
- Mr. Om Kumar, Assistant Administrative Officer retired from the Council's services w.e.f. 28.02.2017.

A visit of Sh. Devendra Chaudhry, IAS and Secretary, Animal Husbandry, Ministry of Agriculture & Farmers Welfare, Govt. of India at ICAR-NDRI.

MAIN CAMPUS, NDRI

RESEARCH DIVISIONS

Animal Genetics & Breeding

The Animal Genetics & Breeding (AGB) 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 development of genomic selection strategies for dairy cattle and buffaloes for improving performance traits, 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 its 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 academic activity for development of human resources 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 33 National Training Programs have been organized so far 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 Genomic Analysis Lab., Livestock Record Cell and Artificial Breeding Research Complex. 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 433 books and 308 M.Sc. /M.V.Sc./ Ph.D. theses.

Livestock Production & Management

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 alongwith the Dairy Cattle Breeding Division and post graduate and doctorate degrees were being awarded since the year 1976. Beside research, the faculty of LPM has been engaged in teaching both at UG and PG levels and in research in the frontline areas of all applied aspects of dairy animal production and has been successful in evolving many transferable technologies and development of package of practice on the routine care and management of dairy animals. The LPM faculty is also shouldering the responsibility of the routine management of the cattle yard and breeding bulls maintained at the Artificial Breeding Research Center of the Institute, besides supporting the training and extension activities of the Institute. The faculty is also responsible for HRD development in the area of Scientific Dairy Farming, Commercial Dairy Farming, Infertility Management of Dairy Animals and Frozen Semen Processing and Quality Control.

Animal Biotechnology Centre

Animal Biotechnology Centre 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 Animal Biotechnology Centre: 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, to train manpower in application of Biotechnology in Dairy Production and Dairy Processing and to organize Masters and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

The centre has state-of-the-art biotechnology research facility, which includes specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research, Structural Biology etc.

Animal Nutrition Division

Animal Nutrition (AN) Division undertakes basic and applied research, 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; nutritional biotechnology laboratory. Some of the sophisticated instruments available include GC-mass spectrophotometer, atomic absorption spectrophotometer, gas-liquid chromatography, HPLC system, ^{15}N- Analyzer, methane analysis equipment using SF_6 technique, spectrophotometer, PCR machine etc. For the past few years precision nutrition and nutrient gene interaction studies are being undertaken. Besides research, Animal Nutrition Division also offers the M.Sc./M.V.Sc. and Ph.D. in Animal Nutrition.

Forage Research Management Centre

Farm Management Section was created as a part of Animal Nutrition Division and thereafter, it was renamed as Forage Section in the year 2000. Forage Research Management Centre came into existence in 2010 with following objectives: i) To generate the human resource in Forage agronomy ii) To develop the agro-techniques for enhancing the fodder productivity and quality through efficient management of resources iii) To disseminate the knowledge about new agro-techniques for forage crop production and management to the dairy farmers and extension functionaries.

Forage Research Management Centre has started post graduate programme in M.Sc./ and Ph.D. in Agronomy (Forage Production) during 2010 and 2014, respectively. It has also been approved by Academic Council as Agronomy Section in 2017. The students are acquainted with the recent developments in agronomy and resource management covering major fields viz. crop husbandry, conservation and utilization of different fodder crops, agro forestry and agrostology, soil fertility management, water management, weed management, plant nutrition and sustainability, integrated nutrients management, cropping systems, dairy farming, farming systems, integrated farming systems and fodder seed production agronomy etc. Moreover, about 20 species of grasses/forage legumes germplasms are being maintained in the fields that are used for teaching, demonstrations and multiplication. The centre has initiated Azolla rearing and Moringa (Drumstick) cultivation for conducting of research on animal feeding and multiplication. The centre is also involved in carrying out external projects viz. ISRO project on "Fodder crop

assessment" from space application centre, Ahmadabad; All India Co-ordinate project (AICRP) on "Forage crop production" from IGFRi, Jhansi; "Silage making from different hybrid varieties maize and sugar graze"from UPL Advanta. The passed out M.Sc. Agronomy (Forage Production) students have been placed for job in NDDB, Banks and state department in various positions.

Animal Physiology Division

The objectives of the Animal Physiology Division are : to conduct basic and applied research in lactation, environment, growth and reproduction physiology; to impart advance training in various aspects of Animal Physiology; to undertake post graduate programmes of education in Animal Physiology at Master's and Doctoral levels and to develop and demonstrate technologies at field level.

The notable salient achievements of the Division are: Tharparkar cows have unique adaptative genetic and physiological alterations in skin pigmentation than the crossbred cows in different seasons; astaxanthin supplementation around parturition improved immunity through down regulating NFkB p65 mRNA gene expression in crossbred cows; thermal image analysis revealed marked differences in blood flow at different anatomical sites of the body indicating better thermal adaptability of Indigenous cows than the crossbred cattle; melatonin implant ameliorates adverse effects of thermal stress, potentiates immunity and abates apoptosis rate in heat stressed buffaloes; prilled fat supplementation during transition period improved lactation persistency and reproductive efficiency in cows and buffaloes; higher plasma cortisol and lower IGF-1 mRNA expression in periparturient crossbred cows in comparison to Sahiwal suggests extra management care for high yielding animals; receptor specific for uncarboxylated osteocalcin- GPRC6A on buffalo leydig cells up regulated testosterone production *in vitro* and peroxynitrite adversely impact fertility potential of crossbred bulls by it action on sperm attributes.

The Division has modern facilities of hormone assay by radioimmunoassay and enzyme immunoassay methods, tissue culture and molecular research facilities. Division has developed strong expertise in climate research by establishing modern state-of-the-art facilities at National Initiative on Climate Resilient Research Centre and a modern custom designed shelter system with heat stress amelioration facilities. Some of the unique facilities like psychrometric chamber, CO_2 environment chamber and animal calorimeter chamber are used to determine the climate change effects on physiological, biochemical and molecular parameters. The contribution of Division has been well recognized by the Best thesis research work award to PG students, involvement of faculty members as RAC members/ member of management committees of ICAR institutes, awards for publication in Hindi and publication of a text book on lactation physiology.

Animal Biochemistry Division

Research endeavors 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; body slimming effect of conjugated linoleic acid and its mechanism; characterization and sequencing of milk lysozyme and its use for detection of sub-clinical mastitis; 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; transduction pathways (PI3K and MAPK) in cattle granulosa cells during steroidogenesis and apoptosis.

The contributions of the Division have been amply recognized by three Ahmed Kidwai Memorial Awards, two Jawahar Lal Nehru Awards, Dr. P. G. Nair Award, AAAP/CAPI Outstanding Research Award, Bio-Nutra Senior Award, two Sukumar Basu Memorial Awards, Young Scientist Award, IUIS/FIMSA Travel Bursary Award, K. K. Iya Award, Best Division Award (2014-15), Fellowship of National Academy of Agricultural Sciences (NAAS) Award, NRDC Meritorious Innovation Award, Chellappa Memorial Oration Award and several paper presentation awards.

The Division has laboratories for functional foods and therapeutics; Prebiotics and probiotics; Bioactive peptides and immunology; Bioinformatics; Molecular Endocrinology, Reproductive Biochemistry and Nanoscience. The Division manages Small Animal House that caters to the need of students and scientists for laboratory animals viz. rat, and mouse etc.

Dairy Chemistry

The mandate of Dairy Chemistry (DC) 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 and micellar stability enabling manufacture of satisfactory products like cheese, condensed milk and rasogolla; humanization of buffalo milk and glyceride structure of buffalo milk fat; evaluating role of phospholipids in stability of dairy products; revealing chemistry of ghee and ghee residue flavour; antioxidant properties of ghee residue; chemical makeup and structural integrity of milk fat globule membrane; influence of various processing parameters on the major minerals and trace elements and their partitioning; rapid and simple methods for the determination of SNF in milk; formulation of quality standards of milk and milk products now prescribed by the Central Committee of Food Standards under the Ministry of Health as well as Bureau of Indian Standards; modification of Gerber test for simultaneous estimation of milk fat and availability of fat for detection of adulteration; simple tests for the detection of adulteration of milk and milk products; methods of manufacturing of butter and cheese colour from annatto seeds; preparation of rennet from fistulated calves and vegetable sources; structure and bacteriostatic role of lactoferrin; characterization and crystallization of buffalo lactoperoxidase; functional properties of WPC; renovation of rancid ghee and role of antioxidants in enhancing the shelf life of fat rich dairy products; effect of processing treatments on vitamins; status of pesticides and antibiotic residues in milk and milk products; methodologies for non-dairy whitener, low fat frozen dessert, calcium fortified milk, coconut filled Gouda cheese and low cholesterol ghee; a platform test for detection of detergent in milk; a colour based test to detect adulteration of milk with 2.5 to 10% soya milk; a multi-purpose device for dialysis; buffer exchange and concentration.

Different analytical methods developed for testing of milk & milk products: Strip based tests developed for the detection of added Urea, Neutralizers, Hydrogen peroxide, Glucose, Maltodextrin in milk; New color based method developed for rapid detection of detergents in milk; Method developed for Vegetable oil detection in ghee using RP-HPTLC; An analytical protocol developed for the estimation of vitamin D_2 in fortified toned milk and based on physico-chemical properties different methods assessed for detection of soybean oil and buffalo body fat in ghee. Antimicrobial peptides identified from skim milk by fermentation using selected proteolytic *lactobacillus* strains includingα_{S1}-CN (24-34), β-CN (197-209), β-CN (199-209), β-CN (193-207). Buffalo α_s-casein hydrolysates assessed for their antioxidant activity. Process for preparation of curcuminnano-emulsion optimized using milk proteins and assessed for antioxidant activity in animal model system.

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, Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ neutraceuticals and quality assurance).

The faculty of Dairy Chemistry Division is also contributing in the activity of National Referral Centre for Milk Quality & Safety which include testing of samples, training providing consultancy services etc. The facility houses sophisticated equipments like GS-MS, HPLC, FTIR, AAS, ELISA etc. and is being used by the faculty and students of other Divisions.

Dairy Technology Division

The Dairy Technology (DT) Division, one of the earliest Division of NDRI, Karnal, is involved in teaching, research, training and consultancy activities. Over the years, the Division has made significant contributions to the technological repertoire for the dairy industry. The educational programmes include flagship programme of B.Tech. (Dairy Technology) and Masters and Ph.D. (Dairy Technology). The research efforts of the Division are channeled through in-house projects including dissertations of Master's and Doctoral students, and sponsored projects. The research is geared to improved processing and packaging technologies for traditional, composite, western and dried dairy products. The Division has developed strong expertise in the area of membrane processing and biotechnological applications to improve the functionality of products. The ICAR has recognized the Division as Centre for Advanced Studies (CAS) in Dairy Technology since 1994 (now rechristened Centre for Advanced Faculty Training in Dairy Processing) to train teaching faculty of State Agricultural Universities and other institutions in recent developments in the subject. The Division has organized 33 training courses under the programme.

The Division has excellent infrastructure for teaching, research and extension. The Division has sophisticated analytical instruments including texture analyzers, colourflex, water activity meter, rheometer, rapidviscoanylugraph (RVA), viscometer for characterization of processed dairy products. Experimental Dairy has capacity to process approximately 10000 l per day and consists of pasteurizer, spray dryers, sweet making milk machines, process vat, ghee, manufacturing unit, ice-cream freezers, butter churner and membrane processing laboratory is equipped with pilot scale microfiltration, ultrafiltration, nano-filtration and reverse osmosis unit.

Dairy Microbiology Division

Dairy Microbiology (DM) Division is currently engaged in research, teaching, consultancy, training and technology transfer in specialized field of Dairy Microbiology. Broadly, the research work of the Division covers the areas related to starter cultures and fermented milk products; direct vat starters (DVS); indigenous probiotics, their functional efficacy and gut microbiota, prebiotics and synbiotics; functional fermented foods, bioactive peptides, microbial metabolites and biopreservatives; biosensors, quality assurance and food safety as well as rumen micro-organisms. Division has played a leading role in establishing National Collection of Dairy Cultures (NCDC) with current repository of more than 600 cultures and National Referral Centre for milk quality and safety. The Division has recently 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. Few more such products like carbonated lassi, vitamin B12 rich propioni-yoghurt, blueberry fortified probiotic dahi, real time test for detection of *E. coli* and antibiotic residues in milk have been developed. 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 in Dairy Microbiology. Recently, M. Tech and Ph.D. in 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 (DE) Division was established as one of the major research divisions from the inception of the Institute. It is contributing in teaching research, training and industrial consultancy. 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 breakthrough in developing a number of process equipment for manufacturing indigenous milk products. Many of these equipments 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 developed equipments. The Division has developed equipments for the manufacture of khoa, burfi, basundi, ghee etc on the 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 are development of weight based filling system for rabri and development of equipment for mechanized production of kheer and rabri. The Division also conducts specialized training to the graduate engineers during summer.

Dairy Economics Statistics & Management

The Division of Dairy Economics, Statistics & Management (DES&M) was created during the IV Five Year Plan. In the early stage, the focus of research in the Division was on conducting research in economics of milk production and processing, with thrust on cost-returns studies. During subsequent periods, the research programmes of the Division enveloped more intricate and broader aspects of dairy enterprise encompassing backward and forward linkage factors for facilitating technology evaluation and transfer. The Division, over the years, has developed good infrastructure in terms of scientific manpower, teaching and training aids, divisional library and computer unit. In response to the research demands of the clientele systems, the Division has been orienting its research priorities and conducting the research accordingly. From simple economic analysis of milk production, the division works on advanced aspects of value chain management, implication of economic reforms on dairy sector, climate change and economic impact assessment through the staff research projects and post-graduate research programmes of the scholars.

