भाकृअनुप
ICAR

2015-16

वार्षिक प्रतिवेदन
Annual Report

ndri

भाकृअप–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 Universit 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 tate-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.

Centre of Excellence in Milk Safety established 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.

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.

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 in Dairy Sector.
- Dissemination of Innovative Dairy Technologies.

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ANNUAL REPORT 2015-16



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PREFACE



It gives me an immense pleasure to present before you the Annual Report of NDRI for the period 2015-16. The report chronicles the significant achievements of the Institute in the area of Dairy Research, Education, Extension and related activities initiated to strengthen these programmes. The information has been so arranged that it provides a holistic view of this premier dairy Institute of the country and its functioning.

During the year 2015-16, the research and development agenda of NDRI got further impetus through well-defined and structured research programmes comprising 72 in-house and 78 externally funded research projects. NDRI has been successful in getting external funding from almost all leading national funding agencies viz., Department of Biotechnology (DBT), Department of Science and Technology (DST), National Bank for Agriculture and Rural Development (NABARD), National Dairy Development Board (NDDB), National Bureau of Agriculturally Important Micro-organisms (NBAIM), National Fund for Basic and Strategic Research on Agriculture (NFBSARA), Ministry of Food Processing Industries (MoFPI), Department of Atomic Energy (DAE), Indian Council of Medical Research (ICMR) and Department of Animal Husbandry and Dairying (DAHD).

The Institute has been continuously successful in establishing its forte in the area of cloning by producing many cloned calves one after the other. A female cloned calf named 'Swarupa' produced through 'Hand-guided Cloning' was born on August 1, 2015. 'Swarupa' is a clone of 'Karan-Kirti', the highest milk producing Murrah buffalo at NDRI Livestock Research Centre. NDRI also procured 34 Gir milk cattle from ICAR-Indian Grassland and Fodder Research Institute (IGFRI), Jhansi in a bid to conserve the Gujarat breed famous for its tolerance to stress and resistance to tropical diseases. Initiatives are being taken to establish 'Bull Mother Farm' at livestock research centre of NDRI. Concerted efforts are directed towards genomic selection for improvement of reproduction and production performance in dairy animals and digitization of pedigree and performance records of cattle and buffaloes.

In the area of dairy processing, some of the significant research achievements include a novel method for fortification of paneer with iron using edible biopolymers; reduction of sodium up to 70% in many cheese varieties including Cheddar, Mozzarella and Processed cheese without compromising the quality characteristics of cheese; and development of protocols for cream cheese, cheese dip and wheat grass incorporated yoghurt cheese. Studies have revealed that

orange peel, pomegranate peel and grape seed are excellent natural sources of antioxidants for use in fat rich dairy food products like ghee to retard oxidative deterioration.

To address the growing concern for adulterated milk, paper strip based test for rapid detection of sucrose in milk has been developed. A PCR based methodology has been developed to detect the pig body fat (lard) in Ghee. The paper strip assay developed for pesticide detection is based on novel approach of exploiting spores as bio-recognition elements. Paper strip assay has also been developed for detection of antibiotics in milk employing marker enzymes and demonstrated sensitivity against different group of antibiotics i.e. penicillin, cephalosporin, streptomycin, sulfa drugs, macrolides at their regulatory codex limits.

In the area of mechanization, Semi automatic weight based filling system for kheer has been developed. Program to view colour of the dairy and food products on the basis of CIE Lab values; Turbo assisted Scraped Surface Heat Exchanger (SSHE); Prototype of ohmic milk heating system (1 litre capacity); microprocessor based automated instrumentation system for pneumatic paneer hoop-cum-press unit and an Infrared Assisted Baking Oven are a few other innovations made in the area of process engineering. The Institute has also initiated waste segregation at source as a step towards waste reduction and management and also to reduce environmental pollution.

NDRI has been ranked as 4th top Agricultural University of India as per the published reports. In addition to National Diploma in Dairy Technology at Southern Regional Station Bangalore, the Institute has also started Diploma in Animal Husbandry and Dairying at its Eastern Regional Station, Kalyani from the year 2014-15. A new Post Graduate course entitled "Food Science and Nutrition" has been introduced from the academic session 2016-17.

Fourteenth Convocation of NDRI was held on 5th March, 2016. Prof. Kaptan Singh Solanki, Hon'ble Governor of Haryana was the Chief Guest on the occasion. Dr. Jimmy Smith, Director General, ILRI, Kenya delivered the Convocation Address. Seventh Dr. D. Sundaresan Memorial Oration Award was bestowed upon Dr. R. B. Singh, Chancellor, Central Agricultural University, Imphal. Dr. K. K. Iya Memorial Oration Award was presented to Dr. Gurbachan Singh, Chairman ASRB, New Delhi and Dr N. N. Dastur Memorial Oration Award to Dr. B. N. Mathur, Former Director NDRI, Karnal & NAARM, Hyderabad.

A unique extension initiative, "Farmers' School" was taken up further by National Dairy Research Institute, in which 20 farmers of Gorgarh village in Karnal district were enrolled for imparting non- formal education on all aspects of agriculture. The Innovative Approach "Dairy Education at Farmers' Door" initiated by NDRI, has reached the end of the 6th year. Under this programme, a team of NDRI scientists including subject matter specialists from production, processing and management disciplines, visits villages on 2nd Saturday of every Month. Twenty four Kisan Sangoshties were organized with the dairy farmers and farm women in the adopted villages for transfer of technologies developed during 2015-16. Thirty three women empowerment training courses and campaigns were organized benefiting 555 farm women. KVK of NDRI organized 220 training programmes (both on campus and off campus) on different aspects of dairying and allied fields of agriculture for the benefit of over 7400 farmers, farm women, rural youth and entrepreneurs.

Entrepreneurship Development Programme has been restructured to cover all dairy products and extended its duration from 6 days to 10 days. Agri-business programme has also been initiated for establishing firm linkages for the technologies developed at the Institute. For entrepreneurship development, BPD unit organized 17 training programmes during 2015-16. A total number of 292 trainees participated in two Entrepreneurship Development Programmes on "Commercial Dairy Farming". A total of 16 incubatees were enrolled under the mentorship of scientists of NDRI, Karnal and graduated to start their business ventures. Six entrepreneurs initiated their ventures under business incubation through TBI and most of the ventures were initiated with the technologies sourced from NDRI, Karnal. Besides, these active hand-holding of trainees from various ED

programmes resulted in establishment of more than 170 business ventures including 130 dairy farms, 37 milk processing units, three food processing units and one feed manufacturing unit.

During 2015-16, ISO 9001:2008 certification to NDRI was reaffirmed for Research, Teaching, Training and Consultancy in the field of Dairy Production, Dairy Processing and Dairy Management. Another landmark has been the creation of a new Boys Hostel and a Girls Hostel having the capacity to lodge 150 boys and 50 girls, respectively. Sports Complex/Multipurpose Hall (Kalki-Bhawan) and a twenty room Guest House has been made fully functional at NDRI, Karnal.

All this could be achieved by the Institute with the dedication, hard work, cooperation and understanding of the NDRI fraternity. Here I feel privileged to acknowledge and place on record the contributions made by the Joint Directors, Senior Officers, Faculty, Staff and students of NDRI in the growth of the Institute. I am sure that with their unrelenting support and efforts, we would be able to march ahead in fulfilling the mandate and objectives of NDRI and bring success and glory to the Institute in the years to come.

I sincerely hope that this Annual Report would serve as a source of valuable information to the professionals of the Scientific as well as Academic Institutions and other Dairy Development Organizations in the country.



(A. K. Srivastava)

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 Bangalore, the headquarters of the Institute were moved to the present location at Karnal in 1955. It has two regional stations, one at Bangalore 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/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 and D activities viz. i) Dairy Production, ii) Dairy Processing and iii) Dairy Extension/Management. All the R and D activities are managed through thirteen Research Divisions/Sections, namely, Dairy Cattle Breeding, Livestock Production and Management, Dairy Cattle Nutrition, Forage Research, Dairy Cattle Physiology, Animal Biochemistry, Animal Biotechnology, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, Dairy Extension and Dairy Economics, Statistics and Management at the main station and its two regional stations. The Institute also has an Agricultural Technology Information Centre (ATIC), Krishi Vigyan Kendra and Dairy Training Centre and Artificial Breeding Research Centre. The Institute has infrastructure consisting of central facilities such as Livestock Research Centre, Forage Research and Management Centre, Animal Health Complex, Model Dairy Plant, Technology Business Incubator, Business Planning and Development Unit, National Referral Laboratory for Milk Quality and Safety, Experimental Dairy Plant, Consultancy Unit, Library and National Bio-informatic Centre, Computer Centre, Estate Section and Maintenance Engineering Section. The administrative functions viz. purchase, stores and security are under the administrative control of the Joint Director (Admn.) and Registrar, whereas finance division is under the administrative control of Comptroller (Finance). The Institute presently has strength of 160 scientists, 220 technicians, 132 administrative and 469 skilled supporting staff.

BUDGET OUTLAY

The financial outlays of the Institute in terms of actual expenditure for Plan and Non-plan for the year 2015-2016 was ₹ 16898.70 lakhs and budget sanctioned for plan and non-plan for the year 2015-2016 was ₹ 16936.00 lakhs. These figures include the financial outlays for the strengthening of Regional Stations.

RESEARCH

A total number of 72 in-house and 78 externally funded research projects were in operation during the year 2015. In order to strengthen basic and strategic research, funding from five extra-mural research projects has touched approximately ₹ 116.15 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 Bureau of Agriculturally Important Micro-organisms (NBAIM), National Fund for Basic and Strategic Research on Agriculture (NFBSARA), Ministry of Food Processing Industries (MoFPI), Department of Atomic Energy (DAE) and Indian Council of Medical Research (ICMR).

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

- A female cloned calf named '**Swarupa**' produced through 'Hand-guided Cloning' was born on August 1, 2015. Swarupa is a clone of 'Karan-Kirti', the highest milk producing Murrah buffalo at NDRI Livestock Research Centre.
- Transgenic buffalo embryos containing human insulin gene were produced from transfected buffalo fetal fibroblasts.
- Transgenic goat embryos containing human lactoferrin gene were produced using transfected goat fetal fibroblasts as donor cells.
- Germ line cell-specific genes were identified in buffalo and buffalo embryonic stem cell lines were differentiated towards germ lineage.
- VASA-transgenic buffalo embryonic stem cell lines were established and differentiated to germ lineage.
- Oocyte-like cells were generated from goat ovarian epithelial stem cells.
- Global transcriptome profiling was carried out in goat embryos at different stages of development, produced by *in vitro* fertilization, somatic cell nuclear transfer and parthenogenesis.
- High throughput RNA sequencing of buffalo oocytes revealed genes, which are significantly affected in 'Good' vs. 'Bad' oocytes. Affected pathways in inferior quality oocytes were identified.
- Buffalo recombinant interferon-tau was produced.
- Buffalo oocytes were found to be most vulnerable to heat stress-related effects during their mid maturation phase.
- A battery of unique non-coding mi & pi RNAs was discovered in buffalo oocytes, which could be linked to their competence. Major genes under CLR and NLR category were amplified and sequenced completely.
- Potential protein biomarkers were identified in urine and serum of cows for early detection of pregnancy 16 days post artificial insemination.
- Methods were standardized for *in vitro* differentiation of buffalo mammary epithelial cells for expression of milk proteins (casein).
- The function of MGP-40, a mammary-specific protein which protects the loss of mammary epithelial cells during mammary gland involution via activation of STAT-3 phosphorylation, was deciphered.
- 3-D structure of buffalo oviductin was determined. It was found to have a chitinase- like domain and a mucin domain.
- Buffalo oviductin was observed to have a positive effect on several sperm quality-related parameters such as motility, viability, acrosomal integrity and capacitation. Oviductin was found to increase cleavage rate and blastocyst formation during IVF.
- Salivary proteome of Sahiwal cows revealed 3000 proteins, which is the highest number reported hitherto.
- A stably transfected COS-1 cell line was established which expressed recombinant buffalo leukemia inhibitory factor.
- Recombinant buffalo GDF9 (57 kDa) was shown to enhance cleavage and blastocyst rate during production of IVF buffalo embryos.
- A peptide based anti-LH antibody was developed for estrus detection.
- HDAC inhibitor attenuates LPS mediated inhibition of aromatase (*CYP19A1*) expression and 17β-estradiol production in granulosa cells. This has been proposed as a potential therapeutic strategy to treat infertility underlying postpartum uterine infections.
- Direct saliva transcript analysis was identified as a novel non-invasive method for oestrus marker detection in buffaloes.

- Buffalo salivary fern patterns at the oestrus showed lower fractal dimension values than other days of an oestrous cycle.
- Three models were developed for the prediction of the energy value of milk which could be used as one of the selection criteria of Murrah buffaloes by the dairy industry to judge the milk quality of Murrah buffaloes and assessing the nutritional security in any village rearing this breed of buffaloes in the country.
- Four Murrah bulls were selected in the 16th set under Network Project on Buffalo Improvement.
- Single-trait animal model was found to be superior than other single trait sire evaluation methods in KF cattle.
- Multi-trait evaluation methodology was developed for selection and sire evaluation for higher productivity and fertility in KF cattle.
- Multi-trait animal model was developed for selection of Murrah buffaloes for higher fertility and milk production.
- In organized herd under PT programme, Murrah bulls should be used prior to 3.5 years, which is expected to result in 5.08 % better CR based on first A.I, in comparison to Murrah bulls used after 4.5 years of age.
- A methodology was developed for prediction of lifetime milk production of Tharparkar cows.
- Best THI model was identified to assess the heat stress in Murrah buffaloes in relation to reproductive performance. THI should be ≤ 75 for better reproduction performance in Murrah buffaloes.
- Random regression model (RRM) was developed for accurate estimation of genetic parameters of test day milk yields & breeding value prediction in Sahiwal animals.
- Cytogenetic and molecular cytogenetic techniques were developed for identification of dairy animals with sub-fertility problems in the herd.
- The immune response candidate genes were explored for polymorphism using PCR-RFLP analysis and their association with clinical mastitis in Sahiwal, Karan Fries cattle and Murrah buffaloes was studied.
- The differential association of genetic variants of immune response genes with clinical mastitis can be utilized as an aid to selection after validation on large number of dairy animals.
- The increase in ambient CO_2 levels and elevated temperature, which are important factors of the climate change significantly affected livestock, particularly the crossbred heifers.
- The enzyme immunoassay was standardized and validated for androstenedione estimation in bovine plasma.
- It was observed that THI had positive correlation with plasma prolactin, semen volume and negative corelation with sperm motility, viability and membrane functions.
- Expression of HSP70, HSP90, HSP105 and HSF1 increased during summer and HSP27 during winter season as a natural protective and homeostatic response to thermal stress in bulls.
- A down-streaming of adhesion molecules of neutrophils and pro-inflammatory cytokines was observed in pregnant cows during peri-implantation period.
- Up-regulation of interferon stimulated genes (ISG15, OAS1, MX, IFI 16) had its association with successful implantation in pregnant cows.
- Extended short day photoperiod (ESDP) improved significantly the BCS and body weights of buffalo heifers.
- Female Murrah buffaloes supplemented with fermented yeast culture attained puberty by 20 months and conceived by 24 months of age. Male calves attained puberty by 24 months of age.
- Prilled fat supplementation (75-100g/d) during transition period and in early lactation increased milk production by 10 and 15 % in crossbred cows and buffaloes, respectively.

- Beneficial fatty acids for human health (MUFA, PUFA and CLA) increased in milk of different farm animals during winter season due to higher availability of naturally grown fresh grass and green fodders which are rich source of unsaturated fatty acids.
- Supplementation of mustard oil, soybean oil and rice bran oil @ 3.5% of concentrate mixture, influenced significantly (P<0.05) number of small size follicles (<3 mm) and medium size follicles (3-6 mm)
- Total conjugated linoleic acid concentration (g/100 g fat) was higher (P<0.05) (30-40%) in winter than summer. Sheep milk contains the highest concentration of CLA which was 0.75 g in winter and 0.46g in summer.
- Bioavailability and retention of the minerals vary with feed. Mn bioavailabilty showed wide variation i.e 1.7-9.1 % in the cakes.
- Fe retention was in the range 3-6% in maize/ oats while it was retained upto 10% from berseem fodders.
- CP and DCP requirement for maintenance during summer and winter season was revealed from equation were 5.83, 4.25 g/kg$W^{0.75}$ and 5.97, 4.16 g/kg $W^{0.75}$, respectively in Murrah buffalo heifers.
- Methane emission by Indian Livestock is 10.52 Tg/yr and Nitrous oxide is 80 Gg/yr as per 2012 livestock census.
- First transcriptome and variant analysis at base resolutions level of *B.indicus* Malnad Gidda cattle was carried out. From the variant analysis of the sequencing data ~10,000 SNPs in coding regions were found among which ~9,000 were novel and ~6,400 were amino acid changing.
- A high degree of genetic variability in aquaporin 7 gene was observed in Khillari cattle and buffaloes (Murrah and Surti buffaloes). The observed association between genetic variants and semen quality traits offers an opportunity towards identification of markers for semen quality traits.
- A total of 42 plants belonging to 27 families were found to be used commonly by Malnad Gidda keepers and traditional healers of Karnataka for the treatment of livestock as well as for their functional properties.
- Studies showed that there exists high degree of genetic variation between Khillari and HF bulls with respect to coding regions of FSH-β, INH-α, LH-β and KiSS1 genes. The entire coding region of INH-β gene was highly conserved in both HF and Khillari bulls.
- Similar genetic identity (99%) with *Bos taurus* and *Bos indicus* were observed both in Deoni and Jersey crossbred cattle.
- Sequence analysis of TLR2 gene revealed fourteen nucleotide changes (SNPs) in both the breeds (14 SNPs in Deoni and 16 in Jersey crossbred cattle).
- CMT, EC and digital reader Porta check (PortaSC$^{C®}$) were found to be good indicators for detection of subclinical mastitis under field conditions.
- Information on TLR2 genotypes and their association with udder health parameters, TDMY and fat percent could be strong support to initiate marker assisted selection.
- The ejaculates with desired neat semen quality and initial progressive motility (>70 %) were subjected to freezing using Tris and Egg Yolk Citrate extender and about 1,990 AI doses of Deoni and 12,745 AI doses of Malnad Gidda were cryopreserved.
- Supplementation of optimum doses of fat and water soluble vitamins in lactating cows improved extent and rate of fermentation.
- Both fat and water soluble vitamins had collectively exhaustive effect on the microbial protein production and immunity in the rumen of lactating cows.
- The stability of Sodium Caseinate stabilized curcumin nanoemulsion in Ice-cream was ascertained.
- Buffalo casein hydrolysates enriched with potential antioxidant peptides were developed.

- A novel method for fortification of paneer with iron was developed using edible biopolymers. The process resulted in increasing of iron content of paneer from 31 to 94 mg/kg (on dry basis).
- The amount of sodium in many cheese varieties including Cheddar, Mozzarella and Processed cheese was reduced up to 70% sodium without compromising the quality characteristics of cheese.
- A study revealed that orange peel, pomegranate peel and grape seed could be good natural sources of antioxidants for using in fat rich dairy food products like ghee to retard oxidative deterioration.
- Manufacturing protocols were developed for cream cheese, cheese dip and wheat grass incorporated yoghurt cheese.
- Consumption of indigenous probiotic *L. plantarum* MTCC 5690 in the form of fermented dairy foods could increase the functioning of intestinal barrier in normal health as well as enteric infection conditions.
- Metagenomic Sequencing data (554 and 428 Mb) from study groups (20-30 and 50-60 age groups; vegetarians and non-vegetarians) were generated using 454 GS-FLX system.
- Therapeutic potential of two indigenous strains of probiotic *lactobacilli* Lp91 and Lf1 was established in DSS colitis mouse model.
- The study of antibiotic resistance among commercial probiotics demonstrated a wide range of resistance among *Lactobacillus* isolates.
- *Streptococcus thermophilus* NCDC 659, was demonstrated to possess an inherent GSH biosynthesis ability owing to the presence of a bifunctional fusion protein (GshF.
- Two prolific indigenous vitamin B12 producing strains of *Lactobacillus plantarum* namely BCF20 and BHM10 were isolated, identified and characterized. Besides, these strains were also found to possess promising anti *H. pyloric* activity *in-vitro* and per se offers an ideal choice for its use as a multifunctional agent for further *in-vivo*studies focusing on B12 deficiency and *H. pylori* infection models.
- A strip based test was developed for detection of sucrose in milk.
- A PCR based methodology was developed to detect the pig body fat (lard) in Ghee.
- Twenty geospatial maps related to milk production and factors affecting it have been prepared for geo-spatial modelling. A hedonic price model of ghee was developed to estimate the implicit economic values of attributes of ghee including brand name and packaging quality.
- A study indicated that, dairying as whole had a very positive impact on their livelihood and their overall empowerment in terms of increased knowledge level, better adoption of technologies and improved entrepreneurial behavior of SHG members. SHG is a movement for women empowerment; dairying through SHG movement plays a major role in sustaining the livelihood of members.
- Pesticide extraction protocol was optimized and linked with developed colorimetric spore based assay miniaturized on 96 well plate and biochip for better pesticide sensitivity.
- A three step assay was developed for rapid detection of pesticides in milk, especially organophosphorus and carbamate group at ≥ MRL in food matrix including milk and milk products.
- The paper strip assay developed for pesticide detection is based on novel approach of exploiting spores as bio-recognition elements.
- Paper strip assay demonstrated comprehensively detection of organo-phosphorous and Carbamate Groups of pesticide at 1-10ppb limit with great degree of repeatability and selectivity.
- An enzyme based assay was developed for detection of *E. coli* based on marker enzymes by employing ECSM as selective medium in lyophilized form with sensitivity of 0.35 ± 0.10 log cfu/ml within 14.30 ± 0.45 h of incubation at 37°C.

- Paper strip assay was developed for detection of antibiotics in milk employing marker enzymes and demonstrated sensitivity against different group of antibiotics i.e. penicillin, cephalosporin, streptomycin, sulfa drugs, macrolides at their regulatory codex limits.
- A starter culture for Greek Style Yoghurt was formulated.
- Process for Direct Product Probiotic (DPP) *Lactobacillus casei* NCDC 298 and NCDC 610 Cultures by spray drying was standardized.
- Recombinant mucus binding protein (rMub), S-layer protein (rSlp) of lactic acid bacteria were shown to preclude the binding of enterotoxigenic *E. coli* (ETEC) with human enteric cell lines Caco-2 and HT-29.
- Dietary incorporation of galactomannan (a soluble fiber) or diosgenin (a sapogenin) in high fat diet was found to be effective in resisting the epididymal fat mass accumulation and rise in fasting blood glucose in mice.
- Four osteogenic peptides derived from buffalo casein were identified and functionally characterized. The peptide 2 (a nonapeptide) exhibited maximum osteogenic potential.
- A Casein-derived antioxidative peptide VLPVPQK was observed to alleviate hydrogen peroxide-induced oxidative damage and cell death in osteoblast cells via inhibition of ROS production and enhancement of antioxidant defense system.
- Four synthetic peptides (tri, hexa, hepta and decapeptide) out of ten peptides derived from buffalo casein showing significant anti-oxidative potential by chemical methods were evaluated on human intestinal epithelial cells (Caco-2 cells) for cellular response by inducing H_2O_2 stress. No cytotoxic response was shown by any of the four peptides.
- *Lactobacillus rhamnosus* (MTCC 5897), under *in vivo* and *in vitro* trials on mice and intestinal Caco-2 cells, respectively demonstrated its safety with various biochemical indices without any adverse cytotoxic effects.
- By the use of naturally occurring antioxidants like ferulic acid and oryzanol in diet, the hyperlipidemia associated with obesity can be targeted and prevented.
- Goat milk derived casein hydrolysates exhibited better antioxidative potential than goat milk and goat milk derived casein.
- On account of their size, nanomaterials (NMs) can easily diffuse into membrane and hence are responsible for production of free radicals, which cause membrane destabilization leading to cell death.
- DPP-IV inhibitory milk bioactive peptides were generated by fermentation using *Lactobacillus* spp.
- Soya bioactive peptides derived from Glycinin (G1, G2, G3, G4 & G5) and β-conglycinin (α & α′) having ACE-Inhibitory and anti-oxidative property were identified and characterized by LCMS/MS.
- NCDC 144 yoghurt culture was used for blueberry fortified synbiotic fruit yoghurt preparation. Bioactive peptide fractions were prepared from the fruit yoghurt. 10 kDa fractions showed highest antioxidant activity (2076.02 µmol/litres TEAC).
- Maximum lactose hydrolysis and ethanol production was achieved by immobilized *S. cerevisiae* along with chitosan immobilized β-galactosidase.
- The native strain of human origin *Lactobacillus plantarum* HIF 81 was identified and characterized for its cholesterol biotransformation potential besides safety, techno-functional attributes, bile salt hydrolase activity and *in- vivo* efficacy for management of hypercholesterolemia.
- Trehalose contents from *Kluyveromyces marxianus* MTCC 1389 were found to be higher in osmotic stress 190 mg/g cell dry wt and 121 mg/g cell dry wt under NaCl (0.25M) and lactose (15% w/v) stress, respectively as compared to oxidative stress (100 mg/g cell dry wt).

- Colostrum whey fermentates using proteolytic *L. rhamnosus* C28 and *L. rhamnosus* C34 and their 10 kDa fractions of the peptides showed good antimicrobial activity (17 mm) against different pathogens.
- Soymilk supplemented with curcumin(@ 0.04%) and fermented with. *L. acidophilus* NCDC195 (LA195) and *S. thermophilus* NCDC323 (YC323) exhibited antimicrobial activity against broad spectrum of pathogens and antioxidant activity (989.70 TEAC (µM)).
- Differential proteome of *L. fermentum* NCDC 400 in response to bile stress indicated that most of the down regulated proteins were the ones involved in binding activity, cell division, translation and protein folding.
- Semi automatic weight based filling system for *kheer* was developed.
- Program to view colour of the dairy and food products on the basis of CIE Lab values was developed.
- Turbo assisted Scraped Surface Heat Exchanger (SSHE) was developed.
- Prototype of ohmic milk heating system (1 litre capacity) was developed.
- Analysis of energy and exergetic performance of spray drying system for milk-malted millet food indicated that the exergy efficiencies ranged from 8.852 to 11.028%. Also, the relationship between drying air temperature and exergy efficiency was established. In addition, the energy lost to the atmosphere during spray drying was also computed.
- A microprocessor based automated instrumentation system for pneumatic paneer hoop-cum-press unit was developed and its operational efficiency is being studied.
- An Infrared Assisted Baking Oven was developed.
- Value chain analysis of animal feed industry was carried out to suggest upgrading, management and development strategies, especially from the perspective of value chain financing, so that the performance of this important agro-industry can be enhanced to the benefit of dairy sector.
- Impact assessment studies were undertaken for evaluating the technologies, institutional arrangements and development programmes related to dairying.

EDUCATION

- NDRI offered B.Tech (Dairy Technology) a four year degree programme, Masters and Doctoral Degree programmes in sixteen disciplines of Dairying. In addition, the Institute also offered Diploma in Dairy Technology at its Southern Campus, Bangalore and Diploma in Animal Husbandry and Dairying at its Eastern Campus, Kalyani.
- A new post graduate course entitled "Food Science and Nutrition" was introduced in academic session (2016-17).
- M.Tech. Dairy Engineering Programme was restarted at Dairy Engineering Division, NDRI Karnal.
- The Institute had on the rolls 12 foreign students (9 in Doctoral programme, 2 in Masters programme and 1 in Graduate progammes being offered by NDRI Deemed University). These students are from Mauritius, Ethopia, Bangladesh, Vietnam, Eritea, Sudan, Syria, Afganistan and Nigeria.
- Fourteenth Convocation of NDRI was held on 5th March, 2016. Prof. Kaptan Singh Solanki, Hon'ble Governor of Haryana was the Chief Guest on the occasion. Dr. Jimmy Smith DG, (ILRI), Kenya delivered the Convocation Address. Degrees were awarded to 90 Ph.D., 111 Masters and 30 B. Tech. (DT) students on this occasion.
- In the year 2015-16, NDRI organized Academic Week prior to Convocation by organizing the series of academic events such as Memorial lectures & presentation of academic achievements and innovations in teaching by different Heads of Divisions followed by deliberations by panelists, selection of students for Best Thesis Awards, etc. "Best Thesis Awards" were also given to Master's and Doctoral students to encourage spirit of competition and motivation for quality research work.

- Dr. K. K. Iya Memorial Oration Award was presented to Dr. Gurbachan Singh, Chairman ASRB, New Delhi; Dr N. N. Dastur Memorial Oration Award to Dr. B. N. Mathur, Former Director NDRI, Karnal & NAARM, Hyderabad and Dr. D. Sundaresan Memorial Oration Award to Dr. R. B. Singh, Chancellor, Central Agricultural University, Imphal.
- Winter school on "Current Concepts and Frontier Technologies for Fertility Management in Farm Animals" was organized from 5th – 25th October, 2015.
- The Centre of Advanced Faculty Training in Dairy Processing oragnised a National Training programme on "Instrumentation involved in Quality Assurance of Milk and Milk Products" from 3rd – 23rd October, 2015.
- A 21 day winter school was organized on the theme "Advanced Techniques and Novel Approaches for Quality and Safety Evaluation of Dairy Foods" during 17th November to 7th December, 2015.
- A 21 day National Training Programme on "Designing New Age Dairy Foods" was organized under the aegis of Centre of Advanced Faculty Training in Dairy Processing at NDRI from 28th November to 18th December, 2015.
- A short course on "Cross Breed Male Infertility and Bovine Genomics" was organized at NDRI, Karnal during 8th – 17th December, 2015.
- North Zone – Zonal Event of ANVESHAN-2015: The Students Research Conventional was organized by NDRI, Karnal during 28th – 29th December, 2015. A total of 85 research scholars representing 20 universities attended the convention.
- A 21 day Training Programme on " Genetic Evaluation and Multiplication of Superior Germplasm for Genetic Improvement in Livestock" was conducted at NDRI, Karnal from 9th -29th March, 2016.

EXTENSION

- Twenty four Kisan Sangoshties were organized with the dairy farmers and farm women in the adopted villages for transfer of technologies developed during 2015-16. Farmers were also made aware about the reproductive management practices, mastitis control, disease preventive measures, clean milk production practices, preparation of value added milk products, management of fodder scarcity period and round the year green fodder production.
- Thirty three women empowerment training courses and campaigns were organized benefiting 555 farm women. Farm women could generate more income from dairying and maintain healthy atmosphere in their respective families.
- KVK of NDRI organized 220 training programmes (both on campus and off campus) on different aspects of dairying and allied fields of agriculture such as crop production, horticulture, bee keeping and fisheries apart from home science for the benefit of 7410 farmers, farm women, rural youth and entrepreneurs.
- ATIC NDRI provided 6547 services to 10439 persons of different states through video shows, lectures, personal discussions, published literature, toll free phone calls and e-mails.
- NDRI organized 36 Infertility/Veterinary aid Campaigns and Exposure Visits at nearby villages viz., Deepo, Dugro and Gumto. A total number of 920 animals were treated against the contagious diseases, infertility and for pregnancy diagnosis and general veterinary problems.
- An action research study was conducted to promote two women based Self Help Group (SHG) working exclusively on dairying activity around Bengaluru distrct. Interventions through need based trainings and supply of strategic inputs had favourable influence on the livelihood of the member farmers.
- Entrepreneurship Development through BPD unit of ICAR-NDRI organized 17 training programmes during 2015-16. A total number of 292 trainees participated in two Entrepreneurship Development Programmes on "Commercial Dairy Farming". Twenty veterinary officers from Tripura state were trained in the area of infertility management in

dairy animals and 23 Livestock Development Officers from Maharashtra were trained in the areas of Agribusiness and Dairy Technology. A group of 10 participants was imparted training on manufacturing of cheese. Two training programmes were conducted for 49 rural youth on scientific dairy farming and milk and milk products processing.

- A total of 16 incubatees were enrolled under the mentorship of scientists of NDRI, Karnal and graduated to start their business ventures. Six entrepreneurs initiated their ventures under business incubation through TBI and most of the ventures were initiated with the technologies sourced from NDRI, Karnal. Besides, these active hand-holding of trainees from various ED programmes resulted in establishment of more than 170 business ventures including 130 dairy farms, 37 milk processing units, three food processing units and one feed manufacturing unit.
- For strengthening agro-dairy development through need-based interventions at Lalukheri village, Distt. Shamli, (UP) scientists of the Dairy Technology Division, NDRI assisted in establishing an Entrepreneur group and trained them.
- Artificial Breeding Centre conducted two training programes during (2015-16) for the Veterinary officers, quarantine officers and other technical staff of different Semen stations under World Bank Funded National Dairy Plan-I : by NDDB.

INFRASTRUCTURE

- BPD Unit got commissioned and inaugurated.
- A Boys' Hostel (Narmada Hostel) with 150 rooms got constructed and made functional.
- A wing of Kaveri Hostel (Hemavati wing) with 50 rooms got constructed and made functional.
- A Sport Complex with a multi-purpose hall & 24 rooms got constructed.
- The work of grinding and polishing of the Auditorium Building (Dr. D. Sundaresan Hall) was carried out.

NEW INITIATIVES

- Entrepreneurship Development Programme restructured to cover all dairy products and extended duration from 6 days to 10 days.
- One sponsored agri-business programme initiated for establishing firm linkages for the technologies developed at the Institute.
- Dairy Technology Division has initiated waste segregation at source as a step towards waste reduction and management and also to reduce environmental pollution.
- Genomic selection for improvement of reproduction and production performance in dairy animals.
- Digitalization of pedigree and performance records of cattle and buffaloes initiated.
- Establishment of 'Bull Mother farm' at livestock research centre, NDRI Karnal initiated.
- NDRI procured 34 Gir milk cattle from ICAR-Indian Grassland and Fodder Institute (IGFRI), Jhansi in a bid to conserve the Gujarat breed famous for its tolerance to stress and resistance to tropical diseases.
- A new programme Farmers Farm School initiated at Gorgarh village, Karnal with a batch of 20 farmers.

कार्यकारी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का अग्रणी एवं प्रतिष्ठित अनुसंधान संस्थान है जोकि 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 बैंगलोर में स्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में करनाल स्थानान्तरित कर दिया गया। इस संस्थान के दो क्षेत्रीय केंद्र है जो कि बैंगलोर एवं कल्याणी में स्थित हैं। दक्षिण व पूर्वी क्षेत्रीय केंद्र स्थानीय क्षेत्र में कृषि वातावरण के अनुरूप डेरी विकास के लिए अनुसंधान एवं सहयोग प्रदान करने में लगे हुए हैं। शैक्षिक कार्यक्रमों के संचालन हेतु संस्थान को मान्य विश्वविद्यालय का दर्जा प्राप्त है।

संगठनात्मक स्वरूप

संस्थान की प्रबंध प्रणाली भारतीय कृषि अनुसंधान परिषद् 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 एवं विस्तार परिषद, समितियों को सौंपा गया है। संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र (1) डेरी उत्पादन (2) डेरी प्रसंस्करण तथा (3) डेरी विस्तार प्रबंधन है। सभी अनुसंधान एवं विस्तार कार्यक्रम संस्थान के मुख्यालय तथा इसके दो क्षेत्रीय केंद्रों पर संस्थान तेरह प्रभागों/अनुभागों डेरी पशु प्रजनन पशुधन उत्पादन एवं प्रबंधन, डेरी पशुपोषण, चारा अनुसंधान, डेरी पशु शरीर क्रिया विज्ञान, पशु जीवरसायन, पशु जैव प्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी इंजीनियरी, डेरी सूक्ष्मजीव विज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र सांख्यिकी एवं प्रबंधन प्रभाग के अन्तर्गत संपन्न होते हैं। संस्थान में एक कृषि प्रौद्योगिकी सूचना केंद्र (एटिक), कृषि विज्ञान केंद्र तथा डेरी प्रशिक्षण केंद्र भी हैं। संस्थान में पशुधन फार्म, चारा फार्म एवं प्रबंधन केंद्र, पशु स्वास्थ्य परिसर, मॉडल डेरी संयंत्र, टेक्नोलोजी बिजनस इनक्यूबेटर, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय सेवा एवं राष्ट्रीय जैवसूचना केंद्र, कंप्यूटर केंद्र, संपदा अनुभाग, तथा अनुरक्षण इंजीनियरी अनुभाग जैसी केंद्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे वित्त, क्रय, भंडार, स्थापना, राजभाषा एकक तथा सुरक्षा के कार्यकलाप संयुक्त निदेशक (प्रशासन) एवं कुलसचिव के नियंत्रण में है जबकि वित्त विभाग वित्त नियंत्रक (कम्पट्रोलर) के नियंत्रण में हैं। संस्थान में इस समय 160 वैज्ञानिक, 220 तकनीशियन 132 प्रशासनिक तथा 469 निपुण सहायक कर्मचारी सेवारत हैं।

बजट

संस्थान का वर्ष 2015–2016 में योजना और गैर–योजना शीर्ष में वास्तविक व्यय बजट 16898.70 लाख रुपये था तथा वर्ष 2015–16 के लिए योजना एवं गैर–योजना शीर्ष के लिए कुल बजट 16936.00 लाख रुपये स्वीकृत किया गया। इसमें मान्य विश्वविद्यालय तथा कृषि विज्ञान केंद्र तथा क्षेत्रीय केंद्रों का बजट भी शामिल है।

अनुसंधान

वर्ष 2015 के दौरान कुल 72 अन्तः संस्थानीय तथा 78 बाह्य अनुसंधान परियोजनाओं का कार्य चल रहा था। मूल एवं महत्वपूर्ण अनुसंधान कार्यो को सुदृढ़ करने के अतिरिक्त वित्तीय अनुसंधान परियोजनाओं से फंडिंग रु. 116.15 करोड़ रुपये तक पहुंच गई है। राष्ट्रीय डेरी अनुसंधान संस्थान लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेन्सियों जैसे जैव प्रौद्योगिकी विभाग (डी.बी.टी.), विज्ञान एवं प्रौद्योगिकी, 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 उपयोगी सूक्ष्मजीव ब्यूरो (एन.बी.ए.आई.एम.), कृषि पर मूल एवं महत्वपूर्ण अनुसंधान के लिए राष्ट्रीय फंड (एन.एफ.बी.एस.आर.ए.) खाद्य प्रसंस्करण उद्योग मंत्रालय (एम.एफ.पी.आई.), परमाणु ऊर्जा विभाग (डी.ए.ई), भारतीय चिकित्सा अनुसंधान परिषद (आई.सी.एम.आर.), तथा पशुपालन एवं डेयरिंग विभाग (डी.ए.एच.डी.) से बाह वित्तीय सहायता प्राप्त करने में सफल रहा है।

फंडिंग एजेन्सियों से प्राप्त सहायता ने वैज्ञानिकों को स्टेम कोशिका, भैंस की क्लोनिंग, ट्रांसक्रिप्टोन, एम्बयोजनेसिस, बायोसैंसर, नैनोप्रौद्योगिकी, क्षेत्रीय पशुओं में एबायटिक दाब, न्यूट्रास्यूटिकल्स 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।

- 1 अगस्त 2015 को हैंड गाइडिड तकनीक द्वारा स्वरूपा नामक मादा क्लोन का जन्म हुआ। स्वरूपा एनडीआरआई पशुधन अनुसंधान केंद्र की उच्चतम दूध देने वाली मुर्रा भैंस करण–कीर्ति का क्लोन है।
- ट्रांसजैनिक भैंस के भ्रूण जिसमें मानव इन्सुलिन जीन पाया जाता है,जिसको ट्रांसफेक्टेड भैंस के फेटल फाइब्रोब्लास्ट से पैदा किया गया है।

- ट्रांसजैनिक बकरी के भ्रूण जिसमें मानव लेक्टोफेरेन जीन पाया जाता है, का उत्पादन ट्रांसफेक्टेड बकरी के फेटल फाइब्रोब्लास्ट से किया गया।
- जर्म लाइन विशिष्ट कोशिका जीन की भैंस में पहचान की गई तथा भैंस में एम्ब्रयोनिक स्टेम कोशिका लाइन की पहचान जर्म लिनियज की दिशा में किया गया।
- वी.ए.एस.ए. ट्रांसजैनिक भैंस एम्ब्रायोनिक स्टेम कोशिका लाइन को स्थापित किया गया तथा इनकी पहचान की गई।
- बकरी की ओवेरियन इपिथिलियल स्टेम कोशिका से ऊसाईट जैसी कोशिकाएं उत्पन्न की गई।
- इनविट्रो फर्टीलाइजेशन, सोमेटिक कोशिका स्थानान्तरण एवं पार्थेनोजिनेसिस द्वारा बकरी के भ्रूण विकास की विभिन्न अवस्थाओं पर ग्लोबल ट्रांसक्रिप्टोम प्रोफाइलिंग तैयार की गई।
- भैंस के ऊसाईटस में उच्च थ्रोपुट आर.एन.ए. श्रृंखला पहचानी गई, जो अच्छे एवं खराब ऊसाईटस में सार्थक रूप से प्रभावित हुई। प्रभावित पाथवे में निम्न गुणवता के ऊसाईट पहचाने गए।
- भैंस में पुनः संयोजित इंटरफेरोन–टाऊ का उत्पादन किया गया।
- भैंस के ऊसाईट अपनी परिपक्वता के मध्य काल में ऊष्मा संबंधी तनाव के प्रति अधिकतम संवेदनशील पाए गए।
- भैंस के ऊसाईट में एक विशिष्ट नोन कोडिंग एमआई एवं पीआई आरएनएज की बैटरी को खोजा गया, जिनको भैंस की क्षमता के साथ संबंध किया जा सका। सीएलआर एवं एनएलआर श्रेणी के जीन्स मुख्यरूप से आकार में बढ़े हुए एवं पूर्णरूप से श्रेणीबद्ध थे।
- कृत्रिम गर्भाधान के 16 दिन बाद गर्भाधान की पहचान के लिए गाय के मूत्र एवं सिरम में सक्षम प्रोटीन बायोमार्कर की पहचान की गई।
- मैमरी (स्तन) इपिथिलियल कोशिकाओं की पहचान के लिए इंविट्रो तकनीकी को प्रमाणित किया गया, जिससे कि भैंस के दूध की प्रोटीन (केसिन) का प्रदर्शन किया जा सके।
- स्टेट–3 फोसफोराइलेशन को सक्रिय करके एमजीपी–40, एक स्तन विशिष्ट प्रोटीन है, जो स्तन की इपिथिलियन कोशिकाओं की स्तन ग्रंथि इंवोल्युशन के दौरान नुकसान से बचाने वाले कार्यो को पहचाना गया।
- भैंस के ओविडक्सन (डिंबवाहिनी) का 3–डी ढांचा निर्धारित किया गया। इसमें काइटिनेज एवं म्युसिन जैसे डोमेन पाये गए।
- भैंस की डिंबवाहिनी में यह देखा गया कि यह शुक्राणु गुणवत्ता से संबंधित कई कारकों जैसे गतिशीलता, जीवन क्षमता, एक्रोसोमल इंटेग्रेडिटी एवं कैपेसिटेशन पर सकारात्मक प्रभाव रखती है। आईवीएफ के दौरान डिंबवाहिनी क्लीवेज दर एवं ब्लास्टोसिस्ट निर्माण को बढ़ाती है।
- साहीवाल गाय की लार के प्रोटीयोम में 3000 प्रोटीन देखे गए, जोकि आज तक की अधिकतम संख्या है।
- एक स्थाई ट्रांसफेक्टेड सीओएस–1 कोशिका लाइन को स्थापित किया गया, जिसने भैंस के पुनरूसंयोजित ल्युकेमियारोधी कारक को प्रदर्शित किया।
- भैंस के संयोजक जीडीएफ 9 (57 केडीए) ने आईवीएफ भ्रूण के उत्पादन के दौरान क्लेवेज और ब्लास्टोसिस्ट को बढ़ाया।
- इस्ट्रस (मद) पहचान के लिए एक पेप्टाइड आधारित एंटी एलएच एंटीबोडी का विकास किया गया।
- ग्रानुलोसा कोशिकाओं में एरोमेटेज (सीवाईपी19एआई) की अभिव्यक्ति एवं 17 बीटा–इस्ट्राडियोल उत्पादन रोकने में एचडीएसई एलपीएस मिडियेटेड रोधीकारक ने भूमिका निभाई। इसे एक संभावित बांझपन अंतर्निहित प्रसवोत्तर संक्रमण के इलाज के लिए चिकित्सीय रणनीति के रूप में प्रस्तावित किया गया।
- लार के प्रत्यक्ष प्रतिलेख विश्लेषण द्वारा भैंसों में ऑइस्ट्रस पहचान के लिए एक नोवल नोन इंवेजिव विधि को पहचाना गया।
- ऑइस्ट्रस चक्र के दौरान भैंस की लार फर्न पैट्रन में ऑइस्ट्रस के दौरान अन्य दिनों की अपेक्षा कम फ्रेक्शनल डायमेंशन पाए गए।
- दूध की ऊर्जा शक्ति के पूर्व निर्धारण हेतु तीन मॉडल विकसित किए गए। इन मॉडलों का उपयोग मुर्रा भैंस के चयन एवं उसकी दुग्ध गुणवता को मापने तथा जिस गांव में इस नस्ल को पाला जाता है, उनके पोषण सुरक्षा को मापने के लिए एक मापदंड के रूप में डेरी उद्योग द्वारा किया जा सकता है।
- नेटवर्क प्रोजेक्ट के तहत भैंस में सुधार के लिए चार मुर्राहा सांडो का चयन 16वें सैट में किया गया।
- करण फ्रीज गायों में एकल ट्रेट मॉडल अन्य एकल ट्रेट सायर मुल्यांकन विधियों की तुलना में अधिक उत्तम पाया गया।

- करण फ्रीज गायों में उच्च उत्पादकता एवं प्रजनन क्षमता हेतु चयन एवं सायर मुल्यांकन के लिए मल्टी ट्रेट मुल्यांकन विधि विकसित की गई।
- मुर्राहा भैंस में अधिक दुग्ध उत्पादन एवं प्रजनन क्षमता के लिए मल्टी ट्रेट एनीमल मॉडल विकसित किया गया।
- पीटी कार्यक्रम के तहत संगठित पशु समूह में मुर्राहा सांड को 4.5 वर्ष की आयु में उपयोग की तुलना में 3.5 वर्ष से पहले मुर्राहा सांड के उपयोग से सीआर आधारित प्रथम कृत्रिम गर्भाधान में 5.08 प्रतिशत अच्छे परिणाम संभावित हैं।
- थारपारकर गाय के संपूर्ण जीवन भर के दुग्ध उत्पादन की भविष्यवाणी के लिए एक विधि को विकसित किया गया।
- मुर्राहा भैसों की प्रजनन क्षमता के संबंध में ऊष्मा तनाव को जांचने के लिए उत्तम टीएचआई मॉडल पहचाना गया। अच्छी प्रजनन क्षमता के लिए टीएचआई 75 के बराबर या कम होनी चाहिए।
- साहीवाल पशुओं में प्रजनन क्षमता की भविष्यवाणी एवं दुग्ध उत्पादन जांचने के लिए आनुवांशिक कारकों को सही सही मापने के लिए रैंडम रिग्रेशन मॉडल विकसित किया गया।
- पशु समूह में सब–फर्टीलिटी समस्याओं से ग्रसित दूध देने वाले पशुओं की पहचान के लिए साइटोजेनिक एवं मोलिक्युलर साइटोजेनिक तकनीक विकसित की गई।
- पीसीआर–आरएफएलपी विश्लेषण के उपयोग से पोलीमोरफिज्म के लिए रोग प्रतिरोधी प्रतिनिधि जीन के प्रभाव का पता लगाया गया तथा साहीवाल, करण फ्रीज एवं मुर्राहा भैंस में क्लीनिकल मैस्टाइटिस (थनैला) से इनके सह–संबंध का अध्ययन किया गया।
- प्रमाणित अध्ययन के पश्चात क्लीनिकल मैस्टाइटिस (थनैला) के साथ जेनेटिक वैरिएंटस के रोग प्रतिरोधी प्रभाव वाले जीन के बदलते हुए संबंध का एक साधन के रूप में पशु चयन के लिए उपयोग किया जा सकता है।
- जलवायु परिवर्तन के कारकों यथा कार्बनडाइआक्साइड एवं तापमान में बढ़ोतरी ने पशुओं को विशेष रूप से संकर नस्ल की बछडियों को अधिक प्रभावित किया।
- बोवाइन प्लाजा में एनड्रोस्टेनेडियोन मुल्यांकन के लिए एंजाइम प्रतिरक्षा प्रणाली को मानकीकृत एवं प्रमाणित किया गया।
- अध्ययन में यह पाया गया कि टीएचआई प्लाजा प्रोलेक्टिन, वीर्य की मात्रा के साथ धनात्मक रूप से तथा शुक्राणु गतिशीलता, जीवनशीलता एवं मैमब्रेन फंक्शन के साथ गुणात्मक रूप से सह–संबंध था।
- सांडो में ऊष्मा तनाव की प्राकृतिक एवं होम्योस्टेटिक प्रतिक्रिया से गर्मियों के दौरान एचएसपी–70, एचएसपी–90, एचएसपी–105 तथा एचएसएफ–1 तथा शीत ऋतु में एचएसपी–27 की अभिव्यक्ति में वृद्धि हुई।
- गर्भवती गायों में पेरी–इमप्लांटेशन समय के दौरान न्यूट्रोफील्स एडहेजन मोल्युक्ल की डाउन स्ट्रीमिंग एवं प्रो–इनफ्लेमेट्री साइटोकाइनिन को देखा गया।
- इंटरफेरोन द्वारा उत्तेजित होने वाले जीन (आईएसजी–15, ओएएस–1, एमएक्स, आईएफआई–16) के अप–रेगुलेशन का गर्भवति गायों में सफलतापूर्वक इम्प्लांटेशन के साथ संबंध है।
- भैंस की कटडियों के शरीर भार एवं बीसीएस में लघु दिवस प्रकाशावधि काल में बढ़ोतरी द्वारा सार्थक सुधार हुआ।
- जिन मादा मुर्राहा भैंस के फीड को किण्वित खमीर क्लचर द्वारा पोषित किया गया उनमें 20 माह में पबर्टी (योवनावस्था) एवं 24 माह में गर्भधारण किया साथ ही नर बछड़ों ने पबर्टी (योवनावस्था) 24 माह की आयु में पाई।
- संकर गायों और भैंसों के ट्रांजिशन पिरियड एवं प्रारंभिक दुग्ध काल में पूरक प्रिल्लड वसा (75 से 100 ग्राम प्रति दिन) देने से दुग्ध उत्पादन में क्रमश:10 एवं 15 प्रतिशत की बढ़ोतरी हुई।
- सर्दी के मौसम में प्राकृतिक रूप से उगने वाले घास एवं हरे चारे की फसलें जोकि असंतृप्त वसीय अमलों से भरपूर है जिसकी अधिक उपलब्धता के कारण पशुओं के दूध में मानव स्वास्थ्य के लिए लाभदायक वसीय अमल (एमयूएफए, पीयूएफए एवं सीएलए) की दूध में वृद्धि हुई।
- सरसों, सोयाबीन एवं राइसब्रान तेल को दाना मिश्रण के 3.5 प्रतिशत मात्रा पूरक आहार के रूप में देने पर छोटे आकार के फोलेक्यूल्स 3 मिमी. से कम तथा मध्यम से आकार के फोलिक्यूल्स 3 से 6 मिमी. सार्थक रूप से प्रभावित हुए।
- सर्दी के मौसम में गर्मी की अपेक्षा 30 से 40 प्रतिशत कुल कोंज्युगेटिड़ लिनोयिक अम्ल (ग्राम/100 ग्राम वसा) की मात्रा अधिक थी। भेड़ के दूध में सीएलए की मात्रा अधिक पाई गई जो सर्दी में 0.75 एवं गर्मी में 0.46 ग्राम/100 ग्राम वसा थी।
- फीड के साथ खनिज तत्वों की जैव उपलब्धता तथा संग्रहण परिवर्तित होता है। विभिन्न खलियों में मैगनीज तत्व की जैव उपलब्धता 1.7 से 9.1 प्रतिशत तक ही विविधता पाई गई।

- मक्का व जई चारे में पाए जाने वाले लोहा तत्व का रिटेंशन 3 से 6 प्रतिशत तक था जबकि बरसीम चारे में यह 10 प्रतिशत तक था।
- वर्ष 2012 की पशु गणना के आधार पर यह आंका गया कि भारतीय पशुधन द्वारा मिथेन गैस 10.52 टेरा ग्राम प्रतिवर्ष तथा नाइट्रस आक्साइड 80 गिगा ग्राम प्रतिवर्ष छोड़ते हैं।
- मल्नाड गिडा गाय में प्रथम ट्रांसक्रिप्टोम एवं वरिएंट विश्लेषण बी. इंडिकस के आधार रिजोल्युशन स्तर पर किया गया। –10000 एसएनपी श्रृखंलाब) आंकड़ों के वैरिएंट विश्लेषण में –9000 और –6400 बदलते हुए एमिनो एसिड इनकोडिंग क्षेत्र पाए गए।
- खिलारी गाय, मुर्राहा तथा सुरती भैंसों में एक्वापोरिन 7 जीन में उच्च स्तर की आनुवांशिक विभिन्नता पाई गई। आनुवांशिक वैरिएंटस एवं वीर्य गुणवत्ता ट्रेटस के मध्य पाए गए जुड़ाव ने वीर्य गुणवत्ता ट्रेटस पहचानने के लिए मार्करस को ढूंढने की संभावना का एक मौका देते हैं।
- मलनाड गिडा रखने वाले पशुपालक कुल 42 तरह के पौधे जो 27 पादप फैमिली से संबंधित हैं, इनका उपयोग पशुओं के उपचार एवं उनके अंदर पाए जाने वाले कार्यकारी गुणों के कारण करते हैं।
- अध्ययन में पाया गया कि होल्सिटिन फ्रीजन सांड एवं खिलारी नस्ल के बीच एफएसएच–बीटा, आईएनएच–अल्फा, एलएच–बीटा एवं केआईएसएस1 जीन में उच्च स्तर की आनुवांशिक विभिन्नता पाई गई। आईएनएच–बीटा जीन का संपूर्ण कोडिंग रिजन होल्सिटिन फ्रीजन एवं खिलारी सांडो में उच्च मात्रा में संरक्षित था।
- देवनी एवं जर्सी संकर गायों में बोस टौरस एवं बोस इंडिकस के साथ समान आनुवांशिक पहचान 99 प्रतिशत पाई गई।
- टीएलआर 2 जीन के श्रृखंला विश्लेषण में 14 न्यूक्लियोटाइड बदलाव (एसएनपी) दोनों नस्ल में पाए गए (देवनी में 14एसएनपी तथा जर्सी) संकर में 16 एसएनपी) ।
- स्थानीय परिस्थितियों में सब–क्लीनिकल थनैला निदान के लिए सीएमटी, ईसी एवं डिजिटल रिडर पोर्टा चेक अच्छे सूचक पाए गए।
- टीएलआर–2 जीन प्रारूप एवं उनका थन के स्वास्थ्य कारकों, टीडीएमवाई एवं वसा प्रतिशत के साथ जुड़ाव की जानकारी, मार्कर की सहायता से पशु चयन करने की प्रक्रिया को मजबूती प्रदान करेगी।
- ट्रीस एवं अंडे का योक तथा एक्सटेंडर का उपयोग करके फ्रीजिंग द्वारा इजेकुलकेटस की वांछित साफ सुथरी वीर्य गुणवता एवं प्रारंभिक बढ़ती हुई गतिशीलता (70 प्रतिशत से ज्यादा) प्राप्त की गई एवं 1990 देवनी नस्ल की तथा 12745 मलनाड गिडा नस्ल की कृत्रिम गर्भाधान डोजेज क्रायोप्रिजर्व की गई।
- दुधारू गायों में उचित मात्रा में पूरक वसा एवं जल में घुलनशील विटामिन किण्वन की दर को बढ़ाते हैं।
- दुधारू गायों के पेट में रोग प्रतिरोधात्मक क्षमता एवं जीवाणु द्वारा प्रोटीन उत्पादन, वसा एवं जल में घुलनशील विटामिन दोनों के सम्मलित प्रभाव से बढ़ते हैं।
- आईसक्रीम में करक्यूमिन के नैनोइम्लसन को सोडियम केसिनेट को स्थिर करने, का पता लगाया गया।
- खाने योग्य बाइपोलिमर के उपयोग से पनीर में लोहे तत्व का फोर्टीफिकेशन करने की उत्कृष्ट विधि को विकसित किया गया। इस विधि द्वारा पनीर में लोहे तत्व की मात्रा 31 से 94 मिग्रा. प्रति किलोग्राम की वृद्धि हुई।
- अनेक प्रकार की चीज की किस्में जिनमें छेदार, मोजेरिला एवं परिष्कृत चीज भी शामिल हैं, इसमें सोडियम की मात्रा 70 प्रतिशत तक कम की गई तथा चीज की गुणवता से भी समझौता नहीं किया गया।
- अध्ययन में पाया गया कि संतरे के छिलके, अनार के छिलके एवं अंगूर के बीज अच्छे प्राकृतिक एंटीऑक्सीडेंटस के स्रोत हो सकते हैं, इनका उपयोग घी जैसे वसा से भरपूर भोज्य उत्पादों में आक्सीकरण के द्वारा होने वाले नुकसान को रोकने के लिए किया जा सकता है।
- क्रीम चीज, चीज डिप एवं गेहूं व घास मिश्रित योगर्ट चीज को तैयार करने के लिए निर्माण प्रक्रिया विकसित की गई।
- देसी प्रोबायोटिक एल. प्लेनटेरम एमटीसीसी 5690 को किण्वित डेरी खाद्य पदार्थो के रूप में उपयोग से सामान्य स्वास्थ्य के साथ साथ संक्रमण के समय भी आंत्र में ठहराव की क्रिया को बढ़ाया जा सका।
- 454 जीएस–एफएलएक्स प्रणाली उपयोग कर विभिन्न अध्ययन समूहों (20–30 एवं 50–60 आयुवर्ग, शाकाहारी एवं मासाहारी) से मैटाजिनोमिक सिक्वेंस डाटा (554 एवं 428 एमबी) तैयार किया गया।
- डीएसएस कोलाइटिस माउस मश्वडल में प्रोबायोटिक लेक्टोबेसिलाइ एलपी91 एवं एलएफ1 के दो देसी स्ट्रेंस की चिकित्सीय क्षमता को स्थापित किया गया।
- एंटीबायोटिक प्रतिरोध का पता लगाने के लिए एक अध्ययन में व्यापारिक प्रोबायोटिक ने लेक्टोबेसिलस आइसोलेटस की विस्तृत श्रृंखला में प्रदर्शन किया।

- स्ट्रेपटोकोकस थ्रमोफिलस एनसीडीसी 659 में बाइफंक्सनल फ्फयूजन प्रोटीन (जीएसएचएफ) की उपस्थिति के कारण अंतर्निहित जीएसएच जैव संश्लेषण योग्यता प्रदर्शित की।
- लेक्टोबेसिलस प्लांटेरम के दो प्रोलिफिक देसी विटामिन बी12 उत्पादन करने वाले स्ट्रेंस जैसे बीसीएफ–20 एवं बीएचएम–10 की पहचान पृथककरण एवं कैरेक्टराइज किया। इन विट्रो प्रयोग से पता लगता है कि ये स्टेंस बहुत अच्छी एच.पाइलोरिक रोधी गतिविधि भी रखते हैं और बहुकार्यकी एजेंट के रूप में इनविवो प्रयोग जिनमें बी–12 की कमी एवं एच.पाइलोरी संक्रमण मॉडल में उपयोग करने की अच्छी पसंद प्रदान करते हैं।
- दूध में सुक्रोज की मात्रा का पता लगाने के लिए स्ट्रीप आधारित टेस्ट को विकसित किया गया।
- घी में सुअर की चर्बी (लार्ड) का पता लगाने के लिए एवं पीसीआर आधारित कार्य प्रणाली विकसित की गई।
- जियोस्पासियल मॉडलिंग के लिए 20 दुग्ध उत्पादन एवं इसको प्रभावित करते वाले कारकों से संबंधित जियोस्पासियल नक्शे तैयार किए गए। घी को प्रभावित करने वाले कारकों जिसमें ब्रांड नेम एवं पैकेजिंग गुणवत्ता भी शामिल है, का मूल्य निर्धारण के लिए एक हैडोनिक कीमत मॉडल विकसित किया गया।
- एक अध्ययन में पाया गया कि दुग्ध व्यवसाय स्वयं सहायता समूह की जीविकोपार्जन, ज्ञान के स्तर एवं तकनीकों की अच्छी ग्राहियता, सशक्तिकरण एवं उद्यमशीलता में सुधार से बहुत अच्छा धनातात्मक प्रभाव रखता है। स्वयं सहायता समूह महिला सशक्तिकरण के लिए एक अभियान है, स्वयं सहायता समूह अभियान के माध्यम से दुग्ध उत्पादक सदस्यों की आजीविका बनाए रखने में महत्वपूर्ण भूमिका निभाता है।
- अच्छी पेस्टीसाइड संवेदनशीलता के लिए पेस्टीसाइड एक्सट्रेक्शन प्रोटोकश्वल अनुकूलित किया गया और इसको कोलोरिमैट्रीक आधारित एस्से की 96 मिनीएच्चरड प्लेट एवं बायोचीट के साथ संयोजित किया गया।
- दूध एवं दुग्ध उत्पाद में एमआरएल के बराबर या अधिक पेस्टीसाइड विशेष तौर पर ऑर्गेनोफोस्फोरस एवं कार्बामेट समूह की पहचान के लिए तीन स्तरीय एस्से (विधि) विकसित किया गया।
- पेस्टीसाइड पहचान के लिए विकसित पेपर स्ट्रीप एस्से एक आदर्श दृष्टिकोण के रूप में जीवाणुओं के अवशोषण एवं तत्वों के बायोरिकोगनेशन पर आधारित है।
- आर्गेनेफास्फोरस एवं कार्बोमेटस समूह के पेस्टीसाइड को 1–10 पीपीबी सीमा तक पहचान के लिए बहुत अच्छी पुनरावृत्ति एवं चयन योग्य परिणाम हेतु पेपर स्ट्रीप एस्से का प्रदर्शन किया गया।
- इकोलाई की पहचान के लिए एक एंजाइम आधारित परख विकसित की गई, जो मार्कर एंजाइम पर आधारित थी।
- विभिन्न एंटीबायोटिक जैसे पैंसलिन, सेपालोसपोरिन, स्ट्रेप्टोमाइसिन, सल्फा ड्रग्स, मक्रोलाइडस को उनके निर्धारित कोडक्स सीमा तक दूध में पहचान करने के लिए एंजाइम मार्कर आधारित पेपर स्ट्रीप परख विकसित की गई।
- ग्रीक जैसे योगर्ट तैयार करने हेतु स्टार्टर कल्चर बनाया गया।
- डायरेक्ट प्रोडक्ट प्रोबायोटिक लेक्टोबेसिलाई केसाई एनसीडीसी–298 एवं एनसीडीसी–610 कल्चर के लिए स्प्रे द्वारा सुखाने की विधि को मानकीकृत किया गया।
- मनुष्य की इंटरीक कोशिका लाइन केको–2 एवं एचटी–29 के साथ इंटेरोटोक्सीजेनिक ई.कोलाई के बंधन को हटाने में लेक्टीक एसिड बैक्टिरिया की पुनः संयोजित म्यूकस जड़ित प्रोटीन, एस–स्तरीय प्रोटीन में प्रदर्शन किया।
- चूहों में इपीडीडीमल वसा संचय एवं रक्त ग्लूकोज में बढ़ोतरी को प्रभावी रूप से रोकने में, उनके उच्च वसा वाले भोजन में ग्लेक्टोमेनन एवं डायोसजेनिन शामिल करने का प्रभाव पाया गया।
- भैंस के केसिन से चार आस्टीयोजेनिक पैप्टाइड को निकाला गया तथा उनकी पहचान कर कार्यकारी लक्षणों का वर्णन किया गया। पेप्टाइड–2 में अधिकतम आस्टीयोजेनिक क्षमता दर्शायी।
- एक केसिन व्युत्पित एंटीआक्सीडेटिव पेप्पटाइड वीएलपीवीपीक्यूके को आस्टीयोब्लास्ट कोशिकाओं की मृत्यु एवं हाईड्रोजनप्रोक्साइड द्वारा उत्तेजित आक्सीकरण नुकसान रोकने में सहायक पाया गया। ये कार्य आरओएस उत्पादन को रोककर एवं एंटीआक्सीडेंट रक्षा प्रणाली में बढ़ोतरी के माध्यम से किया गया।
- भैंस के 10 केसिन में से 4 सिंथेटिक पेप्टाइड (ट्राई, हैग्जा, हैप्टा एवं डेका पेप्टाइड) व्युत्पित किए गए। जिन्होंने सार्थक एंटीआक्सीडेटिव पोटेंशियल दर्शाया। इनका मूल्यांकन मनुष्य आंत्र की इपिथिलियल कोशिकाओं में उनके कोशिकिय प्रभाव को हाईड्रोजनप्राक्साइड तनाव उत्पन्न कर किया गया। किसी भी पेप्पटाइड द्वारा साइटोटोक्सीक प्रभाव नहीं दिखाया गया।
- चूंहों एवं आंत्र की केको–2 कोशिकाओं में लेक्टोबेसिल्स रहेमनोसस (एमटीसीसी–5897) क्रमशः इनविवो एवं इनविट्रो परीक्षणों द्वारा प्रदर्शित किया गया। प्रदर्शन में ये सुरक्षित थे साथ ही विभिन्न जैव रसायनिक सूचकांको पर भी कोई विपरीत साइटोटोक्सीक प्रभाव नहीं दिखाया गया।

- हाईप्रलिपिडिमिया से जुड़ा हुआ मोटापे को रोकने के लिए भोजन में प्राकृतिक रूप से पैदा होने वाले एंटीआक्सीडेंटस जैसे फेरूलिक अमल एवं ओराइजानोल किया जा सकता है।
- बकरी का दूध एवं उससे व्युत्पित केजीन की तुलना में बकरी के दूध से प्राप्त केजीन हाईड्रोलाइसेटस ने अधिक एंटीआक्सीडेटिव क्षमता दर्शायी।
- नैनो पदार्थो का आकार छोटा होने के कारण मेमब्रेन में आसानी से मिश्रण हो जाता है। जिसके कारण ये फ्री रेडिकल्स के उत्पादन हेतु उत्तरदायी होते हैं, जिनके कारण मेमब्रेन के स्थायित्व में कमी आती है और कोशिकाए मर जाती है।
- लेक्टोबेसिलस स्पीसिज के उपयोग द्वारा किण्वन से डीपीपी–4 रोधक दूध के बायोएक्टीव पेप्टाइड पैदा किए गए।
- ग्लाइसिनिन एवं बीटा–कोनग्लाइसिनीन से सोया बायोएक्टीव पेप्टाइड व्युत्पित किए गए। जिसमें एसीई रोधक एवं एंटीआक्सीडेटिव गुणों की पहचान कर एलसीएमएसध्द्वारा कैरेक्टराइजड भी किया गया।
- ब्ल्युबैरी मिश्रित सिनबायोटिक फलयोगर्ट तैयार करने में एनसीडीसी–144 योगर्ट कल्चर काम में लिया गया। फल योगर्ट से बायोएक्टीव पेप्टाइड के फ्रेक्सन भी तैयार किए गए। 10 केडीए फ्रेक्सन ने अधिकतम एंटीआक्सीडेंट क्रिया दर्शायी (2076.02 माइक्रो मोल प्रति लीटर टीईएसी)।
- चितोसान इमोब्लाइजड़ बीटा–ग्लेक्टोसाइडेज के साथ साथ इमोब्लाइजड एस.केरेवीजी द्वारा अधिकतम लेक्टोस हाईड्रोलाइसिस एवं इथेनोल उत्पादन किया गया।
- मनुष्य से उत्पन्न लेक्टोबेसिलस प्लांटेरम एचआईएफ–81 के मूल स्ट्रेन की पहचान एवं लक्षणों का वर्णन किया गया। हाईपरकालेस्ट्रोलेमिया के प्रबंधन के लिए इसकी कोलेस्ट्रोल सुरक्षा के अलावा बायोट्रांसफोर्मेशन क्षमता, तकनीकी कार्यकारक, बाइलसाल्ट हाईड्रोलेज प्रतिक्रिया को इन–विवो किया गया।
- ऑक्सीडेटिव तनाव (100 मिग्रा. प्रति ग्राम कोशिका के शुष्कभार) की तुलना में क्रमशः सोडियम क्लोराइड तनाव (0.25एम) एवं लेक्टोज तनाव (15 प्रतिशत भारध्आयतन) में क्लूवेरोमाइसेस मार्कसीनस एमटीसीसी 1389 में ट्रेहेलोज की अधिक मात्रा आस्मेटिक तनाव में 190 मिग्रा. प्रति ग्राम कोशिका के शुष्कभार एवं 121 मिग्रा. प्रति ग्राम कोशिका में शुष्कभार पाया गया।
- विभिन्न रोग जनकों के विरूद्ध प्रोटियोलाइटिक एल. रहेमनोसस सी–28 एवं एल. रहेमनोसस सी–34 एवं उनके 10 केडीए फ्रेक्कसन के कोलेस्ट्रन व्हे फर्मेटेटस ने अच्छी एंटीमाक्रोबिएल प्रतिक्रिया दर्शायी (17 एमएम)।
- सोया मिल्क में करक्यूमिन 0.04 प्रतिशत मिश्रित कर एल. एसिडोफिलस एनसीडीसी–195 (एलए–195) एवं एस. थर्मोफिलस एनसीडीसी–323 (वाईसी–323) द्वारा किण्वित करने पर बहुत अधिक रोगाणुजनक के विरूद्ध एंटीमाइक्रोबीयल एवं एंटीआक्सीडेंट गतिविधि (989.70 टीईएसी माइक्रोमोल) प्रदर्शित की।
- तनाव पित्त के कारण एल.फरमेंटम एनसीडीसी–400 के प्रोटीयोम ने दर्शाया कि नीचे के स्तर की सबसे विनियमित प्रोटीनरोधी गतिविधि, कोशिका विभाजन, कोशिका पुनःरूपन और प्रोटीन लेयर में शामिल थे।
- खीर तैयार करने के लिए भार आधारित सेमि आटोमेटिक फिलिंग प्रणाली विकसित की गई।
- सीआईई प्रयोगशाला मूल्यों के आधार पर डेरी एवं खाद्य उत्पादों का रंग देखने के लिए कार्यक्रम तैयार किया गया।
- ट्रबो की सहायता से स्क्रेपड सतही ऊष्मा विनिमयक विकसित किया गया।
- ओहमिक दूध गर्म करने की प्रणाली (1 लीटर क्षमता) का प्रतिरूप तैयार किया गया।
- स्प्रे द्वारा दुग्ध–माल्ट मिलेट खाद्य को सुखाने की प्रणाली का ऊर्जा एवं ऊर्जाशीलता क्षमता का विश्लेषण किया गया तथा पाया गया कि ऊर्जा क्षमताएं 8.852 से 11.028 प्रतिशत के मध्य पाई गई। सुखाने वाली हवा के तापमान एवं ऊर्जा क्षमता के मध्य संबंध स्थापित किया गया, साथ ही सुखाने के दौरान ऊर्जा के हुए नुकसान का आकलन भी किया गया।
- न्यूमेटिक पनीर हूप कम प्रेस इकाई के लिए एक माइक्रो प्रोसेसर आधारित स्वचालित उपकरण प्रणाली विकसित की गई एवं इसकी कार्यकारी क्षमताओं का भी अध्ययन किया गया।
- एक इनफ्रारेड आधारित बेकिंग ओवन विकसित किया गया।
- विभिन्न व्यूह रचनाएं, प्रबंधन एवं सुधार विशेषरूप से वितीय व्यवस्था हेतु सुझाव देने के लिए पशु फीड उद्योग का मूल्य श्रृंखला विश्लेषण किया गया। जिससे कि इस कृषि आधारित उद्योग के लाभ डेरी उद्योग को मिल सकें।
- डेरी से संबंधित विकास कार्यक्रम संस्थागत व्यवस्थाओं एवं तकनीकियों के प्रभाव का मूल्यांकन करने के लिए अध्ययन किया गया।

शिक्षण एवं प्रशिक्षण

- एनडीआरआई बी.टेक. (डेरी प्रौद्योगिकी) में चार साल का स्नातक कार्यक्रम, डेरी के 16 विषयों में परास्नातक और डॉक्टरेट डिग्री पाठ्यक्रम चलाता है। इसके अलावा संस्थान क्षेत्रीय केंद्र बैंगलोर में डेरी प्रौद्योगिकी में डिप्लोमा तथा क्षेत्रीय केंद्र कल्याणी में पशुपालन एवं डेरी में डिप्लोमा पाठ्यक्रम चलाता है।
- एक नया पोस्ट ग्रेजुएट कोर्स खाद्य विज्ञान एवं पोषण शैक्षणिक सत्र (2016–17) में शुरू किया गया था।
- डेरी इंजीनियरिंग विभाग, एनडीआरआई, करनाल में एम.टेक डेरी इंजीनियरिंग पाठ्यक्रम दोबारा से शुरू किया गया।
- संस्थान में 12 विदेशी छात्र (डाक्टरेट प्रोग्राम में 9, परास्नातक में 2 और ग्रेजुएट प्रोग्राम में एक) छात्र शिक्षा प्राप्त कर रहा है। ये विद्यार्थी मॉरीशस, इथोपिया, बांग्लादेश, वियतनाम, इरिटिया, सूडान, सीरिया, अफगानिस्तान और नाइजीरिया से संबंध रखते हैं।
- एनडीआरआई में पांच मार्च 2016 को चौदहवें दीक्षांत समारोह का आयोजन किया गया। माननीय राज्यपाल हरियाणा, प्रो. कप्तान सिंह सोलंकी मुख्य अतिथि रहे। डा. जिमी स्मिथ, महानिदेशक (आईएलआरआई) केन्या ने दीक्षांत भाषण प्रस्तुत किया। इस अवसर पर 90 पीएच.डी. 111 मास्टर्स और 30 बीटेक के छात्रों को डिग्री प्रदान की गई।
- राष्ट्रीय डेरी अनुसंधान संस्थान ने वर्ष 2015–16 में दीक्षांत समारोह से पहले शैक्षणिक सप्ताह आयोजित किया गया। इसमें स्मारक व्याख्यान तथा विभिन्न विभागाध्यक्षों द्वारा शिक्षण में शैक्षिक उपबल्धियों के प्रस्तुतिकरण तथा नवीन विधियों जैसे शैक्षणिक कार्यो की श्रृंखला आयोजित की। इसके अतिरिक्त श्रेष्ठ थीसिस पुरस्कार के लिए छात्रों का चयन, पैनलिस्टों द्वारा विचार विमर्श किया गया। उच्च कोटि का अनुसंधान कार्य करने के लिए प्रतिस्पर्धा की भावना जगाने तथा उन्हें प्रोत्साहित करने के उद्देश्य से श्रेष्ठ थीसिस पुरस्कार भी मास्टर एवं डाक्टरेट छात्रों को प्रदान किए गए।
- डा. के.के. अइया स्मारक व्याख्यान पुरस्कार डा. गुरबचन सिंह, चेयरमैन, एएसआरबी, नई दिल्ली, डा. एन.एन. दस्तूर स्मारक व्याख्यान पुरस्कार डा. बी.एन. माथुर, पूर्व निदेशक एनडीआरआई करनाल तथा नार्म हैदराबाद तथा डा. सुंदरेशन स्माकरक व्याख्यान पुरस्कार डा. आर.बी. सिंह, कुलपति, केंद्रीय कृषि विश्वविद्यालय, इमफाल को प्रदान किया गया।
- मौजूदा अवधारणाओं और डेरी पशुओं में प्रजनन क्षमता प्रबंधन के लिए अग्रणी प्रौद्योगिकियों पर 5 से 25 अक्टूबर 2015 तक शीतकालीन स्कूल का आयोजित किया गया।
- काफ्ट के तत्वावधान में डेरी प्रसंस्करण में दूध की गुणवत्ता आश्वासन और दूध उत्पादों में शामिल उपकरण विषय पर एक राष्ट्रीय प्रशिक्षण कार्यक्रम 3 से 23 अक्टूबर 2015 तक आयोजित किया गया।
- डेरी खाद्य पदार्थो की गुणवत्ता और सुरक्षा मूल्यांकन के लिए उन्नत तकनीक एवं सिफारिश विषय पर 17 नवंबर से 7 दिसंबर तक 21 दिवसीय शीत कालीन स्कूल का आयोजन किया गया।
- एनडीआरआई के डेरी प्रसंस्करण में उन्नत संकाय प्रशिक्षण केंद्र तत्वावधान में डिजाइनिंग न्यू डेरी फूड्स विषय पर आधारित 21 दिवसीय राष्ट्रीय प्रशिक्षण कार्यक्रम 28 नवंबर से 18 दिसंबर तक आयोजित किया गया।
- एनडीआरआई में संकर नस्ल के सांडो में बांझपन और गोजातीय जीनोमिक्स विषय पर दस दिवसीय (8 से 17 दिसंबर) लघु कोर्स का आयोजन किया गया था।
- नोर्थ जोन–जोनल इवेंट आफ अंवेषण 2015 का आयोजन 28 से 29 दिसंबर के दौरान किया गया। इसमें 20 विश्वविद्यालयों का प्रतिनिधत्व करने वाले 85 शोध छात्रों नें इस सम्मेलन में भाग लिया।
- संस्थान में पशुधन आनुवांशिक सुधार के लिए उन्नत जीवद्रवों का परीक्षण एवं वृद्धि विषय पर 21 दिवसीय (9 से 29 मार्च) प्रशिक्षण कार्यक्रम आयोजित किया गया था।

विस्तार

- अपनाए नए गांवों में डेरी कृषकों तथा कृषक महिलाओं के लिए वर्ष 2015–16 के दौरान विकसित प्रौद्योगिकियों के हस्तांतरण के लिए 24 संगोष्ठियां आयोजित की गई। कृषकों को प्रजनन प्रबंधन प्रक्रियाओं, थनैला नियंत्रण, रोग बचाव मापदंड, स्वच्छ दुग्ध उत्पादन प्रक्रियाओं, नवीन डेरी उत्पाद तैयार करना, कम अवधि में हरे चारे का उत्पादन, प्रबंधन तथा पूरे वर्ष हरे चारे का उत्पादन कैसे किया जाये इसके बारे में भी जागरूक किया गया।
- महिलओं के लिए संस्थान में 33 महिला सशक्तिकरण प्रशिक्षण एवं शिविर आयोजित किए गए। इससे 555 कृषक महिलाओं ने लाभ उठाया। ग्रामीण महिलाएं डेयरिंग से अधिकतम आय अर्जित कर सकती है तथा अपने अपने परिवारों में स्वस्थ वातावरण कायम रख सकती हैं।
- राष्ट्रीय डेरी अनुसंधान संस्थान के कृषि विज्ञान केंद्र तथा डेरी प्रशिक्षण केंद्र ने पूरे देश के 7410 कृषकों, ग्रामीण महिलाओं, ग्रामीण युवाओं तथा उद्यमियों के हित के लिए फसल उत्पादन, बागवानी, मधुमक्खी पालन, मत्स्य पालन,

गृहविज्ञान जैसे कृषि से संबंधित क्षेत्रों एवं डयरिंग के विभिन्न पहलुओं पर 220 प्रशिक्षण कार्यक्रम (परिसर पर एवं परिसर से बाहर) आयोजित किए गए।

- राष्ट्रीय डेरी अनुसंधान संस्थान के एटिक केंद्र ने विभिन्न राज्यों के 10439 व्यक्तियों को वीडियो शो, व्याख्यानों, व्यक्तिगत चर्चाओं, प्रकाशित साहित्य, टोल फ्री फोन कौल्स तथा ई–मेल के माध्यम से 6547 सेवाएं प्रदान की।
- राष्ट्रीय डेरी अनुसंधान संस्थान ने समीपस्थ गांवों अर्थात दीपो, डूगरू तथा घुमटु जैसे गांवों में 36 बांझपन के पशुचिकित्सा सहायता शिविर आयोजित किए। कुल 1275 पशुओं का संक्रामक रोगी, बांझपन तथा गर्भाधान निदान एवं सामान्य पशु चिकित्सा संबंधी समस्याओं का उपचार किया गया।
- महिलाओं को प्रोन्नत करने के लिए दो स्वयं सेवी समूह (एस.एच.जी.) चलाए जा रहे हैं जो कि बैंगलोर जिले के आस पास पूर्ण रूप से डेयरिंग संबंधी कार्यकलाप चला रहे हैं। सदस्य कृषको की जीविका पर इन प्रशिक्षणों एवं निवेशों की आर्पूति का अनुकूल प्रभाव था।
- भारतीय कृषि अनुसंधान परिषद–राष्ट्रीय डेरी अनुसंधान संस्थान के बी.पी.डी. यूनिट द्वारा उद्यमिता विकास द्वारा वर्ष 2015–16 के दौरान 17 ट्रेनिंग कार्यक्रम करवाए गए। व्यावसायिक डेरी फार्मिंग पर बी.पी.डी. के द्वारा दो उद्यम विकास कार्यक्रम चलाए गए, जिसमें 292 प्रशिक्षणार्थियों ने भाग लिया। त्रिपुरा राज्य से 20 पशु चिकित्सा अधिकारियों को डेरी पशुओं में बांझपन प्रबंधन के क्षेत्र में दो बैचों में प्रशिक्षित किया तथा महाराष्ट्रा से आए 23 पशु चिकित्सा अधिकारियों को एग्री बिजनेस तथा डेरी टेक्नोलोजी विषय पर प्रशिक्षित किया गया। दस लोगों के एक समूह को चीज बनाने की ट्रेनिंग दी गई। वैज्ञानिक डेरी फार्मिंग, दूध एवं दूध उत्पादों के प्रसंस्करण पर 49 ग्रामीण युवाओं के लिए दो प्रशिक्षण कार्यक्रम आयोजित किए गए।
- एनडीआरआई करनाल के वैज्ञानिकों की सदस्यता के तहत 16 उद्यमियों ने दाखिला लिया, जोकि व्यापाार कारोबार शुरू करने के लिए स्नातक की उपाधि प्राप्त कर रहे थे। छह उद्यमियों ने टी.बी.आई. के माध्यम से व्यापार ऊष्मायन के तहत अपना कारोबार शुरू किया। अधिकतर प्रौद्योगिकियों का स्त्रोत एनडीआरआई करनाल रहा। इसके अलावा विभिन्न प्रवर्तन निदेशालय कार्यक्रमों से प्रशिक्षुओं ने 130 डेरी फार्म, 37 दुग्ध प्रसस्करण इकाइयों, तीन खाद्य प्रसंस्करण इकाइयों, तीन खाद्य प्रसंस्करण इकाइयों और एक फीड इकाई सहित 170 से अधिक कारोबार की स्थापना हुई।
- कृषि डेरी विकास को मजबूत बनाने के लिए उत्तर प्रदेश के शामली जिले के लालूखेड़ी गांव में डेरी प्रौद्योगिकी प्रभाग के वैज्ञानिकों ने एक उद्यमी समूह स्थापित करने में सहायता प्रदान की और उन्हें प्रशिक्षित किया।
- कृत्रिम प्रजनन केंद्र की ओर से पशु चिकित्सा अधिकारी, संगरोध अधिकारियों और अन्य तकनीकी कर्मचारियों के लिए एनडीडीबी के द्वारा वर्ष 2015–16 के दौरान दो प्रशिक्षण कार्यक्रमों का आयोजन किया गया।

नई पहल

- सभी डेरी उत्पादों के बारे में जानकारी देने के लिए उद्यमिता विकास कार्यक्रम का पुनर्गठन किया गया और इसकी अवधि 6 से 10 दिन कर की गई।
- संस्थान द्वारा विकसित की गई तकनीकों का डेरी उद्योग के साथ मजबूत संबंध बनाने के लिए एक प्रायोजित एग्री–बिजनेस कार्यक्रम आयोजित किया गया।
- डेरी टेक्नोलोजी प्रभाग ने पर्यावरण प्रदूषण को कम करने के लिए अपशिष्ट में कमी और प्रबंधन की दिशा में अपशिष्ट पदार्थो का पृथककरण कर इस दिशा में एक कदम आगे बढ़ाया।
- डेरी पशुओं के प्रजनन और उत्पादन में सुधार के लिए जीनोमिक चयन शुरू किया गया।
- गाय और भैंस की वंशावली एवं प्रदर्शन रिकार्ड का डिजिटलीकरण शुरू किया गया है।
- एनडीआरआई के पशुधन अनुसंधान केंद्र में बुल मदर फार्म शुरू किया गया है।
- एनडीआरआई ने आईसीएआर–भारतीय ग्रासलैंड एवं चारा संस्थान झांसी से गुजरात की प्रसिद्ध नस्ल गिर की 34 दूध देने वाली गायों को प्राप्त किया। इससे गुजरात की नस्ल की ऊष्णकटिबंधिय बीमारियों के प्रति रोधी एवं तनाव सहन करने की क्षमता जानने के साथ साथ इनका संरक्षण भी किया जाएगा।
- गांव गोरगढ़ में 20 किसानों के बैच के साथ एक नया फार्मर फार्म स्कूल कार्यक्रम शुरू किया गया।

INTRODUCTION





One Institute - Three Campuses and Two Service Centres

■ 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 Bangalore 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.

■ Main Campus of NDRI, Karnal

This is a unique campus which alongside Deemed University and residential buildings also 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 of NDRI, Bangalore

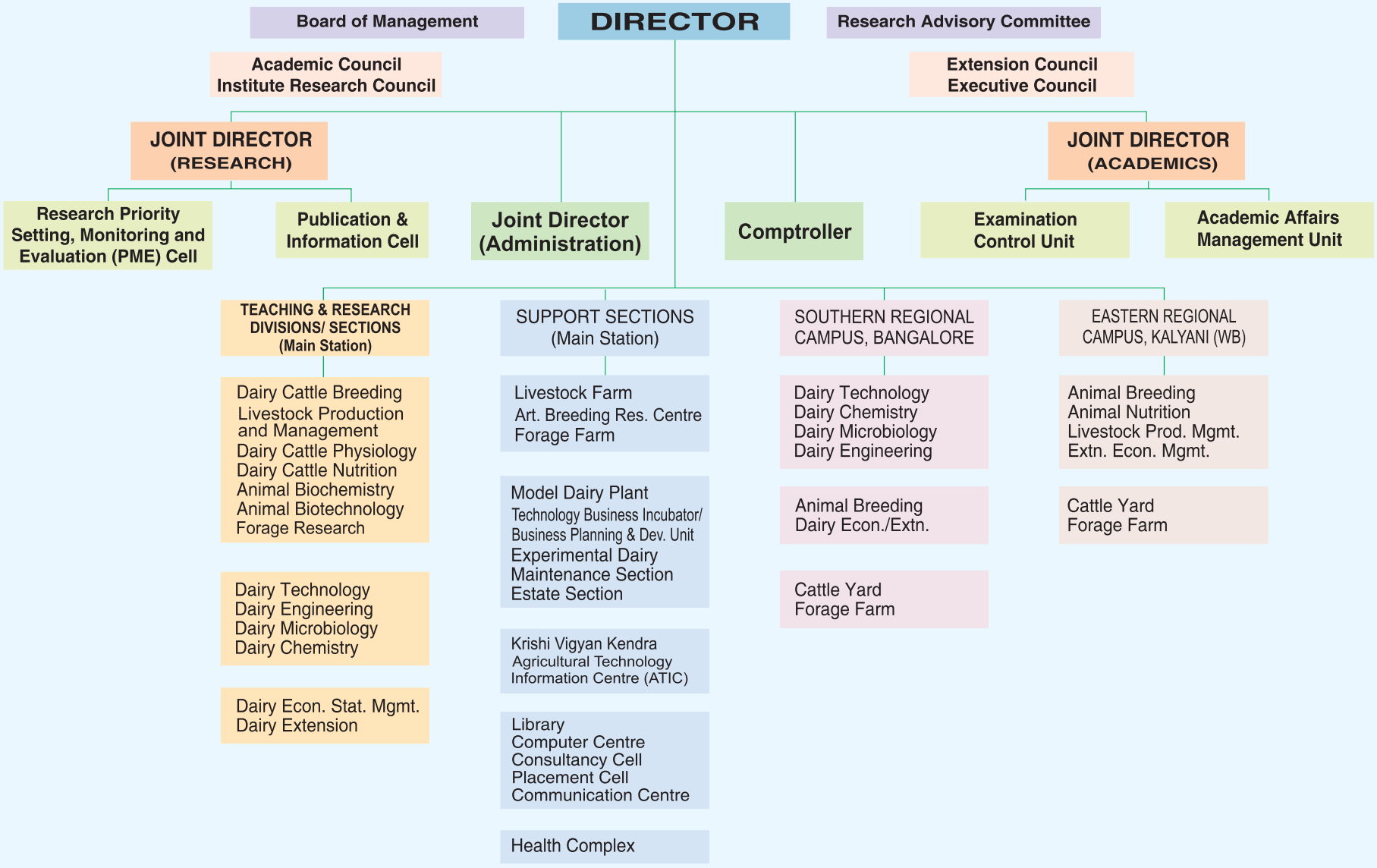
The foundation stone of the edifice of NDRI was laid at Bengaluru on July 1,1923. It was the forerunner institution in starting dairy education programmes to meet the manpower requirements of the Nation's dairy industry. Upon shifting of the institute Head Quarters to Karnal in 1955, the establishment 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.

■ Eastern Campus of NDRI, 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.

■ Two Service Centres at Lalukheri, Mazzaffarnagar (UP) and Piprakothi Motihari, East Champaran (Bihar)

Organizational Structure of NDRI



ORGANISATIONAL SETUP

The organisational structure of NDRI follows the Deemed University pattern of the ICAR. The policy making functions are managed through five main bodies focused at research, education and extension activities.

- 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 area of research, academics and administration are responsible to co-ordinate research and educational activities of various Divisions and Regional Stations, respectively. Each of the Regional Stations is administered through the Head located at the station. The scientific and teaching work at the main station is conducted through 16 subject-matter disciplines.

Board of Management

Chairman	**Dr. A. K. Srivastava** Director, NDRI
Member	**Dr. R. K. Malik** Joint Director (Research), NDRI
Member	Joint Director (Academic), NDRI
Members (Head of Divisions/ Principal Scientists nominated By President of ICAR)	**Dr. S. K. Kanwajia** Principal Scientist, DT Division
	Dr. M. S. Chauhan, Director CIRG, Makhdoom
	Dr. A. K. Punia, 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, Head, VPM, IVRI, Izatnagar
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)	**Dr. Ram Swarup, Prof.** 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	**Dr. A. K. Srivastava** Director, NDRI
Vice-Chairman	**Dr. R. R. B. Singh** Joint Director (Academic)
Member	**Dr. R. K. Malik** Joint Director (Research)
Members (Fiver Eminent Scientists from outside the NDRI)	**Dr. Kusumakar Sharma** Ex-Asstt.Director General, ICAR
	Dr. P. S. Panday, ADG (EP&HS) KAB-II, New Delhi
	Dr. S. K. Garg, Dean College of Veterinary Sciences, Veterinary University, Mathura (U.P)
	Dr. A. M. Thakar, Dean College of Veterinary Sciences, AAU, Anand (Gujarat)
	Dr. Tasleem Ahmad Ganai, Professor, Animal Genetics & Breeding & Registrar, SKUAST-K Shalimar (Kashmir)
Member (DDG Education or his nominee)	DDG (Edn.), ICAR KAB-II, New Delhi
Members (One Senior Scientist from each Division)	**Dr. S. K. Kanwajia**, Academic Coordinator **Dr. Sumit Arora**, PS & COE **Dr. O. K. Hooda**, Head, DCP Division **Dr. Khajan Singh**, Head, D. Extn. Division **Dr. R. K. Sharma**, Head, ABC. Division **Dr. Smita Sirohi**, Head, DES&M Division **Dr. Bimlesh Mann**, Head, DC Division **Dr. A. K. Chakravarti**, Head, DCB Division **Dr. Latha Sabikhi**, Head, DT Division **Dr. A. K. Tyagi**, Head, DCN **Dr. Sunita Grover**, Head, DM Division **Dr. R. S. Manik**, Incharge, ABTC **Dr. Pawan Singh**, Incharge, LPM **Dr. Magan Singh**, Sr. Scientist, I/c FR&MC
	Dr. B. Surendra Nath, Head, SRS, Bangalore
	Dr. T. K. Dutta, Head, ERS, Kalyani
(Two Representatives from PG Faculty)	**Dr. T. K. Datta**, PS, ABTC **Dr. A. Kumaresan** Sr. Sci. (ARGO)
Students Member	**Mr. Sunil Kumar**, Ph.D. (ARGO) **Ms. Priyanka**, M.Tech (DE)
Member Secretary	Joint Director Admn. & Registrar, NDRI Deemed University

Research Advisory Committee

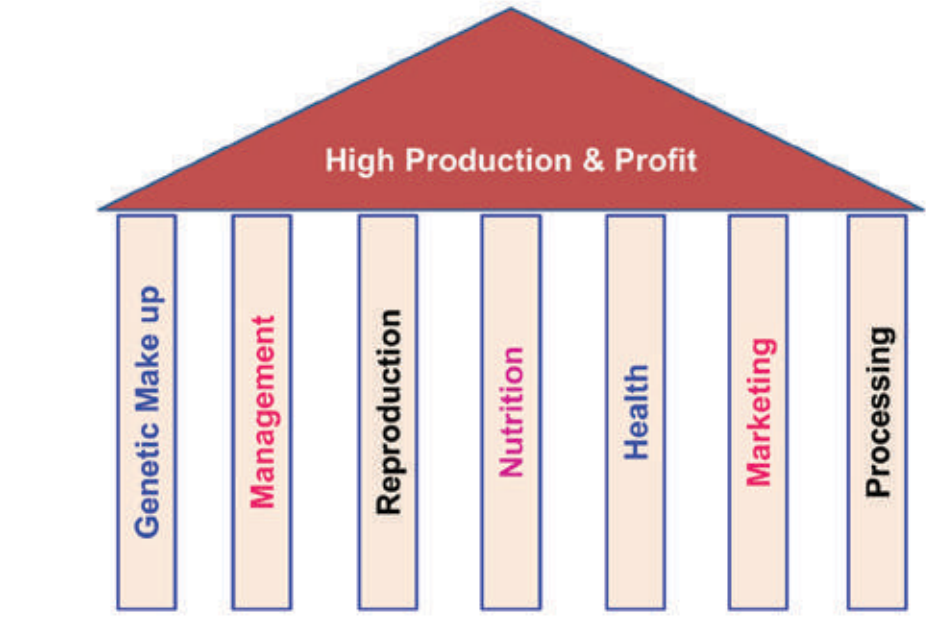
Chairman (An Eminent Scientist from outside ICAR system, nominated by DG, ICAR	**Dr. M. L. Madan** Ex-DDG (AS), ICAR
Member	**Dr. H. Rahman** Deputy Director General (AS), ICAR, New Delhi
Member	**Dr. A. K. Srivastava**, Director, NDRI, Karnal
Member	**Dr. P. S. Birthal**, Director, Institute of Development 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, Bangalore
Member	**Sh. Jagdish Rana** Village-Arainpura, Tehsil-Gharonda, District-Karnal
Member Secretary	**Dr. R. K. Malik** Joint Director (Res.)

Extension Council

Chairman	**Dr. A. K. Srivastava**, Director, NDRI
Members	**Dr. R. K. Malik**, Joint Director (Res.), NDRI
	Dr. R. R. B. Singh, Joint Director (A), NDRI
	DDG (Agricultural Education), ICAR, New Delhi or his nominee
	Dr. Bimlesh Mann, Head, DC
	Dr. S. S. Lathwal, I/c, LRC
	Dr. Smita Sirohi, Head, DES&M
	Dr. Archana Verma, PS, DCB
	Dr. A. K. Singh, Head, DE
	Dr. P. S. Oberoi, PS & I/c, ATIC
	Dr. A. Kumaresan, Sr. Scientist, AGRO
	Dr. Pawan Singh, PS & I/c, LPM
	Dr. T. K. Dutta, Head, ERS, 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,
	Director (Farm Information), Directorate of Extension, Govt. of India, New Delhi
Member Secretary	**Dr. Khajan Singh**, Head, Dairy Extension, NDRI

RESEARCH ACHIEVEMENTS

- Biotechnological interventions for higher productivity
- Genomic selection and animal breeding
- Animal fertility, reproduction and diagnostics
- Feed, fodder and animal productivity
- Management and health of dairy animals
- Novel approaches in value addition
- Bioactive peptides and nutraceuticals
- Probiotics, bioactive molecules, functional foods and health
- Process engineering
- Biotechnological approaches in quality assurance
- Value chain analysis
- Impact and sustainability assessment
- Managing risk and vulnerability
- Extension approaches for socio-economic upliftment through dairying
- Regional priorities for dairy development: policy analysis & strengthening database



Pillars of Success in Dairying

BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY

Cloning Research

'Swarupa', a Clone of Elite Murrah Buffalo Karan-Kirti

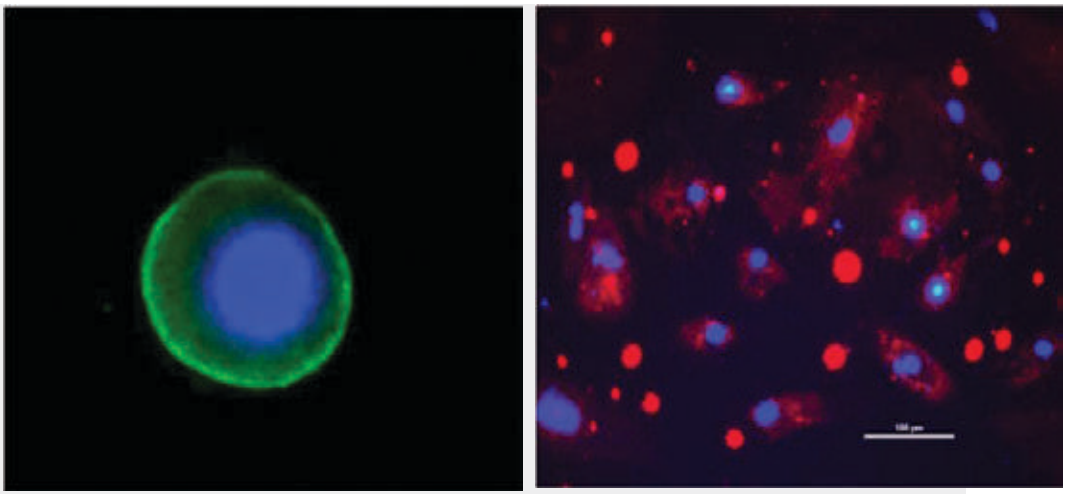
A female cloned calf named **'Swarupa',** weighing 32 kg, was born through normal delivery on August 1, 2015. The calf was produced through 'Hand-guided Cloning Technique'. The donor cell used for cloning was from the ear of an adult outstanding buffalo named 'Karan-Kirti' at NDRI Livestock Research Centre. Karan-Kirti had yielded 4425 kg of milk in its first lactation in 427 days of lactation and had a yield of 3812 kg in 305 days. Its peak yield of 25.1 kg was the highest daily yield of a buffalo recorded so far in the history of the Institute.



Swarupa

Buffalo Embryonic Stem (ES) Cells Differentiated to Primordial Germ Cell-Like Cells

ES cells, which offer a sustainable source of cells, were differentiated to primordial germ cell-like cells with the long-term aim of developing artificial gametes, which hold a great promise for production of transgenic animals, designer animals, biopharming, conservation of endangered species or resurrection of the extinct species. ES cells were induced to differentiate to germline cells using various inducers such as retinoic acid (RA), bone morphogenetic protein-4 (BMP-4), adult testicular cell conditioned medium (TCM) and cumulus cell conditioned medium (CCM). A cocktail of inducers named 'SCM' was designed which resulted in considerably higher expression of germ lineage-associated genes, as determined by qPCR assay. SCM had better efficiency to induce most of the germ lineage- associated genes, especially those related to oogenesis and formation of a mature oocyte. This was followed by CCM, TCM, RA and BMP-4 induction conditions, in that order, while spontaneous cultures showed the lowest level of germ lineage gene expression. Upon haploid cell analysis, SCM differentiation cultures revealed higher fraction of haploid cell population than RA-induced differentiation. Oocyte-like cells produced under SCM-induced differentiation showed presence of a putative polar body, indicating occurrence of in vitro maturation.



Immunocytochemistry for oocyte- and spermatocyte-specific protein markers induced by retinoic acid stimulation.

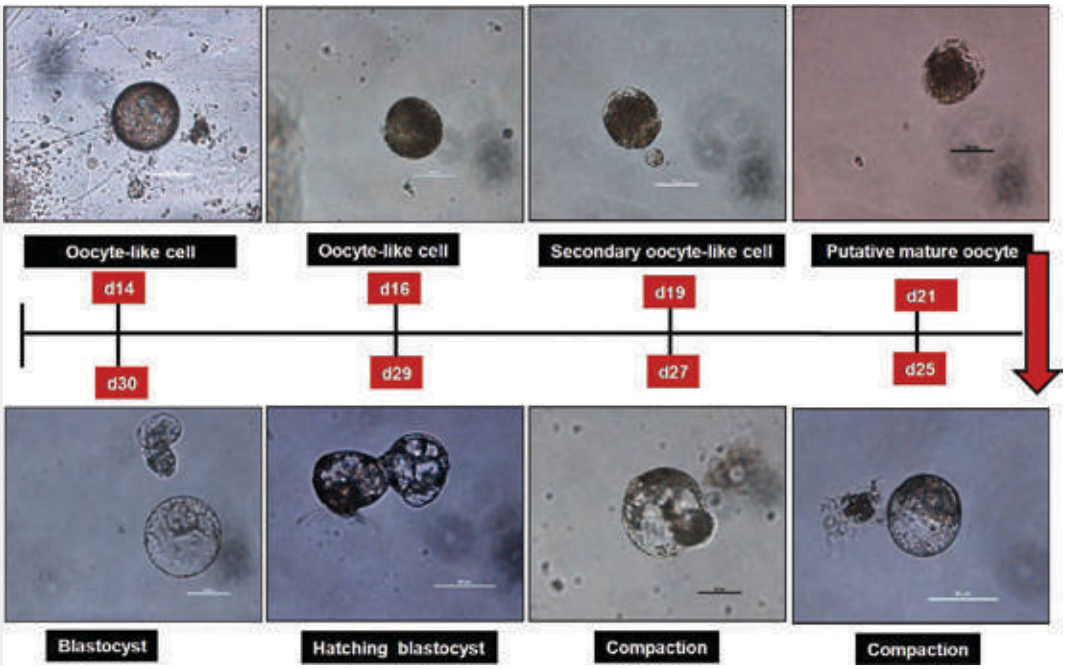


Fig.: Developmental competence of the oocyte-like cells following parthenogenesis in extended cultures in semi-attached mode of development

Goat Ovarian Surface Epithelial Stem Cells Differentiated to Primordial Germ Cell-Like Cells

Ovarian surface epithelium stem cells are continuously repaired during folliculogenesis. These stem cells have the potential of being used for production of oocytes in large numbers from a single ovary, which could be used for various applications such as fast multiplication of superior germplasm of livestock, saving endangered animals, treatment of infertile human couples etc. Putative ovarian surface goat epithelial stem cells were cultured in vitro and characterized for stem cell markers viz. Oct-4, Nanog and Sox2 by immunostaining and RT-PCR. These cells were then differentiated in vitro into primordial germ cell-like cells. Round oocytes-like cells were observed after 30 days of culture. Characterization of primordial germ cells was done by immunostaining and RT-PCR by using pre-meiotic markers viz. VASA, DAZL and STELLA. The oocyte-like cells were round in shape with distinct zonae pellucidae, high nucleus-to-cytoplasm ratio. These results provide evidence for the presence of putative stem cells with pluripotent characteristics in the ovarian surface epithelium, which can be differentiated to primordial germ cell-like cells.

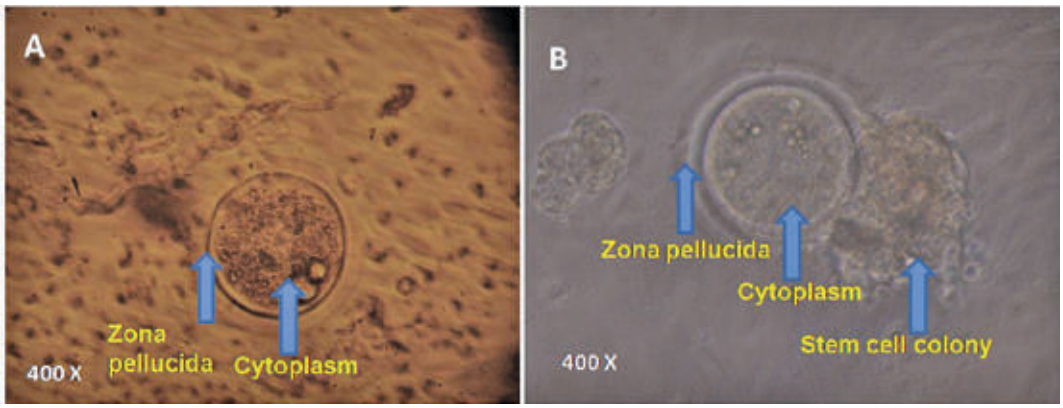


Fig.: A and B: Oocyte-like cells produced from goat ovarian surface epithelial stem cells after 30 days of in vitro culture

Production of Recombinant Buffalo Interferon-Tau and its Effect on In Vitro Buffalo Embryo Production

Interferon-tau (IFN-tau), which is secreted by the trophoblast cells of the developing embryos, acts as the signaling molecule for maternal recognition of pregnancy. For production of recombinant buffalo IFN-tau, total cellular RNA extraction from primary trophectodermal cells and RT-PCR were performed using gene-specific primers designed against known bovine IFN-tau sequence. Cloning of the PCR amplified products followed by screening of the recombinant colonies gave 13 distinct cDNA variants that encoded for 8 distinct buffalo IFN-tau isoforms, out of which the relatively predominant buffalo interferon tau (BuIFN-tau) was expressed in a prokaryotic expression system. The recombinant BuIFN-tau was confirmed by SDS-PAGE and Western blotting and subjected to three steps of large scale purification using His affinity chromatography, anion exchange chromatography and gel filtration chromatography. The purified recombinant BuIFN-tau protein was reconfirmed by mass spectroscopy analysis. Supplementation of in vitro embryo culture medium with purified BuIFN-tau (2 µg/ml) significantly improved the rate of blastocyst production. In conclusion, at least 13 distinct *IFNT* gene variants exist in buffalo that encode 8 different proteins expressed in trophectodermal cells of in vitro developed buffalo blastocysts.

Deciphering the Root Cause of Heat Stress on Developing Oocytes and Embryos

Reduced fertility of animals under heat stress conditions is perceived as a serious constraint causing huge economic loss to farmers in terms of missed conceptions and early embryonic mortality. Compromised developmental ability of oocytes as a result of heat stress could be one of the key contributing factors. A systematic in vitro stress model was developed to understand the stage at which oocyte development and embryonic growth are most adversely affected by heat stress and how these effects are manifested in the growing embryos. The cleavage and further development rates of embryos displayed significant reduction as a result of heat stress. Quality of blastocysts produced out of heat-stressed oocytes was observed to be poor in terms of their inner cell mass and trophectoderm cell numbers. The most vulnerable stage of oocytes was interpreted as the mid maturation phase between 8-12 h of in vitro maturation. The effect of heat stress during this time was found to have cascading effect causing compromised embryonic development also. Similarly, embryos at the earliest cleavage stage between 1 to 4 h after IVF were found most sensitive to heat stress. The gene expression study revealed that the most likely cause of oocyte deterioration as a result of heat stress is increased oxidative stress and ATP starvation leading to apoptosis.

The important milestones of embryonic development like maternal-to-embryonic transition and morula-to-blastocyst transition were found to be seriously compromised. Treating oocytes with agents like Resveratrol, sphingosin-1-p (S1P) and E-64 a protease inhibitor,during IVM could help to overcome the stress-induced deleterious effects in oocytes and resulting in gaining back acceptable cleavage and blastocyst rates. The information suggests that specific intervention particularly during estrus and immediately after breeding can rescue oocytes and early embryos from entering into heat stress related deteriorations and thereby saving heat stress associated fertility losses.

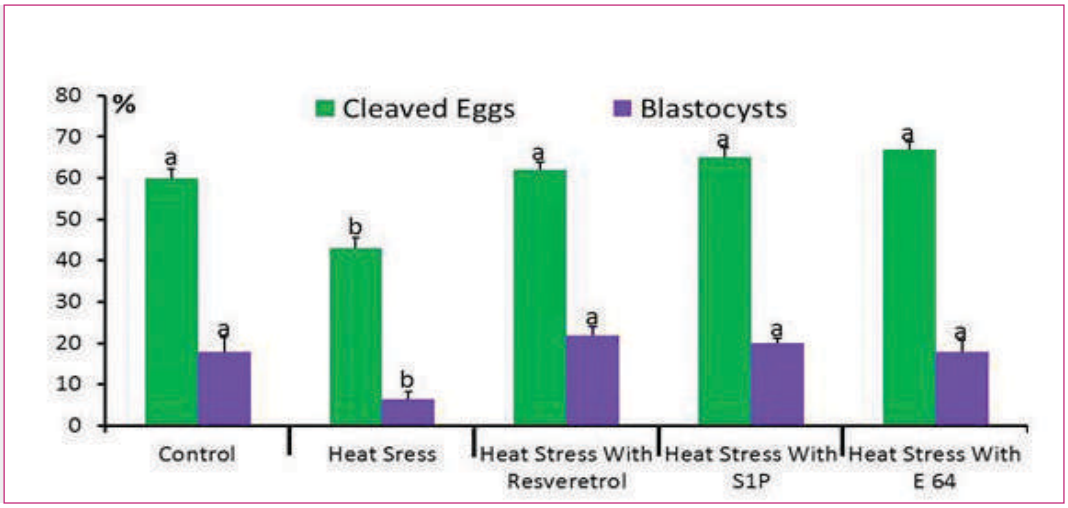


Fig.: Culturing buffalo oocytes with Resveretrol, S1-P and E 64 rescued them from heat stress associated deleterious effects

Explaining the 'Oocyte Competence'

A fundamental question still remains to be answered is 'what makes an oocyte more competent than others?' Possibly, the clues for detecting animals with better fertility lies in identifying the exact molecular event (s) which ultimately makes only few oocytes to participate in the process of fertilization amongst millions of them. A simple to perform and noninvasive Briliant Cresyl Blue (BCB) staining method optimized to preselect the buffalo oocytes as "Good" vs "Bad". The whole transcriptomeinformation from the classified oocyte groups were categorized into broad functional categories of metabolism, genetic information processing, environmental information processing and cellular processes. A total of 38 definite biological pathways were found enriched in 'Good' oocytes, which are most likely to play crucial roles in determining the oocyte and embryo development competence. PI3K-AKT and MAPK pathways were stimulated to augment the oocyte development process. The gene expression in cumulus cells of 'Good' and 'Poor' oocytes were also assessed to reveal that these cells play determining roles in oocyte maturation process. Inhibiting the cumulus cell apoptosis using a protease inhibitor E-64 resulted in significant increase of blastocyst development rate and also the quality of blastocysts. Strategies based on the generated genomics information will have potential implications on fertility augmentation in buffaloes.

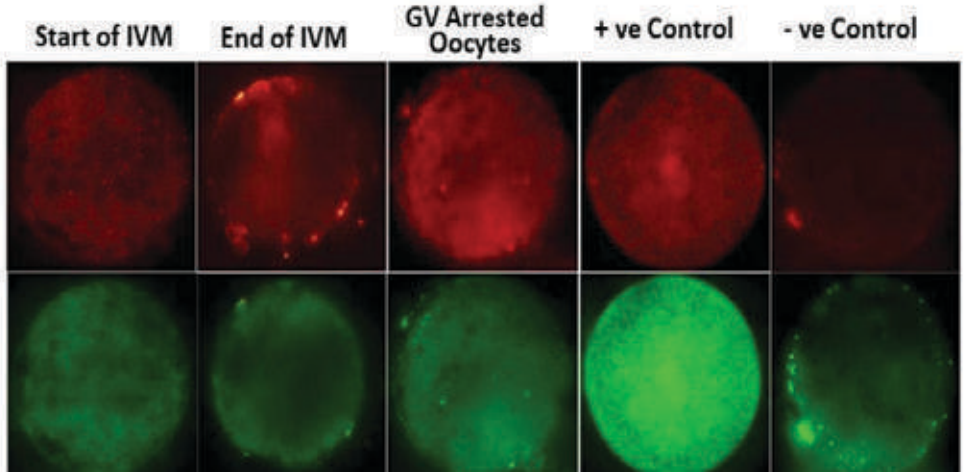


Fig.: Functional normalcy of oocyte cytoplasms in GV Synchronised Buffalo oocytes

Imparting Artificial Competence to Buffalo Oocytes Using Recombinant GDF-9

It was demonstrated earlier that GDF-9 expression in maturing buffalo oocytes play vital role in making them ready for successful fertilization and further development. The recombinant buffalo GDF-9 (57kDa) was expressed in *Kluveromyces lactis* yeast expression systems. The secondary structure analysis of recombinant GDF-9 protein by using circular dichroism suggested

presence of 55-60% beta pleated sheet, a hallmark of TGF-beta family proteins. The effect of recombinant protein was tested on *in vitro* pre- and post-fertilization events in buffalo. Adding r-GDF-9 in maturation medium resulted in significant increase of both pre-and post-fertilization attributes of oocytes like better cumulus expansion, more MII stage oocytes, better cleavage rate and a dramatic increase in blastocyst rates. Effectiveness of r-GDF9 for increasing the oocyte competence has been explained in terms of improved steroidogenesis, controlled apoptosis and better functioning of TGF-β signaling pathways. The study strongly suggests that recombinant GDF-9could be a promising molecule to augment IVF protocols in buffalo.

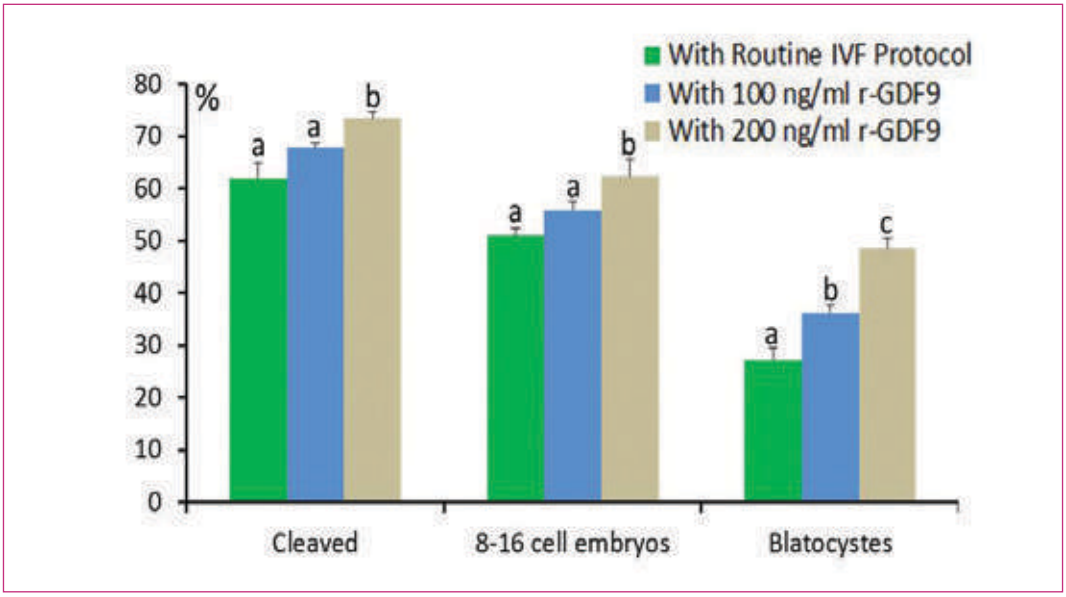


Fig.: Recombinant buffalo GDF9 resulted in increased production of IVF produced embryos

Identification of Potential Biomarkers for Early Detection of Pregnancy in Cattle

An early, reliable and noninvasive method of early pregnancy diagnosis is a prerequisite for efficient reproductive management in dairy industry. The early detection of pregnancy also helps to reduce the calving interval and rebreeding time which is beneficial for farmers and dairy industries. For identifying potential biomarkers for pregnancy detection at an early stage (16-25 days) in cattle, differential-in-gel electrophoresis (DIGE) and label free quantitation (LFQ) were performed for identification of proteins which have significant differential expression during pregnancy. DIGE experiment revealed 11 differentially expressed proteins, out of which 9 were up regulated ≥1.5-fold. LFQ data analysis gave 202 differentially expressed proteins, 30 out of which were up-regulated and 40 down regulated ≥1.5 and ≤0.6-folds, respectively. The differentially expressed proteins were actively involved in pregnancy-associated events such as embryo implantation, establishment and maintenance of pregnancy. The set of protein biomarkers identified for early detection of pregnancy can be further explored for development of urine-based pregnancy diagnosis kit.

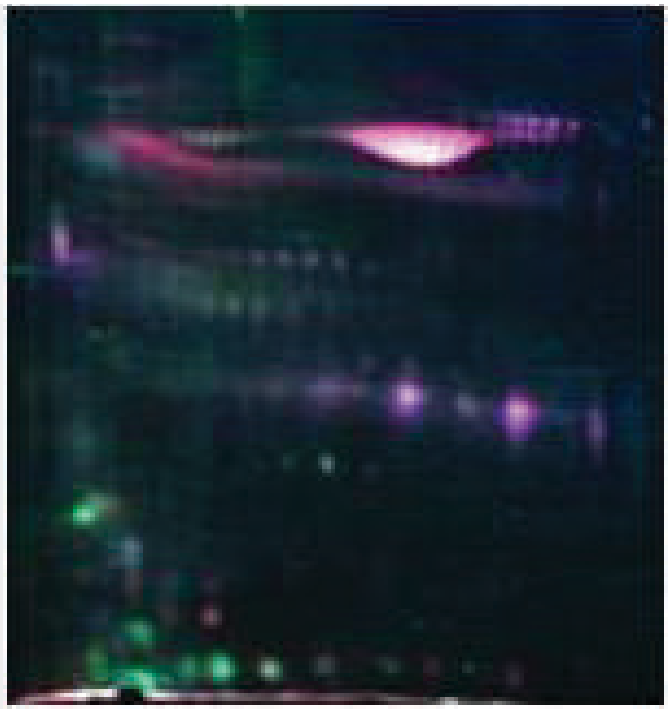


Fig.: 2-Dimensional Differential-in-Gel electrophoresis (2D-DIGE) showing differentially expressed proteins in urine of pregnant cattle

Mammary Gland Protein-40 (MGP-40) Induces Epithelial Mesenchymal Transition in Mammary Epithelial Cells and Protects the Mammary Gland during Involution

The physiological function of MGP-40, a chitinase-like protein, which is over expressed during mammary gland involution, is poorly understood. Using an in vitro model of the buffalo mammary epithelial cell (BuMEC), it was found that buffalo MGP-40 was highly up regulated in BuMECs in serum-starved condition or after treatment with prolactin suggesting that it may have a role in stress response. Over expression of MGP-40 following transfection of BuMECs with a mammalian expression construct of pCI neo harbouring MGP-40 gene enhanced proliferation of BuMECs and protected them from apoptosis under serum-free conditions. In contrast, MGP-40 attenuated the mitogenic effect of insulin in BuMECs. Over expression of the MGP-40 reduced dome formation, acinar polarization and casein synthesis in BuMECs in the presence of lactogenic hormones. It also induced Stat3 phosphorylation and epithelial-to-mesenchymal transition (EMT)-like features suggesting that MGP-40 is involved in protection of BuMECs under stress conditions and that it inhibits cellular differentiation and induces EMT-like features.

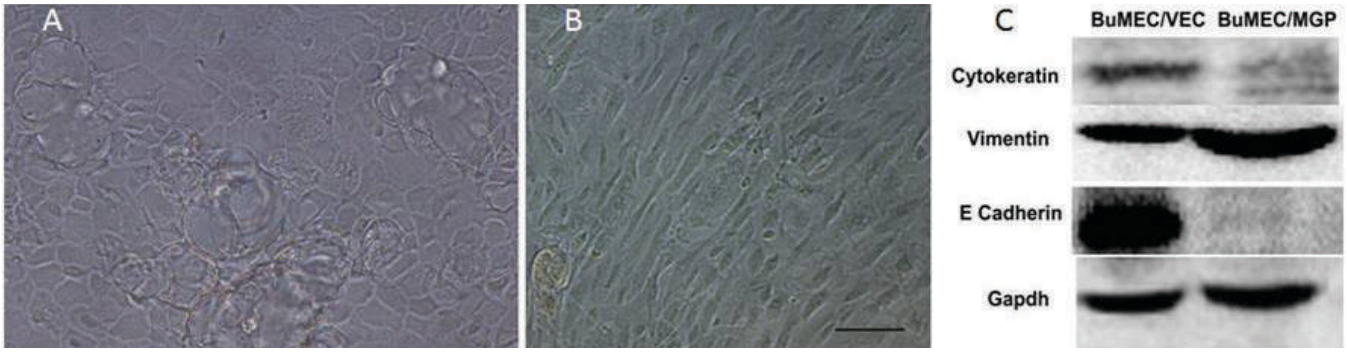


Fig.: Over expression of MGP-40 induces epithelial mesenchymal transition (EMT)-like features in BuMEC. A. Phase contrast microscopic image of BuMEC. B. Phase contrast microscopic image of MGP-40 over expression in BuMEC showing elongated morphology. C. Western blot analysis of Cytokeratin 18, E-cadherin and Vimentin. BuMEC/MGP shows reduced levels of Cytokeratin 18 and E-cadherin and increased levels of Vimentin compared to BuMEC/VEC

Characterization of 3D Structure of Oviductin

Oviductin is a high molecular weight oviduct-specific glycoprotein secreted by the non-ciliated epithelial cells of oviduct during estrous cycle and early pregnancy. It plays an important role during fertilization and early embryonic development. The 3-dimensional structure of oviductin was determined by homology modeling for understanding its functional role. Oviductin has 2 domains namely chitinase-like domain and mucin-like domain. Model structures of both the domains were determined separately. The structures were built using various modeling programs and the model built by Modweb server was found to be highly optimal. The overall structure of the built model displays the typical fold found in other members of GH18 family which consists of a large (β/α)8 TIM barrel domain and a small (α+β) domain. Structural comparison of the built model with its structural homologues revealed some amino acid substitutions in substrate-binding groove and active site, changes in some loop conformations which were found to be conserved in other family members. Molecular docking of chitinase-like domain model with its ligands revealed the role of different amino acids in various hydrophobic and polar interactions with sugar ligands. Ligand-binding was also confirmed through experimental fluorescence quenching assay where a significant quenching of fluorescence was observed upon ligand-binding with both native and recombinant oviductin.

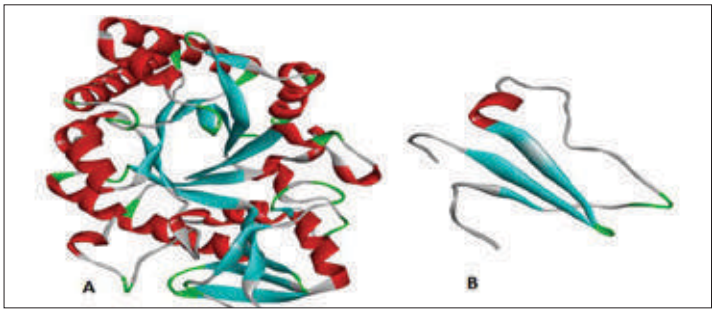


Fig.: Cartoon representations of buffalo oviductin: (A) N-terminal chitinase-like domain; (B) C-terminal mucin-like domain consisting of 1-361 and 362-519 amino acid residues, respectively

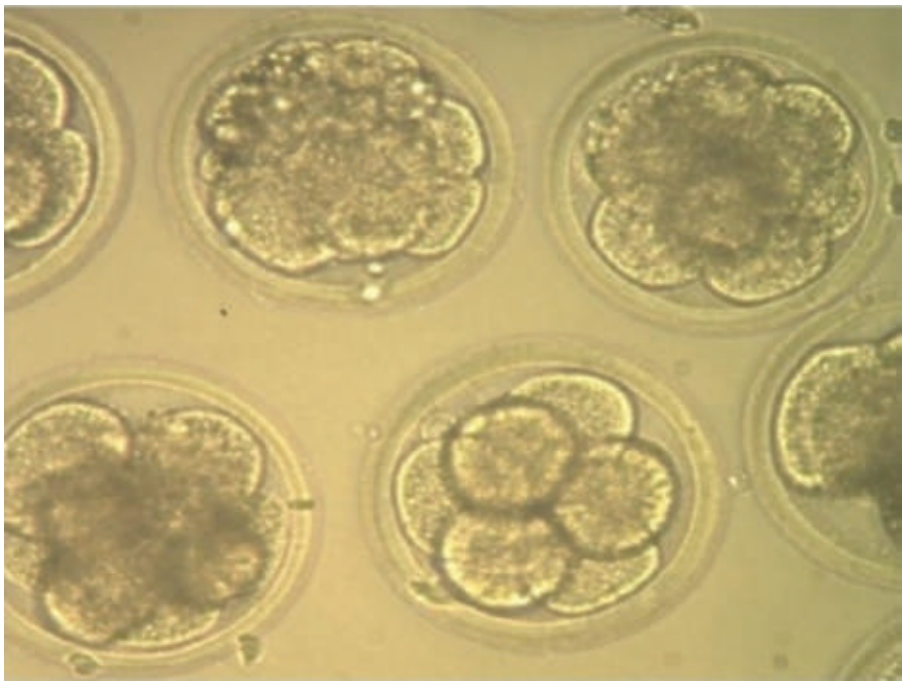
Proteome Profile of Saliva of Sahiwal Cows (*Bos indicus*) Revealed 441 Proteins

For discovering a biomarker for pregnancy diagnosis using samples that can be collected non-invasively, 441 proteins were identified in the saliva of non-pregnant and pregnant Sahiwal cattle at Day 0, Day 7, Day 18, and Day 28 by Differential-in-Gel electrophoresis (DIGE) and TMT-labeled relative quantitative proteomics using LC-MS/MS. At least 91 proteins had signal peptide evidence predicted from SignalP 4.1. The major proteins belong to catalytic activity group, binding proteins, metabolic proteins mainly hydrolase family, cell communication etc. This is probably the first report (in our knowledge) that provides evidence of CA-IV in the saliva of cattle. Total protein concentration in saliva was found to range from 0.5 µg/ml to 4 µg/ml. IgG, MUC19, albumin, ovostatin2, lactoferrin, lactoperoxidase and carbonic anhydrase VI were found to be among the most abundant proteins observed in non-pregnant cow saliva.

Development of Caprine Embryos after *In Vitro* Maturation and Fertilization of Oocytes using Cryopreserved Black Bengal Buck Semen and Cryopreservation of Immature Cattle Oocytes

Attempt was made to develop embryo using *in vitro* matured oocytes collected from slaughter house ovaries and fertilized with *in vitro* capacitated cryopreserved Black Bengal buck semen. Goat ovaries were collected from local abattoir, Kolkata and brought to the laboratory in normal saline supplemented with streptopenicillin maintaining 30-35°C. Cumulus oocytes complexes (COCs) were isolated and washed thoroughly in washing media. Then groups of 10-20 COCs were placed in 50 µl droplets of maturation medium, covered with sterile mineral oil in a 35 mm petri dish and incubated for 28 h at 38.5 °C in a 5% CO_2 incubator with maximum humidity in air. After 28 h of incubation, COCs were inseminated with *in vitro* capacitated sperm suspension prepared from four days refrigerated preserved buck semen straws and allowed for fertilization in FBO media. After 18 h presumptive embryos were washed and kept in RVCL media for cleavage. After 40-42 h the cleaved oocytes were placed in replacement media for further development. The medium was replaced after every 24 h with fresh replacement medium.

To cryopreserve immature cattle oocytes ovaries were collected from Kolkata abatoir and transported to the laboratory within 3-4 h. in a thermo flask containing normal saline fortified 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 cryopreservation/vitrification media. The equilibration media contains 50% DPBS and 50% vitrification media. Subsequently COCs were loaded in the 0.25 ml straw and sealed the open end with hot forceps and were plunged into liquid nitrogen directly. The oocytes may be used for *in vitro* maturation and fertilization for embryo development.



GENOMIC SELECTION AND ANIMAL BREEDING

Crossbred Cattle and Sires

In crossbred cattle improvement programme a total of 38 Karan Fries cows (27%) were selected as elite cows for nominated matings with an average 305-day milk yield as 4713 kg and average EPA as 4412 kg which were 16.3% and 14.4% higher than the herd average (3945 kg) and average EPA (3826 kg).

The heritability estimates from animal models (single and multi-trait) were more accurate than corresponding single-trait sire model (ST-SM) because it took account of all kinds of relationships among animals. The single-trait animal model (ST-AM) was superior to other single trait sire evaluation methods (LSQ, SRLS, BLUP and ST-SM) based on sire error variance, coefficient of determination (R^2) and coefficient of variation. The breeding values of Karan Fries sires estimated by single trait LSQ, SRLS, BLUP, ST-SM and ST-AM methods for FL305MY differed significantly. Three-trait animal model with FL305MY + AFC (FSP as covariate) and FL305MY + Fat + SNF yield and four-trait animal model with FL305MY + SNF yield + AFC + FSP had the highest range of breeding values.

Indigenous Cattle and Bulls



» In indigenous cattle improvement programme the herd strength of Tharparkar cattle was increased to 123 females (18 female calves, 47 heifers and 58 cows) as compared to a total 83 females in 2011.

» A total of 13 out of 57 (23%) cows with either FLY-305 >2000 kg or Best 305-LY> 2500 were identified as elite cows. Analysis of disposal pattern data over the years revealed that average number of female calves born reaching the milch herd was around 81%, indicating better adaptability of the breed.



» During the year 2015 (January-December, 2015) a total of 8720 doses of frozen semen were produced and 3464 doses were supplied to developmental agencies and farmers. Presently around fifty-eight thousand doses of frozen semen of fifteen Tharparkar bulls are available for use in the herd and dissemination.

» The Sahiwal cattle improvent programme is based on multiple herds. The herd strength of female was 331 including

184 breedable females. A total of 29 growing males and breeding bulls were also available at the Germplasm Unit, NDRI, Karnal.

» Eleven out of 26 young Sahiwal males were reserved for future breeding. EPD % of the selected males were 8.5% and average of Dam's best Lactation Yield was 3166 kg against herd average of 1939 kg. A total of 37 out of 184 Sahiwal females were identified as elite cows The average of 305-FLY, Best 305-LY, average 305-LY and EPA were 2661, 3264 (2554-4947), 2799 and 2407 kg, respectively against herd average of 1967 and 1976 kg.

» Random regression model (RRM) resulted in more smoothed estimate of additive genetic variance and lower error variance compared to the univariate animal model. Thus, RRM can be used for accurate estimation of test day milk yields, genetic parameters and breeding value prediction as it accounts for major sources of variation and gives the lowest error variance.

Murrah Buffaloes

For buffalo improvement programme, the breeding programme in the Murrah herd was followed for test mating of XVth and XVIth set of bulls. Fifteenth set had 15 bulls of which 13 bulls and 16th set had 15 bulls, of which one bull was used for test mating up to March, 2016. The dams' best lactation 305 day or less milk yield of test bulls had ranged from 2828 in first lactation to 4636 kg. Three proven bulls were used in the centre.

The herd strength was increased during the period. Average age at first service and age at first calving of buffaloes were 28.20 and 39.29 month. Average age for initiating training and age at first collection of the young Murrah bulls has significantly reduced to 18.23 and 23.01 months. The average service period of buffaloes has been estimated as 134.03 days. The overall female conception rate in the herd was 40.53 %. The wet and herd average were increased to 8.48 kg and 4.13 kg, respectively. The average milk Fat, SNF and Total solid were estimated as 8.28 %, 9.60 %, and 17.88 %, respectively.



Five elite Murrah male calves were reserved. The dam's best 305 days lactation milk yield of reserved males ranged from 2951 Kg in first lactation to 3349 kg. The EPD and superiority of reserved Murrah male calves ranged from 15 to 110 Kg and 4.66 to 15.03 %, respectively. The center proposed 10 Murrah bulls out of which four breeding bulls were selected for test mating under XVI th Set. The dam's best 305 days milk yield of selected bulls ranged from 3349 in first lactation to 4090 kg.

Forty-three Murrah buffaloes were identified as elite animals. The average lactation milk yield of elite Murrah buffaloes increased to 3294.11 Kg which was 53.35 per cent higher than the herd average. The information on 305 days milk yield of daughters were collected, compiled and supplied to Nodal institute for genetic evaluation of XI th set of Murrah bulls.

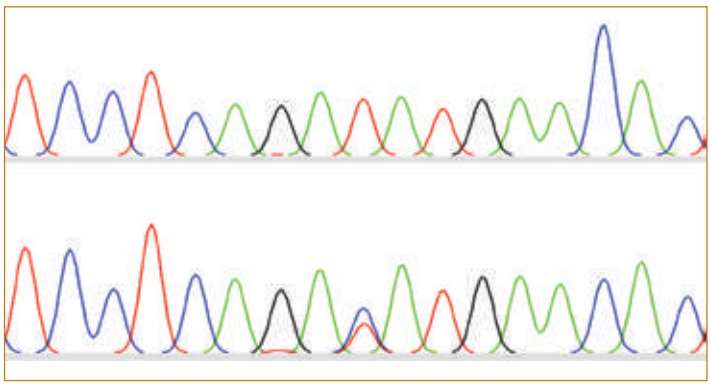
The NDRI centre has produced 16158 doses of frozen semen during the period. The centre has supplied 4270 doses of frozen semen to other centers. In addition 6232 doses of semen were supplied to NDRI Field Unit and 12792 doses of frozen semen to farmers and other dairy development organizations.

Field Progeny Testing Programme for Buffaloes

In Field Progeny testing for buffalo a total of 3737 AI were performed in Murrah Buffaloes under field conditions during 2015 and as a result 51.8 % conception rate was obtained. Across the villages, the highest conception rate was observed in Rindal (55%) and lowest was observed in the village Sheikhpura (47%). A total of 1739 (919 males and 820 females) Murrah buffalo calves were born in the farmers' herds and performance data on 161 daughters have been recorded for evaluation of bulls under field conditions. As many as 16 breeding bulls belonging to the 14th and 15th set were used for AI during the year.

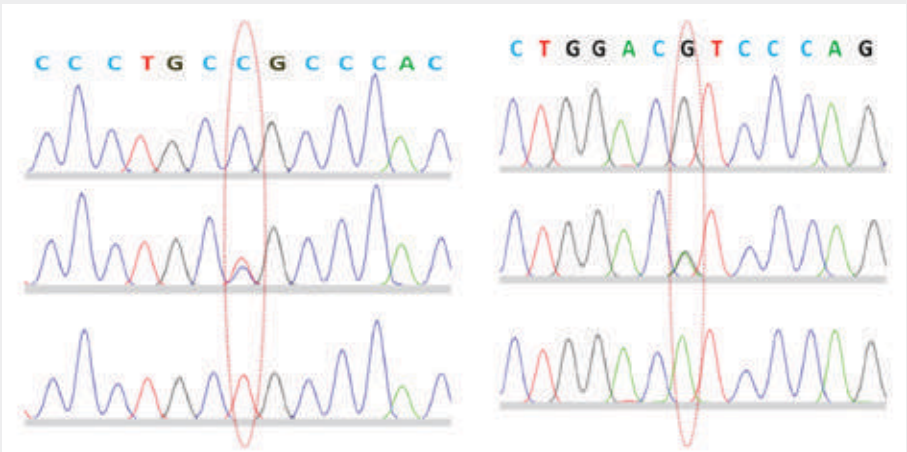
In molecular genetics study it has been observed that the SNPs g.1669T>C of PROP1, g.97C >T and g.426 G > A of SPAG11 and g.312 G > A and g.389 C > T of ITGB5 genes have an higher association with conception rate / fertility of Murrah bulls.

Chromatogram Showing Variation at Position g.1669 (T>C) of PROP1 Gene in Murrah Bulls



In another study, a significant association of g.97C>T and g.426 G>A of SPAG 11 gene with seminal parameters and conception rate has been observed.Highest conception rate was observed in animals with haplotype 'ACTAT'.

Chromatogram of SNP at Position g.97C>T and g.426 G>A of SPAG11 in Murrah Bulls



The significant association of g.312G>A and g.389C>T of ITGB5 gene with seminal parameters and conception rate has been observed. Highest conception rate was observed in animals with haplotype 'GGTCG'.

Whole Genome Based SNP Mining and Development of Breed Signatures for Dairy and Dual-Purpose Indigenous Cattle (DBT)

To compare the immunity of indigenous and crossbred cows, blood and milk samples were collected from Tharparkar (TP), Sahiwal (SW) and Karan Fries (KF) cows. There was no difference in the blood TLC of TP cows, whereas, TLC increased significantly ($P<0.05$) in SW and KF cows suffering from mastitis. Blood neutrophil (%) increased significantly ($P<0.05$) from healthy to mastitis animals in all the 3 breeds of cows. PA of blood neutrophils was estimated by NBT assay and found to be lowest in KF cows followed by SW and TP cows. Milk SCC and DLC were also estimated from healthy animals and those suffering from subclinical and clinical mastitis. Milk SCC were highest in KF cows followed by SW and TP cows, whereas, percent neutrophils were found to be higher in SW cows. Phagocytic activity of milk neutrophils was lowest in crossbred cows as compared to indigenous cows. Also PA of milk neutrophils was found to be significantly ($P<0.05$) lower as compared to the blood neutrophils.

Evaluation and Improvement of Indigenous Cattle of Malnad Region of Karnataka

Malnad Gidda cow's milk was found to have higher lactoferrin (antimicrobial and antiviral substance) content as compared to other breeds of cattle and buffaloes and low somatic cell count. The incidence of many tropical diseases in Malnad Gidda cattle is extremely low. Molecular

characterization of genes associated with growth (Growth Hormone, IGF1, and IGFBP3), milk quality (Lactoferrin gene, Beta- Casein gene), reproduction (GnRHR gene, Kiss1 Gene, GSPAG11, Aquaporin 7 gene) elucidated high variability among Malnad Gidda cattle. The SSCP variants of exon 3 and exon 15 of lactoferrin gene were found to have significant ($P \leq 0.05$) and highly significant ($P \leq 0.01$) effect on lactoferrin content, while the variants of exon 2 and 6 were found to have association with milk Somatic Cell Score in this breed. A proteomic analysis of milk from Malnad Gidda cows at different stages of lactation gave an overview of the genes involved in lactation and the composition of milk at various stages. Frozen Semen from elite Malnad Gidda bulls were made available to the farmers for the first time through State Animal Husbandry & Veterinary Services, Govt. of Karnataka. AI using frozen semen of Maland Gidda has been started in their home tract due to Institute intervention. The output of this research as well as knowledge on scientific rearing was disseminated by arranging training programmes and effective print and mass media.

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

Investigation was carried out to characterize the entire coding region of aquaporin 7 gene using PCR-SSCP technique and to detect the association of genetic variants with semen quality in *Bos indicus* (Khillar), and *Bubalus bubalis* (Murrah) bulls. Sequencing was employed to detect single nucleotide polymorphisms (SNPs). Analysis revealed polymorphism in exons 1, 4, 5, 7 and 8 for Murrah. Exons 2, 4 and 6 revealed 3, 2 and 4 unique SSCP patterns respectively in Khillar cattle. SSCP variants of exon 1, 5 and 8 were associated ($P \leq 0.05$) with hypo-osmotic swelling (HOS) reactivity in frozen semen, sperm viability and Post Thaw Motility (PTM) respectively in Murrah bulls. The study indicated high degree of genetic variability in aquaporin 7 gene in Khillari cattle and Murrah buffaloes.

Molecular Characterization of TLR-2 Gene and its Association with Milk Yield and Milk Quality Traits in Jersey Crossbred and Deoni Cattle

PCR-RFLP revealed polymorphism in amplified fragments of exon 2-1, CRS exon 2-1 and CRS exon 2-5 of TLR2 gene using *EcoRV, Hae III* and *HhaI* restriction enzymes, respectively in Jersey crossbred and Deoni native breeds. The sequences of exon 2 of TLR2 gene were submitted online in NCBI gene bank and received the Accession Numbers KU057163 and KT719392 in Deoni cattle. Similar genetic identity (99%) with *Bos taurus* and *Bos indicus* were observed both in Deoni and Jersey crossbred cattle. Sequence analysis of TLR2 gene revealed fourteen nucleotide changes (SNPs) in both the breeds (14 SNPs in Deoni and 16 in Jersey crossbred cattle). Information on TLR2 genotypes and their association with udder health parameters, TDMY and fat percent would be strong support to initiate marker assisted selection.

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

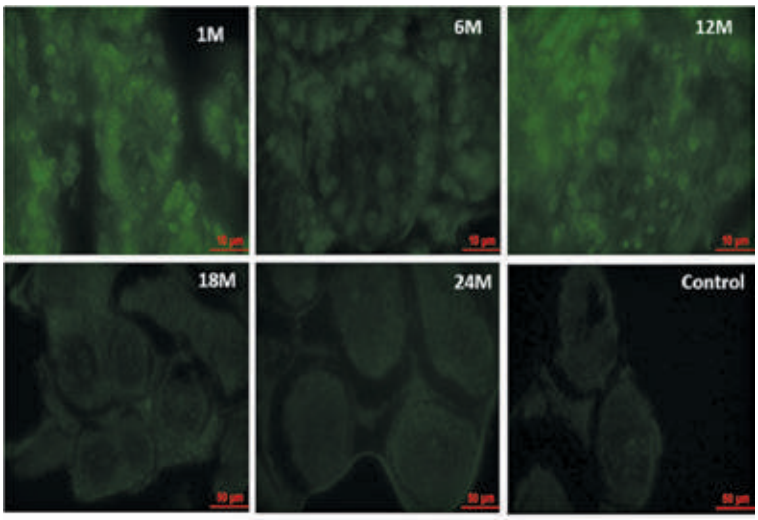
Estimates of (co)variance components and genetic parameters were obtained for lactation traits of Jersey crossbred cattle, maintained at the Eastern Regional Station of National Dairy Research Institute, Kalyani, Nadia, West Bengal, India over a period of 34 years (1981-2014). Data on 1170 records of animals descended from 59 sires and 218 dams were used in the study. Direct heritability estimates were inflated substantially for all traits when maternal effects were ignored. The model which included additive direct, additive maternal effects, and also includes the additive direct–maternal covariance (Model 4) was the best fitted model for 305 days milk yield. For description of total milk yield lactation length, the model with direct genetic effects (Model 1) was considered the most suitable model in the present data set. Further, the model which included additive direct, additive maternal effects, and also include the additive direct–maternal covariance (Model 4) was also considered the best fitted model for describing the peak yield and total milk yield per lactation length of animals. The model with only a permanent environmental effect due to the dam (Model 2) was clearly most suitable for milk production efficiency trait, calculated in terms of total milk yield per day of calving interval in this study. The estimated value for direct heritability for 305 days milk yield was 0.55 and maternal genetic (m^2) effects contributed 9% to the total phenotypic variance as per the best fitted model. Maternal genetic (m^2) and permanent environment (c^2) effects did not contribute to the total phenotypic variance of total milk yield and lactation length in present study.

ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS

Basal Concentrations of Reproductive Hormones in Karan Fries and Tharparkar Males

A schedule of three blood samples collected at the interval of 1.5 hour in a single day was used to estimate follicle stimulating hormone (FSH), luteinizing hormone (LH) and testosterone at the age of 1,6, 12, 18 and 24 months of age in Karan Fries (n=6) and Tharparkar males (n=6). The concentrations of LH were significantly ($P<0.05$) higher in Tharparkar males compared to Karan Fries males at 24 months of age. Testosterone concentrations did not differ between different age groups in Karan Fries males. In case of Tharparkar males, significantly ($P<0.05$) higher testosterone concentrations were observed at 24 months age compared to other age groups.

Age Related Changes in Transcriptional Abundance and Circulating Levels of Anti-Mullerian Hormone and Sertoli Cell Count in Crossbred and Zebu Bovine Males

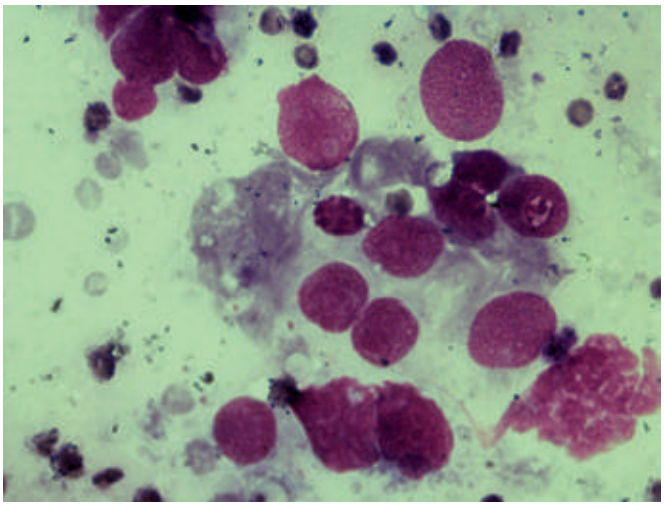


Age related changes in immunoexpression of AMH antibody in testicular tissue of crossbred males

Age related changes in peripheral Anti-Mullerian hormone (AMH) concentrations and transcriptional abundance of AMH gene in testicular tissue was studied in crossbred and Zebu males. In both the breeds, basal AMH concentrations were estimated using ELISA method in blood plasma obtained from 6 males each at 1, 6, 12, 18 and 24 months age. Immunolocalization of AMH was also performed in the testicular tissue. The true Sertoli cell count was significantly higher in Zebu compared to crossbred males at all age groups studied except at 6 months age. The relationship between Sertoli cell count and circulating AMH concentrations was negative and significant ($r=-0.81$; $P=0.004$). Thus, expression of AMH gene in testicular tissue and peripheral blood concentrations of AMH were higher in young compared to adult in both crossbred and Zebu males. Between breeds, the transcriptional abundance and circulating levels of AMH was higher in Zebu compared to crossbred males.

Comparative Efficiency of Percutaneous Needle Aspiration Method and Castration for Extraction and *In Vitro* Culture of Spermatogenic and Sertoli Cells

To find out the accuracy of fine needle aspiration method in estimating testicular cells and their indices, we compared the findings of testicular histology with testicular FNAC. In this study, 89 % agreement was found between histology and testicular fine needle aspiration cytology in evaluation of the number of testicular cell and their indices. The FNAC method can also be used to extract the testicular cells for *in-vitro* culture. Sertoli cells obtained from 1 month old males exhibited rapid growth and multiplication in *in-vitro*. The number of Sertoli cells increased by 3.4 and 7.4 times at first and second passage. Sertoli cells obtained at 6 months and afterward grew slowly with advancing age viz. 2.6 and 5.2 times, 1.4 and 2.3 times, 0.9 and 1.9 times at 18



months and 0.8 and 1.2 times at 24 months of age at first and second passage. Similar growth characteristic were observed in in-vitro cultured spermatogenic cells also. Spermatogenic cells derived from 1 month of age showed faster growth and multiplication. The number of spermatogenic cells increased by 1.5 times and 5.5 times at first and second passage. Spermatogenic cells obtained from males of 6 months and afterwards grew slowly (1.8 and 3 times at 6 months, 1 and 1.8 times at 12 months, 0.4 and 1.05 times at 18 months and 0.7 and 1.3 times at 24 months, after first and second passage).

Probably this is the first such attempt to culture the Sertoli and spermatogenic cell from the sample obtained through testicular fine needle aspiration. Since, similar growth and culture characteristics of Sertoli and spermatogenic cells were observed in both FNAC and castration methods, FNAC may be used as complementary technique for isolation and culture of Sertoli cell and spermatogenic cell to avoid the castration to the large animals.

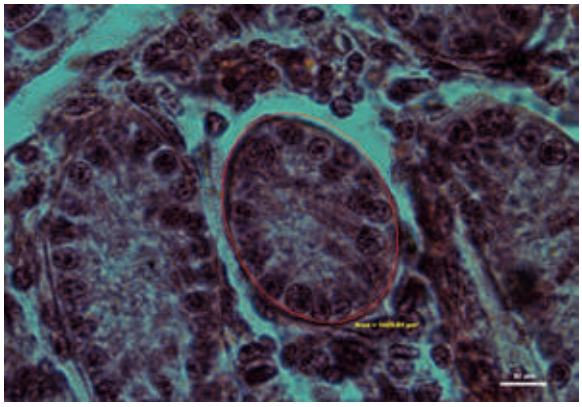
Differential Expression of Proteins in *In-Vitro* Cultured Spermatogenic Cells from Crossbred and Zebu Males

Cultured spermatogenic cells obtained from 6 and 24 months old crossbred and Zebu males were utilized for studying the differential expression of proteins using LC-MS/MS technique. A total 2895 proteins were identified in 6m Zebu X 6m crossbred comparison, out of which 1596 and 738 proteins were present exclusively in 6m Zebu and 6m crossbred spermatogenic cells respectively, whereas 592 proteins were common in both the groups. Among these common proteins, 64 proteins were differentially expressed between the groups. Similarly, total 2899 proteins were identified between 24m Zebu X 24m crossbred groups, among which 1016 and 1246 proteins were present solely in Zebu and crossbred spermatogenic cells, respectively. Out of remaining 637 proteins which were present in both the groups, 34 proteins were differentially expressed between Zebu and Crossbred cells. A total 2812 proteins were identified between 6m crossbred X 24m Crossbred groups, out of which 843 and 1422 proteins were exclusively found in 6m Crossbred and 24m Crossbred cells respectively, whereas 547 proteins were common in both the groups. Out of these, 547, 21 proteins differed significantly ($P<0.05$) between 6m Crossbred X 24m Crossbred groups.

These preliminary findings indicate that several proteins were differentially expressed (either up regulated or down regulated) in cultured spermatogenic cells of crossbred compared to Zebu males. Exploring the functional aspects of these proteins may help in improving our understanding on the etiology of high incidence of infertility in crossbred males.

Association of Peripartum Progesterone, Estradiol, Cortisol, PGFM and Relaxin Concentrations with Retention of Fetal Membranes in Dairy Cows

Retention of fetal membranes (RFM) in bovines not only lowers productivity and fertility but also leads to significant economic loss to the dairy farm. Peri-partum progesterone, estradiol, cortisol, PGFM and relaxin concentrations in crossbred cows with normal parturition (NP; n=6) and with RFM (n=6) was compared. Blood samples were collected at weekly interval from 30 days prepartum till 7th day before calving, followed by every alternate days till calving and 1st and 2nd day after calving. Significantly ($P<0.05$) higher plasma cortisol concentrations was observed between day 3 prepartum and day 2 postpartum in RFM cows compared to NP cows. Plasma estradiol level was significantly ($P<0.05$) lower in RFM group than NP group on the day of calving while progesterone concentrations did not differ between the groups. In RFM cows, plasma Prostaglandin F2 metabolite (PGFM) level was significantly ($P<0.05$) lower on day 1 and day 2 postpartum compared to NP



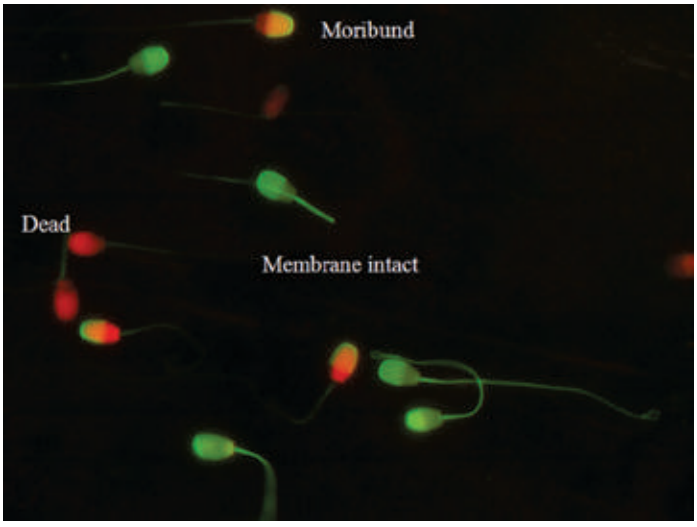
cows. On the day of calving and on day 1 postpartum, relaxin concentration was significantly (P<0.05) higher in NP cows compared to RFM cows. Based on ROC analysis, it was inferred, that cows with cortisol concentration above 7.35 ng/ml and PGFM concentration below 1072 pg/ml on day -1 had 5.99 times higher risk of developing RFM.

Salivary Crystallization as a Tool for Timing of Insemination and Early Pregnancy Diagnosis in Dairy Cattle

It was attempted to assess if salivary crystallization pattern can be used to identify suitable time for insemination and for early pregnancy diagnosis in dairy cows. Blood and saliva samples were collected from Sahiwal cows (n=20) on every alternate days from day 0 (estrus) till next estrus. All the cows were inseminated at this estrus and, blood and saliva samples were collected till 25 days post-insemination. Crystallization pattern was studied in saliva while estradiol and progesterone concentrations were estimated in blood plasma. The crystallization pattern was compared between estrous cycle and pregnancy. Mainly, six types of crystallization pattern were observed in saliva of cows. Among different patterns, pattern 2 was observed on the day of estrus in all cows. All the cows that became pregnant showed only pattern 2 on the day of insemination. On day 16 of pregnancy all the cows showed pattern 4. On day 20 of estrous cycle, saliva of all the cows showed only pattern 2. The appearance of pattern 2 was positively and significantly related to estradiol: progesterone ratio (r=0.86; p=0.0001). It may be inferred that pattern 4 was associated with pregnancy and absence of pattern 2 on day 20-25 post-insemination may be considered as an indication of pregnancy in cows.

Identification of Suitable Combinations of *In Vitro* Sperm Function Test for Prediction of Buffalo Bull Fertility

Different sperm functional characteristics in frozen-thawed semen of buffalo bulls were assessed and their relationship with field fertility was estimaetd. Frozen semen samples from 3 different freezing operations each from nine Murrah buffalo bulls (used in progeny testing program) were utilized for assessment of different sperm functions related to fertilizing potential. Bulls were classified into high, medium and low fertile based on non-genetic parameters adjusted field fertility. The sperm functions estimated was membrane integrity using CFDA/PI, acrosome reaction status using FITC-PNA, status of apoptosis using Annexin-V, protamine deficiency using CMA3, membrane stability using Merocyanine 540 and lipid peroxidation status using BODIPY. Among different combinations of tests, the combination with minimum number of tests that could predict buffalo bull fertility with high accuracy (Adjusted R^2 = 0.73) included, moribund spermatozoa, live acrosome intact spermatozoa and spermatozoa without lipid peroxidation.



Modulation of Uterine Immunity to Prevent Postpartum Uterine Infections in Dairy Cows

The study elucidates the interaction between endocrine and uterine immune mechanism in the process of development of post partum uterine infections in dairy cows. For this purpose profiling of hormones like estradiol, progesterone, PGEM and PGFM during peripartum period i.e. -7 to +7 days of calving and expression of estradiol (ER) and progesterone receptor (PR) and PGES and PGFS in endometrial biopsy samples during period immediate to calving were carried out. Lowered (P<0.05) conc. of estradiol, and PGFM and high (P<0.05) conc. of PGEM during peripartum period were observed in cows that developed postpartum uterine infections than cows that did not develop uterine infections. Lowered (P<0.05) expression of estradiol (ER) and PGFS and heightened (P<0.05) expression of PGES in endometrial tissue were observed in cows that developed postpartum uterine infections during period immediate to calving.

To understand the uterine immune mechanism playing role for onset of postpartum uterine infections, expression of mRNA of genes encoding antimicrobial peptides (AMPs) and interleukins

(ILs) in endometrial tissue samples during period immediate to calving were carried out. Lowered (P<0.05) expression of antimicrobial peptides including beta defensin 4 and 5, S100A8, S100A12 and interleukins IL-1β, TNF-α and heightened (P<0.05) expression of S100A9, IL-6, IL-8 and IL-10 in endomterium at the time of calving were observed in cows that developed postpartum uterine infections than normal cows.

To understand the negative effect of NEBAL on uterine health of Sahiwal cows, BHBA concentration was estimated during peripartum period. BHBA level was significantly (P<0.05) high during the period 21 days before calving to 35 days postcalving in cows that developed postpartum uterine infections than normal cows. Furthermore, a significant correlation was obtained between BHBA and endometrial expression of antimicrobial peptides during the period immediate to calving. Reciever operator curve analysis also revealed BHBA value >769.3 mg/dl during 21 days prepartum to 7 days postpartum and value >766 and 749.2 mg/dl at 21 days and 35 days post calving respectively increased the relative risk for development of postpartum uterine infections in Sahiwal cows.

Effect of Astaxanthin on Semen Functions In Karan Fries Bulls during Summer

Astaxanthin was supplemented (0.25mg/kg body wt.) from April to August to Karan Fries bulls. It was observed that the physical parameters of semen were almost maintained. The mRNA expression of mitochondrial transcription factor A, Succinate dehydrogenase and citrate dehydrogenasee increased by astaxanthin supplementation indicating that the supplementation of astaxanthin may improve the mitochondrial functional activity and semen quality of Karan Fries bulls during summer season.