Dairy Extension

Dairy Extension (D. Ext.) 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, KisanSanghosthi 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.

Extension Education Programme "Dairy Education at Farmers' Door" is continued to strengthen the effective dissemination of dairy production and processing technologies among farming community. A Extension Approach "Farmers Farm School" in village Gorgarh has been started since August, 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 1240945.7 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 10.5 and 11.0 kg per head per day, respectively. The milking average of Sahiwal cows and Murrah buffaloes was 6.5 and 7.5 kg per animal per day, respectively. One Sahiwal cow (SW-2182) produced best milk yield of 26.5 kg in peak lactation. Best yield in Murrah buffalo (MU- 6625) was 17.5 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 28.5 kg (KF-7507) and 22.5 kg (KS-4402), respectively.

Bovine Strength of Cattle and Buffaloes as on 31-03-2017

Age group	Cattle						Buffaloes	Total Bovines
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	GIR	Total	Murrah	
Calves upto 6 months (Male)	24	12	03	43	10	92	32	124
Calves upto 6 months (Female)	25	08	01	33	08	75	30	105
Heifers	116	61	06	111	34	328	170	498
Cows	155	63	13	173	54	458	203	661
Male stock (young)	28	09	03	47	09	96	14	110
Bullocks/	-	01	-	-	-	01	-	01
Teaser Bulls	-	-	-	-	-	-	03	03
Total	**348**	**154**	**26**	**407**	**115**	**1050**	**452**	**1502**

Flock Strength of Goats as on 31-03-2017

Age Group	Alpine x Beetal	Sannen x Beetal	Total
Female			
Kids upto 6 months	32	14	46
6-12 months	07	-	07
Yearling	28	11	39
Goats	46	14	60
Male	26	07	33
Kids upto 6 months	-	-	-
Bucks	12	08	20
Total	**151**	**54**	**205**

Milk production at NDRI, Karnal during 2016-17

Total Milk production (kg)		:	1240945.7 kg
Average Number of Animals in Milk per day:	Cattle	:	285
	Buffaloes	:	107
	Goats	:	52

Sale of Livestock during 2016-17

Mode of Disposal	Cattle	Buffaloes	Goats	Total
Public Auction ₹	1328700.00 (245)	3398000.00 (145)	547600.00 (127)	5274300.00 (517)
On Book Value ₹	485644.00 (16)	571402.00 (25)	199200.00 (34)	1256246.00 (75)
Grand Total ₹	1814344.00 (261)	3969402.00	746800.00 (161)	6530546.00 (592)

» Auction of animals was conducted on 22nd & 23 rd July , 2016 and 17th & 18th March 2017

* Figure in parentheses indicates the total number of animals sold.

Performance of Dairy Animals during 2016-17

Particulars	Genetic Groups					
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Murrah
Average number of animals in milk per day	84	31	15	12	143	107
Average number of dry animals per day	90	39	22	05	51	128
Milking average (kg) per day	6.5	4.2	5.6	10.5	11	7.5
Overall average (kg) per day	3.1	1.9	2.3	7.4	8.1	34
Best yield (kg) in a day	26.5	12.5	16	22.5	28.5	17.5
Animal Number	SW-2182	TP-1315	G-31	KS-4402	KF-7507	MU-6625

Flock performance of Goats during 2016-17

Particulars	Genetic Groups	
	Alpine x Beetal	Sannen x Beetal
Average number of animals in milk per day	38	14
Average number of dry animals per day	17	07
Milking average (kg) per day	1.5	1.4
Overall average (kg) per day	1.0	09
Best yield (kg) in a day (Animal Number)	3.8 (AB-222)	3.7 (SB-257)

Month-wise Milking Average (kg.) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal 2016-17

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)/ anima/ 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
April-16	82	7.7	32	4.2	20	5.6	12	11.1	135	9.5	105	7.0	42	1.9	18	2.0
May-16	92	7.2	34	4.0	20	5.7	12	11.4	136	10.2	95	7.0	47	1.5	19	1.4
June-16	87	7.6	39	4.2	16	5.9	12	11.0	135	10.9	91	7.4	46	1.4	19	1.3
July-16	86	7.1	38	4.2	11	6.4	12	9.8	132	10.3	90	6.9	42	1.2	20	1.1
Aug.-16	85	6.5	36	4.5	13	5.8	13	9.6	133	10.3	79	7.3	37	1.1	17	1.0
Sept.-16	84	6.3	38	4.1	14	6.0	13	9.5	140	10.3	82	7.3	32	0.9	12	0.8
Oct.-16	84	6.1	36	4.3	16	5.5	12	9.9	142	10.2	95	8.1	22	0.9	08	0.9
Nov.-16	87	5.1	31	4.1	15	4.1	13	9.9	156	10.7	114	7.8	29	1.5	09	1.2
Dec.-16	84	5.4	23	4.2	13	4.3	13	10.0	158	11.5	133	7.7	39	1.8	11	1.3
Jan.-17	72	5.9	18	4.8	11	5.9	14	9.3	157	11.9	138	7.8	41	1.8	12	1.5
Feb.-17	79	6.5	18	5.2	12	6.3	13	9.5	153	13.1	134	7.5	45	1.7	14	1.6
Mar.-17	85	6.8	23	4.3	18	6.2	11	10.8	143	12.9	130	7.4	42	2.0	13	1.9
Average	**84**	**6.5**	**31**	**4.2**	**15**	**5.6**	**12**	**10.5**	**143**	**11.0**	**107**	**7.5**	**38**	**1.5**	**14**	**1.4**

Fodder and Concentrate during 2016-17

Months	Type of Fodder (Qntls.)				Concentrate
	Green	Dry/Hay	Silage	G. Total	(kgs.)
April-2016	10968.00	-	6519.50	17487.50	74000.000
May-2016	10127.00	503.25	3137.75	13768.00	114560.560
June-2016	11297.75	734.00	83.50	12115.25	122913.880
July-2016	16902.25	338.00	-	17240.25	137278.040
August-2016	16884.75	130.50	-	17015.25	118855.600
September-2016	15307.00	-	-	15307.00	105298.010
October-2016	13317.50	-	-	13317.50	96837.000
November-2016	12154.50	-	2756.00	14910.50	112347.000
December-2016	19035.50	325.00	2013.00	21373.50	125963.800
January-2017	18640.00	400.00	-	19040.00	119014.000
February-2017	18639.75	232.00	-	18871.75	111891.000
March-2017	17999.50	238.00	2272.50	20510.00	123346.000
Total	**1,81,273.50**	**2900.75**	**16782.25**	**2,00,956.50**	**1362304.890**

Total Milk Production and Milk Supplied to Experimental Dairy Plant during 2016-17

Month	Total Milk Production	Total Disposal Milk	Total Milk Send to Experimental Dairy	Total Milk Received by Experimental Dairy
April-2016	96096.6	12194.8	83317.3	82980.0
May-2016	101073.3	12682.8	87862.9	87979.0
June-2016	100121.8	12549.3	87273.6	87372.0
July-2016	95205.9	12604.0	82248.2	82025.0
August-2016	92456.2	11677.6	79841.4	80004.0
September-2016	91203.5	11566.4	78659.2	79097.0
October-2016	98139.1	14788.7	82727.5	83310.0
November-2016	102946.2	23518.5	78769.1	78576.0
December-2016	115210.1	28550.8	85837.9	85580.0
January-2017	117290.2	18874.7	97457.3	97499.0
February-2017	111346.1	13002.0	97304.4	97300.0
March-2017	119856.7	13182.2	106311.4	105905.0
Total	**12,40,945.7**	**1,85,191.8**	**10,47,610.2**	**10,47,627.0**

Fat and SNF Percentage of Cattle and Buffaloes during 2016-2017

First Lactation						
Particulars	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No of observations	387	169	17	56	655	274
Average fat %	4.35	4.22	4.32	4.02	4.02	7.86
No. of observations	387	169	17	56	655	274
Average SNF%	8.71	8.70	8.71	8.65	8.65	9.51
All Lactations						
Particulars	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of observations	1011	332	173	147	1637	1301
Average fat %	4.40	4.22	4.27	3.98	4.03	8.00
No. of observations	1011	332	173	147	1637	1301
Average SNF%	8.72	8.70	8.72	8.65	8.66	9.55

Month-wise Milking Average (kg) as Fat Corrected Milk of Cows and Buffaloes Maintained at NDRI, Karnal 2016-2017

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
April-2016	82	8.13	32	4.42	20	5.35	12	11.95	135	9.75	105	8.42
May-2016	92	7.45	34	4.05	20	5.82	12	11.53	136	10.43	95	8.64
June-2016	87	7.49	39	4.10	16	5.44	12	10.87	135	11.19	91	9.56
July-2016	86	7.92	38	4.35	11	6.42	12	10.08	132	10.56	90	8.78
Aug.-2016	85	7.05	36	4.76	13	5.98	13	9.99	133	10.69	79	8.66
Sept.-2016	84	6.54	38	4.37	14	6.20	13	8.93	140	10.03	82	9.30
Oct.-2016	84	6.48	36	4.63	16	5.50	12	10.06	142	10.14	95	9.90
Nov.-2016	87	5.49	31	4.26	15	4.28	13	9.65	156	10.67	114	9.06
Dec.-2016	84	6.26	23	4.91	13	4.93	13	10.30	158	12.20	133	10.20
Jan.-2017	72	6.83	18	5.21	11	6.39	14	9.61	157	12.52	138	10.24
Feb.-2017	79	6.39	18	5.06	12	6.05	13	8.86	153	12.18	134	8.57
Mar.-2017	85	7.74	23	4.66	18	6.58	11	11.26	143	12.90	130	9.82
Average	**84**	**7.02**	**31**	**4.52**	**15**	**5.76**	**12**	**10.22**	**143**	**11.15**	**107**	**9.29**

Production and Reproduction Performance of Cattle and Buffalo 2016-2017

	Sahiwal	Tharparkar	Karan Fries	Murrah
First Lactation				
Age at first calving (months)	38.50 (40)	38.50 (12)	36.90 (31)	43.21 (29)
Total milk yield (kg)	2001 (22)	1150 (10)	3643 (24)	2770 (22)
305 or less days milk yield (kg)	1850 (22)	1098 (10)	3147 (24)	2503 (22)
Lactation length (days)	312 (22)	285 (10)	368 (24)	360 (22)
Service period (days)	145 (10)	123 (6)	123 (16)	138 (19)
Dry period (days)	91 (9)	148 (6)	60 (16)	116 (5)
Calving interval (days)	402 (9)	412 (6)	400 (16)	448 (5)
All Lactations				
Total milk yield (kg)	2384 (68)	1386 (26)	3996 (56)	2717 (87)
305 or less days milk yield (kg)	2212 (68)	1305 (26)	3405 (56)	2536 (87)
Lactation length (days)	312 (68)	286 (26)	363 (56)	336 (87)
Service period (days)	140 (34)	131 (16)	146 (39)	132 (55)
Dry period (days)	107 (34)	133 (16)	73 (39)	111 (27)
Calving interval (days)	427 (34)	420 (16)	423 (39)	428 (27)
Average number of lactations	2.54 (68)	3.31 (26)	2.29 (56)	2.81 (87)
Best Lactation 305-days Milk Yield				
Milk yield (kg) Animal Number	4395 2051	2112 1304	5582 7412	3923 7054
Lactation no.	2	2	3	2

*Figures in parentheses indicate the number of animals.

Artificial Breeding Research Center

The Artificial Breeding Research Centre (ABRC) has 150 breeding bulls (Sahiwal-38, Tharparkar-9, Karan Fries-29, Karan Swiss-02, Murrah-56, Gir-16), it is engaged in progeny testing programme for Sahiwal and Murrah bulls. This center is engaged 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, estrous synchronization.

Research, Extension & Education Achievements

Four Murrah breeding bulls were selected under Network Project on Buffalo Improvement for the 17th set of progeny testing programme and 10 Sahiwal bulls were selected under AICRP on 'Genetic improvement of Sahiwal cattle'.

Cryopreservation of semen of breeding bulls: During 2016-17, frozen semen of eight Murrah bulls under 'Network project on Buffalo improvement', seventeen Sahiwal bulls under AICRP on 'Genetic improvement of Sahiwal cattle' and sixteen Karan Fries crossbred bulls under Progeny Testing of KF bulls were preserved for distribution to different participatory center.

The center also preserved the semen of six elite Tharparkar bulls maintained for multiplication of Tharparkar germplasm. Bull semen under progeny testing programme are supplied to different centre in the country for test mating, collection of data on conception rate and progeny testing parameters etc.

Breeding bulls at ABRC during 2016-17

Murrah Bulls		Sahiwal Bulls		Karan Fries Bulls	
16th Set	17th set	2nd Set	3rd Set	14th Set	15th Set
6379	6822	2004	2095	7564	7668
6409	6994	2019	2144	7616	7693
6646	7010	2030	2179	7629	7819
6753	7016	2037	2212	7643	7822
	-	2056	2233	7650	7825
-	-	2073	2262	7684	7831
-	-	2138	2270	7708	7834
-	-	-	2286	7709	7860
-	-	-	2289	-	-
-	-	-	2181	-	-
4	4	7	10	8	8

Reproduction Management

The center performed 1180 artificial insemination in the Institute Livestock Research Center and monitored the reproductive efficiency of NDRI herds.