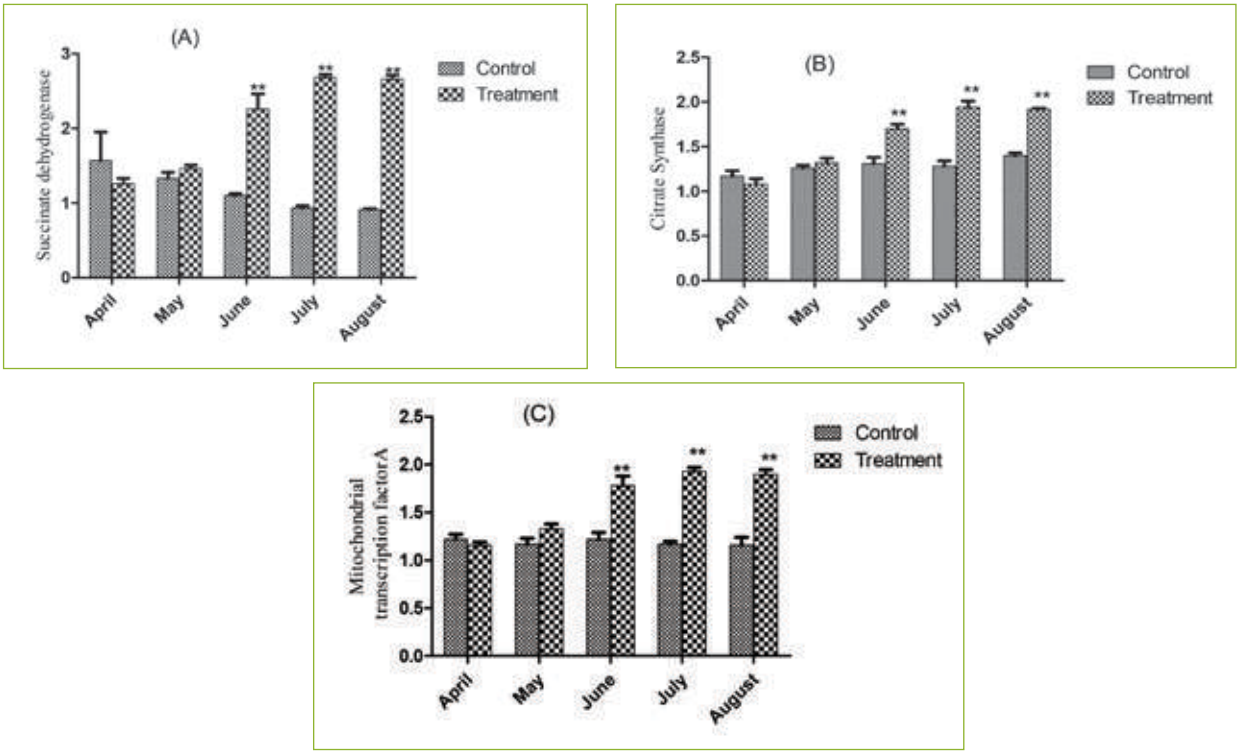


***Fig.: S**uccinate dehydrogenase (A), citrate synthase (B) and mitochondrial transcription factor A (C) mRNA relative expressions in spermatozoa of Karan Fries bulls during April to August months in control and treatment groups*

Assessment of Early Pregnancy by Analysis of Neutrophil Dynamics and Gene Expression in Dairy Cattle

During implantation there is a two way communication between the conceptus and the mother's immune system. Blood neutrophils are sensitive to implantation signals received from the conceptus in pregnant cows. Neutrophils play an important role during peri-implantation period by showing changes in their expression which can be measured by isolating these cells from the circulation during days 12 to 20 post insemination. The results indicated that there was down-streaming of adhesion molecules of neutrophils along with pro-inflammatory cytokines in pregnant cows. Also, up-regulation of interferon stimulated genes like ISG15, OAS1, MX, IFI16 only in pregnant cows clearly indicates their role in successful implantation.

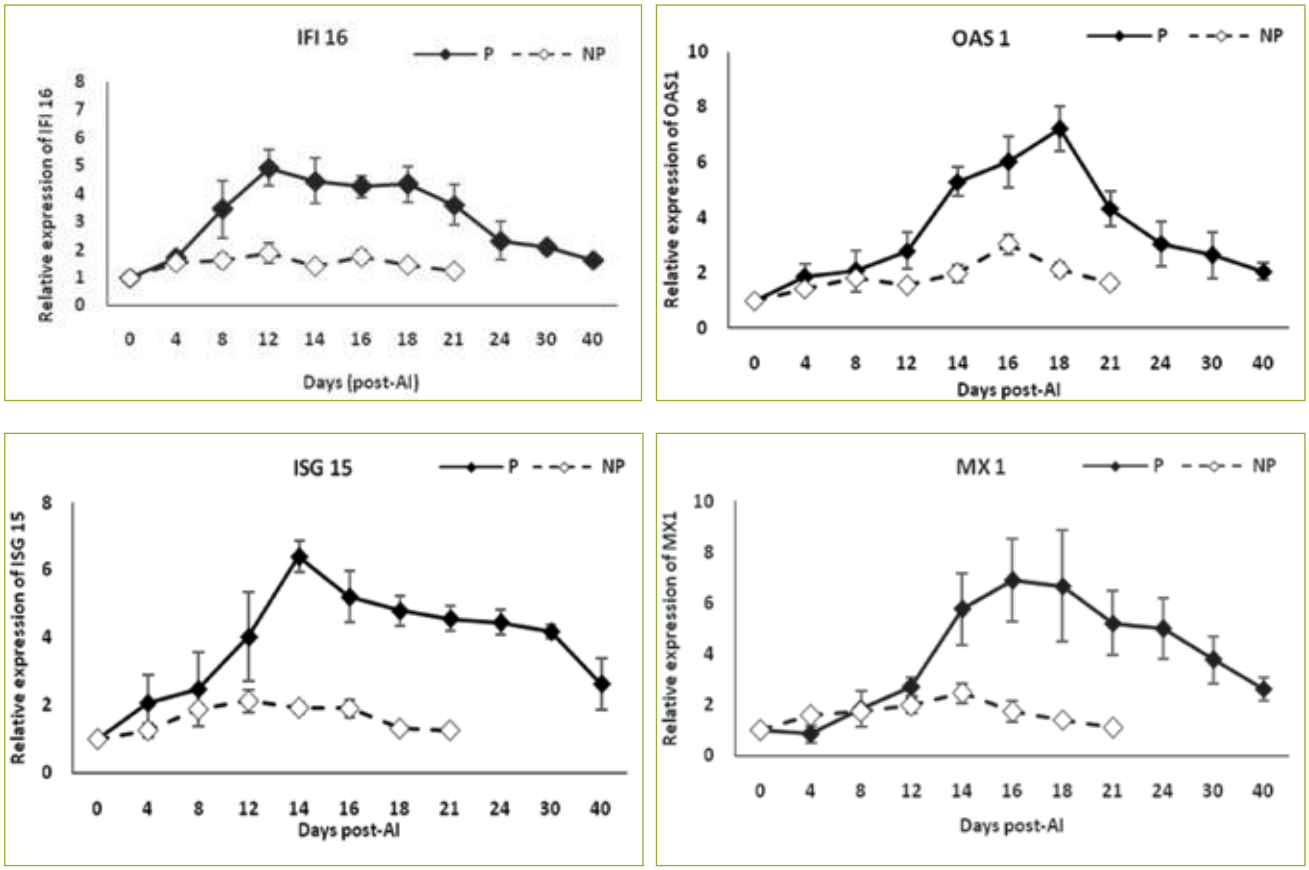


Fig.: *Higher expression of genes in pregnant cows as compared to non-pregnant cows*

To understand how polymorphonuclear leukocytes (PMN), integrate and prioritize multiple chemotactic signals to navigate during periods of demand like subclinical mastitis (SCM), clinical mastitis (CM), pregnancy (P) and at calving (C). Results showed that irrespective of physiological stage of the cows immune suppression was found to be always cortisol dependent. Also observing neutrophil activity and mRNA expression of genes isolated from neutrophils of cows can be used as indicators to assess the health/physiological status promptly for immediate therapeutic or management-related actions

Role of Histone Deacetylase (HDAC) Inhibitor in Preventing LPS Mediated Inhibition of Aromatase *(CYP19A1)* Expression and 17β-estradiol Production in Granulosa Cells

LPS inhibits CYP19A1 expression and 17β-estradiol (E2) production in granulosa cells (GCs). This is one of the major causes of infertility underlying postpartum uterine infections. However, the precise molecular mechanism is not well elucidated. Therefore, the hypothesis was tested if Trichostatin A (TSA), a HDAC inhibitor, can attenuate LPS induced pro-inflammatory cytokine gene expression and can prevent LPS mediated down-regulation of CYP19A1 expression and E2 in GCs. The present study demonstrated that TSA pre-treatment attenuated- LPS induced immune response involving NF-κB and HDACs, and thus prevented inhibition of CYP19A1 expression and E2 production through chromatin remodeling. Our study suggests that HDAC inhibitors could be a potential therapeutic strategy to treat infertility underlying postpartum uterine infections.

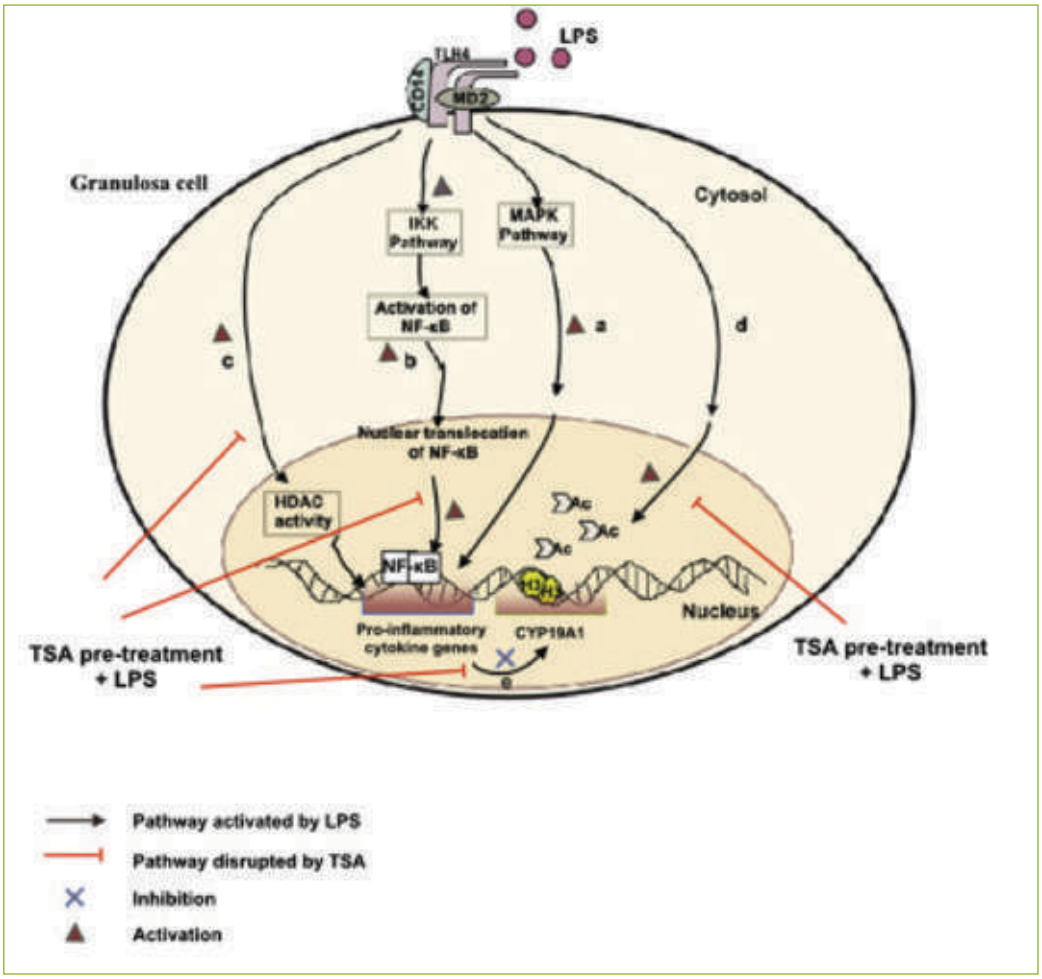


Fig: *Schematic representation of the proposed mechanism of TSA action on LPS mediated down-regulation of CYP19A1 and E2 production in buffalo GCs. LPS binds to TLR4 complex in GCs and transiently induces pro-inflammatory cytokine expression by – (a) activating MAPK pathway, (b) nuclear translocation of NF-κB and (c) up-regulating nuclear HDAC activity (mechanism unknown). At 24 h, (d) LPS down-regulated CYP19A1 expression by deacetylation of H3 (K9/14). TSA pre-treatment prevented LPS induced immune response by inhibiting – (c) increase in HDAC activity, and (b) nuclear translocation of NF-κB. TSA pre-treatment mediated attenuation of LPS induced immune response prevented cytokine mediated down-regulation of CYP19A1 expression (e). Also, TSA pre-treatment prevented – (d) LPS mediated H3K9/14 deacetylation at CYP19A1 PII to increase aromatase transcript expression and thus E2 production in buffalo GCs (in vitro).*

Detection of Oestrus Marker in Buffaloes by Direct Saliva Transcript Analysis

Salivary RNA-based biomarkers are not available for any physiological condition in farm animals. Saliva, after removal of the cells and particulate matter, was directly used for RT-PCR without RNA isolation. Direct saliva transcript analysis (DSTA) showed a suggestively significant higher expression of the Heat shock protein 70 (HSP70) and Toll-like receptor 4 (TLR4) at oestrus than the diestrous period in buffaloes by a non-parametric Mann-Whitney U test. Therefore, DSTA without RNA isolation is an easy method to identify salivary RNA markers for oestrus detection in buffaloes.

Characterization of Lower Fractal Dimension Values of Buffalo Salivary Fern Patterns at Oestrus

Saliva at oestrus showed a typical symmetrical fern-like crystallization patterns with significantly ($P< 0.05$) lower fractal dimension values. Fractal analysis is generally used for those objects, which do not follow general Euclidian geometry but follow fractal geometry. Fractal geometry has two basic properties, self-similarity and non-integer dimension. As the dried saliva is expected to show fern patterns with these fractal geometry properties, fractal analysis is implemented for salivary fern patterns to quantify their non-integer dimension values in this study.

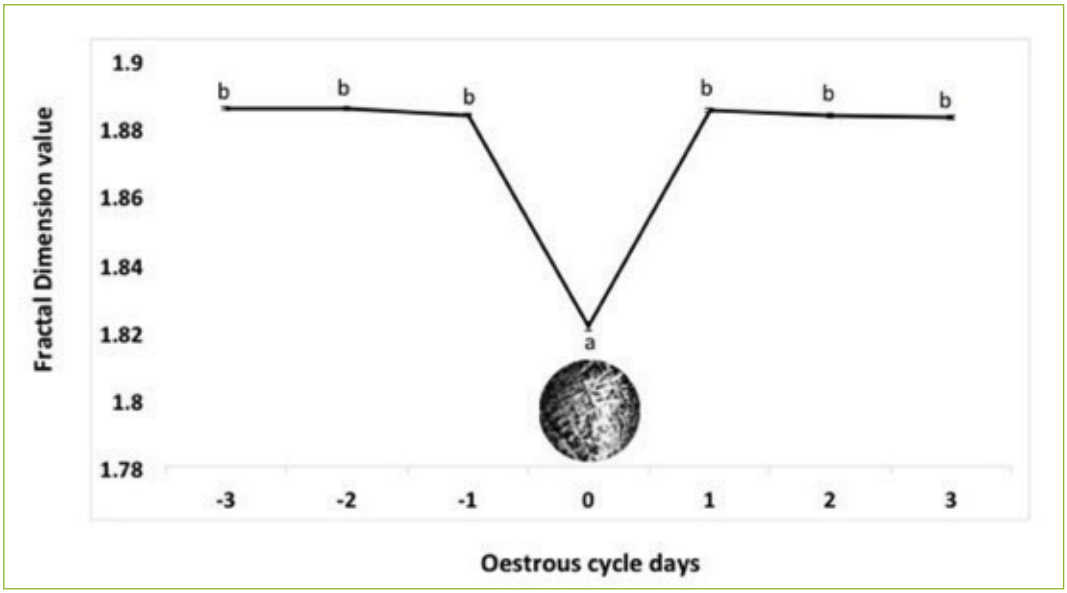


Fig: *Fractal dimension values of the salivary crystallization patterns at oestrus and -3 to +3 days of the oestrous cycle in buffaloes. The fractal dimension values (Mean ± SEM) of the typical salivary fern patterns at oestrus (n = 7) had significantly (P < 0.05) lower fractal dimension values than the fractal dimension values (n = 7) of the salivary crystallization patterns at -3, -2, -1, 1, 2, and 3 days of the oestrous cycle in buffaloes. Alphabets a, b indicate the significant difference at P < 0.05 by a non-parametric Mann-Whitney U test.*

Biosafety and Amelioration of Nanomaterials (NM) Induced Toxicity

On account of their size NMs can easily diffuse into membrane and hence are responsible for production of free radicals which cause membrane destabilization leading to cell death. Taurine which is also known as membrane stabilizer, might help in countering NMs associated membrane destabilization. Ag NPs and multi-walled carbon nanotubes (MWCNTs) induced deterioration in sperm functionality parameters were significantly reduced by 50 mM of taurine due to its antioxidative and membrane stabilizing effect. This is probably the first study reporting amelioration of nanotoxicity using antioxidants in male germ cells as a model system. The *in vitro* studies further potentiate the fact that the main cause of nanotoxicity is NMs induced oxidative stress and these can be prevented by using antioxidants. Since the preventive potential of vitamin E and curcumin were found to more effective in either of the treatment group, these two antioxidants were chosen for *in vivo* amelioration taking albino mice as animal model system. Buffalo bull spermatozoa were treated with different doses of NMs for different time intervals and IC_{50} values were obtained. Several sperm functionality parameters were assessed in IC_{50} treated spermatozoa. Membrane damage, ROS production and oxidative stress appeared to be the principal causes of nanotoxicity. Vitamin E and curcumin supplementation significantly reduced nanotoxicity probably due to its lipid soluble nature and potential defense against ROS and LPO attack. ROS levels were significantly reduced by exposure to dietary antioxidants – Vitamin E and curcumin as well as NAC. Histological examination of testis and epididymis revealed gross pathological changes in mice fed with Ag NPs. Liver injury marker enzymes (AST, ALT, ALP) were reduced in mice co-exposed with NMs and antioxidants as compared to mice fed with NMs alone. Accumulation of Ag NPs in mice testes down regulated genes responsible for steroidogenesis, including P450-c 17 and 17β-HSD.

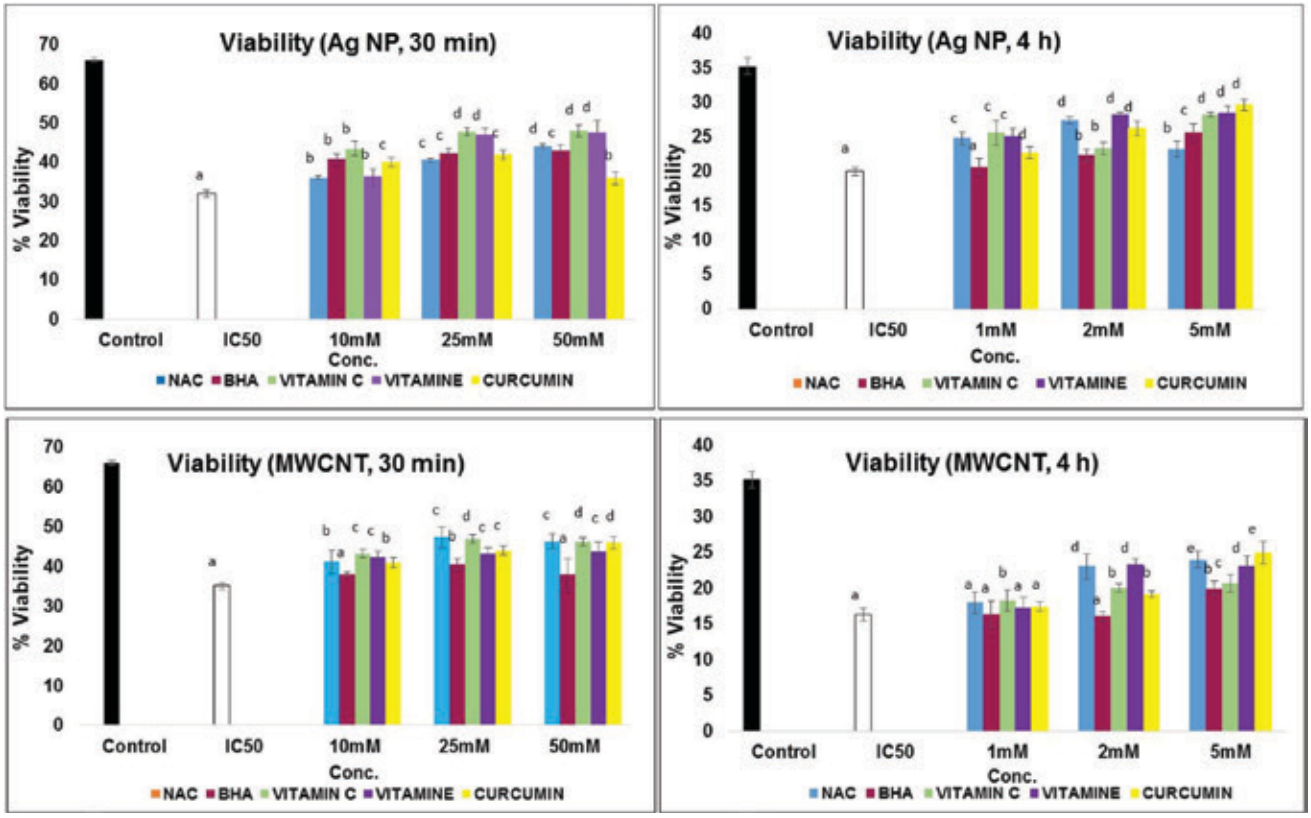


Fig: *Viability restoration by synthetic and dietary antioxidants in buffalo bull spermatozoa pre-exposed to Ag NPs or MWCNTs. In short term group, cells were pre-treated with Ag NP (IC_{50}) and MWCNT (IC_{50}) for 30 minutes followed by treatment with synthetic and dietary antioxidants (10, 25 and 50 mM) for 30 min (A and B). In long term group, pre-treated cells were treated with antioxidants @ (1, 2, and 5 mM) for 4 h (C and D). All values are presented as mean±S.E.M. Bars with different superscripts are significantly different ($p<0.05$).*

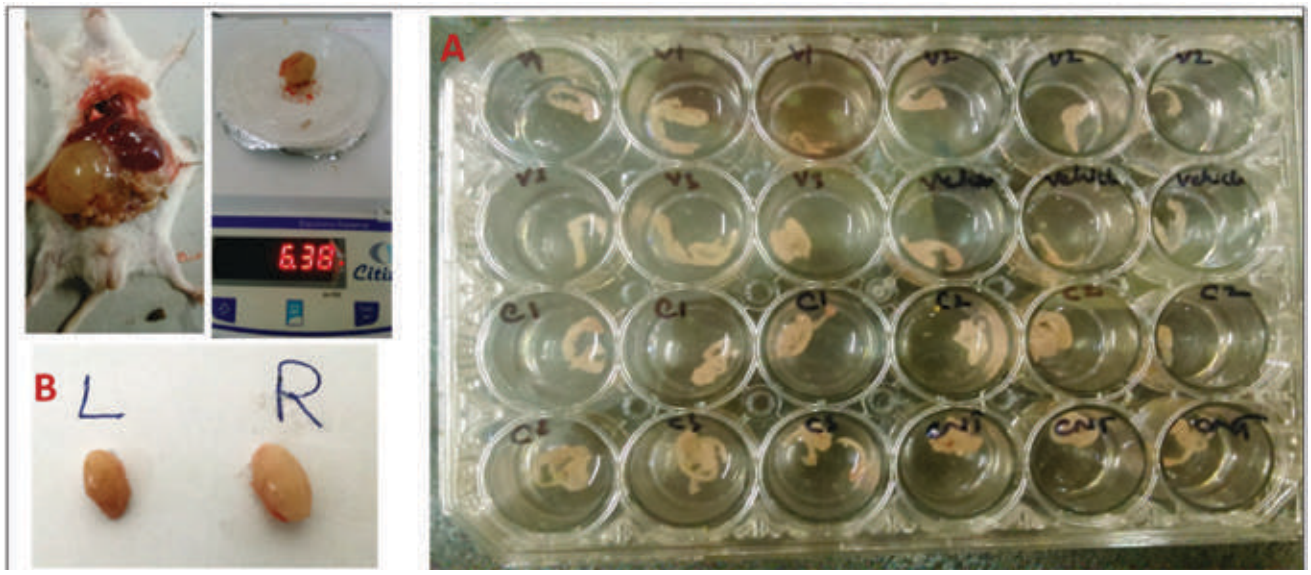


Fig: Isolation of Reproductive Organs followed by Dissection.
(A) Represents epididymis of control and treated group in HTF media and (B) Weight reduction in left testis in Ag NPs treated mice.

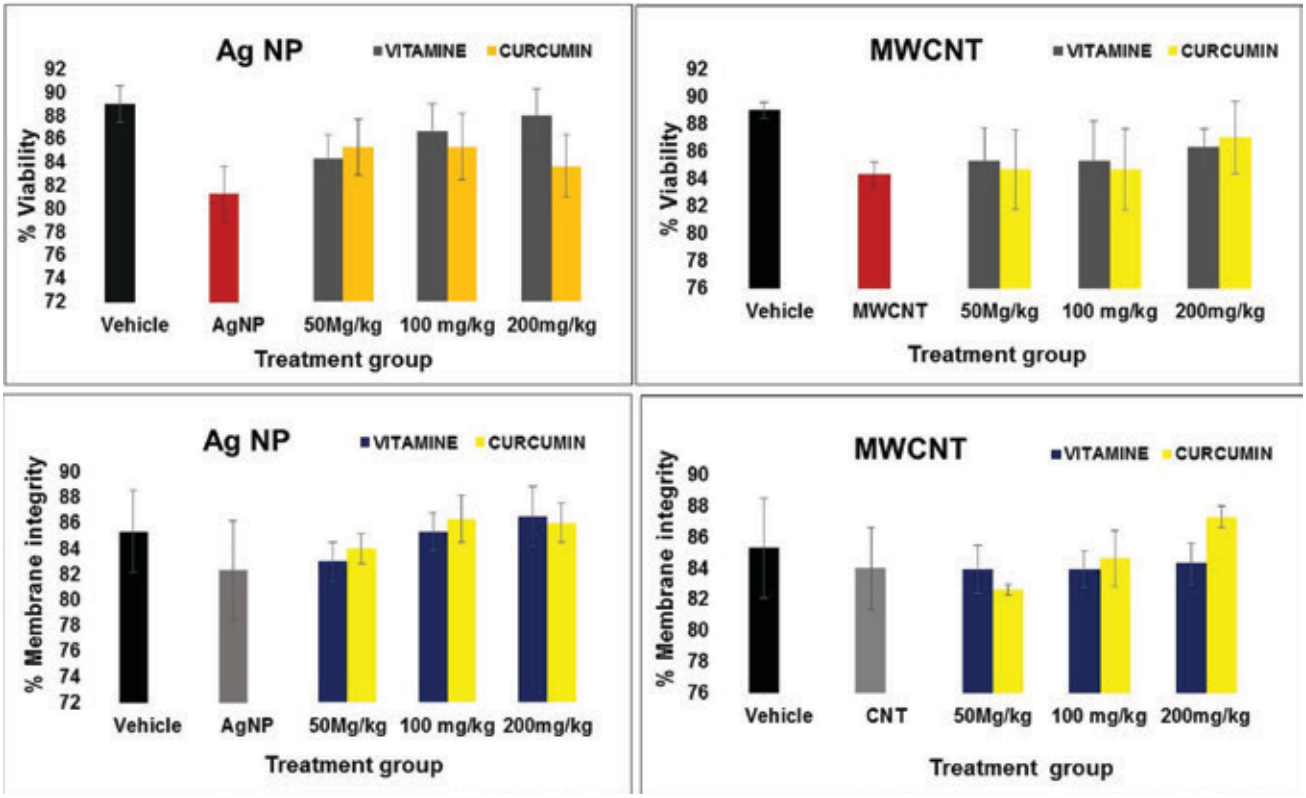


Fig: Percent Viability of Epididymal Spermatozoa in Different Experimental Group.
(A, B) Represents percent viability of epididymal spermatozoa in Ag NPs and MWCNTs treated groups, with and without co-exposure of antioxidants. (C, D) Percent membrane integrity of epididymal spermatozoa in Ag NPs and MWCNTs treated group with and without co-exposure of antioxidants.

Reproductive Performance Evaluation and Improvement of Deoni (Bos indicus) Cattle

Calving interval, CTFS and SP were highly influenced by parity i.e. as the parity advanced, reproductive efficiency increased. Season showed significant influence over CTFS only. Farm and period (management) influenced CI, AFS and AFC. The mean interval from calving to first AI was ranging from 46 to 225 days. First AI – CR was higher between 120-180 days than 30-120 days and cows first inseminated at an early stage of lactation had a lower CR. Supplementation of trace minerals and vitamins during transition period improved better energy and immune status in primiparous Deoni cows with more detailed studies, IRT could possibly be employed as a non-invasive diagnostic tool to monitor estrous cycle, detect estrus and predict ovulation based on skin surface temperature differentials in cows.

Chemically Defined Extender for Buck Semen Preservation and Artificial Insemination

Chemically defined semen extender for Black Bengal buck semen preservation has been developed. Egg yolk present in the semen extender protects the sperm cells from cold shock damages during storage at low temperature. Demands for replacement of egg yolk in goat semen extenders have increased in the recent years as the interaction between Egg Yolk Coagulating Enzyme and phospholipase present in the goat seminal plasma with egg yolk causes damages to sperm cells. Egg yolk also increases the risk of microbial contamination of semen. Soybean lecithin which is rich in phosphatidylcholine was used as a replacement with egg yolk in preservation of Black Bengal buck semen. Tris hydroxyl methyl amino methane based extender with 1, 1.5 and 2% (w/v) levels of soybean lecithin was tested for freezing of buck semen. Semen samples were evaluated for progressive forward motility, functional membrane integrity and concentration of lipid peroxide compound malondialdehyde (MDA) after initial dilution with extender, 3 hours of equilibration and after freezing and thawing. It was observed that Tris based semen extender for preservation of Black Bengal semen could be prepared by replacing egg yolk with soybean lecithin at 1.5% (w/v) with optimal post thaw recovery for insemination purposes.

Table: *In Vitro* Sperm Characters of Semen Preserved in Extenders with Soybean Lecithin

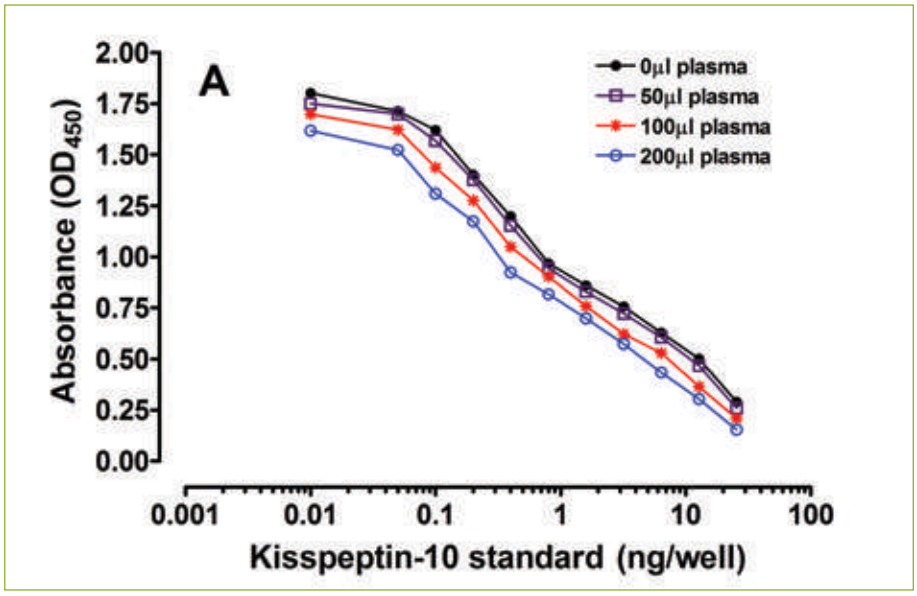
Observations		1% Soybean lecithin	1.5% Soybean lecithin	2% Soybean lecithin
Sperm motility-progressive forward (%)	After Initial dilution	66.00^{a1}	75.45^{a2}	73.33^{a2}
	After equilibration	59.50^{b1}	65.00^{b2}	65.71^{b2}
	Post Thaw	10.00^{c}	22.65^{c2}	15.56^{c3}
Membrane integrity (%)	After Initial dilution	64.06^{a}	60.44^{a}	60.38^{a}
	After equilibration	62.71^{a1}	55.36^{b2}	58.88^{a2}
	Post Thaw	5.00^{b1}	28.99^{c2}	19.02^{b3}
MDA concentration (μ mol/ml)	After Initial dilution	0.0151	0.0257	0.0321
	After equilibration	0.0158	0.0272	0.0386
	Post Thaw	0.0176	0.0294	0.0405

Means with different superscripts a, b, c in a column differ significantly at P< 0.01 for particular parameter

Means with different superscripts 1, 2 in a row for particular parameter differ significantly at P< 0.01

Development and Validation of a Highly Sensitive Bovine Specific Enzyme Immunoassay for Determination of Plasma Kisspeptin Concentrations during Reproductive Cyclicity and Different Phases of Pregnancy in Crossbred Cows

Kisspeptin, a decapeptide and potent secretagogue of GnRH has emerged recently as a master player in the regulation of reproduction in animals. Determination of kisspeptin in peripheral circulation is, therefore, very important for studying the control of its secretion and its role on reproduction in bovine species. The information on this is not available during any physiological state in this species, which may probably be due to non-availability of simple assay procedure to measure the hormone. Therefore, the objective of this study was to develop and validate a simple and sufficiently sensitive enzyme immunoassay (EIA) for kisspeptin determination in bovine plasma using the biotin-streptavidin amplification system and second antibody coating technique. Biotin was coupled to kisspeptin and used to bridge between streptavidin-peroxidase and the immobilized kisspeptin antiserum in the competitive assay. The mean plasma kisspeptin concentration during different days of the estrous cycle was different (P<0.001). Three peaks of kisspeptin were recorded, one on a day before appearance of preovulatory LH surge, second at day 6 and third one at day 18 of the estrous cycle. Plasma kisspeptin concentrations increased (P<0.001) from first through last trimester of pregnancy. Kisspeptin concentrations were also measured in different follicular, luteal and placental tissues. Follicular and placental kisspeptin levels increased (P<0.01) during follicular development and with the advancement of pregnancy, respectively. On the other hand, luteal concentrations of kisspeptin decreased (P<0.01) with its developmental process. In conclusion, a simple, sufficiently sensitive and direct EIA procedure has been developed for the first time to determine plasma kisspeptin levels in bovine. A wide range of kisspeptin concentrations can be detected during different physiological stages in bovine using this Kisspeptin-EIA procedure.



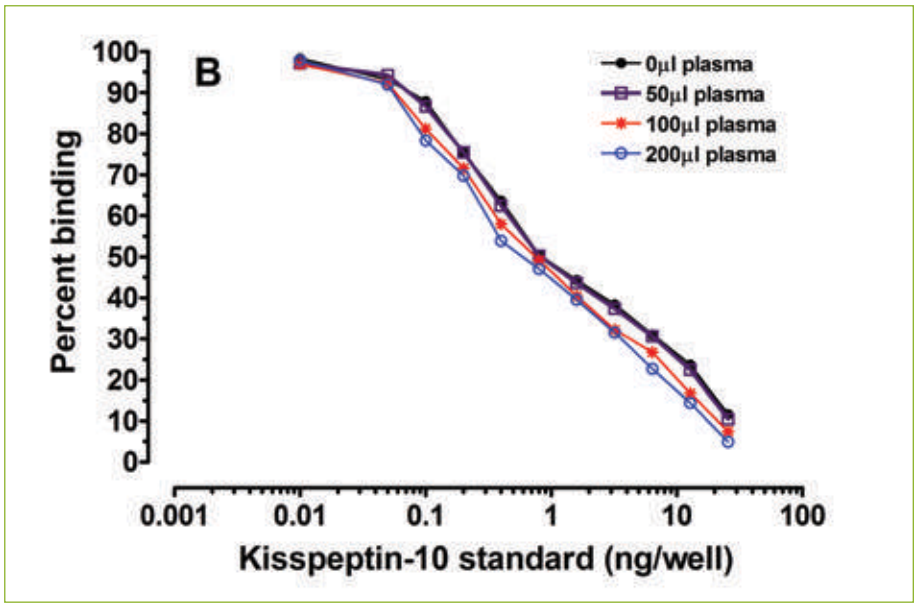


Fig.: Influence of different volumes viz., 50, 100 and 200µl of plasma on OD displacement (A) and percent binding (B) in kisspeptin standard curve. Along with different volumes of plasma the standards were also prepared in assay buffer. Optical density was measured at 450nm.

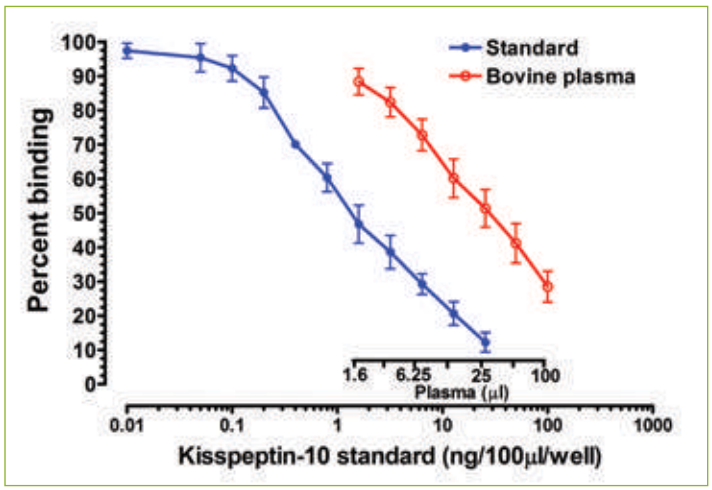


Fig.: Parallelism for kisspeptin standards with serially diluted different volumes of 1.6, 3.125, 6.25, 12.5, 25, 50 and 100µL of bovine plasma samples containing high endogenous kisspeptin (n=4). Standards for kisspeptin were ranging from 0.01 to 25.6ng per 100µl per well.

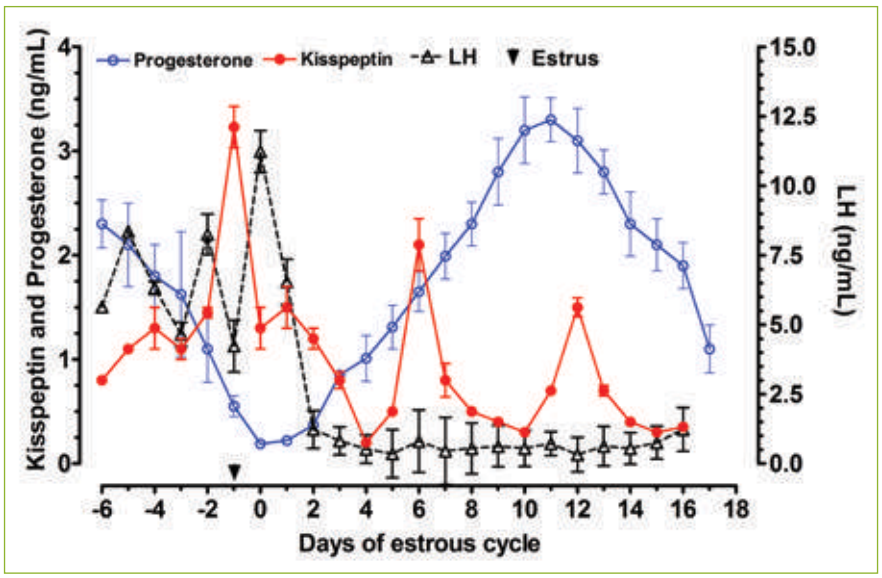


Fig.: Plasma kisspeptin, LH and progesterone profiles (mean±SEM) in cycling cows (n=6)

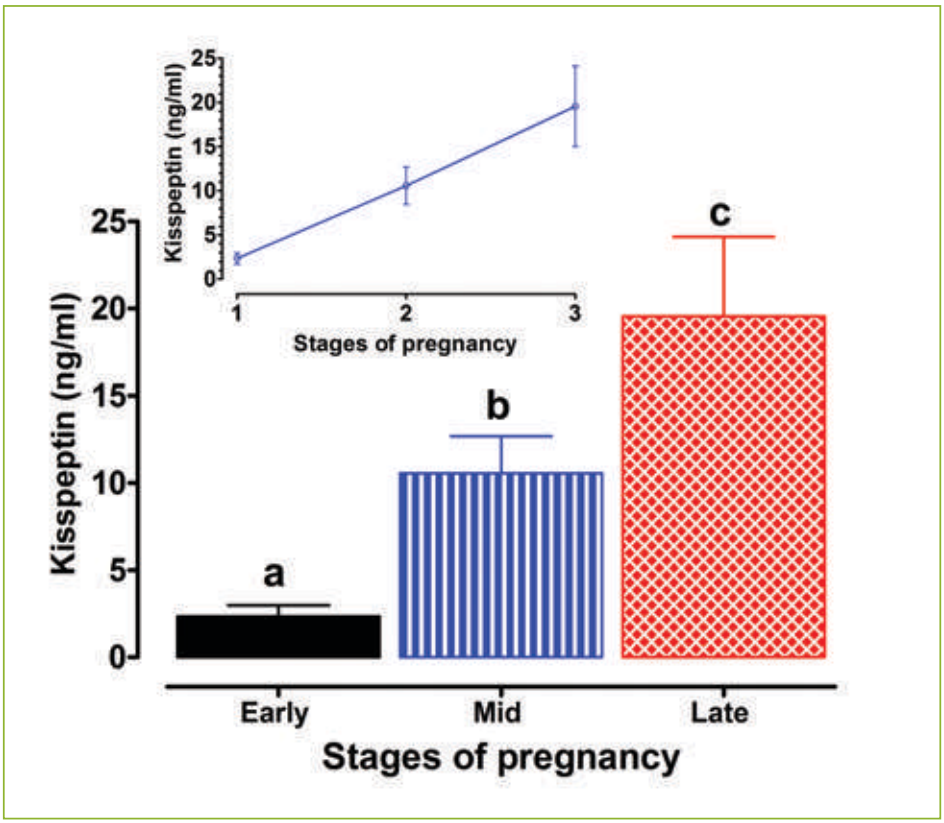


Fig.: Plasma kisspeptin profiles (mean±SEM) in pregnant cows during early (<10 weeks; n=6), mid (>10 to <20 weeks; n=6) and late (>20 to 36 weeks; n=6) stages of pregnancy. Bars indicated with different letters (a,b,c) differ (P<0.001).

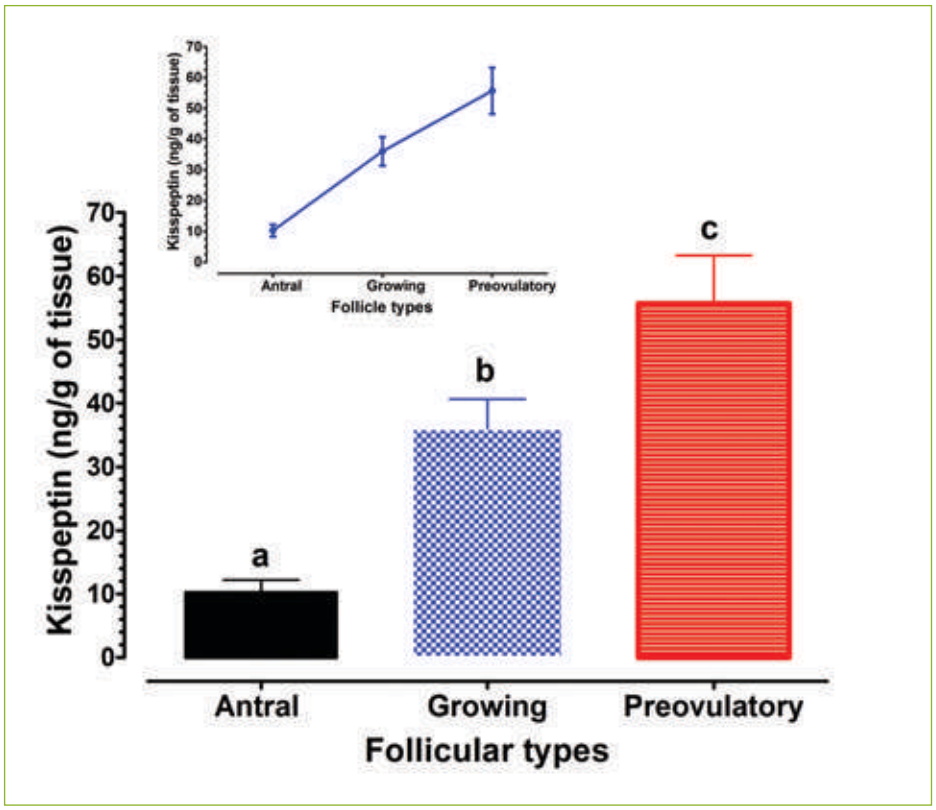


Fig.: Kisspeptin content (mean±SEM) of different types of follicular tissues. Ten grams of antral (5-6 mm), growing (8-10 mm) and preovulatory (15-16 mm) follicles were extracted (n=4). Bars indicated with different letters (a,b,c) differ (P<0.001).

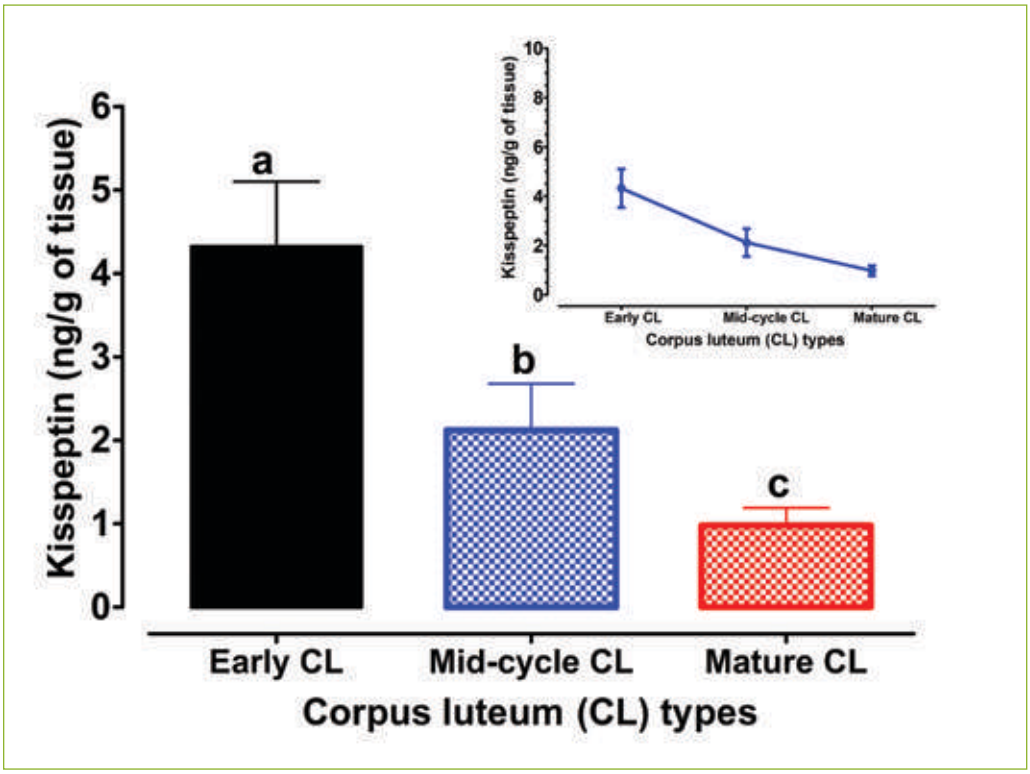


Fig.: Kisspeptin content (mean±SEM) of different types of bovine corpus luteum (CL). Ten grams of early, mid-cycle and mature CL tissues were extracted (n=4). Bars indicated with different letters (a,b,c) differ (P<0.001).

Development for New Kisspeptin-based Method of Estrus Synchronization for Times-AI

The aim of the present study was to develop a new method of synchronization of estrus/ovulation for crossbred cows based on kisspeptin, a potent secretagogue of GnRH. For the purpose, a total of 108 estrous cycles were studied in cyclic heifers. The animals divided equally into two groups were treated either with ovsynch protocol of estrus synchronization (group-I; GnRH: day 0; PGF2α: day 7 and GnRH: day 9) or with a new method of synchronization based on kisspeptin (group-II; kisspeptin: day 0; PGF2α: day 7 and kisspeptin: day 9). Heifers were monitored regularly with transrectal ultrasonography for follicular dynamics and occurrence of ovulation. It was found that the kisspeptin based protocol induced better growth of follicles than ovsynch one. Ovulation rate was significantly higher (P<0.05) in the animals of group-II than group-I. As revealed through ultrasonography as well as plasma progesterone profiles, the process of luteolysis starts early even before PGF2α injection in kisspeptin based protocol than ovsynch. Thus, a new method of synchronization of estrus/ovulation based on kisspeptin in bovine species has been developed for the first time. The newly developed method has been found to be better than the conventional ovsynch method in terms of percent ovulation in the treated animals.

Development of Mathematical Model of Bovine Estrous Cycle based on Endocrine Profile

Declined fertility of the high yielding dairy cows reared under intensive condition of management is of great concern not only for India but the whole world. The bovine estrous cycle particularly the estrus is tightly controlled by the complex interplay of various organs and hormones. Mathematical modeling of the bovine estrous cycle could help in understanding the dynamics of this complex biological system. Therefore, a mechanistic mathematical model for the estrous cycle of Indian crossbred cows that exclusively include the key hormones that interact to control these processes has been developed. The data generated by the lab for approximately 163 estrous cycles having 1793 reading related to different hormones like LH, FSH, progesterone, estrogen etc. under the control of the hypothalamo-pituitary-gonadal (ovarian) axis. The developed model was capable enough to generate successive estrous cycles of 21-day length. The model contains seven differential equations and 34 parameters. By simulating the developed model, a set of equations

and parameters that were obtained were found to describe vividly the system consistent with empirical knowledge. In conclusion, it is for the first time a mechanistic mathematical model of the estrous cycle for the Indian crossbred cows has been developed and it can be used for predicting hormonal *inter milieu* of the complex biological system without spending much time and money towards laboratory estimation. The developed model may also be used as a basis for more elaborate models that can predict the effects of external manipulations and genetic differences in Indian bovines.

Development of a Rapid Microtitreplate Based Colorimetric Method for Estimation of Non-esterified Fatty Acids in Bovine Plasma

Non-esterified fatty acid (NEFA) is one of the most important blood metabolites contributing significantly during body growth, cyclicity, pregnancy and lactation, and it plays more vital role particularly during transition phase of the biological processes like pregnancy to lactation transition period. Determination of blood concentrations of NEFA is, therefore, important. The measurement technique or assay for measurement of blood NEFA should be simple, reliable, accurate, rapid and cheap. Here, we developed a sensitive and fast microtitreplate colorimetry based method for estimation of NEFA in bovine plasma. The method is simple to perform and gives accurate, precise results in 100 µl samples. The developed method requires at least five times less quantity of plasma and reagents than that of already existing methods. Furthermore, ability of the method for taking reading of all the samples together on microtitre plate in a reader enable us to save lot of time. Hence, the developed method may be adopted for estimation of NEFA in bovine plasma.

Designing of Cheaper Bovine Specific Kisspeptin-10 Peptide

Commercially available kisspeptin-10 is synthesized based on the last ten amino acids sequence from amino-terminal end of human kisspeptin. Our study shows that bovine kisspeptin sequence has 69% homology to human kisspeptin sequence. Therefore, we sequenced the bovine kisspeptin and designed bovine specific kisspeptin-10. Synthesized bovine kisspeptin-10 based on our amino acid sequence has been found to be cheaper and equally potent as that of commercially available kisspeptin-10.



Sh. Radha Mohan Singh Ji, Hon'ble Union Minister for Agriculture & Farmers Welfare addressing the faculty and Staff of NDRI

FEED, FODDER AND ANIMAL PRODUCTIVITY

Evaluation of Canola Cake as a Replacement for Mustard Cake in Lactating Crossbred Cows

The aim of the study was to to evaluate the effect of replacing mustard cake with canola cake in the concentrate mixture on feed intake, body weight, milk production and its composition and reproductive performance and to evaluate the economics of feeding canola cake on lactating crossbred cows. For this study sixteen freshly calved crossbred lactating Karen Fries cows in their first to third parity had been selected from NDRI herd and randomly divided into two homogeneous groups based on the milk yield of their previous lactation. Groups were balanced for parity and time of calving. The cows in Group I were fed on a ration as per NDRI feeding schedule consisting of concentrate mixture according to the milk yield with *ad lib* feeding of seasonal green fodders and the cows in Group II were fed on a ration as per NDRI feeding schedule consisting of concentrate mixture according to the milk yield with *ad lib* feeding of seasonal green fodders. The concentrate mixture was formulated by replacing the mustard cake (14 parts) with the same amount of canola cake. Rest of the ingredients of the concentrate mixture were the same. The data were analysed using suitable statistical techniques.



Canola plant



Canola cake

Based on the results of the study, it was concluded that:

- The chemical composition of canola cake as a source of feed protein for lactating crossbred dairy cows was found to be better as it had lower levels of acid detergent fiber (ADF), neutral detergent fiber (NDF) and glucosinolates and higher levels of crude protein (CP) as compared to mustard cake.
- The feeding of concentrate mixture formulated by replacing mustard cake with canola cake to lactating crossbred dairy cows had no effect on their feed intake, body weight changes, daily milk yield and milk composition. However, the mean daily milk yield in cows fed canola

cake based concentrate mixture was higher by 1.06 kg as compared to cows fed mustard cake based concentrate mixture.

» Feeding canola cake as a replacement for mustard cake in diets of lactating crossbred cows did not affect the in vitro digestibility, apparent digestibility and nutrient intake of DM, OM and CP. However, the percent feed efficiency was better for canola cake concentrate mixture fed cows indicating better productive performance.

» Feeding of canola cake as a replacement for mustard cake showed similar days to first service, days open and number of service per conception however, canola cake concentrate mixture has indicated an improvement in the reproductive performance by increasing conception rate.

» The cost of feeding of lactating crossbred cows supplemented with concentrate mixture formulated by replacing mustard cake with canola cake was lower by ` 0.84 per cow per day and the net income over feed cost was higher by about ` 22.57/- from milk or ` 27.56/- from 4% FCM on account of feeding canola cake based concentrate mixture.

Therefore, canola cake can completely replace mustard cake in the diet of lactating crossbred cows without affecting feed efficiency, voluntary feed intake, nutrient digestibility, nutrient utilization, body weight as well as their productive and reproductive performance. Moreover, it resulted in lowering the cost of milk production.

Manipulation of Partitioning of Nutrients and Energy Balance to Augment Milk Production and Reproductive Performance in Dairy Animals (BRNS)

Murrah buffaloes supplemented with prilled fat @100g/d and @ 150g/d during transition period produced higher milk yield (@2.47kg/d) with more fat, and consumed more DMI ($P<0.01$) and TDNI. The body weight and BCS was higher in treatment group than the control. An improvement in energy balance of buffaloes occurred in terms of DE, ME, NE and the ME/kg and DE/kg of milk ($P<0.01$) which led to higher gross feed efficiency and more milk yield. In another experiment feeding of prilled fat (100g/d) and *S. cerevisiae (*25g/d) mixture during day -21 to + 90 days, improved metabolic body weight ($P<0.05$) and BCS ($p<0.01$) of rural buffaloes due to higher DMI ($p<0.05$). Milk production and milk fat increased by 18.94 and 6.6% in the treatment group buffaloes than the control. A significant reduction in milk SCC occurred in treatment group which indicated better udder health status. Higher plasma levels of GH, leptin, T_3, T_4 ($P<0.05$) in treatment group resulted in higher milk yields due to better partitioning of energy and nutrients towards mammary gland for milk production. Milk yield though declined after withdrawal of feeding but was still higher ($p<0.05$) in treatment group by 14.44%. The feeding of prilled fat alone or in combination with *S. cerevisiae* was cost effective and generated additional income of INR. 117 to 137/day/animal in different experiments. The treatment resulted in early onset of estrous cyclicity with higher conception rates and lesser service period.

Green Fodder and Grain Yield of Barley *(Hordeum vulgare L.)* Varieties as Affected by Sowing Time and Stage of Harvesting

The field experiment was laid out in split-split plot design with four treatment Variety RD 2715 (V3) sown on 10th November performed butter and significantly differed in plant height, leaf length and harvested at 65 DAS. It is concluded from the study that sowing between 21st October to 10th November is ideal time for dual purpose barley for production of higher fodder, grain and straw. On the basis of the performance of RD 2552 in terms of higher green fodder as well as grain production and B:C ratio, this would be advisable for cultivation as dual purpose barley.

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

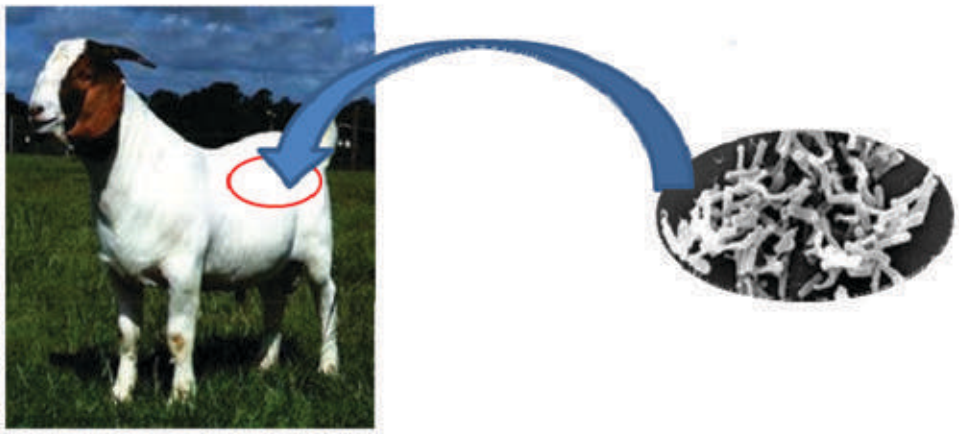
Three different experiments were conducted. The results from the study suggested that for obtaining good quality fodder in good tonnage 60 kg/ ha seed rate alongwith 125% RDF should be used. Variety J-1006 was superior over African tall in growth and yield. Moreover, leaf stem ratio was significantly better in J-1006. Application of zinc either as basal or foliar spray improved all growth and yield parameters and yield as well over no zinc. Interaction effect between Variety and Zn levels was not found to be significant.

Fatty Acids Profile in Milk of Different Species

Total saturated fatty acids (g/100g of fat) (Goat, Sheep, Camel, Buffalo and Cow) Goat, Sheep, Camel, Buffalo and Cow milk samples were ($P<0.05$) higher (13-14%) in summer than winter in milk of all the species. Total PUFA concentration (g/100g fat) was ($P<0.05$) higher (3-4%) in winter than summer and highest concentration was found in buffalo milk (4.17 in winter and 2.71g in summer), as compared to goat (3.47 in winter and 2.55 g in summer), Sahiwal (3.43 in winter and 1.94 g in summer), sheep (3.41 in winter and 2.63 in summer) and in crossbred cattle (3.10 in winter and 1.53g in summer), respectively. Total conjugated linoleic acid concentration (g/100g fat) was higher ($P<0.05$) (30-40%) in winter than summer. Sheep milk contains highest concentration of CLA which was 0.75 g in winter and 0.46g in summer. Goat, Sahiwal cow, buffalo, camel and crossbred cow milk contained CLA (g) 0.73 and 0.43, 0.62 and 0.39, 0.61 and 0.42, 0.59 and 0.42 and 0.55 and 0.38 respectively in winter and summer. Beneficial fatty acids for human health (MUFA, PUFA and CLA) increased in milk of different farm animals during winter season due to higher availability of naturally grown fresh grass and green fodders which are rich source of unsaturated fatty acids.

Effect of Administration of High CLA Producing Butyrivibrio fibrisolvens In-1

The present study was conducted to investigate the effect of administration of high CLA producing Butyrivibrio fibrisolvens In-1 on fatty acid composition of milk and rumen fluid in lactating goats. Four groups (n = 5) of lactating goats were assigned the following treatments: Control (C) (basal diet); T1 (basal diet + linoleic acid source), T2 (basal diet + suspension of Butyrivibrio fibrisolvens In-1, 109 CFU head−1) and T3 (basal diet + linoleic acid source + suspension of Butyrivibrio fibrisolvens In-1, 109 CFU head−1).Total CLA content of rumen fluid increased ($P < 0.05$) by 218.72, 182.26 and 304% whereas total saturated fatty acid (SFA) content was lowered ($P < 0.05$) by 6.1, 4.44 and 9.55% in T1, T2 and T3, respectively, as compared to control.



Effect of CLA on Reproduction

Twenty Murrah buffalo heifers (15-17 months age, 240-245 kg body weight) were randomly divided into four groups (T0, T1, T2 and T3) of five animals in each on the basis of age and body weight. All the heifers were fed with concentrate mixture, green fodder and wheat straw in 50:40:10 ratios, respectively. Heifers in T_1, T_2 and T_3 were supplemented with mustard oil, soybean oil and rice bran oil @ 3.5% of concentrate mixture, respectively, while heifers in T_0 acted as control. The heifers in T1, T2 and T3 groups attained puberty and sexual maturity at an early age as compared to the animals of T0 groups and also conceived at an earlier ($P<0.05$) age compared to the control animals. The number of small size follicles (<3 mm) and medium size follicles (3-6 mm) were influenced significantly ($P<0.05$) among the groups due to dietary supplementation of vegetable oils. However, no difference was reported ($P>0.05$) in number of large follicles among treatment and control groups. Total number of ovarian follicles and diameter of the large follicle differed significantly ($P<0.05$) among the groups.

Methane Emissions from the Dry Buffaloes Fed on Oat Hay or Silage

Methane production using SF_6 technique was measured in the dry Murrah buffaloes were fed on oat hay or oat silage solely. There existed no difference in the DM intake (kg and % BW) among the groups fed on oat hay or silage.

Enteric CH_4 emissions (L/d) was significantly higher (P<0.05) in oat hay fed group (341.35) than oat silage (317.86) group. Methane loss as percentage of DE and ME energy intake was 13.51,16.41 and 11.61, 13.97 in oat hay and oat silage groups, respectively which significantly (P<0.05) differed between the group. The overall methane production was significantly lower (P<0.05) in oat silage group than oat hay fed group. From the study, it may be suggested that feeding of silage in ruminant can reduce methane production (6.86%) compare to feeding of hay.

Bioavailability of Trace Minerals from Commonly Used Feeds and Fodders

Information on the bioavailability of trace minerals from the feeds and fodders is scanty and not well characterized, so attempts were made to assess the bioavailable fraction of trace minerals (Cu, Mn, Fe, Co and Zn) from commonly used fodders (maize,oats and berseem) and oil seed cakes (GNC, SBM, CSC,mustard cake and maize germ meal) by conducting animal experiments. From oats and maize only 2-4% Cu (% total Cu intake) was retained, while the values were comparatively higher i.e. 8-11%from berseem fed group. Co was found to be retained only up to 2% from the two non leguminous fodders while values were in the range of 4.4-6.0% in berseem fed groups. Similarly, Mn retention was in the range of 4-7% in oats and maize group and corresponding values were 8.5-10.8% in berseem fed groups. Fe retention was in the range 3-6% in maize/ oats while it was retained upto 10% from berseem fodders. Retention of Zn was highest (14-20%) among the tested trace minerals. Zinc bioavailabilty was in the range of 12-20% in all the cakes except SBM which had values more than 30%.

Effect of Chromium Supplementation on Milk Production and Some Blood Metabolites of Murrah Buffaloes

Trace minerals are known to maintain productivity and reproductive performance of livestock along with health status. The effect of chromium from different sources on milk production in lactating Murrah buffaloes was investigated. Fifteen lactating Murrah buffaloes were selected and divided in to three groups of 5 animals in each on the basis of milk yield, days in lactation and parity. All buffaloes were fed as per the ICAR-2013 feeding standards. Chromium was supplemented @ 1.5 ppm in the form of chromium chloride as inorganic form and chromium propionate in organic form. Feeding trial of 90 days was conducted including a 7 days digestion trial and daily dry matter intake, milk yield, fortnightly body weight, milk composition were recorded. Nutrient digestibility remained unaffected but hormonal concentration and blood metabolites (except T_4, blood urea nitrogen and cortisol) were affected. There was significant decrease in NEFA, TBARS and significant increase in T_4 concentration in Cr supplemented groups during experimental period. Organic form of chromium was more effective over inorganic form. It might be due to more bioavailability of organic form than inorganic form. The chromium supplementation increased milk yield and dry matter intake of lactating buffaloes in early lactation but not in middle and late lactation.

Variability in Residual Feed Intake, Nutrient Utilisation and Blood Parameters in Murrah Buffalo Calves

The present investigation was undertaken to study variability in residual feed intake, nutrient utilization and blood metabolite parameters in 18 female Murrah buffalo calves fed rations consisting of wheat (*Triticum aestivum*) straw, berseem (*Trifolium alexandrinum*) fodder and concentrate mixture to meet their requirements (ICAR, 2013). Body weight and feed intake were recorded regularly during a trial period of 90 days. Residual feed intake (RFI) values were calculated for individual calves and they were put into low (n = 8; RFI= - 0.13 kg/ d) and high (n = 10; RFI= +0.10 kg/d) RFI groups. The levels of total plasma protein (6.80 vs. 7.43 g/dl), albumin (3.46 vs. 3.71 g/dl), aspartate aminotransferase (102.20 vs. 122.60 IU/L) and cortisol (3.48 vs. 5.32 ng/ml) were lower (P<0.05) in low RFI group compared to high RFI group. Overall, the performance of low RFI group of female Murrah buffalo calves was better.

Growth and Nutrient Utilization in Calves Fed Rice Gluten Meal Replacing Groundnut Cake in Concentrate Mixture

Met, Thr, and Lys content of ground nut cake was 1.17, 2.59 and 3.29 respectively, while that of rice gluten meal was 2.08, 3.16 and 3.19 (% CP) respectively. The Concentration of critical AA like lysine was almost comparable with that of GNC whereas methionine level was slightly higher in RGM.

It was concluded that the replacement of ground nut cake with 50% and 75% levels of rice gluten meal on crude protein basis in the ration of growing cross bred calves does not have any adverse effect on nutrient utilization and growth performance and thus rice gluten meal can replace ground nut cake upto 75% in concentrate mixture of growing calves.

Effect of Vitamin Supplement on *In Vitro* Fermentation, *In Vivo* Microbial Protein Synthesis and Milk Production in Deoni Cows.

The study evaluated optimum dose of soluble vitamins WS; B1 to B7, B9, B12 and C) and, their supplementation on *in vivo* microbial protein, health and milk production. Study recommended the optimum doses of FS and WS vitamins in dairy cows for better fermentation and supplementation of FS and WS vitamins to improve few blood parameters and Ig, respectively to improve cow health.

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



Research has shown that distillers' grains are considered good sources of protein for dairy cattle. Fiber, protein and fat are concentrated approximately 3-fold in distillers grains (DG) when starch is fermented to produce ethanol, thus DG can replace the protein source in diets of cattle. Rice Distillers Grain with Solubles (RDGS) is an important agro-industrial by-product of the distillers industries in Asian countries. In the present work, efforts have been made to evaluate the chemical composition of Rice Distillers Grain with Solubles (RDGS) and the effect of supplementing RDGS on milk yield and milk composition of Jersey crossbred cows. Chemical analysis indicated that it is a good source of protein. A lactation trial of 15 weeks was conducted on 12 Jersey crossbred cattle divided in to 2 groups. There was no significant difference in total DMI and CP intake. The average milk yield was slightly higher in the treatment group. However, the difference was not statistically significant. The average percentage of milk fat, milk protein, SNF, total solid and ash showed no significant difference between two groups. . From the present study it can be concluded that there was no adverse effect of replacing SBM by RDGS on Milk Yield or composition and thus economize the ration keeping in view of the lower cost of RDGS in comparison to SBM.

Utilization of Rice-based Condensed Distillery Syrup (RCDS) in Lactating Jersey Crossbred Cattle Ration



Rice Condensed Distillery Syrup (RCDS) is an 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. Some works have been conducted on chemical composition and feeding value corn based Condensed Distillery Soluble. However, works on nutritive value of rice based CDS and its utilization in dairy cattle ration are scanty. In the present study, efforts have been made to evaluate the chemical composition of Rice-based Condensed Distillery Syrup (RCDS) and the effect of supplementing RCDS on milk yield and milk composition of Jersey crossbred cows. The RCDS required for the present study was provided by IFB Agro Industries Limited, Kolkata. The DM cont RCDS was around 33 per cent. Chemical analysis indicated that it is a fair source of protein and a very good source of soluble carbohydrate. A lactation trial of 15 weeks was conducted on 12 Jersey crossbred cattle distributed into two groups. From the present study, it can be concluded that, RCDS was found to be a good source of protein and a very good source of soluble carbohydrates and there was no adverse effect of replacing part of concentrate mixture (15% on DM basis) by RCDS on palatability, TDMI, Milk Yield, FCM yield and milk composition. Replacement of Concentrate Mixture by RCDS @ 15% (on DM basis) reduced the feed cost without affecting the milk production.





Nutritional Evaluation of Some Feed Resources from Ayodhya Hill of Purulia District

Twelve samples of tree leaves were collected from Ayodhya Hill of Purulia District, West Bengal. Mean values for CP, EE, TA, AIA, NDF, ADF and Lignin in tree leaves on DM basis, respectively were 12.94 ± 1.31, 3.85 ± 0.46, 10.13 ± 0.84, 0.88 ± 0.16, 44.02 ± 2.24, 30.04 ± 1.86 and 5.54 ± 0.53%, respectively. On basis of comparative chemical composition four tree leaves were selected i.e. *T. tomentosa* (Tr. A)*, B. variegata* (Tr. B), *L. leucocephala* (Tr. C) *and B. monosperma* (Tr. D). On the basis of comparative chemical composition, a growth trial of 105 days was conducted using twelve crossbred divided in (T_0) and (T_1). Two iso-nitrogenous concentrate mixtures were prepared, replacing 50% of wheat bran with dried *B. variegata* leaves. Fortnightly DMI kg/day, CPI (g/day), TDN (kg/day) did not differ significantly between the two groups. ADG was 663.5 ± 55.01 (T_0) and 698.41 ± 40.96 (T_1) and they did not differ significantly amongst each other. Blood parameters were within the normal range and were similar statistically. Thus, it can be concluded that *B. variegata* leaves can replace wheat bran in concentrate mixture of growing calves up to 50% level without any adverse effect on growth, nutrient intake, nutrient utilization and blood parameters.

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



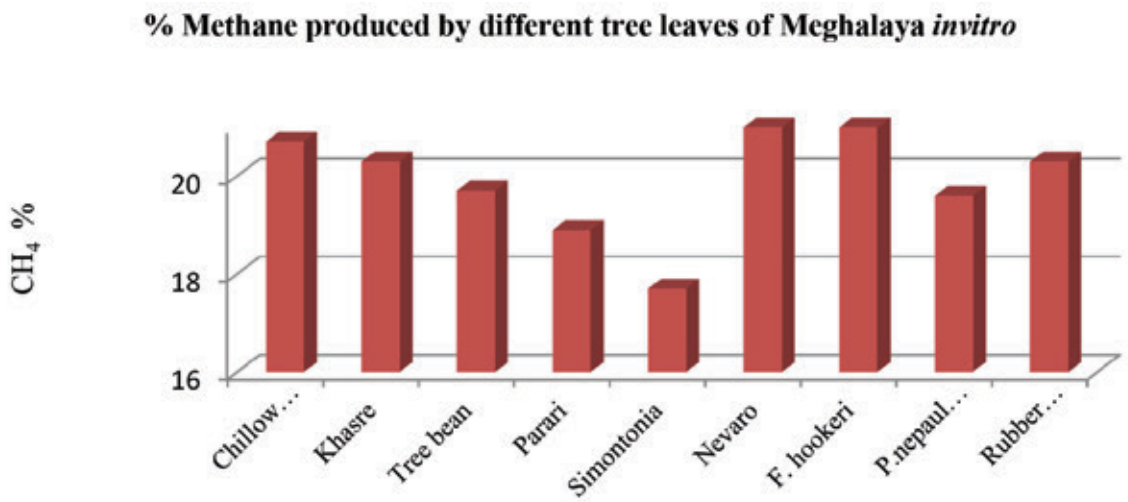
Schefflera



Prunus

In north-eastern states of India, tree leaves generally used as a livestock feed. However, these tree leaves were not nutritionally evaluated as an animal feed. Animals refuse to eat certain tree leaves due to its higher content of condensed tannin and lignin. Twelve tree leaves e.g., chillowance (*Schima wallichii*), barhar/wild jack fruit (*Artocarpus lakoocha*), wild cheri (*Prunus ceresoides*), kharse (*Ficus hirta*), rai khanyum (*Ficus semicordata*), tree bean (*Parkia roxburghil*), parari (*Schefflera wallichina*), simontonia (*Exbucklandia populnea*), nevaro (*Ficus auriculata*), *Ficus hookerai*, *Prunus nepaulensis* and rubber tree (*Ficus elastica*) were collected from Meghalaya and their nutrient compositions was estimated. Further, nutritional evaluation of these collected tree leaves was done by *in vitro* gas production technique using cattle rumen liquor. These collected trees leave contained 28.4 to 39.1% DM on fresh basis.

Organic matter (OM) and CP content of these collected tree leaves varied from 86.6 to 96.7 and 8.6 to 30.8 % where as NDF and cellulose content varied from 43.3 to 70.3 and 9.1 to 26.4 % on DM basis, respectively. EE content of these tree leaves varied from 1.9 to 4.8 % on DM basis. Highest total carbohydrate content was observed in *Exbucklandia populnea* tree leaves and it was 83.9 % on DM basis. It was concluded from the *in vitro* studies that *Schefflera wallichina* and *Prunus nepaulensis* were the best tree leafs among the collected/tested tree leaves for feeding to the livestock and *Ficus hookerai* may be used as a rumen manipulator to reduce ruminal methane production.



MANAGEMENT AND HEALTH OF DAIRY ANIMALS

Development of Management Practices for Provision of Effective Milk Let-Down Stimulus in Weaned Cows and Buffaloes

The aim of the project was to study the effect of calf weaning versus natural suckling and use of a calf dummy for milk let-down on milking behaviour, performance, milk quality and udder health of Murrah buffaloes and Sahiwal cows and on the growth performance, immune status and behaviour of their calves. For this experiment 24 late pregnant Murrah buffaloes and 18 late pregnant Sahiwal cows were selected and equally divided into 3 groups. The Group I cows and buffaloes were allowed natural suckling for milk let-down stimulus at the start of milking and at the end of milking, the calves were again allowed to suckle the required amount of colostrum as well as milk and in Group II of cows and buffaloes the calves borne were weaned at birth and trained manually to drink colostrum as well as milk from a pail. Milk let-down stimulus to the cows and buffaloes was provided by provision of concentrate mixture and teat massage before milking and the milk feeding was done artificially. In Group III a synthetic dummy calf which had been maternally bonded with the cows and buffaloes at the time of calving was used for milk let-down stimulus before every milking. The data were analysed using suitable statistical techniques and the salient findings obtained are presented as under:

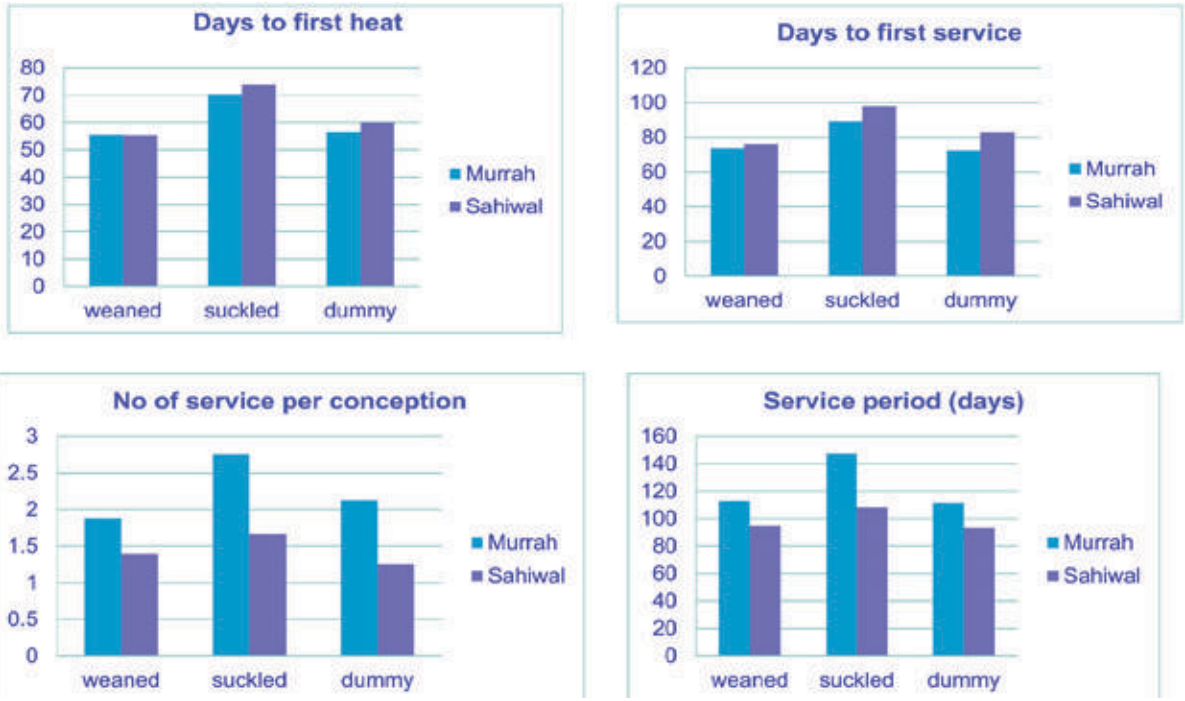




Table: Mean value of various productive performance parameters

Parameter	Weaned	Suckled	Dummy used
Daily colostrum yield (kg)			
Murrah buffaloes	3.27 ±.10[a]	4.94 ± 0.09[b]	3.52 ± 0.08[a]
Sahiwal cows	3.84 ± 0.61[a]	4.50 ± 0.53[b]	4.21 ± 0.82[b]
Daily milk yield (kg)			
Murrah buffaloes	6.74 ± 0.40[a]	9.11 ± 0.16[b]	8.29 ± 0.46[c]
Sahiwal cows	6.607 ± 0.61[a]	7.59 ± 0.28[b]	7.16 ± 0.70[c]
Total lactation milk yield (kg)			
Murrah buffaloes	1738.62 ± 264.10[a]	2785.06 ± 279.39[b]	2210.75 ± 240.40[c]
Sahiwal cows	1770.50 ± 241.27[a]	2568.50 ± 232.16[b]	2107.87 ± 329.05[c]
Total lactation length (days)			
Murrah buffaloes	256.25 ± 18.55[a]	349.50 ± 30.96[b]	297.00 ± 19.74[c]
Sahiwal cows	269.60 ± 29.37[a]	336.00 ± 17.93[b]	285.50 ± 19.12[c]

Mean values of reproductive parameters of Murrah buffaloes and Sahiwal cows



The study showed that the milking behaviour, productive performance and udder health of Murrah buffaloes and Sahiwal cows provided natural suckling and calf dummy for milk let-down stimulus was better as compared to calf weaned Murrah buffaloes and Sahiwal cows. The reproductive performance of naturally suckled buffaloes and Sahiwal cows was marginally adversely affected in comparison to weaned buffaloes. The reproductive performance of calf dummy used buffaloes and cows was almost comparable with that in the calf weaned buffaloes and cows. The fat content was lower in the milk of naturally suckled cows and buffaloes as compared to the fat content in calf weaned and calf dummy used cows and buffaloes. The growth performance, the immune status and behaviour of naturally suckled buffalo calve**s** was better as compared to weaned calves

Effect of Modified Housing System on Performance and Behaviour of Crossbred Cows during Hot-Humid and Autumn Seasons

The effect of modified housing system on comfort level, performance and behaviour of crossbred cows during hot humid and autumn seasons was studied. For this experiment 16 lactating crossbred cows in their early lactation were selected and were divided into two groups of 8 cows each. One group of cows was housed under existing loose housing system consisted by asbestos roof at a height of 12 ft from the ground with a roof width of 10 ft. The floors were made of reinforced cement concrete in the covered area the open area was brick paved and the feeding was done through an elevated manger. As a heat stress ameliorating measure water sprinklers were installed inside the covered area along with ceiling fans. Another group of cows were housed under modified shed chracterized by raising the roof height to 15 feet and width of roof to 20 feet. Sand bedding was provided both inside half of covered area and in open paddock adjoining the covered area. The feeding was done at ground level installing fenceline feeding system and the shed was made mosquito and fly proof by covering the both the covered and open area with a synthetic nylon mosquito net. In order to alieviate the impact of heat stress, time-control foggers were used with added air circulation using heavy duty dairy fans.

Thus, it was observed that the cows housed inside modified shed were more comfortable and had improved physiological reactions and behavioural responses during hot-humid season as compared to cows housed in existing shed. The crossbred cows housed under the modified shed had better productive and reproductive performance during hot-humid as well as during autumn season as compared to cows housed in existing shed.

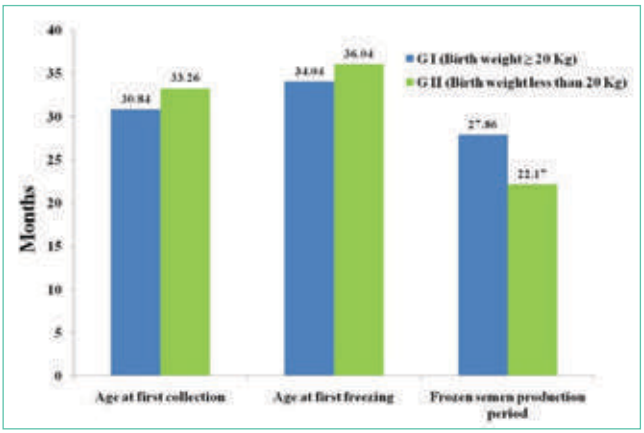
Testing of Jeevan Pashudhan (Penergetic T) and Jeevan Pashudhan Ultra (Penergetic M) for Improved Immunity and Prevention of Mastitis in Dairy Animals

Supplementation of Penergetic-t (2mg/cow/day) improved the phagocytic activity of blood neutrophils during the transition period (4 week before and 4weeks after parturition) thereby indicating the improvement in immune status of the animals and improvement in milk yield has been also observed. The supplementation of Penergetic –M reduced the milk somatic cell counts in sub clinical mastitis cases, and improved milk yield during early lactation. No apparently visible side effects were observed of both these products in the supplemented cows.

Management Practices to Improve Semen Productivity by Mitigating Low Libido Problem in Sahiwal Bulls

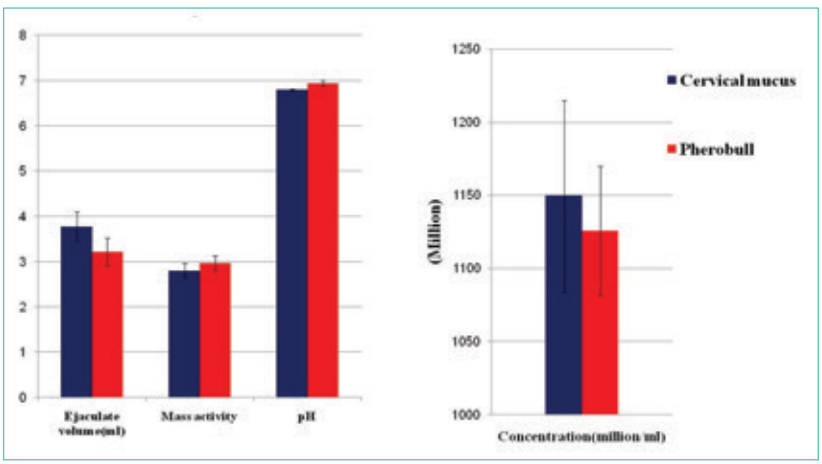
One of the major reasons of culling of Sahiwal bulls was poor libido (23.12%) and average age at first semen donation of Sahiwal bulls was 32.43 months (1996-2014). In order to overcome the problem experiments were carried out on different breeding bull management practices.

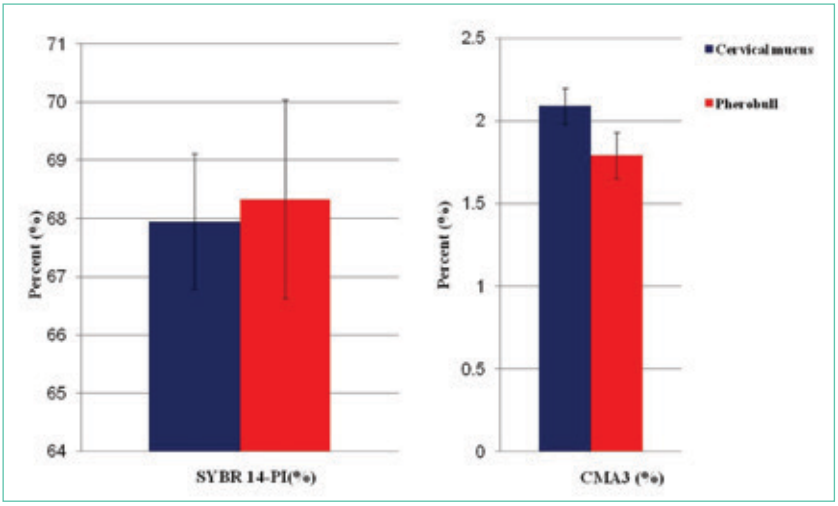
» The bulls having higher birth weight (more than 20 kg) higher scrotal circumference (>36 cm) higher scrotal surface temperature gradient variation from neck to ventral (3-5.72°C) produced better quality semen.



» Daily two hour exercise in long range, same bull handler and application of halter for controlling resulted in the donation of semen by 100% bulls in contrast semen donation by only 60% bulls in control group. The significant finding was related with average age at first semen donation, which was 21.3 months in treatment group as compared to 34.6 months in control group. The bulls started donating semen at early age and produced good quality of semen well within acceptable range.

» Eight Sahiwal bulls, with poor libido and not donating semen were studied for the biostimulation interventions through cervical mucus and pherobull application. The results revealed that 75% bull started donating semen after cervical mucous application. All sexual behaviour parameters (SA, RT, DT, TTTM, PES, PPS, ETS, LS, MAS and SBS) were found significantly (P<0.01) improved in both the treatment group as compare to control.





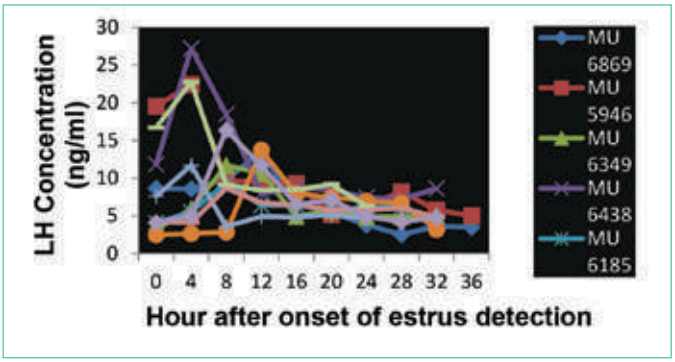
» After GnRH treatment three bulls out of four non donating bulls started donating semen and later on continued in semen production without giving any GnRH intervention. There was improvement in seminal profile and reaction time in poor quality semen producing bulls.

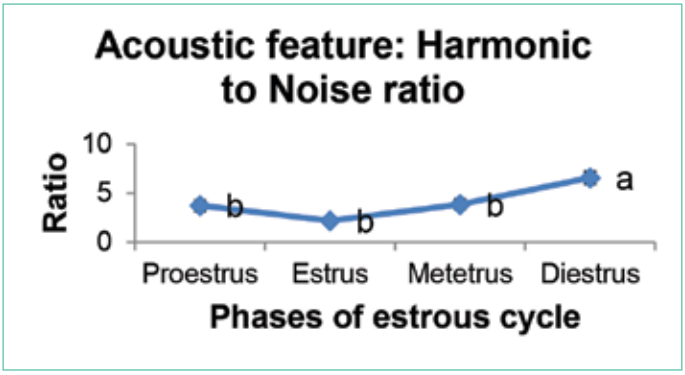
Bioacoustics Tool: A Novel Non-invasive Approach for Efficient Monitoring of Health and Productivity in Dairy Animals

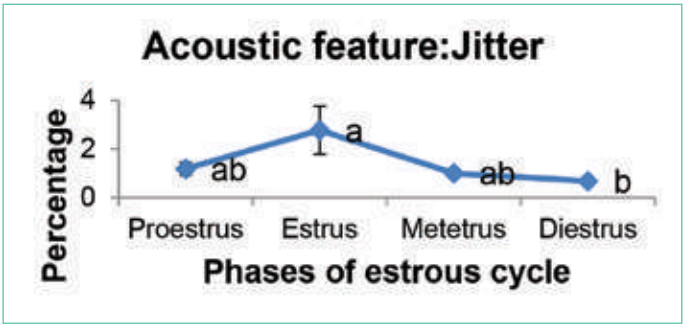
The study was conducted with the objective to individual identification of dairy animal and differentiation of estrus phase of estrous cycle through the changes in acoustic features of vocal signal of particular dairy animal. Twenty-five Murrah buffaloes and 25 KF cows were selected for recording of their voice to identify their individuality. Among these, 10 animals from each species were selected for identification of estrus phase and time of ovulation through vocalization and hormone profile (LH, Estrogen & Progesterone). Analysis of bioacoustics features revealed that differences for amplitudes, total energy, mean power, pitch, intensities, formants (F1, F2, F3 and F4), number of pulse, number of period, unvoiced frames, degree of voice breaks, jitter, shimmer, mean noise to harmonic ratio (%) and mean harmonic to noise ratio (dB) differed significantly of ($P < 0.001$) in both Murrah buffalo and KF cow. Number of pulse, maximum intensity, mean pitch, degree of voice break, jitter %, shimmer %, mean HNR and all four formant were found to differ significantly ($p < 0.05$) in all 25 murrah buffaloes and KF cows. Discrimination of estrus phase from other phases through changes in acoustic features suggest that Pitch, Intensity, Jitter, Shimmer, NHR, HNR and Formants frequency were differed significantly ($P < 0.05$) between the all four phases. Estrus phase vocalization had significantly higher ($P < 0.05$) call duration, mean amplitude, mean pitch, NHR, NHR and F1, F2, F3 and F4 formants than diestrus phase. It was found that most of the acoustic features were found significantly positive correlated with estrogen hormone and negatively correlated with the progesterone hormone during all phases of estrous cycle.

Hence, it is possible to get information about individuality and phases of estrous cycle of, dairy animals by means of monitoring vocalization. There is possibility to identify dairy animals most fertile time of estrous cycle by changes in the acoustic features of vocal signal. So dairy animal's vocalization could be used solely or in combination with other automated systems for detecting of their individuality and stage of their reproductive cycle.

Changes in LH concentration during Estrus phase in Murrah buffaloes

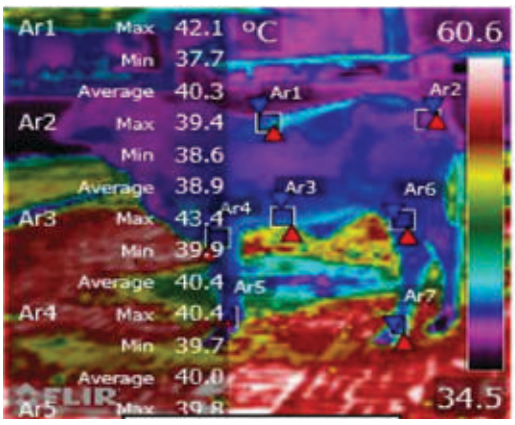




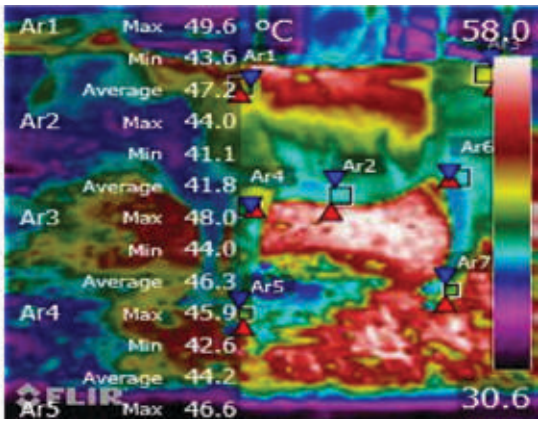


Effect of Elevated Temperature and Carbon Dioxide Level on Physiological and Biochemical Functions in Zebu and Crossbred Heifers

Elevated temperature and carbon dioxide levels under controlled conditions significantly affected the physiological, biochemical, enzymatic and hormonal profile of Tharparkar and Karan Fries heifers. With increase in CO_2 levels above normal (Control) and elevated temperature, the deviations in these parameters were significantly higher than the control conditions. Furthermore the effects on all the parameters studied in the present investigation were more significant in Karan Fries than Tharparkar heifers. The study indicated that the increase in ambient CO_2 levels and elevated temperature, which is one of the reasons of the climate change may have significant effects on livestock particularly the crossbred animals.



Tharparkar cattle



Karan Fries cattle

Fig.: TP cows reflect a greater proportion of incident solar radiation thereby maintaining its body temperature than KF which is dark-colored and wooly hair coat and thus is absorbing heat and unable to maintain its body temperature

Validation of putative Reference Genes for Gene Expression Studies in Heat Stressed and α-MSH Treated Melanocyte Cells

The internal reference genes from different functional classes that could serve as best IRG for melanocyte cells for heat and α-MSH treatment were studied. GeNorm, Normfinder and Best keeper algorithm was used to measure the gene transcript stability. Pair wise comparison using geNorm revealed HPRT and RPS23 as the most stable combination of IRGs with M-value of 0.29 followed by UXT and RPL4. The Normfinder analysis also identified the same set of stably

expressed genes (UXT, RPL4, RPS23 and HPRT), however, their ranking order was little different. The UXT gene showed lowest crossing point SD and CV values of 0.30 and 1.17, respectively. The study revealed that UXT, HPRT and RPS23 are the best internal reference genes to examine gene expression stability of potential IRGs for melanocyte cell line.

Expression of Metabolic Related Genes in Tharparkar and Karan Fries Heifers during Different Seasons

Expression of Metabolism Related Genes: The expression study on metabolic related genes in Tharparkar and Karan Fries heifers during different seasons indicated that the expression dio2 gene (thyroid function), NBEA (Body weight and feed intake) and TRIPII gene (thyroid regulation) was higher in winter season compared summer and autumn seasons Whereas the expression of ITGA9 gene was higher in summer compared to autumn and winter in both the breeds of cattle. Results showed that Tharparkar breed is more adapted to hot humid season than Karan Fries.

Life Cycle assessment of milk production was also done. The results revealed that enteric fermentation from crossbreds were higher than that of indigenous cattle and buffaloes. The total water footprints in the study varied from around 1200-1600 m3/ton of milk production, the highest being of local cow and lowest being of cross bred. Acidification and eutrophication potential of milk production varied from 8.53 kg SO2eq./ton to 17.43 kg SO2eq./ton and 16.03 kg NO3eq./ton to 32.76 kg NO3eq./ton, respectively.

Studies on the Effect of Photoperiod on Growth and Puberty of Buffalo Heifers

The BCS and body weights improved insignificantly (P>0.05) in the buffalo heifers under extended short day photoperiod (ESDP) as compared to those exposed under short day photoperiod (SDP). All the heifers except one in the ESDP group achieved puberty.The extended photoperiod of 4 hours has been found beneficial for the growth of buffalo heifers during winter. The practice may be taken up by farmers for better growth of heifers without any adverse effect.

National Innovations on Climate Resilient Agriculture-Deoni Breed

The study was conducted to evaluate the effect of seasons and time of recording observations on physiological and haematological profiles of lactating Deoni cows maintained under semi-intensive management. Season and time of physiological observations had highly significant (P<0.01) effect on skin temperature, pulse rate and respiration rate in Deoni cows. The season had highly significant (P<0.01) effect on haematological parameters. The time of observations had highly significant (P<0.01) effect on RBC, Hb, HCT, N and L.Six Deoni and seven Malnad Gidda male calves were subjected to semen collection training using artificial vagina method and most of the bulls have been successfully trained. Ejaculates with desired neat semen quality i.e. concentration (> 500 x 106 / ml) and initial progressive motility (>70 %) were subjected to freezing using Tris and Egg Yolk Citrate extender and about 1990 AI doses of Deoni and 12745 AI doses have been cryopreserved.

Effect of Clinical Mastitis on Reproductive Performance in Crossbred Cows

It was found that clinincal mastitis affected cows had significantly (p< 0.05) delayed DTFDH, DTFI, more DO and SC compared to clinically healthy cows. Single episode sufferers had delayed DTFDH and DTFI; multiple episodes (relapse, and recurrence) sufferers had more DO and SC. Severely affected cows had significantly (p< 0.05) altered reproduction than mild-moderate cases. First and second parity cows suffered with CM had significantly (p< 0.05) delayed DTFDH, DTFI, higher DO and more SC. The mean peak LH concentration decreased while, timing of the LH surge delayed in CM cows. The LPS concentration was significantly (p < 0.05) higher in CM affected cows.

Effect of Supplementation of Trace Mineral and Vitamins during Transition Phase on Energy Status, Productive and Reproductive Performance on Deoni Heifers

The dairy animal experiences a dramatic shift in endocrine profile and metabolic processes, during transition period which leads to negative energy balance. The deficiencies of micronutrients around peri-parturient period are associated with metabolic disorders and negative impact on the production and subsequent fertility of the cow. A study was carried out with an aim to study the effect of supplementation of trace minerals and vitamins through transition phase (-21 to

+21 days respective to calving) on energy status and reproductive performance of primiparous *Deoni* cows. It is suggested that supplementation of trace mineral and vitamins during transition phase could result into better energy status of animal and subsequent reproductive performance in *Deoni* cows.

Effects of Supplementation of Area-Specific Mineral Mixture (ASMM) on Growth Performance in Growing Crossbred Heifers

Minerals are required for the normal functioning of essentially all biological processes in the body. An essential mineral is one which is required to support adequate growth, reproduction and health, when other nutrients are optimal. Deficiencies of each macro or micro mineral in animal results in abnormalities that can only corrected by suitable supplementation of specific mineral/s. In the present study, effects of area specific mineral mixture supplementation on growth performances (body weight and average daily gain) were studied. For these purpose, 18 growing crossbred heifers of similar age and body weight were divided in to two groups viz., Control-T0 (N=6) and Treatment-T1 (N=12) supplemented with 0 and 30g ASMM/animal/day, respectively. This study revealed that supplementation of area specific mineral mixture enhances growth performance in growing crossbred heifers.

Table: Growth Performances of Experimental Animals

Attribute	Control	Treatment	Level of Significance
Initial BW (kg)	223.83 ± 12.91	224.67 ± 13.13	NS
Final BW (kg)	268.00a ± 14.58	282.33b ± 14.21	P < 0.05
Total BW gain (kg)	44.17a± 4.82	57.67b ± 6.42	P < 0.05
ADG (kg/d)	0.368a ± 0.08	0.481b ± 0.06	P < 0.05

*Values with different superscripts in row differ significantly (P<0.05) from each other

Effect of Area Specific Mineral Mixture Supplementation on Changes of Blood Metabolites, Blood Enzymes and Hormones during Pubertal Process of Cross Bred Heifer

The present study was conducted to find out the effects of area specific mineral mixture (ASMM) supplementation on changes of blood metabolites, blood enzymes AST (aspartate aminotransferase) and ALT (alanine aminotransferase) and hormonal profiles (Progesterone and estradiol-17β),For these purpose, 18 growing crossbred heifers of similar age and body weight were divided into two groups viz., Control-T_0 (N=6) and Treatment-T_1 (N=12) supplemented with 0 and 30g ASMM/animal/day, respectively. Mean blood concentrations of AST (93.12 ± 5.37 and 100.24 ± 6.67 IU/ml) and ALT (35.50 ± 2.12 and 37.16 ± 1.56 IU/ml) did not differ significantly (P>0.05) between the groups. Interestingly, the plasma progesterone concentrations during the entire cycle as recorded in the ASMM treated animals were significantly (P<0.01) higher than those in control. This study revealed that there is no harmful effect on supplementation of area specific mineral mixture rather it improves the growth of animal.

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

The intra mammary infection (IMI) in crossbred dairy cows of lower gangetic region causes higher economic losses to farmers and considered as a major constraints for milk production. Field study was conducted by door to door visit to dairy farmers of two adapted villages (Muratipur, Chandamari) of ERS, NDRI, Kalyani, Nadia dist, WB. A total of 219 milk samples were collected and analysed which revealed that Log $_{10}$ SCC (cells / ml) were significantly (P<0.01) higher in IMI cows (6.55 ± 0.05) as compared to no-IMI cows (4.05 ± 0.04). Analysis of observations of management practices (%) indicated that the washing of animals (4-11%) before milking and the washing of udder and teats (3-19%) before milking were higher in farmers having single cow but it was reduced when animal number were increasing. The study concluded that there is a significant association between animal keeping pattern and hygiene status, cleanliness at study area. So efforts should be made to increase cleanliness and hygiene status in milking cows itself, housing of animal and milkers of farmer's house to increase milk hygiene and udder health status at Nadia district of WB.

NOVEL APPROACHES IN VALUE ADDITION

Stability of Microencapsulated Grape Seed Extracts in Yoghurt Preparation

Grape seed extracts (GSE) microcapsules prepared with a blend of WPC: Gum Arabica/Maltodextrin incorporated in yoghurt up to 1% unlike 0.25% direct addition was acceptable on sensory basis. Water holding capacity, texture and viscosity of GSE microcapsules incorporated yoghurt were significantly better than unencapsulated GSE. Antioxidant activity and TPC of GSE microcapsules incorporated yoghurt remained stable throughout storage.

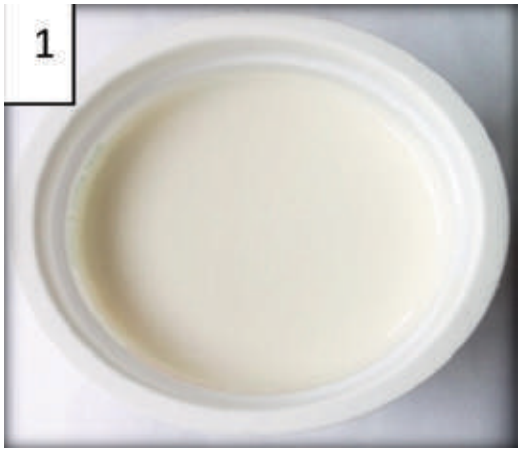


Fig.: Encapsulated GSE polyphenols

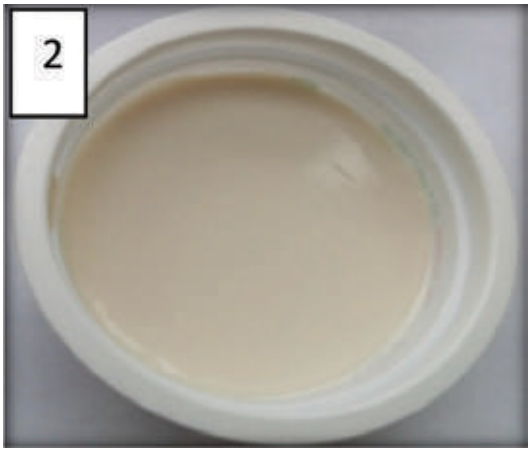


Fig.: Unencapsulated GSE polyphenols

Evaluation of Dairy Conjugates as Effective Emulsifiers for the Delivery of Herbal Bioactives

Protein–polysaccharide conjugation via a Maillard-type reaction is a suitable way to modify milk proteins for producing speciality ingredients for food applications, as the resultant conjugates are very stable to changes in pH, ionic strength and temperature. They also have improved emulsification properties, solubility around the isoelectric pH of the protein and heat stability. Several herbs, though have medicinal cannot be incorporated in food systems as they impart undesirable flavour and bitter taste to the food and makes it unacceptable. Double emulsions provide protective encapsulation to these bioactive substances in the internal droplets and mask their undesirable flavours and herbal notes and also may assist in controlled (sustained and delayed) release of bioactive ingredients. Milk protein based conjugates may provide enhanced stability to double emulsions containing bioactive plant and herbal ingredients to be incorporated in food. Sodium caseinate and whey protein based conjugates were prepared through conjugation of sodium caseinate/WPC with selected polysaccharides at different protein: polysaccharide ratio. Once selected, these were used as hydrophilic emulsifiers for optimising the double emulsions in the W/O/W system, where PGPR, salt, the selected conjugate and the speed of emulsification were selected.

Development of Low Sodium Cheese Varieties

Attempts have been made worldwide to produce low sodium cheese by using salt replacers such as potassium chloride, but the desired level of reduction could not be achieved due to bitter taste and soft body and texture in the final product. Using novel salt replacers with bitter blockers

and odor induced saltiness enhancement (OISE) are such technologies which have been used successfully in many food systems. The objective of the work was incorporate these emerging techniques in the area of salt reduction for reducing sodium in selected cheese varieties. Salt replacers, flavour enhancers and bitter blockers were used in combination for manufacturing low sodium Mozzarella cheese and Cheddar cheese. The study suggested that about 65% and 75% sodium could be successfully reduced using these ingredients in Mozzarella and Cheddar cheese respectively. The rate of changes in proteolysis, lipolysis and glycolysis during ripening was higher in low sodium Cheddar cheese. However, the product was acceptable up to 6 months ripening period and the sensory scores were at par with its full sodium counterpart. Attempts are also in progress to manufacture low sodium and low fat Cheddar cheese. The effect of sodium reduction on bioactive peptides of low sodium Cheddar cheese is being investigated.

Shelf-life Extension of Aloe vera Supplemented Probiotic *Lassi* by Non-thermal Interventions

Keeping in view of the growing consumer demands, a technology for the manufacture of *Aloe vera* supplemented probiotic *lassi* (APL) was developed. Storage studies revealed that APL is acceptable up to 12 days at refrigeration temperature. The short shelf-life of APL was due to post acidification which is common in fermented milks. Besides their functionality and nutrition, shelf-life of the functional foods plays an important role in their marketing. The commercial success of these products depends on the ability to be preserved in its fresh form for longer time at retail outlets. The study was related to the extension of the shelf life of APL using non-thermal interventions namely packaging and high hydrostatic pressure. During the current period, the addition of copper at different levels on the sensory, physico-chemical and textural quality characteristics of APL was evaluated. It was concluded that addition of copper @ 5 ppm resulted in enhanced shelf-life of APL without any adverse effects on its sensory and physico-chemical characteristics. The relative bacterial growth ratio (RBGR) of different potent probiotic strains was assessed for their use, in order to ascertain their oxygen tolerance for their use in APL manufacture intended for long time storage.

Biogenic Production and Characterization of Selenium Nanoparticles using *Lactobacilli*

As many as 10 prolific Se producing cultures were screened for production of Selenium nanoparticles (Se-NPs) and *L. fermentum* S23 was adjudged the best. SeNPs were observed to be optimally produced at a concentration of 200 ppm of sodium selenite after 7h of incubation. Further, the characterization of biosynthesized SeNPs produced under optimized conditions was carried out by an array of sophisticated instruments viz., Differential Light Scattering (DLS) Instrument, UV VIS Spectrophotometer, Fourier transform infrared(FTIR) Spectrometer and Scanning electron microscope (SEM). A well-defined absorption peak at 200-205 nm was observed in UV-Vis spectra while DLS revealed moderately stable SeNPs with a size of 190-220 nm and zeta (ζ) potential of -10 to +10mV. The SEM revealed the presence of extra and intracellularly located monodispersed and spherical Se-NPs with an average size of 100-160 nm. The FTIR peaks at 2916.36, 1622.33, 1529.55 & 694.37 cm-1 corresponded to functional groups alkanes, primary amines, nitro compounds & alkyl halides resp. The findings of the present study indicate the potential of food grade *lactobacilli* for biogenic production of well characterized SeNPs with perceptible antipathogenic attributes for food safety application.



Fig.: Biogenic production and characterization of selenium nanoparticles using lactobacilli

Differential Proteome Analysis of Dairy Based *Lactobacillus Fermentum* NCDC 400 Strain

In order to identify differentially expressed proteins in NCDC 400 and RS2 strains of *L. fermentum* in response to bile stress, the cultures were subjected to various bile concentrations to evaluate

cell survivability. Among the various cell disruptive methods, sonication alone yielded better recovery of proteins (1503.77 µg/ml) in NCDC 400. 2D gel electrophoresis (2D GE) and Shotgun proteomics approaches using Mass Spectrometry was applied for protein profiling and differential proteome analysis. On using shotgun proteomics approach (using LC-MS) for identification of the differentially expressed proteins (label free quantitation), a total of 222 and 194 proteins in NCDC 400 and RS2 strains, when exposed to bile stress, could be identified. Bioinformatics analysis of the differentially expressed proteins revealed that most of proteins were involved in Binding Activity (mostly down regulated) and catalytic Activity (up regulated). Majority of the proteins that were up regulated belonged to metabolic activity, carbohydrate metabolism, and hemostatic process.

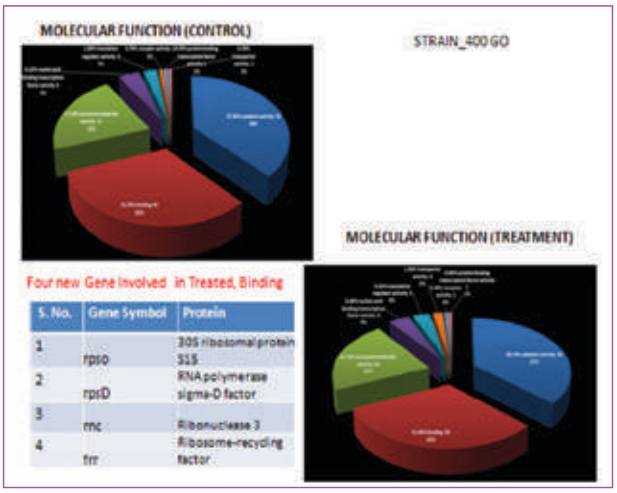


Fig. : Gene ontology based classification of proteins involved in molecular function (In NCDC 400 at 1.2% bile treatment, additional proteins involved in molecular functions were identified)

Bio-ethanol Production from Whey by using Immobilized B-Galactosidase and *Saccharomyces Cerevisiae* in Different Matrices

A total of six cultures that included *K. marxianus* MTCC 1388, *K. marxianus* MTCC 1389, *K. marxianus* MTCC188 and two thermotolerant lab isolates *K. marxianus* 6C18, *K. marxianus* 6C23 were screened for the production of β-galactosidase using whey. Maximum enzymatic activity was obtained from *K. marxianus* MTCC 1389, and this was optimized for further production of β-galactosidase. The maximum β-galactosidase activity of was achieved in whey using *K.marxianus* MTCC 1389 after optimization. Screening of *S.cerevisiae*DE2 and *S.cerevisiae* MTCC 170 was done for thermo, sugar and ethanol tolerance. *S.cerevisiae*DE2 was selected as it had shown more stress tolerance. The biocatalyst was immobilized on chitosan macroparticles using glutaraldehyde as a crosslinking agent that exhibited excellent functional activity at 35°C. Chitosan was used due to its low-cost and its acceptance as a biodegradable polymer. The maximum immobilization yield achieved was 97.4% using longer contact period. The relative activity of the β-galactosidase was found to be higher for immobilized enzyme at 30-37°C. Almost 89% lactose hydrolysis was attained for concentrated whey (100g/L) and immobilized enzyme retained 89% catalytic activity after 15 cycles of reuse. Finally, β-galactosidase was immobilized on chitosan and *S.cerevisiae* on calcium alginate, and both were used together for the production of ethanol from concentrated whey. Maximal ethanol titer of 28.9 g/L was achieved during fermentation at 35°C compared with free cells added along with the immobilized β-galactosidase where maximum ethanol titer reached to 23.5g/L.

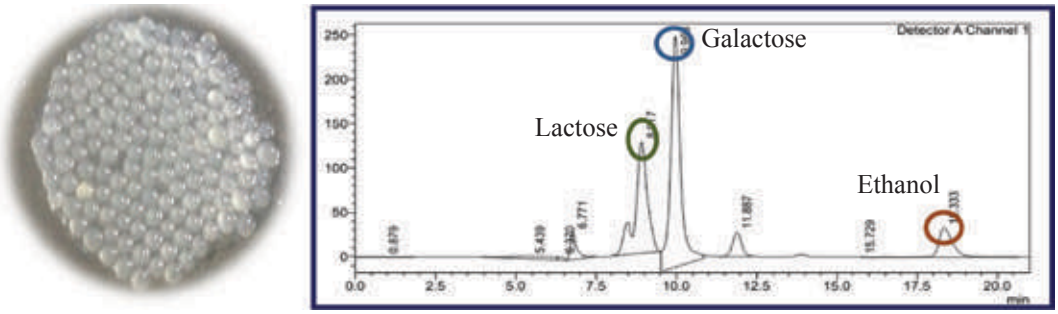


Fig. : Lactose hydrolysis and ethanol production by immobilized S.cerevisiae along with chitosan immobilized β-galactosidase

Development of Weight Based Metering and Filling System for Viscous Dairy Products

Engineering properties are important for design of product manufacturing, filling and conveying systems.

a) **Kheer:** A metering and filling system, designed on the basis of engineering parameters of kheer, was fabricated in Research and Development Workshop, Dairy Engineering Division of the Institute. The trials were conducted to evaluate its performance for kheer. It was observed that filling time for cups decreased with increasing speed of product agitator and metering mechanism. This is so because at higher speeds more kheer is dispensed through the system. The sensory scores were observed to decrease with an increase in the speed of the product agitator and metering system. This was probably observed as a result of increased whipping and mixing of the product as it moves through the metering system. Power requirement for the product agitator and metering mechanism was observed to increase with an increase in its speed. During trials on the machine for kheer, it was observed that modifications of the machine are necessary for its efficient operation. The modifications of metering and filling system for viscous dairy products were being done for its efficient operation. The modifications, e.g. product conveyor, inclination of conveyor, speed (rpm) of conveyor etc., were considered for improvement of metering and filling system. The efforts are also being made for provision of semi-automatic operation of the modified metering and filling system for viscous dairy products.

b) **Rabri:** Rabri, a viscous dairy product, was prepared by using standard method at various levels of total solids. Engineering parameters of rabri were determined at different total solids (40-55%). Among the different models investigated, Carreau-gahleitner model best described the rheological behaviour of rabri serum. The colour attributes (L*, a*, b*, whiteness index, chroma value, hue angle) of rabri were also determined. The whiteness index decreased from 79.07 to 73.30 with increase in total solids from 40 to 55%.

Process Development for Production of Curd Rice with Extended Shelf-life

Curd rice is a popular delicacy in Indian cuisine especially in southern part of the country. Among the different ratios of raw rice and water tried for cooking the rice, the use of 1:5 raw rice to water ratio for open pan cooking gave optimum hardness of cooked rice on the basis of texture profile analysis (TPA) and sensory analysis of curd rice. In case of pressure cooking, 1:3.5 raw rice to water ratio was found optimum on the basis of TPA analysis and sensory analysis to produce curd rice. Different cooked rice to milk ratio attempted i.e. 1:0.8, 1:1 and 1:1.2, it was concluded that the cooked rice to milk ratio of 1:1 was optimum to produce most acceptable curd rice based on sensory evaluation on 9-point Hedonic scale. Hardness of rice grains in curd rice affected the body and texture of curd rice and finally the overall acceptability of final product.

Post Processing Interventions to Improve Quality and Shelf Life of Curd Rice

The process for preparation of spiced curd rice were standardised based on sensory evaluation. The test product samples were compared against unspiced control samples prepared using the *dahi* culture for changes in its physico – chemical, microbial and sensory quality. It was observed that the samples stored at ambient temperature stayed good for 4 days for MP pouches and PS cups against 2 days of shelf life in for the curd rice which was not seasoned with spices and herbs. Refrigeration was observed to enhance the shelf life of the product up to 16 days and the samples packed in Metalized Polyster (MP) pouches and Polystyrene cups (PS) cups were observed to score better during storage than samples stored in LDPE pouches. Two post processing treatments, namely mild hydrothermal treatment and microwave treatment were evaluated in isolation and combination for its effect on the product. The post – processed samples stored under refrigeration were found to keep well up to 24 days, indicating an improvement in shelf life.

Characterisation and Process Optimization for the Production of Kharwas – A Traditional Colostrum Based Delicacy

Kharwas is one of the colostrum based delicacies popular in Maharashtra. The present investigation was carried out to characterise the kharwas, to optimise the method of manufacture of kharwas, to develop appropriate packaging system for the product and to assess its shelf-life. The composition and physico-chemical properties of bovine colostrum obtained from Deoni and crossbred cattle were assessed and very large variations were observed up to five days of postpartum. In the present investigation, it was found that 1.81 to 2.21 ratio of protein to non-

casein protein in the blend of colostrum to produced good quality kharwas. During optimization trials, it was observed that incorporation of sugar @ 18 % or jaggery @ 20 % imparted desired sweetness. Amongst the low calorie sweeteners, sucralose @ 300 ppm was most acceptable. Thermisation was observed to be an important process parameter and temperature - time combinations of 87 ± 1°C/30 ± 1 min or 97 ± 1°C/20 ± 1 min resulted in the product with desired body & texture, and good overall acceptability. The shelf-life of kharwas packed in polypropylene cup was found to be 16 days at 5 ± 1°C and 1 day at 30 ± 1°C. The cost of production per unit pack of 250 g was ₹ 50 in comparison to the sale price of ₹ 70 resulting in net realisation of about ₹ 81 per kg of the product.

Extension of Shelf-life of Ghee using Extracts of Fruit and Vegetable By-products

Powder from pomegranate peel (PP) and grape seed (GS) was prepared. Antioxidant capacity viz., total phenol content and radical scavenging activity of the extracts of PP and GS were determined at different extraction parameters. On the basis of optimized conditions, different levels of extracts of PP and GS (PPP) were incorporated into ghee and subjected to sensory evaluation to select optimum level of extracts. Ghee incorporated with PP extract and GS extract showed to exhibit more antioxidant properties than control ghee and ghee incorporated with BHA. Modeling of AoAs of PP and GS extracts in ghee showed that the data followed mostly first order and zero order rate of reactions. The study revealed that pomegranate peel extract and grape seed extract could be a better, safe, cheep and alternative natural source of antioxidant for retarding oxidation of fat in ghee.

Development of Low Fat Fiber Enriched Mascarpone Cheese

Mascarpone is a soft and un-ripened variety of Italian cheese newly introduced in the Indian cheese market. It contains moderate levels of fat (~40%) with high spreadable property and can be used as substitute of butter. Considering the ill effects of high fat consumption and beneficial effects of fiber, an attempt was made to standardize the manufacturing process of fibre enriched, low fat Mascarpone cheese with suitable fat replacer. The mean spreadability of 1.83 ($N.sec^{-1}$) in Mascarpone cheese containing 16% fat (60% fat reduction) added with 10% fat replacers was more than that of cheese made with 24 and 20% fat (40% and 50% fat reduction) and it was very similar to that of control cheese. Shelf life studies showed that fat replaced sample had shelf life 2 days more than that of control sample when packed in polyethylene pouch and stored at 5-8^{0}C.

Incorporation of Concentrated Whey in the Production of Multigrain Biscuits

Whey is one of the major by-products of the dairy industry all over the world. The disposal of whey, because of its high BOD, requires appropriate treatment which adds to the cost of operation of dairy plants. The studies indicated that either paneer whey or cheese whey concentrated to 25 % TS can be used to replace up to 50 % water in the preparation of biscuits. This implied that whey concentrated to 12.5 % TS could replace water completely in the preparation of multigrain biscuits. The replacement resulted in improvement in sensory parameters, increased TS in biscuits and hence improved nutritive value. A baking temperature of 170ºC / 25 min was observed to be optimal and incorporation of baking powder at 2000 ppm improved significantly the sensory parameters of whey incorporated multigrain biscuits. The biscuits packed in metalized polyester pouches (100 µ) had shelf life beyond 39 days at 50 ºC corresponding to a shelf life of 16 months at 30ºC storage. Based on the results, it can be concluded that concentrated paneer whey can successfully be utilized in the preparation of multigrain biscuits.

Evaluation and Optimization of Spray Drying Performance of Milk-Barnyard Millet Food and Characterization of Product Quality

Barnyard millet (*Echinochloa frumentacea*), being a rich source of iron and fibre, was selected for blending with milk and produce a powdered product. Pasting parameters such as pasting temperature and peak, breakdown & setback viscosities of both raw and starch-hydrolyzed blends were measured at the temperature range of 50 to 95°C, to evaluate the effect of enzyme addition on hydrolysis of millet starch. Optimization of spray drying of milk-malted millet using response surface methodology showed that the inlet air temperature at 200°C, outlet air temperature at 70°C and at 1:1 blending ratio was ideal to get the desirable powder quality in terms of its bulk density, moisture content, as well as powder yield and thermal efficiency. The shelf life models were validated by accelerated shelf life studies. The milk-malted barnyard millet powder packaged in PET laminate was found to be the best in terms of retaining the quality of the product, which gave a shelf life of more than 90 days.

BIOACTIVE PEPTIDES AND NUTRACEUTICALS

Recombinant Expression of Proteolytic Enzymes of Lactic Acid Bacteria

Proteolytic enzymes are used in various industrial processes like production and debittering of protein hydrolysates. In milk system, casein is broken down to generate smaller peptides which are further hydrolyzed to release free amino acids. Recombinant leucyl aminopeptidase (PepL) of *L. rhamnosus* GG and proline aminopeptidase (PepP) of *L. acidophilus* NCFM were cloned, expressed in *E. coli* expression system followed by affinity purification. PepL and PepP showed maximal activity against Leu-pNA and Pro-pNA, respectively. PepL and PepP were stimulated by Co^{2+} and Mn^{2+} ions, respectively, and strongly inhibited by Cu^{2+} ions and 1,10-phenanthroline. The thermal stability of these enzymes was also enhanced by respective metal ions. These results suggested PepL and PepP to be Co^{2+} and Mn^{2+} dependent metalloenzymes, respectively. Various physicochemical properties like pH and temperature optima were observed close to physiological conditions. Given that these enzymes are highly specific to the respective substrates, the recombinant enzymes could find an application in protein/peptide sequencing and production of nutraceuticals like bioactive peptides.

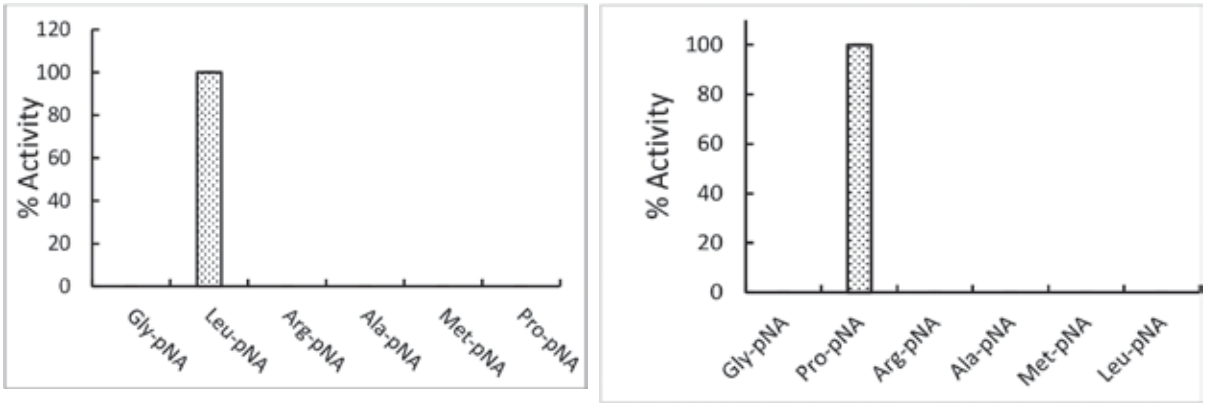


Fig.: Substrate specificity of leucyl aminopeptidase (PepL) (left side panel) and prolyl aminopeptidase (PepP) (right side panel).

Osteogeneic Effect of Bioactive Peptides Derived from Buffalo Casein

Osteogeneic potential of four buffalo casein derived peptides namely 1, 2, 3 and 4 of below 1 kD have been studied using rat calvarial cells. All the peptides induced proliferation of calvarial cells significantly in comparison to control at 30ng/ml concentration. The differentiation of calvarial cells analyzed in terms of alkaline phosphatase activity, osteocalcin levels and expression of differentiation marker genes viz. Alkaline phosphatase (ALP), Osteocalcin (OCN) and Collagen-α1 (COL-1) showed that all the peptides significantly enhanced alkaline phosphatase activity and mineral deposition in comparison to the control. However, peptides 2 and 3 induced more ALP activity and mineral deposition than peptide 1 and 4 in comparison to the control. The marker genes expression was also significantly upregulated in the presence of peptides and no cytotoxic effect of any of the four peptides was observed during 21 days treatment period. The peptide 2 was selected further for delineating the downstream signaling molecules involved in osteoblast differentiation. All the three differentiation marker genes (ALP, OCN and COL) expression, ALP activity and staining significantly decreased with Akt inhibitor treatment while, the Erk inhibitor did not show any negative effect. Mineral deposition and osteocalcin levels decreased significantly in

presence of Akt inhibitor treatment than Erk inhibitor treatment. The results showed the peptide 2 induced osteoblast differentiation through Akt (protein kinase B) phosphorylation as detected by immunocytochemistry and immunoblotting studies.

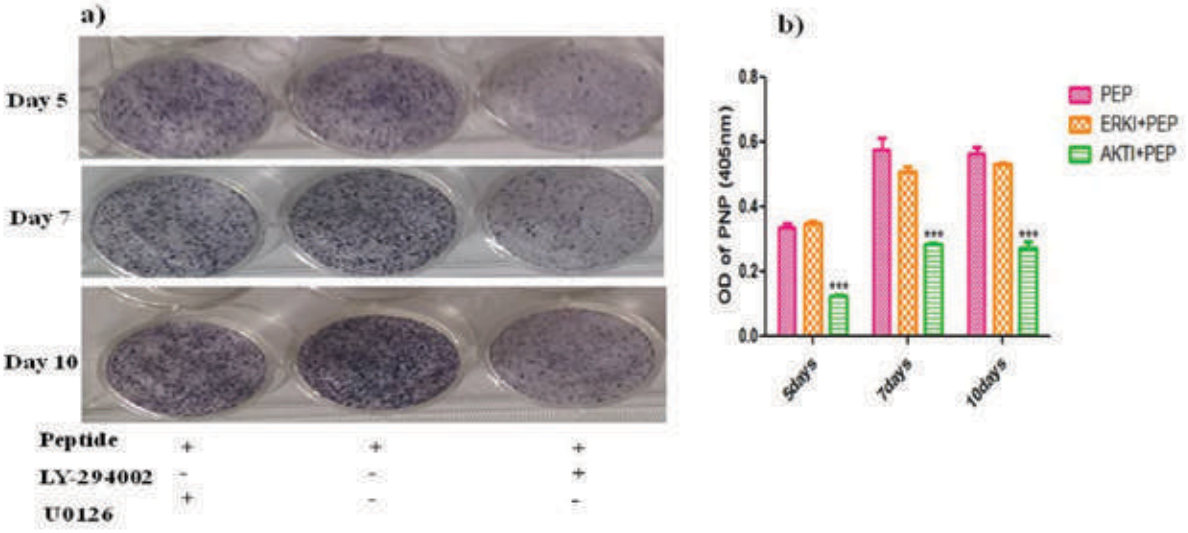
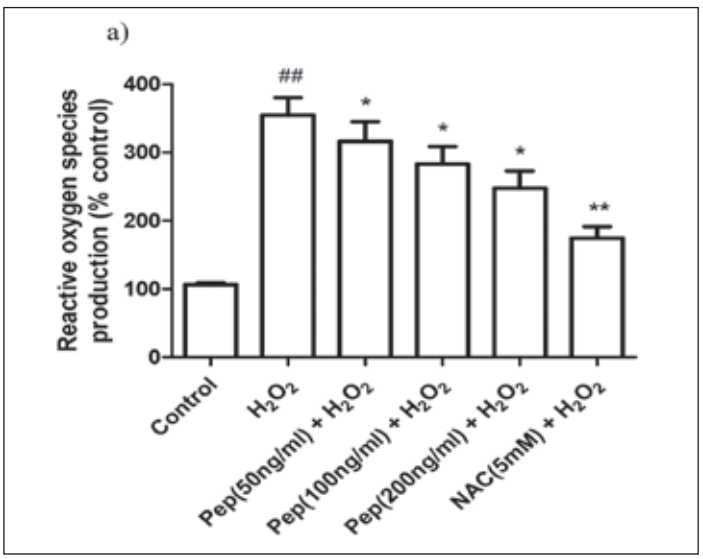


Fig. Effect of Erk (U0126) and Akt (LY-294002) inhibitors on ALP staining of osteoblast cells (day 5, 7 & 10). b) Effect of inhibitors on ALP activity *.The values are expressed as Mean ± S.E.M., (n=3). The bars bearing stars differ significantly (**p<0.01)*

Defensive Role of Casein Derived Antioxidative Peptide in Hydrogen Peroxide-Induced Cellular Oxidative Damage in Osteoblast Cells

Oxidative stress can alter cellular functions and has been implicated in the development of osteoporosis. To investigate the protective effects of casein derived peptide VLPVPQK (PEP) against oxidative damage, an *in vitro* oxidative cell injury model induced by hydrogen peroxide (H_2O_2) in rat calvarial osteoblastic cells was used and markers of cellular oxidative damage were examined. Osteoblasts were pretreated with PEP at different concentrations (50-200ng/ml) for 2 and 7 days followed by treatment of 0.3mM H_2O_2 for 24 h. It was observed that PEP significantly increased cell viability compared to group treated with H_2O_2 alone. Moreover, PEP treatment significantly decreased lipid peroxidation (MDA) and reactive oxygen species (ROS) and prevented the decrease of reduced glutathione (GSH) level, superoxide dismutase (SOD) and catalase (CAT) activities compared to group treated with H_2O_2 alone. In addition, PEP pretreatment significantly attenuated caspase-3/9 activities and reversed H_2O_2-induced cell death compared to group treated with H_2O_2 alone. Altogether, results demonstrated that PEP can protect osteoblasts against H_2O_2-induced oxidative damage via inhibition of ROS generation and enhancement of antioxidant defenses system. These data also suggest that PEP might be effective in providing protection against osteoporosis associated with oxidative stress.



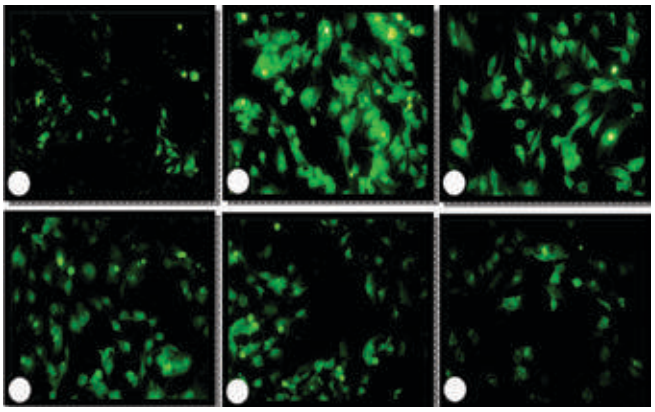
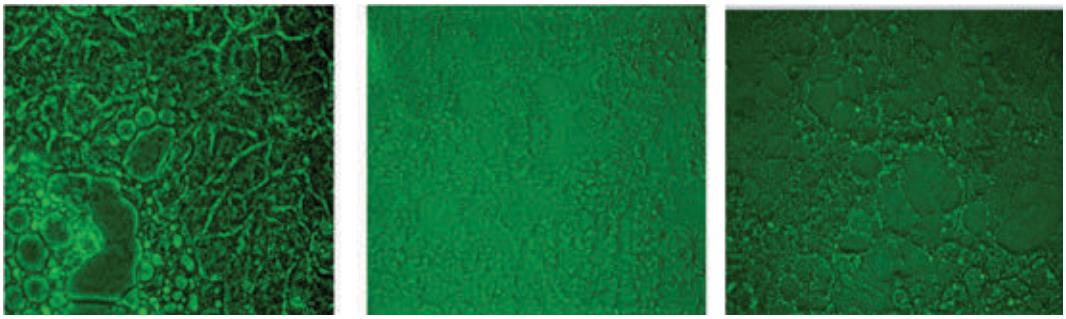


Fig: *Protective effect of PEP on intracellular ROS generation induced by H_2O_2 treatment in osteoblast cells. Osteoblast cells were pretreated with PEP at different concentrations for 7 days followed by treatment of 0.3mM H_2O_2 for 24 h. a): Quantitative analysis of ROS generation by fluorescent probe DCFH-DA using multimode detection plate reader. b): Representative images of ROS production by fluorescent microscope (Olympus).* ***1:*** *Control group;* ***2:*** *H_2O_2;* ***3****: Pep (50ng/ml) + H_2O_2;* ***4:*** *Pep (100ng/ml) + H_2O_2;* ***5:*** *Pep (200ng/ml) + H_2O_2;* ***6:*** *NAC (5mM) + H_2O_2. $^{\#\#}P < 0.01$ compared with the control group; $^{*}P < 0.05$ and $^{**}P < 0.01$ in comparison to the group treated with H_2O_2 alone.*

Antioxidative Potential of Buffalo Casein Derived Peptides in Human Intestinal Epithelial Cells *In Vitro*

Bioactive peptides represent one of the source of health-enhancing components. They are having various beneficial properties including opioid, antioxidative, antihypertensive, antimicrobial, mineral binding and immunomodulatory. Ten buffalo casein derived peptides were selected based on the sequence alignment using clustalW analysis with antioxidative and immunomodulatory peptides from bovine and goat casein available in the literature. Three chemical methods based on hydrogen-atom-transfer (HAT) were applied to screen the antioxidant activities of the peptides. It was found that four peptides (tri, hexa, hepta and decapeptide) out of ten peptides showed extraordinary oxygen radical absorption capacity (255, 229, 229, 242μM TEAC) and ABTS free radical scavenging ability (76%,84%,78% and 82%) respectively. Besides this, peptides also exhibited inhibitory activity towards linoleic acid peroxidation (55%, 6 %, 4% and 4%), which is also a HAT-based assay. The potential bioactivity of these four distinct casein peptides was assessed by investigating their cytoprotective effect against H_2O_2 induced oxidative stress using human intestinal epithelial (Caco-2) cells. These results were also linked with induction of Nrf-2 signalling by its activation and translocation to the nucleus and consequent up regulation of antioxidative enzyme levels such as catalase, SOD and glutathione peroxidase in Caco-2 cells. With these findings, our data demonstrate that peptides derived from buffalo casein may lower the risk of reactive oxygen metabolites and can act as a biological antioxidant.



(A) ***(B)*** ***(C)***

Fig: *Morphological characteristics of Caco-2 cells after H_2O_2 treatment (A) Cells without peptide and H_2O_2 (B) Cells only with H_2O_2 (C) Cells with peptide and H_2O_2.*

Antioxidative Potential of Goat Milk, Goat Milk Derived Casein and Casein Hydrolysates

Investigation was carried out to study the antioxidative potential of goat milk, goat milk derived casein and casein hydrolysates. Casein isolated from goat milk was subjected to *in vitro* hydrolysis by gastrointestinal enzymes pepsin (P), trypsin (T) and chymotrypsin (C) individually and in different

combinations (PC, PT, TC and PTC) for 3 hours. Thereafter, the antioxidative activity of goat milk, goat milk derived casein and casein hydrolysates was evaluated *in vitro* by ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) assay and measured in terms of TEAC (Trolox Equivalent Antioxidative Capacity). It was found that the casein isolated from goat milk has significantly less antioxidative potential as compared to goat milk. After hydrolysis of casein by P, T, C, PC, PT, TC and PTC, the antioxidative activity in all the hydrolysates increased significantly ($P<0.05$) as compared to casein and goat milk. Also, the maximum antioxidative potential was observed in C and PTC hydrolysates.

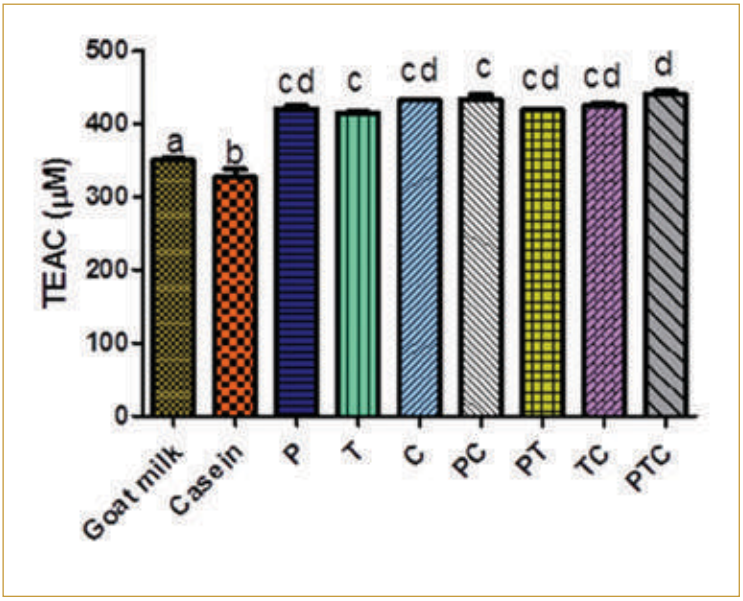


Fig: *Trolox Equivalent Antioxidative Capacity of casein hydrolysates. The values are expressed as Mean ± SEM (n=3). The bars bearing different alphabets differ significantly (P<0.05).*

Evaluation of the Stability of Sodium Caseinate Stabilized Curcumin Nanoemulsion in Icecream

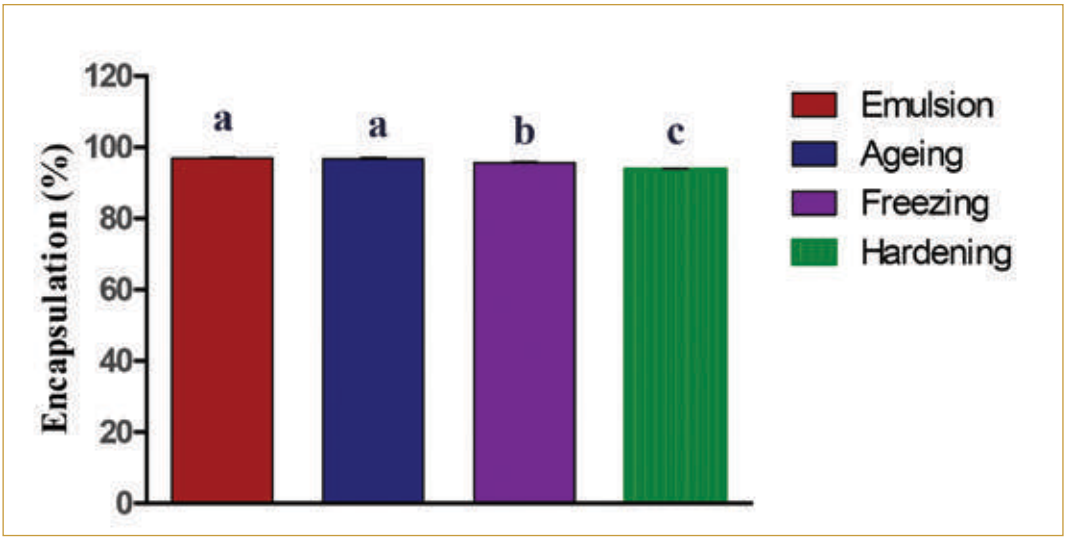


Fig.: Stability of encapsulated curcumin during processing of Icecream

The curcumin Nanoemulsion was prepared using milk fat (8%), medium chain triglycerides (2%), curcumin (0.24%) and sodium caseinate (6%) having a mean particle size of 333.8 ± 7.18 nm, a zeta potential of −44.1 ± 0.72 mV and an encapsulation efficiency of 96.9 ± 0.28%. The second preparation was used in the dairy product (Ice-cream) and encapsulation efficiency was 93.7± 0.36% in the product after hardening. The colour difference (ΔE) between control and encapsulated curcumin in the product was observed to be 6.90. This formulation was incorporated in to the dairy product (Ice cream). Moreover, there was no significant effect on sensory attributes (with mango flavour) between control and nanoencapsulated curcumin.

Immunomodulatory Properties of Buffalo Casein Hydrolysates

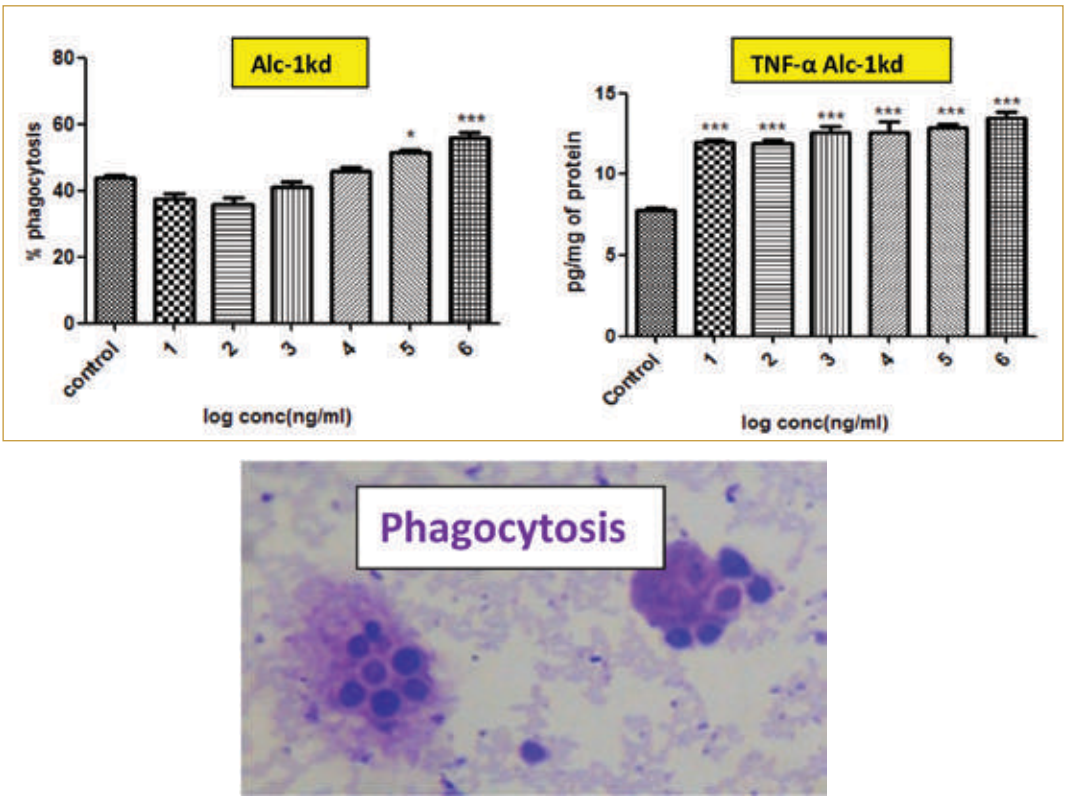


Fig.: Immunomodulatory properties of buffalo casein hydrolysates

Buffalo casein hydrolysates generated using commercial microbial proteases with endo- and /or exopeptidase activity, resulted in maximum suppressive effect (proliferation index-0.476-1.320) on lymphocyte proliferation at lower concentration whereas phagocytosis assay showed stimulatory effect at higher concentration. Based on measurement of release of interleukins into the media by cultured splenocytes, it was observed that TNF-α has significant level ($p<0.0001$) in the supernatant of cultured splenocytes irrespective of hydrolysates concentration used during culturing. However, no remarkable changes were found in the interleukins levels of TGF-β, IL-4 and IFN-γ.

Production of Antimicrobial Bioactive Peptides from Bovine and Non-Bovine Milk by Microbial Fermentation and Simulated Gastro-Intestinal Digestion for Development of Functional Ingredients

Cow, buffalo and goat milk procured from cattle yard NDRI, Karnal; camel milk from NRCC, Bikaner and sheep milk from local villages near Karnal were used for the production of bioactive peptides. Milks fermented by proteolytic *L. rhamnosus* culture for 48 h showed maximum antimicrobial activity against several pathogens. The most sensitive pathogens were *Bacillus cereus*, *Listeria monocytogenes* and *Escherichia coli.* Cow, buffalo and sheep milks were found to possess maximum antimicrobial activity in 10kDa fractions as compared to 5 and 3 kDa fractions. Goat milk had maximum activity in 5 kDa fractions as compared with camel milk which showed maximum activity in 3kDa fraction. The sheep milk showed broad spectrum of antimicrobial activity against all the test pathogens as compared to cow, buffalo, goat and camel milk. HPLC chromatogram of the fermentate fractions indicated that bioactive peptides were generated on fermentation.These antimicrobial peptides generated by milk fermentation can be incorporated in the form of ingredients in functional foods, dietary supplements and even pharmaceuticals with the purpose of delivering specific health benefits.

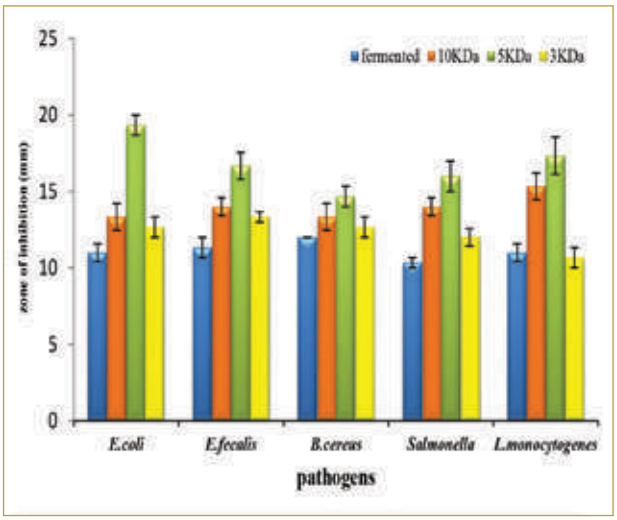


Fig: Antimicrobial activity of goat milk fermentate, 10, 5 and 3kDa fractions

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

Current investigation used seven *Lactobacillus* strains for the production of bioactive peptides from soy aqueous extract prepared with high protein content using standard method. Antimicrobial peptides active against several food pathogens were produced by all the strains during extract fermentation. LP C2 also showed highest antioxidant activity (1882.38 TEAC µM and 47.128 % DPPH inhibition) in addition to 73.986 % ACE Inhibitory activity. On the basis of highest antioxidant, antimicrobial, ACE-inhibitory and α-Galactosidase activities along with good growth and substrate utilization properties, LPC2 was selected for production of antimicrobial and antioxidative bioactive peptides. LCMS/MS was used for the identification of bioactive peptide sequences followed by BIOPEP database. A total number of 136 peptides were identified from the 9 precursor soy proteins, majority by beta-conglycinin, glycinin and lectin, with their reported bioactivities, antioxidant and ACE-Inhibitory. The study resulted into identification of bioactive peptides with anti-microbial and antioxidant activities.

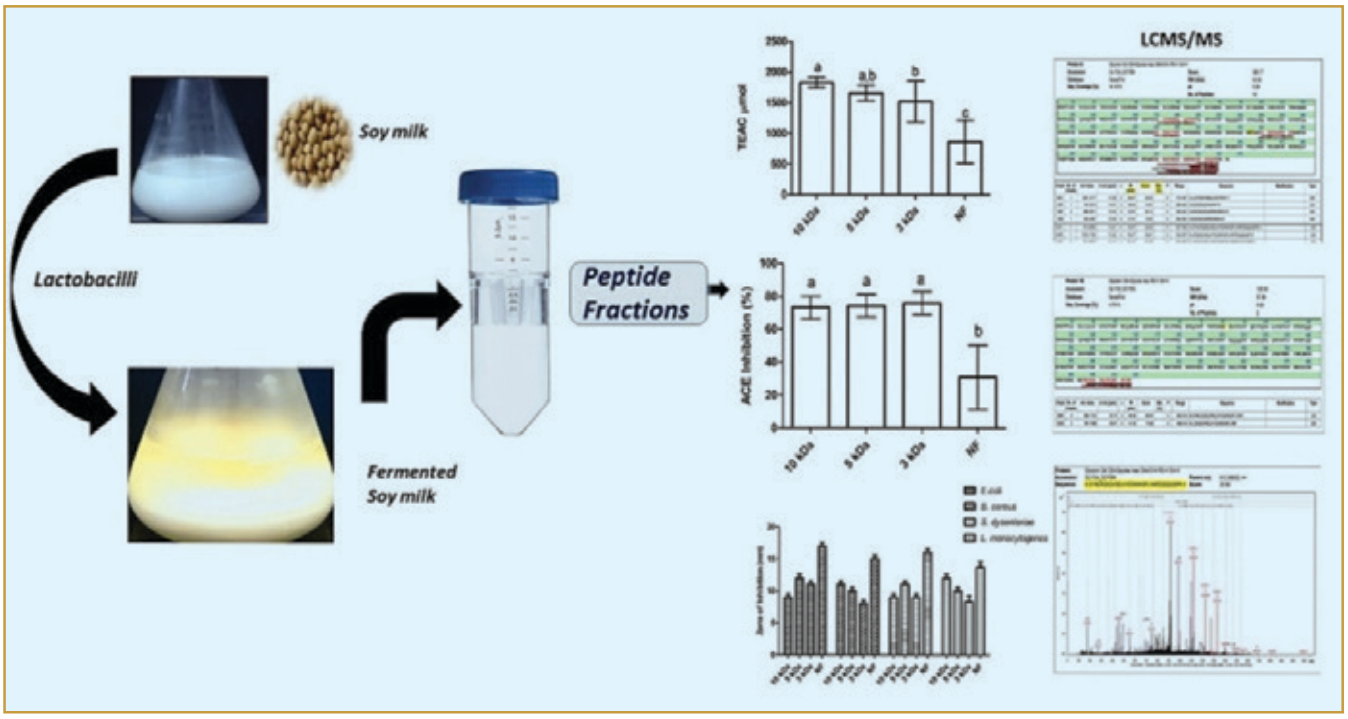


Fig. : Soy extract derived bioactive peptides by L. rhamnosus

PROBIOTICS, BIOACTIVE MOLECULES, FUNCTIONAL FOODS AND HEALTH

Countering Gastrointestinal Tract Pathogens by Adhesion-Promoting Probiotic Surface Proteins

Probiotics have been clinically proven to improve the health and well-being of the host against infective agents. Traveller's diarrhoea and inflammable bowl syndrome are well known examples which can be managed by probiotic therapy. The probiotics therapy, however, suffers with several problems like cell unviability in the formulations, antibiotics resistance/susceptibility of probiotic organisms, undocumented health claims, and general public perception against microbes. Probiotic organisms talk to host via surface adhesion proteins (mucus binding protein, Mub; fibronectin binding protein, Fbp; collagen binding protein, Cbp and surface layer protein, Slp) and compete with pathogens for the binding sites on enterocytes. For targeted application against pathogens, these surface proteins were cloned, and overexpressed in *E. coli*. The purified recombinant Mub, Fbp, Cbp and Slp showed binding with human intestinal tissues, human enterocytes (HT29 and Caco-2 cell lines), rat mucus, and mucin III proteins. Preincubation of human cell lines with the recombinant proteins excluded the binding of enterotoxigenic *E. coli* with Caco-2/HT29 cell lines. Mub (0.4 mg/ml) decreased pathogen binding by as much as 88%, while SlpB inhibited binding by 73% at 0.2 mg/ml. Fbp reduced binding of pathogenic *E. coli* by 64%. Incubation of Slp with murine splenocytes also modulated expression of pro- and anti-inflammatory interleukin genes. These results suggested that recombinant preparation of adhesion promoting surface proteins has the potential for replacing probiotics in targeted applications like pathogen exclusion.

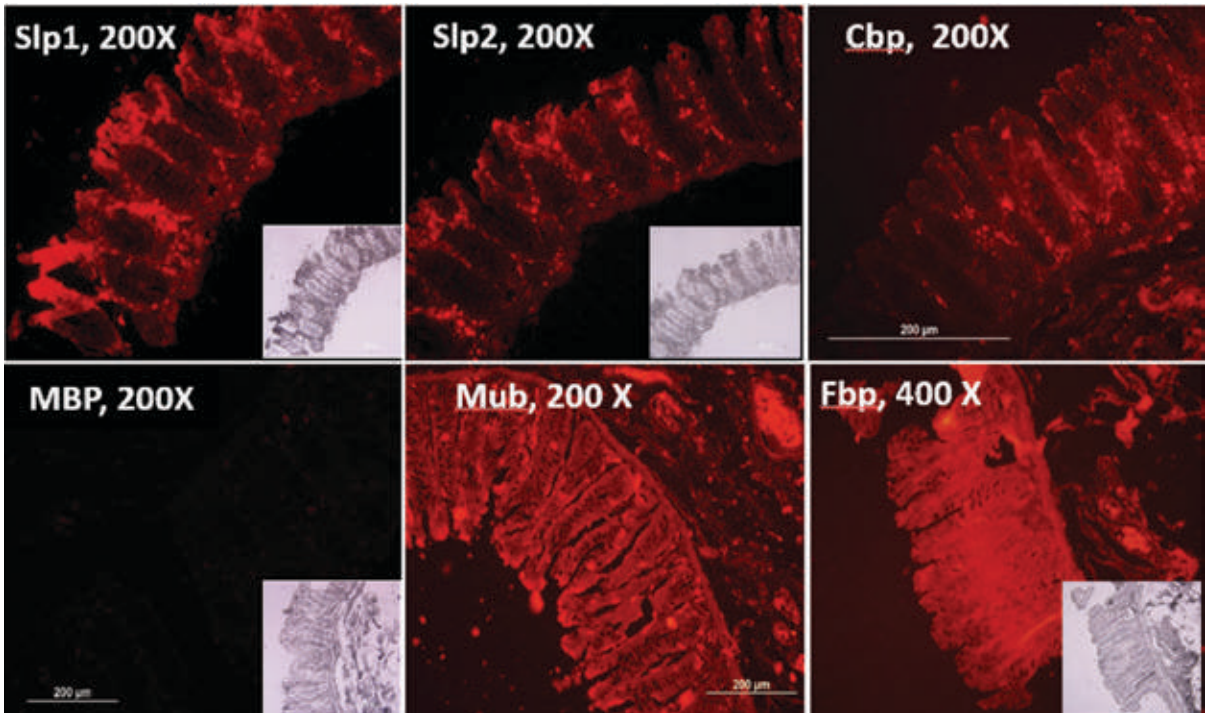


Fig.: Binding of various adhesion promoting probiotic surface proteins with human intestinal tissue trol detected by immunofluorescence produced by phycoerythromycin labelled secondary antibodies. Primary antibody was directed against maltose binding protein (MBP) which was expressed as fusion tag with recombinant adhesion promoting proteins. MBP alone was also used as control. Absence of fluorescence in case of treatment with only MBP suggested that fluorescence signal produced is because of binding of adhesion promoting fusion proteins

Anti-Adiposity Potential of Galactomannan and Diosgenin

Effects of dietary incorporation of locust bean galactomannan (soluble fiber) and diosgenin (a sapogenin) on body weight, fat mass accumulation, fasting blood glucose, serum insulin, lipids and organ weights were evaluated in C57BL/6 mice fed high fat diet (60% kcal from fat). The final body weight after 18 weeks was found to be higher in high fat diet (HFD) fed mice as compared to the control group. Dietary incorporation of locust bean galactomannan /diosgenin significantly resisted the increase in body weight, increase in fasting blood glucose and accumulation of epididymal fat compared to mice fed HFD only. Increase in serum insulin level was resisted to the significant extent by locust bean galactomannan. However, HOMA-IR score was significantly lowered by locust bean galactomannan as well as diosgenin. While serum triglycerides were significantly lowered by dietary incorporation of locust bean galactomannan, the total cholesterol level was reduced to significant extent both by the two compounds diosgenin. However, significant differences could be observed in liver, kidney and spleen weights among different treatment groups.

Safety Assessment and Adherence Knack of Probiotic *Lactobacillus rhamnosus* MTCC-5897 under *In Vivo* and *In Vitro* Conditions

Probiotics are beneficial live organisms which have been in use from old ages but have become the focus of recent times because of their immense health benefits. Being essential components of modern day functional foods it is worthwhile to check the safety aspect of probiotics before their industrial and commercial use. Based on this, the current study was undertaken to assess the cytotoxicity of an indigenous probiotic strain namely *Lactobacillus rhamnosus* (LR MTCC 5897). The strain is well known to alleviate ovalbumin induced allergy, immunosenescence and age inflicted oxidative stress in mice at two very critical stages of development, one at suckling weaning transition and another at elderly stage where immune system is highly compromised. So the adherence of the culture to intestinal epithelial cells was also evaluated under the present investigation. The study was carried out in two phases, one under *in vivo* conditions on albino mice and another on human colorectal adenocarcinoma Caco-2 cell line under *in vitro* culture conditions. The four groups of mice were fed with bacterial cell counts 10^{7}- 10^{13} cfu/ml respectively in saline and their cytotoxic evaluation was carried out by assessing various physical and biochemical parameters such as percent gain in body and organ weights, liver function tests, total cholesterol levels, HDL, triglycerides in serum and MDA levels in liver. Inflammatory markers like monocyte chemotactic protein-1(MCP-1) and tumour necrosis factor (TNF-α) were also detected in intestinal fluid. Under *in vitro* studies, Caco-2 were exposed to 10^{6}-10^{10} cfu/ml of suspended culture media up to 24hr and then cytotoxic studies were carried out by using MTT assay and by measuring supernatant LDH levels. Besides, the adherence ability of probiotic culture was also assessed both by Scanning Electron Microscopy (SEM) and plate count methods. In conclusion, no cytotoxicity was observed under both *in vivo* and *in vitro* trials which established that the probiotic culture *Lactobacillus rhamnosus* MTCC-5897is safe for consumption and thus can be used as an ingredient of various functional foods.