A.I. and PD of Breeding bulls at NDRI herd during 2016 (Jan. to Dec.)

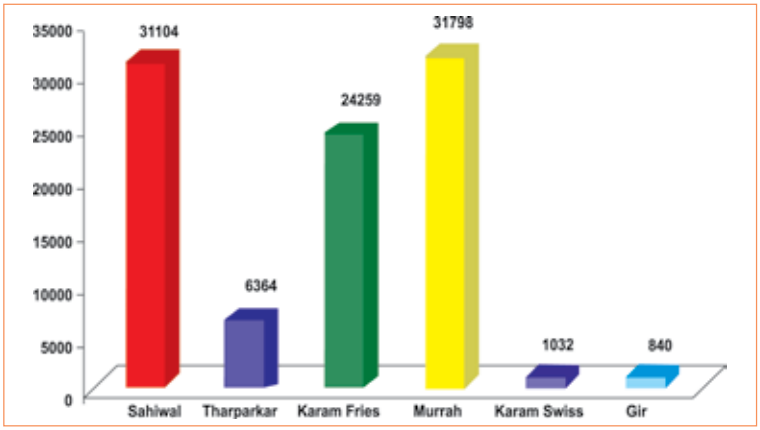
Month	Sahiwal		Karan Fries		Karan Swiss		Tharparkar		Murrah	
	AI	PD	AI	PD	AI	PD	AI	PD	AI	PD
Jan	17	6	27	11	5	2	6	3	35	12
Feb	34	19	31	16	1	-	3	1	27	14
Mar	24	10	35	17	4	2	7	4	27	10
Apr	36	24	48	21	2	2	11	3	30	12
May	49	16	33	12	2	1	21	12	14	2
June	35	16	21	3	2	1	12	5	21	8
July	20	10	19	6	1	-	8	2	5	1
Aug	22	6	23	7	1	-	9	5	18	4
Sept	24	16	35	10	2	-	8	6	29	15
Oct	24	8	42	12	-	-	10	5	43	21
Nov	21	9	24	11	2	1	11	5	28	10
Dec	14	4	25	10	1	1	9	4	32	14
Total A.I.	320	144	363	136	23	10	115	55	309	123

Reproductive Status of NDRI Herd during 2016 (Jan. to Dec.)

Particulars	Breeds					
	SW	TP	KS	GIR	KF	MU
Cow / Buffalo						
Nos. of observation	75	34	2	14	69	52
Service period (days)	135.62	119.5	214.5	88.64	149.30	142.0
No. of service/conception	1.42	1.35	2.5	1.42	1.59	1.48
Heifer						
Nos. of observation	40	15	2	8	32	39
Av. age at maturity (Month)	32.22	34.66	27.00	40.62	26.50	34.35
Av. age at conception (Month)	34.12	35.46	27.00	41.62	27.00	35.00
No. of service/conception	1.47	1.26	1.0	1.37	1.18	1.23
Conception rate (%)						
Conception rate Ist service.	52.14	52.17	57.14	54.83	42.94	56.29
Conception rate 3rd service	82.82	76.81	85.71	77.41	69.93	77.77
Over all conception rate	45.00	47.82	43.47	52.00	37.46	39.80

Production of Superior Germplasm

The center is involved in production and conservation of superior male germplasm of cattle and buffaloes. During 2016-17 a total of 95,397 doses of frozen semen were produced.



Breed wise production of superior germplasm (April, 16 - March, 17)

Dissemination of Superior Germplasm

The center is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes (Table 4). During the year ABRC disseminated 79,279 ml doses liquid semen of Sahiwal, KF and Murrah bulls to local farmers and also disseminated / supplied 77,890 doses frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers and various Dairy development organizations / Institutes / Gaushalas of 13 states viz., Haryana, Punjab, Uttarakhand, Delhi, U.P, Rajasthan, Bihar, Himachal Pradesh, Madhya Pradesh, J&K, Maharashtra, Assam, Odisha.

Month-wise Dissemination of Semen Doses (2016 – 2017)

Month	Liquid semen doses (ml) to Farmers	Frozen semen doses to Farmers / Institutes / Dairy Development Agencies
April-2016	5790	4050
May-2016	6554	3222
June-2016	6210	4585
July-2016	6560	5650
August-2016	7870	11859
September-2016	9360	6618
October-2016	6925	13590
November-2016	6380	4040
December-2016	6100	6532
January-2017	5755	7800
February-2017	4920	6911
March-2017	6855	3033
Total	**79279**	**78890**

Trainings Organized

» ABRC conducted exposure visit cum training programme on "Commercial Dairy Farming" under SINED-TBI during this period.

» ABRC gave exposure visit to farmers and trainees of KVK and students of In Farm Training.

» ABRC conducted training programmes under NDP-1 to the semen station officials and technical staff for 15 participants of different parts of the country. Details of the Training Programmes are:

- Breeding soundness examination and andrological examination of bull" for VO and QCO of semen station: 4-16 July, 2016
- Breeding soundness examination and andrological examination of bull" for VO and QCO of semen station: 8-20 August, 2016.

Forage Production Section

Allocation of the Farm Land to Different Units

Sr. No.	Unit	Area (Acres)	Area (hectare)
1	Forage Production Section &RFS (Seed)	805.69	326.19
2	Farm Building, Road Drains, Channel & Silo Pit.	106.21	42.78
3	Area under Eucaleptus trees (Farm)	5.01	2.23
	Land under Forage Production Section	**916.91**	**371.20**
	Land under Campus, Buildings and other Institute Activities		
1	Narmda Hostel, Kalki Bhawan, Plantation area and Dairy Mela Ground	42.75	17.31
2	Institute campus and Building	324.53	131.39
3	Dairy Demonstration & other schemes , KVK	33.39	13.52
4	Animal Breeding Complex, Block-5	10.00	4.05
5	Model Dairy Plant	20.50	8.30
		431.17	174.57
	Grand Total	**1348.08**	**545.77**
	Land with NDRI, Karnal as on May, 2016		
	Land handed over to other agencies		
1	Indian Railway	0.49	0.20
2	33KVA H.S.E.B., Karnal (Station)	0.49	0.20
3	N.B.A.G.R (ICAR)	74.99	30.36
4	DWR	47.97	19.42
	Total	**123.94**	**50.18**
	Overall Land	**1472.02**	**595.95**

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 requirements of fodder, some area is utilized for production of fodder seed and other grain crops to meet out the requirements for transfer of technology programmes of Institute and partial fulfillment of the grain component of feed.

Fodder/Seed/Feed Production and Supply

A total number of 2,04,873.50 quintal good quality green fodder was produced from high yielding varieties of fodder crops of Maize, Sorghum, Sorghum x Sudan hybrids, Bajra, Sugargraze and Cowpea during Kharif season and Berseem, Oats Chinese Cabbage and winter Maize in Rabi season. Similarly, seed/grain crops of Oats, and Chinese Cabbage were also grown. During the period under report a total of 2,00,649.25 q of fodder including 1,81,273.00 q. green fodder 16782.25 q. Silage and 2594.00 q. dry fodder was supplied to cattle yard. Total production of seed/grains of Oats and Chinese cabbage was 2287.05 q. and 206.90 q., respectively.

Production and Productivity of Forage Crops (Green Fodder) during 2016-17

S. No.	Crop	Area(ha)	Average Yield (q/ha)	Production (q)
1.	Berseem+Mustard	62.38	1080.21	67383.50
2.	Oats+ Maize	38.76	384.02	14885.00
3.	Oats	1.62	351.85	570.00
4.	Napier Grass (Perrinal)	1.01	1464.85	1479.50
5	Maize	121.51	239.76	29133.75
6.	Maize + Cowpea	28.60	279.45	7992.50
8.	Jowar (Multicut)	33.78	336.08	11353.00
9.	Jowar (Single cut)	38.09	193.90	7386.00
10.	Cowpea	9.71	225.23	2187.00
11.	Bajra	23.05	543.81	12535.00
12.	Bajra + Cowpea	5.58	256.27	1430.00
13.	Sugargraze	10.33	348.74	3602.50
14.	Sugargraze +Jowar (SC)	71.84	308.55	22166.50
15.	Sugargraze + Cowpea	6.47	280.40	1814.25
	Total	**452.73**	**-**	**1,83,918.50**

Production and Productivity of Grain Crops

Crop	Area(ha)	Average Yield (q/ha)	Production (q)
Oats	90.04	14.70	1323.60
Total	**90.04**	**-**	**1323.60**

Production and Productivity of Straw

Crop	Yield (q)	Area (ha)	Average Yield (q)
Oats Straw	90.04	36.89	3322.25
Total	**90.04**	**36.89**	**3322.25**

Fodder Supply to Cattle Yard during 2016-17

Month	Green (q)	Silage (q)	Dry (q)	Total (q)
April-2016	10968.00	6519.50	-	17487.50
May-2016	10127.00	3137.75	196.50	13461.25
June-2016	11297.75	83.50	734.00	12115.25
July-2016	16902.25	-	338.00	17240.25
August-2016	16884.75	-	130.50	17015.25
September-2016	15307.00	-	-	15307.00
October-2016	13317.50	-	-	13317.50
November-2016	12154.50	2756.00	-	14910.50
December-2016	19035.00	2013.00	325.00	21373.50
January-2017	18640.00	-	400.00	19040.00
February-2017	18639.75	-	232.00	18871.75
March-2017	17999.50	2272.50	238.00	20510.00
Total	**1,81, 273.00**	**16782.25**	**2594.00**	**2,00,649.25**

Forage Conservation

Sufficient quantity of green fodder of maize/sugargraze/bajra and jowar was conserved as 17669.00 q. silage and 3322.25 q. dry fodder such as oats straw as 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 is very low, silage and oats straw were supplied.

Revenue Generation by Sale of Silage and Straw & Wood at Forage Production Section

Sr. No	Crop Name	Qty. (qntls)	Rate per quintal ₹	Total amount ₹
1	Silage	230.25	225/-	51806.25
2	Straw	1477.77	450/-	665000.00
3	Wood sold in public auction			
	Shisham Wood	98.90	1280/-	126592.00
	Ucaliptus/Kikar wood	205.85	525/-	108071.25
	Misc. Wood	234.15	400/-	93660.00
	Grand total	**-**	**-**	**10,45,129.50**

Calculated Cost of Fodder Supplied to Cattle Yard from Forage Production Section during 2016-17

Sr. No.	Crop Name	Quantity (q.)	Rate (₹/q.)	Amount (₹)
1.	Green	181273.00	150/-	27190950.00
2.	Silage	16782.25	225/-	3776006.25
3.	Straw	2594.00	450/-	1167300.00
	Total	**2,00,649.25**	**---**	**3,21,34,256.25**

Revolving Fund Scheme on Seed Production

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 and sale to Farmers, other Agencies and use at NDRI Farm. During the year under the report, a total of 469.37 q. seeds of improved varieties of fodder crops, 702.48 q grains and 8606.75 q green fodder; 1856.00 q Bhusa and 13180.00 q. silage were produced and total ₹ 8557285.50 Revenue was generated under Revolving fund scheme on Seed Production during the report as per given below:

Production of Seed under RFS Seed Production during the year 2016-17

Kind of Seed	Quantity of Seed (q.)	Rate (₹/q.)	Amount (₹)
Oats kent	277.07	3500/-	9,69,745.00
Mustard Chinese Cabbage	192.30	7000/-	13,46,100.00
Total	**469.37**		**23,15,845.00**

Production of Grains under RFS Seed Production during the year 2016-17

Kind of Grain	Quantity of Grain (q.)	Rate (₹/q.)	Amount (₹)
Mustard Chiness Cabbage	14.60	3200/-	46720.00
Mustard	1.50	3200/-	4800.00
Oats	686.38	1600/-	10,98,208.00
Total	**702.48**	**-**	**11,49,728.00**

Green Fodder, Dry Fodder and Silage Making under RFS, Seed Production during the year 2016-17

Kind of Fodder	Quantity (q.)	Rate (₹/q.)	Amount (₹)
Green Fodder	8606.75	150/-	12,91,012.50
Straw, oats	1856.00	450/-	835200.00
Green fodder supplied to silo pit for silage making	13180.00	150/-	19,77,000.00
Grand Total	**-**	**-**	**41,03,212.50**

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; providing generator 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 Human Health Complex (HHC) was established in 1991. It is catering to the health needs of the employees, students and retirees of NDRI and the other sister ICAR Institutes situated at Karnal. Full time Doctors for Allopathic treatment and part- time practitioners for Ayurvedic & Homoeopathic (currently vacant) systems of medical aid are available at the HHC. Well qualified & trained nursing staff, laboratory technicians and pharmacists assist the Doctors in providing the desired medical facilities.

The following facilities are available in the Centre:

» Diagnostic clinical lab well equipped with a fully automatic Haematoanalyzer and a semi-auto Biochemical analyzer. All the routine blood and urine tests such as Complete Blood Count, Sugar, Malaria Parasite Lipid Profile Uric Acid etc. are carried out by trained staff.

» X-Ray facilities for all types of common ailments.

» Physiotherapy Unit for the benefit of the patients suffering from various chronic ailments such as lower back-ache, joint and muscular pains, etc. The Unit has a Transe Electric Nerve Stimulator (TENS) and has acquired an Ultra Sonic Electronic Massager this year for providing physiotherapy facilities to the patients.