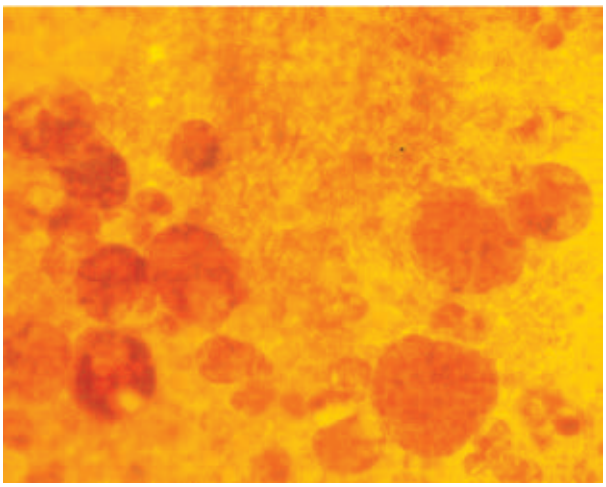


Fig.: Viable caco-2cells with Neutral Red dye

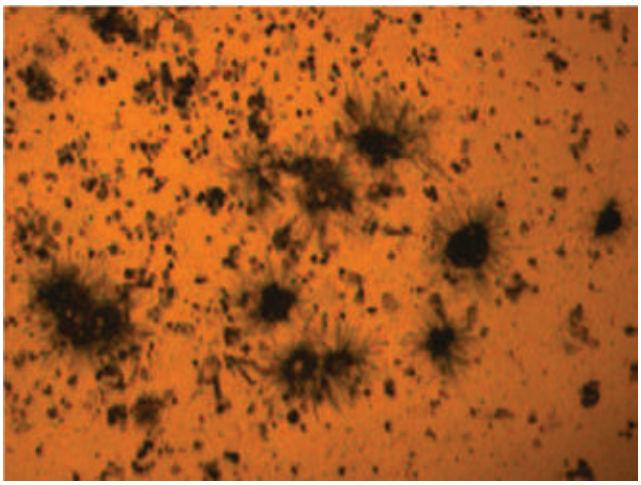


Fig.: Viable Caco-2 cells with MTT formazan

Effect of Oryzanol and Ferulic Acid on Lipid Profile in High Fat-fed Mice

Recently a number of studies have focused the use of naturally occurring antioxidants for prevention and treatment of obesity and its associated disorders such as type II diabetes mellitus, cardiovascular disease, and dyslipidemia. Oryzanol and ferulic acid, the major phenolic compounds in rice bran oil, were reported to have strong antioxidant activities and possess various physiological properties, such as inhibition of tumor promotion, reduction of serum cholesterol levels, and protective action against liver injury. The given study was conducted to see the comparative effects of oryzanol and ferulic acid on lipid profile of the C57BL/6 mice fed with high fat diet for 16 weeks. There were four treatment groups fed with Control diet (CON), High fat diet (HFD), High fat diet containing oryzanol (HFD-ORY), and High fat diet containing ferulic acid (HFD-F.A). The mice were fed for 16 weeks and allowed free access to food and drinking water during experimental period. At the end of the experimental period, the mice were anaesthetized and sacrificed. Blood samples were collected and serum was separated for measurement of Triglycerides, Total cholesterol and HDL-Cholesterol. HFD group mice exhibit the significantly increased content of total cholesterol and triglycerides than CON group mice. The HFD-ORY group and HFD-FA group showed significantly lower concentrations of triglycerides, total cholesterol, VLDL-Cholesterol and LDL-Cholesterol than HFD group. The value of HDL-Cholesterol was also higher significantly in both groups than HFD group. It suggests that both of these phenolic compounds suppress the high fat diet induced hyperlipidemia.

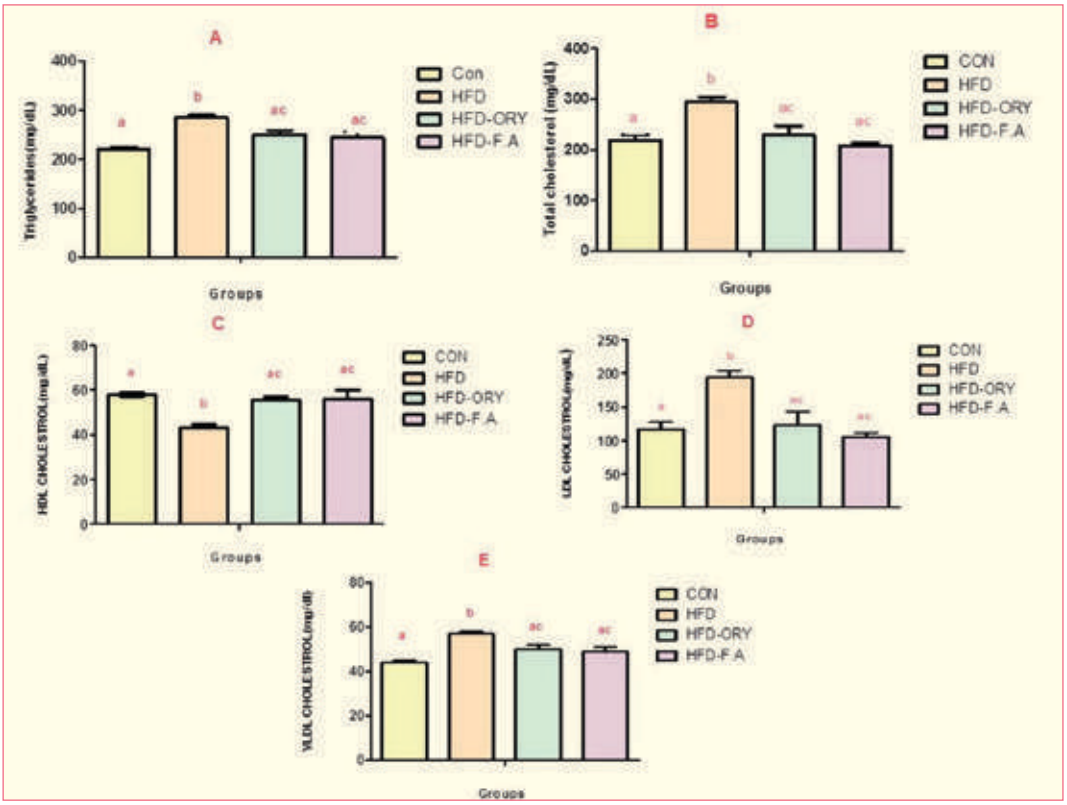


Fig: *Effects of Oryzanol and Ferulic acid on lipid profile: (A) Triglycerides, (B) Total Cholesterol, (C) HDL-Cholesterol, (D) LDL-Cholesterol and (E) VLDL-Cholesterol. CON-Control Diet, HFD-High fat diet, HFD-ORY-High fat diet containing oryzanol, HFD-F.A-High fat diet containing Ferulic acid. Columns with different letter differ significantly (P<0.05).*

Characterization of Buffalo Milk Derived Nanovesicles

Buffalo milk-derived nanovesicles were isolated and characterized by dynamic light scattering (DLS), nanoparticle tracking analysis (NTA), scanning electron microscopy (SEM), Western probing, and Fourier transform infrared (FTIR) spectroscopy. The comparative expression profiles of immune miRNA signatures (miR-15b, miR-21, miR-27b, miR-125b, miR-155, and miR-500) in the nanovesicles isolated from milk, serum, and urine revealed that these miRNAs are present abundantly ($P < 0.05$) in milk-derived nanovesicles. Milk miRNAs, miR-21 and -500, found stable under different household storage conditions indicated that these could be biologically available to milk consumers. Overall, nanovesicles are a new class of bioactive compounds from buffalo milk with high proportion of stable immune miRNAs compared to urine and plasma of same animals.

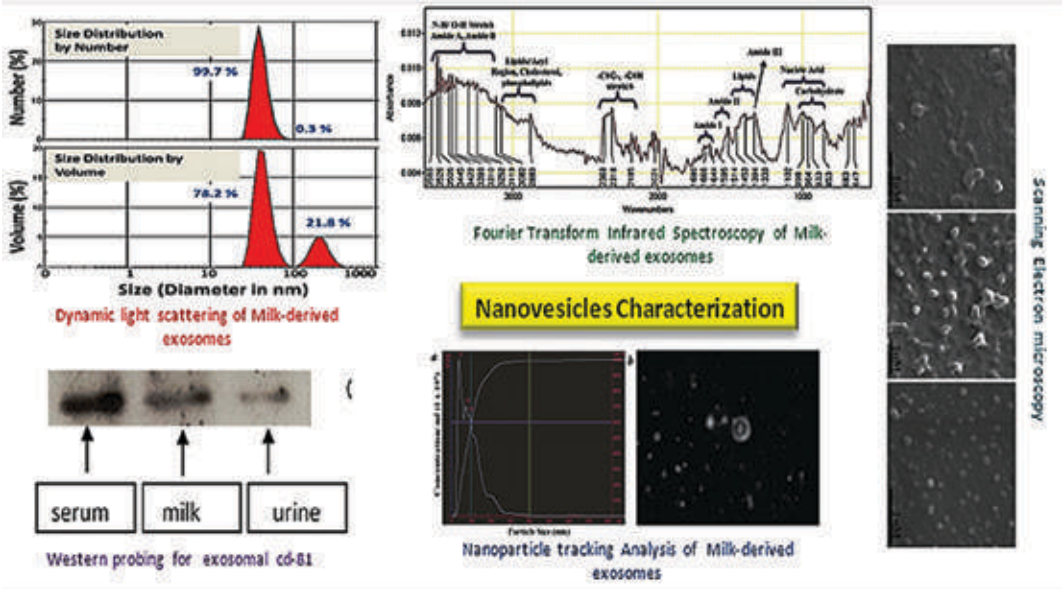


Fig: Characterization of the buffalo milk-derived nanovesicles by dynamic light scattering (DLS), Western probing, Fourier transform infrared (FTIR) spectroscopy, nanoparticle tracking analysis (NTA) and scanning electron microscopy (SEM). The DLS data suggested a bimodal size distribution with one mode near 50 nm and the other around 200 nm for the nanovesicles. The NTA and SEM data also supported the size of nanovesicles within a range of 50–200 nm. The FTIR measurements of nanovesicles identified some prominent absorption bands attributable to the proteins (1300–1700 cm^{-1}, amide A and amide B bands), lipids (2800–3100 cm^{-1}), polysaccharides, and nucleic acids (900–1200 cm^{-1}).

Evaluation of Mineral Bound Milk Based Ingredients for Milk Fortification

Methods were standardised for the preparation of different milk protein – mineral (iron/zinc) complexes and lactose – mineral (iron/zinc) complexes. Lactose – iron complex powder was slightly brownish in colour, whereas, lactose-zinc complex powder was similar to pure lactose powder. The *in-vitro* bioavailability of bound minerals from milk component - mineral complexes was evaluated using Caco-2 cell cultures. The levels of these ingredients were optimized for milk fortification.

Screening Probiotics and Prebiotics for Expression of Glucagon like Peptide-1 (GLP-1), a Satiety inducing Hormone, as Prophylactics against Diabetes Mellitus – 2

Efforts were made in this study to explore indigenous probiotic strains as natural dietary stimulants for GLP-1 secretion *in vitro* in human (NCI-H716) and murine (STC-1pGIPNeo) cell line to exploit them as prophylactics against Diabetes Mellitus-2. The expression and secretion of GLP-1 by probiotic strains both in Live (L) and Heat Killed (HK) forms (postbiotics) appeared to be strain specific. Heat killed preparations of probiotics were comparatively more effective in stimulating secretion of GLP-1. In addition, the role of PC3 and FFAR2 in the secretion of GLP-1 has also been established among the promising strains of probiotic lactobacilli. Among casein and whey protein hydrolysates, WP3, CP1, Lh288 (*L. helveticus* NCDC288 milk fermentate) and Lh292 (*L. helveticus* NCDC 292 milk fermentate) exhibited the maximum potential to induce proglucagon expression as well as GLP-1 secretion in STC-1 cells. The co-expression of GIP, CCK and PYY were also assessed using RT-qPCR with the purified fractions of casein hydrolysates. The peptide CP1 F7 purified from casein hydrolysate upregulated the expression of pro-GIP to a significant level. However, the conditioned media obtained after utilization of prebiotics by probiotic *Lactobacillus* strains did not induce GLP-1 secretion to a significant level. Two of the probiotic strains when tested in diabetic rat model also induced GLP-1 secretion. The consolidated data indicates that some strains could stimulate GLP-1 secretion and expression in probiotic form, others in postbiotic form and some were effective both in probiotic and postbiotic form.

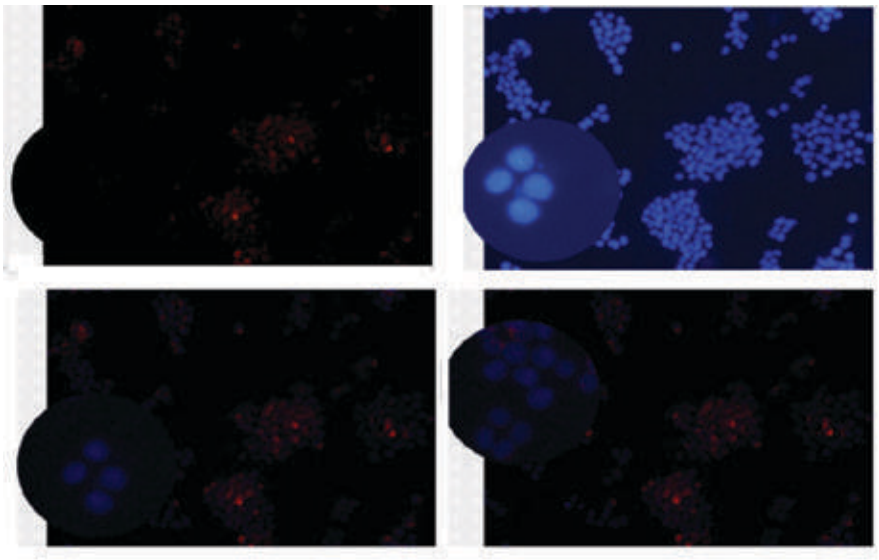


Fig. NCI -H716 cells expressing Chromagranin

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

The objective of the work was to compare the gut microbiota of North and North – eastern regions of India since dietary habits in these two regions are quite different. A study population size of 40 subjects which included 10 vegetarian and 10 non vegetarian under the age group of 20-30 and similarly 10 vegetarian and 10 non vegetarian under the age group of 50-60 after following the inclusion and exclusion criteria as laid down in the proforma was selected. The metagenomic DNA extracted from all the 40 samples was evaluated for suitability for PCR. PCR amplification of the bacterial 16S rRNA gene hypervariable V3–V5 region incorporating the 454 universal adapters and multiplex identifiers at the 5' end of the reverse primer was carried out. After determination of quantity and the size of the amplicons, emulsion PCR containing 1 x 10^9 molecules/µl in each pool was carried out with the pooled amplicon libraries separately in the separated 96 well PCR plates. A total of 2.2 and 2.4 million beads were recovered from different pooled amplicon libraries and the sequencing was carried out with 2,000,000 beads from each pool in the region1 and region 2 respectively of the PicoTiterPlate (PTP) according to standard 454 GS-FLX (Roche) protocols using the GS Titanium Sequencing Kit (Roche Diagnostics) and the GS Junior device. The 554 and 428 Mb of sequencing data with average Q value of 34 obtained during the course of study resulted from high quality reads.

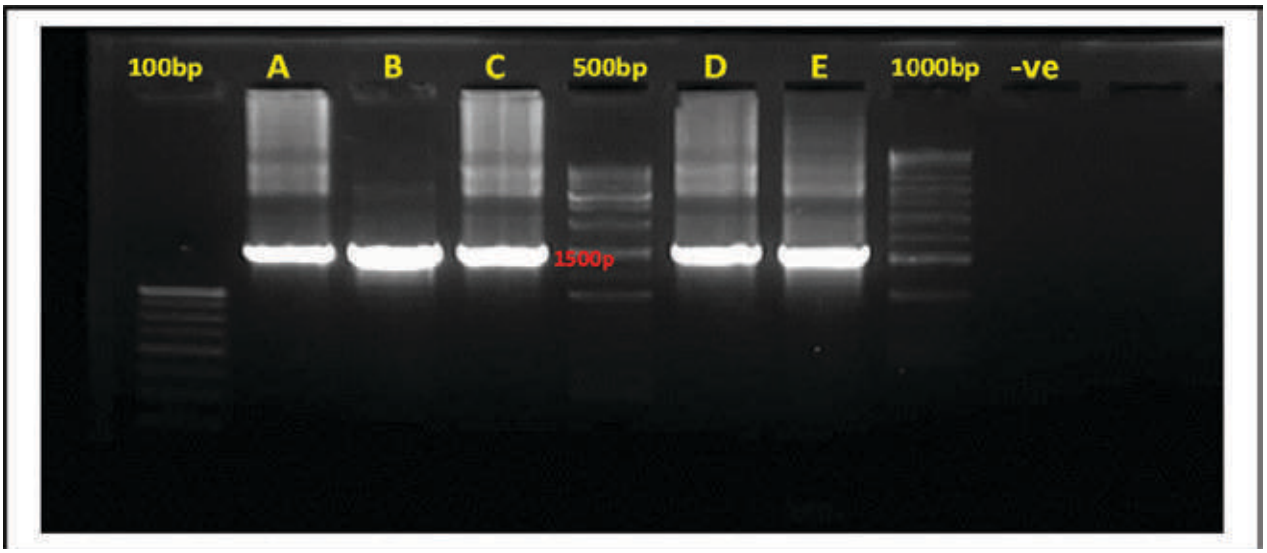


Fig: PCR amenable metagnomic DNA from faecal samples

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

The project involved the selection of probiotic bacterial strains exhibiting antagonistic activity against "Enteroaggregative *E. coli* (EAEC), followed by studying their effectiveness in *in-vitro* cell line model. Among all the test lactobacilli, the strain Lf11 exhibited maximum antagonistic activity with zone of inhibition of 14mm, followed by *L. plantarum* RD01 and *L. plantarum* SG-25 (13mm). Besides, seven strains namely *L. plantarum*RD03, *L. casei*LbS6, *L. plantarum* SG-13, *L. rhamnosus* SG-16, *L. fermentum* SG-27, *L. rhamnosus* SG-32 and *L. plantarum* SG-36 showed zones of inhibition of around 12 mm. From the above results, the ten probiotic lactobacilli which showed zone of inhibition ≥ 12mm were selected for further studies for their effectiveness against EAEC *in vitro* in cell line model.

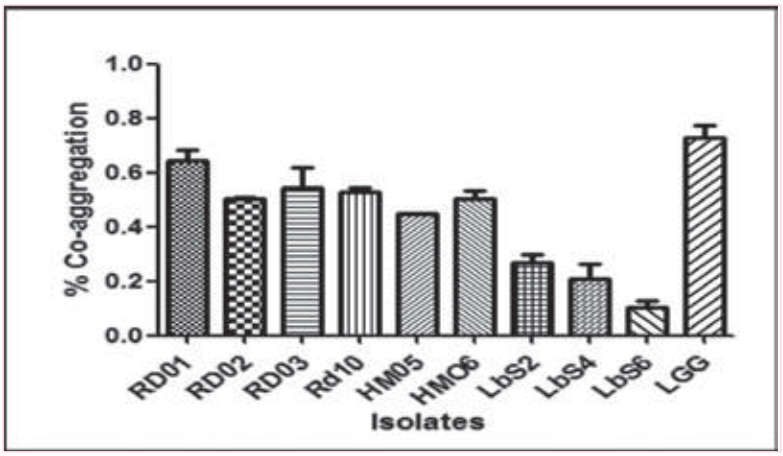
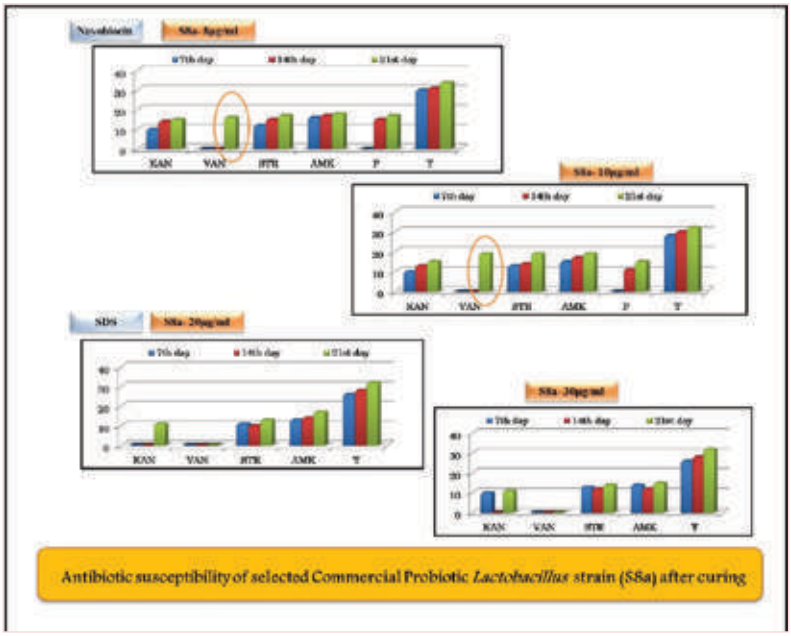


Fig. Co-aggregation potential of probiotic lactobacilli

Status of Antibiotic Resistance among Commercially Available Probiotic Bacteria

The determination of Minimal inhibitory concentration (MIC) and antibiotic resistance profiles of 29 strains (out of 30 cultures isolated from 19 commercially available probiotic products) was carried out by Broth microdilution and E-Test strips methods. All the isolates possessed MIC higher than the value prescribed by CLSI against a number of antibiotics. *Lactobacillus* strains displayed resistance to Aminoglycosides: Gentamicin (MIC 0.19- 24 µg/ml); Tobramycin (MIC 0.19-64 µg/ml). Six *Lactobacillus* strains were further selected for plasmid curing on the basis of their multiple antibiotic resistance profiles with curing agents Novobiocin and SDS in order to cure their respective antibiotic resistance properties. Novobiocin demonstrated curing in almost all the strains except strain S10b, where the curing was partially efficient. The results indicated the presence of multiple antibiotic resistance in most of the isolates. The findings of project have rendered valuable information on validation of activity and identity of probiotic bacteria claimed on the labels of probiotic products being sold in India. The results of the present study demonstrated a wide range of resistance of alarmingly high magnitude among *Lactobacillus* isolates.



Antibiotic susceptibility of selected Commercial Probiotic *Lactobacillus* strain (S8a) after curing

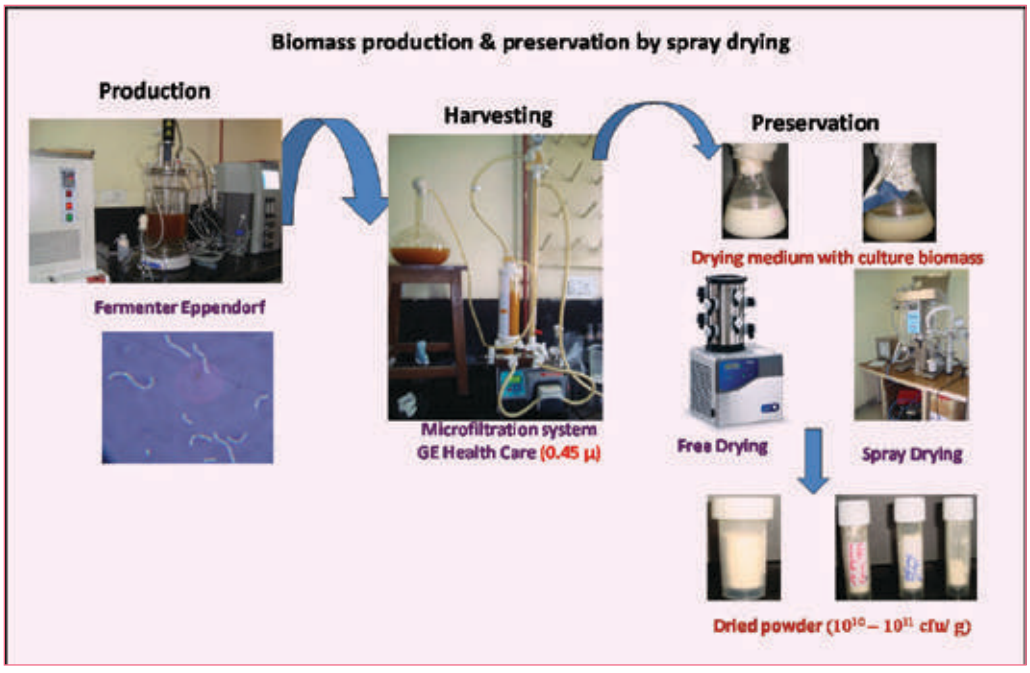
Network Project: Dairy Microbes under the Scheme on Veterinary Microbes (National Research Centre on Equines, Hisar, Haryana)

Propionibacterium strains were found to be fairly wide spread in different dairy products especially in cheese varieties as they could be isolated from various cheeses,

raw milk,dahi, and yoghurt samples. YELA media supplemented with 4 µg/ml Cloxacillinwas was observed to be the most suitable among the media used for selective isolation of Propionibacteria from dairy products. Out of 108 randomly selected colonies. Forty strains were biochemically identified *as P. freudenreichii*. Among these, 33 strains were identified as *P. freudenreichii* subsp. *Shermanii,* whereas 7 as *P. freudenreichii* subsp. *freudenreichii* on the basis of nitrate reduction and lactose fermentation phenotype. Based on the molecular characterization by genus and Species specific PCR, all the biochemically identified 40 isolates were confirmed as *P. freudenreichii* sub sp. *shermanii*. The total number of dairy microbes deposited and given accession numbers under this project reached 480. The centre wise contribution included GBPUAT, Pantnagar: 30, AAU, Anand :97, KVAFSU, Bengaluru: 46, and NDRI:307.

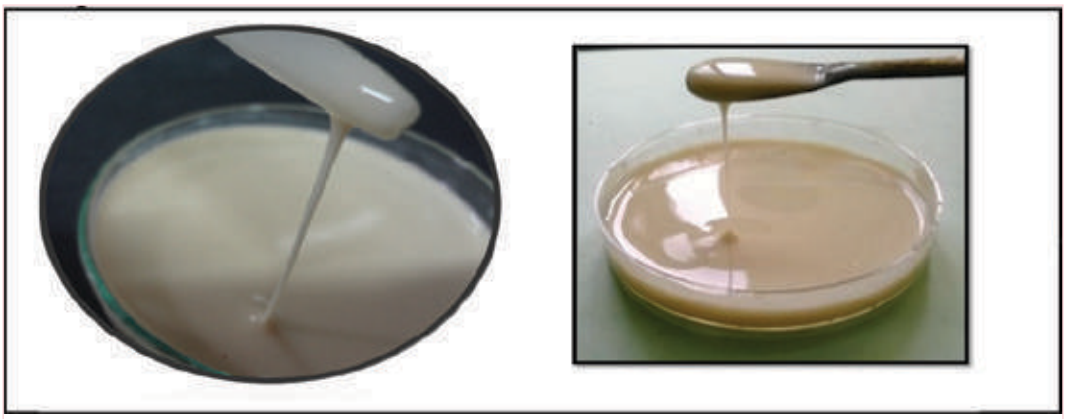
Healthy Foods: Production of Stable and Active Probiotics

L. rhamnosus NCDC 610 (LR-610) and *L.casei* NCDC 298 (LC-298) cell biomass has been prepared in a formulated whey based medium and preserved by Freeze and Spray drying. Fermentation conditions for production of *Lactobacillus* sp. biomass in whey based medium have been optimized at fermenter scale. Cell biomass has been harvested by applying microfiltration and centrifugation and preserved by freeze drying (10^{11} – 10^{12}cfu/ g powder) and spray drying (10^{10} – 10^{11}cfu/ g powder). Concentrated and dried cell biomass has been applied in value addition to fermented dairy beverage and *Kulfi* (10^{8-9}cfu/ ml). Viable counts of 10^{8}cfu/ ml could be achieved during storage. Thus, the parameters for production of *Lactobacillus* spp. biomass and preservation in powder form(s) have been optimized. Concentrated and dried *Lactobacillus* biomass has application as starters/ functional supplements for value addition of fermented and non-fermented dairy products.



Diversity of Exopolysaccharides (EPS) Produced by Lactic Acid Bacteria

Diversity of EPS produced by lactic acid bacteria was explored**.** A total of 224 EPS producing lactic cultures were isolated from milk and dahi samples collected from nearby villages and towns of Karnal District. Ropy polysaccharides (RPS) were produced by 148 isolates while capsular polysaccharides (CPS) by 163 isolates whereas 79 produced both RPS and CPS. Forty nine promising EPS producing cultures selected were identified as *Lactobacillus* (21) and *Streptococcus* (28) spp. which included *S. thermophilus* and *L. acidophilus*, *L. delbrueckii* subsp. *bulgaricus*, *L. fermentum* and *L. rhamnosus*. *L. rhamnosus* (Ndri1) showed the highest level of EPS production at 215 mg/L. The HPLC analysis revealed that the EPS produced by Ind15 was homopolysaccharide which was also confirmed by NMR.*S. thermophiles* Kri 3 and Kan 3 (less ropy and capsular) strains performed better for the manufacture of low-fat dahi. Capsular and less ropy culture *S. thermophilus* Grv3 + *Lb. delbreuckii* subsp. *bulgaricus* HH9 was better for low-fat yoghurt while *S. thermophilus* Vis 1 + *L. delbrueckii* subsp. *bulgaricus* Ind15 for low-fat shrikhand. In case of stirred product, *S. thermophilus* AM1 was better for low-fat lassi. The findings of the study indicated that the EPS producing lactic cultures do influence the properties of fermented milk products.



Aflatoxin M_1 Mitigation by Probiotic *Lactobacillus* Species

Thirty probiotic lactobacilli strains were evaluated for their AFM_1 binding ability, which ranged from 2.46 to 64.16%. The binding ability was noticed to be time dependent (6, 12 and 24h) and strain specific. The highest AFM_1 binding was observed in *L. plantarum* CRD7, *L. rhamnosus* CRD9, *L. plantarum* CM 63, *L. plantarum* BM 71, *L. plantarum* HIF 81 to the tune of 64.16, 61.03, 54.16, 53.30 and 56.84%, respectively, after 24 h contact time. The stability of bacterial-AFM_1 complex was assessed by repeated washings of the complex which indicated that complex was highly stable as only 17.30, 0.98% of AFM_1 was released back into medium. The findings of the study suggested that instead of metabolic degradation, aflatoxins bind to lactobacilli cell wall. The research findings clearly indicate that AFM_1- selected probiotic strains complex exhibit potent stability as well as significantly reduce AFM_1 bio-accessibility under simulated GIT conditions.

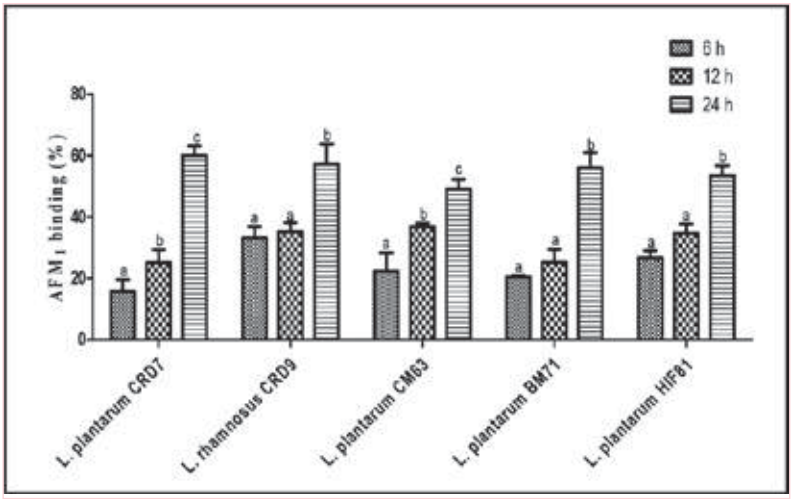
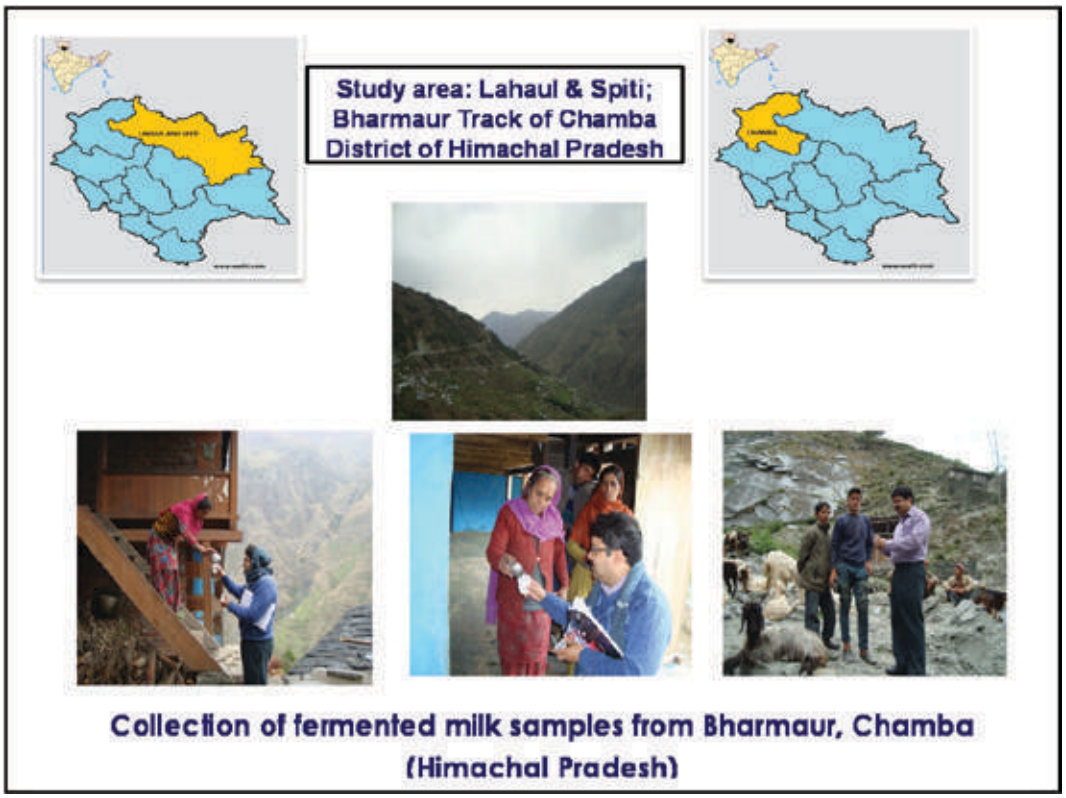


***Fig.:** AFM1 binding ability of selected probiotic lactobacilli in milk*

Bio-prospecting of Lactic Cultures from 'Cold Desert Regions' to Develop Functional Fermented Milk Products with Potential Health Benefits

Traditional fermented foods and beverages which form important constituents of staple diet of people belonging to tribal belts of Lahul and Spiti, Kinnaur, Chamba of Himachal Pradesh are prepared by fermenting vegetables, cereals and milk. The fermentation is carried out by undefined cultures inoculated from the previous batches of products. Predominant microorganisms include lactic acid bacteria (*Lactococcus* spp., *Lactobacillus* spp. and *Leuconostoc* spp.) and yeasts (*Saccharomyces* spp., *Kluyveromyces* spp.). The aim of the project is to isolate lactic acid bacteria from fermented foods of cold desert region, evaluation of their potential techno-functional attributes for preparation of cottage cheese culture in DVS form. *Lactococcus lactis* cultures were collected from National Collection of Dairy Culture (NCDC), ICAR-NDRI, Karnal and six potent strains were selected based on technological attributes studied for formulation of starter cultures for dahiand cottage cheese. Sixteen samples of fermented foods (Dahi/curd, lassi, pickles) traditionally prepared at household were also collected from Villages around Bharmour of Chamba Distt., Hamachal Pradesh. The microbiological analysis reveals that the samples were heavily loaded with yeast and moulds besides high number of lactic acid bacteria.



Effect of Probiotic *Lactobacillus Reuteri* Strains, their Surface Proteins and Extracellular Components on Intestinal Epithelial Barrier Function

Probiotics exert several beneficial effects on human health, including interaction with the immune system, production of antimicrobial substances, enhancement of the mucosal barrier function and competition with enteropathogens for adhesion sites but the mechanism involved in some of them is still either unknown or very sketchy. It was hypothesized that the cell surface proteins and extracellular proteins from probiotics might act as a mediator that triggers the gene regulation cascades leading to beneficial or health promoting effects in host. Eight probiotic *L. reuteri*strains of fecal origin were selected for this study. In order to remove surface proteins, the *L. reuteri*strains were treated with 5M LiCl for 30 min. The strains were evaluated for their ability to resist gastrointestinal conditions, auto-aggregation, co-aggregation with pathogens, cell surface hydrophobicity, adhesion to Caco-2 cell lines and competitive exclusion of pathogens (*E. coli* ATCC25922, *S. typhi* NCDC113, *L. monocytogenes* ATCC53135 and *E. feacalis* NCDC115) for adhesion to Caco-2 cells before and after LiCl treatment. Also, the results of auto aggregation, coaggregation, adhesion and competitive exclusion were compared with heat treated *L. reuteri* strains and their respective cell free supernatant. The viability of cells without surface proteins was significantly reduced in Simulated Stomach Duodenal Passage (SSDP) indicating the protective role of surface proteins against the hostile gastrointestinal environment. Removal of the surface proteins reduced auto-aggregation, cell surface hydrophobicity and adhesiveness of the probiotic strains. The changes in the surface characteristics were also studied using scanning electron microscopy (SEM) and transmission electron microscopy (TEM). The co-aggregation and pathogen inhibition efficiency (in competition, exclusion and displacement assays) of *L. reuteri* strains evanesced upon exposure to LiCl, suggested that proteinaceous components on the surface of *L. reuteri* mediate the co-aggregation and adhesiveness.Also, it was observed that the cell free supernatant and heat killed forms of the strains were able to inhibit the pathogens *in vitro*. The expression of defensins (hBD-2 & hBD-3), claudin-1 and occluding was studied using probiotic strains (untreated and LiCl treated), heat killed probiotic and cell free supernatant (CFS) in the absence and presence of the pathogenic culture by RT-qPCR. The results showed that the probiotics significantly upregulate the expression of genes encoding claudin-1, occludin, hBD-2 & hBD-3. Also, the surface and extracellular proteins extract from *L. reuteri*LR6 significantly decreased the adhesion of *S. typhi* NCDC113 to Caco-2 cells. These observations suggest that LiCl treatment removes the surface proteins which are important for probiotics adhesion as well as for gene regulation cascades.

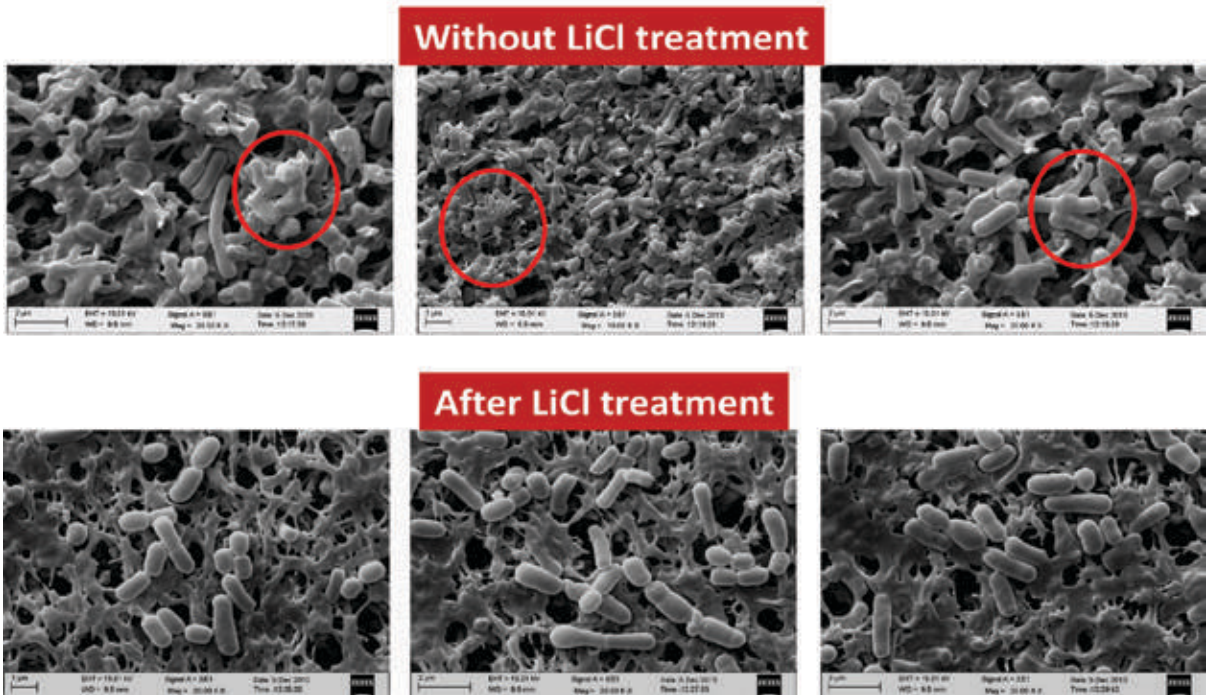


Fig.: Scanning electron microscopy (SEM) to determine effect of LiCl treatment (5M) on cell auto-aggregation. (A) Untreated L. reuteri LR6 showing aggregation; (B) LiCl treated L. reuteri LR6 showing separated cells.

Glutathione System in Lactic Acid Bacteria and its Modulation with Selenium

The research work pertains to study of the glutathione system in lactic acid bacteria and its modulation with selenium. Bioinformatic analysis revealed the presence of glutathione biosynthesis bifunctional fusion gene (gshF) in different lactic acid bacteria. Among all the tested species, highest GSH production was observed in *S. thermophilus* NCDC 659 (7.22 ± 0.64 nm/mg protein). The GSH concentration in *S. thermophilus* NCDC 659 increased significantly at tested Se supplementation levels of 5,10,25 mg/L reaching 28.47 nm/mg at Se concentration of 25 mg/L. A 5.82 fold increase was observed in gshR expression at Se concentration of 25 mg/L. Se supplementation caused a repression in gst expression. *S. thermophilus* NCDC 659 exhibited highest antimutagenic activity (25.55 %) at selenium concentration of 10 mg/L. Treatment of Caco-2 cells with Se enriched *S. thermophilus* NCDC 659 filtrate did not elicit any genotoxic response even at the highest concentration of 100 mg/L as evident from tail moment analysis in comet assay. Selenium supplementation had a remarkable effect on antigenotoxicity against MNNG mostly at lower concentrations of 5 (35%) and 10 mg/L (44 %). Selenium, thus, has a multilevel interaction with glutathione and modulates the activities of the associated enzymes. Glutathione on the other hand is essential for Se detoxification.

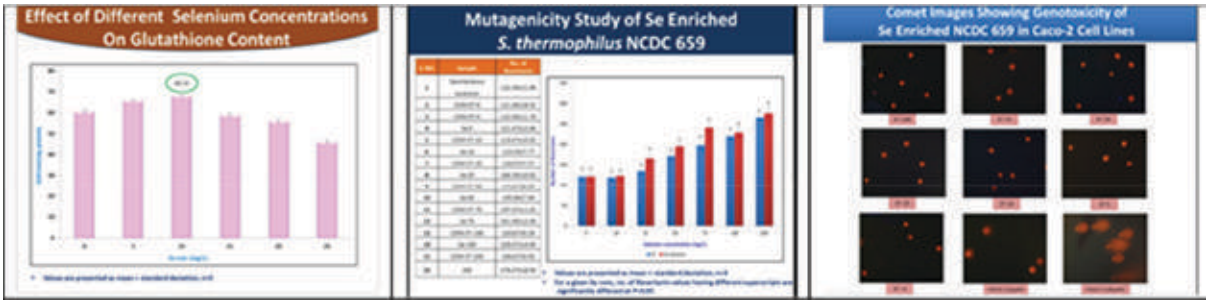


Fig.: Glutathione System in Lactobacilli and its Modulation with Selenium

Exploring *Lactobacilli* for Vitamin B12 Production

The present study included isolation of *lactobacilli* from dairy and non-dairy origin, screening them for probable B12 production potential using a polyphasic methodology, exploring selected strains for *in-vitro* vitamin production and testing vitamin producing strains for *in-vitro* anti *H. pyloric* potential. Out of 70 *lactobacilli* isolates, two most prolific vitamin producers produced vitamin B12 at a level of 70.13 ± 7.15 g/l and 32.1 ± 4.78 g/l, respectively. This study reports for

the detection of seven important B12 related genes, including cbiK, on genomic DNA of both B12 producing *L. plantarum* strains (BHM10 and BCF20). Moreover, these strains have been found to possess promising anti *H. pyloric* activity *in-vitro* and per se offers an ideal choice for its use as a multifunctional agent for further *in-vivo* experiments focusing on B12 deficiency and *H. pylori* infection models. Hence, *L. plantarum* BHM10 and BCF20 have the potential for their adaptation in food and dairy sector as functional adjunct cultures to produce fermented products with elevated levels of B12 vitamin and thus, can serve as a novel probiotic organism coupled with advantage of B12 production.

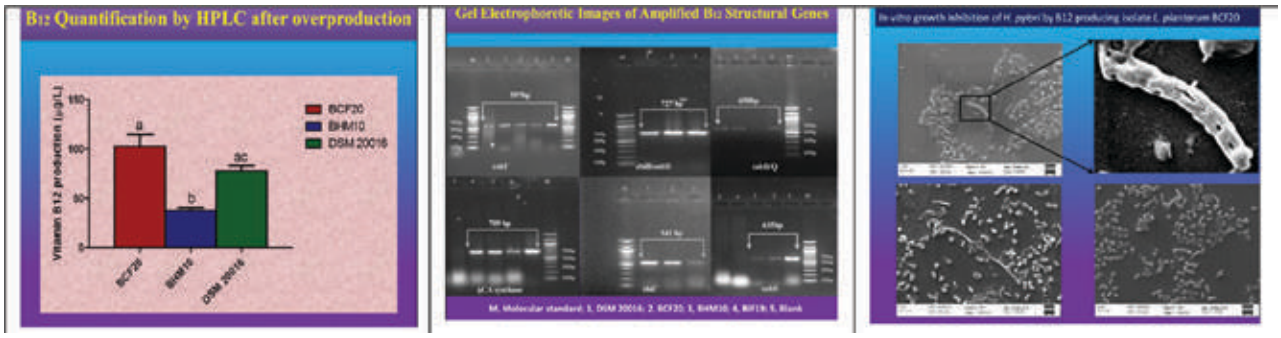


Fig.: Exploring lactobacilli for vitamin b12 production and inhibition of Helicobacter pylori

Cholesterol Biotransformation Potential of *Lactobacillus* Species for Management of Hypercholesterolemia in Rat Model

Out of twenty five probiotic lactobacilli cultures exhibiting >60% cholesterol reduction, *L. plantarum* HIF81 exhibited highest cholesterol reduction of 76.58% and biotransformation of cholesterol to coprostanol ability of 21.86 ± 1.54 µg/mL besides possessing excellent survival to simulated gastrointestinal conditions, ability to de-conjugate major bile acids as well as has *bsh* gene. The *in-vivo* efficacy of *L. plantarum*HIF81 in two formats (lyophilized and dahi) was investigated on 5 ± 1 weeks old spraguedowley rats for 90 days. The observations on hypocholesterolemic efficacy revealed 28.08, 19.7, 56.96, 19.76 and 63.21% reduction in serum total cholesterol, triglyceride, LDL-cholesterol, VLDL-cholesterol and atherogenic index, respectively, whereas HDL-cholesterol levels increased significantly i.e. 26.66%, as compared to hypercholesterolemic group. Fecal excretion of cholesterol and coprostanol were found significantly higher in probiotic treatment (29.24 ± 3.02 µg /g) as compared to normal (13.8 ± 2.27) and hypercholesterolemic groups (22.39 ± 1.28). Liver and aorta histopathological observations showed less deposition of lipid in hepatocytes and no plaque formation in aorta of *L. plantarum* HIF81 fermented milk fed group than other treatment groups. The study revealed that probiotic *Lactobacillus* strain possesses the ability for management of hypercholesterolemia.

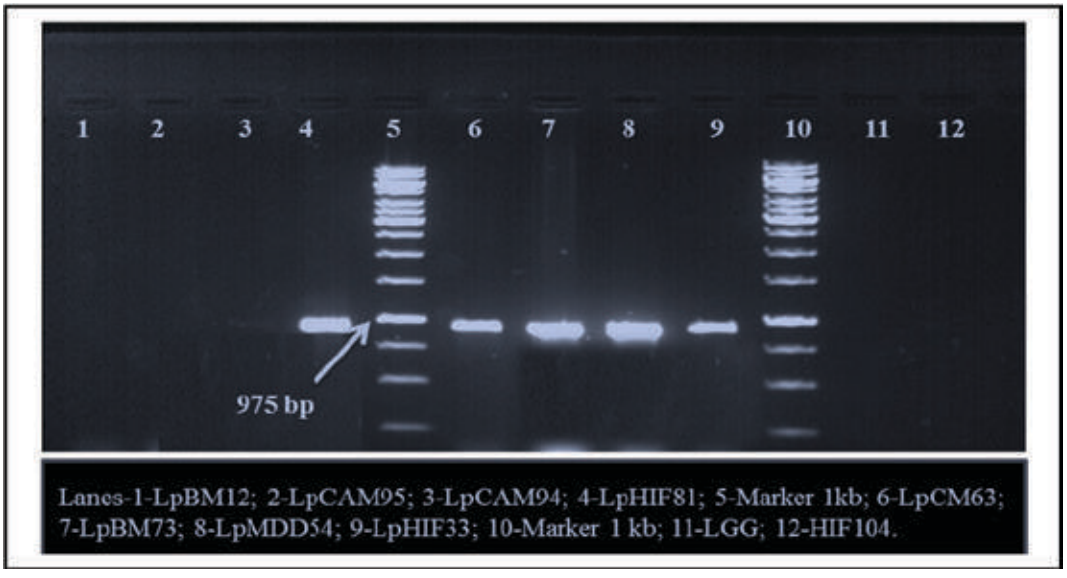


Fig: PCR amplification of bsh gene in L. plantarum isolates

Preparation of Biofunctional Whey and Soymilk based Fermented Beverage with Curcumin Supplementation

Soymilk was prepared by adding whey in place of water (1:4 w/v) and supplemented with curcumin. *L. acidophilus* NCDC195 (LA195) and *S. thermophilus* NCDC323 (ST323) were used for fermentation of whey based soymilk. Antimicrobial activity of curcumin was analyzed at different % concentration (0.02, 0.04, 0.06, and 0.08) against pathogens. On the basis of maximum antimicrobial and antioxidant activity, LA195+ST323 combination was selected for the preparation of fermented whey based soymilk drink at 1% of inoculum level at 37°C for 20 hrs. Sensory evaluation indicated that soy beverage with 12% of 50% sugar solution was having more acceptability in terms of colour and flavour. Product was stable for 4 days at 4°C and no coliform and yeast and mold were present. The soy beverage produced possessed antimicrobial and antioxidant activities and was acceptabable in terms of colour and flavour.

Formulation of Defined Strain Starter for Greek-Style Yoghurt

Greek yoghurt, a fermented semi-solid product, is derived from yogurt by draining away part of its water and water-soluble components. Greek yogurt can also be prepared by concentrating milk by ultra-filtration or addition of milk solids to make up the total solids in final product before fermentation (Greek-style yogurt). In formulation of yogurt culture(s) for Greek-style yogurt, 9 *Streptococcus thermophilus*(ST) and 9 *Lactobacillus bulgaricus*(LB) cultures were cultured in milk (15 and 25% TS). Based on acidification profile, curd setting time, body and texture of curd, and culture ratio (ST:LB), ST526 and 455 and LBI15 and HH9 were selected. Two culture combinations (ST-526+LB-I15 and ST-455+LB-HH9) yielded curd with good body, texture, flavour (acetaldehyde) and culture ratio in milk (3% fat, 25% TS). The quality of Greek and *Greek-style yoghurt* prepared using selected culture combination was better as compared to the NCDC 144 yogurt culture. Thus, the selected culture combinations will be helpful for production of good quality yoghurt and Greek-style yoghurt.





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

Processed cheese was prepared by using Cheddar cheese whey and Paneer whey. Addition of water in cheese during processing was totally replaced with whey. Addition of whey did not show much variation in the yield of cheese. Moisture variation was minimum (43.10 - 43.50 %). However, the lowest pH of 5.88 - 5.95 was observed in the cheese made using Paneer whey. There was no noticeable difference observed in sensory characteristics among control, cheese with cheese whey and cheese with Paneer whey. Whey incorporation contributed some colour when the moisture content in processed cheese was below 40%. Highest hardness (28.86 N) was observed in the control cheese followed by the cheese made using Paneer whey and cheese whey. Gumminess was minimum (41.82 N) and maximum (63.61N) in the processed cheeses made using cheese whey and control, respectively.

Isolation and Identification of Bacteriophages from Dairy Products and Environment and Evaluation of Starter Cultures for the Phage Resistance

The presence of phages in the dairy environment is a major setback for the fermentation industry. In this project, the dairy environment viz, Processing Unit and Livestock Research Centre were screened for the presence of phages using the starter cultures. The results showed the presence of tailed phages (Myoviridae) from the samples of cheese section and also in the paneer dip solutions which were stored in the cheese section. This indicates the probable airborne transmission of phages. So, the preventive measures for the phage contamination of the dairy environment should also focus on the air spray of disinfectants along with other control measures.

Development of Resilient Probiotic Foods Designed for the Indian Market Conditions

In order to launch indigenous probiotic products in the country, some of the most vital issues that need to be appropriately dealt with, include novel indigenous probiotic strains with proven functional efficacy, both *in-vitro* and *in-vivo*, their inter-compatibility, effective dosage and colonization in the human gut. The selected probiotic strains need to survive the processing lines of the carrier food besides tolerance/resistance to the stresses during storage of the food and also the harsh gastric environment during the transit to the target site. In order to achieve the objective of survival of the probiotic strains during storage at ambient temperatures the probiotic strains were evaluated for their probiotic attributes and subjected to microencapsulation in collaboration with Riddet Institute, Massey University, North Palmerston, New Zealand. Six probiotic cultures were selected on the basis of their appreciable probiotic attributes. These cultures were further subjected to a battery of *in vitro* evaluation tests viz. acid tolerance, bile tolerance, survival in simulated stomach duodenum passage, cell surface hydrophobicity (n-hexadecane), cell-auto-aggregation, co-aggregation with pathogen (*E. coli*). The cultures under study were further evaluated for their safety. Further, *in-vivo* studies were carried out using a breast fed infant feces lab isolate *L. reuteri* LR6 to investigate the effects of a high dietary soybean oil and cholesterol on serum total cholesterol, low density lipoprotein (LDL-C), high density lipoprotein (HDL-C), and triglycerides. Significant changes were seen in lipid profile, lactobacilli and coliform count among the groups. Also, immunomodulatory effects of the same isolate was analysed in swiss albino mice. The results showed that *L. reuteri* LR6 was effective in lowering cholesterol levels and in boosting the immune response. Further, suitable Indian food formats will be developed for probiotic delivery, in the quest to design "Resilient Probiotic Foods" for the Indian market

PROCESS ENGINEERING

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

Buffalo milk was procured from the local farm and concentrated to 22% total solids in a rotary evaporator at 45°C. The physical and thermal properties of both feed and dried milk powder were determined using thermal properties analyzer. From the mass balance, energy balance, heat loss, specific energy and exergy of drying air, spraying air and ambient air, as well as, those of the feed and dry powders, the energy and exergy efficiencies of spray drying of buffalo milk were computed at the three temperatures. The exergy efficiencies ranged from 8.852 to 11.028%. Also, the relationship between drying air temperature and exergy efficiency was established. In addition, the energy lost to the atmosphere during spray drying was also computed.

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

The variation in the pressure applied over the paneer hoop has found to have significant effect on the moisture content. The highest moisture content (56.25%) was observed for 7 kg applied pressure for 20 minutes duration and the lowest value (47.35%) was observed for 13 kg applied pressure for 30 minutes which showed that an increment in the duration of press of 10 minutes has reduced the moisture content by about 5 percent. The results of porosity value indicated that pressure and the interaction of pressure and time have significantly affected the porosity of the paneer. Overall the applied pressure greatly influenced the porosity.

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

A hybrid oven was developed and fabricated.The mean air velocity of 1.43 m/s was measured using a digital anemometer. Infrared (IR) source was provided by two numbers of 500W quartz lamps at the top with separate power control (Dimmerstat) for it. Three baking pans could be accommodated in this oven. This oven could be operated in five different modes viz. free convection, forced convection, IR alone, combination of free convection & IR and combination of forced convection & IR.

Development of Process Protocol for Image Analysis and its Application for Detection of Adulteration of Cow Ghee with Vegetable Fat

An attempt was made to apply image analysis to predict the level of adulteration of ghee with *vanaspati*. Both colour image analysis and texture image analysis were applied to a total of 210 images to extract mathematical descriptors for the image. The results were also compared with physicochemical tests namely, Baudouin test, BR reading, apparent solidification time test, melting point, RM value and critical temperature of dissolution. A prediction model incorporating 4 select image analysis parameters viz., pixel intensity, branches, equivalent diameter and luminance developed using discriminant analysis and multivariable regression. The developed model was validated using test samples of non-experimental adulteration levels and also on a market sample of ghee and the model was found to predict the level of adulteration with the coefficient of determination of >0.85 indicating good prediction.

Application of Image Analysis for Online Monitoring of Khoa Quality

An attempt was made to investigate the feasibility of applying image analysis to monitor the quality of *khoa* during its preparation process. Image acquisition system settings and position for obtaining quality images in situ were calibrated based on preliminary studies. Temporal mapping of images during its manufacturing was carried out at 5 min intervals and the images were imported to software packages to analyse its colour and image texture. The extracted image colour and texture parameters were correlated with sensory data and hardness value obtained by convectional texture profile analysis. It was observed that there were very good linear correlation (R^2>0.85) between image texture descriptions and hardness value. Comparison of the colour parameters of images acquired in situ and under standard illumination in the laboratory indicated a need to develop suitable models to correlate those two.

Design and Development of Eutectic Module for Cooling Raw Milk

The present work was carried to design and develop a eutectic module for raw milk cooling. Spherical and cylindrical shaped eutectic modules made of SS 304 series were developed and the cooling performance of different refrigerants inside the eutectic module was evaluated. Temperature profile of four refrigerants inside spherical module was monitored during their freezing and cooling of milk. The spherical eutectic module (150 mm in diameter) filled with water as refrigerant provided the maximum cooling effect (cooled 5 L of milk from 33.2 to 12.8°C in 26 min) followed by 20% propylene glycol solution (from 33.4 to 17.1°C in 22 min). The microbiological quality (TBC and MBRT) of raw milk cooled using the developed spherical eutectic module was found to be better than control (milk without cooling). The developed spherical module containing secondary refrigerant will be useful for raw milk cooling at the farm level for small quantities of milk.



Machine Vision System for Quality Evaluation of Dairy Products Based on Colour Measurement

In food and processing industry colour is one of the important quality parameters. Quantative analysis using colour measuring instruments is always preferred over qualitative evaluation as it enables accurate and repeatable colour measurement. Once the colour of product is measured based on any colour scale, it is difficult to observe the colour shade if the product is not available. Therefore efforts were made to develop system for colour simulation based on numerical values. At present such features are available only with proprietary software supplied along with commercial colour measuring instruments. For image processing and analysis Scilab 5.4 software was used. Graphic user interface (GUI) based program was developed to take inputs for CIE Lab values. The program automatically calculates and displays the image on the computer screening for the colour shade corresponding to CIE Lab values. Such a system will be useful in product formulation R&D and for quality control of product even from a remote location.

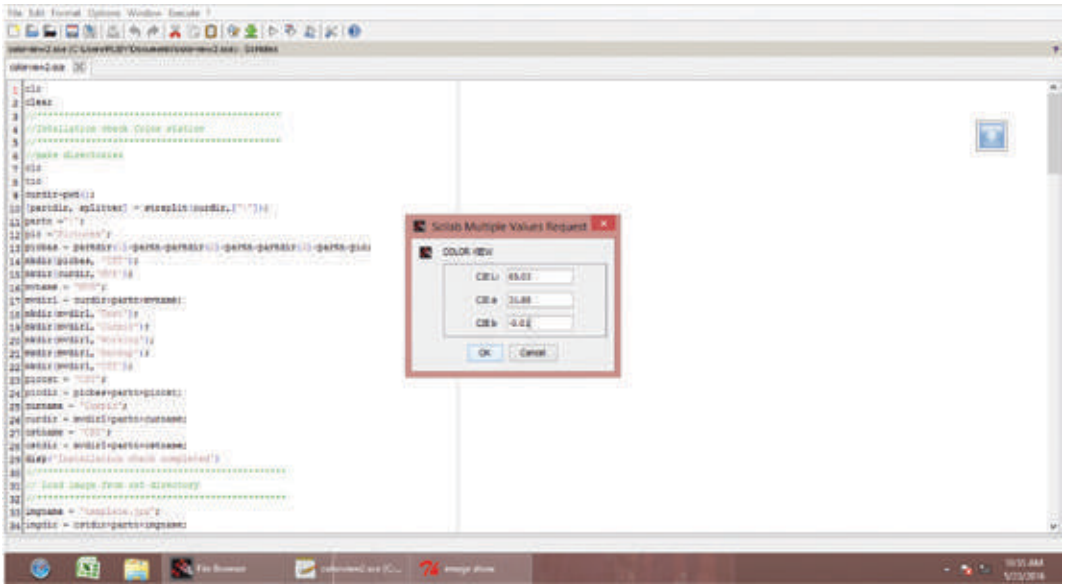


Fig.: Graphic user interface for entering CIE Lab values

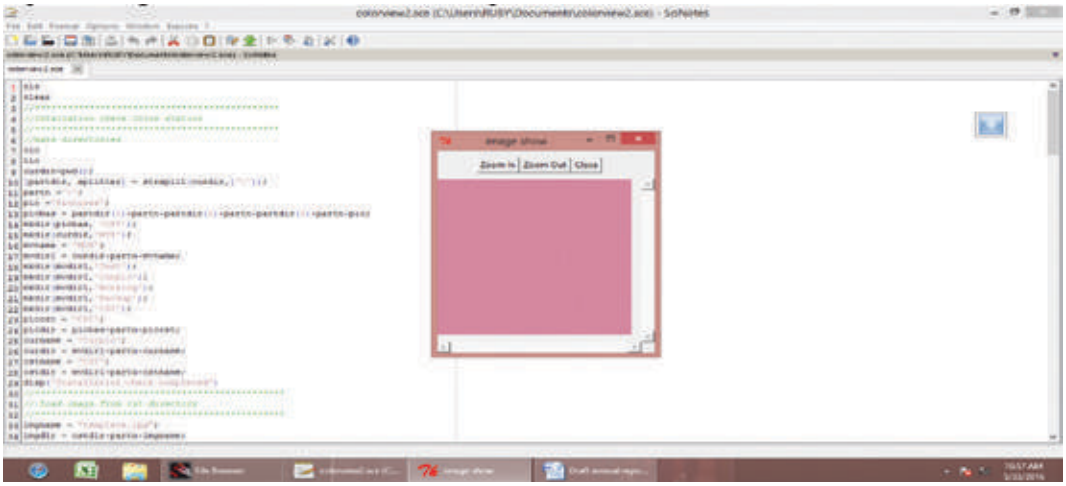


Fig.: Shade patch simulating colour of flavoured milk based on CIE Lab values

BIOTECHNOLOGICAL APPROACHES IN QUALITY ASSURANCE

A Strip Based Test for Detection of Sucrose in Milk

A rapid strip based test for detection of sucrose in milk has been developed. The developed strip test can detect 0.1% sucrose in milk in 5 min.The intensity of developed pink colour in presence of sucrose is proportional to its concentration in milk. In case of pure milk, the strip retains its original white colour. The test is convenient to do and can be easily done at milk collection center as well as at house hold level. The technology of the strip is available from NDRI on commercial basis and for further information, Institute Technology Management Unit (ITMU) may be contacted.

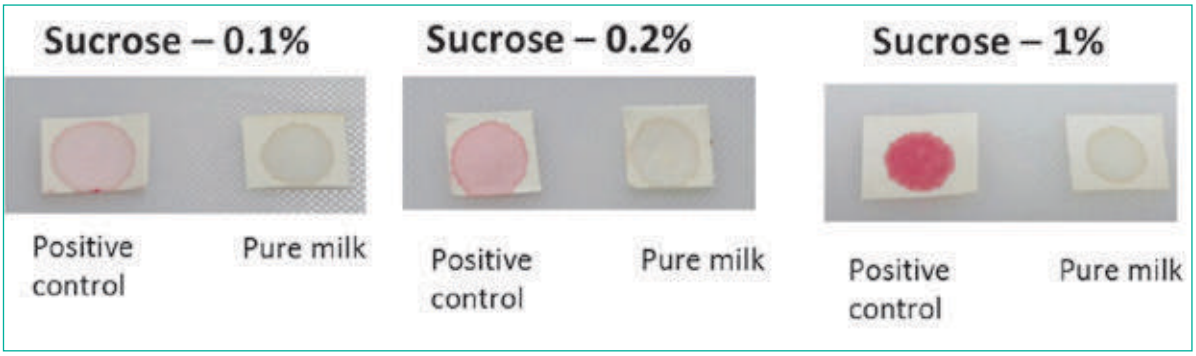


Fig.: Working of the strip based test for detection of sucrose (at various levels) in milk

Development of PCR based Methodology to Detect the Pig Body Fat (Lard) in Ghee

An isolation protocol of DNA from fat samples (Ghee and Clarified Body fats) has been standardized. DNA isolated from body fats and ghee was amplified using species specific primers, wherein it was noticed that pig specific primer amplified the DNA isolated from pig body fat (lard) and goat specific amplified the DNA isolated from goat body fat. Using pig species specific primer targeting mt-cyt gene amplicon size 149 bp, pig body fat could be detected in both cow and buffalo ghee upto 10% level. The method was found to be good and reproducible. Using same protocol, adulteration of ghee samples with commercial lard was also achieved and the level of detection was the same as in case of laboratory prepared lard. Similarly, using goat species specific primer targeting mt-cyt gene amplicon of size 294 Bp , got body fat could be detected in ghee to the tune of 10% .

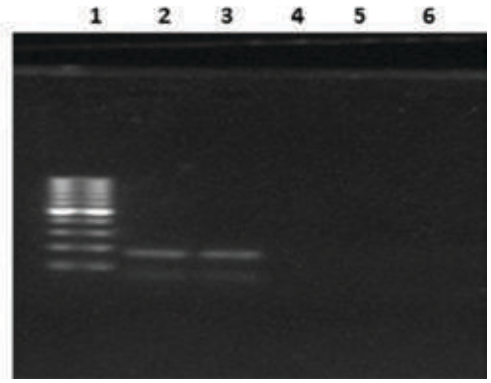


Fig. Lane1: 100 bp DNA ladder, Lane2: Ghee +20% lard, Lane3: Ghee +10% lard, Lane 4: Ghee +05% lard, Lane 5: Ghee, Lane 6: Negative control

Validating Procedures for the Measurement of Heat Resistant Spoilage and Pathogenic Bacteria in Milk to Provide a Scientific and Technical Basis for Future Developments in the Management of Food Safety in South Africa, India and Brazil

Efforts were made to isolate heat resistant aerobic spore forming *Bacillus spp*. particularly *Bacillus sporothermodurans* from formal, informal and processing sector. A total of 32 aerobic spore forming bacteria were isolated from all the sectors. Out of 32 isolates, five viz. *Bacillus spp.* B5, *Bacillus spp.* B6, *Bacillus spp.* B15, *Bacillus spp.* B19 and *Bacillus spp.* B26 were identified as *Bacillus sporothermodurans*.

Microbial Diversity of Bio-Films in Dairy Niche

A total of 87 representative colonies were isolated from 87 biofilm samples of raw milk dump tank, storage tank, chiller, pasteurizer, homogenizer, cream separator, ice cream freezer, powder plant (roller dryer), Dahi and Paneer vats. The biochemical observations of 44 Gram negative rods using API 20E kit revealed that fifteen each belonged to *Pseudomonas* and *Klebsiella*, respectively. Similarly four of the isolates were identified as *Salmonella*, *Enterobacter*, *Citrobacter* and *E. coli* respectively. Out of the five Gram positive cocci, two were identified as *Staphylococcus* and *Enterococcus*. One presumptive colony of Listeria from PALCAM agar was identified as *Listeria* spp. by API LISTERIA Kit. The MIC and MBEC of the target genera (*Bacillus*, *Pseudomonas*, *E. coli,Listeria*, *Salmonella* and *Staphylococcus*) against iodophore was observed to be in the range of 20-70 and 250-550 ppm, respectively. These preliminary observations indicate that biofilms exist in dairy processing lines, which may act as sources of contamination of milk and milk products and thus threat to public health and food safety.

Development and Evaluation of Spore Based Biosensors for Monitoring of Pesticide Residues in Milk (NICHE area of Excellence)

For routine monitoring of pesticides under field application, three stage assay on paper strip has been developed based on "spore germination and enzyme inhibition principle". In case where analyte i.e. pesticide is absent, specific marker enzyme (s) are produced by spores during germination which act specifically on chromogenic substrate resulting in colored end product on paper strip, whereas complete inhibition of marker enzyme takes place when pesticides are present in food sample (Patent Reg. 3819/DEL/2015). Paper strip assay is based on novel approach of exploiting spores as bio-recognition elements with marker enzyme (s) from prokaryotic system which otherwise is acetycholin esterase sourced from eukaryotic system. Spore based approach is unique IP and has been attempted for the first time in India and abroad. Paper strip assay as depicted in the following figure can detect insecticide (OP/OC), herbicide and fungicides at regulatory limits with great degree of repeatability and selectivity.

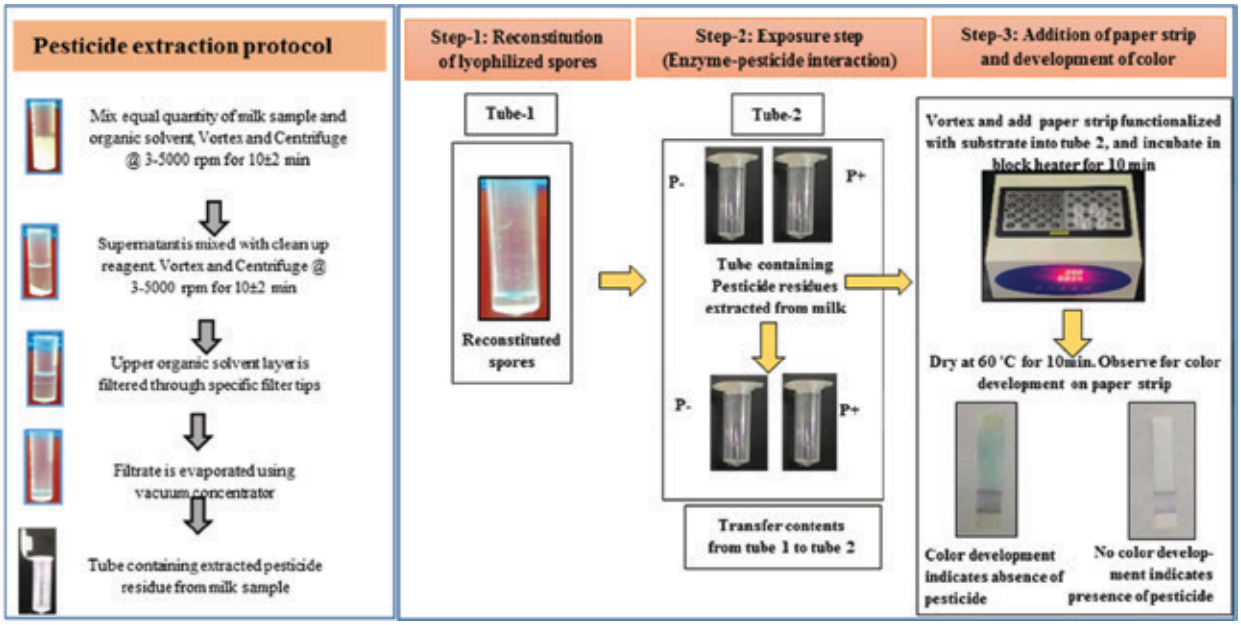


Fig.: Paper Strip Assay for Rapid Detection of Pesticide Residues in milk

Outreach (ICAR funded) Project on Monitoring of Drug Residues and Environmental Pollutants

The paper strip assay was developed for detection of antibiotics in milk. Strips were functionalized with spores/enzyme substrates and nutrient mixture lyophilized in tube was optimized. Novel marker enzymes I & II were found to be significantly released during spore germination and were explored in the development of antibiotic assay. Employing these marker enzymes, different paper with pore size varying from 1-11µm were evaluated. Novel germinants namely sorbose, sorbitol, galactose, lactose, maltose were found effective in triggering germination in *B. stearothermophilus* spores as evident from release of marker enzymes. Spores and marker enzymes substrate(s) were lyophilized on selected paper strip using easy printer and process was optimized. The optimized assay on paper strip was evaluated for LOD against different group of antibiotics spiked in milk. Appearance of purple color indicates absence of antibiotic whereas no color development indicates presence of antibiotics in milk. The intensity of color developed on strip can be correlated with quantity of antibiotics present in milk. The paper strip assay was also evaluated with milk samples procured for survey work.

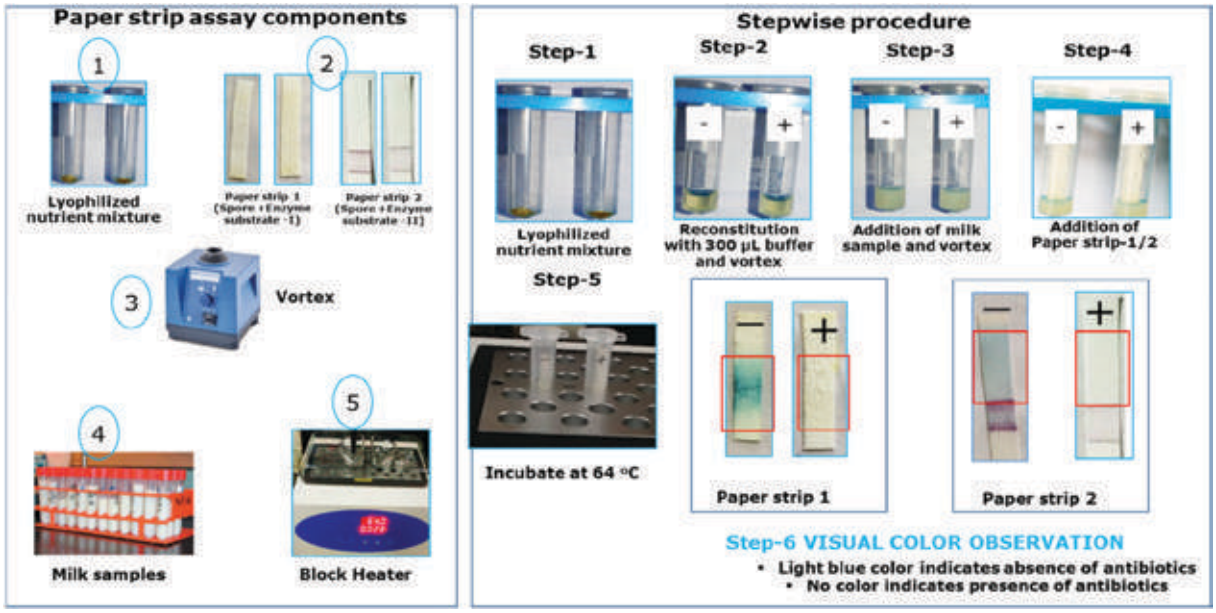


Fig.: Paper Strip Assay for Detection of antibiotic residues in milk

Spore Based Sensor for Pesticide Residues in Milk

Initially, expression of seven enzymes namely, α-D-galactosidase, α-D-glucosidase, α-amylase, aminopeptidase, esterase, β-D-galactosidase and β-D-glucosidase were evaluated in different strains of *Bacillus megaterium* i.e. MTCC 1684, 2412, 2949 and ATCC 9885, 14185. *B. megaterium* MTCC 2949 showed better expression and was evaluated with 16 germinants comprising of 12 sugars and 4 amino acids for their germination potential based on measurement of O.D. and phase contrast microscopic observations. The optimized three step assay protocol was evaluated for sensitivity and specificity. LOD for organophosphorous (OP) and carbamate (CM) pesticides were observed in the range of 10ppb-10 ppm and 1 ppm-10 ppm, whereas on 96 well plate assay, higher sensitivity was observed in their respective range of 0.1 ppb-100 ppb and 100 ppb and the protocol was specific also. Subsequently, a protocol for extraction of pesticides from spiked reconstituted milk samples was optimized for various parameters such as organic solvent, volume of milk and purification of extracted layer. "Three step Spore based assay" as developed in current investigation was found useful for rapid detection (within 2.0-2.5 h), of OP and CM group of pesticides employing spores as bio-recognition molecule as an alternative to acetyl-choline esterase which is present in eukaryotic system.

Paper Strip Based Spore Sensor for Pesticide Residues in Milk

*B. megaterium*2949 and *B. licheniformis*14850 were screened for five marker enzymes and expression of esterase was achieved within 15-30 min using dextrose as germinant and indoxyl acetate as chromogenic substrate with significant colour intensity. *B. megaterium*2949 strain was used as source of enzyme(s) during spore germination for assay development. Whatman filter

paper W602H was selected as it showed optimal colour intensity, distribution and retention. Although, acetone was found inhibitory, acetonitrile showed no inhibition up to 5.0 mL. Further, inhibition was increased to 1.0 ppm in "Three step protocol". Optimal values for the different parameters were set viz. for solvent volume-2.5mL, spores volume-50µL, dextrose volume-30µL, dextrose concentration-30mM, indoxyl acetate volume-10µL, indoxyl acetate concentration-20mM, germination time-20min, exposure time-50min and enzyme substrate reaction time-60min for functional working of assay on paper strip. Paper strip assay showed sensitivity in the range of 10 ppb-1 ppm for organophosphorous (OP), 10 ppm for carbamate and 100 ppm for organochlorine pesticides. Further, attempts were made with unheated spores which showed that paper strip based assay worked within 1h 05 min compared to 2h10min for heated spore with significant advantages in terms of higher colour intensity achieved in enzyme substrate reaction, no requirement for germinant and volume of spore reduced significantly from 50 to 20µL. There was no observed interference/cross reactivity with other inhibitors at, above or below maximum residue level (MRL). The shelf-stability of spores and substrates on paper strip was observed for up to 2-3 months.