Health Camps: HHC also organizes various health awareness programmes and free specialist medical consultation camps for the benefit of the Staff and their dependents for better health care. In collaboration with the leading health service providers in India, Human Health Complex (HHC) organised following camps/programmes attended by on an average more than 100 persons in each camp.

» Eye Check-up Camps: (30.04.2016, 04.07.2016, 09.08.2016 & 01.09.2016)

» Bone Mineral Density (BMD) Check-up Camp: (14.06.2016 & 22.08.2016)

» Health Check-up for Uric Acid Camp: (20.10.2016)

» Health Check-up for Cardiology Camp: (09.03.2017)

» Health Check-up for Orthopedic Camp: (23.03.2017)

Experimental Dairy Plant

Experimental Dairy Plant has been set up at 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 requirements of research and teaching, the plant is used for converting the surplus milk into variety of dairy products. Experimental Dairy manufactured Milk Powder- 26,411 kg., Pasteurized Butter (200 gm)- 2,235 kg., Ghee- 17,617 kg., Paneer- 41,355 kg., Burfi – 6,695.5 kg., Kalakand- 37,356 kg., Lassi (200 ml)- 1,69,804 pkts., Ice-cream (100 ml)- 1,13,234 cups, Flavored Dairy Drink (200 ml) - 3,24,715 pkts., Processed Cheese Slices (200 gm)- 1,107 pkts., Gulab Jamun Mix – 6,785 kg., Pizza Cheese (200 gm)- 3277 plastic container etc. during 2016-17. These products are sold through the Milk Parlour located at the institute's main entrance gate. Experimental Dairy provides practical, teaching and training facility to students and research facility to scientists of the NDRI Deemed University. It also provides training facility to outside students of various universities/colleges in the Dairy field. A total no. of 64 students from several intuitions was provided training during the financial year 2016-17. 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 the Dairy. Experimental Dairy is certified under Quality management system ISO 9001-2008 and HACCP-15000 by BIS, Chandigarh. The revenue generated from the sale of milk and milk products during the financial year 2016-17 was ₹ 6,44,21,724.37.

Computer Centre

Computer Centre is a central facility to provide computational support to the scientists and administration; and to impart training to students/scholars. There is a well established Computer Laboratory for students' teaching, which is equipped with state-of-the-art 64-bit i5 computer systems together with multi-function laser printers. These computer systems are equipped with different software, i.e., operating systems such as Unix/Linux, MS-Windows; and statistical/scientific computing systems like SAS 9.3 with JMP, MATLAB, etc. Also, compilers for various programming languages are available, which include FORTRAN 90, C, C++, R, Python, Visual Studio, etc. The Institute has a well established Local Area Network (LAN) system connecting all the research Divisions and sections through optical fiber/UTP cabling to cover the main buildings and through ADSL switches for distantly located buildings, thereby providing connectivity to all the scientists, technical/administrative staff and students. A video conferencing facility is operational at the Institute that is being used by various academic activities such as meetings with ICAR Head Quarters, conducting viva-voce exams of other universities, etc. The Computer Centre offers two Computer Science courses to under-graduate students and one course to post-graduate students including Ph.D. scholars.

Participants from 15 countries listening to the expert lecture on "Precision Dairy Farming" at the Computer Lab in FTF-ITT

Management Information Service

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.

Agriculture Knowledge Management Unit

The Agriculture Knowledge Management Unit (AKMU) is fully functional with the Internet and e-mail connectivity through National Knowledge Network node (1 Gbps) provided by the National Informatics Centre (NIC) Govt. of India and through leased line (2 Mbps) provided by ERNET India Ltd. 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. AKMU is also undertaking the implementation of ICAR programmes like Personnel Management Information System (PERMISNet), National Information System for Agriculture Education Network (NISAGENet) and Half Yearly Progress Monitoring System (HYPM). Also, Statistical Cell is functioning under Computer Centre, which disseminates university related information to various state- and national-level government agencies.

Website

The ICAR-NDRI Website (http://www.ndri.res.in) disseminates 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.

National Library in Dairying

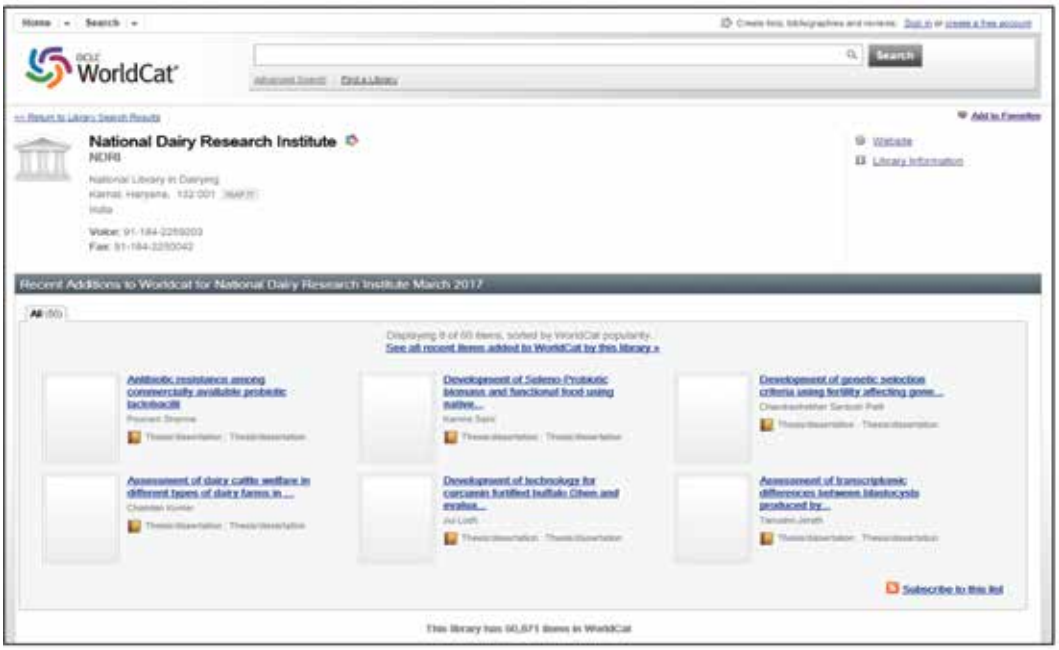
The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 100 periodicals are subscribed to keep track of the current scientific/technical developments. There are 93,070 volumes which includes 52,821 books, standard and annual reports, 34,019 bound journals, 4,730 theses and 1,500 CDs. 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. Provides instant Document Delivery Services to users of ICAR sister Institutes, State Agricultural Universities and other participating Institutions on their request.

Document Delivery Report of CeRA 2016-17		
Total Document Delivery Request received and delivered to ICAR Institutes/ State Agricultural Universities	Total Requests Received	Total Requests Fulfilled
	290	222

The Library is also an active partner of Agricat (a sub-portal under WorldCat). Presently 50,871 catalogue records of Library, NDRI available on Agricat/ WoridCat 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 digitized 3287 records of institute outputs, which includes valuable books, institutional publications, M.Sc. and Ph.D. Dissertations, reports, conference proceedings and ~ reprints etc. available 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.

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 the all the events organized by the Institute. During the period under report, the centre also organized eleven numbers of 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. A total numbers of 355 programmes were handled during (2016-17).

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 48 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 and a total number of 32 video films were edited on the above programmes.

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 (MDP) is presently certified under the **Food Safety Management System ISO 22000:2005.**

Special Features

» Model Dairy Plant provides six months in-plant training to the students of B.Tech. (Dairy Technology) of the NDRI Deemed University during the 4th year of the course curriculum.

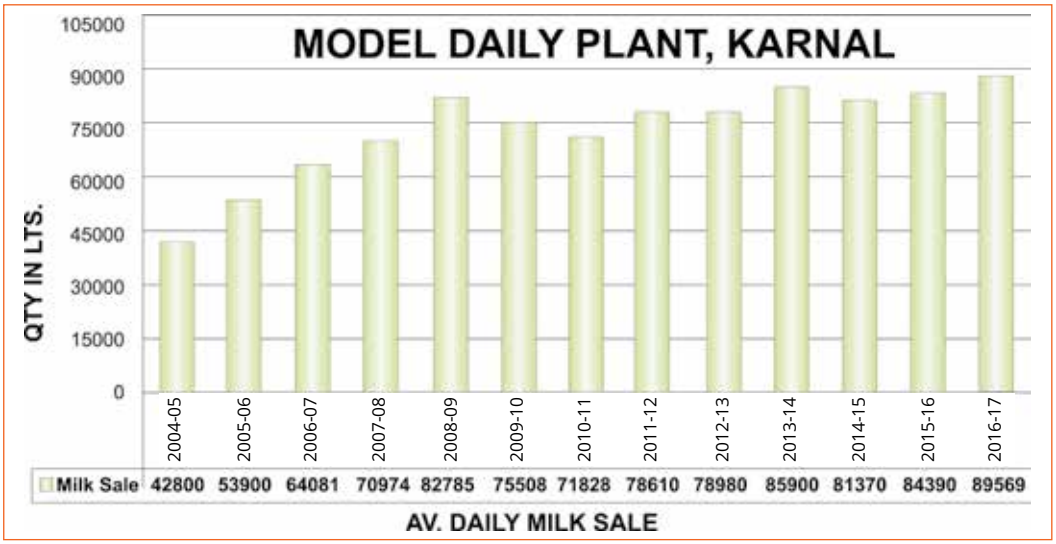
» The students are provided with complete infrastructure for training, which helps them in gaining sufficient experience in managing the modern commercial Dairy Plant and instills confidence in handling real life problems pertaining to production management.

» 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.

» Model Dairy Plant (MDP), an autonomous unit of ICAR, is independently managed by a committee, whose Chairman is the Director of NDRI.

Liquid Milk Processing / Packaging

MDP is currently engaged in processing and packaging of milk for Mother Dairy in five different variants (Full Cream, Standard, Toned, Double Toned, Skim Milk and Cow Milk). MDP is presently processing / packing 80-85 thousand liter per day (TLPD) of polypack Milk in all the varieties for Mother Dairy, 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.

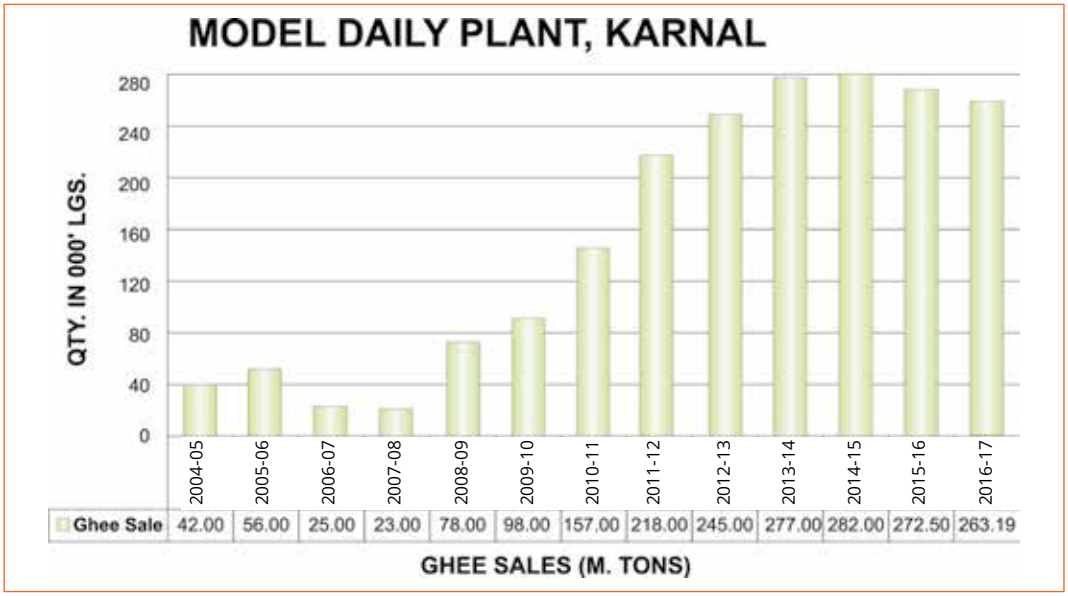


Ice Cream Manufacture

MDP has an agreement with Mother Dairy for processing and packing of Ice-cream in Mother Dairy brand on job work to the tune of 7000 liters per day (LPD). The production of ice-cream is further enhanced to 12000 LPD during the summer season. The ice cream manufactured at MDP is of different varieties i.e. Vanilla, Strawberry, Mango, Butter Scotch etc. and as per the requirements of Mother Dairy.

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 20-25 metric tons per month. All the Ghee manufactured at MDP is being sold through the MDP Sale Counter.