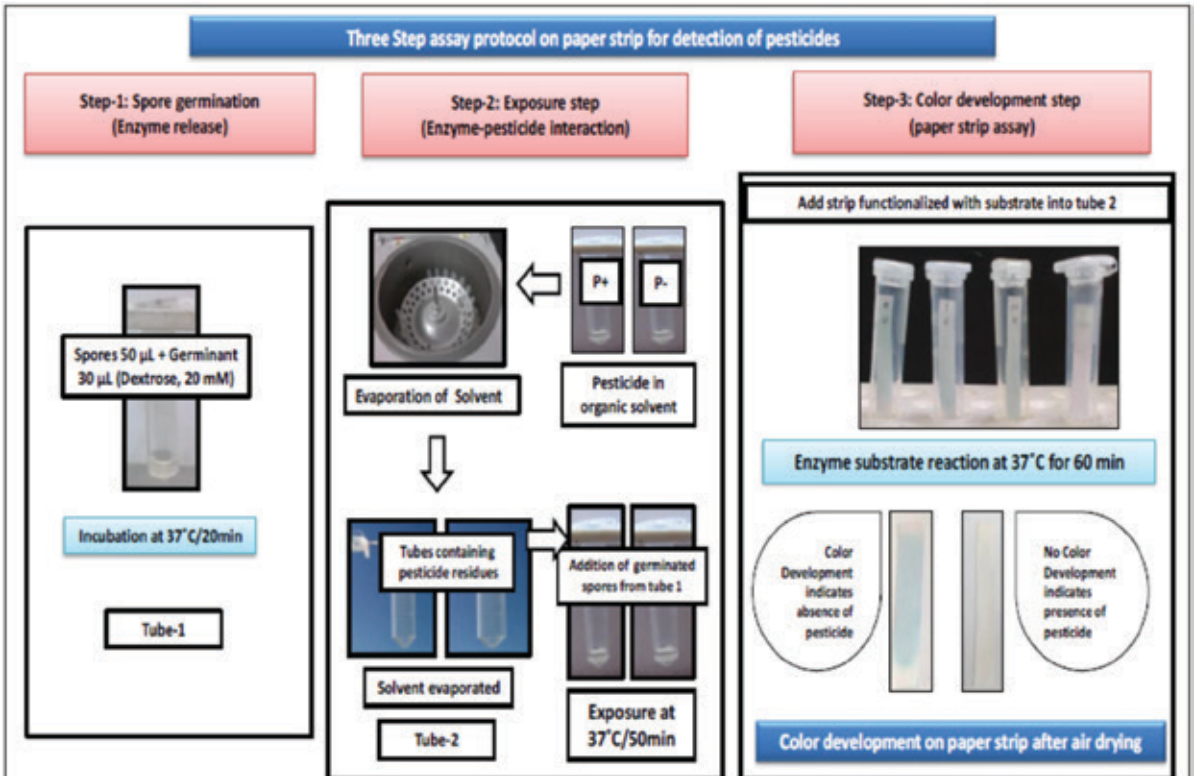


Fig.: Three step assay on paper strip for detection of pesticides

Development of "Three Step – Enzyme Based Kit" for Detection of *E. coli*/ Coliforms in Milk and Milk Products

Initially, target bacteria and other contaminants in Enterobacteriaceae family were screened for different marker enzymes and after selecting the suitable marker enzymes/substrates, the concentrations of selective agents were optimised to achieve inhibition of contaminants like *Salmonella*, *Shigella*, *Yersinia*, *Proteus, Serratia, Citrobacter, Enterobacter* and *Klebsiella* to an extent of 6.71, 6.35, 6.72, 5.39, 4.68, 5.55, 3.69 and 4.47 log cfu/ml, respectively, in ECSM used for *E. coli* detection. Similar optimization was carried out for coliform group in CSM. Further, enzyme based assay was developed for detection of *E.coli*/coliform employing marker enzymes and subsequently efforts were made to identify *E.coli O157:H7* employing marker enzymes/ sugars. Two stage assay developed for *E.coli* employing ECSM as selective medium in lyophilised form could detect 0.35 ± 0.10 log cfu/ml within 14.30 ± 0.45 h of incubation at 37°C. Assay for coliform could detect 0.57 ± 0.15 log cfu/ml within 12.15 ± 0.30 h of incubation employing CSM as selective medium. The developed assays on *E.coli*/coliform were evaluated with 139 milk samples and random tests were carried out with IS-5887 (Part 1): 1976 Part-I, IS-5401 (Part-2): 2002 protocol. Based on the above findings, the developed assay can be used for routine detection of *E.coli*/coliform in milk at various stages of production and processing.

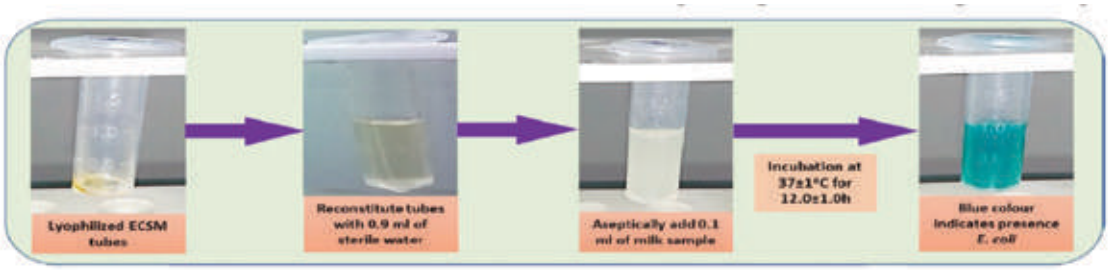


Fig.: Stage-1 Presumptive detection of E.coli in milk sample

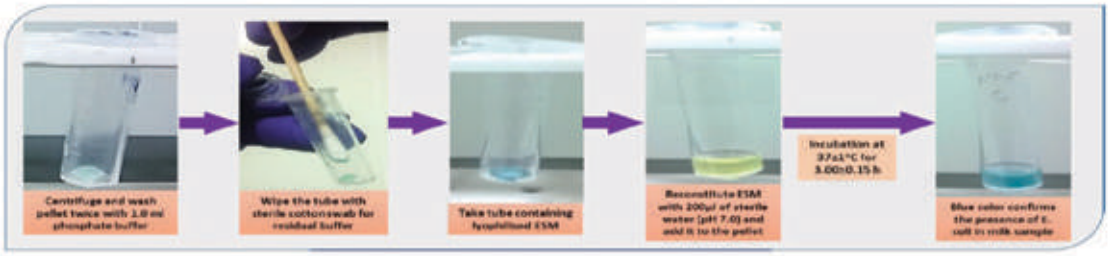


Fig.: Stage-2 Confirmation of E.coli in milk sample

Working Performance of Spore-Enzyme Based Kit for Detection of Antibiotic Residues in Milk and its Validation

B. stearothermophilus 331 was selected and evaluated for MICs using spore based kit. The developed Kit showed sensitivity at or below MRL for antibiotics like Penicillin, Ampicillin, Amoxicillin, Cephazolin, Cephalexin, Doxytetracycline, Oxytetracycline, Tetracycline, Gentamicin, Neomycin, Streptomycin, Kanamycin, Lincomycin and chloramphenicol. The spore based kit was evaluated for interference of inhibitors other than antibiotic residues in milk. Results revealed that pesticides, aflatoxin M1 and heavy metals did not interfere with the assay at recommended level set by codex/ FSSAI. Interference of detergent (Sodium Hypochlorite), sanitizers (Iodophores, QAC) and neutralizers (formalin) were also investigated and their impact was found at very high level which is practically not feasible under field conditions. The results indicate better performance in terms of sensitivity and working time i.e. 2.30 min. The modified spore based kit was evaluated with raw milk (77Nos.) and pasteurized milk (43Nos.) under field condition. Three raw milk samples were found to be antibiotic positive with spore based kit and were contaminated with β-Lactam as revealed by Charm 6602/ Rosa assay. The validation results showed good correlation with AOAC approved system. Shelf life study showed that developed kit has shown stability up to 150 days.

VALUE CHAIN ANALYSIS

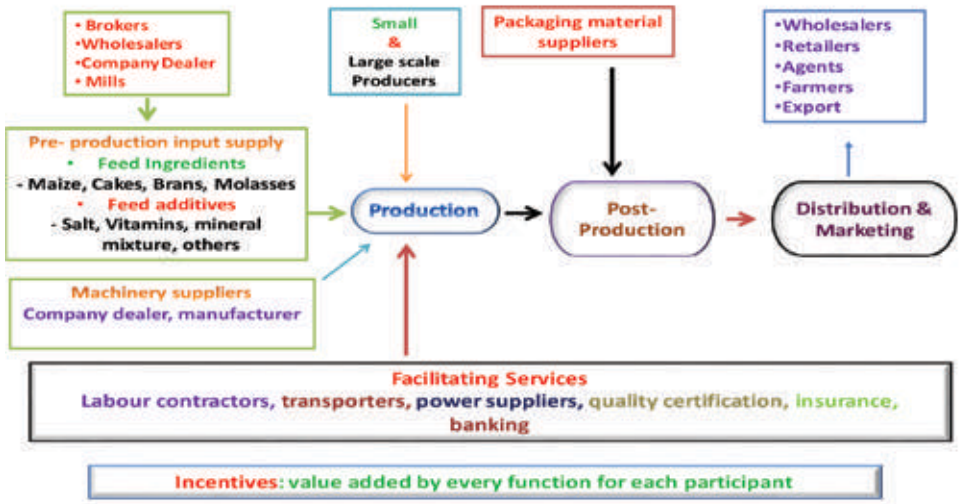
Value chain analysis (VCA) helps to understand the full range of activities that are required to bring a product or service from conception stage to its end use and identify change agents and leverage points for policy and technical interventions.

Value Chain Analysis for Enhancing the Performance of Animal Feed Industries

The studies conducted on the compound animal feed value chain in two different dairy production environments in the country, viz. dynamic (Punjab and Haryana) and transient (W.Bengal and Odisha), indicate that each of the six major stakeholder groups in cattle feed value chain, *viz.*, major feed input suppliers, minor input supplier, feed producers, feed marketers, service providers and dairy farmers, require technical and/or policy support to enhance their economic performance. The value addition ranged from ` 2550-3200/tonne of compound cattle feed in the dynamic region and was higher (` 3950-4650/tonne) in the transient region.

The major weaknesses in the value chain that have to be overcome are, high susceptibility to seasonal price fluctuations, lack of adequate quality control, low responsiveness of milk productivity to feed product under field conditions and inadequate storage facilities. There is lack of capacity to use the financial tools to hedge the price risk arising due to high volatility in prices. The key interventions for upgradation, management and development of the cattle feed value chain in the country have been outlined in four major heads: quality assurance and feed safety, maintaining profitability, capacity and skill development and value chain financing.

General Value Chain Map of Cattle Feed Industry



Value Chain Analysis of Milk & Milk Products

The study on value chain of milk and milk products in milk-shed areas of Ballabhgarh and Sirsa milk plants in Haryana, showed that marketed surplus of milk was 76-79% of production. The cooperative dairy plants were collecting milk from the farmers, at an average procurement cost of about ₹ 1.65/litre and processing them into various value added dairy products. The profit margin was highest in Dahi (>30%) and lowest in paneer (<3%). The milk plants were earning a margin of 9-13% on pasteurized full cream milk (6.1 % Fat and 9.0 % SNF), while the milk producers get a margin of 6-7% on sale of raw milk of same composition, indicating that processing of milk is profitable than the production. The milk producer's under the cooperative structure get more than 70% share in the consumers' rupee, even without adding the additional gains they may get from re-distribution of organizational profits.



Fig.: Share of Dairy Farmer in Consumer's Rupee

Marketing of Livestock and Livestock Products

Marketing of livestock and livestock products is an important aspect of livestock production and management. The analysis of bovine marketing in unorganized sector of Haryana (Rohtak and Karnal districts) indicated that five marketing channels prevail in the state for all three types of milch bovines i.e., indigenous cows, cross-breed cow and buffaloes,: (I) Farmer-Farmer, (II) Farmer-Commission agent-Local Trader, (III) Farmer- Local Trader-Distant Trader, (IV) Farmer-Local Trader-Farmer and (V) Farmer-Broker-Farmer. Transportation costs accounted for major expenditure among different component of costs in marketing of bovine. General appearance, udder attachment, milk yield, order of lactation and breed were significant factors that influences prices of milch cows while in case of milch buffalo, milk yield and order of lactation exert significant impact on the prices of buffaloes. Un-remunerative margin, Price bargaining by the buyers and lack of organized market are the major problem faced by the seller while high transport cost, government formalities to purchase animal and harassment at check points are the major problem faced by the buyer.

In another study on marketing, the focus was on the marketing efficiency of different milk marketing channels operating in the traditional supply chain, in Ranchi district of Jharkhand. The comparison of margins of producers versus milk marketing intermediaries revealed that producer was getting margin ₹ 2.50/litre from buffalo milk, ₹ 2.86/litre from crossbred cow milk, whereas milk market intermediaries made margin of ₹ 2.22 /litre to as high as ₹ 5.79/litre.

An Economic Analysis of Dairy Value Chains in Tamil Nadu

The study was conducted in one cooperative and private dairy for value chain analysis which covered Tiruppur and Coimbatore districts of Tamil Nadu with the objectives, to analyze the production, procurement and processing of milk at different stages of value chain, to evaluate the performance of dairy value chains and to assess the problems faced by stakeholders in dairy value chain. The study found that the cost of per litre of milk production in cooperative milk producers was higher compared to the milk producers of private dairy. Among the constraints in dairy farming, high cost of feeds and fodder was ranked higher by milk producers of cooperative dairy and it was lack of credit availability for milk producers of private dairy. The constraints like frequent power failure, lack of skilled person and poor roads which leads to higher transportation costs were the major problem in case of both organized dairies. The study highlighted that there is a need to strengthen the activities of value chain with a focused approach on milk procurement, processing and marketing of milk products which help to serve consumers effectively and affect efficiency in milk production and processing.

IMPACT AND SUSTAINABILITY ASSESSMENT

Economic Evaluation of Prepared Animal Feed

Impact assessment of agricultural technologies, institutions and policies is vital for improving the capacity to learn from past experience.

A field level study analysing the impact of prepared compound cattle feed (CCF) on productivity and profitability of milk production showed that the adoption of CCF was 50-60% in Haryana and Punjab and 60-80% in W.Bengal and Odisha. In the northern India, the milk yield of crossbred cows fed with CCF was 16.8% higher than those not fed with the same, while the corresponding percentage was 62% in the Eastern India. The adoption of CCF generated an economic surplus of over ₹ 44000 million in Eastern India. Whereas, in Northern India, due to the unfavourable milk-feed ratio, the technology can generate a positive economic surplus only if there is a decline in feed cost by ₹ 3/animal or additional increase in milk yield by 100 gms.

Ex-ante Evaluation of Sexed Semen Technology

An ex-ante evaluation of sexed-semen technology in the Punjab and Haryana brought out that despite around 10 times higher cost of insemination from sexed - semen as compared to the unsexed semen and nearly 10% lower conception rates, the progressive farmers in the region have high willingness to pay for the sexed semen due 40 percent point higher probability of a female calf using the sexed semen.

Impact Assessment of Women Dairy Cooperative Societies

Impact assessment of Women Dairy Co-operative Societies on the income, employment and women empowerment was conducted taking Begudari district (Bihar) as the study area. The average man days of employment in a year for women in cooperative member households (91.65 man days) were more than that of non-member households (81.14 man days), and the monthly net income for member group (₹ 5,470) was found to be more than that of non-member group (₹ 1,744), indicating that membership in co-operatives had a significant positive impact on the income of women dairy farmers. The women's empowerment score was also found higher for member group at 0.66 against 0.53 for non-member group.

A Comparative Study on the Adoption of Good Dairy Farming Practices in the Central Plain and Eastern Plain Zones of Uttar Pradesh

Through, India stands first in milk production, but due to unhygienic and unhealthy milk production practices by majority of the state producers thus, the milk produced is of poor standards. There are very few reports on the adoption of Good Dairy Farming Practices (GDFP) among the farmers. it was found from the study that overall only (12.00%)of the farmers adopted good dairy farming practices. As the overall adoption of good dairy farming practices is low, there is a need to organize awareness programs and trainings to the stakeholders for capacity building and appropriate policy and schemes should be formulated to facilitate adoption of good dairy farming practices.

Performance of Agripreneurs under Agri-Clinics and Agribusiness Centres Scheme in Karnataka- An Exploratory Study

It was found that majority of successful (65.00%) and unsuccessful (70.00%) agripreneurs completed graduation. Education, innovativeness and achievement motivation had significant

and positive correlation with the performance of the agripreneurs at 0.05 level of probability. Majority (61.88%) of the clients had perceived medium level of perception in availing the benefits from the agripreneurs. The main reason behind this finding is the clients might be benefited from the dairy enterprise in terms of steady profitability in their income, better standard of living and adoption of scientific dairy farming practices in their farms. Finance is a most important aspect of any business. The major problems faced by agripreneurs related to finance were, non-cooperation of bank officials.

Effectiveness of Mobile Advisory Services in Dairy Farming

NDRI-MS Portal was developed for advisory services. This software is designed in ASP.Net 4.0 using C# language. Database is designed using SQL Server 2008.NDRI-MSShort Message Service (SMS) portal was used to disseminate for information/advisories to dairy farmers by SMS in local language based on farming practices across six states namely Haryana. Punjab, Gujrat, Uttarakhand, Uttar Pradesh and Rajasthan. In this reporting period 138 messages of dairy farming were delivered to the respondents. In this process1 17200 SMS were delivered. Majority of the respondents (82.75%) reported that mobile advisory services were relevant in dairy farming. The sustainability of mobile use in dairying as perceived by respondents indicated that 57.91% and 27.16% of the dairy farmers were in medium and highly sustainable score categories, respectively, while 14.91% fell under low sustainable score categories.

Sustainability Assessment of Bagepalli Biogas CDM Project in Karnataka

Study revealed that, majority of the biogas users (67.00%) had medium level of perception towards the biogas CDM project. Further the mean value of perception was 3.98 and median value was 4.00, which indicated the high level of perception of biogas users regarding the project. Project increased employment in the study area and the Benefit Cost ratio was very high in this project. This project was highly sustainable (Sustainability Index value of 0.80) in its entire major dimensions like social, technical, economic and environmental sustainability. Biogas users saved fuel wood of 5.55 kg/household/day, kerosene saved was 3.10 litres/ household/month and there was a saving of time of 1hour 50 minutes. As perception & experience of the rural biogas users in the study area was very positive towards CDM biogas project and project is sustainable Government of India and NGO's working at grass root level should involve actively to replicate such models across the rural India with similar conditions.

Impact of Doodh Ganga Yojna on Dairy Farming in Kangra district of Himachal Pradesh

Average milk yield of beneficiary's animals was 7.48 ± 1.3, 5.09 ± 0.76 and 5.44 ± 0.60 and non-beneficiary's animals was 6.69 ± 1.5 4.39 ± 0.87 and 4.83 ± 1.00 litre/day/animals, lactation length of beneficiary's animal was 276.02 ± 5.44, 251.43 ± 9.12 and 265.25 ± 7.20 while non-beneficiary's animals was 266.51 ± 6.2, 239.68 ±7 .81 and 256.42 ± 5.71 days/animals. The value of overall livelihood security of the beneficiaries was 47.67% and 43.11 of the non-beneficiaries. Most serious constraint as perceived by the beneficiary dairy farmers and delay in loan sanctioning was second important constraint. Lack of awareness about the scheme among the farmers was perceived as most serious constraint perceived by the officials.

Effect of Urbanization on Livelihood of Farmers in Dairy and Crop Production System in the Peri-urban area of Bengaluru

Decrease in herd size shows that the relative probability of a respondent to get engaged in a non-agricultural activity is more than the agriculture and allied activities in comparison to the crop+dairy activities. Additional source of income from peri-urban dairy and high demand and price for milk in peri urban areas were reported as most advantageous by the farmers. More disease incidence reported as serious constraint. Better accesses to the educational institutes, diversification in livelihood pattern were positive effect of urbanisation. Negative effects like land loss, unethical land purchases and land transactions were noticed.

Assessment of Dairy Cattle Housing and Production System in Peri-Urban Villages in Nadia District of West Bengal

Dairy animals housing can influence production, reproduction, growth, health and expression of normal domesticated behavior of dairy animals. Study was conducted on institute adopted villages near Kalyani, Nadia, West Bengal to assess prevailing housing amenities for dairy cattle and review the dairy production system. Study revealed that peri-urban village dairy farmers were mostly following intensive dairy production system (93.33%) and very few were following semi-intensive (6.67%) dairy production using supportive grazing through lands on road sides and places of others properties. The study found that in peri-urban villages' dairying was a subsidiary occupation; production system was intensive in characteristics, but managed with very poor and negligible animal housing amenities that needed further improvement for optimum milk production.

Sustainability of Dairy-based Livelihood in the Districts of West Bengal: A Macro Level Analysis

The concept of sustainable livelihood security has wider generic meaning pertaining to sustainable development to ensure ecologically secure, economically efficient, socially equitable and sufficiency in infrastructure in the society. Dairying provides sufficient income to the farming community of West Bengal. Therefore, sustainability of dairy-based livelihood in the districts of West Bengal was assessed to find out necessary interventions to be required to ensure sustainable livelihood security of dairy farmers. An exclusively district level Sustainable Livelihood Security Index was developed underline the principle of Human Development Index of UNDP by using 17 indicators divided into four sub-indices i.e. Ecologically Security index, Economic Efficiency Index, Infrastructure Sufficiency Index and Socially Equity Index. The overall mean value of Sustainable Livelihood Security Index was found to be 0.38 with a range from 0.12 (Purulia district) to 0.59 (Darjeeling district), indicated the sustainability status was low. In case of sub indices, Infrastructure Sufficiency Index (0.49) and Ecologically Security Index (0.45) were stronger indices than other two indices, Economic Efficiency Index (0.32) and Socially Equity Index (0.29) which signified the very lower level sustainability. Thus, dairy-based Sustainable Livelihood Security Index (SLSI) not only highlights the state of sustainability of dairy-livelihood but also emphasizes the area where necessary policy matter needs to be intervened for improvement of livelihood of dairy farmers.

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MANAGING RISK AND VULNERABILITY

Livestock Insurance for Risk Reduction

A major part of regular income of small and marginal farmers is generated through the sale of milk and milk products. The farmer faces livelihood risk in the event of death of his milch animal. To cover the risk, Government of India introduced the Livestock Insurance Scheme on a pilot basis during the years 2005-06 providing subsidy to the extent of 75% on premium. The basic risk covered under this is death of the milch animal under any unforeseen circumstances.

A study was conducted to examine the performance of the aforementioned insurance scheme and factors determining the adoption of livestock insurance by the dairy farmers in the state of Haryana – a leading milk producing state. The claim amount to premium ratio was estimated to be 0.48 showing financial viability of the scheme in the short- and long-run. The number of claims lodged were 1.6% of the number of animals insured and of this around 87% of claims were settled. The herd size and percentage of crossbred animals in the herd had positive effect on the adoption of insurance. There was 21% increase in odds ratio with one unit increase in herd size elucidating increase in livestock insurance with commercialisation. The undervaluation of animals, complex procedures and lack of information were stated to be major reasons for lower adoption.

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

The major psychological impact of disaster observed by the respondents were changes in thinking (81.68%) followed by feeling (60.67) and behaviour (59.91%). Overall 67.42 percent respondents have the psychological impact of disaster in the study area. It is indicated that after the flood disaster, farmers change their thinking, feeling and behaviour about the intensity and damaged due to disaster. The kind of disasters in last five years perceived by the farmers in the area indicated that 8 types of natural disaster were perceived by the respondents and draught (79.82%) followed by landslide 67.11% were the most frequent disaster. Other disaster such as floods (64.91%), soil erosion (64.47%), wildlife (61.84%), earthquakes (26.75), thunderstorms (24.12), and forest fire (21.49%). The respondents were reported that landslides (66.23%) followed by wildlife were the major cause of economic losses in all reported natural disasters.



EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING

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

Most of the farmers (59.16%) suggested that, Sudha dairy was the main promoting agency for collection centre. From the study, it emerged out that 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 factors. 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.

Empowerment of Tribal Farmers for Good Dairy Farming Practices through Multimedia Approach

Educational Multimedia Module (IEMM) on Good Dairy Farming Practices (GDFPs) module was developed with 25 video documentaries about GDFPs which include breeding, feeding, healthcare, management and advances in dairy farming to explore the effectiveness of the IEMM on Good Dairy Farming Practices (GDFPs) towards knowledge gain and symbolic adoption of tribal farmers in Chhattisgarh state. Thus, IEMM has been developed for 2.7 hours with High Definition (HD) video format in two languages viz., English, Hindi which is user-friendly and interactive in nature. Effectiveness of the IEMM analysis observed that developed IEMM found highly effective in terms of knowledge gain. With respect to symbolic adoption, the study found the significant increase in the adoption behaviour symbolically due to the exposure of IEMM intervention. It may be concluded that the developed IEMM module was highly influenced the respondents in their knowledge gain and symbolic adoption for GDFPs. Hence, effort has to be taken by different stakeholders to promote IEMM among dairy farmers to increase the production in dairy sector.

Development and Validation of Bilingual Information Module on Transition Period of Dairy Animals

Milk production of dairy animals is mostly effected by productive and reproductive traits of dairy animals. Dairy animals often fail to adapt to the metabolic and management changes, resulting in 75.00 percent of dairy animal disease incidence during the first month after calving. The study revealed that feeding of mineral mixture and calcium supplementation was not a regular habit. The pregnant animal during the dry period were not fed any extra concentrate (63.75%) by the farmers. It was seen that the economic loss due to decreased reproductive efficiency (87.25%) and delay in appropriate treatment (86.25%) were the important problem faced by the respondents. The result indicates that majority of the dairy farmers and field officers were satisfied with information module. The study concluded that the variables such as farmer's education, annual income and ICT utilization are found to be important variables influencing the implementation of ICT based services.

Exploring the Potential Use of Social Media in Communicating Agricultural Information in Haryana

It was observed that majority (80.00%) of the farmers were young having minimum of matriculate level of education, attended computer trainings (35.00%), and seeking information from family members and fellow farmers. Farmers (77.50), extension personnel (57.50%) and researchers (52.50%) were having smart phones, with personal accounts in Facebook (90.00, 90.00 and 77.50% resp.) and Whatsapp (7.50, 60.00 and 55.00% resp.) were looking for agricultural information to the extent of (60.00, 85.00 and 85.00% resp.). But they preferred social media for entertainment up to the extent of 83.75, 67.50 and 66.25%, respectively. Rather than agricultural information, they use social media for getting/ sharing information on practices of agriculture, subject matter information and new practices/ updates up to the extent of 52.32, 62.50, and 60.93%, respectively. High cost of the data service, unsuitable & incomprehensible information and weak research extension linkages respectively were the main constraints faced by them. The study exposed the ground reality of use of social media which could help the extension personnel to develop the models which can make social media user friendly in communicating agricultural information.

Dairy Entrepreneurship Development of Rural Women: An Action Research

Two women based SHG exclusively on dairying was formed and promoted successfully demonstrated that dairying as an income generating activity & could be taken up by the rural women through SHG platform for sustaining their livelihood. The institute's interventions in terms of both dairy production as well as processing related technologies were transferred to the SHG members through on-campus and off-campus training, demonstrations, visits etc. The results of the study indicated that, dairying as whole had a very positive impact on their livelihood and their overall empowerment in terms of increased knowledge level, better adoption of technologies and improved entrepreneurial behavior of SHG members. The present project has successfully demonstrated that dairying as an income generating activity has improved overall socio-economic standard by securing a monthly income of ₹ 6000-7000 from dairying activity alone. SHG is a movement for women empowerment; dairying through SHG movement plays a major role in sustaining the livelihood of members.

Upliftment of Socio-Economic Condition of Tribal People through Integrated Livestock Farming in North Eastern Hill Region/Eastern Part of India



The works under TSP were focused to treat the animals from different diseases, immunization against different diseases in cattle, goat, poultry, deworming against different enteric parasites of the animals in the tribal dominated areas of Sundarbans, South 24 Paraganas, Ayodhya hill areas of Purulia, Duars region of Jalpaiguri. Feed resource development was also focused in these areas to increase the production potential of the animals. This has developed favourable attitude of the tribal dairy farmers towards the 'Scientific Dairy farming Practices'.

Improving the Livelihood through Dairy Farming in North Eastern Region of India

One training programme was organized during 2nd March, 2016 to 5th March, 2016. Thirteen farmers from Umlyngka Milk Producers' Cooperative society, East Khasi Hills, Meghalaya got training in the aforementioned training programme. Four veterinary health-cum-vaccination camps were organized in Smit Village and Umlyngka village of Meghalaya; and Bagma and Bamulia village of Tripura state of India. Apart from that, four 'Scientist- Farmers interaction session' was also organized in which 242 famers have been benefitted. In the camps fodder seeds and rooted slips, veterinary medicines, mineral mixture etc. were distributed among the dairy farmers. These initiatives under the project inspired the farmers to take the dairy farming as a major source of livelihood.

REGIONAL PRIORITIES FOR DAIRY DEVELOPMENT: POLICY ANALYSIS & STRENGTHENING DATABASE

Economics of Dairy Production and Processing

Studies are regularly undertaken in various parts of the country to work out the economics of milk production and processing.

In Begusarai district of Bihar, the average daily maintenance cost of crossbred cow was about ₹ 225 and that of buffaloes little lower at ₹ 209/day. The cost of cow milk production worked out to be ₹ 21.00-24.50, and dairy farmers earned net returns ranging from ₹ 2 to 5/litre, depending upon the agency of milk sale. The returns were lower in case of sale to the unorganized milk marketing channels such as vendors and higher for sale to dairy cooperatives. The cost of production of buffalo milk was ₹ 34-37/litre and net returns were very low, less than ₹ 1/lit. Whereas, the maintenance cost of crossbred cows and buffaloes was ₹ 162 and ₹ 172/day, respectively in Ranchi district of Jharkhand. The cost of milk production was ₹ 23/lit. for cow milk and Rs.30/ lit. for buffalo milk. The pricing of milk was such in the area that dairy farmers could earn a net return of ₹ 2-3/lit. of milk production in case of both, cows and buffaloes.

The milk processing in co-operative dairy plant of capacity 50,000 litres per day located in coastal Odisha, generated a total revenue of ₹ 6827.40 lakhs in 2013-14, of which the contribution of toned milk (88.89%) was maximum, followed by whole milk curd (4.89%), paneer (2.69%) and sweet dahi (1.73%). Among different products manufactured, Paneer manufacturing turned out to be the lowest profitable proposition earning only 5% profit over manufacturing cost. It was observed that actual production of all the products in a year was higher than the calculated break-even quantity.

Demand and Supply of Milk and Milk Products

The macro study at national and sub-national level on the pattern and trends in consumption expenditure pattern of milk and milk products showed that the diet pattern of higher income groups is in consonance with the global trends, that is a shift away from fat based dairy products. Income induced diversification towards products like curd, ice-cream are also emerging for other income groups. There is non-linearity in monthly per-capita consumption expenditure of food and milk and milk products, indicating that after a threshold income, no amount of increased income can induce the consumer to purchase more food/MMP. Urbanization and education promotes diversification towards value-added milk products. Households with higher proportion of children prefer liquid milk than other milk products. Liquid milk was found to have own-price inelasticity whereas most of the other milk products are own-price elastic.

Regional Priorities for Dairy Development

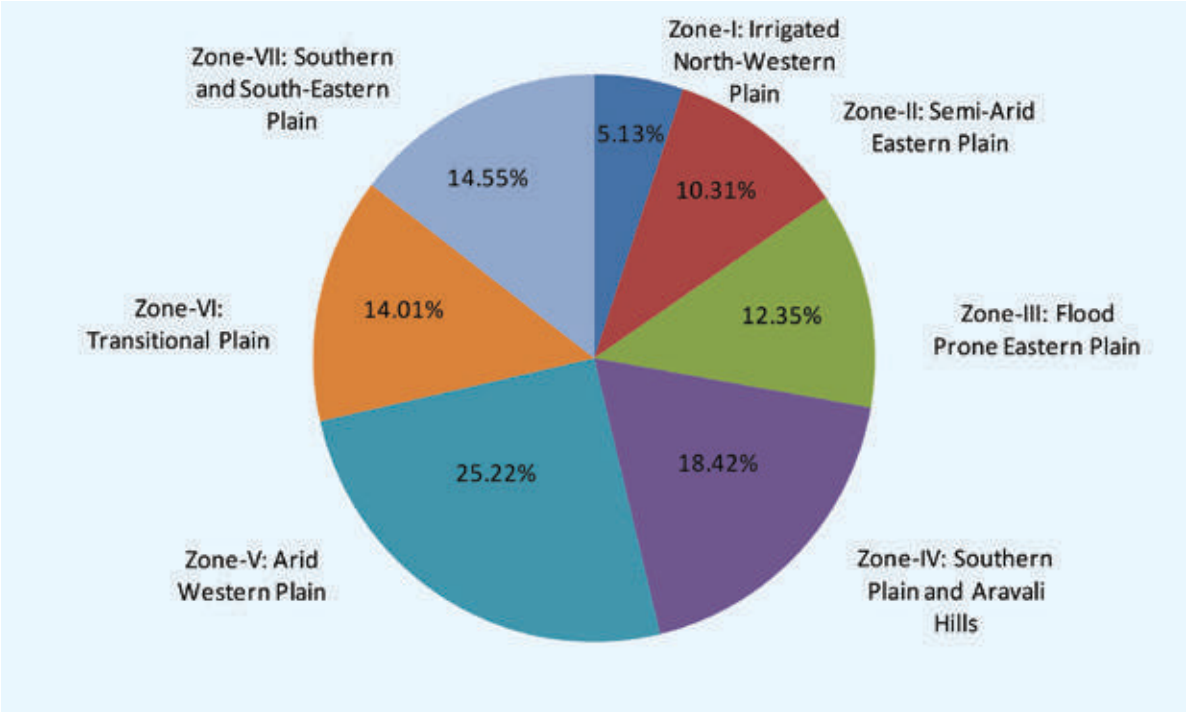
Given the diversity in resource endowments and socio-economic conditions in vast country like India, regional priority setting is an important area of policy research.

a) **Maharashtra:** In the state of Maharashtra, Principal Component Analysis (PCA) was carried out to construct a district level dairy development index using 15 indicators at 5 points of time. Western Maharashtra is the most developed region with the highest index value and Vidarbha is the least developed region with the lowest index value over the years. The key

regional priorities for balanced development were identified as: i) Focus on increasing milk production by improving livestock support services in Konkan region, ii) Non conventional feed, balanced ration and development of new compound cattle feed industry in Western Maharashtra, iii) Milk marketing is major concern for Khandesh and Marathwada region, iv) Except grazing area all other indicators are weak in Vidarbha region which shows the failure of government schemes, so there is need to have public private partnership in this region to increase the efficiency of livestock support services which ultimately develop dairy sector and reduce disparity in dairy development.

b) **Rajasthan:** In the state of Rajasthan, the issue of balanced regional development was addressed using multi-criterion scoring method (congruence method) for normative allocation of the investment resources across agro-climatic zones in Rajasthan. For balancing the efficiency, equity and sustainability criterion for livestock development in the state, the top two zones that require ardent policy attention are, Arid Western Plains and Southern Plain and Aravali Hills, where nearly 43% of the resources for livestock development should be invested. The topography of the arid western plain that covers the Thar desert also necessitates establishing mobile veterinary and health care facilities to cover the vast stretch of area. The Southern Plain and Aravali Hill region has 44% deficit of feed and fodder resources, which is also reflected in the high yield gap in milk and wool production. The next zone in terms of investment priority, is also from southern part of the state. This zone has large concentration of tribal population. The region requires instantaneous policy attention to improve livestock productivity through technological advancement, labour productivity by training them in scientific livestock farming practices, and introduction of value-added products for enhancing calorie intake.

Indices of Investment Priorities in Livestock Sector across Agro-climatic Zones in Rajasthan



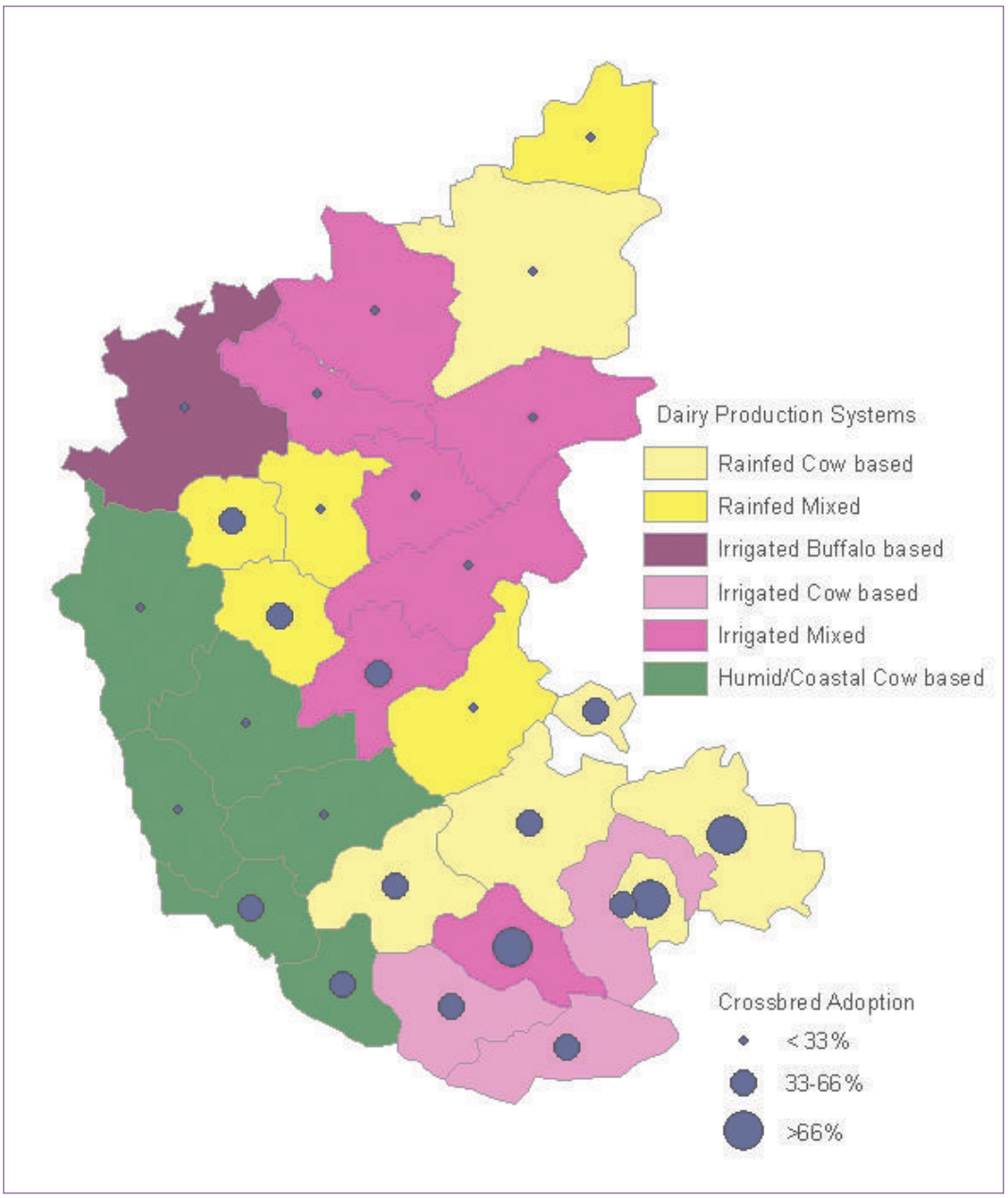
Empowerment and Group Cohesiveness among Members of Women Dairy Cooperatives in Karnataka

From the study it was revealed that overall empowerment of women Karnataka is 43.33%. Most of the women were having medium level empowerment followed by 36.25 in low category and less than one-fourth (20.42 %) of them in high category. Strongest component has been found to be the psychological empowerment as far as empowerment was concerned and the weakest dimension was found to be the political empowerment. Majority (55.83%) of the members had medium level of group cohesiveness. The major constraints of the respondents with respect to

women dairy cooperatives under different categories were family member do not render help in house hold work ranked first followed by illiteracy, lack of support from family to participate in cultural and community activities. It is suggested that WDCs should encourage women to take part in political activities also.

Geo-spatial Databank and Data Mining for Strategic Planning and Development of Dairying in Karnataka State

Trends in cattle and buffalo population and milk production were analysed for the State of Karnataka. The compound growth rate of milk production for the last 13 years is about 4%. The maximum growth of productive dairy animal population, average milk yield and milk production was in 1990's. Of late productive animal population and average milk yield is improving after a negative growth rate in the case of indigenous cattle and buffalo.Twenty geospatial maps related to milk production and factors affecting it have been prepared for geo-spatial modelling. A hedonic price model of ghee was developed to estimate the implicit economic values of attributes of ghee including brand name and packaging quality. Analysis revealed that there is a significant economic incentive for the producers for building up the brand name and improvement in packaging quality.



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 or 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 15th July, 2015 under the chairmanship of Dr. B. N. Mathur, Former Director, NDRI, Karnal.

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 21st to 23rd & 25th April, 2015 at NDRI, Karnal; 29th April,2015 at ERS, Kalyani and 9th June, 2015 at SRS, Bangalore. 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 12th to 15th October, 2015 at NDRI, Karnal, 20th October, 2015 at SRS, Bangalore and 16th November, 2015 at ERS, Kalyani, respectively. IRC meetings were chaired by Dr. A. K. Srivastava, Director and convened by Dr. R. K. Malik, 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.

Vision 2050

PME Unit coordinated the preparation and documentation of Vision 2050 of NDRI. NDRI Vision 2050 was suitably revised in light of the deliberations held at the Council under the Chairmanship of Secretary DARE & Director General, ICAR. The Vision document of NDRI was prepared as per the directives from the Council and released at the ICAR Foundation Day organized on 25th July, 2015 at Patna.

Evaluation of Contract/Consultancy Projects

PME Cell also screened and evaluated contract/consultancy research proposals received from time to time. PME cell meetings to consider the following contract /consultancy projects were held on 6th April, 2015, 1st July, 2015 and 21st February, 2015:

» Consultancy research project proposal entitled "Impact Assessment and Evaluation of Ration Balancing Program in Northern and Western Region".

» Contract research project proposal entitled "Assessment of Sugar graze Crop Silage in term of Quality and Nutritive Value".

» Contract research project proposal entitled "Effects of Calcium Propionate, Mycotoxin Binder and CLA on Milk Yield, its Composition and Nutrient Digestibility in Murrah Buffalo".

» Preparation of probiotic (Lbs 1 and Lbs 2) concentrates in an optimized whey based medium.

Research Projects Database Management

A database through PIMS package of research projects was updated for all the projects in operation during the year 2015. 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, five meetings of Technical Screening Committee were held on 7th April, 2015, 17th June, 2015, 14th August, 2015, 18th November, 2015 and 20th January, 2016. Sixteen manuscripts were scrutinized and got reviewed. The following 16 no. manuscripts of the Books/ Technical Bulletins were screened:

» Beneficial Effect of Supplementation of Fermented Yeast Culture to Anestrous and Endometritic Cross bred KF Cows .

» Navjaat Ewam Chhote Bachhdo Ki Dekhbhaal Ewam Prabandhan.

» Dhoodaroo Pashu Prabadhan.

» Gender Sensitization for Development

» Pashuo Mein Transition Kaal Ewam Prabandhan.

» Veterinary Pharmacovigilance: Basics and its Global Status.

» Applied Animal Nutrition Research Techniques.

» Handbook on Milk Analysis.

» Go Pashuo Mein Prajnan Prabhandhan ke Mool Sidhant.

» Thanella Rog: Ilaz Se Behtar Hai Bachav.

» Scientific Dairy Farming Practices (under Farmers Farm School).

- Gayon Va Bainso Mein Prajnan Prabhandhan.
- Transition Period Management of Dairy Animals.
- Unnat Dairy Adhik Utpadan.
- Chaara Sarankshan Evam Protsahan.
- Implications of Supplementation of Fermented Yeast Culture to Low Body Weight. Murrah Female Calves in Augmenting Growth Rate and Puberty.

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 2014-2015.
- Four issues of "NDRI News Letter" - a quarterly newsletter in English.
- NDRI publication entitled "A Rendezvous with NDRI".
- NDRI publication entitled "Indian Dairy Sector: Challenges and Opportunities".
- Self Study Report for Accreditation.
- NDRI Publication-Vision-2050.
- 14th Convocation Director's Report.
- Research Projects list of the Institute (2015).
- Two IRC Proceedings under the research programmmes identified by Research Advisory Committee for NDRI, Karnal.
- Prepared information on research achievements of NDRI for inclusion in ICAR/DARE Annual Report 2015-2016 and ARIS Newsletter.
- Information on NDRI for inclusion in ICAR/IAUA/VCI Newsletters.





Research Information Management

This Unit also prepared 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 15th July, 2015 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 15th July, 2015.
- Additional information with respect to NDRI, Karnal for inclusion in the ICAR/DARE Annual Report (2016-2017).
- Information related to on-going research projects wise achievements alongwith allocated budget and time frame.
- Consolidation of information pertaining to collaborations with developing countries- progress.
- Consolidation of information on assessment of training needs for scientific, administrative and supporting staff.

- Consolidation of information on organic animal production.
- Consolidation of information on consultancy assistance from bilateral partners and multilateral organizations.
- Information on major highlights/activities of last six months of the Institute for inclusion in the publication of the ICAR Bulletin on achievements of last six months for onward submission to the Animal Science Division of ICAR, New Delhi.
- 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 2014-2015.
- Information regarding significant events for the period April to June, 2015.
- Information with respect to the Institute in a questionnaire for publishing in Dairy special issue of Agriculture Today Magazine-Livestock and Dairy for the month of June, 2015.
- Information sought by the Council with respect to minimizing post harvest crops losses, impact of chemical fertilizers and pesticides on agriculture and allied sector in the country, comprehensive agriculture research based on geographical conditions and impact of climate changes to ensure food security in the country.
- Information on skill development trainings imparted to rural youth and farmers during 1st April to 31st December, 2015.
- Information sought on genuine contribution, very focused study and output, elevation of livelihood among citizens, farmers, unemployed youth pertaining to BIDAR Parliamentary Constituency, Karnataka through intervention of ICAR.
- 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.
- Success Stories of progressive farmers based on the extension activities of the Institute.
- 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 and changed the relevant sectors and institutional endeavors to enhance efficiencies of the Institute.
- 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, manpower, budget (plan & non plan) XI Plan and XII Plan, 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) Region schemes being carried out at Eastern Regional Station, Kalyani for onward submission to the 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.

Action Taken Reports

- Information in terms of counter comments of the Institute on the action point No. 10 i.e. use of best agricultural equipments and works for the development of dairying.
- Action Taken Report against recommendation emerged with respect to NDRI in the 10th Report of Committee on Agriculture on Demands for Grants (2015-16) of the Ministry of Agriculture (DARE).
- Action Taken Report against recommendation emerged with respect to NDRI in the XXII Mid Term Review Meeting of ICAR Regional Committee held on 27-28th June, 2014 at CIFRI, Barrackpore.
- Action Taken Report against recommendation emerged with respect to NDRI in the 23rd meeting of ICAR-Regional Committee No. VII held on 17-18 October,2014 at Raipur.
- Action Taken Report on digitization of research projects: Minutes of the action points of the meeting with MoS (A) with ICAR officials.
- Action Taken Report on recommendations emerged during Annual Conference of Directors of ICAR Institutes held on 15-16 May, 2015 at NAS Complex, Pusa, New Delhi.
- Action Taken Report (ATR) on the points related to NDRI on proceedings of Annual Conference of Directors of ICAR Institutes held on 15th -16th May, 2015 at NASC Complex, New Delhi.

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 DDG (AS), ICAR on 22nd January, 2016 at NASC Complex, New Delhi.
- 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 on 21st December, 2015 at ICAR.

Collation

- Research projects undertaken/undergoing at NDRI in the areas of animal sciences/Post harvest technologies, packaging, new products development, supply chain or allied fields.
- Information on the issues of post harvest losses for inclusion in the agenda items discussed during the meeting taken by the Hon'ble Prime Minister of India to review the Departments/ Ministries i.e. Department of Agriculture and co-operation and Department of Agriculture Research & Education.
- Information on training programmes organized/collaborative programmes under taken/ students for SAARC countries.
- Information on collaboration with developing counties/write-up on major highlights, activities of last six months for inclusion in the ICAR publication.
- Information on major technologies developed/transferred/commercialized by NDRI through Technology Management Unit.

» Information on organic animal production and semen sexing in cattle.

» Audit (external) queries from time to time and co-ordination with other Organizations/Institutes by sending the desired information through several questionnaires.

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, 14 numbers of abstracts of papers were also processed for presentation at various Seminars/Symposia/Workshops/Conferences etc.

Parliament Questions

A total number of 26 parliament questions (Lok Sabha & Rajya Sabha) were attended. In addition, this unit also prepared the counter comments of the Institute with respect to recommendations made by the Parliamentary Standing Committee on Agriculture.

Promotion of National and International Linkages

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

PME Activities at a Glance

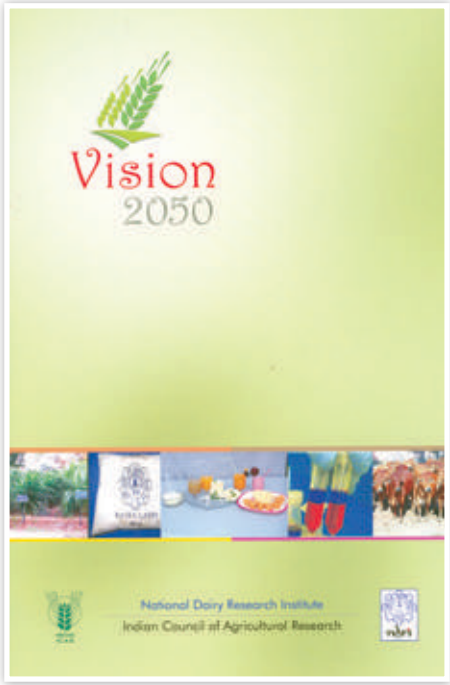
In –House Research Projects	:	72
Completed Research Projects	:	50
New Research Projects	:	22
Externally Funded Projects (National)	:	72
Externally Funded Projects (International)	:	05
Contract/ Consultancy Projects Screened Proposals evaluated	:	04
IRC Meetings Convened and Co-ordinated	:	02
RAC Meeting Convened and Co-ordinated	:	01
Technical Screening Committee Meetings	:	05
Manuscripts of Technical Bulletins/Books Scrutinized/ Evaluated	:	16
NDRI- Annual Report (2014-2015)	:	01
Quarterly NDRI News Letter (4 Issues)	:	04
NDRI Publication- A Rendezvous with NDRI	:	01
NDRI Publication -Indian Dairy Sector: Challengers and Opportunities	:	01
NDRI Publication-Vision-2050	:	01
Self Study Report for Accreditation	:	01
Research Project Document (2015)	:	01
Proceedings of IRC	:	02
14th Convocation Director's Report	:	01
Abstracts Forwarded	:	14
Various Write-ups on NDRI	:	33
Action Taken Reports/Status Reports	:	17
Six Monthly Reports	:	02
Parliament Questions Attended	:	26
Information Under RTI Act-2005	:	10
Monthly Reports	:	12
Write-ups on XII Plan	:	06
Monitoring of TSP Scheme - Quarterly Reports	:	07
Six Monthly Reports/Annual Progress Reports	:	02
Retention Cases of Scientists Handled	:	05
Assessment Cases of Scientists Handled	:	19
Visits Co-ordinated	:	20

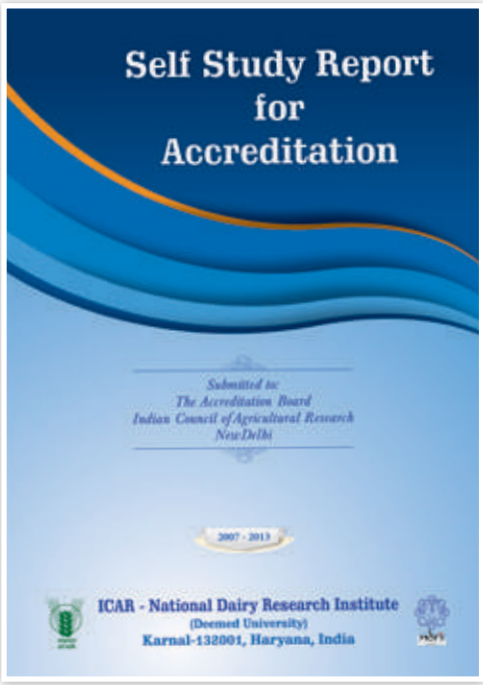
Research Projects-2015-16 (In-House)

SL. No.	Project Title	PI
1.	Multiplication and dissemination of Tharparkar germplasm (Lead Division: Dairy Cattle Breeding)	A. K. Gupta
2.	Multi-trait evaluation of Karan Fries cattle for higher productivity and fertility (Lead Division: Dairy Cattle Breeding)	Avtar Singh
3.	Identification of stage-specific small, non coding RNAs in buffalo oocytes and pre-implantation embryos (Lead Division: Animal Biotechnology Centre)	Rakesh Kumar
4.	Production of buffalo recombinant interferon-tau and evaluation of its biological activity (Lead Division: Animal Biotechnology Centre)	D. Malakar
5.	Generation of induced pluripotent stem (iPS)-like cells from buffalo fibroblasts (Lead Division: Animal Biotechnology Centre)	M. K. Singh
6.	Diagnostic potential of salivary fern patterns, steroids and miRNA for buffalo estrus detection (Lead Division: Animal Biochemistry)	Suneel Kumar Onteru
7.	Cryopreservation of cattle oocytes and their post thawing embryo development through *in vitro* techniques (Lead Station: ERS-Kalyani)	S. K. Das
8.	Development of genetic model for improving the selection efficiency of crossbred cattle at ERS NDRI, Kalyani (Lead Station: ERS-Kalyani)	A. Mandal
9.	Development of suitable protocol for semen preservation and artificial insemination of Bengal goat (Lead Station: ERS-Kalyani)	M. Karunakaran
10.	Application of kisspeptin, a noble GnRH secretagogue for augmentation of reproduction in crossbred cows (Lead Station: ERS-Kalyani)	M. Mondal
11.	Evaluation of single nucleotide polymorphism in candidate genes associated with semen quality in Murrah buffaloes and Khillar cattle (Lead Station: SRS, Bangalore)	K. P. Ramesha
12.	Investigation on QTL and non-genetic factors regulating postpartum productive and reproductive performances in Deoni Cattle (Lead Division: SRS, Bangalore)	D. N. Das
13.	Genomic selection for improvement of reproduction and production performance in dairy animals (Lead Division: Dairy Cattle Breeding)	A. K. Chakravarty
14.	Studies on indicators of retention of fetal membranes and evaluation of preventive/therapeutic regimes for maintaining postpartum fertility in dairy bovine (Lead Division: LPM)	A. Kumaresan
15.	Development of management practices for provision of effective milk let-down stimulus in weaned cows and buffaloes (Lead Division: Livestock Production & Management)	M. L. Kamboj
16.	Management practices to improve semen productivity by mitigating low libido problem in Sahiwal bulls (Lead Division: Livestock Production & Management)	Mukesh Bhakat
17.	Studies on reproductive performance and fertility augmentation in Deoni Cattle (Lead Station: SRS, Bangalore)	S. Jeyakumar
18.	Influence of some managemental practices on incidence of sub clinical mastitis and milk quality in dairy cows (Lead Station: ERS, Kalyani)	Champak Bhakat
19.	Modulation of uterine immunity to prevent postpartum uterine infections in Dairy Cows (Lead Division: LPM)	Rubina K. Baithalu
20.	Effect of Azolla supplementation on growth, reproductive and productive performance of Alpine x Beetal goats (Lead Division: LPM)	Ramesh Chandra
21.	Investigation on factors affecting semen quality and freezability in Deoni and Malnad Gidda cattle (Lead Station: SRS, Bangalore)	Mukund A. Kataktalware
22.	Development of suitable housing for dairy cows in lower Gangetic regions of West Bengal (Lead Station: ERS-Kalyani)	D. K. Mandal
23.	Evaluation of bovine major acute phase proteins as a predictive biomarker of postpartum performance in Deoni Cows (Lead Station: (Lead Station: SRS-Bangalore)	A. Manimaran
24.	Effect of dietary unsaturated fatty acids on puberty in buffalo heifers (Lead Division: Dairy Cattle Nutrition)	Amrish Tyagi
25.	Assessment of variation in residual feed intake in ruminants (Lead Division: Dairy Cattle Nutrition)	Chander Datt
26.	Studies on metabolizable protein and energy allowances for growth and puberty in buffaloes (Lead Division: Dairy Cattle Nutrition)	Goutam Mondal
27.	Precise energy and protein provisions for transition buffaloes for optimizing production, immunity and fertility (Lead Division: Dairy Cattle Nutrition)	Nitin Tyagi

SL. No.	Project Title	PI
28.	Refinement in inventory of methane and nitrous oxide emission from dairy animals (Lead Division: Dairy Cattle Nutrition)	Madhu Mohini
29.	Green fodder and grain yield of Barley (*Hordeum vulgare L.*) varieties as affected by sowing time and stage of harvesting (Lead Division: Dairy Cattle Nutrition)	Magan Singh
30.	Comparative nutritional evaluation and utilization of some newer feed resources in Dairy Cattle Ration (Lead Station: ERS-Kalyani)	A. Chatterjee
31.	Dietary manipulation of rumen fermentation using tree leaves of north eastern India for improving growth performances in calves (Lead Station: ERS-Kalyani)	A. Santra
32.	Effect of supplementation of area-specific mineral mixture (KALMIN) on productive and reproductive performance in dairy animals (Lead Station: ERS-Kalyani)	M. K. Gosh
33.	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
34.	Refinement of energy and protein requirements for cattle and buffaloes during different seasons (Lead Division: Dairy Cattle Nutrition)	S. S. Kundu
35.	Development of calf starter for higher growth in Sahiwal calves (Lead Division: Dairy Cattle Nutrition).	S. K. Tomar
36.	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
37.	Evaluation of sorghum forage varieties and their nutritive value under different nutrient management (Lead Division: Dairy Cattle Nutrition).	Magan Singh
38.	Evaluation of osteogenic peptides from buffalo milk (Lead Division: Animal Biochemistry)	Suman Kapila
39.	Post processing interventions to improve quality and shelf- life of curd rice (Lead Station: SRS, Bangalore)	Menon Rekha Ravindra
40.	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
41.	Evaluation of antioxidative potential of goat milk in controlling hypercholesterolemia (Lead Division: Animal Biochemistry)	Sunita Meena
42.	Size dependent variations in lipid fractions of fat globules in milk from different species (Lead Division: Dairy Chemistry)	K. P. Indumathi
43.	Aflatoxin M_1 mitigation by probiotic *lactobacillus* species (Lead Division: Dairy Microbiology)	Chand Ram
44.	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
45.	Proteome analysis of *Lactobacillus fermentum* strains in response to acid stress (Lead Division: Dairy Microbiology).	Pradip Behare
46.	Incorporation of whey and hydrolysed whey proteins in processed cheese to enhance functional attributes (Lead Station:SRS-Bangalore)	Bikash Chandra Ghosh
47.	Machine vision system for quality evaluation of dairy products based on colour measurements. (Lead Division: Dairy Engineering)	P. S. Minz
48.	Extension of shelf-life of ghee using extracts of fruit and vegetable by-products (Lead Station: SRS, Bangalore)	M. Manjunatha
49.	Development of weight based metering and filling system for viscous dairy products (Lead Division: Dairy Engineering)	P. Barnwal
50.	Evaluation of dairy conjugates as effective emulsifiers for the delivery of herbal bioactives (Lead Division: Dairy Technology)	Latha Sabikhi
51.	Development of low sodium cheese varieties (Lead Division: Dairy Technology)	Yogesh Khetra
52.	Shelf life extension of *Aloe vera* supplemented probiotic *lassi* by non-thermal intervensions (Lead Division: Dairy Technology)	Shaik Abdul Hussain
53.	Analysis of energy and exergetic performance of spray drying system for milk-malted millet food (Lead Station: SRS, Bangalore)	P. Heartwin Amaladhas
54.	Design and development of micro-processor based automated instrumentation system for pneumatic paneer hoop cum-press unit (Lead Station: SRS, Bangalore)	Chitranayak

SL. No.	Project Title	PI
55.	Development of infrared assisted baking oven and evaluation of baking characteristics of *Chhana Podo* (Lead Station: SRS- Bangalore)	F. Magdaline Eljeeva Emerald
56.	Post partum metabolic and immune indicators of mastitis in dairy cattle (Lead Division: Dairy Cattle Physiology)	Manju Ashutosh
57.	Isolation and identification of bacteriophages from dairy products & environment and evaluation of starter cultures for phage resistance (Lead Station: SRS, Bangalore)	S. Varalakshmi
58.	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
59.	Studies on investigation of the changes on fat and solids not fat (SNF) contents during the milk collection stages (Lead Division: Dairy Chemistry)	Laxmana Naik N.
60.	Monitoring milk urea level as potential tool for milk quality (Lead Division: Dairy Chemistry)	Raman Seth
61.	Development of need-based web-enabled interactive information delivery system for dairy stakeholders (Lead Division: Dairy Extension)	Sujeet K. Jha
62.	Value chain analysis of milk and milk products in organized sector in Haryana (Lead Division: DES&M)	A. K. Chauhan
63.	Impact of training programmes in scientific dairy farming in district Solan of Himachal Pradesh (Lead Division: KVK)	Dalip K. Gosain
64.	Livelihood perspective of dairy based integrated farming system in Haryana (Lead Division: Dairy Extension)	Khajan Singh
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, Bangalore)	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, Bangalore)	M.C.A. Devi
69.	Socio-economic assessment of indigenous dairy cattle holders in Southern India (Lead Station: SRS, Bangalore)	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)	Senthil Kumar, R.
72.	Improving knowledge in preparation of traditional milk products through multimedia (Lead Division: Dairy Extension)	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.

S L . 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.	R. K. Malik	S. K. Tomar, Surajit Mandal and A. K. Singh	DST (Indo Newzealand)	2013-15
2.	Development and application of lactic acid bacteria as designer products.	S. K. Tomer	-	BBSRC Funded joint India-UK collaboration project.	2014-2017
3.	Validating procedures for the measurement of heat resistant spoilage and pathogenic bacteria in milk, to provide a scientific and technical basis for future developments in the management of food safety in South Africa, India and Brazil.	Sunita Grover	Rashmi H. M	ESBA Indo South Africa and Brazil	2014-17
4.	Phylogenetic study of ruminal bacteria and its potential for CLA production and gene expression pattern of linoleic acid isomerase and reductase with different dietary supplementary supplementation and its subsequent utilization as probiotics for animals.	A. K. Tyagi	Sumit Arora	DST (Indo-Ireland)	2013 - 2015
5.	Characterization of nano-structure of buffalo milk.	Bimlesh Mann	Rajesh Bajaj and Rajan Sharma	DARE (Ministry of Agriculture) Collaborative Project India and Australia.	2015-16
National Collaborations					
6.	Network project on buffalo Improvement-Field Unit (CIRB Hisar-125001).	Avtar Singh	A. K. Chakravarty and A. K. Gupta	ICAR	2007-2017
7.	Network project on buffalo Improvement-Institute herd (CIRB Hisar-125001).	A. K. Chakravarty	Pawan Singh	Network	2007-2017
8.	Monitoring of drug residues and other environmental pollutants-outreach project of ICAR.	N. K. Goel	Raghu H. V	ICAR	2012-2017

S L . No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
9.	Indigenous breed program (Sahiwal Cattle).	K. Gupta	Avtar Singh, A. K. Chakravarty, T. K. Mohanty, S. S. Lathwal and Anupma Mukherjee	ICAR	2010-2017
10.	Deciphering the mechanism of aberrant maternal recognition of pregnancy events in sheep and buffalo under heat and nutritional stress.	T. K. Datta	Dheer Singh Rakesh Kumar	NASF	2010-15
11.	Anti-Mullerian hormone profile, its characterization and expression for using diagnostic marker for fertility assessment in farm animals.	Avijit Halder (NER, Tripura)	S. De	DBT	2012- 2016
12.	National innovations on climate resilient agriculture (NICRA).	R. C. Upadhyay S. V. Singh	O. K. Hooda, S. V. Singh, Anjali Aggarwal, S. S. Kundu, Shiv Prasad, Chander Datt, A. K. Mohanty, S. De, M. S. Chauhan, Smita Sirohi, R. K. Malik, A. K. Punia, Dheer Singh, R. Yadav, Ritu Chakravarty, Vivek Sharma, Avtar Singh, D. Gupta, Archana Verma and P. S. Minz	CRIDA (ICAR)	2010-17
13.	Screening probiotics and prebiotics for expression of glucagon like peptide-1(GLP)-1), a satiety inducing hormone, as prophylactics against diabetes mellitus-2.	Sunita Grover	Rashmi H. M.	ICMR	2012-15
14.	Establishment of facilities for research and training in stem cell technology in pigs.	M. S. Chauhan	P. Palta, R. S. Manik, S. K. Singla and M. K. Singh	DBT	2012-16
15.	Status of antibiotic resistence among commercially available probiotic bacteria.	S. K. Tomar	Paswas Goswami (BCAS) (D.U)	ICMR	2012-15
16.	Diversity study of CLA producing indigenous *butyrivibrio spp* its subsequent utilization as a probiotic for animals and genes expression pattern of enzymes involved in biohydrogation of fatty acids.	K. Tyagi	Neelam Kewalramani and S. De	DBT	2011-2015
17.	Infertility in crossbred bulls: Search for spermatogenic cell markers for early prediction on fertility.	Kumaresan	Sunita Yadav (AIIMS)	NFBSFARA	2012-16

S L . No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
18.	Development of transgenic goat for production of human lactogerrin.	M. S. Chauhan	D. Malakar, Manoj Kumar, Sudarshan Kumar, R. S. Manik, P. Palta and S. K. Singla	NFBSFARA	2012-16
19.	Diversity of exopolysaccharides produced by lactic acid bacteria.	Pradip Behare	-	DST	2013-16
20.	Network programme on veterinary type culture (VTC)-Rumen Microbes.	K. Tyagi	-	ICAR	2010-2017
21.	Scheme on Dairy Microbes under Network Mode.	R. K. Malik	Surajit Mandal S. K. Tomar and P.V. Behare	Network	2010-15
22.	Digestive enzymes (α-glucosidase and α-amylase) probiotics lactic acid bacteria for controlling postprandial hyperglycemia.	S. K. Tomar	J. K. Kaushik	DBT	2012-15
23.	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	2012-17
24.	Bioacoustics tool: A novel non-invasive approach for efficient monitoring of health and productivity in dairy animals.	S. S. Lathwal	T. K. Mohanty, Archana Verma, S. V. Singh and A. P. Ruhil	DBT	2013-2016
25.	Luteinizing hormone based sensor for estrus detection in buffaloes.	Dheer Singh	Suneel Kumar Onteru T. K. Datta and Y. S. Rajput	NFBSFARA	2013- 2016
26.	Enhancing development competence of oocytes for better in vitro fertilizing ability.	K. Dutta	S. De	NASF	2013-2016
27.	Development of strip based detection tests for selected adulterants and contaminants in milk.	Rajan Sharma	Bimlesh Mann	MoFPI	2013-15
28.	Development of parthenogenetic goat from embryonic stem cells.	M. K. Singh	M. S. Chauhan and R. S. Manik	NASF	2013-2017
29.	Healthy foods: Production of stable and active probiotics.	Surajit Mandal	S. K. Tomar, Kaushik, Kahamrui and Pradip V. Behare	MoFPI	2013-2015
30.	Production of buffalo casein hydrolysates enriched with antioxidative and immunomodulatory peptides and their application for the development of functional beverage.	Rajesh Kumar	Bimlesh Mann, Rajeev Kapila and Suman Kapila	MoFPI	2013-2015
31.	Mineral bound with based ingredients: Preparation, characterization and application.	Sumit Arora	Suman Kapila, A. K. Singh and Vivek Sharma	MoFPI	2013-15

S L . No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
32.	Recombinant expression of *lactobacilli* aminopeptidases for the production of bioactive peptides.	J. K. Kaushik	Rajesh Kumar	DBT	2013-2016
33.	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
34.	Development of chromatographic and PCR based methodology to ascertain the Quality of milk fat and its validation under field conditions.	Vivek Sharma	Sumit Arora, Darshan Lal and S. De	MoFPI	2014-2015
35.	Preparation and characterization of nanoemulsions of curcumin for their use in functional foods.	Bimlesh Mann	Rajan Sharma, Rajesh Kumar and Shaikh Abdul Husain	DST	2014-15
36.	Onset of puberty and induction of estrus: role of kisspeptin (Kiss1) in bovine species (Mithun and Cattle).	Mohan Mandal (PI of Cooperating Institute).	A.Chatterjee	DBT	2014-2017
37.	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
38.	Microbial diversity of industrial waste polluted sites of Punjab: Biogeochemical interactions for recycling of metals and degradation of pollutants.	Chand Ram	-	DBT	2014-2017
39.	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
40.	Microbial diversity of bio-films in dairy niche.	R. K. Malik	A. K. Puniya and S. K. Tomar	AMAAS	2014-2017
41.	Comparative metagenome of human gut of North and North-eastern region of India"	Sunita Grover (PI of Collaboration Institute)	Rashmi, H. M.	DBT	2014-2017
42.	Development of aptamer based detection system for aflatoxin M1 in milk.	Rajan Sharma	-	DBT	2014-17
43.	Controlled release dispensers for delivery of semiochemicals.	Gautam Kaul	-	DBT	2014-17
44.	Study of mechanism of probiotic action in persistent diarrhea in children caused by enteroaggregative E. coli-using a mouse model.	Sunita Grover	Rashmi H. M	ICMR	2015-2017
45.	"Incentivizing Research in Agriculture" Project-V Semen sexing in cattle.	S.K. Mohanty and S. K. Singla	-	ICAR	2014-17
46.	Development of mammalian cell based biosensor prototypes for toxins in commercial milk.	Suneel Kumar Onteru	Dheer Singh and A. K. Singh	DBT	2014-18
47.	Elucidating the mechanism of pashmina fibre development: An OMICS approach.	J. K. Kaushik	-	NASF	1.7.2015 to 30.6.2018

S L . No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
48.	Leukemia inhibitory factor: pluripotency in buffalo stem cells	Sudarshan Kumar	A. K. Mohanty J. K. Kaushik D. Malakar	NASF	1.7.2015 to 30.6.2018
49.	Cloning of wild buffalo in Udanti-Sitanadi of Chhattisgarh.	S. K. Singla	M. S. Chauhan R. S. Manik P. Palta S. S. Lathwal	Govt. of Chhattisgarh	May 2013-April 2016
50.	Optimization of procedures for improving cloning efficiency in buffalo.	S. K. Singla	M.S . Chauhan P. Palta R. S. Manik	DBT	November, 2014-October 2017
51.	Buffalo transgenesis for expression of desired proteins.	M. S. Chauhan	P. Palta S. K. Singla R. S. Manik M. K. Singh	DBT	23.6.2014 to 22.6 2016
52.	Delineating Beta Casein variants in indian cows and potential health implications of A1A2 milk.	K. Mohanty	Sudarshan Kumar	NASF	1.7.2015 to 30.6.2018
53.	Water budgeting and improving water productivity livestock based farming.	Ashutosh	O. K. Hooda and Manju Ashutosh	ICAR and ILRI	2015-17
54.	Bio-prospecting of lactic acid cultures from cold dessert region to develop functional fermented milk products with potential health benefits.	Surajit Mandal	S. K. Tomar and Pradip V. Behare	DST	2015-18
55.	Impact assessment of agricultural research and development.	Smita Sirohi	B. S. Chandel, T. K. Mohanty and A. K. Singh	ICAR	2015-17
56.	Value chain analysis for enhancing the performance of animal feed industry in diverse dairy production environments.	Smita Sirohi	B. S. Chandel, A. K. Tyagi and Bitan Mondal (Visva Bharti Shantiniketan W. B)	NABARD	Apil, 2015-Oct, 2015
57.	Impact assessment and evaluation of ration balancing program in northern and western regions.	Smita Sirohi	B. S. Chandel	NDDB	Apil, 2015-Oct, 2015
58.	Evaluting the impact of ration balancing in dairy animals.	S. S. Kundu	Chander Datt, Goutam Mondal, Nitin Tyagi, Madhu Mohini, S. K. Tomar and S. S. Thakur	NDDB	2013-16
59.	Preparation of the inventory of methane and nitros oxide emission from Indian livestock for 2010.	Madhu Mohini	S. S. Thakur and Goutam Mandal	Min. of Environ. And Forest.	2014-15
60.	Whole genome based SNP mining and development of breed signatures for dairy and dual-purpose indigenous cattle.	K. Dang	Avtar Singh	DBT	2014-17
61	Assessment of early pregnancy by analysis of neutrophil dynamics and gene expression in dairy cattle.	K. Dang	A. K. Mohanty and Rajeev Kapila	DBT	2014-17
62.	Empowerment of farm women through livestock technologies.	K. Ponnusamy	P. S. Oberoi	ICAR	2015-17

S L . No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
63.	Livestock methane reduction through immunization based approaches.	Dheer Singh	Suneel Kumar Onteru, G. Mandal and A. K. Puniya	DBT	2014-17
64.	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.	Dheer Singh	Suneel Kumar Onteru	ICAR Consortia	2015-17
65.	Lactation stress associated postpartum anestrus SNP array in buffaloes.	Suneel Kumar Onteru	Dheer Singh,	NFBSFARA	2015-2018
66.	Biosafety of Nanomaterials.	Gautam Kaul	Bimlesh Mann	Consortia of Research platform on Nanotechnology	2014-17
67.	Electrospun smart O2 sensor for modified atmosphere packaged dairy products.	P. N. Raju	-	ICAR	2016-18
68.	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	MoFPI	2016-18
69.	Social perspective of deagrarianization and its effect on livelihood security of farming community in Punjab	S. Meena	H. R. Meena, Gopal Sankhala and Rakesh Kumar	ICSSR	2016-17
70.	Development of web module on reproduction management of dairy animals.	Nishant Kumar	S. S. Lathwal, A. Kumaresan, Pawan Singh, M. L. Kamboj S. K. Jha, Sanjit Maiti and A.P. Ruhil	ICAR	2015-16
71.	Nano encapsulation of functional ingredients for their delivery in dairy foods.	Bimlesh Mann	Rajan Sharma, Rajesh Bajaj, Gautam Kaul and Richa Singh	ICAR- consortia Research Platform (CRP) on the nano-technology in agriculture	2014-17
72.	Establishment of agri-business incubation centre.	K. Singh	-	NAIF	2015-17
73.	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	2015-17
74.	A collaborative research project on empowerment of farm women through livestock technologies.	K. Ponnusamy	P. S. Obori	CIWA	2015-17
75.	Countering gastrointestinal tract pathogens by adhesion promoting probiotic surface proteins.	J. K. Kaushik	Sudarshan Kumar and Sunita Grover	NASF	2012-15
76.	Genetic diversity and heplotyping of innate immune genes in Indian cattle and buffalo.	S. De	Sudarshan Kumar	DBT	2012-15

S L . No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
77.	Bio-prospreting of lactic cultures from cold desert regions to develop functional fermented milk products with potential health benefits.	Surajit Mandal	S. K. Tomer and Pradeep Behare	HPAUP Kangra	2015-18
78.	Early detection of pregnancy in cows and buffaloes by pregnancy associated proteins (PAPs).	K. Mohanty	Sudarshan Kumar, T. K. Mohanty and A. K. Dang	NEBSFARA	2012-15



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 take 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, NDRI and other members include chairman consultancy processing cell, scientists from various disciplines, and an external member. During the year 2015-16, nine 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 discussed and MoUs were exchanged between NDRI and firms for Technology Transfer.

During the year 2015-16, a total of 11 technologies developed at the Institute were transferred to 9 commercial houses through 15 different MoUs thereby earning a total of ₹ 44,02,304 (including Service Tax) for the Institute through technology transfer fee, royalty and fee for additional freeze dried cultures for previously sold technologies. Two technologies were transferred on more than one occasion. The list of technologies transferred are as follows:

S. No	Name of the Technology	Inventor	Date of signing of MoU	Name of the firm to which technology was transferred	Revenue received *(₹)
1.	Whey Jaljeera Drink	Dr. A.K. Singh Dairy Technology	19-05-2015	Abis Dairy Farm Rajnandgaon, Chhattisgarh	1,12,360
2.	Misti Doi with Fast Acidifying High Sugar Tolerating Lactic Culture	Dr. Surajit Mandal Dairy Microbiology			1,79,776
3.	Improved Texture Dahi	Dr. Latha Sabikhi Dairy Technology			1,68,540
4.	Bajra Lassi	Dr. A.K. Singh Dairy Technology			1,68,540
5.	Strip Based Test for Detection of Maltodextrin in Milk	Dr. Rajan Sharma Dairy Chemistry	09-06-2015	M. Bhandari Chem Pvt. Ltd, Ahmaedabad	1,71,000
6.	A Process for Pre-paration of Low Cholesterol Ghee	Dr. Darshan Lal Dairy Chemistry	15-07-2015	Vaishal Patliputra Dugdh Utpadak Sahkari Sangh Ltd., Patna	6,84,000
7.	Strip Based Test for Detection of Maltodextrin in Milk	Dr. Rajan Sharma Dairy Chemistry	21-08-2015	Vaishal Patliputra Dugdh Utpadak Sahkari Sangh Ltd., Patna-801505	1,71,000
8.	Misti Doi with Fast Acidifying High Sugar Tolerating Lactic Culture	Dr. Surajit Mandal Dairy Microbiology	12-09-2015	C.P. Milk and Food products Pvt. Ltd., Lucknow (UP)	1,82,400
9.	Strip Based Test for Detection of Maltodextrin in Milk	Dr. Rajan Sharma Dairy Chemistry	16-09-2015	HavmorIcecream Ltd., Ahmedabad	1,71,000

S. No	Name of the Technology	Inventor	Date of signing of MoU	Name of the firm to which technology was transferred	Revenue received *(₹)
10.	Nutrimix	Dr. A. K. Singh Dairy Technology	17-09-2015	IRA Foods Pvt. Ltd, Kurukshetra	1,71,000
11.	Technology of Kheer Mohan Production from Buffalo Milk	Mr. G S Meena Dairy Technology	28-10-2015	Krishna Chilling Center, Gangapur city, Rajasthan	2,05,200
12.	Misti Doi with Fast Acidifying High Sugar Tolerating Lactic Culture	Dr. Surajit Mandal Dairy Microbiology	7-12-2015	ITC LIMITED, Bangalore	1,83,200
13.	Whey Based Medium for Lactic Acid Bacteria	Dr. Surajit Mandal Dairy Microbiology	05-02-2016	Absource Biologics(P) Ltd., Pune	6,87,000
14.	Bioprocess for Direct Vat Set (DVS) Misti Dahi Culture	Dr. Surajit mandal Dairy Microbiology			8,01,500
15.	EPS Producing Culture For Pre-paration Of Low-Fat Dahi	Dr. Pradip V Behare Dairy Microbiology			1,14,500
16.	Mineral Mixture (Cation & Anion) as Royalty	Dr. Veena Mani Dairy Cattle Nutrition	-	Kamdhenu Feeds, Saharanpur	2,19,888
17.	Sugar Tolerating Actic Culture for Preparation of Misti Doi (for additional freeze dried culture)	Dr. Surajit Mandal Dairy Microbiology	-	Namaste India Foods Pvt. Ltd, Kanpur	11,400
Total					44,02,304

*This amount includes service tax also.

Technologies Ready for Commercialization

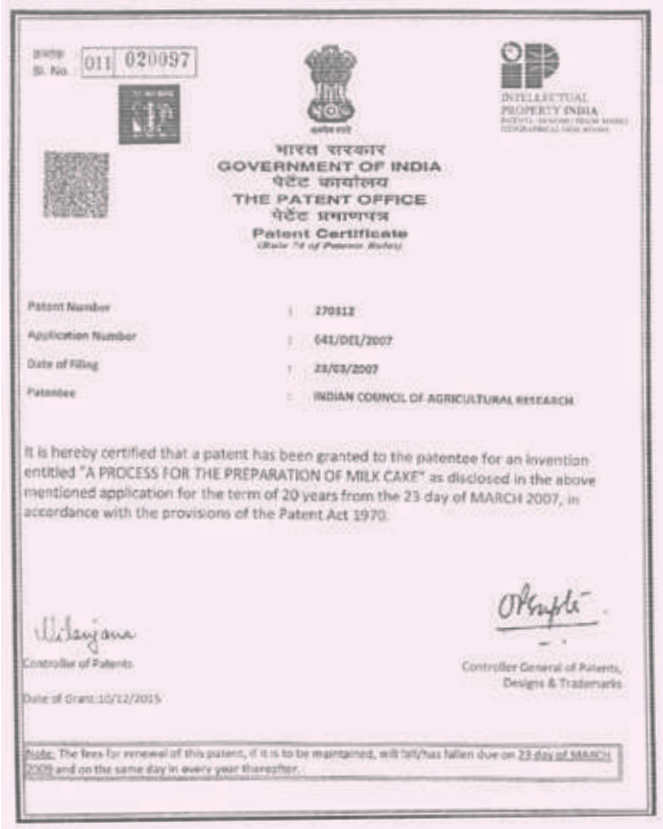
In the year 2015-16 pricing of the following technologies were fixed.

1. Exopolysacchrides producing lactic culture for preparation of low fat lassi.
2. Strip based test for detection of sucrose in milk and milk product.
3. Probiotic cultures *Lactobacillus acidophilus* LaVK2 and *Bifidobacterium bifidum* BbVK3.
4. Technology of Kheer Mohan production from buffalo milk.
5. Two stage enzyme assays for detection of *E.coli* in milk; whey based medium for lactic acid bacteria.
6. Bioprocess for direct vat set misti dahi culture.
7. EPS producing culture for preparation of low-fat dahi.
8. DNA based method for differentiation of cow & buffalo butter/ghee.
9. DNA based method for differentiation of cow, buffalo, sheep, goat and camel milk.
10. DNA based method for differentiation of cow, buffalo, sheep, goat and pig meat.
11. Buffalo mammary epithelial cell line (BuMEC_ND1).
12. Biofunctional fruit yoghurt.
13. A process for iron fortification of paneer using edible coating.
14. Technology to prepare a kit for the detection of vegetable oil/fats in ghee.
15. Methodology to confirm the presence of lard in ghee.
16. Whey tamarind drink and whey mango drink were finalized for initiating commercialization process.

Patent Granted (2015-16)

1. A Process for the Preparation of Milk Cake **(Patent Grant No. 270312, Grant date: 10/12/2015). Inventors: Anil Kumar, G. R. Patil, A. A. Patel, R. R. B Singh.**

A process for the manufacture of milk cake having the typical flavour, characteristics of the conventional product has been developed. The typical caramelized flavour is imparted by heat desiccation of milk while the desirable grain formation is attained through addition of acidifying agents and application of heat. The colour is provided by a thermization process. The longer shelf life and the safety of the product is ensured through optimization of various parameters.



भारत सरकार
GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
पेटेंट प्रमाणपत्र
Patent Certificate

Patent Number : 270312
Application Number : 641/DEL/2007
Date of Filing : 23/03/2007
Patentee : INDIAN COUNCIL OF AGRICULTURAL RESEARCH

It is hereby certified that a patent has been granted to the patentee for an invention entitled "A PROCESS FOR THE PREPARATION OF MILK CAKE" as disclosed in the above mentioned application for the term of 20 years from the 23 day of MARCH 2007, in accordance with the provisions of the Patent Act 1970.

Controller of Patents
Date of Grant: 10/12/2015

Controller General of Patents, Designs & Trademarks

Note: The fees for renewal of this patent, if it is to be maintained, will fall/has fallen due on 23 day of MARCH 2009 and on the same day in every year thereafter.

Patents Filed (2015-16)

1. Aptamers specific for cefquinome (**Inventors:** Rajan Sharma, Amit Kumar Barui, Y. S. Rajput and Bimlesh Mann) (**Application No.:** 1775/DEL/2015).
2. Novel Peptide sequence and polyclonal antibodies for the detection of cow and buffalo luteinizing hormone (**Inventors:** Varij Nayan, Suneel Kumar Onteru and Dheer Singh) (**Application No.:** 1854/DEL/2015).
3. Rapid spores-enzyme based miniaturised assay (s) for detection of pesticide residues (**Inventors:** Naresh Kumar, Nimisha Tehri, Rajesh Gopaul, Pradeep Kumar Sharma, Brijesh Kumar, Spurti Morab and Raghu H.V.) (**Application No.:** 3819/DEL/2015).
4. A process for iron fortification of paneer using Edible Coating (**Inventors:** Narender Raju Panjagari, Jotarkar Parameshwar Sarangdhar, Ashish Kumar Singh and Sumit Arora) (**Application No.:** 3926/DEL/2015).

MOU Signed for Transfer of Technologies

» MoU exchanged between **NDRI** and **Abis Dairy Farm** for the technology of (A) Whey Jaljeera Drink, (B) Misti Doi with fast acidifying high Sugar Tolerating Lactic Culture(S) (C) Preparation of Improved Textured Dahi and (D) Bajra Lassi.

» MoU exchanged between **NDRI** and **BHANDARI CHEM Pvt. Ltd** for the technology of Strip Based test for Detection of Maltodextrin in Milk.



Institute-Industry Meet

The scientific team from NDRI are continuously making efforts for developing new technologies with relevance in milk quality, milk safety, healthy foods, fortified milk products, dairy equipment, mineral mixture etc. as per the need of the dairy farmers and industry. As a result, a number of innovative technologies have come into market. This year NDRI conducted an Institute - Industry Meet on 17th December, 2015 at NDRI, Karnal in which technologies developed at NDRI and other institutes of the zone were presented and displayed by the inventors in front of stockholders from various industries. In this event, a technology compendium titled "Technologies for Commercialization" was published consisting of 100 technologies from all the zonal Institutes.

Technology Sharing Business Meet

On the sidelines of the 44th Dairy Industry Conference ITMC of NDRI organized a "Technology Sharing Business Meet" on 19th February, 2016. During this event, technologies developed at ICAR-National Dairy Research Institute, Karnal were presented and demonstrated to the entrepreneurs and representatives of Industries.

Zonal Agro-Technology Management Center (ZTMC)

As per ICAR Guidelines for Intellectual Property Management and Technology Transfer/ Commercialization, ICAR-National Dairy Research Institute, Karnal has been designated as one of the Zonal Agro-Technology Management Center (ZTMC) vide letter no. F.No. IP& TM-7(5)/2013-IPR dated 02.12.2014

In this ZTMC 8 Institutes (*National Bureau of Animal Genetic Resources, Karnal; Central Institute for Research on Buffaloes, Hissar; Central Institute for Research on Cattle, Meerut; Central Institute for Research on Goats, Makhdoom; National Research Centre on Camel, Bikaner; National Research Centre on Equines, Hissar; National Research Centre on Mithun, Medziphema; and National Research Centre on Yak, West Kemang*) have been assigned in the zone.

In continuation, a Zonal Institute Technology Management Committee (ZITMC) of ten members has been constituted. The role of the committee is to facilitate/ manage IP protection/ maintenance and technology transfer/ commercialization for ICAR institutions in the zone.

Overview of Intellectual Property Management Activities

Particulars	No.
Technologies Developed	11
Technologies Transferred	15
Technologies Commercialized	15
Pricing of Technologies Fixed	16
Patents Filed	04
Patents Granted	01
MoUs Signed with Different Firms	15
Institute Industry Meet	01
Institute Technologies Sharing Meet	01
ITMC Meeting	09
Revenue Generation through Commercialization of Technologies	₹ 44.02 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 12 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 progressive farmers, unemployed rural youth, IT professionals, engineers, and retired officials and women entrepreneurs. The total number of participants were 292.
- BPD organized two Entrepreneurship Development Programme (EDP) on "Milk and Milk Product Processing" for 31 participants to promote value addition at the farm/producer's level and improve the profitability of milk producers.
- BPD organized one Entrepreneurship Development Programme (EDP) on "Technology of Cheese Manufacture" for 10 participants from 18th to 23rd January, 2016.
- BPD organized two specialized training programme on "Fertility Management of Dairy Animals" for 20 veterinary officers of Tripura to apprise them of reproduction related issues in dairy animals and interventions to solve them.
- Training-of-Trainers (YOT) programme on "Agribusiness and Dairy Technology" was organized for 23 Livestock Development officers (LDO) of Maharashtra from 27th to 31st January, 2016 and 10th – 14th February, 2016. Training Programme was sponsored by MCAP Cell of VANA MATI.
- Two training programmes under Unnat Bharat Abhiyan were conducted for rural youths on "Scientific Dairy Farming" and "Milk & Milk Product Processing" which was attended by 49 youths.

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, 16 incubatees were enrolled under the mentorship of scientists of NDRI, Karnal and graduated to start their business ventures. Six entrepreneurs initiated their ventures under business incubation through SINED (TBI) during the year 2015-16 and most of the ventures initiated with the technologies sourced from NDRI, Karnal. Besides, these active hand-holding of trainees from various EDP programmes resulted in establishment of more than 170 business ventures including 130 dairy farms, 37 milk processing units, 3 food processing units and one feed manufacturing unit. In order to offer the facility of test marketing for these entrepreneurs, two booths have been constructed at the institute. Apart from in-house incubation, six entrepreneurs and organizations have been enrolled for virtual incubation.

New Dairy Products Launched



Sugar Free Kulfi being Launched at NDRI, Milk Parlour

Dr. A. K. Srivastava launching newly developed natural dairy based health drinks at NDRI milk parlour





Launch of Mother Gain Healthy Drink by Dr. A. K. Srivastava, Vice-Chancellor & Director NDRI and Sh. Pankaj Nain, SP Karnal at International Women's Day Celebrations on 8th March, 2016

Linkages Developed

» With NABARD Regional Office for the mobilization of entrepreneurs and project funding of entrepreneurs.

» Agribusiness Incubation (ABI) platform- a network of about 20 organizations and institutions.

» Funding agencies- Punjab National Bank (PNB), Sarva Haryana Gramin Bank, Ministry of Foods Processing Industries (MOFPI), Micro, Small and Medium Enterprise (MSME).

» Singed MOU with YPARD (Young Professional for Agriculture Development) India

Consultancy Processing Cell Activities and Achievements

Consultancy Assignments

Consultancy processing Cell of BPD Unit of NDRI is actively engaged in offering consultancy to various organizations and individuals on wide range of issues. During the year 2015-16, more than 86 organizations and individuals approached for consultancy. Eleven assignments were taken up by the unit.

Contract Research

Scientists of NDRI, Karnal are also undertaking contract research as per the guidelines of Professional Service Functions and proposals are screened through PME Cell of NDRI, Karnal. During the year, 6 new and 4 existing contract research projects were implemented through Consultancy Cell at main centre and two contract research projects were initiated at ERS of NDRI, Kalyani and SRS of NDRI, Bangalore, respectively. The area of contract research included nutritional trials, silage making, testing of food ingredients, probiotic product development and testing of supplements etc.

Contract Services

Contract services like testing of feed & food samples, preliminary discussions on problem solving, supply of milk adulteration kits, antibiotic kits, microbial cultures and other inputs, were offered to 39 organizations and individuals.

Training of Students from Other Universities and Colleges

One hundred and twelve students from 24 different universities and colleges were enrolled for training in various laboratories and sections of NDRI, Karnal through consultancy processing cell. These students stayed from 1-6 months' duration and completed their trainings in areas like milk & milk product processing, food technology, biotechnology, animal farm management, dairy microbiology, dairy chemistry and dairy engineering. A total number of 28 students from other ICAR Institutes and State Agriculture Universities (SAUs) were also imparted training at NDR, Karnal.

Non-student Training Programmes

Representatives from industry, government officials and from other business establishment underwent training in laboratories and sections at NDRI, Karnal through Consultancy Processing Cell (CPC) of NDRI, Karnal. A total number of 46 trainees were attended the programmes.

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 was 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. NDRI is well equipped and staffed to meet emerging needs of the 21st Century of the Dairy Industry. The university offers academic programmes both at 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 2015-16.

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 (Forage Production), and xvi) Animal Reproduction, Gynaecology and Obstetrics.

The Institute offers Doctoral degree programme in the all the above disciplines except Food Science & Nutritoln.

Diploma in Dairy Technology and Animal Husbandry

The Diploma in Dairy programme being offered at SRS, Bangalore 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 ERS of NDRI, Kalyani, offers intensive training in Animal Husbandry & Dairying.

Scholarship and Fellowships

Masters in Dairying and Ph.D. students are awarded Institute scholarship at the following rates in accordance as per 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.	₹ 13,125/- P.M. for three years and ₹ 10,000/- per annum as contingency.
Ph.D. (In-service)	₹ 1000/- P.M. for three years and ₹ 10000/- per annum as contingency

ICAR Junior Research Fellowship

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

ICAR Senior Research Fellowship

Ph.D.	₹ 12000/- P.M. (For Non Veterinarians) for 1st and 2nd year and ₹ 14,000/- for 3rd year; and ₹ 10000/- per annum as contingency.
Ph.D.	₹ 14,000/- P.M. (For Veterinarians) for 1st and 2nd year and ₹ 15000/- for 3rd year; and ₹ 10000/- per annum as contingency.
Ph.D. (In-service)	₹ 1000/- P.M. for 3 years and ₹ 10,000/- per annum as contingency.

National Talent Scholarship

The National Talent Scholarship (NTS) @ ₹ 1000/- per month is awarded by ICAR on merit provided that the university/institute is located outside the state of his/her domicile.

A number of scholarships are offered by corporate and individual donors i.e. M/s Nestle India Ltd., Dr. L. C. Sikka Memorial Trust, Dr. D. Sundaresan Memorial, Dr. P. G. Nair Award, Bhogi Bhai and Sushila Ben Mehta Trust, Dr. I. S. Verma Memorial, Alumni Silver Jubilee Scholarship, Dr. P. Bhattacharyya Memorial Trust, M. M. Malik Memorial Scholarships and Prof. R. D. Verma Scholarship.

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 ₹ 20,000 to 60,000/- 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 UG and PG programme was held by the Education Division of ICAR on 15th and 29th June, 2nd and 4th July, 2015, respectively at NASC Complex, New Delhi.

Entrance Examination

An all India Competitive entrance examination for admission to Ph.D. programme for the session 2015-16 was conducted by NDRI on 12.5.2015 at three centers i.e. Karnal, Bangalore and Kalyani.

Admissions

Admission for the academic session 2015-16 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 and the admission process was closed on 4.9.2015.

Registration of Students



A total of 20 students joined Diploma in Dairy Technology**,** 20 students joined Diploma in Animal Husbandry & Dairying**,** 30 students including one foreign national joined B.Tech.(Dairy Technology**),** 156 students joined Masters' programme**,** 115 students including one foreign national joined the Ph.D. Programme.

Degrees Awarded during the 14th Convocation

B.Tech. (Dairy Technology)	:	30
Masters in Dairying	:	111
Ph.D.	:	90

Meetings

- 80th & 81st meeting of the Standing Committee on Course Curricula and Academic Affairs were held on 10.7.2015 and 17.2.2016.
- 58th, 59th and 60th meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 22.7.2015, 5.1.2016 and 23.2.2016.
- 39th Meeting of Academic Council was held on 27th July, 2015
- 40th Meeting of Academic Council was held on 3rd March, 2016.

Fourteenth Convocation of NDRI Deemed University

Fourteenth Convocation of NDRI Deemed University was held on 5th March, 2016. Shri Kaptan Singh Solanki, Hon'ble Governor of Haryana presided over the Function and Dr. Jimmy Wilson Smith, Director General, ILRI delivered the Convocation Address. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI Deemed University presented the Convocation Report.



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

Students Awarded Medals in B.Tech. (Dairy Technology)

Name of the Student	Type of Medal
Digvijay	Gold
Anurag Kushwaha	Silver
Gaurav K R Deshwal	Bronze

Students Awarded Medals in M.Sc. / M.V.Sc. / M.Tech.

Name of the Student	Discipline	Type of Medal
Indu Devi	Livestock Production Management)	Gold
Shruti	Agricultural Extension Education)	Silver
Vineeth M.R.	Animal Genetics & Breeding)	Bronze

Students Awarded Medals in Ph.D.

Name of the Student	Discipline	Type of Medal
Soumya N.P.	Animal Genetics & Breeding)	Gold
Richa Singh	Dairy Chemistry)	Silver
Yogesh Khetra	Dairy Technology)	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. Two theses in each programme were recommended by committees in each discipline. The students presented their theses before the Award Committee. The award committees evaluated the theses and gave their recommendations for the Best Thesis Awards in their respective groups as given below:

Best Masters' Thesis Awards

Group	Name of the student	Name of the Guide	Discipline
Production	Mr. Mohanned Alhussain	Dr. A. K. Dang	Animal Physiology
Processing	Mr. Saurabh Kadyan	Dr. Naresh Kumar	Dairy Microbiology
Social Science & Management	Mr. Parameswarnaik J.	Dr. Senthil Kumar	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. Two theses in each programme were recommended by committees in each discipline. The students presented their theses before the Award Committee. The award committees evaluated the theses and gave their recommendations for the Best Thesis Awards in their respective groups as given below:

Group	Name of the student	Name of the Guide	Discipline
Production	Ms. Shrabani Saughandhika	Dr. D. Malakar	Animal Biotechnology
Processing	Ms. Shilplashree B. G.	Dr. Sumit Arora	Dairy Chemistry
Social Science & Management	Dr. P. Mooventhan	Dr. K. S. Kadian	Agricultural Extension Education

Best thesis award carries a Citation, certificate and a cash prize of ₹ 5000/- for Best Master's Thesis and a Citation, certificate and Gold Medal for Doctoral Thesis.

Dr. D. Sundaresan Memorial Oration Award-2016 was bestowed on Dr. R. B. Singh, Chancellor, Central Agricultural University, Imphal. Dr. Singh delivered the lecture on 27th February, 2016 on the topic "White Revolution for Green Economy" at NDRI Karnal. The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. N. N. Dastur Memorial Oration Award-2016 was bestowed on Dr. B. N. Mathur, Former Director, NDRI, Karnal & NAARM, Hyderabad. Dr. Mathur delivered the oration on 3rd March, 2016 on the topic "Dr. Dastur's Legacy: Dairy Education in India and Way Forward" at NDRI Karnal. The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. K. K. Iya Oration Award-2016 was bestowed on Dr. Gurbachan Singh, Chairman, ASRB, New Delhi. Dr. Singh delivered the lecture on 29th February, 2016 on the topic "Talent Search in Agricultural and Allied Sciences: Challenges and Opportunities" at NDRI Karnal. The award carries an amount of ₹ 20,000, a citation, shawl and a certificate

Best Division Award for Academic Achievements and Innovations in Teaching

The Different Heads of Divisions presented the innovations and significant achievements during 2015-16 in education/research and consultancy during Academic Week Celebrations. "Best Division Award" was presented to Dairy Technology and Dairy Chemistry Division jointly.

Best Teacher Award for Excellence in Teaching

Best Teacher Awards at Under-graduate teaching and post-graduate levels at NDRI, Karnal to recognize and promote teaching excellence and motivate the faculty to adopt high standards for content preparation, delivery of lectures, motivation of students and overall development of students were conferred upon at Dr. Pradeep Behare, Scientist, Dairy Microbiology Division for UG teaching and Dr. Suman Kapila, Principal Scientist, Animal Biochemistry Division for PG teaching.



Sh. Radha Mohan Singh Ji, Hon'ble Union Minister for Agriculture & Farmers Welfare inaugurating the Indore Sports Complex

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 Gumto.

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 (2015-2016)

Sl. No.	Activities	No. of Cases
1	A. I. in Cows	475
2	Conception rate (%)	48.00
3	A.I. in Buffaloes	320
4	Conception Rate (%)	36.60
5	No. of C.B. calves born	85
6	No. of buffalo calves born	132
7	General Treatment cases	450

Infertility and Veterinary Aid Campaigns

A total number of 36 camps were organized in Deepo, Dugro and Gumto villages. During the Campaigns, a total number of 920 cases were treated for reproductive disorders and various veterinary ailments. Ectoparasitic control campaign and deworming programmes for control of endo-parasites were conducted.

Kisan Sangosthies

Thirty six Kisan Sangosthies were organized at village level to update the knowledge of dairy farmers and to provide the on spot solutions to their problems and large number of farmers attended these sangosthies.

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 every 2nd Saturday. Scientists also obtain the feedback from the participating farmers attended to farmers' problems related to scientific dairy farming, crop husbandry practices and also to give veterinary advice to the farmers.



Farmers' Farm School

NDRI has started "Farmers' Farm School" (FFS) since 30th August, 2014 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 for practical classes. A total number of 20 candidates enrolled in the first batch of the Farmers' Farm School at Gorgarh village have passed out in the month of July 2015 and they were awarded certificates during the Meeting of Academic Council held on 27th July, 2015.



A new batch consisting of 20 farmers was registered on 5th August, 2015 for a period of one year (two semester). The video coverage of Farmers Farm School of NDRI was telecast by many channels (Aajtak, DD Kisan, Haryana News, E-TV, etc.) and covered by print media.

Forage Museum

To maintain the green fodder availability round the year, a forage museum was established in around 2 acres of land at fodder production farm of NDRI.

1. **Perennial grass block:** There are six perennial grasses alongwith germplasm of 18 varieties **(**Napier-8, Guinea-3, Nandi Grass-1, Anjan-4, Paragrass-1, Bahia grass-1) planted in this block. As there is a demand for perennial grasses and legume, NDRI developed additional 2 acres block for Napier germplasm to meet the demand of farmers/ visitors.
2. **Perennial legume block:** There are four species of perennial legumes (Clitoria-2, Siratro -1 and Hedge Lucerne-1) planted in this block.
3. **Seasonal fodder crops block**: African tall variety of maize PC-6 variety of sorghum was cultivated in kharif season and three varieties of Berseem (Mescavi, BL-12 and BL-42), two varieties of oats (Kent, OS-6) and one variety of turnip (red) was cultivated at forage museum in rabi season.
4. **Silvi-pastrol block:** Ten species of fodder tree were planted i.e. Bauhinia, Cluster fig, Siris, Gliricidia, Ardu, Khejri, Bhimal, Agasthi, Acacia, Azadirachtaindica, Mahua, Drumstick. Guinea grass (var-Hamil) were planted between the rows of trees to meet the regular supply of green fodder in form of tree leaves and grass.

5. **Horti-pastrol model block**: Hundred lemon plants were planted at the distance of 10 x 10 m and between the plants hamil variety of Guinea grass was planted so that farmers could get additional green fodder alongwith fruits.

The museum is supplying the rooted slips as sample (10 rooted slips of concerned grass) to the farmers and visitors.

Dairy Samachar

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

Technologies Assessed and Transferred

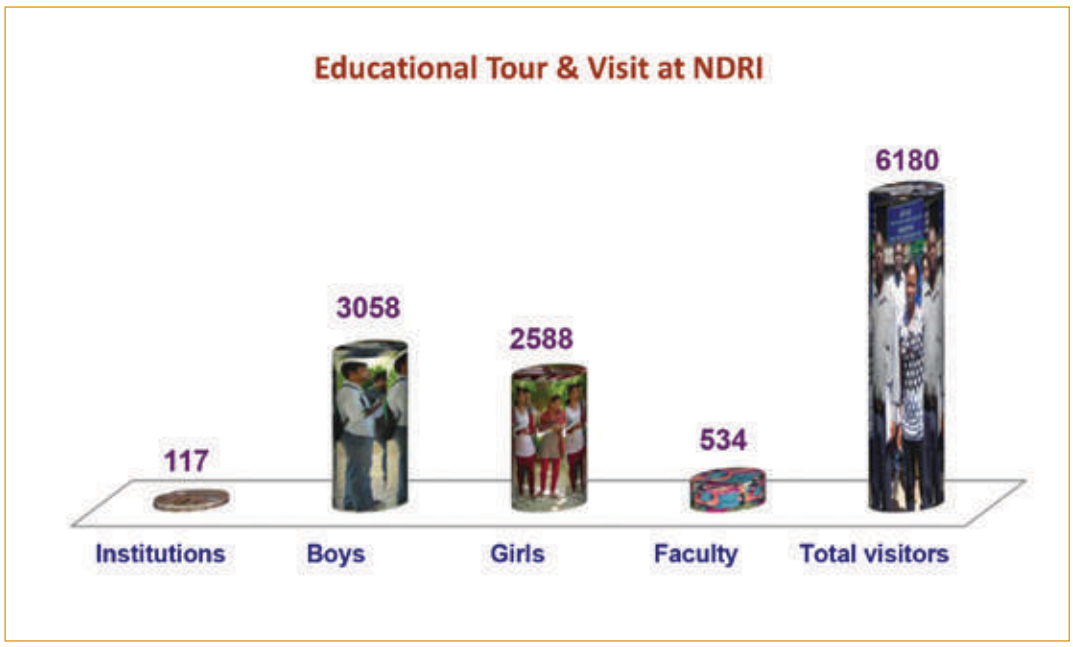
- Complete feed preparation using locally available resources.
- Balanced feeding of dairy animals.
- Silage making.
- Round the year green fodder production.
- Vaccination of animals.
- Deworming schedule of dairy animals.
- Precaution for the control of mastitis.
- Management of dairy animals for clean milk production.
- Tree plantation in the NICRA villages.
- Urea molasses mineral block preparation.

Radio/TV Talks and Advisory Services

- Eight TV talk was delivered for effective dissemination of dairy farming technologies among dairy stake holders through various TV channels.
- Besides regular advisory services through postal, e-mail, phone to individual farmers/ NGO's/ relevant departments were provided all over the country in response to their particular/general queries regarding latest technologies of the institute and modern dairy farming practices.

Educational Visits at NDRI

A total of 6180 visitors (Students & Faculty) of 117 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.





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 2015 to March, 2016)

Title of the Course	Duration (days)	No. of Courses	No. of Beneficiaries	Mandays Trained
On Campus				
Dairy Production				
At KVK	5	19	1,269	6,345
Sponsored	5	46	1,361	6,805
Dairy Processing	5	6	100	500
Crop Production	4	4	92	368
Vermiculture	3	3	64	192
Bee-keeping	4	3	185	740
Fish Farming	4	2	121	484
Home Science	1-12	9	204	792
Total (A)		92	3,396	16,226
Short Integrated Training Programmes (B)	1-2	85	3,047	3,305
Total (A+B)		177	6,443	19,531
Off Campus				
Scientific Dairy farming	1	8	284	284
Dairy Processing	1	3	50	50
Crop Production	1	16	256	256
Clean Milk Production	1	2	30	30
Home Science	1	6	151	151
Resource Conservation Technology	1	2	41	41
Soil Health Management	1	3	72	72
Vermiculture	1	2	28	28
Bee Keeping	1	1	55	55
Total (C)		43	967	967
Grand Total (A) + (B) +(C)		220	7410	20,498

State-wise Beneficiaries of on Campus KVK Training Programmes

Sr. No.	State	No. of Beneficiaries
1.	Haryana	3,638
2.	Bihar	1,110
3.	Uttar Pradesh	1,101
4.	Punjab	319
5.	Gujarat	277
6.	Himachal Pradesh	256
7.	Rajasthan	233
8.	Jammu & Kashmir	135
9.	Jharkhand	86
10.	Chhatisgarh	77
11.	Odisha	62
12.	Madhya Pradesh	42
13.	Kerala	35
14.	Arunachal Pradesh	23
15.	Delhi	5
16.	Uttrakhand and others	11
Total		7,410

Front Line Demonstrations (2015-16)

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. The KVK organized various FLDs in pulses, oilseeds and fodder crops that is presented in the table. The total demonstrations organized were 223 in an area of 81.0 hectares.

Results of FLDs Conducted in 2015-16

Sr. No.	Crop		Variety	Total No. of Demo.	Area (ha.)	Av. yield
1.	Oilseeds	Mustard	Pusa Vijay CS-56 RB-50	5 5 5	2.0 2.0 2.0	17.60 18.60 16.50
2.	Pulses	Gram	HC-1	117	45.75	18.00
		Summer Moong	MH-421 SML-668	9 6	3.64 2.42	5.30 5.80
3.	Fodder	Oats	OL-10	10	2.0	494.0
		Sorghum (Jowar)	Hira Moti	21	6.0	642.0
		Maize	African Tall J-1006	3 13	0.7 4.0	518.0 469.0
		Bajra	FBC-16	16	6.0	445.0
		Berseem	BL-42 HB-1 HB-2	10 5 8	2.00 1.00 1.60	1370 1149 1002

Animal Health Management Activities

The KVK has two Dairy Vikas Kendras in the adopted villages, namely: Taprana and Phusgarh distt Karnal to take care of animal health and artificial insemination in the operational area. The animal health management activities and field extension activities were carried out through these Dairy Vikas Kendras. At these Kendras, a total number of 3574 cases were attended, out of which 21 cases were for general treatment, 78 for dehorning, 1284 for pregnancy diagnosis and 2191 A.Is. in dairy animals. Through Artificial Insemination, 11447 calves were born.

Promotion of Gram and Moong Cultivation

KVK concentrated its efforts in increasing the Gram and Moong cultivation area in the district. Gram Variety HC-1, Moong varieties SML-668 and MH-421 were promoted and the farmers having different categories of land holding were encouraged to increase the pulse production and improve soil fertility.



Promotion of Conservation Agriculture Technologies in Wheat and Paddy

Conservation agriculture technologies like zero tillage, direct seeded rice and bed planting in cultivation of wheat and paddy cultivation were demonstrated to various groups of farmers and farm women not only from Karnal district but also from other states.

Meetings of Scientific Advisory Committee

Meetings of Scientific Advisory committee of KVK were held on 6th May, 2015 and 30th October, 2015 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.

Social Awareness Programme against Crop Residue Burning

Twenty five campaigns and awareness programme were organized in different villages of Karnal to enlighten the farmers on losses due to residue burning in the fields.

KVK organized a programme on "Mass Social Learning on Elimination Residue Burning and Promoting Direct Seeded Rice" to commemorate the culmination of Social Awareness Campaign week against Residue Burning on 1st May, 2015 at Village Beer Narayana, District Karnal. The prorgamme was participated by 400 farmers and farm women.

Kharif Kisan Sammelan

A Kharif Kisan Sammelan was organized in KVK on 14th July, 2015 in which about 345 farmers, farm women and rural youth participated. An exhibition of various activities of ICAR institutes situated in Karnal and Horticulture Research Center was also arranged for updating the knowledge of farmers.

World Soil Day

KVK organized a "World Soil Day" to distribute the soil health cards at KVK NDRI Karnal on 5th December 2015. Public representatives Sh. Bakshish Singh, Chief Parliament Secretary Development and Panchyati Raj Department, Govt. of Haryana were present in the function. KVK distributed 50 Soil Health Cards to the farmers. 250 farmers including 37 farm women of Karnal district and from Hanuman Garh district of Rajasthan participated in the programme. An exhibition of the technologies and the products of the IARI Regional Station, IIWBR, SBI, Regional Station, NDRI, KVK, NHRDF, Salaru and CCSHAU, Regional Station was organized for the benefit of farmers. In the programme eight farmers of the district who have adopted the conservation agricultural technologies were also honoured.

Women in Agriculture Day

KVK celebrated "Women in Agriculture Day" in village Beed Narayana, on 4th December, 2015 to recognize the significant role being played by women in modern agriculture. In this programme, a total number of 75 farm women participated. Lectures were delivered and a quiz was organized during the programme.

Programme Under Mera Gaon Mera Gaurav

KVK organized a field day in village Darar on 17th December 2016 under the progarmme "Mera Gaon Mera Gaurav" in which about 45 farmers and farm women participated. In this programme, the activities of the NDRI and KVK were highlighted.

Jai Kisan Jai Vigyan Divas

Two programmes were organized to celebrate "Jai Kisan Jai Vigyan Divas" on 23rd and 26th December, 2015 at the Sansad Adarsh Gram village Mohiuddinpur and NDRI Karnal, respectively. In these programmes, about 240 farmers and farm women participated. Lectures were delivered by the experts during the programmes.

DD Kisan Prashan Manch Programmes

Two Kisan Prashan Manch progammes, one with the farmers from Bihar State and other with the farmers from Karnal district were organized and covered by the DD Kisan Channel.

Participation of the Farmers in Krishi Unnati Mela at ICAR-IARI New Delhi

To expose the farmers to the latest developments in agriculture and allied fields, KVK arranged an exposure visit of about 260 farmers from Karnal district to Krishi Unnati Mela at ICAR-IARI New Delhi on 19th March, 2016.

A **"Rabi Kisan Sammelan"** was organized in the KVK on 29th March, 2016 in which lectures on Rabi and Kharif crops were delivered by experts. Sammelan was attended by more than 120 farmers and farm women from Karnal district apart from 40 farmers from Himachal Prdesh. Ten progressive farmers from Karnal district were also recognized in the sammelan.

Programme on Pradhanmantri Fasal Bima Yojna

KVK organized a **"Kisan Sammelan cum Exhibition"** on 31st March 2016 to create awareness amongst the farmers about **"Pradhanmantri Fasal Bima Yojna".** More than 600 farmers and farm women participated in the event. During the sammelan, farmers were enlightened about Pradhanmantri Fasal Bima Yojna and other various schemes being implemented by the State and Central Government for the benefit of farmers.

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)



Agricultural Technology Information Centre at NDRI Karnal became operational in November 2004. This centre is engaged in disseminating information on dairying and allied agricultural fields. Besides NDRI relevant information available from other research stations of ICAR and state institutions located at Karnal are utilized by this centre for the end users visiting this centre. A large number of entrepreneurs, practicing farmers and extension workers are visiting this centre. Besides end users, a large number of students are availing the facilities of ATIC for the orientation programme and to have 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 to unemployed youth to equip them to become job providers, rather than job seekers.

Dissemination of Technological Information

Presently, ATIC of NDRI is using following methods in dissemination information to its users:

» Personal interactions with visiting farmers.

» Display of Models etc; organizing /participating in Melas and Exhibitions.

» Audio/Video shows.

» Visits to dairy farms.

» Information through toll free telephone number (1800-180-1199).

» Providing Publications.

» Providing material inputs like improved seed varieties, Vermi compost etc.

» Through E-mail.

Services Rendered in Agricultural Technology and Technology Products from April 2015 to March 2016

S r . No.	Detail of Services	No. of Services	No. of Persons Benefitted
1.	Dairy/Agriculture related information through Video show and Lecture	85	2945
2.	Personal Discussions with Subject-Matter-Specialist on Dairy Farming	65	121
3.	Information through Dairy/Agriculture Literature	62	82
4.	Information on Agriculture (Seed/Fertilizer/ Compost etc.)	2131	2138
5.	Information through telephone (Toll-free) on Agriculture & Dairying etc.	2861	2861
6.	Information through e-mail on Agriculture & Dairying etc.	86	86
7	Progressive Farmers Meet	0	0
	Total	**5290**	**8233**



WOMEN EMPOWERMENT AND MAINSTREAMING OF GENDER ISSUES

Dairy Extension Division

Forty one empowerment training course and campaigns were organized with the objective to create awareness in the field of dairying and home science and also impart skill in these areas so that farm women could generate more income from dairying and maintain healthy atmosphere in their respective families. By these programme, 635 farm women were trained.

Name of Programme	Village/On-campus	No. of Courses	No. of Participant
Training Programme on Preparation of Value Added Milk Products (Paneer, Whey Drink, Kalakand, Rasmalai, Mango Lassi, Rose Flavored Milk, Matka Kulfi) for Farmers and Farm Women of Maharashtra, Rajasthan and Haryana	On-campus	6	122
Capacity Building of Farm-women on Value Added Milk Products	Subri, Kulwahri Dungro, Kulwahri, Gumto, Gorgarh and Dhamanhari	8	124
Capacity Building of Farm-women on Fruits and Vegetable Preservation	Subri, Kulwahri Dungro, Bazidpur and Shahpur	10	129
Capacity Building of Farm-women in Scientific Dairy Farming	Kulwahri, Subri, Gumto	5	86
Awareness Campaign on Balanced Diet for Growth	Dungro, Subri, Deepo, Dungro	4	48
Awareness Campaign Health and Hygiene	Subri, Deepo, Kulwahri, Gumto	7	111
Empowerment of Farm-women through Self-help Group	Gumto	1	15
Total		41	635



Empowerment and Group Cohesiveness among Members of Women Dairy Cooperatives in Karnataka

From the study it was revealed that overall empowerment of women of Karnataka is 43.33%. Most of the women were having medium level empowerment followed by 36.25% in low category and less than one-fourth (20.42 %) of them in high category. The strongest component was found to be the psychological empowerment as far as empowerment was concerned and the weakest dimension was found to be the political empowerment. Majority (55.83%) of the members had medium level of group cohesiveness. The major constraints of the respondents with respect to women dairy cooperatives under different categories were: lack of help from family members in house hold work followed by illiteracy and lack of support from family to participate in cultural and community activities. It is suggested that WDCs should encourage women to take part in political activities also.

Krishi Vigyan Kendra (KVK)

For women empowerment 15 different progarmmes were organized on scientific dairy farming, clean milk production, milk storage, milk products making, stitching, embroidery, preservation of fruits and vegetables, preparation methods of sauses, jams, pickles etc., by the KVK in the rural areas. A total of 355 women participated in these programmes.



A Breast Feeding Week was celebrated in village Rindal of Karnal district in which 55 rural women participated were appraised of the importance of mother's milk and its role in the growth of infants.

Woman in Agriculture Day was celebrated in village Beed Narayana, District Karnal on 4th December, 2015.

Southern Campus, Bangalore

Dairy Entrepreneurship Development of Rural & Women: An Action Research

Two women based Self Help Groups (SHGs) exclusively on dairying were formed and promoted successfully. It demonstrated that dairying as an income generating activity could be taken up by the rural women through SHG platform for sustaining their livelihood. The Institute's interventions in terms of both dairy production as well as processing related technologies were transferred to the SHG members through on-campus and off-campus training, demonstrations, visits etc. The results of the study indicated dairying as a whole had a very positive impact on their livelihood and their overall empowerment in terms of increased knowledge level, better adoption of technologies and improved entrepreneurial behavior of SHG members. The present project successfully demonstrated that dairying as an income generating activity has improved overall socio-economic standard by securing a monthly income of ₹ 6000-7000 from dairying activity alone. SHG is a movement for women empowerment; dairying through SHG movement plays a major role in sustaining the livelihood of members.

HONOURS AND AWARDS

Dr. A. K. Srivastava, Director and Vice Chancellor NDRI was conferred **"Doctor of Science (Honoris Causa)"** for his significant contributions made in the field of Veterinary and Animal Sciences at Pandit Deen Dayal Upadhyay Pashu Chikitsa Vigyan Vishaw Vidyalaya, Mathura on 17th November, 2015.



Dr. A. K. Srivastava, Director NDRI receiving degree of "Doctor of Science (Honoris Causa)" at PDDUPCVV, Mathura

Dr. A. K. Srivastava, Director and Vice Chancellor NDRI received an award for "**Outstanding Contribution to Education"** by Dewang Mehta Education Foundation on 28th November, 2015 at Mumbai.

Dr. Sunita Grover, Head, Dairy Microbiology Division was awarded "**ICAR Rafi Ahmed Kidwai Award 2014 in Animal and Fisheries Sciences Category" for her outstanding research contributions in the area of probiotics**. The award was given during the Award Ceremony on the occasion of ICAR Foundation Day Celebrations on 25th July, 2015 at Patna.

Dr. T. K. Datta, Principal Scientist, Animal Biotechnology Centre received **"XVI Hari Krishna Shastri Memorial Award"** for outstanding scientist in the field of agricultural sciences for the year 2015 by IARI, New Delhi. The award was given by Hon'ble President of India.

Dr. A. Kumaresan, Sr. Scientist, Livestock Production & Management was awarded "**ICAR Lal Bahadur Shastri Outstanding Young Scientist Award 2014 in Animal and Fisheries Sciences Category".** The award was given during the Award Ceremony on the occasion of ICAR Foundation Day Celebrations on 25th July, 2015 at Patna

Dr. Bimlesh Mann, Head, Dairy Chemistry Division was awarded "**ICAR Bharat Ratna Dr. C. Subramanian Award for Outstanding Teachers 2014 in Animal and Fisheries Sciences Category"**. The award was given during the Award Ceremony on the occasion of ICAR Foundation Day Celebrations on 25th July, 2015 at Patna.

Dr. Suman Kapila, Principal Scientist, Animal Biochemistry Division received "**Best Teacher Award 2015"** for teaching at PG level in 14th Convocation of NDRI Deemed University held on 5th March 2016.

Dr. Pradip Behare, Scientist, Dairy Microbiology Division received "**Best Teacher Award 2015"** for teaching at UG level in 14th Convocation of NDRI Deemed University held on 5th March 2016.

Ashish Kumar Singh, Principal Scientist, Dairy Technology & Head, Dairy Engineering Division received **S. K. Sirohi Memorial Award** for Young Researcher for the year 2016 during 14th Convocation on 5th March 2016.

Dr. A. Manimaran, Scientist, SRS Bangalore received "**Prof. V. V. Ranade Young Scientist Award"** in recognition of excellent work and its presentation titled during XV Annual Convention of ISVPT on "Nutritional Pharmacology and Toxicology Beyond Calories" at NDRI, Karnal during 14th-16th January, 2016.

Dr. Sanjit Maiti, Scientist, Dairy Extension Division received "**Jawaharlal Nehru Award"** for outstanding doctoral thesis research in Social Science for the year 2014 by ICAR on 24th July, 2015.

Ms. U. Mothwal, Ph.D. student, Animal Biotechnology Centre received **"Young Investigator Award"** (1st position) by Probiotic Association of India (PAi) for her research work "PepL of *L. rhamnosus* GG is a Cobalt Dependent Highly Specific Leucyl Aminopeptidase" at 3rd Biennial PAi Conference and International Symposium on Stress, Microbiome and Probiotics jointly organized by PAi and National Institute of Science Education and Research (NISER) at Bhubaneswar from 11th – 13th March, 2016.

Ms. R. Devi, Ph.D. student, Animal Biotechnology Centre received **"Young Investigator Award"** (2nd position) of Probiotic Association of India (PAi) for her research work "S-layer Proteins of Lactobacilli Inhibits ETEC Adhesion to the Human Intestinal Cells and Modulates Innate Immune Response of Mice Immune Cells" at 3rd Biennial Pai Conference And International Symposium on Stress, Microbiome and Probiotics Jointly Organized By Pai And National Institute of Science Education and Research (NISER) at Bhubaneswar from 11th – 13th March, 2016.

Ms. Alka Parmar, Student, Dairy Chemistry Division received **"First Position for Young Researcher Award"** for the Oral Presentation in International Conference on Sustainable Innovations in Dairying held at Nalanda, Bihar from 2nd – 5th April, 2015.

Mr. S. Soren, Dairy Cattle Physiology received "**Best Oral Presentation Award"** on "Physiological Approaches for Development of Climate Resilient Livestock Farming" in session IV: Stress physiology, Livestock health & production of XXIV Annual conference of SAPI & National Symposium at Guwahati, Assam from 21st - 22th January, 2016.

Dr. S. V. Singh, Principal Scientist, Dairy Cattle Physiology received "**Best Oral Research Paper Presentation Award"** for the article on "Impact of Climate Change on Productive and Reproductive Performance of Cattle and Buffaloes" by Andaman Science Association during National Seminar on "Harmonizing Biodiversity and Climate Change: Challenges and Opportunity" held at ICAR-CIARI, Port Blair, India from 17th – 19th April, 2015.

Mr. S. Kumar, Dr. S. V. Singh, Ms. Beenam and Dr. R. C. Upadhyay received "**Best Oral Presentation Award"** for paper "Heat Stress Alleviation in Sahiwal Calves Supplemented Chromium Propionate" during the IIIrd Biennial National Conference on "Interventions in Livestock Production Cum-Health and Crop Mixed Farming for Nutrition Security" organized by college of Veterinary and Animal Sciences, CSKHPKV in collaboration with IGFRI and IVRI centres, Palampur from 4th -5th November, 2015.

Mr. S. K. Yadav, Mr. P. Singh, Dr. S. V. Singh, Dr. M. Bhakat, Dr. A. Singh, and Dr. S. Mondal received "**Best Oral Presentation Award"** for paper "Scrotal Surface Temperature and its Relationship with Body Weight, Body Condition Score and Scrotal Circumference in Murrah Buffalo Breeding Bulls" during International Conference, ISAPM 2016 on "Innovative Designs, Implements for Global Environment & Entrepreneuriak Needs Optimizing Utilitarian Sources" held at college of Veterinary Science Rajendra Nagar, Hyderabad from 28th - 31st January, 2016.

Ms. Priyanka Singh Rao, Scientist, Dairy Chemistry Division got **"First Prize"** in Oral Presentation in National Conference on Food Processing and Technology: Current Status and Future Prospects (NCFPT-2016) held at Shoolini University, Solan.

Dr. Rishika Vij received "**INTAS Pharma Young Scientist Award"** during 25th Annual Convention of Indian Society of Veterinary & Toxicology (ISVPT) on Nutritional Pharmacology and Toxicology

beyond Calories held from 14th -16th January, 2016 at NDRI, Karnal. (Comparative Analysis of Transepithelial Transport of Milk Derived Bioactive Peptides) (**Major Advisor Dr. Suman Kapila**).

Dr. Srinu Reddi, student, (Animal Biochemistry) received **"Young Scientist Award"** during 44th DIC – Dairy Industry Conference held from 18th - 20th February, 2016 at NDRI (Identification and Functional Characterization of Osteogenic Peptides) from Buffalo Milk" (**Major Advisor Dr. Suman Kapila**).

Mr. Arun Kumar, Mr. P. Vikram Simha, Mr. H.V., Dr. Heartwin A. Pushpadass, Dr. F. Magdaline Eljeeva Emerald and Dr. M. Manjunatha received with **"First Prize"** for the paper presentation on "Influence of Moisture Content on Flow Characteristics of Spray Dried Milk-Malted Barnyard Millet Powder. In: 6th International Conference on "Emerging Technologies in Food and Nutrition for Health Management" Bengaluru, 14th - 15th May, 2015.

Dr. S. Saugandhika Ph.D. student, Animal Biotechnology Centre received "**Best Thesis Award"** for Production Group for her Ph.D. thesis entitled "Molecular Cloning and Expression of Buffalo Recombinant IFN-Tau and its Effect on *In Vitro* Embryo Development" during 14th convocation of NDRI Deemed University held on 5th March, 2016.

Dr. Shilpa Shree B.G., Dairy Chemistry Division received **"Best Thesis Award"** in processing group for Doctoral research for her work on "Development and Evaluation of Milk Protein – Mineral Complexes" during the 14th Convocation of National Dairy Research Institute, Karnal, 5th March, 2016.

Mr. Saurabh Kadyan awarded **"Best M. Sc. Thesis Award"** (Processing Group) for his M. Sc. Dissertation work carried out in Dairy Microbiology under the guidance of Dr. Naresh Kumar, Principal Scientist, Dairy Microbiology Division, NDRI on the topic entitled "Two Stage Enzyme Based Kit for Detection of *E.coli* in Milk**"** during 14th Convocation of NDRI Deemed University held on 5th March 2016.

Dr. Mohanned Alhussien, student (Animal Physiology) received **"Best Master's Thesis Award"** in the Production group for his thesis on "Expression of Chemokine Receptors (CXCR1/CXCR2), IL8, CD11b and CD62L and its Effect on Chemotactic and Phagocytic Activities of Cow Neutrophils" during 14th convocation of NDRI Deemed University held on 5th March, 2016.

Mr. Parameswaranaik J. Student (Dairy Extension) received **"Best Master Thesis Award"** for his thesis work in Social Science & Management Group during 14th convocation of NDRI Deemed University held on 5th March, 2016.

Dr. P. Mooventhan, Student, Dairy Extension Division received **"Best Thesis Award"** in Social Science & Management Group for his thesis during 14th convocation of NDRI Deemed University held on 5th March, 2016.

Dr. Sanjit Maiti, Scientist, Dairy Extension Division received **"Best Ph.D. Thesis Award"** from Indian Association of Hill Farming during National seminar on "Sustaining Hill agriculture in Changing Climate" on 5th – 7th December, 2015.

Ms. Pampi Paul, Student, Dairy Extension Division received "**Best M.Sc. Thesis Award"** for her thesis work from Indian Association of Hill Farming (IAHF) during National Seminar on "Sustaining Hill Agriculture in Changing Climate" on 5th -7th December, 2015.

Emerson Cup 2015 Jury Award for "Eutectic Module for Milk Cooling" by Emerson Climate Technologies awarded for the M.Tech Thesis by Darshan G.B.

Sh. Chiranjee Aggarwal, Assistant, Director Office, NDRI, Karnal received **"Best Worker Award"** for administrative category and **Sh. Ram Pal Saini,** Skilled Supporting Staff, Dairy Technology Division, NDRI, Karnal for supporting category employees of ICAR during the celebrations of ICAR Foundation Day of ICAR on 25th July, 2015 at Patna**.**

Best Division Award for 2014-15 was given jointly to Dairy Technology and Dairy Chemistry Division of NDRI during 14th Convocation on 5th March 2016.

Dr. K. Ponnusamy, Principal Scientist, Dairy Extension Division received "Outstanding Scientist Award" from Venus International Foundation, Chennai in December 2015.

Ms. Heena Lamba, Dr. Latha Sabikhi and Dr. Sathish Kumar M.H. Dairy Technology Division received **"Best Research Paper Award"** for the paper presented at the 6th International Conference on "Emerging Technologies in Food and Nutritional Sciences" organised by International Institute of Food and Nutritional Sciences (IIFANS), New Delhi and SRS-ICAR-NDRI at Bangalore.

Dr. Chand Ram Grover, Principal Scientist, Dairy Microbiology Division received **"Best Paper Award"** for best research publication entitled "Cholesterol Assimilation Potential of Probiotic *Lactobacillus* Species in Cream for Production of Reduced Cholesterol Butter" in the "Dairy Processing Area" published in *Indian Journal of Dairy Science* for the calendar year 2014 during 44th DIC - Dairy Industry Conference 2016 held at NDRI, Karnal.

Dr. C. N. Pagote, Principal Scientist and **Mr. P. Nawale,** M.Tech student of NDRI, SRS Bangalore received **"Best Paper Award"** for best research paper entitled "Standardisation of Method of Manufacture of Khoa Jalebi" published in Indian Journal of Dairy and Biosciences, vol 24, pp. 25-35, for the year 2014-15.

Mr. Tanmay Hazra, Student, Dairy Chemistry Division received **"Best Paper Award"** for the paper entitled **"**Detection of Adulteration of Ghee (Clarified Milk Fat) with Palmolein and Sheep Body Fat using Reichert-Meissl (RM) Value Coupled with Solvent Fractionation Technique" published in Ind. J. Dairy Sci., by IDA in 44th Dairy Industry Conference held at NDRI**,** Karmal from 18th - 20th February, 2016.

Dr. Srinivas B. and **Dr. M. Sreenath,** SRS, Bangalore received **"Best Paper Award"** for the paper entitled "Impact of Dual Organism Probiotic Supplements on the Performance Of Lactating Cows" published in Indian Journal of Dairy and Bioscience 22: 42-49, 2015.

Dr. D. N. Das, Dr. N. P. Soumya and **Dr. Sukanta Basak**, SRS, Bangalore received **"Best Popular Article Award"** entitled "Sexed Semen: A Novel Opportunity for Dairy Farmers" published in Indian Journal of Dairy and Biosciences Vol 24, 2015.

Mr. Kamal Gandhi, Student, Dairy Chemistry Division received "**Second Best Paper Award"** in Dairy Processing Category for the Paper Published in Indian Journal of Dairy Science (2014) by Indian Dairy Association.

Dr. Neelam Upadhyay, Scientist, Dairy Technology Division received **"Second Best Paper Award"** during the 44th Dairy Industry Conference organized by ICAR-NDRI, Karnal and Indian Dairy Association from 18th – 20th February, 2016.

Ms. Heena Lamba, Ph.D. student of Dairy Technology Division got "**Second Prize"** in the Young Researcher Award for oral presentation during the 44th Dairy Industry Conference 18th -20th February, 2016.

M. P. Rahila, B. S. Nath, N. L. Naik, M. Manjunatha and Heartwin A. Pushpadass received "**Second Prize"** for Oral presentation on "Rosemary (*Rosmarinus officinalis*) extract: A source of Natural Antioxidants to Extend the Shelf-life of Ghee" at National Seminar on Quality- A Tool for Value Addition of Dairy Foods organized by Alumini Association, Southern Regional Station, ICAR-National Dairy Research Institute, Bengaluru, 23rd - 24th January, 2016.

Dr. Rishi Kanta Singh, Dr. A. K. Chauhan and Dr. Raj Kumar Yogi**,** DESM Division received **"Second Best Paper Award"** for their paper entitled "Economic Analysis of Milk Production And Its Disposal Pattern in IDDP Area of Meghalaya State" published in the Indian Journal of Dairy Science; by the Indian Dairy Association under "Dairy Economics, Extension and Management Area".

Ms. Anupama Rani, Student, Dairy Chemistry Division got "**Best Poster Award"** for the poster entitled "Validation of Rapid RP-TLC Method for the Detection of Adulteration of Vegetable Oil in Ghee (Clarified Milk Fat)". presented in the International Conference on Sustainable Innovations in Dairying (ICSID 2015) at Rajgir, Nalanda, Bihar from 2nd -5th April, 2015.

Ms. Chitra Gupta Student, Dairy Chemistry Division received **"Best Poster Award"** for the poster entitled "Iron Microencapsulation with Blend of Gum Arabic Maltodextrin and Modified Starch (Hicap 100) using Modified Solvent Evaporation Method" in 44th Dairy Industry Conference held at NDRI**,** Karmal from 18th - 20th February, 2016.

Ms. Alka Parmar, Student, Dairy Chemistry Division received **"Best Poster Award"** for the poster "FM-4 Enhancement of Antioxidant and Sensory Properties of Buffalo Casein Hydrolysates using Sequential Enzymatic Hydrolysis" at International Conference on Sustainable Innovations in Dairying held at Nalanda, Bihar from 2nd – 5th April, 2015.

Mr. Arun Beniwal, Ms. Priyanka Saini and Dr. Shilpa Vij received "**Best Poster Award"** for their paper entitled **"**Physiological Growth Profile of the Dairy Yeast *Kluyveromyces Marxianus* 6C17 on Galactose during Batch Cultivation (PD-026)" during 44th DIC - Dairy Industry Conference held from 18th - 20th February, 2016 at NDRI, Karnal.

Ms. Rinky Gupta, Dr. S. K. Tomar, Mr. Hitesh and Dr. Rameshwar Singh received "**Best Poster Award"** for their paper entitled "Evaluation of Antimicrobial Attributes of Lactobacilli as Protectant for Cottage Cheese (PA-041)" during 44th DIC - Dairy Industry Conference held from 18th - 20th February, 2016 at NDRI, Karnal.

Ms. Aiswarya S. Panicker, Dr. Pradip V. Behare and Dr. A. K. Mohanty received "**Best Poster Award"** for their paper entitled "Investigation of Bio-Markers of Bile Tolerance in Putative Probiotic *Lactobacillus Fermentum* by Differential Proteomics (PA-021)" during 44th DIC - Dairy Industry Conference held from 18th - 20th February, 2016 at NDRI, Karnal.

Mr. Naresh Kumar N., Mr. A. Kalyan, Mr. M. Balhara, Mr. S. Kadyan, Mr P. K. Sharma, Mr. R. Shukla and Mr. H. V. Raghu received "**Best Poster Award"** for their paper entitled "Enzyme Based Concept for Rapid Detection of Hygiene and Safety Indicators in Milk (QA-035)" during 44th DIC - Dairy Industry Conference held from 18th - 20th February, 2016 at NDRI, Karnal.

Mr. Latika Bhandari, Ph.D. student of Dairy Technology Division got "**Best Poster Award"** in Poster Session on Health and Allied Sciences, Pharmacy & Nutrition during the North Zone Students Research Convention (ANVESHAN-2015) 28th – 29th December, 2015.

Dr. A. K. Roy, Principal Scientist, Dairy Cattle Physiology received "**Best Poster Award"** at Biennial National Conference of the Indian Academy of Veterinary Nutrition and Animal Welfare organized by Department of Animal Nutrition, College of Animal and Veterinary Sciences, CSK HPKV in collaboration with IGFRI, Centre and IVRI station, Palampur-176062 (HP) from 4th - 5th November, 2015.

Mr. S. Kumar, Dr. S. V. Singh, Mr. P. Manjari, Mr. U. Maibam, Ms. Beenam and Dr. R. C. Upadhyay received "**Best Poster Award"** for paper "Effect of Chromium Supplementation on Immunological Status of Sahiwal Calves under Extreme Environmental Conditions" in the technical session "Eco- Resilient Feeding and Precision Nutrition during the ANSICON- 2016" organized by Animal Nutrition Society of India and ICAR-NDRI, Karnal from 6th – 8th February, 2016.

Dr. S. Jeyakumar, Senior Scientist, SRS Bangalore received "**Best Poster Award"** at the 44th Dairy Industry Conference held at ICAR-NDRI, Karnal between 18th-20th February, 2016.

Ms. N. Veena, Dr. B. Surendra Nath, Dr. B. V. Balasubramanyam and Dr. Sumit Aro**ra** got "**Best Poster Award"** under the Dairy Product Development category on "Development of functional milk fortified with Omega-3 Fatty acids, Phytosterols and Soluble Dietary Fibre" at 44th DIC- Dairy Industry Conference held at ICAR-NDRI, Karnal, during 18th-20th February, 2016.

Dr. A. Kumar, Dr. R. Kaushik, Dr. P. Mehta, Dr. M. S. Chauhan, Dr. S. K. Singla, Dr. P. Palta, Dr. R. S. Manik and Dr. M. K. Singh, Animal Biotechnology Centre received **"Best Poster Award"** for their paper "Generation of Buffalo Transgenic Cell Line Containing Human Lysozyme Gene" at National Conference on Applications of Biotechnology for Sustainable Development held at DAV college, Amritsar from 16th – 17th October, 2015.

Dr. P. Vats, Dr. R. Kaushik, Dr. P. Mehta, Dr. M. K. Singh, Dr. P. Palta, Dr. S. K. Singla, Dr. R. S. Manik and Dr. M. S. Chauhan, Animal Biotechnology Centre received **"Best Poster Award"** for their paper "Identification, Isolation and Cloning of Goat Rosa 26 Locus for Site Specific Transgene Integration" at National Conference on Applications of Biotechnology for Sustainable Development held at DAV college, Amritsar from October 16th -17th 2015.

Dr. T. Sharma, Dr. D. Nagoorvali, Dr. S. Viviyan, Dr. A. Sharma, Dr. M. K. Singh, Dr. S. K. Singla, Dr. P. Palta, Dr. R. S. Manik and Dr. M. S. Chauhan**,** Animal Biotechnology Centre received **"Best Poster Award"** for their paper "Transition of Development and Apoptosis-Related Mirnas Expression in Goat (*Capra Hircus*) during Different Stages of Parthenote Embryo Development' at International Conference on Reproductive Health with Emphasis on Occupational, Environmental and Lifestyle Factors & 26th Annual Meeting of the ISSRF, Ahmedabad from 18th – 20th February, 2016.

Mr. Prashant Singh, Mr. Eshu S. Singhal, Mr. Vijay S. Baddela, Mr. Naresh Golla, Dr. Dheer Singh and Dr. Suneel K. Onteru, (Animal Biochemistry) received "**Best Poster Award"** for the poster "Salivary Estradiol Estimation in Ruminants" under the Pharmacokinetics Category in the XV Annual Convention of Indian Society of Veterinary & Toxicology (ISVPT) on Nutritional Pharmacology and Toxicology beyond Calories held from 14th – 16th January, 2016 at NDRI.

Ms. Meenashri, Mr. Himanshu Aggarwal, Dr. Dheer Singh and Dr. Suneel K. Onteru (Animal Biochemistry) received "**Best Poster Award"** for the poster "Development of Serum Free Buffalo Hepatocyte Culture System for Future Toxicological Studies" under the Toxicology category in

the XV Annual Convention of Indian Society of Veterinary & Toxicology (ISVPT) on Nutritional Pharmacology and Toxicology beyond Calories held from 14th – 16th January, 2016 at NDRI.

Ms. Payal Rani, Dr. Suneel K. Onteru and Dr. Dheer Singh, (Animal Biochemistry) received "**Best Poster Award"** for the poster "Exosome: A Novel and Stable Pharmacological Vehicle" under the Therapeutics Category in the XV Annual Convention of Indian Society of Veterinary & Toxicology (ISVPT) on Nutritional Pharmacology and Toxicology beyond Calories held from 14th – 16th January, 2016 at NDRI.

Dr. Naresh Kumar, Mr. N. Kalyan, Mr. A. Balhara, Mr. M. Kadyan, Mr. S. Sharma, Mr. P. K. Shukla R. and Mr. Raghu, H. V. Dairy Microbiology Division received **"Best Poster Award"** for paper entitled "Enzyme Based Concept for Rapid Detection of Hygiene and Safety Indicators in Milk. (QA-035)" during 44th DIC Conference 2016 held at NDRI, Karnal.

Mr. Subrota Hati, Mr. Keyur Patel, Mr. B. K. Mishra, Mr. Mandal S and Mr. J. B Prajapati, Dairy Microbiology Division received **"Best Poster Award (1st Prize)"** for paper entitled "Antimicrobial, Antioxidative and ACE-inhibitory activity of Fermented Soy Milk with Proteolytic Lactic Acid Bacteria" presented in a National Seminar on "Advances of Bioinformatics and Computational Biology in Applied Biotechnology" at Bioinformatics Centre (BIF), Department of R.D.A.P., North-Eastern Hill University, Meghalaya on 5th October, 2015.

Ms. Jasmine Kaur, and **Dr. S. S. Thakur,** Principal Scientist, Dairy Cattle Nutrition Division received **"Best Poster Award"** for paper "Comparison of Chemical Composition of Phalaris Minor Seeds and Conventional Energy Sources" during 1st National Conference of the Society for Veterinary & Animal Husbandry Extension, held at GADVASU, Ludhiana from 18th -20th November, 2015.

Dr. Neelam Upadhyay, Scientist, Dairy Technology Division received **"Best Poster Award"** in the Quality Assurance category held at 44th Dairy Industry Conference organized by ICAR-NDRI, Karnal and Indian Dairy Association from 18th – 20th February 2016.

Mr. Arvind Kumawat, Mr. P. S. Minz, Mr. P. Subramani, Ms. Priyanka, Mr. Dharin Jayswal, Dairy Engineering received **"Best Poster Award"** for the paper entitled "Energy Conservation Opportunities in Dairy Industry" in Dairy Process Development & Engineering Category in 44th Dairy Industry Conference held during 18th – 20th February, 2016 at NDRI, Karnal.

Dr. K. C. Neethu, Dr. Heartwin A. Pushpadass, Dr. F. Magdaline Eljeeva Emerald, Dr. P. Arun Kumar and Dr. B. Surendra Nath, SRS, Bangalore received **"Best Poster Award"** for the paper entitled "Comparison of Microstructure Evolution of Pantoa Fried in Sunflower Oil and Ghee." during 6th International Conference on "Emerging Technologies in Food and Nutrition for Health Management, Bengaluru from 14th - 15th May, 2015.

Dr. Sanchita Garai, Dr. C. Bhakat, Dr. S. Maiti, Dr. T. K. Dutta, Dr. B. S. Meena and Dr. K. Singh, Dairy Extension Division received **"Best Poster Award"** for the paper entitled "Sustainability of Dairy based Livelihood in the districts of West Bengal: A Macro level Analysis" with co-authors in 44th DIC- Dairy Industry Conference, NDRI, Karnal during 18th -20th February 2016.

Dr. Sanchita Garai, Dr. C. Bhakat, Dr. S. Maiti, Dr. T. K. Dutta, Dr. B. S. Meena and Dr. K. Singh received **"Best Poster Award"** for the paper entitled "Sustainability of Dairy based Livelihood in the districts of West Bengal: A Macro level Analysis" in 44th Dairy Industry Conference, NDRI, Karnal during 18th – 20th February, 2016.

Dr. S. Jeyakumar, SRS, Bangalore received **"Best Poster Award"** in the 44th Dairy Industry Conference held at NDRI, Karnal between 18th - 20th February, 2016.

Mr. Darshan G. B., M.Tech student of NDRI, SRS Bangalore shortlisted and ranked as 10th among top 50 under the Indian Innovation Growth Programme (IIGP) 2016 for his innovation "Cooling Module for Milk and other Fluids".

Ms. Indumati K. P., Dairy Chemistry Division selected for **"Netaji Subhas - ICAR International Fellowships (NS ICAR IFs)"** Pursuing Doctoral Degree Abroad in the Identified Overseas Universities/ Institutions.

Ms. Nimisha Tehri, Ph.D. student, Dairy Microbiology Division received **"Second Best Poster"** Award for the poster entitled "Expression of marker enzymes during spore's germination for novel application in assay development" by Tehri, N., Gopaul, R., Kumar, N., Raghu H.V., Yadav, A., Thakur, G., Sharma, P.K. (2015) at 12th Agriculture Science Congress (ASC), Karnal on 3rd - 6th February, 2015 under the area of Food safety and quality management.

Mr. Prasad Patil received "**Young Scientist Award (Third Prize)"** during 44th DIC - Dairy Industry Conference held from 18th - 20th February, 2016 at NDRI, Karnal (Alpha-glucosidase and DPP-IV Inhibitory Activities of Peptides in Milk Fermented with *Lactobacillus* spp

Dr. S. K. Singla and **Dr. M. S. Chauhan,** Principal Scientists, Animal Biotechnology Centre and **Dr. Y. S. Rajput, Head,** Animal Biochemistry Division were awarded "**NAAS Fellowship"** whereas **Dr. Kumaresan,** Sr. Scientist, Livestock Production & Management was awarded "**NAAS Associateship"** during the Silver Jubilee Celebration of National Academy of Agricultural Science at Delhi during 2nd – 5th June, 2015.

Dr. S. S. Lathwal, Incharge Livestock Research Centre honoured with **"National Fellow"** of Animal Production and Management (FNAPM) in recognition of his significant contribution towards livestock development, by Indian Society of Animal Production and Management (ISAPM) during international conference on livestock from 28th – 31st January, 2016 at Hyderabad.

Dr. K. P. Ramesha, Principal Scientists, SRS, Bangalore was awarded **"Fellowship of National Academy of Veterinary Sciences (India)"** at IVRI, Izatnagar, Bareily, U.P. on 28th October, 2015.

Mr. D. Juyal, Dr. I. K. Sawhney, Dr. A. K. Dodeja, and Mr. P. S. Minz, Dairy Engineering received **"Young Scientist Award Appreciation Certificate"** for the paper "Improvisation of Rotor Blade Assembly of Scraped Surface Heat Exchanger for Energy Conservation" In 44th Dairy Industry Conference Make in India: Dairying 2030 at ICAR-National Dairy Research Institute, Karnal during 18th – 20th February, 2016.

Dr. N. P. Soumya, Ph.D. student, SRS, Bangalore student received **"Gold Medal"** for Ph.D. research work during 14th Convocation of NDRI Deemed University held on 5th March, 2016.

Dr. S. Subash, SRS, Bangalore received **"Award of Academic Excellence and Gold Medal"** during September 2015 for having secured First position in Post Graduate Diploma in Technology Management in Agriculture (PGDTMA) - One Year Distance Learning Programme jointly offered by University of Hyderabad & NAARM, Hyderaba



PUBLICATIONS

Research Papers

Aarif, O. and Aggarwal, A. (2015) Dry period cooling ameliorates physiological variables and blood acid base balance, improving milk production in murrah buffaloes. *Int. J. Biomet.*, DOI 10.1007/s00484-015-1044-4.

Aarif, O. and Aggarwal, A. (2016) Evaporative cooling in late-gestation Murrah buffaloes potentiates immunity around transition period and overcomes reproductive disorders. *Theriogenology,* 84: 1197–1205.

Abdullah, Muzamil, Mohanty, T. K., Patbandha, T. K., Bhakat, M., Madkar, A. R., Kumaresan, A. and Mohanty, A. K. (2015) Pregnancy diagnosis-positive rate and conception rate as indicator of farm reproductive performance. *Indian J. Anim. Res.,* DOI:10.5958/0976-0555.2015.00155.7.

Aggarwal, D., Sabikhi, L. and Sathish, M. H. K. (2015) Formulation of reduced-calorie biscuits using artificial sweeteners and fat replacer with dairy–multigrain approach. *NFS J.* (Elsevier), http://dx.doi.org/10.1016/j.nfs.2015.10.001. Published online: Oct 31, 2015.

Aggarwal, S., Rajput, Y. S., Singh, G. and Sharma, R. (2015) Synthesis and characterization of oxytetracycline imprinted magnetic polymer for application in food. *Applied Nanoscience,* DOI DOI: 10.1007/s13204-015-0437-3.

Agrawal, Nimisha, Sharma, Dinesh Kumar, Mandal, Ajoy, Rout, Pramod Kumar and Kushwah, Yogendra Kumar (2015) Dynamics of faecal egg count in natural infection of *Haemonchus spp*. in Indian goats. *Vety. World*, 8 (1): 38-41.

Alhussien, M., Kaur, M., Manjari, P., Kimothi, S. P., Mohanty, A. K. and Dang, A.K. (2015) A comparative study on the blood and milk cell counts of healthy, subclinical, and clinical mastitis Karan Fries cows. *Veterinary World,* 8 (5): 685-89.

Amitraj, K., Khamrui, K., Devaraja, H. C. and Mandal, S. (2016) Optimization of ingredients of a chhana (heat acid coagulated milk curd) based low fat spread using response surface methodology. *Int. J. Dairy Technol*., DOI: 10.1111/1471-0307.12272. Published online: Jan 8, 2016.

Amrutkar, S. A., Pawar, S. P., Thakur, S. S., Kewalramani, Neelam J. and Mahesh, M. S. (2015) Dietary supplementation of rumen protected methionine, lysine and choline improves lactation performance and blood metabolic profile of Karan- Fries cows. *Agric. Res.* 4 (4): 396-404.

Amrutkar, S. A., Pawar, S. P., Thakur, S. S., Kewalramani, Neelam and Kaur, Jasmine (2016) Effect of pre-partum supplementation of rumen protected methionine lpus lysine and choline supplementation on the performance of crossbred cows. *Indian J. Anim. Sci.,* 86 (1): 65-69.

Anand, V., Jaswal, S., Singh, S., Kumar, S., Jena, M. K., Verma, A. K., Yadav, M. L. Janjanam, J., Lotfan, M. Malakar, D., Dang, A. K., Mohanty, T. K., Kaushik, J. K. and Mohanty, A. K. (2016) Functional characterization of Mammary Gland Protein-40, a chitinase-like glycoprotein expressed during mammary gland apoptosis. *Apoptosis,* 21 (2): 209-24.

Anand, V., Jaswal, S., Singh, S., Kumar, S., Jena, M. K., Verma, A. K, Yadav, M. L., Janjanam, J., Lotfan, M., Malakar, D., Dang, A. K., Mohanty, T. K., Kaushik, J. K. and Mohanty, A. K. (2015) Functional characterization of Mammary Gland Protein-40, a chitinase-like glycoprotein expressed during mammary gland apoptosis. *Apoptosis,* 21 (2): 209-24.

Anurag, Rahul K., Manjunatha, M., Jha, Shyam Narayan and Kumari, Leena (2015) Storage Quality of Shelled Green Peas under MAP at Different Storage Conditions. *J. Food Sci. and Tech.,* DOI: 10.1007/s13197-015-2066-y.

Argade, S. D., Sankhala, G. and Kisan, W. S. (2015) Farmer's perception towards integrated farming systems in Maharashtra: A methodological approach. *Int. J. Ext.,* 03 (01): 25-30.

Arya, Ashwani, Verma, Archana, Gupta, I. D., Shahid, A. Shergojry, Magotra, Ankit, Kumar, Dhaman and Singh, Arun P. (2015) Molecular characterization and SNP identification in HSPB1 gene in Murrah buffalo. *Indian J. Anim. Res.,* 48 Online Published Date: 2015-03-10 DOI: 10.5958/0976-0555.2015.00035.7.

Asha, A., Manjunatha M., Rekha, R. M., Surendranath, B., Heartwin, P., Rao, J., Magdaline, E., Sinha, C. (2015) Antioxidant activities of orange peel extract in ghee (butter oil) stored at different storage temperature. *J. Food Sci. and Technol.,* 52 (12): 8220-8227 DOI 10.1007/s13197-015-1911-3.

Ashry, M., Lee, K., Mondal, M., Datta, T. K., Folger, J. K., Rajput, S. K., Zhang, K., Hemeida, N. A. and Smith, G. W. (2015) Expression of TGFβ superfamily components and other markers of oocyte quality in oocytes selected by brilliant cresyl blue staining: Relevance to early embryonic development. *Molecular Reproduction & Development*, 82: 251–64. doi: 10.1002/mrd.22468.

Aswin, K. and Srinivas, B. (2015) Allantoin, creatinine and uric acid – A metabolic markers in dairy cattle – a HPLC study. *Spinco Biotech. Cutting Edge,* 5 : 21-24.

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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 provide opportunities to the employees to develop their competencies.

A. Deputations Abroad

- **Dr R. K. Malik, Joint Director (Research)** and **Dr. Surajit Mondal,** Scientist visited Riddet Institute, Massey University, Palmerston North 4442 from 22nd October to 4th November, 2015 under the DST funded Indo-NZ project: "Development of Resilient Probiotic Foods Designed for the Indian Market Conditions".
- **Dr A. K. Srivastava, Director, NDRI** and **Dr A. K. Tyagi,** Head, Dairy Cattle Nutrition Division were deputed as expert members to Michigan Biotechnology Institute, MSU, USA from 2nd – 5th December, 2015 to develop long term collaborative research and development programme for "Biomass Upgrading Technologies for Animal Feed and Fodder in India".
- **Dr. Rajeev Kapila,** Principal Scientist, Animal Biochemistry Division was deputed as Visiting scientist / Guest lecturer **to** Anhalt University of Applied Sciences, Kothen, Germany under **Erasmus Mundus Programme** for teaching European students of M.Sc. in Food Science, Technology and Nutrition from 23rd May to 21st June, 2015.
- **Dr. Sohan Vir Singh**, Principal Scientist, Dairy Cattle Physiology Division attended workshops on "Agricultural Model Inter Comparison and Improvement Project (Ag MIP)'s Phase-II Fundamental" held at Zimbabwe from 23rd June to 1st July, 2015 and at Dakar, Senagal from 22th– 29th February, 2016.
- **Ms. Namita Rokana,** Ph.D. scholar, Dairy Microbiology Division presented paper entitled **"**Impact of probiotic fermented milk formulations on amelioration of *Salmonella* infection through modulation of intestinal barrier function" at International Association for Probiotics and Prebiotics (ISAPP) Students and Fellows Association (SFA)-2015 annual meeting held at Washington DC, USA from 18th – 21st May, 2015.
- **Ms. Kiran Thakur,** Ph.D. scholar, Dairy Microbiology Division presented paper entitled "Harnessing *Lactobacilli* for Riboflavin Production" at International Association for Probiotics and Prebiotics (ISAPP) Students and Fellows Association (SFA)-2015 annual meeting held at Washington DC, USA from 18th – 21st May, 2015.