Cheese and Paneer

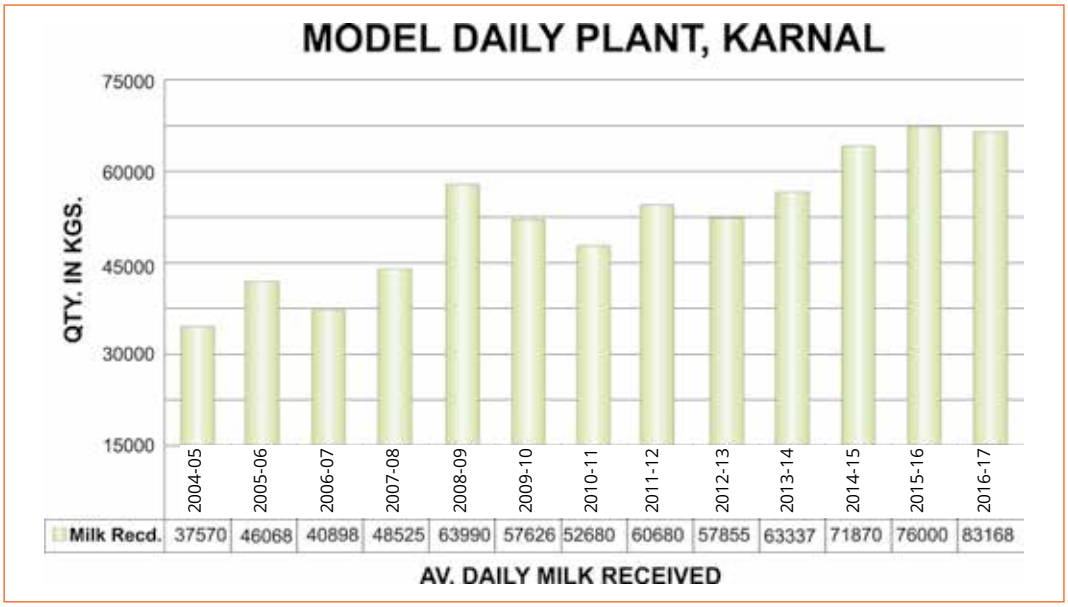
MDP is also engaged in training students in manufacturing of Cottage Cheese, Processed Cheese, Paneer on trial basis. The section is operated occasionally for the purpose of taking trials and making the students familiar with the manufacturing details.

Pinni Manufacturing

Pinni was launched at the thirteenth Convocation of NDRI Deemed University on 14th February 2015 and developed by the students of batch 2010-14. Total Sale of Pinni was 17.70 tons in the year 2016-17.

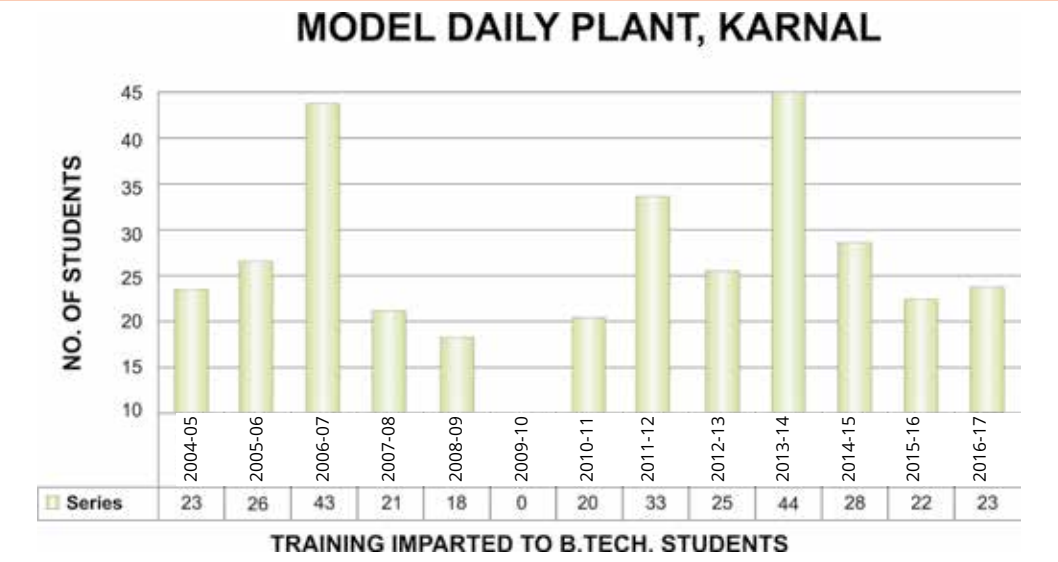
Procurement of Milk

MDP does not have its own infrastructure for milk procurement and is receiving milk on behalf of Mother Dairy from the new generation cooperatives of Punjab and Rajasthan. The average milk procurement per day is around 55,000 to 60,000 LPD, which is sufficient to meet day to day demand of different milk variants being packed at MDP.



Training to the Students

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 batches of B.Tech. (DT) students. The student trainees are provided ₹1500/- per month as stipend. So far, 528 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 2016-17

- Average milk dispatch per day was 89569 lt.
- Ghee sale was approximately 268 MT this year.
- The operational profit was 261.19 lakh for the year 2015-16
- New PLC based 6 ltr milk packing machine installed.
- Old Milk Pasteurizer Plant was updated with PLC system.
- Mix proof pneumatic valves was replaced with new latest technology valves.
- New screw air compressor installed.

Twenty Five Member delegation of Washington AgForestory Class 38 Visiting Model Dairy Plant

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 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.

The Southern Regional Station, 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 molecular genetics, 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. The library at this Station is stocked with 12590 books, 10691 bound volumes of journals, 2464 theses and 1295 reprints. Library subscribes to 50 Indian / Foreign Journals relevant to various disciplines of Dairy Science. There is a good hostel and guest house facility for the stay of students and visitors.

Education

The course work for Ph.D (Dairy Engg.), M.Tech (Dairy Engg.), M.Tech (DT), and Diploma (DT) are being conducted at the campus. The students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Animal Nutrition, Livestock Production & Management, Agricultural Economics and Agricultural Extension Education are being guided for their Doctoral and Masters' dissertation work.

Short term Training Programmes are being imparted 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 of the Indira Gandhi National Open University. About 20 Students were registered and counselled for Practical and Theory classes.

Scholarships and Fellowships

The Ph.D. and M.Tech. Students are awarded with ICAR-NDRI Fellowship and external fellowship as shown below:

Scholarship/Fellowship	Ph.D.	M.Tech.
NDRI Fellowship	29	27
YCAR-SRF/JRF	-	02
CSIR-SRF Fellowship	-	-
Moulana Azad National Fellowship	01	-
Rajiv Gandhi National Fellowship	02	-
INSPIRE (SRF)	02	

Training Programmes

» Three days Training Programme on "'Cattle Rearing and Livestock Management" for SAMETI-ATMA Sponsored training programme for Field Veterinary Extension Officers from Tamil Nadu during May, 2016. (Two batches).

» National Training Programme for Technical Staff of the ICAR Institutes on 'Precision Instrumentation in Dairy Research and Food Quality Evaluation' from 6th to 11th February, 2017.

» Brainstorming Session on "Scope of Indigenous Breeds of Cattle Towards Sustainable Production and Livelihood in the Current Climate Change Scenario" on 1st July, 2016.

» Training Course on "Recent Extension Approaches for Dairy Entrepreneurship Development" during 1st - 8th December, 2016.

» National Consultation "Small Farmer Production Systems: Way Forward" organized by NABARD Chair Professor during 22nd - 23rd December, 2016.

» Training Programme on 'Farm Business Management for Animal Husbandry Sector' organised by SRS, NDRI & MANAGE, Hyderabad, during 31st January to 3rd February, 2017

» ICAR-National Training on "Technology Management and Business Planning for Entrepreneurship Development" during 13th -18th March 2017.

» Training Programme on "Scientific Dairy Farming" for livestock farmers under ATMA, Villupuram District, Tamil Nadu during 28th – 30th March, 2017.

» Training Programme for Veterinary Officials of Department of Animal Husbandry, Tamilnadu during May to June 2016 for 100 trainees in 5 batches.

» ATMA Exposure Training Programme for Livestock Farmers of Southern Districts of Tamilnadu during 12th -13th July, 2016.

» Training Programme on "Commercial Dairy Production for Entrepreneurs" during 18th – 23rd July, 2016.

» Interstate Exposure Training Programme for Livestock Farmers under ATMA, Coimbatore, Theni District, Tamil Nadu during 14th – 16th June, 2016 and 27th – 29th July, 2016, respectively.

» ATMA Exposure Training Programme for Livestock Farmers of Northern Districts of Tamilnadu during 7th - 10th September, 2016.

» Training programme for the technical staff of ICAR on "Dairy Farm and Milk Processing Plant Management" during 19th – 24th September, 2016.

» Training Programme for ICAR Technical Officers on Good Laboratory Practices during 17th – 22nd October, 2016.

» Dairy Orientation Programme for Progressive Dairy Farmers of Karnataka Milk Federation during 25th – 26th October, 2016.

» Model Training Course "Recent Extension Approaches for Dairy Entrepreneurship Development" during 1st – 8th December, 2016.

Other Major Events

» **An Institute – Industry Meet** was organized at Southern Campus of ICAR-NDRI, Bengaluru on 21st April 2016 with a Brainstorming Session on "Composite Dairy Foods". Scientists of ICAR-NDRI and 45 representatives of more than 15 industries interacted in the Meet.

A document on technologies ready for commercialization being released during Institute – Industry Meet at Southern Campus, Bengaluru

- **94th Foundation Day Celebration** of ICAR-NDRI and Brainstorming Session on "Scope of Indigenous breeds of cattle towards sustainable production and livelihood in the current climate change scenario" was organized at Southern Campus of ICAR-NDRI, Bengaluru on 1st July 2016**.** About 270 participants including guests, Alumni of NDRI, staff & students of SRS of NDRI and staff of other ICAR institutes attended the function.
- The **Vigilance Awareness Week** was observed at Southern Campus of ICAR-NDRI, Bengaluru on 31st October 2016 by taking the Pledge both in English and Hindi administered by the Head of the Campus.
- **World Food Day** was celebrated on 17th October, 2016 on the theme 'Climate is changing: Food and agriculture must too'. Dr. K. N. Ganeshaiah, Former Dean (PGS) UAS, Bengaluru was the chief guest of the function and he delivered a lecture on "Impact of climate change on food production".
- **Kannada Rajyotsava:** On 29th of November 2016, the Kannada Rajyotsava was organized. Dr (Mrs.) B. K. Sumitra, Noted Kannada Playback Singer was the Chief Guest. Many sports, cultural and literary competitions were conducted for staff, students, staff children and contract labourers and prizes were distributed to the winners and runners.
- **Workshop on "Mastitis Control - Way Forward":** One day workshop on "Mastitis Control-Way Forward" was organized jointly by NDDB and Southern Campus of ICAR-NDRI, on 15th December, 2016. The workshop was attended by 100 participants from various organizations.
- **National Consultation on "Small Farmer Production Systems: Way Forward"** was organized during 22nd - 23rd December, 2016 at Southern Campus of ICAR-NDRI Bengaluru and ICAR-NIANP Bengaluru under the aegis of NABARD, Southern Campus of ICAR-NDRI, ICAR-NIANP, UAS Bengaluru and NAAS, New Delhi.
- **Teachers' Day:** The students of the campus celebrated the 'Teacher's Day' on the 6th September, 2016 to show their respect and gratitude towards the teachers.
- **Fresher's Day:** The senior students of the Station celebrated the 'Fresher's Day' on the 6th September, 2016 to welcome the I Year Students to the Institute. The students also performed various cultural activities like singing, dancing, skits etc. to demonstrate their talent and entertain the audience.
- **Hindi Day Celebration:** Hindi day was celebrated on 23rd September, 2016 at Southern Campus of ICAR-NDRI, Bengaluru. Dr Arvind Kumar, from Jain University, Bengaluru was the Chief Guest. Many competitions were held for staff & students to commemorate the occasion.
- **Gandhi Jayanti:** Gandhi Jayanti was celebrated on 2nd October, 2016. Staff and students assembled in Gandhi Park. The staff members and students took part in the Swacch Bharat Abhiyan and more than 100 tree saplings were planted in the Institute/Hostel premises.
- **National Milk Day:** National Milk Day was celebrated on 26th November, 2016 and a guest lecture on "Challenges and Issues of Indian Dairy Cooperatives in Producing Quality Milk" by Sri. B. Nataraj, Director (QC), Karnatak Milk Federation, Bengaluru was organized.
- **Agricultural Education Day:** Agricultural Education Day was observed on 3rd December, 2016 and an elocution competition was conducted for the Diploma, PG and Ph.D. students of our Institute on the topic "Agricultural Education – Scope and Opportunities". Prizes were given to the winners.

Livestock Research Centre

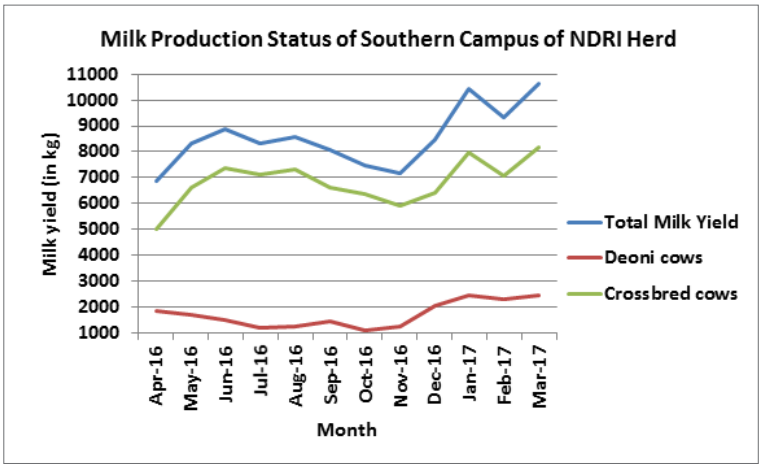
Herd strength and performance of dairy herd: The livestock research centre of the station houses Deoni cattle, HF crossbred cows and Malnad Gidda bulls. Herd strength at Livestock Research Centre, Southern Campus of Bengaluru comprises 242 animals of which 178 are Deoni and 64 Holstein Friesian (HF) crossbreds. Deoni cattle comprises 56 adult females, 26 are between 1 to 6 months age; 20 in 6 months to 1 year of age; 30 nos. in 1-2 years of age and 35 are above 2 years of age. The number of bulls and bullocks in Deoni breed are 4 and 7, respectively. The total milk production of the herd during the current year was 102539. The production performance of the Deoni cattle viz. average daily milk yield, peak yield and days to reach peak yield was 3.5 kg, 4.68 kg and 15.05 days, respectively. The reproductive performance characteristics viz. age at first calving, calving interval, days to first post partum service and service period was 44.7 months, 413.66 days, 87.6 and 103.9 days, respectively. In HF crossbred

cows, the mean age at first calving, calving interval, days to first post partum service and service period was 21.7 months, 496.33 days, 77 and 51.8 days, respectively. The total number of calves born (average per month) in Deoni and crossbred cattle was 48 (4) and 24 (2), respectively.

Lactation Performance of Deoni and HF Crossbred Cows at Southern Campus of ICAR-NDRI (2016-2017)

Month/ Breed	Total Milk Production			Wet Average		Cows in Milk (no.)		Cows in Dry (no.)	
	Deoni	Crossbred	Total	Deoni	Crossbred	Deoni	Crossbred	Deoni	Crossbred
April, 2016	1851	5010	6861	2.87	12	15	13	35	11
May, 2016	1708	6607	8315	3.72	14.14	14	17	37	7
June, 2016	1508	7381	8889	3.9	15.3	13	15	39	9
July, 2016	1189	7121	8310	3.3	13.2	12	18	41	9
Aug., 2016	1222	7340	8562	3.2	12.2	15	20	39	7
Sept., 2016	1466	6632	8098	3.6	11.7	13	19	32	8
Oct., 2016	1103	6373	7476	3.2	11.7	11	18	33	7
Nov., 2016	1250	5920	7170	3.8	12.8	14	16	30	9
Dec., 2016	2064	6425	8489	3.8	12.9	20	17	24	8
Jan., 2017	2445	7966	10411	3.9	13.1	21	19	30	6
Feb., 2017	2275	7049	9324	3.5	11.8	22	23	29	3
March, 2017	2469	8165	10634	3.5	11.8	25	22	31	5
Total/ overall Average	**20550**	**81989**	**102539**	**3.5**	**12.7**	**16**	**18**	**33**	**7**

Forage Production: Forage production section is involved in cultivation of quality fodder crops and supply of harvested fodder crops to the cattle of LRC. Besides, forage section is involved in training and demonstration of cultivation of fodder varieties to farmers and trainees.



Production of Different Fodder Crops at LRC (2016-17)

Month	Type of Fodder Produced (in quintal)						
	Napier	Guinea	Paragrass	Maize	Jowar	Total	Daily Average
Apr-16	352	48.5	1064.5	0	0	1465	48.83
May16	760	115	749.5	0	0	1624.5	52.4
Jun-16	291	1063	404	0	0	1758	58.6
Jul-16	702	530	531	0	0	1763.5	56.88
Aug-16	804.5	65	1114	8	0	1991.5	64.24
Sep-16	45	293.5	1036	355.5	52.5	1782.5	59.41
Oct-16	332	99	685.5	219.5	371	1707	55.06
Nov-16	560.5	56.5	902.5	11	8	1618	53.9
Dec-16	255	70.5	1325.5	8	0	1661	53.58
Jan-17	408	127.5	780	108.5	0	1424	45.93
Feb-17	278.5	32.5	970	0	6.5	1287.5	45.98
Mar-17	478	95	425.5	0	0	998.5	32.21
Total	**5267**	**2596**	**9988**	**710.5**	**438**	**19081**	**52.25**

Recently, forage section has established a green fodder demonstration unit with 21 fodder crop varieties viz. CO3, Hamil guinea, Anjan, Fodder groundnut, Hybrid CN sampoorna, Moringa, CO5, Bundle guinea, BH18, DH6, Signal, Congo signal, HNCOBN5, Grazing guinea, Rhodes grass, BHN10, APBN, COFS31, HNDHN6,HN IGFRI 7 and Azolla. This unit serves as live demonstration plots and farmers/trainees are benefitted by observing various fodder varieties at one place. In addition, medicinal plant garden has been recently established to demonstrate their use and benefits in animal and human health. Besides, land reclamation activity has been initiated and converted into Broad Bed and Furrow (BBF) system to reduce salinity and water stagnation and utilize effectively the land for fodder production and agro-forestry to maximize fodder supply to dairy herd.

Experimental Dairy

Sale of Milk and Milk Product (2016)

Product	Quantity Sold	Amount ₹ Lakhs
Milk sweet, kg	541	1.43
Flavoured milk, pkt	9332	1.12
Process cheese, pkt	5997	4.80
Paneer, kg	2062	5.17
Butter, kg	284	0.94
Gulabjamun mix, pkt	239	0.12
Cheese puri mix, pkt	360	0.18
Chhana podo, pkt	1980	1.31
Kunda, cups	2336	0.62
Curd, pkt	2040	0.24
Khoa, kg	65	0.18
Milk, lit	38106	12.93
Cheddar cheese	10.1	0.03
Total		**29.07**

Extension Activities

» Advisory services / technical advice was rendered to twenty seven needy clientele during their personal visits to the Institute, mail enquires and phone queries. The profile of advisory services included dairy production and dairy processing aspects, information regarding dairy inputs, dairy development schemes, credit availability for dairy projects, information on

training schedule, training programmes on scientific dairy farming, feasibility of commercial dairy projects, availability of high yielding dairy animals, training programmes for farmers and farmwomen, availability of publications in dairy farming aspects, technical know-how, consultancy services for dairy business projects and training programmes on commercial dairy business aspects.

» A total number of 921 persons visited the Institute in twelve batches comprising of students from various academic institutes, farmers and trainees from the southern region and other States. The visitors were briefed on Institute profile.

» Extension literature on 'Green Fodder Production' was prepared in English and others literature on clean milk production, indigenous dairy animals and dairy products of the region prepared exclusively for the clientele groups of the southern region was distributed to the needy clientele groups during the visits, dairy education at farmers' door programme and exhibitions, visitors and trainees during their visits to the Institute.

» The rural extension programme in adopted villages has been initiated in new cluster of villages in Varathur Block of Bengaluru Rural District.

» ICAR-NDRI Collaborative Farmers FIRST Programme: A collaborative research project entitled "Enriching knowledge and integrating technology and institutions for holistic village development in horticulture-based farming system" for the **Farmer FIRST Programme** of **ICAR** under the priority area "Technology Assessment and Refinement" by ICAR-IIHR and SRS : ICAR-NDRI was initiated in the selected villages in Kanakapura block of Ramanagara District of Karnataka. Under the Farmer FIRST programme Southern Campus conducted field survey and identified six villages in Kanakapura block of Ramanagara District, Karnataka, Vasappanadoddi, Yeremgere, Balepura, Kebbedoddi, Chikalegowdanadoddi and chikkayeremgere. About 100 farm families including 35 farm families from tribal settlements, involved in animal husbandry & dairying were identified as beneficiaries for the programme which included a series of planned activities as institute interventions for integrated development of selected villages and the beneficiary farm families. The selected villages were visited and awareness on green fodder production, clean milk production practices and improved dairy farming practices among beneficiary farm families was made through individual and group discussions. A one day Clean Milk Production Campaign as on-campus training programme was organised which from the project villages, 30 farm beneficiaries comprising of farmers, farm women and farm youth attended the programme. The participants were briefed about the Institute activities and were taken round the fodder demonstration unit, fodder farm and livestock research unit. A lecture presentation was made on importance of clean milk production and the package of practices on clean milk production. Extension Literature in local language on "Clean Milk Production" was distributed to the participants for know-how and practice of recommended practices.

» Dairy Education at Farmers' Door: The 'Dairy Education at Farmers' Door' as a new initiative was organized and visits were made by the multidisciplinary team on Second Saturdays to villages of Bengalure South and during January to June 2016, respectively and to villages of Varthur block, Bengalure North during July to December, 2016. The multi-disciplinary team visited individual households and interacted with the farmers regarding dairy farm management and the problems faced in dairy farming. Necessary technical advice was rendered on various aspects of scientific dairy farming, green fodder production, clean milk production and dairy animal management aspects to the farmers and farm women at their doorsteps.

Consultancy

» Under consultancy project for Nandini Sperm Station, KMF, Hessaraghata, Bengaluru we screened 187 animals for Casein A1 and A2 genotyping at a cost of ₹ 2, 15,050.

» A total revenue of ₹ 5,89,825/- was collected towards training fees for training programmes during the year 2016-17.

EASTERN CAMPUS, KALYANI

The main objective of establishing the Eastern Campus of ICAR National Dairy Research Institute 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 station 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 Eastern Regional Station 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 research work was mainly related to Animal Nutrition (1964-1972), Animal Nutrition and Dairy Chemistry & Bacteriology (1972-1976), Animal Nutrition, Animal Breeding, Soil Science Dairy Economics and Dairy Extension (1977-1985), Animal Nutrition, Livestock Production and Management, Animal Breeding, Forage production, Dairy Economics & Statistics and Dairy Extension (1986-1991), Animal Nutrition, Livestock Production and Management, Animal Breeding, Forage production, Dairy Economics & Statistics and Dairy Extension (1992-1997). Animal Biotechnology section started functioning during 2005. The Animal Physiology and Reproduction laboratory was also established in 2013-14. Goat farm was also established in 2014-15 in a small scale for research, education and training purposes.

The Eastern regional station of National Dairy Research Institute has infrastructure facilities like Research Laboratories, Cattle Herd, Fodder Farm, Library, Computer section, Guest House etc.

The Library contains 1655 books, 3360 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. Presently 20 journals are subscribed.

The Computer Center facilitates the maintenance of database. The institute has Internet connectivity through VSAT and NKN, which are useful for searching literature and references.

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.

Events & Extension Activities

» Additional Krishi Vigyan Kendra for Nadia district of West Bengal was inaugurated on 19th January, 2017 at Eastern Campus of ICAR-NDRI, Kalyani, West Bengal.

- A Brain Storming Session on "Physio- Nutritional Approaches for enhancing reproduction in dairy animals" was organized at ICAR-NDRI- Eastern Campus, Kalyani on 9th May, 2016.
- ERS of ICAR-NDRI, Kalyani provided day-to-day service on treatment of ailing animals, deworming, vaccination, AI etc. in the adopted villages. A total of 176 animals got AI service from 'Dairy Vikash Kendra' situated at the adopted village. A total of 818 farmers were benefitted by the interventions given by ERS of ICAR-NDRI in the adopted villages. A total of 1005 animals were attended. Four animal health-cum-vaccination camps were organized in the adopted village in which a total of 410 animals were vaccinated. A total of 140 farmers were benefitted by the intervention.
- Eastern Campus of ICAR-NDRI participated in 6 exhibitions in different parts of West Bengal and North Eastern states of India for technology demonstration related to the dairy animal production.
- One training programme on "Artificial Insemination and Veterinary First Aid" was organized in the Institute during 31st January to 3rd March, 2017 in which 13 trainees participated.
- Guided visit for a total of 734 visitors were organized by ERS of ICAR-NDRI for government officials from West Bengal and North Eastern states, students from various Institutes, farmers from different organizations.
- One SMS portal was launched for disseminating information to the farmers including tribal farmers regarding different aspects of scientific dairy farming on 9th May, 2016 during the brainstorming session on 'Physio-nutritional Approaches: Avenue for Enhancement of Reproductive Efficiency in Dairy animals'.

Orientation Visit for School Children of Eastern States

During the Regional Science Congress organized by Jawahar Navodaya Vidyalaya, Kalyani two lecture sessions on 'Animal science and its future prospects' and 'Scope and opportunity of agriculture education vis-à-vis research : A national perspective' was delivered by the scientists of the institute on 15.11.2016. ERS of ICAR-NDRI organized one orientation visit for school children (130 students, class 9 and 11 standard) of Jawahar Navodaya Vidyalayas of West Bengal, Bihar and Jharkhand states in the campus. The theme of the visit was awareness development among School Children in respect of Indian Agriculture including Animal Husbandry Development for food and livelihood security.

Award for Exhibition Stall

ERS of ICAR-NDRI, Kalyani bagged second best exhibition stall award on 14.12.16 in the 'Kisan Mela'organised by ERS of IVRI and Sasya Shyamala Krishi Vigyan Kendra at Arapanch village of South 24 Paraganas district of West Bengal.

'Dairy Education at Farmer's Door' programme was organized on 2nd Saturday every month by team of Scientists and Staff at NDRI-Eastern Regional Station, Kalyani. The main theme of the programme was to educate the farmers on Scientific Dairy Farming practices including goat farming. The visiting teams gave useful advice on feeding practices of both the large and small ruminants, cleanliness of animals and cattle sheds, disease and vaccination awareness and good housing system of the animals etc. The animals were also vaccinated against HS and FMD. Deworming of animals was also done and mineral mixture and vitamins were also distributed to the villagers.

Extension Activities in Tribal areas of West Bengal

- Six vaccination-cum-animal health camps were organized in the tribal dominated areas of West Bengal for scientific dairy animal production and animal husbandry practices. In these camps, a total of 6563 no. of animals were attended and inputs like fodder seeds, mineral mixture etc. were distributed among the tribal dairy farmers. Apart from that, several Training programmes were also organized under the programme.
- Training programmes on "Scientific dairy farming for tribal unemployment youths" were organized during 20th - 22nd December, 2016. Twenty participants from West Medinipore and Bankura districts of West Bengal had participated in the programme. Faculties of the station provided the training on different aspects of scientific dairy farming mainly housing and management, feeds and feeding practices, fodder cultivation practices, disease control measures, oestrus detection and reproductive management etc.
- A total of seven scientist farmers interaction sessions were organized. Experts of NDRI-ERS, Kalyani interacted with the farmers on the areas such as Importance of feeding mineral mixture, Vaccination and deworming, Important green fodder varieties and their cultivation practices, Artificial insemination and heat detection, Azolla production and Clean milk production.
- One Awareness Camp on 'Agriculture and Dairy farming' for Tribal School Children was organized at this Institute' Kalyani campus on 20th December, 2016. A total of 103 tribal students alongwith 7 teachers/ teaching staffs participated in the awareness camp. Students were exposed to various aspects of agriculture and animal husbandry which aroused curiosity among the participants.

Extension activities in North Eastern Hill Region

- Four North Eastern states of India namely, Arunachal Pradesh, Meghalaya, Tripura and Sikkim were covered. Several visits were arranged and inputs such as veterinary medicines, mineral mixture, concentrate mixture, fodder seeds, livestock, extension literatures etc. were distributed among the farmers. In the scientists-farmers interaction sessions several aspects of animal husbandry were explained to the farmers of the North Eastern States.
- Team from ERS of ICAR-NDRI, visited Meghalaya and by collaborating with ICAR Institute for NEH, Umiam, organized animal health-cum-vaccination camp, interaction-cum-demonstration session with farmers. Team from ERS of ICAR-NDRI organized animal health-cum-vaccination camp and distributed medicines for livestock and fodder seed among the farmers of Meghalaya state. Scientists from ERS have visited and organized veterinary health camps in Tripura,

Arunachal Pradesh and Sikkim. In those camps veterinary medicines and fodder seeds were distributed to the farmers. Discussions and interactions were carried out on various topics about above aspects including various livestock production systems and its constraints, solutions etc. in depth during the interaction sessions. In Yewang Village of Arunachal Pradesh piglets were distributed among tribal dairy farmers. Several inputs like mineral mixture, concentrate mixture, fodder seed, extension literatures etc. were distributed among the farmers during various visits to the North Eastern states.

Sports Events Organized

» Sports event for the students of DAHD course and Post-graduation at ERS Campus was organized. Athletic event comprising 100 meter running race, relay race and long jump for both girl and boys were organized on 02.03.2017. Series of badminton and cricket matches were also conducted for the students of the campus.

Livestock Farm

Annual Performance of ERS-NDRI Herd (2016)

Particulars	Jersey Cross (2016)
Herd strength as on 31-12-2016	185
Total milk production (kg)	161030.00
Av. no. of cows in milk/day	54.0
Av. no. of cows in dry/day	17
Wet average (kg)/day	8.31
Herd average (kg)/day	6.25
Age at first calving (month)	33
No. of inseminated	97
No. of pregnant cows	44
Conception rate (%)	45.4
Service period (days)	135
Inter calving period (days)	450
Mortality (%)	3.2

Milk Production Performance at ERS-NDRI Herd (1.1.16-31.12.16)

Months (2016)	Milk Production (kg)	Wet Average (kg)	Herd Average (kg)	Average FAT %	Average SNF %
January	12509.5	8.41	6.51	4.80	8.63
February	12869.0	8.66	6.71	4.53	8.10
March	13434.5	8.21	6.46	4.88	8.66
April	12964.5	8.24	6.28	4.74	8.38
May	13259.0	8.89	6.20	4.70	8.34
June	13661.5	8.92	6.34	4.76	8.33
July	14105.5	8.41	6.26	4.92	8.62

August	13828.0	8.15	6.91	4.85	8.62
September	12670.0	8.22	6.10	4.67	8.35
October	13543.0	7.92	6.10	4.97	8.64
November	13225.0	7.62	5.93	4.79	8.36
December	14960.5	8.12	6.19	4.95	8.66
Total Milk	161030.0				
Overall Average	**13419.17**	**8.31**	**6.25**	**4.80**	**8.47**

Forage Farm

Forage Farm section is engaged in cultivation of quality fodder crops in about 27-30 hectares of area (NDRI, Kalyani and IVRI, Kalyani land) 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, chaff cutter etc. There is a small vermin-compost unit used for production of vermi-compost and also 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 about 700 plants of teak, shesham *etc*. growing around the Institute premises. Besides, there is a fodder herbarium for training and demonstration purpose. The Forage Section has necessary facilities covering the theoretical and practical part of training on fodder crop production.

Production of Different Fodder Crops at ERS Fodder Farm 2016-17

Sl. No.	Type of Fodder	Quantity (q)
1	Maize / Maize+Cowpea	2159.10
2	Sorghum / Sorghum + ricebean/ Sorghum +cowpea	7094.08
3	Oats/ Oats + Mustard	2721.30
4	Berseem / Berseem+ Mustard,	2375.80
5	sole Cowpea/ Sole ricebean	158.15
6	Hybrid Napier grass , guinea grass, para grass	495.05
7	coix	36.00
	Total	**15039.48 q**

Production of Different Fodder Seeds at ERS 2016-17

Sl. No.	Type of Fodder Seed	Quantity (kg)
1	Cowpea (Var-B, L-2)	84.00
2	Ricebean (Var-B-1)	325.00
3	Ricebean (Var-B-2)	195.00
4	Coix	35.00
	Total	**639.00**

Resource Generation by Eastern Campus, Kalyani

Sl. No.	Heads	Amount ₹ Lakhs
1.	Sale of Milk	39.67
2.	Sale of Animals	3.29
3.	Sale of fodder/seed	0.47
4.	Rent of guest house	0.15
5.	Training fees	1.13
5.	Any others/ Miscellaneous	2.11
6	Semester fees (Diploma)	3.00
7	Semester fees (Ph.D, M.V.Sc, M.Sc)	0.91
	Total	**51.23**

BUDGET AND EXPENDITURE

The budget and expenditure including Plan and Non-plan for the year 2016-2017 was ₹16978.59 lakhs and ₹ 17230.35 lakhs, respectively for the Institute and its Regional Stations.

Financial Outlays & Expenditure during 2016-17

NDRI (including ERS, Kalyani)

(₹ in lakhs)

Sr. No.	Head	Non-Plan		Plan	
		Budget	Expenditure	Budget	Expenditure
1.	Grant in Aid : Capital	52.85	52.17	340.25	339.65
2.	Grant in Aid : Salaries	6051.90	5850.91	2.00	-
3.	Grant in Aid : General	8744.50	8729.53	360.80	352.72
	Total	**14849.25**	**14632.61**	**703.05**	**692.37**

SRS, Bengaluru

(₹ in lakhs)

Sr. No.	Head	Non-Plan		Plan	
		Budget	Expenditure	Budget	Expenditure
1.	Grant in Aid : Capital	9.10	9.09	39.75	39.65
2.	Grant in Aid : Salaries	1050.20	1036.60	-	-
3.	Grant in Aid : General	517.00	506.29	62.00	61.98
	Total	**1576.30**	**1551.98**	**101.75**	**101.63**

Revenue Generation

The Revenue Receipts of the Institute and the Regional Campuses for the year 2016-2017 were ₹ 1147.26 lakhs.

Sl. No.	Head	Amount (₹ in lakhs)
1.	Sale of Farms Produce	370.23
2.	Sale of Old Vehicle/Other Machine Tools	14.12
3.	Sale of Livestock	85.07
4.	Income from Royalty/Sale of Publication/Advertisement	2.51
5.	License Fee	88.13
6.	Interest Earned on Loans and Advances	24.78
7.	Leave Salary and Pension Contribution	3.68
8.	Receipt from Schemes	3.02
9.	Analytical and Testing Fee	3.94
10.	Application Fee from Candidates	21.84
11.	Diploma Charges	1.07
12.	Receipt from Services Rendered	3.49
13.	Unspent Balance of Grants	21.16
14.	Interest Earned on Short Term Deposits	167.13
15.	Interest Generated from Internal Resource	145.43
16.	Miscellaneous Receipts	191.66
	Total	**1147.26**

Position of Manpower at NDRI, Karnal and its Regional Stations as on 31.03.2017

Type of Posts	Existing		
	Approved by D/o Expenditure	In position	Vacant
Scientific	194	159	35
Administrative (Group A&B)	36	34	02
Technical	352	202	150
Administrative (Group Non-gazatted)	127	93	34
Supporting	755	433	322
Total	**1464**	**921**	**543**

Dr. A. K. Srivastava, Director and Vice Chancellor, NDRI inaugurating the POS machine at NDRI Milk Parlour

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। इस एकक में वर्ष 1988, 1989 एवं 2011 में क्रमशः हिन्दी अनुवादक, सहायक निदेशक ;राजभाषाद्ध एवं उप निदेशक;राजभाषाद्ध के पद सृजित किए गए। राजभाषा एकक द्वारा संस्थान के अधिकारियों, वैज्ञानिकों, मंत्रालयिक स्टाफ, 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 गतिविधियों का आयोजन किया गया।

» संस्थान में गठित संस्थान राजभाषा कार्यान्वयन समिति की वर्ष में चार बैठकें प्रत्येक तिमाही में एक आयोजित की गई। इन बैठकों में राजभाषा कार्यान्वयन के क्षेत्र में संस्थान की प्रगति का आंकलन किया जाता है एवं भावी कार्यक्रमों हेतु कार्ययोजना तैयार कर उन्हें कार्यान्वित किया जाता है।

» राजभाषा नियम 1976 के नियम–11 का अनुपालन करते हुये संस्थान द्वारा सभी प्रकार के मानक फार्मों एवं स्टेशनरी सामान आदि को द्विभाषी रूप में प्रयोग करना सुनिश्चित किया जा रहा है।

» राजभाषा के प्रगामी प्रयोग को सतत् बढ़ाने एवं कर्मचारियों की सरकारी काम–काज में राजभाषा के प्रयोग में होने वाली झिझक को दूर करने के लिए प्रत्येक तिमाही में कम से कम एक हिंदी कार्यशाला का आयोजन किया जा रहा है। दिनांक 20.9.2016 को ''प्रशासनिक हिंदी'' विषय पर आयोजित कार्यशाला में 43 कर्मचारियों ने, दि. 10.11.2016 को ''कंप्यूटर पर युनिकोड एवं तकनीकी टूल्स के द्वारा हिंदी प्रयोग को बढ़ावा'' विषय पर आयोजित कार्यशाला में 16 कर्मचारियों ने भाग लिया। इसी प्रकार संस्थान में 10.3.2017 को आयोजित हिन्दी कार्यशाला में 47 प्रतिभागियों ने भाग लिया।

» संस्थान में 14 सितंबर से 26 अक्तूबर 2016 तक राजभाषा चेतना मास का आयोजन किया गया। इस अवधि में हिंदी टिप्पण एवं मसौदा लेखन प्रतियोगिता, हिंदी कार्यशाला, संस्थान के वैज्ञानिकों, तकनीकी वर्ग के अधिकारियों एवं शोध–छात्रों हेतु 'शोधपत्र/ पोस्टर प्रदर्शन प्रतियोगिता आयोजित की गई। इसके अलावा नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों हेतु दिनांक 01.10.2016 को हिंदी गीत–गायन प्रतियोगिता का आयोजन किया गया। इस कार्यक्रम मे 16 कार्यालयों के 28 कार्मिकों ने भाग लिया। दिनांक 29.10.2015 को आयोजित राजभाषा पुरस्कार वितरण समारोह में हिन्दी पखवाड़ा–2016 के दौरान आयोजित हिन्दी टिप्पण आलेखन प्रतियोगिता के 5 विजेताओं, हिन्दी शोध–पत्र पोस्टर प्रतियोगिता के 6 विजेताओं एवं गीत गायन प्रतियोगिता के 7 विजेताओं, कुल 18 प्रतियोगियों को पुरस्कृत किया गया।

» वर्ष 2015–16 की वार्षिक मूल हिन्दी टिप्पण/आलेखन प्रतियोगिता में 12 कार्मिकों ने भाग लिया तथा नियमानुसार 10 सुपात्र कर्मचारियों को नकद पुरस्कार एवं प्रमाण पत्रों से पुरस्कृत किया गया। वर्ष 2016–17 की प्रतियोगिता के लिए 11 प्रविष्ठियॉ प्राप्त हुई हैं तथा सुपात्र 10 कर्मचारियों को पुरस्कृत किया।

» संस्थान के अधिकारियों एवं कर्मचारियों के लिए ''राजभाषा बनाम स्वच्छ भारत अभियान'' एवं ''राजभाषा–दशा और दिशा'' विषयों पर 2 निबंध प्रतियोगिताएं आयोजित की गईं एवं विजेताओं

को प्रमाण पत्र से सम्मानित किया गया। दि. 28.2.2017 को संस्थान में हिंदी टाइपिंग प्रतियोगिता का आयोजन कराया गया तथा विजेताओं को प्रमाण पत्र से सम्मानित किया गया।

» हर वर्ष की भॉति संस्थान की वार्षिक गृह पत्रिका ''दुग्ध गंगा'' के वर्ष 2016–17 के छठे अंक को पूर्णतः हिन्दी में प्रकाशित किया गया है। तिमाही न्यूज लैटर ''डेरी समाचार'' भी पूर्णतः हिन्दी में प्रकाशित किया जा रहा है।

» संस्थान के निदेशक, नगर राजभाषा कार्यान्वयन समिति, करनाल के पदेन अध्यक्ष हैं। उनकी अध्यक्षता में समिति की दो बैठकें, प्रथम बैठक दिनांक 24.6.2016 को एवं दूसरी बैठक दिनांक 29.11.2016 को संपन्न हुई। नराकास की छमाही बैठकों में करनाल में स्थित 70 केन्द्र सरकार के कार्यालयों, उपक्रमों, निगमों, अनुसंधान संस्थानों, विश्वविद्यालयों, लिमिटेडों तथा राष्ट्रीयकृत बैंकों आदि के प्रशासनिक अध्यक्षों, वरिष्ठ अधिकारियों, राजभाषा अधिकारियों एवं प्रतिनिधि अधिकारियों द्वारा प्रतिभागिता की जाती है। इन बैठकों में भारत सरकार, राजभाषा विभाग के अधिकारी भी शामिल होते हैं। समिति रूटीन प्रकार के कार्यों के अलावा अध्यक्ष नराकास एवं संस्थान के निदेशक महोदय के मार्गदर्शन में संस्थान के राजभाषा एकक के प्रभारी नराकास समन्वयक एवं सचिव नराकास द्वारा समिति के सदस्य कार्यालयों को राजभाषा के प्रचार, प्रसार एवं कार्यान्वयन हेतु समय समय पर मार्गदर्शन एवं सहयोग भी प्रदान किया जा रहा है। समिति द्वारा छमाही बैठकों में सदस्य कार्यालयों के प्रधानों एवं प्रतिनिधियों की सहमति से विभिन्न राजभाषा गतिविधियों का आयोजन किया गया। नराकास के तत्वावधान में दि. 28.1.17 को केन्द्रीय मृदा लवणता अनुसंधान संस्थान करनाल में हिन्दी शब्दावली एवं वाक्यांश प्रतियोगिता, दि. 20.2.17 को जवाहर नवोदय विद्यालय, सग्गा, करनाल कार्यालय में ''राजभाषा प्रबंधन'' विषय पर हिन्दी कार्यशाला, दि. 22.2.17 को पंजाब नैशनल बैंक, मंडल कार्यालय, सेक्टर 12, करनाल कार्यालय में हिन्दी कंप्यूटर टाइपिंग प्रतियोगिता'', दि. 8.3.2017 को संस्थान द्वारा नराकास के तत्वावधान में ''राजभाषा ज्ञान लिखित प्रतियोगिता'' एवं दि. 9.3.2017 को संस्थान में ''बसन्त का पैगाम, नराकास एवं राजभाषा हिन्दी के नाम'' बैनर तले राजभाषा संगोष्ठी का आयोजन किया गया।

» 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 इस एकक द्वारा किया जाता है।

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हिंदी आलेख

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SWACHH BHARAT ABHIYAN: CLEAN & GREEN NDRI

Swachh Bharat Abhiyan is a mission led by the government of India to make India a clean India. To realise Gandhi Ji's dream of a Clean India, NDRI is supporting this drive of the Government of India by organising 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 truly effective and successful.

NDRI organized a cleaning campaign on massive scale. More than 2100 employees and students of this Institute together took the task to clean every nook and corner of 1400 acre area of NDRI. Residents of NDRI were sensitized for the making their surroundings clean. The employees of NDRI launched several campaigns jointly with villagers to implement the Hon'ble Prime minister's call for National Sanitation Campaign (Swachh Bharat Abhiyan) nearby Karnal district and (Swachchta Pakhwada) was also celebrated twice at the institute during the period from 16th - 31st May, and 16th – 31st October, 2016, respectively. And also cleaned office area including nearby gardens, back yards, parking lot corridors, roofs and laboratories.

On 2nd Octomber, 2016, all employees and students of the Institute together took the mission forward and cleaned individual chambers/ offices, laboratories and the corridors. Laboratories were also re-organised, by discarding old chemical solutions, samples etc. All the old records were screened out, segregated and put at proper place for future use; Working areas, slabs, chemical & media racks, storage, shelves refrigerators, equipments in laboratories were cleaned while the chemicals & media were re-arranged. In addition, cleaning of Machine Workshop, Electrical Store, Civil Store, Office, Carpentry Workshop, Refrigeration Wing, Civil Wing, and Electrical Wing of Maintenance Engineering Section were also cleaned during this period.

Regional Campuses, Southern Campus, Bengaluru and Eastern Campus, Kalyani also organised cleanliness drive. All the staff members and students cleaned the office and residential areas and premises of regional campuses.

Awareness Campaigns

A team of extension scientists also organised 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. The emphasis was given for wider adoption of the bio-waste management towards minimizing as well as processing of bio-wastes into clean and environment-friendly bio-fuels & organic manures and effective waste management and use of composite manure for improving soil fertility, collection of organic waste materials like organic garbage, tree-leaves, etc during the various awareness campaigns organized on "*Swachh Bharat Abhiyan* by the Institute in the nearby villages. Awareness was also created among the farmers enrolled with the "*Farmers' Farm School*" about the importance of sanitation. KVK also sensitized the farmers and farm women to keep the surrounding environment neat and clean during campaign drives and training programmes.

As a part of Swachha Bharath Abhiyan, staff and students of Southern Campus of Bengaluru carried out cleaning of the premises on every Saturday afternoon, which improved the cleanliness of the campus.

Clean and Green Drive

The plants planted last year in the campus area were being jointly taken care of the Institute Staff and the Estate Section of the Institute. All the plants are healthy and growing well. A large number of tree saplings were planted in the campus on 15th August 2016. Dairy Extension Division of NDRI, organised meetings with farmers, farm women and village youth and emphasis was given on maintaining clean environment, healthy lifestyle and sustainable livelihood in rural area. The villagers were also sensitized about climate resilient technologies and approaches. The interactions were followed by tree plantations in adopted villages. A team of extension scientists/technical officers also interacted with the villagers and emphasised on the need for cleaning and sanitizing of the sheds. They also advised the dairy farmers/farm women to follow the practices associated with '*Clean Milk Production*'. Farmers were also asked to provide the clean water to animals for prevention of stomach disorders and internal parasites. Importance of feeding of mineral mixture to animals was also emphasized by the team for maintenance of production and reproduction performance of animals, so that the farmers can get better milk yield to enhance their income. The farmers were educated about the prevention of mastitis in the dairy and significance of maintaining health & hygiene at the household-level, in the rural areas.

As a part of the initiative, about 700 tree saplings were planted in the Southern campus of NDRI, Bengaluru. The staff and students took active part in the event. Dr. A. N. Yellappa Reddy, Member, Karnataka High Court of Lok Adalat, as well as the Chief Advisor, Bengaluru University Bio-diversity Park, addressed the gathering and highlighted the importance of ecology and fodder trees for animal feed.

In this context, it may be mentioned here that one special "*Cleanliness Drive*" was undertaken at the Institute-level, on 2nd October, 2016 on the occasion of '*Gandhi Jayanti*'. Apart from that, *Swachchhta Pakhwada* was also celebrated twice, at the Institute, during the period of 16th – 31st May, 2016 and 16th – 31st October, 2016, respectively.

Dr. Trilochan Mohapatra, Secretary, (DARE) & DG, ICAR planting sapling during his visit at Eastern Campus, Kalyani

MERA GAON MERA GAURAV (MGMG)

This *Scheme* has been initiated at the Institute-level (as per the directives of the I.C.A.R.) since August-September 2015. As of now, 29 teams comprising of 4 Scientists each from different disciplines of the Institute have been 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. During the period under report, various teams of the Institution visited nearby villages and carried out following activities such as Interface Meetings/ Sangoshties Trainings/ Demonstrations/Mobile-based Advisory Services/Literature support provided/Awareness created on (Topics: Health and hygiene, Balanced feeding of dairy animals, Importance of girls' education, Purchasing only Indian items to promote indigenous products, Eco-friendly celebration of festivals, Preparation of Milk products & Value-addition, Winter management techniques for crops and animals, 'Scientific Dairy Farming' practices and Swachchh Bharat Abhiyaan)

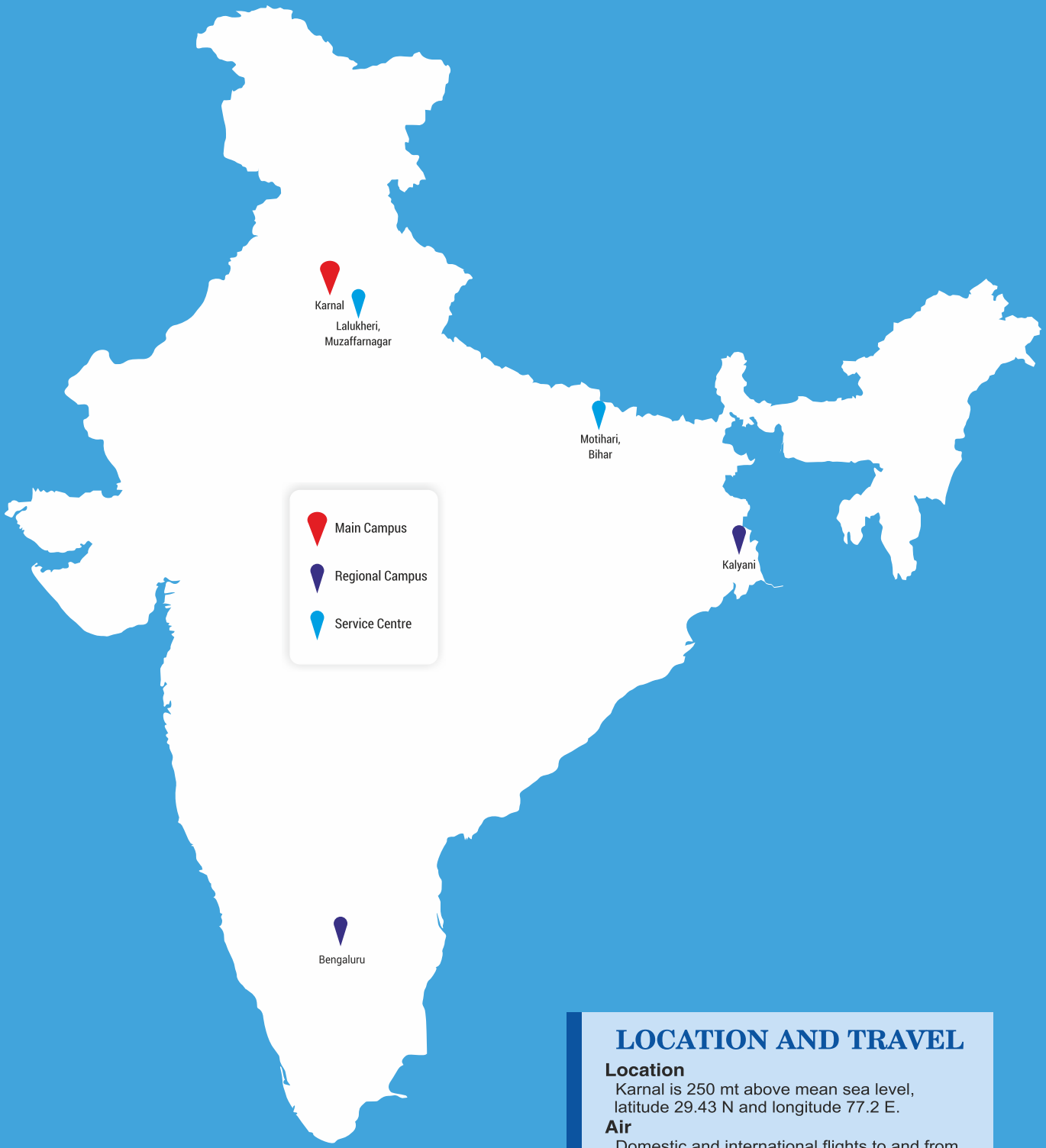
NDRI developed linkages with other agencies, viz NABARD office, Karnal, Jan Kalyan Samiti, Karnal, Arpana Trust, Karnal, Pragati Social Service, Karnal, IARI, New Delhi, N K Dairy Equipments, Karnal, CSSRI, Karnal (under Farmers First Project), Regional Station of IARI, New Delhi (at Karnal), Regional Station of Sugarcane Breeding Institute, Coimbatore (at Karnal) for creating awareness anong farmers about scientific dairy farming and dairy management practices for better economic returns to farmers.

Southern Campus of NDRI, Bengaluru

A cluster of villages was identified in Bengaluru Rural Districts and six groups of scientists, comprising four scientists from different multi-disciplinary team were formed to conduct the baseline survey and further implementation of need based institute interventions and other developmental activities on regular basis under Mera Gaon Mera Gaurav Programme.

Eastern Campus of NDRI, Kalyani

'Mera Gaon Mera Gourav' programme in selected villages was implemented. Twenty five village visits were organized to update the knowledge of dairy farmers about scientific dairy farming. Thirteen Kissan Sangosthies were organized and technical literature was distributed among the farmers. Seeds of Maize (Variety-African Tall) and Cowpea (Variety-B.L.-1) were distributed. Demonstration pertaining to azolla cultivation was also organized in the farmer's field. Regular mobile based advisory services through SMS disseminating important technical information were also rendered to the famers.



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^{0}C
Max. Temperature in summer : 45^{0}C
Annual Rainfall : 70 cm

ICAR-NATIONAL DAIRY RESEARCH INSTITUTE
(Deemed University)
Karnal - 132 001 India
Tel. : 0184-2252800 | Fax : 0184-2250042 | E-mail : dir@ndri.res.in
Website : www.ndri.res.in

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