B. Participation in Trainings/Workshops (Category-wise) within India

Faculty

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Dr. K. Ponnusamy, PS	Workshop on "IARI-SAUs/ICAR Institutes Collaborative National Extension Programme".	9th April, 2015	IARI, New Delhi.
Dr. Mahendra Singh, PS Dr. A. K. Roy, Sr. Sci.	5th Training Programme on "Science, Technology and Emerging Trends in Governance for Scientists and Technologists".	1st - 6th May, 2015	Indian Institute of Public Administration, New Delhi

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Dr. Sanket Girdharbhai Borad, Sci. Dr. Neelam Upadhyay, Sci. Dr. Writdhama Prasad, Sci. Sh. Gunvant Singh Rathod, Sci.	Professional Attachment Training.	12th May-27th June, 2015	CIPHET, Ludhiana
Dr. Sachinandan Dey, PS	Workshop on "DNA Profiling for Food Safety".	28th - 29th May, 2015	NIFTEM, Sonipat
Dr. A. Kumaresan, Sr. Sci.	Fourth Annual Review Workshop of NASF.	28th - 29th May, 2015	NAAS Complex, New Delhi.
Dr. A. K. Tyagi, Head Dr. S. S. Thakur, PS Dr. Neelam J Kewalramani, PS Dr.(Mrs.) Veena Mani, PS Dr. S. S. Kundu, PS Dr.(Mrs.) Madhu Mohini, PS Dr. Goutam Mondal, Sr. Sci, Dr. Nitin Tyagi, Sr. Sci,	Regional Workshop on "Nutrition and Feeding Strategies for Goats: Linking Climate Resilient Feeding and Poverty Alleviation".	1st June, 2015	CIRG, Makhdoom, Farah, Mathura.
Dr. Meena Malik, Prof.	Self-Awareness and Higher Goals in Education.	2nd - 6th June, 2015	IIT, Madras
Dr. K. Ponnusamy, PS	Workshop on "Empowerment of Farm Women" through Livestock Technologies".	6th June, 2015	Central Institute for Women in Agriculture (CIWA), Bhubaneswar.
Dr. S. S. Thakur, PS	Workshop on "Recent Dairy Animal Nutrition & Feeding Technologies" organized by Jubilant Life Sciences.	6th June, 2015	NOIDA, U.P.
Dr. Nishant Kumar, Sci.	Training course on "Ultrasonography in Large Animal Reproduction for Fertility Augmentation".	22nd - 27th June, 2015	ICAR-CIRB, Hisar
Dr. Sanket Girdharbhai Borad, Sci. Dr. Neelam Upadhyay, Sci. Dr. Writdhama Prasad, Sci. Sh. Gunvant Singh Rathod, Sci.	Training Professional Attachment Training.	30th June - 27th July 2015	CIFT ,Kochi
Dr. Laxmana Naik, Sci.	Refresher Course on "Food Science and Biotechnology".	4th - 24th July, 2015	BHU, Varanasi
Dr. Naresh Kumar, PS Dr. Rajan Sharma, PS Dr. Surajit Mandal, Scientist	Short Course on "Advanced Diagnostic Approach for Food Borne Contamination of Livestock Products with Special Emphasis on Zoonotic Diseases".	9th July, 2015	NRC-National Research Centre on Yak, Dirang (AP).
Dr. Magan Singh, Sr. Sci. Dr. Sunil Kumar Ontero, Sci.	Refresher Course on "Agricultural Research Management".	13th - 25th July, 2015	ICAR-NAARM, Hyderabad
Dr. Sanket Girdharbhai Borad, Sci. Dr. Neelam Upadhyay, Sci. Dr. Writdhama Prasad, Sci. Sh. Gunvant Singh Rathod, Sci.	Professional Attachment Training.	29th July -12th August, 2015	IISR, Calicut
Dr. S. Subash, Sci. Dr. Shaik Abdul Hussain, Sci.	Training Programme on "Consultancy Projects Management".	3rd – 8th August, 2015	NAARM, Hyderabad
Dr. Smita Sirohi, Head Dr. A. K. Mohanty, PS Dr. K. Ponnusamy, PS	Fourth Annual Workshop and Presenting the Progress of NICRA Project.	13th -14th August, 2015	CMFRI Kochi
Dr. Ajmer Singh, PS	Good Dairy Economics Practices Novel Initiatives and Extension Approaches.	18th - 27th August, 2015	ICAR-NDRI, Karnal
Dr. Rakesh Kumar, Sr. Sci.	Training Programme on "Conservation Agriculture System".	2nd - 11th September, 2015	ICAR-CSSRI, Karnal

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Dr. S. Subash, Sci.	ICAR Short Course on "Business Planning for Developing New Agro Technology Enterprises".	2nd – 11th September, 2015	CTCRI, Thiruvananthapuram
Dr. Sachin Kumar, Sci.	Nutrition for Sustainable Production and Health under Impending Climate Change.	17th September - 7th October, 2015	ICAR-IVRI, Izatnagar
Dr. H. R. Meena, Sr. Sci.	Training Programme on "Capacity Building Programme on Methodology in Agriculture Extension Research".	21st - 24th September, 2015	NASC Complex, New Delhi
Dr. Saroj Rai, Sci.	Winter School Training Programme.	1st - 21st October, 2015	NIANP Bangalore
Sh. Ganga Sahay Meena, Sci. Dr. Yogesh Khetra, Sci. Mr. G.S. Meena, Sci.	National Training Programme on "Instrumentation Involved in Quality Assurance of Milk and Milk Products".	3rd - 23rd October, 2015	DC Division, NDRI, Karnal
Dr. M. Karunakaran, Sr. Sci.	National Training Programme on "Artificial Insemination in Pigs organized by ICAR- Central Coastal Agricultural Research Institute".	24th October, 2015	Goa
Dr. A. K. Gupta, PS	Annual Review "Workshop of AICRP on Cattle".	28th - 29th October, 2015	NASC Complex, New Delhi
Dr. P. Narender Raju, Sci.	Training Workshop on "Innovative Approaches to Technology Enhanced Learning".	28th October, - 6th November, 2015	ICAR-NAARM, Hyderabad
Dr. A. Mandal, Sr. Sci	One day Regional Workshop on "Lower Gangetic Plains Region" Covering West Bengal (Except Hilly Areas), Bramhaputra Valley of Assam and Eastern Part of Bihar.	31st October, 2015	ICAR-CIFRI, Barrackpore, West Bengal.
Dr. Priyanka Singh Rao, Sci. Dr. Sunita Meena, Sci.	Winter School Training Programme on "Advanced Technique... Foods".	17th November, -7th December, 2015	DC Division, NDRI Karnal
Dr. (Ms.) Neelam Upadhyay, Sci. Dr. S. G. Borad, Sci.	CAFT Training Programme on "Designing New Age Dairy Foods" .	28th November, -18th December,, 2015	DT Division, NDRI, Karnal
Dr. Rubina Kumari, Sci. Dr. Mukesh Bhakat, Sr. Sci.	Short Course Training programme on "Cross Breed Male Infertility and Bovine Genomics".	8th - 17th December, 2015	ABC, NDRI, Karnal
Dr. Rakesh Kumar, Sr. Sci.	Training Programme on "Recent advances in Next Generation Sequencing Data Analysis".	8th - 18th January, 2016	IASRI, New Delhi
Dr. Anupama Mukherjee, PS	Bioinformatic Tools for Analysis of Genomic and Proteomic Data in Livestock and Poultry.	19th - 29th January, 2016	ICAR-NBAGR, Karnal
Dr. M. Sivaram, PS	4th National Knowledge Network Workshop.	21st– 22nd January, 2016	JNTU, Hyderabad organized by Department Information Technology, Govt. of India
Dr. Naresh Kumar, PS	Workshop on Fixation of MRL for Pesticides, Veterinary Drugs and Antibiotics in Foods.	1st - 2nd February, 2016	New Delhi
Dr Anjali Aggarwal, PS	Competency Development for HRD Nodal Officers of ICAR.	10th -12th February, 2016	ICAR-NAARM, Hyderabad

Name of Employee	Name of the Training Programme attended	Duration (days)	Organizing Institute
Dr. Mahendra Singh, PS	5th Training Programme on "Science, Technology and Emerging Trends in Governance" for Sci. and Technologists.	15th – 19th February, 2016	Indian Institute of Public Administration, New Delhi
Dr. K. P. Ramesha, PS	Workshop on "Conservation and Optimum Utilization of Indigenous Animal Genetic Resources of Karnataka".	26th February, 2016	Hassan Veterinary College, Hassan at Karnataka
Dr. Nitin Tyagi, Sr. Sci.	Short course on "Clinical Nutrition Approaches for Gut Health of Animals".	5th -14th March, 2016	Jawaharlal Nehru University, New Delhi
Dr. M. Sivaram, Sr. Sci.	Workshop on SAS Visual Analytics 7.1 organized by EPOCH Research Institute (SAS accredited Training Centre).	16th March 2016	Bengaluru
Administrative Staff			
Sh. Mithlesh Kumar, Sr. F&A.O	Management Development Programme on "Public Procurement".	3rd - 8th August, 2015	NIFM Faridabad
Sh. K. P. S. Gautam, CAO Sh. Mithlesh Kumar, Sr.F&A.O	Training Programme on "Administration and Finance Management".	11th -14th August, 2015	ICAR-NAARM, Hyderabad
Sh. S. George, Comptroller	MDP on "Public Procurement".	12th -17th October, 2015	NIFM, Faridabad
Sh. Vishal Acharya, AF&AO	Management Development Programme on Accrual Accounting in Government.	4th - 9th January, 2016	NIFM, Faridabad
Sh. S. George, Comptroller	Workshop on "Formulation of Budget".	28th - 29th January, 2016	NIFM, Faridabad
Technical Staff			
Sh. P. C. Singh, ACTO Sh . Ravi Kant, ACTO Sh. Lehri Singh, ACTO Sh. Y. P. Singh, T O	Competency Enhancement Programme for Technical Personnel.	19th - 29th August, 2015	NAARM, Hyderabad
Sh. Sandeep Deswal, STO	Training Camp for NCC Cadets.	17 - 26 August, 2015	NCC Academy Ropar (PB), Haryana Battalion, Karnal
Sh. Dheeraj Kumar, S.T.A	7th Capacity Building Programme for Technical Personnel.	28th September - 9 October., 2015	IIPA, New Delhi

Training Organized for Supporting Staff

Training on "Emotional Intelligence for Balanced Life" was conducted for supporting staff on 1st February, 2016 by Personality Development Cell of ICAR-NDRI under HRD activities. In this training, a total number of 29 employees from various Divisions participated. There were lectures on "Positive thinking" and 'Stress Management". In addition, yoga was demonstrated practically and there was group discussion also.

HRD Fund Allocation and Utilization

Total HRD fund allocation during 2015-16	:	20 lakhs
Actual expenditure during 2015-16	:	20 lakhs
Percent utilization	:	100 %

Participation in Conferences/Seminars within India

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. R. K. Malik, Jt. Dir. (Res.) Dr. I. K. Sawhney, Head Dr. A. K.Tyagi, Head Dr. Dheer Singh, Head Dr. Sumit Arora, PS Dr. A. K. Singh, PS Dr. Gopal Sankhala, PS Dr. M. S. Chauhan, PS Dr. S. S. Lathwal, PS Dr. Vivek Sharma, PS Dr. S. K. Kanawjia, PS Dr. S. K. Gautam, PS Dr. S. K. Tomer, PS Dr. Veena Mani, PS Dr. S. S. Kundu, PS Dr. Kaushik Khamrui, Sr. Sci. Dr. Sunil Kumar Onteru, Sci. Mr. G. S. Meena, Sci. Mr. Shaik Abdul Hussain, Sci. Mr. Diwas Pradhan, Sci. Ms. Richa Singh, Sci.	International Conference on "Sustainable Innovations in Dairying: Dairy Processing for Nutritional and Livelihood Security" (ICSID 2015)" at Rajgir, Nalanda, Bihar.	2nd – 5th April, 2015
Dr. Sohan Vir Singh, PS Dr. M. K. Ghosh, PS Dr. Mohan Mondal, Sr. Sci.	National Seminar on "Harmonizing Biodiversity and Climate Change" at Port Blair (Andeman & Nicobar Islands).	17th– 19th April, 2015
Dr. A. K.Tyagi, Head Dr. A. K. Singh, PS Dr. Gopal Sankhala, PS Dr. M. L. Kamboj, PS Dr. Rajan Sharma, PS Dr. T. K. Mohanty, PS Dr. Rakesh Kumar, Sr.Sci.	National Seminar at Ajmer Zila Dugdh Utpadak, Ajmer.	18th -19th April 2015
Dr. Latha Sabikhi, Head	National Seminar on "Prospects of Fermentation Technology" held at College of Dairy Science & Technology, Mannuthy, Trichur.	22nd April, 2015
Dr. M .S. Chauhan, PS Dr. Mukesh Bhakat, Sr. Sci.	International Conference on "Low Temerature Science and Biotechnology Advances" at NASC Complex, New Delhi.	27th – 30th April 2015
Mr. Chitranayak, Sr. Sci. Dr. M. Manjunatha, Sci. Dr. S. Subash, Sci.	International Symposium on "Role of Veterinary Ayurveda and Ethno-veterinary Practices in Reducing use of Antibiotic and other Chemical Veterinary Drug in Dairy Farming" at Trans-Disciplinary University (TDU), Yelahanka, Bangalore.	30th April to 1st May 2015
Dr. Latha Sabikhi, Head Dr.(Mrs.) Suman Kapila, PS Dr. B. Surendra Nath, PS Dr. B. C. Ghosh, PS Dr. B. V. Balasubramanyam, PS Dr. P. K. Dixit, PS Dr. K. P. Ramesha, PS Dr. Bandla Srininvas, PS Dr. K. Jayaraj Rao, PS Dr. D. N. Das, PS Mr. Chitranayak, Sr. Sci. Dr. S. Jeyakumar, Sr. Sci. Dr. M. Sivaram, Sr. Sci. Dr. P. Heartwin Amaladhas, Sr. Sci.	6th International Conference on "Emerging Technologies in Food and Nutritional Sciences". organised by International Institute of Food and Nutritional Sciences (IIFANS) and ICAR-NDRI-SRS, Bangalore.	14th – 15th May, 2015

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. Menon Rekha Ravindra, Sr. Sci. Dr. M. C. A. Devi, Sr. Sci. Dr. Mukund A. Kataktalware, Sr. Sci. Dr. F.Magdaline, Sr. Sci. Dr. P. N. Barnwal, Sr. Sci. Dr. S. Subash, Sci. Dr. S. Varalakshmi, Sci. Dr. M. Manjunatha, Sci. Dr. Satish Kumar M.H. Sci.		
Dr. Mukund A. Kataktalware, PS	International Conference on "Climate Change and Social-Ecological-Economical Interface-Building: Modelling Approach to Exploring Potential Adaptation Strategies for Bio-resource Conservation and Livelihood Development" jointly organized by the Centre for Ecological Economics and Natural Resources, Institute for Social and Economic Change (ISEC), Bengaluru and Centre for Environmental Systems Research, University of Kassel, Germany at ISEC, Bengaluru.	20th-21st May, 2015
Mr. Yogesh Khetra, Sci. Mr. G. S. Meena, Sci. Mr. Shaik Abdul Hussain, Sci.	Seminar on "Basics of Rheology: Viscoelasticity and Rheology" at JNU campus, New Delhi.	22nd May, 2015
Dr. Naresh Kumar, PS	Seminar on "Quality Standards and Nutritional Value of Milk. National Institute of Technical Teachers Training and Research (NITTR)", Chandigarh.	30th May, 2015
Dr. Latha Sabikhi, Head Dr. Bimlesh Mann, Head Dr. A. K. Singh, PS Dr. S. K.Kanawjia, PS Dr. Sudhir Kumar Tomar, PS Dr. Shilpa Vij, PS Dr.(Mrs) Suman Kapila, PS Dr. Sunil Kumar Onteru, Sci. Mr. Yogesh Khetra, Sci.	Brainstorming Session on "Functional Livestock Products" at IVRI, Izatnagar, Bareilly.	6th June, 2015
Dr. Ashok Santra, PS	1st International Conference on "Agriculture and Horticulture Science" at New Delhi.	6th – 7th June, 2015
Dr.(Mrs) Smita Sirohi, Head	Workshop on "Integrated Modeling under NICRA" at CESCRA, IARI New Delhi.	8th -9th June, 2015
Dr. A. K. Mohanty, PS	To deliver a talk as a guest faculty in the area of Proteomics to the participants of a summer school at CIFA, Bhubaneshwar.	10th -12th June 2015
Dr. S. K. Tomar, PS	European Union India Dialogue Seminar on "Food Control under in auspices EU-India Capacity Building Initiative for Trade Development" at New Delhi.	23rd -24th June, 2015
Dr. Madhu Mohini, PS Dr. G Mondal, PS	National Inventory Management System, Organised by MoE&F at India Habitat Centre, New Delhi.	3rd July, 2015
Dr. A. Kumaresan, Sr. Sci.	Seminar on "Development in Bovine Reproduction Biotechnologies" at IMV, New Delhi,	13th -14th July, 2015
Dr. Sachinandan Dey, PS	Seminar on "Genomics,,, Biotechnologies" at IMV Gurgaon.	14th July, 2015
Dr. R. K. Malik, Joint Director (Res.) Dr. Dalip Kumar Gosain, PS	9th National Conference on KVK at Patna.	25th - 26th July, 2015
Dr. A. Manimaran, Sci.	Seventh International Clinical Case Conference on "Farm and Companion Animal Practice for Veterinary Students" at VCRI, Namakkal.	13th-14th August, 2015

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. Sumit Arora, PS Dr. Kaushik Khamrui, Sr. Sci.	International Conference on "Food Processing and Analysis" at Chandigarh.	20th – 21st August, 2015
Dr. S. Subash, Sci.	International Agri-business Congress 2015 at BIEC, Bangalore.	21st - 23rd August, 2015
Dr. M. K. Singh, Sci.	3rd Advisory Committee Meeting of NFBSFARA Project at CIRG-Makhdoom, Mathura.	28th August, 2015
Dr. Magan Singh, Sr. Sci.	National Group Meeting Rabi 2015-16 at MPK Rahuri, Maharashtra.	2nd– 4th September, 2015
Dr. M. S. Chauhan, PS	To deliver lecture on "Cloning and Stem Cell... Production in International Conference" at Fortune Murali Park, Vijasywada (A.P.)	10th - 11th September, 2015
Dr. M. Karunakaran, Sr. Sci.	Michael Faraday IET International Summit-2015 at Kolkata.	12th to 13th September, 2015
Dr. A. K. Singh, PS Dr. Rajan Sharma, PS Dr. Gopal Sankhala, PS Dr. B. S. Meena, PS Dr. Rakesh Kumar, Sr. Sci.	National Seminar on "Dairy Vyavsaya Mein Nai Dishai Vision-2020" at Tourism Department, Gwalior.	13th -15th September, 2015
Dr. M. S. Chauhan, PS	6th World Congress on Biotechnology at New Delhi.	5th -7th October, 2015
Mr. G. S . Meena, Sci. Mr. Sanket Borad, Sci.	National Conference on "Innovative Techniques in Food Processing Technology" at SLIET, Longowal.	9th – 10th October, 2015
Dr. P. Narender Raju, Sci.	Research Conclave as part of World Packaging Congress" at Mumbai.	9th – 10th October, 2015
Dr. Rakesh Kumar, Sr. Sci.	25th Asian Pacific Weed Sciences Society Conference on "Weed Science for Sustainable Agri.....Biodiversity" at DWR, Hyderabad.	13th – 16th October, 2015
Dr. H. R. Meena, Sr. Sci.	National Seminar on Rural Transformation in India: Challenges, Opportunity and Strategies organized by the Institute of Management Studies and Research at Maharishi Dayanand University, Rohtak (Haryana).	17th October, 2015
Dr. P. K. Dixit, PS Dr. M. Sivaram, Sr. Sci.	State Level Unit Cost Committee (SLUCC) Meeting Credit Seminar (2016-17) at NABARD, Bengaluru.	28th October, 2015
Dr. A. K. Tyagi, Head	Meeting with Stake Holder at NIANP, Bangalore.	30th October, 2015
Dr. Mahendra Singh, PS	3rd Indian Academy of Veterinary Nutrition and Animal Welfare (IAVNAW) Conference at CSK, HPKV, Palampur.	4th - 5th November, 2015
Dr. H .R. Meena, Sr. Sci.	ISEE Golden Jubilee National Seminar on "Strategy to Drive Skill Based Agriculture Development forward for Sustainability in Rural" organized by the Department of Extension Education, at Institute of Agriculture Science, BHU, Varanasi (U.P.).	5th – 7th November, 2015
Dr. A. Kumaresan, Sr. Sci.	Review meeting of NFBSFARA Project, AIIMS, New Delhi.	14th November, 2015
Dr. K. Punnusammy, PS, Dr. H. R. Meena, Sr. Sci.	National Conference on "Push to the Livestock Farming through Knowledge Empowerment of the Farmers at College of Veterinary Science, GADVASU, Ludhiana.	18th- 20th November, 2015
Dr. A. K. Mohanty, PS	Indo-French Meeting on "Application of Structural Biology.. Design" at Navi Mumbai.	19th- 20th November, 2015

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. Smita Sirohi, Head Dr. B. S. Chandel, PS Dr. A. K. Chauhan, PS Dr. Ajmer Singh, PS	Platinum Jubilee Conference of Indian Society of Agricultural Economics at Dept. of Eco. & Socio of Economics and Sociology, PAU, Ludhiana (Punjab)	19th -21st November, 2015
Dr. S. Subash, Sci.	Rashtriya Krishi Mela 2015 at GKVK Campus, Bangalore.	19th -22nd November, 2015
Dr. R. K. Malik, Joint Director (Res.)	International Conference on "Ethnic Fermented Foods and Beverages: Microbiology and Health Benefits" at Gangtok, Sikkim India.	20th – 21st November, 2015
Dr. A. Chatterjee, PS Dr. Sanchit Maiti, Sci.	22nd International Grassland Congress IGC 2015 at New Delhi.	20th – 22nd November, 2015
Dr. S. Subash, Sci.	Society for Technology Management (STEM) Annual Summit-2015 at Hyderabad.	26th -27th November 2015
Dr. Vijay Kumar, Emeritus Scientist	9th Food World India at FICCI, New Delhi.	3rd December, 2015
Dr. Mukund A. Kataktalware, PS Dr. A. Kumaresan, Sr. Sci. Dr. Rubina Kumari Baithalu, Sci. Dr. Nishant Kumar, Sci.	Conference on "Current Challenges and Opportunities in Animal Reproduction" at Bengaluru.	3rd - 5th December, 2015
Dr. A. Kumaresan, Sr. Sci. Dr. Rubina Kumari Baithalu, Sci.	Conference on "Current Challenges and Opportunities in Animal Reproduction" at Chennai.	6th – 9th December, 2015
Mr. Chitranayak Sinha, Sr. Sci. Smt. F. Magdaline Eljeeva Emerald, Sr. Sci.	International Symposium on "Biodiversity, Agriculture, Environment and Forestry" at Ooty, Tamil Nadu.	11th - 12th December, 2015
Dr. R. K. Malik, Joint Director (Res.) Dr. Bimlesh Mann, Head Dr. T. K. Dutta, Head Dr. Rajan Sharma, PS Dr. M. K. Ghosh, PS Dr. S. K. Das, PS Dr. C. Bhakat, PS Dr. A. Santra, PS Dr. A. Chatterjee, PS Dr. A. Mandal, Sr. Sci. Dr. D. Mandal, Sr. Sci. Dr. M. Mondal, Sr. Sci. Dr. M. Karunakaran, Sr. Sci. Dr (Mrs.) Saroj Rai, Sci. Dr. A. Ghosh, CTO Dr. S. Dutta, CTO Sh. A. Goswami, CTO	Workshop cum Scientists Dairy Industry Partners Meet on "Commercialization of Dairying through Production and Traditional Processing" at ERS, NDRI, Kalyani.	12th December, 2015
Dr. A. K. Mohanty, PS	Targeted Proteomics Workshop and International Symposium at IIT Mumbai.	12th - 15th December, 2015
Dr. D. K. Jain, Emeritus Scientist	Annual Conference of Indian Society of Agricultural Statistics, University of Kota, Kota.	14th -16th December, 2015
Dr. M. C. A. Devi, Sr. Sci. Dr. S. Subash, Sci.	8th GCRA International Conference on "Innovative Digital Applications for Sustainable Development" at University of Agricultural Sciences, GKVK Campus, Bengaluru.	5th -7th January, 2016
Mr. Yogesh Khetra, Sci.	National Livestock Championship and Expo cum Seminar at DAHFDF & FICCI at Sri Muktsir Sahib, Punjab.	11th January, 2016

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. Ajay Mondal, Sr. Sci. Dr. M. Karunakaran, Sr. Sci. Dr. Saroj Rai, Sci.	National Seminar on "Resource Based Inclusive Agriculture and Rural Development Opportunities and Challenges" at Ram Krishna Mission Ashrama, Narendrapur, Kolkatta.	15th – 16th January, 2016
Dr. Nitin Tyagi, Sr. Sci. Dr. H. R. Meena, Sr. Sci.	International Conference on "Recent Advances Agriculture, Aquaculture, Food Technology, Environmental Dynamics and Climate Change (AFTEC-2016)" at Jawaharlal Nehru University, New Delhi.	17th January, 2016
Dr. M. S. Chauhan, PS Dr. Sohan Vir Singh, PS Dr. M. Mondal, Sr. Sci. Dr. M. Karumnakaran, Sr. Sci.	National Symposium on "Physiological Approaches Development at Climate Resilient Livestock Farming" at AAU Khanapara, Guwahati.	21st– 22nd January, 2016
Dr. Rajan Sharma, PS Dr. B. C. Ghosh, PS Dr. B. V. Balasubramanyam, PS Dr. P. K. Dixit, PS Dr. K. P. Ramesha, PS Dr. Bandla Srininvas, PS Dr. K. Jayaraj Rao, PS Dr. D. N. Das, PS Mr. Chitranayak, Sr. Sci. Dr. S. Jeyakumar, Sr. Sci. Dr. M. Sivaram, Sr. Sci. Dr. P. Heartwin Amaladhas, Sr. Sci. Dr.Menon Rekha Ravindra, Sr. Sci. Dr. M. C. A. Devi, Sr. Sci. Dr. Mukund A. Kataktalware, Sr. Sci. F. Magdaline, Sr. Sci. Dr. M. Manjunatha, Sci.	National Seminar on "Quality: a Tool for Value Addition of Dairy Foods" organized by Alumni Association of SRS of ICAR-NDRI, Bengaluru during at Hotel Paraag, Bengaluru.	23rd– 24th January, 2016
Dr. S. Subash, Sci. Dr. S. Varalakshmi, Sci. Smt. T. R. Thivija Kumari, STO K. Geetha Kumari, STO Smt.Vimala, STO Mrs. Janakshi, STO Dr. N. Lingaraju, STO Dr. Siddaramanna, STO		
Dr.(Mrs.) Jancy Gupta, PS Dr. S. K. Jha, PS Dr. H. R. Meena, Sr. Sci.	International Extension Education Conference on "Education Research and Services (IEEC)" at BHU, Varanasi.	27th– 30th January, 2016
Dr. P. K. Dixit, PS Dr. M. Sivaram, PS	State Credit Seminar (2016-17) at NABARD, Bengaluru.	28th January, 2016
Dr. R. K. Malik, Joint Director (Res.)	International Conference on "Emerging Biotechnologies" and to deliver a Plenary Lecture at Kakatiya University, Warangal, Telegana.	28th – 30th January, 2016
Dr. A. P. Ruhil, PS Dr. M. L. Kamboj, PS Dr. S. S. Lathwal, PS Dr. Pawan Singh, PS Dr. Ashok Santra, PS Dr. Mukund A. Kataktalware, Sr. Sci. Dr. Ajay Mondal, Sr. Sci. Dr. M. Karunakaran, Sr. Sci. Dr. K. P. S. Tomer, CTO	International Livestock Conference "Indigenous and Expo and 23rd Annual Convention ISAPM" at NAARM, Hyderabad.	28th - 31st January, 2016
Dr. Rakesh Kumar, Sr. Sci.	International Conference on Biotechnology and Nanotechnology (ICBS-2016) at IIS University Jaipur.	30th January, 2016

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr B. Surendra Nath, PS	Delivered expert talk on the Topic "Ghee – Preparation and Attributes" at Chr. Hansen India Pvt. Ltd. Mumbai.	9th February, 2016
Dr. A. Kumaresan, Sr. Sci.	Second Annual Review Meeting of the NASF NAAS Complex, New Delhi, 11.02.2015	11th February, 2016
Dr. I. D. Gupta, PS	National Symposium on "Policy Planning for Livestock Security Animal Biodiversity" at Shere-e-Kashmir University, Jammu.	11th -12th February, 2016
Dr. Dhruba Malakar, PS	International Symposium on "Integrative Physiology and Comparative Enbcriology alongwith Brain Storming Session" at Banaras Hindu University, Varanasi.	12th -14th February, 2016
Sh. Ganga Sahay Meena, Sci.	International Conference on "Recent Advances in Emerging Technologies ICRAET 2016" at Sri Guru Granth Sahib World University, Fatehgarh Sahib (Punjab).	24th February, 2016
Dr. Sumit Arora, PS Ms. Richa Singh, Sci. Ms. Priyanka Singh Rao Sci.	National Conference on "Food Processing and Technology: Current Status and Future Prospects (NCFPT-2016)" at School of Bioengineering & Food Technology, Shoolini University, Solan (HP).	25th -26th February, 2016
Dr. Archana Verma, PS	International Conference on "Advancing Frontier in Biotechnology for Sustainable & Health, AFBSAH" at SHIATS, Allahabad.	25th -26th February, 2016
Dr. A. Kumaresan, Sr. Sci.	Conference on "Biomedical Sciences in 21st Century and Beyond" organized by the Indian Academy of Biomedical Sciences India Habitat Centre, New Delhi.	26th – 28th February, 2016
Dr. S. K. Tomar, PS	International Workshop under the Aegis of BBSRC India Partnering Award entitled "Development and Application of Lactic Acid Bacteria as Designer Probiotics" at CFTRI, Mysore.	8th - 10th March, 2016
Dr. Archana Verma, PS Dr. Rakesh Kumar, Sr. Sci.	International Conference on "Scenario of Biotechnology in 21st Century" at Devi Ahilya University, Indore.	10th - 12th March, 2016
Dr. Rakesh Kumar, Sr. Sci. Dr. H. R. Meena, Sr. Sci.	National Seminar on "Agriculture Resource Management for Sustainability and Eco-Restoration" at CIAH, Bikaner.	11th – 13th March, 2016
Dr. Sunita Grover, Head Ms. Rashmi, H.M, Sci. Mr. Diwas Pradhan, Sci.	3rd Biennial Conference & International Symposium on "Stress, Microbiome & Probiotics" at NISER, Bhubaneswar.	11th - 13th March, 2016
Dr. M. K. Ghosh, PS Dr. S. K. Das, PS Dr. C. Bhakat, PS Dr. A. Mandal, Sr. Sci. Dr. M. Karunakaran, Sr. Sci. Dr. Asif Mohammad, Sci. Dr (Mrs.) Saroj Rai, Sci. Dr. (Ms) Rajalakshmi, Sci.	National Seminar on "Dairying: Innovative Technology Initiatives in Production and Processing" organised by IDA (East Zone), Kolkata, at West Bengal State Veterinary Council Bhawan Auditorium, Belgachia, Kolkata.	12th March, 2016
Dr. Rajesh Bajaj, PS	To deliver lecture on the theme "Wellness through Innovation" at SKUAST Jammu.	17th March 2016
Dr. P. S. Minz, Sci.	International Conference on "Food Value Chain : Innovation and Challenges" at NIFTEM Kundli.	17th -18th March, 2016

MAJOR EVENTS

Training Programmes/Workshops/Seminars/ Symposia Organized

(April 2015 to March 2016)

Training on 'Animal Genomics Techniques' for officials from Livestock Development Board, Govt. of Uttarakhand & Kerala.	May 1-15, 2015
Training Programme on "Microbiological Methods & Procedures for Dairy Products" to the Employees of M/s SGS India Ltd., Gurgaon.	May 21-30, 2015
Training Program on "Laboratory Techniques in Quality Control for Officers and In-charge of Semen Stations" of NDDB.	July 13-18, 2015
Short Course on "Good Dairy Farming Practices: Novel Initiatives and Extension Approaches".	August 18-27, 2015
Training programme on "Analytical Process for Detection of Antibiotic Residues in Milk using Bacterial Spore as Biosensors".	September 7-12, 2015
National Training Programme (CAFT) on "Instrumentation Involved in Quality Assurance of Milk and Milk Products".	October 3-23, 2015
Winter School on "Current Concepts and Frontier Technologies for Fertility Management in Farm Animals".	October 5-25. 2015
Training on "Animal Genomics Techniques" (for officials from Livestock Development Board, Govt. of Uttarakhand & Kerala).	October 13-23, 2015
All India Dairy Husbandry Officers' Workshop.	October 26, 2015
Training Program on "Laboratory Techniques in Quality Control for Officers and In-charge of Semen Stations" of NDDB.	November 11-22, 2015
Winter School on "Advanced Techniques and Novel Approaches for Quality and Safety Evaluation of Dairy Foods" .	November 17 – December 7. 2015
Workshop on "Resilient Livestock Management System".	November 20, 2015
Brain Storming Session of Karnal NAAS Chapter on "Preparedness of India for Genomic Selection in Farm Animals".	November 21, 2015
"Model Training Course" Extension Division.	November 26 to December 3, 2015
Training Program on "Fertility Management in Dairy Animals" for Veterinarian of Tripura.	December 23-29, 2015
Short Course on "Cross Breed Male Infertility and Bovine Genomics".	December 8-17, 2015
ANVENSHAN: the Student Research Convention.	December 28-29, 2015
XV Annual International Conference of ISVPT on "Nutritional Pharmacology and Toxicology Beyond Calories".	January 14-16, 2016

Training Program on "Fertility Management in Dairy Animals" for Veterinarian of Tripura.	January 18-24, 2016
National Seminar on "Quality a Tool for Value Addition of Dairy Foods".	January 23-24, 2016
Research training in the area of Packaging under the NAM S&T Centre Research Training Fellowship for Developing Country Scientists.	January 30 to June 30, 2016
Training Programme on "Emotional Intelligence for Balanced Life".	February 1, 2016
XVI Biennial Animal Nutrition Conference on "Innovative Approaches for Animal Feeding and Nutrition Research".	February 6-8, 2016
44th Dairy Industry Conference and International Trade Fair for Dairy Farming, Processing, Packaging, Distribution and Products.	February 18-20, 2016
Training Programme on Genetic Evaluation and Multiplication of Superior Germplasm for Genetic Improvement in Livestock".	March 9-29, 2016
Training Programme on "Commercial Dairy Farming".	March 15-19, 2016
Awareness Campaign for Pradhan Mantri Fasal Bima Yojana.	March 31, 2016

Specific Day Celebrations (April, 2015 – March, 2016)	
1. World Veterinary Day.	April 25, 2015
2. World Milk Day.	June 01, 2015
3. National Milk Day.	Nov. 26, 2015
4. World Soil Day.	Dec. 05, 2015
5. Dairy Industry Meet at ERS, Kalyani.	Dec. 12, 2015
6. NDRI-Industry Interface Meeting at Karnal.	Dec. 17, 2015



Prof. Harjinder Singh Distinguished Professor Co-Director, Riddet Institute & Director Massey Institute of Food Science & Nutrition, Massey University, Palmerston North, New Zealand delivering lecture on the 'National Milk Day'

DISTINGUISHED VISITORS

13.04.2015	Five member delegation of Japan International Corporation Agency (JICA)
27.04.2015	Ten member delegation from Ethiopia



Ethiopian delegation visiting Animal Breeding Research Centre, NDRI, Karnal

01.05.2015	Mr. Rene Schoelzel, International Marketing Manager, FSTA, UK
03.05.2015	Thirty five member Team of Dayal Bagh Educational Institute (Deemed University), Agra
24.05.2015	Management Team of CPF (India) Pvt. Ltd. from Thailand
23.06.2015	Twenty five member delegation of Experts Group of Conventional & Traditional Gau Krishi Business (Farmers) Social Activist, Scientist & Technicians led by Dr. Vallabhbhai Kathiria, Chairman, Gauseva and Gaucher Vikas Board, Gujarat.
24.06.2015	Four member delegation from Kisan Advisory Board, Jammu & Kashmir led by Sh. Daljit Singh, Vice Chairman (Minister of State)
24.06.2015	Officials of Milkfed Punjab, Chandigarh
01.07.2015	A delegation led by Sh. M. Vinod Kumar, Hon'ble Member of Parliament and other officials of Karim Nagar Milk Producer Company Ltd., Karim Nagar, Telangana
23.07.2015	Sh. Ashok K. Angurana, Secretary, GOI, Ministry of Agriculture, DAHD&F
10.08.2015	Four member delegation from Kenya, Liberia and Malawi
10.08.2015	A delegation under US India-Africa Training Programme Co-ordinated by MANAGE, Hydrabad
25.08.2015	Mr. Sanjeev Latkar and Mr. Mukund Biwalkar, DSK Milkotronics Ltd.

24.09.2015	Dr. P. K. Chhonkar, Ex-Professor & Head, ICAR Emiratus Scientist at IARI, New Delhi
26.09.2015	Mr. Wojcieh Dziworski and Mr. Chaitanaya Kaushal – Two member delegation of the European Union in New Delhi
29.09.2015	Dr. Nabin Kumar Mishra, Sub-divisional Veterinary Officer, Bargarh, Odisha
09.10.2015	Sh. T. Prabhushankar IAS and Sh. Harpreet Singh Sudan, IAS, Assistant Secretaries, DARE/ICAR
09.10.2015	Four Member delegation from J&K
10.11.2015	Mr. Wojcieh Dziworski and Mr. Chaitanya Kaushal, European Union (EEAS), New Delhi
16.11.2015	Four member delegation from USA
27.11.2015	Dr. Simon Doherty, Animal Science Specialist at UKTI
16.12.2015	Twenty six member delegation from Agricultural Senior Policy Makers, Researchers and other Stakeholders from Afghan
17.12.2015	Sh. Sunil Kumar Singh, Hon'ble AS & FA, Department of Agricultural Research & Education ICAR, Ministry of Food Processing Industries and Ministry of Statistics and Programme Implementation
08.01.2016	Three Senior Officers from Food Processing Sector Skill Council (FICSI), FICCI, New Delhi and National Skill Academy for Food and Drink (NSAFD), UK
19.01.2016	Delegation of Bangladesh Govt. Officials
06.02.2016	Sh. Nikki Chaudhary, Chaudhary Farms, Pilibhit, UP Dairy Farmer
8, 9-02.2016	Sh. Radha Mohan Singh, Hon'ble Union Minister for Agriculture & Farmers Welfare, Govt. of India
14.02.2016	Delegates from Nepal



Delegates from Nepal

21.02.2016	Mr. Ian Halliday, Managing Director of Dairy Austraila
05.03.2016	Prof. Kaptan Singh Solanki, Hon'ble Governor of Haryana
23.03.2016	Delegation from Afghanistan led by HE Deputy Agriculture Minister and Advisor of Presidents alongwith Senior Policy Makers

PERSONNEL

INSTITUTE STAFF
(As on 31st March, 2016)

Research Management Positions

A. K. Srivastava, PhD	Director
R. K. Malik, PhD	Joint Director (Research)
R. R. B. Singh, PhD	Joint Director (Academics)

Director's Cell

A. K. Srivastava, PhD	Director
Nirmala Kumari, BA	Private Secretary
Chiranjee Lal, M.Lib	Asstt. Admn. Officer

Research Prioritization, Monitoring and Evaluation Cell

R. K. Malik, PhD	Joint Director (Research)
Meena Malik, M Phil, PhD	Prof. (English)
Braj Kishor, MA, B Lib Sci	Sr. Technical Officer
Sunil Sharma, MSc	Technical Officer
Ranjana, BA	Private Secretary

Academic Affairs Cell

R. R. B. Singh, PhD	Joint Director (Academic)
S. K. Kanawjia, 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, BEd	Chief Administrative Officer
R. C. Meena, M Com	Sr. Admn. Officer
Ashok Mallick, B Com	Sr. Admn. Officer
R. K. Bansal, MA	Admn. Officer
Ram Niwas, BA	Admn. Officer (E-I)
Ishwar Dayal, BA	Asstt. Admn. Officer (E-II)
S. S. Meena, BA	Asstt. Admn. Officer (DDO)
N. K. Verma, BA	Asstt. Admn. Officer (Purchase)
Rajbir, BA	Asstt. Admn. Officer (Purchase)
Braham Prakash, BA	Asstt. Admn. Officer (E- III)
Dharam Singh Meena, BA	Asstt. Admn. Officer (Stores)

Nirmal Kumar Jain, BA	Asstt. Admn. Officer (E- V)
Subhash Chand, BA	Asstt. Admn. Officer (DDO-DSC)
Ajit Singh, BA	Asstt. Admn. Officer (E- IV)
Anita Rani, BA	Private Secretary

Finance Wing

S. George, MA, PGDLA	Comptroller
Mithlesh Kumar, MSc, PGDCFA	Sr. Fin. & Account Officer
Vishal Acharya, MA	Asstt. Fin. & Account Officer

Dairy Cattle Breeding Division

A. K. Chakravarty, PhD	Head
A. K. Gupta, PhD	Principal Scientist
Archana Verma, PhD	Principal Scientist
I. D. Gupta, PhD	Principal Scientist
Avtar Singh, 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
Vikram	Technical Officer

Livestock Production and Management Section

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

Dairy Cattle 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
S. K. Tomar, PhD	Principal Scientist
Veena Mani, PhD	Principal Scientist
Chander Datt, PhD	Principal Scientist
Nitin Tyagi, PhD	Sr. Scientist
Goutam Mondal, PhD	Sr. Scientist
Sachin Kumar. PhD	Scientist
Karan Singh, MSc	Asstt. Chief Technical Officer
Gian Singh, MSc	Sr. Technical Officer
Sumit Narayan, MSc	Technical Officer

Dairy Cattle Physiology Division

O. K. Hooda, PhD	Head
Mahendra Singh, PhD	Principal Scientist
Sujata Pandita, PhD	Principal Scientist
Parveen Kumar, PhD	Principal Scientist
Sohanvir Singh, PhD	Principal Scientist
A. K. Dang, PhD	Principal Scientist
Anjuli 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. M. S. Chauhan, 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
Ravi Kant, PhD	Asstt. Chief Technical Officer
Mr. Ved Parkash Kalra	Technical officer

Dairy Technology Division

Latha Sabikhi, PhD	Head
Vijay Kumar, PhD	Emeritus Scientist
S. K. Kanawjia, PhD	Principal Scientist
A. K. Singh, PhD	Principal Scientist
Kaushik Khamrui, PhD	Sr. Scientist
Narender Raju Panjagari, PhD	Scientist
Ganga Sahay Meena, MSc	Scientist
Yogesh Khetra, PhD	Scientist
Prateek Sharma, M Tech	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)
A. K. Kohli, Dip. (Mech. Engg.)	Asstt. Chief Technical Officer
Lehri Singh, MSc (Chemistry)	Asstt. Chief Technical Officer
Probir Mondal, IDD	Sr. Technical Officer
Sanjeev Kumar, MA (Economics)	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
P. C. Singh, MSc	Asstt. Chief Technical Officer
Shakuntla Rani, BA	Private Secretary

Dairy Microbiology Division

Sunita Grover, PhD	Head
S. K. Tomar, PhD	Principal Scientist
Naresh Kumar, PhD	Principal Scientist
Shilpa Vij, PhD	Principal Scientist
Chand Ram, PhD	Principal Scientist
Surajit Mandal, PhD	Scientist (SS)
Raghu H.V., MSc	Scientist
P. V. Behare, PhD	Scientist
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, M Tech	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
Om Prakash, Dip. (Agri. Engg.)	Chief Technical Officer

S. K. Chaudhary, AMIE	Chief Technical Officer
Sunil Kumar, MSc	Sr. Technical Officer
J. K. Dabas, M Tech	Sr. 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 and 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	Principal Scientist
A. P Ruhil, PhD	Principal Scientist
A. K. Sharma, PhD	Principal Scientist
Udita Chaudhary, M Sc	Scientist
Tara Chand, BSc	Asstt. Chief Technical Officer
Sunita Chaudhary	Private Secretary

Dairy Extension Division

Khajan Singh, PhD	Head
K. S. Kadian, PhD	Principal Scientist
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 and Management Section

Magan Singh, PhD	Sr. Scientist
Rakesh Kumar, BSc (Agri.)	Sr. Scientist
Uttam Kumar, PhD	Chief Technical Officer
V. K. Meena	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
Pramod Kumar, MSc	Sr. 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

D. V. Sharma	Sr. 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	Sr. Technical Officer
Ravi Rawat, MSc (Entomology)	Sr. Technical Officer
Sukhdev Singh	Technical Officer
Mahender Pal	Technical Officer
Sh. Ashok Kumar	Technical Officer
Mukesh Kumar Dua, BA	Asstt. Admn. Officer

Livestock Research Centre

S. S. Lathwal PhD	Principal Scientist & Incharge
Ramesh Chandra, PhD	Sr. Scientist
A. Kumaresan, PhD	Sr. Scientist
Nishant Kumar, MVSc	Scientist
Rubina Kumari Bithalu, MVSc	Scientist
Amarpal Singh, PhD	Sr.Technical Officer
Ashwani Kumar, MSc	Sr.Technical Officer
Chaman Lal, Dip. (Motor Mechanic)	Technical Officer
Rajbir	Technical Officer
Samar Singh	Technical Officer

Animal Health Complex

K. P. S. Tomar, MVSc	Chief Technical Officer
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
R. T. Bansode, MSc	Asstt. Chief Technical Officer
Jintendra Rana, PhD	Sr. Technical Officer
Subhash Chand, BVSc	Sr. Technical Officer

Library Services

S. S. Thakur, PhD	Head
B. P. Singh, M.A., M. Lib.	Sr. Technical Officer

Computer Centre

A. K. Sharma, PhD	Incharge
Anirudha Kumar MSc, PGDCA	Chief Technical Officer
Gian Singh, MSc	Assistant Chief Technical Officer
Naresh Kumar Dahiya, M Tech	Sr. 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

R. K. Mittal, BE	Chief Technical Officer

Official Language Unit

K. P. S Gautam, M Com, BEd	Incharge
Kanchan Choudhary, MA	Sr. 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
Raj Kumar, ITI (Electrical)	Technical Officer
Sanjeev Kumar, B Tech	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

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
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	Sr. Technical Officer

Southern Campus, Bangalore

B. Surendra Nath, PhD	Head
Bikash Chandra Ghosh, PhD	Principal Scientist
B.V. Balasubramanyam, PhD	Principal Scientist
P.K. Dixit, PhD	Principal Scientist
K.P. Ramesha, 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
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, MSc	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., M Tech	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	Sr. Technical Officer
Siddaramanna, MVSc (Animal Nutrition)	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.)	Technical Officer
Sreekanta,	Technical Officer
Vimala, BSc	Technical Officer
S. Shashi Kala	Asstt. Admn. Officer

Eastern Campus, Kalyani

T. K. Dutta, 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
Dasrath Munjani	Technical Officer
Sukhdev Singh, BA	Asstt. Admn. Officer
Simita Roy, BA	Private Secretary

PERSONALIA

Appointments/Joining

» Dr. R. R. B. Singh, Principal Scientist joined as Joint Director (Academic) w.e.f. 15.01.2016.

» Sh. S. Saha, Joint Director (Admn. & Registrar) joined his duties at NDRI, Karnal on 25.05.2015 on transfer from IVRI, Izatnagar.

» Mr. Gurunatha Gouda Harakangi, Chief Administrative Officer, after his transfer from ASRB, New Delhi joined at SRS of NDRI, Bangalore w.e.f. 10.06.2015.

» Dr. Amrish Kumar Tyagi, Principal Scientist appointed as Head, Dairy Cattle Nutrition Division at NDRI, Karnal w.e.f. 28.10.2015.

» Dr. (Mrs.) Smita Sirohi Principal Scientist appointed as Head, DES&M Division at NDRI, Karnal w.e.f. 28.10.2015.

» Dr. (Mrs.) Sunita Grover, Principal Scientist appointed as Head, Dairy Microbiology Division, NDRI, Karnal w.e.f. 17.03.2016.

» Dr. Dheer Singh, Principal Scientist appointed as Head, Animal Bio-chemistry Division, NDRI, Karnal w.e.f. 17.03.2016 (FN).

» Dr. R. K. Sharma, Principal Scientist appointed to act as Acting Head, Animal Biochemistry Division w.e.f. 01.05.2015.

» Dr. A. K. Singh, Principal Scientist appointed as Acting Head of Dairy Engineering Division at NDRI, Karnal w.e.f. 01.11.2015.

» Dr. Prabhat Palta, Principal Scientist nominated to act as In-charge, ABTC Division, NDRI Karnal w.e.f. 12.03.2016.

» Dr. (Mrs.) Smita Sirohi, Principal Scientist and Head DESM, NDRI, Karnal was appointed as Vigilance Officer NDRI w.e.f. 01.09.2015.

» Sh. Sachin Kumar, Scientist (Animal Nutrition) joined at NDRI, Karnal w.e.f. 01.04.2015.

» Sh. Gunvantsinh Rathod, Scientist (Dairy Technology) joined at NDRI, Karnal w.e.f. 10.04.2015

» Sh. Writdhanma G. Prasad, Scientist (Dairy Technology) joined at NDRI, Karnal w.e.f. 10.04.2015

» Sh. Sanket Girdharbhai Borad, Scientist (Dairy Technology) joined at NDRI, Karnal w.e.f. 10.04.2015.

» Ms. Neelam Upadhayay, Scientist (Food Technology) joined at NDRI, Karnal w.e.f. 10.04.2015.

» Dr. (Mrs.) Saroj Rai, Scientist (LPM) joined at ERS, Kalyani w.e.f. 15.05.2015.

» Dr. Naresh Kumar, Principal Scientist appointed as Incharge/coordinator for National Referral Centre on Milk Quality and Safety (NRCMQS) w. e. f. 01.03.2015.

» Dr. Rajan Sharma, Principal Scientist, Dairy Chemistry Division appointed Nodal Officer, Press & Media, NDRI, Karnal w.e.f. 30.05.2015.

» Dr. Jai Kaushik, Principal Scientist, Animal Biotechnology Centre appointed General Secretary, Staff Club, NDRI, Karnal.

» Sh. Sanjit Maiti, Scientist (Vety. Extn. Education) joined his duty on transfer from ICAR- National Research Center on Yak, Arunachal Pradesh, w.e.f. 17.09.2015.

- Dr. Rajalaxmi Behra, Scientist (Animal Genetic & Breeding) joined at ERS of NDRI, Kalyani w.e.f. 09.10.2015.
- Ms. Vairat Amita Dinkar, Scientist (Agricultural Process Engineering) joined at NDRI, Karnal w.e.f. 12.10.2015.
- Sh. Umesh Chandra Sharma, AAO, IARI, New Delhi joined at NDRI on promotion to the post of Administrative Officer w.e.f. 05.11.2015.
- Dr. Raman Malik, Principal Scientist joined at NDRI, Karnal after transfer from ICAR-CIRB Sub Campus, Nabha (Punjab) under ICAR- Central Institute for Research on Buffaloes, Hisar w.e.f. 16.11.2015.
- Ms. Monika Sharma, Scientist (Food Technology) joined at SRS of NDRI, Bangalore after transfer from ICAR-Central Institute of Post Harvest Engineering & Technology, Ludhiana w.e.f. 01.12.2015.
- Sh. Ram Niwas Panchal, Administrative Officer joined at NDRI Karnal after transfer from IVRI, Barielly w.e.f. 18.12.2015.
- Dr. (Mrs.) Sanchita Garai, Scientist (Dairy Extension) joined at NDRI, Karnal on her transfer from ERS, Kalyani w.e.f. 01.01.2016.
- Dr. A. P. Ruhil, Principal Scientist (Computer Application of Agriculture) joined at NDRI, Karnal on his transfer from ASRB, New Delhi w.e.f. 05.01.2016.
- Dr. J. K. Kaushik, Principal Scientist appointed as Chief Hostel Warden, NDRI, Karnal w.e.f. 16.01.2016.
- Sh. Hardev Ram, Scientist (Agronomy) joined at NDRI, Karnal w.e.f. 16.03.2016.
- Sh. Rajesh Kumar Meena, Scientist (Agronomy) joined at NDRI, Karnal w.e.f.21.03.2016.
- Sh. Chitranayak Sinha, Senior Scientist (Dairy Engineering) joined at NDRI, Karnal on his transfer from SRS, Bangaloe w.e.f 28.03.2016.

Promotions

- Dr. Jancy Gupta, Senior Scientist, Dairy Extension promoted to the post of Principal Scientist w.e.f. 13.03.2008.
- Dr. Meena Malik, Associate Prof. (English) promoted to the post of Professor English w.e.f. 8.7.2011.
- Dr. Ajoy Monadal, Senior Scientist, ERS of NDRI, Kalyani promoted as Principal Scientist w.e.f. 28.07.2013.
- Dr. A. K. Sharma, Senior Scientist, NDRI, Karnal promoted as Principal Scientist w.e.f. 11.08.2013.
- Dr. Dilip Kumar Mondal, Senior Scientist, ERS of NDRI, Kalyani promoted as Principal Scientist w.e.f. 21.08.2013.
- Dr. S. S. Lathwal, Senior Scientist, NDRI, Karnal promoted as Principal Scientist w.e.f. 3.11.2013.
- Dr. Anupama Chattarjee, Senior Scientist, ERS of NDRI, Kalyani promoted as Principal Scientist w.e.f. 21.11.2013.
- Dr. Chander Datt, Senior Scientist, NDRI, Karnal promoted as Principal Scientist w.e.f. 14.01.2014.
- Dr. Ajmer Singh, Senior Scientist, NDRI, Karnal promoted as Principal Scientist w.e.f. 24.02.2014.
- Dr. B. S. Meena, Senior Scientist, NDRI, Karnal promoted as Principal Scientist w.e.f. 19.11.2014.
- Dr. Rakesh Kumar, Sr. Scientist, Forage Research & Management Centre promoted in the pay scale of Rs. 37400-67000+ RGP of Rs. 9,000 w.e.f. 22. 11.2013.
- Sh. P. S. Minz, Scientist, Dairy Engineering Division promoted in the pay scale of Rs. 15600-39100+ RGP of Rs. 7,000 w.e.f. 10.02.2014.
- Dr. Narender Raju P., Scientist, Dairy Technology Division promoted in the pay scale of Rs. 15600-39100+ RGP of Rs. 7,000 w.e.f. 15.12.2013.
- Dr. Yogesh Khetra and Dr. Ganga Sahay Meena, Scientists, Dairy Technology Division promoted in the pay scale of Rs. 15600-39100+ RGP of Rs. 7,000 w.e.f. 15.12.2014.
- Dr. Rekha Ravindra Menon, Scientist, SRS, Bangalore promoted in the pay scale of Rs. 37400-67000+ RGP of Rs. 9,000 w.e.f. 22. 02.2014.

- Dr. S. Subash, Scientist, SRS, Bangalore promoted in the pay scale of Rs. 15600-39100+ RGP of Rs. 7,000 w.e.f. 04.11.2013.
- Dr. (Mrs.) F. Magdaline Eljeeva Emerald, Scientist, SRS, Bangalore promoted in the pay scale of Rs. 37400-67000+ RGP of Rs. 9,000 w.e.f. 04.07.2014.
- Dr. A. Manimaran, Scientist, SRS, Bangalore promoted in the pay scale of Rs. 15600-39100+ RGP of Rs. 7,000 w.e.f. 07.02.2014.
- Dr. Sanchita Garai, Scientist, ERS, Kalyani promoted in the pay scale of Rs. 15600-39100+ RGP of Rs. 7,000 w.e.f. 01.09.2014.
- Sh. Somenath Dutta, Assistant Chief Technical Officer, Eastern Regional Station of NDRI, Kalyani promoted to the post of Chief Technical Officer w.e.f. 23.08.2013.
- Ms. Janakshi, Technical Officer, Southern Regional Station of NDRI, Bangalore promoted to the post of Senior Technical Officer w.e.f. 12.07.2014.
- Sh. Chaman Lal, Technical Officer, Livestock Research Centre promoted to the post of Senior Technical Officer w.e.f. 08.10.2014.
- Sh. K. P. Lakshminarayanappa, Technical Officer, Southern Regional Station of NDRI, Bangalore promoted to the post of Senior Technical Officer w.e.f. 29.10.2014.
- Sh. Meghanathan, Technical Officer, Southern Regional Station of NDRI, Bangalore promoted to the post of Senior Technical Officer w.e.f. 29.10.2014.
- Sh. Deshwirt Sharma, Senior Technical Officer, KVK promoted to the post of Assistant Chief Technical Officer w.e.f. 01.01.2015.
- Sh. Prem Singh, Senior Technical Officer, Estate Section promoted to the post of Assistant Chief Technical Officer w.e.f. 01.01.2015.
- Sh. Y. K. Panwar, Technical Officer, Dairy Cattle Breeding Division promoted to the post of Senior Technical Officer, w.e.f. 01.01.2015.
- Sh. Shish Pal Gupta, Technical Officer, Human Health Complex promoted to the post of Senior Technical Officer, w.e.f. 01.01.2015.
- Sh. Sidhu Purthy, Senior Technical Assistant, Dairy Microbiology Division promoted to the post of Technical Officer w.e.f. 01.01.2015.
- Sh. Mangey Ram, Senior Technical Assistant, Animal Biotechnology Centre promoted to the post of Technical Officer w.e.f. 01.01.2015.
- Sh. Des Raj, Senior Technical Assistant, Computer Centre promoted to the post of Technical Officer w.e.f. 01.01.2015.
- Sh. Kumar Bharat, Senior Technical Officer, ATIC promoted to the post of Assistant Chief Technical Officer w.e.f. 01.01.2015.
- Sh. Ravi Kant, Senior Technical Officer, Animal Biochemistry promoted to the post of Assistant Chief Technical Officer w.e.f. 09.01.2015.
- Sh. Gurpartap Singh, Senior Technical Assistant, Experimental Dairy Plant promoted to the post of Technical Officer w.e.f. 14.01.2015.
- Dr. S. Raju, Assistant Chief Technical Officer, Animal Health Complex promoted to the post of Chief Technical Officer w.e.f. 17.02.2015.
- Sh. Ashok Kumar, Senior Technical Assistant Dairy Microbiology Division promoted to the post of Technical Officer w.e.f. 06.03.2015.
- Sh. Kulvir Singh, Senior Technical Officer, KVK promoted to the post of Assistant Chief Technical Officer w.e.f. 12.05.2015.
- Sh. K. Ningaraju, Technical Officer, Southern Regional Station of NDRI, Bangalore promoted to the post of Senior Technical Officer w.e.f. 06.06.2015.
- Dr. V.R.V. Surendranath Naik, Chief Technical Officer (M&PM) Southern Regional Station of NDRI, Bangalore granted one advance increment w.e.f. 29.06.2015.
- Sh. K. L. Sampath, Senior Technical Officer, Southern Regional Station of NDRI, Bangalore promoted to the post of Assistant Chief Technical Officer w.e.f. 01.07.2014.
- Sh. Mihir Lal Ghosh, Senior Technical Officer, Eastern Regional Station of NDRI, Kalyani promoted to the post of Assistant Chief Technical Officer w.e.f. 01.07.2014.

- Sh. Subhash, Assistant promoted to the post of Assistant Administrative Officer at NDRI, Karnal w.e.f. 10.11.2015.
- Sh. Satpal Hans, Assistant promoted to the post of Assistant Administrative Officer at NDRI, Karnal w.e.f. 12.11.2015.
- Sh. R. K. Bansal, Assistant Administrative Officer promoted to the post of Administrative Officer at NDRI, Karnal w.e.f. 31.12.2015.
- Ms. Anita Rani, Personal Assistant promoted to the post of Private Secretary w.e.f. 12.01.2016.
- Sh. Ajit Singh, Assistant promoted to the post of Assistant Administrative Officer w.e.f. 01.03.2016.
- Sh. Chiranjee Lal, Assistant promoted to the post of Assistant Administrative Officer w.e.f. 11.03.2016.

Retirements/Transfer/Relieved

- Dr. M. S. Chauhan, PS, ABTC Division relieved from his duties at NDRI, Karnal in the afternoon of 30.03.2016 to join as Director, ICAR-CIRG, Makhdoom, Mathura.
- Dr. A. K. Puniya, Principal Scientist, Dairy Microbiology Division relieved from his duties at NDRI, Karnal in the afternoon of 27.05.2015 to join the post of Dean, College of Dairy Science and Technology, GADVASU, Ludhiana.
- Dr. C. N. Pagote, Principal Scientist, SRS Bangalore, retired from Council's service w.e.f. 31.01.2015.
- Dr. L. Louis, Technical Officer, SRS Bangalore, retired from Council's service w.e.f. 31.01.2015.
- Dr. Darshan Lal, Principal Scientist, Dairy Chemistry retired from Council's service w.e.f. 30.04.2015.
- Dr. Bikram Kumar, Principal Scientist, Dairy Engineering. retired from Council's service w.e.f. 30.04.2015.
- Sh. L. Krishnamurthi, Chief Technical Officer, SRS of NDRI, Bangalore retired from Council's service w.e.f. 31.05.2015.
- Sh. Ganpat Rai, Technical Officer (W/S), retired from Council's service w.e.f. 31.05.2015.
- Sh. J. P. S. Malik, Technical Officer (F/FT), retired from Council's service w.e.f. 31.05.2015.
- Sh. Chaman Lal, Technical Officer (W/S), retired from Council service w.e.f. 30.06.2015.
- Sh. Mool Chand Singh, Technical Officer (F/FT), retired from Council service w.e.f. 30.06.2015.
- Sh. Deswrit Sharma, Sr. Technical Officer (W/S), retired from Council service w.e.f. 30.06.2015.
- Sh. Pankaj Chawla, Sr. Technical Officer (W/S), resigned from Council service w.e.f. 15.07.2015.
- Sh. Ramesh T. Bansode, Assistant Chief Technical Technical Officer (L/T), retired from Council service w.e.f. 31.07.2015.
- Dr. J. P. Sehgal, Principal Scientist, Dairy Cattle Nutrition Division retired from Council's service w.e.f. 31.07.2015.
- Dr. A. K. Doodeja, Principal Scientist, Dairy Engineering Division retired from Council's service w.e.f. 31.07.2015.
- Dr Satish Kulkarni, Principal Scientist (DT), SRS, Bangalore retired from Council's service w.e.f. 31.08.2015
- Sh. Sudesh Kumari, Technical Officer (L/T), retired from Council service w.e.f. 31.08.2015.
- Sh. Tek Chand, Technical Officer (W/S), retired from Council service w.e.f. 31.08.2015.
- Sh. Jai Kumar Kewalramani, Joint Director (Admn. & Registrar) retired from Council's service w.e.f. 30.09.2015.
- Dr. H. C. Devaraj, Scientist (DT) was transferred from NDRI, Karnal to SRS of NDRI, Bangalore and joined for duties w.e.f. 04.08.2015.
- Dr. K. K. Datta, Principal Scientist, NDRI, Karnal retired from Council's service on 31.10.2015.
- Dr. Ish Kumar Sawhney, Principal Scientist, NDRI, Karnal retired from Council's service on 31.10.2015.

- Mr. A. K. Sharma, Chief Technical Officer, Experimental Dairy Plant retired from Council's service on 31.10.2015.
- Sh. Ram Shankar Gautam, Deputy Director (OL) retired from Council's service on 31.12.2015.
- Smt. Shulkla Virmani, Private Secretary retired from Council's service on 31.12.2015.
- Mr. Gian Singh, Assistant Chief Technical Officer, Computer Centre retired from Council's service on 31.12.2015.
- Sh. A. K. Barapatre, Assistant Administrative Officer transferred from NDRI, Karnal to NRCE, Hisar on promotion to the post of Administrative Officer and relieved on 15.10.2015.
- Sh. Sathish Kumar. M. H., Scientist, transferred from NDRI, Karnal to SRS of NDRI, Bangalore and joined his duty on 19.10.2015.
- Dr. Laxmana Naik N., Scientist, transferred from NDRI, Karnal to SRS of NDRI, Bangalore and joined his duty on 21.10.2015.
- Sh. Ram Niwas, Assistant Administrative Officer transferred from NDRI, Karnal to IVRI, Barielly on promotion to the post of Administrative Officer and relieved on 04.11.2015.
- Shri. G. G. Harakangi, Chief Administrative Officer, transferred alongwith post from SRS of NDRI, Bangalore to Indian Institute of Horticulture Research (IIHR), Hesarghata, Bangalore and relieved on 16.11.2015.
- Dr. R. Senthil Kumar, Scientist (Vet. Extn. Education) transferred from NDRI, Karnal to ICAR-CIAE, Regional Center, Coimbatore and relieved on 21.11.2015.
- Dr. Anand Laxmi, Principal Scientist transferred from NDRI, Karnal to ICAR- Directorate of Polutary Research, Hyderabad and relieved on 07.12.2015.
- Dr. Asif Mohammad, Scientist transferred from NDRI, Karnal to ERS of NDRI, Kalyani and relieved on 15.12.2015.
- Mr. M. L. Ghosh, Asstt. Chief Technical Officer ERS, Kalyani retired from the Council's services w.e.f. 31.03.2016
- Sh. Subhash Chander, Technical Officer (W/S), retired from Council service w.e.f. 31.03.2016.
- Sh. Ved Prakash Kalra, Technical Officer (L/T), retired from Council service w.e.f. 31.03.2016.



NDRI Football Team has won Inter-Zonal Staff Sports Tournament after 38 years held at CAZRI Jodhpur (Rajasthan) from 8th-12th February 2016

MAIN CAMPUS, NDRI

RESEARCH DIVISIONS

Dairy Cattle Breeding

Dairy Cattle Breeding (DCB) Division has been actively involved in conducting research in the areas of animal genetics and breeding including cytogenetics and biotechnology related to molecular genetics. The main thrust research areas are genetic improvement of crossbred & Sahiwal cattle and Murrah buffaloes by progeny testing of breeding males and judicious selection of males and females, faster multiplication of superior germplasm, evolving selection criteria, development of optimum breeding plans, genetic polymorphism studies at molecular level and its association with production/reproduction traits, disease resistance and thermo-tolerance, screening of young males for genetic disorders and assessment of male fertility.

Another important mandate of the Division is the development of skilled human resources in the field of animal genetics and breeding. The Division also assists KVK/DTC and TBI (SINED) in training programs, consultancy services to farmers and various organizations, supplies superior germplasm in the form of frozen semen and breeding males to farmers, livestock developmental agencies, state governments and other stake holders.

The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at Division of Dairy Cattle Breeding during eighth plan continued its activities on strengthening research, teaching and imparting 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 32 National Training Programs have so far been organized under the aegis of CAFT (AG&B) in the Division.

The organizational structure for research consists of Animal Breeding Lab., Biometrical Genetics Lab., Sire Evaluation Lab., Molecular Genetics Lab, Livestock Genome Analysis Lab and Livestock Record Cell and Artificial Breeding Research Complex. Besides this, breeding herds of cattle (Karan Fries, Karan Swiss, Sahiwal and Tharparkar) and Murrah buffaloes is also the integral part of the Dairy Cattle Breeding Division. The Divisional Library has 433 books and 414 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 at both 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.

Animal Biotechnology Centre

Animal Biotechnology Centre (ABTC) 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 are: 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 Master's and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

The centre has a state-of-the-art biotechnology research facility having specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research and Structural Biology.

Dairy Cattle Nutrition Division

Dairy Cattle Nutrition (DCN) 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 faculty members have been adequately trained in various priority areas and have visited advanced institutions of repute in Europe, Canada and United States of America to gain expertise and exposure in the respective areas. 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.

Dairy Cattle Physiology Division

The objectives Dairy Cattle Physiology (DCP) Division are: to conduct basic and applied research and impart training in various aspects of Animal Physiology; to undertake post graduate programmes of education in Animal Physiology at Master's and Doctoral levels; and development and application of field level technologies.

The notable salient achievements of the division are**:** higher magnitude of expression of HSPs 27, 90 and 105 genes in Karan Fries than Tharparkar Calves indicated lower heat tolerance of KF calves; thermal image analysis and significant difference in blood flow at different anatomical sites of the body indicating better thermal adaptability of indigenous than crossbred cattle; positive correlation between delayed neutrophil apoptosis, persistent staying of neutrophils at the site of infection along with formation of NETs is one of the strategies to fight against the pathogens in the udder during *Staphylococcal* mastitis; yeast culture supplementation significantly reduces the attainment of puberty in Murrah heifers and Prilled fat supplementation 35 days pre-partum to 95 days post-partum improved reproductive efficiency in KF cattle.

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 FSSAI 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; 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 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; Isolation of milk proteins derived bioactive peptides.

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, sucrose in milk; New colour based method developed for rapid detection of detergents in milk;

Method developed for Vegetable oil detection in ghee using RP-HPTLC; Nanoencapsulation of curcumin; Lateral flow based assay was developed for the detection of antibiotics in milk; Development of Aptamer- AuNP assay for Detection of Cefquinome; Development of PCR based methodology to ascertain the quality of milk fat; Preparation and characterization of antimicrobial nanoemulsions of clove oil; Development of Buffalo casein hydrolysates enriched in potential antioxidant peptides.

The Division has state-of-the-art seminar room, lecture room equipped with interactive board, LCD projectors, visualiser, etc., Quality control lab, Undergraduate and Postgraduate labs, Instrument room, Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ neutraceuticals and quality assurance) and Dairy chemistry section of National Referral Centre for the milk quality and safety .

Dairy Technology Division

The Dairy Technology (DT) Division, 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 faculty are channeled through in-house projects including dissertations of Master's and doctoral students, and sponsored projects. The research is geared to improve 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 32 training courses under this programme. The Division of Dairy Technology has received a number of awards in recognition of the outstanding scientific contributions made by the scientists and students, the most recent among them being the Best Division Award for the second time in the past five years and Dr. S. K. Sirohi Memorial Award for Young Researcher, besides the earlier Rafi Ahmed Kidwai Awards, Jawaharlal Nehru Award, DAAD Fellowships, Humboldt Fellowships and several others, including Best Research Paper Awards.

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; 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, rapids 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. A new programme offering 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. The 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. The 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 has been 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 and 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

The 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.

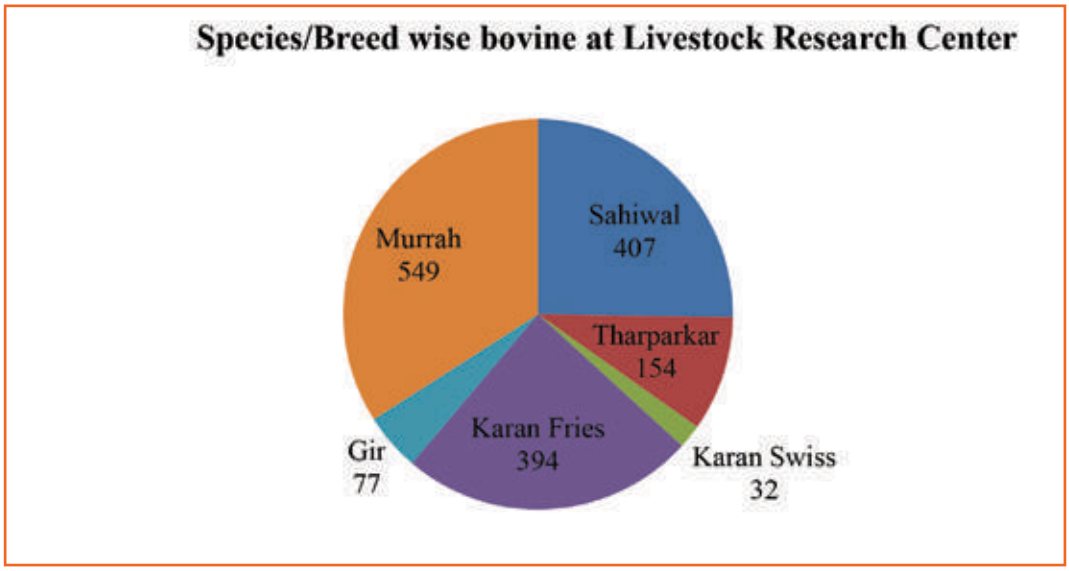
The main extension programme of the Institute such as Dairy Mela and demonstrations, field days, etc. are organized by the division. Research-Extension-Industry-Farmer Interface is also organized by the division to provide an opportunity for the convergence of all stake holders working together for dairy 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, Kisan Sanghosthies and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, help in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers.

One Extension Education Programme "Dairy Education at Farmers' Door" is continuing to strengthen the effective dissemination of dairy production and processing technologies among farming community. A new Extension Approach "Farmers Farm School" in village Gorgarh has been initiated since August, 2014 for updating farmers knowledge in the field of dairy farming, in particular and agriculture, in general.

SUPPORT SECTIONS

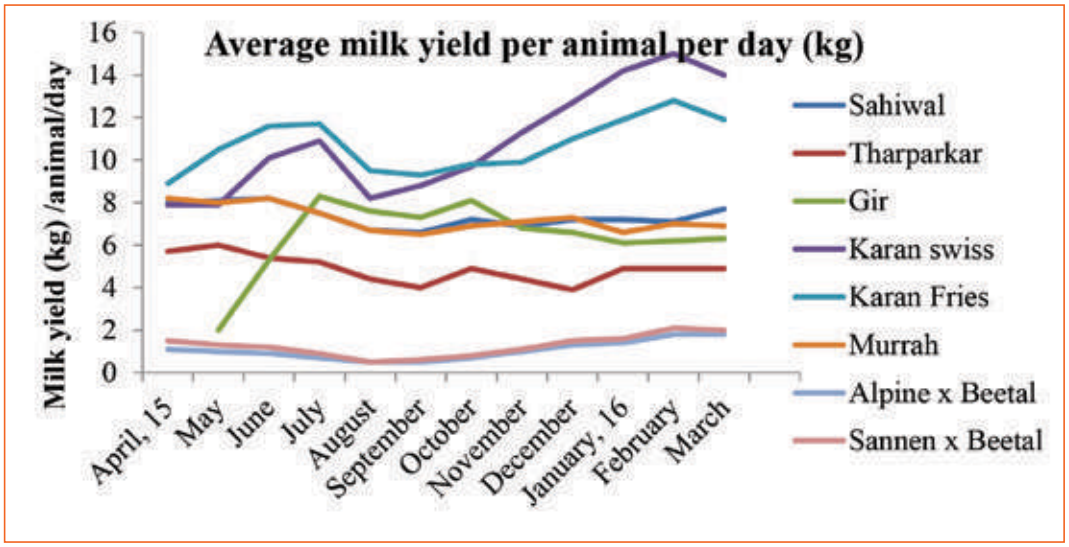
Livestock Research Centre

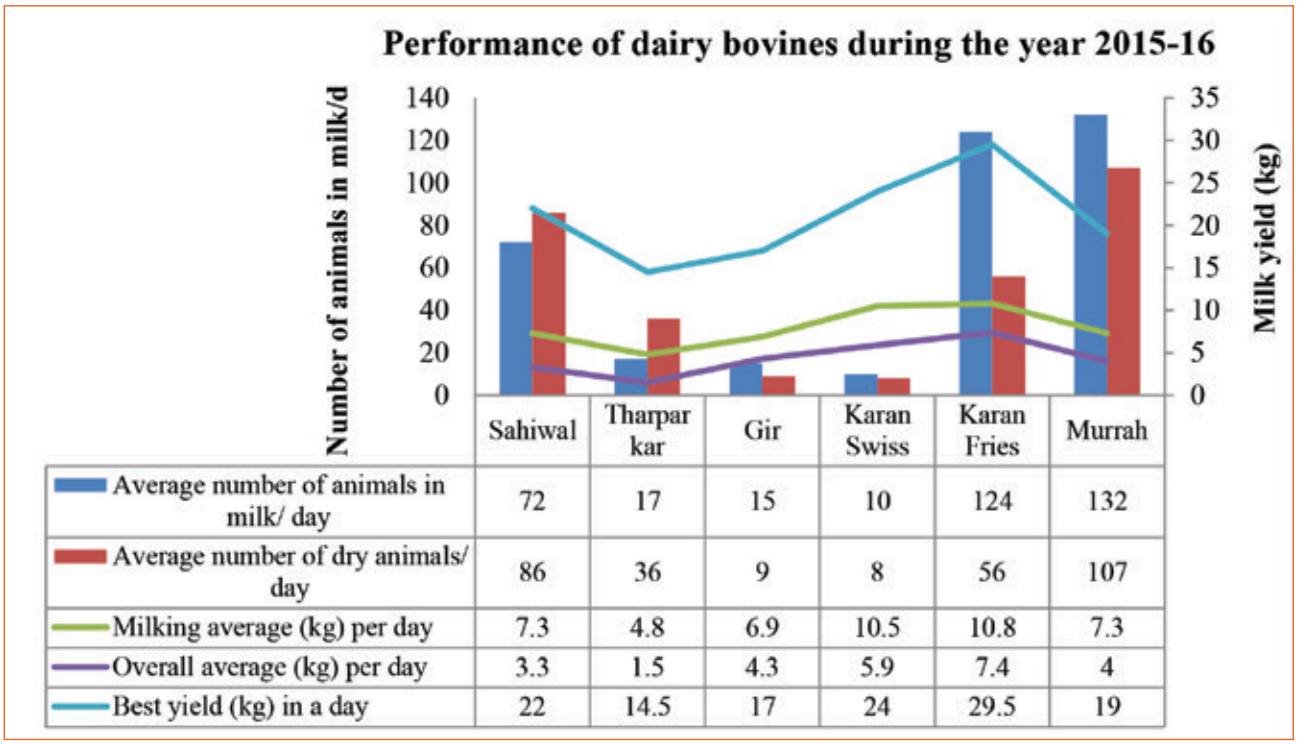
The total milk production of the herd during the current year was 1187187.1 Kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 10.5 and 10.8 kg per head per day, respectively. The milking average of Sahiwal cows and Murrah buffaloes was 7.3 and 7.3 kg per animal/per day, respectively. One Sahiwal cow (SW-2060) produced best milk yield of 22.0 kg in peak lactation. Best yield in Murrah buffalo (MU- 6872) was 19.0 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 29.5 kg (KF-7453) and 24.0 kg (KS-4424), respectively.



Milk Production at NDRI, Karnal during the Year (2015-16)

Total Milk Production (kg)	:	1187187.1 kg	
Average Number of Animals in Milk per day	:	Cattle	238
		Buffaloes	132
		Goats	42





Month-wise Milking Average (kg) as Fat Corrected Milk of Cows and Buffaloes Maintained at N.D.R.I. Karnal (2015-2016)

Month	Sahiwal 4% Fat		Tharparkar 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
April 2015	57	8.19	9	6.01	12	8.13	113	9.17	139	9.71
May 2015	63	8.48	11	6.31	10	8.68	103	11.16	130	10.70
June 2015	71	8.64	14	5.82	11	10.11	104	11.93	123	10.58
July 2015	72	8.01	17	5.96	12	11.40	114	12.21	126	9.89
August 2015	72	7.26	20	4.83	13	8.35	127	9.57	139	8.64
September 2015	81	6.86	20	4.48	12	8.64	136	9.32	150	8.56
October 2015	73	8.07	16	5.45	9	9.98	128	10.21	147	9.14
November 2015	78	6.85	17	4.53	8	11.17	135	9.87	142	9.14
December 2015	77	7.35	18	4.14	8	11.80	133	11.32	133	9.24
January 2016	71	7.53	19	4.45	7	14.54	131	12.24	133	8.60
February 2016	70	7.34	19	5.01	8	14.69	135	12.39	118	8.19
March 2016	75	8.36	24	4.99	10	14.49	133	12.04	108	9.32
Average	72	7.75	17	5.16	10	11.00	124	10.95	132	9.31

Production and Reproduction Performance of Cattle and Buffalo (2015-2016)

Traits	Sahiwal	Tharparkar	Karan Fries	Murrah
First Lactation				
Age at 1st calving (Months)	38 (43)	40 (7)	36 (26)	39.29 (24)
Total milk yield (kg)	2575 (16)	632 (1)	4034 (20)	2627(36)
305 or less days milk yield (kg)	2376 (18)	632 (1)	3172 (24)	2431(36)
Lactation length (days)	332 (16)	144 (1)	389 (20)	350(36)
Dry period (days)	121 (7)	-	68 (11)	88 (9)
Service period (days)	155 (7)	-	157 (11)	149 (9)
Calving interval (days)	438 (7)	-	437 (11)	395(9)
All Lactations				
Total milk yield (kg)	2233 (69)	1893 (14)	3988 (117)	2728(118)
305 or less days milk yield (kg)	2126 (71)	1841 (14)	3488 (128)	2523(118)
Lactation length (days)	287 (69)	262 (14)	355 (119)	362(118)
Dry period (days)	182 (38)	177 (9)	166 (33)	130 (92)
Service period (days)	186 (38)	173 (9)	198 (68)	134 (92)
Calving interval (days)	467 (38)	460 (9)	477 (64)	445 (92)
Average number of lactations	2.8 (70)	3.3 (14)	2.66 (144)	2.48 (118)
Best Lactation 305-days Milk Yield				
Milk yield (kg)	4947	3322	6813	4187
Animal number	2182	1290	7068	490
Lactation number	1	2	3	4
Best Lactation Total Milk Yield				
Milk yield (kg)	6730	3493	10225	5312
Animal number	2182	1290	7068	6630
Lactation number	1	2	3	2
Lactation length (days)	475	350	541	529

Artificial Breeding Research Center

The Artificial Breeding Research Centre (ABRC) has 127 breeding bulls (Sahiwal-36, Tharparkar-11, Karan-Fries- 25, Karan Swiss -02, Murrah – 45, Gir-07, Rathi-01), it is engaged in progeny testing programme for Sahiwal, Murrah and Crossbred Karan Fries Bulls. This centre is also engaged in active research on bull management, semen cryobiology, spermatogenesis; bull fertility assessment. The quality germplasm is being disseminated to the farmers and developmental agencies.

Research Highlights

» The centre has developed management strategies through systematic exercise, application of halter and bull handler for Sahiwal Bull for better sexual behaviour during semen collection on dummy with artificial vagina and reduction of average age of first semen donation of the young Sahiwal bulls. The centre has developed biostimulation strategies and GnRH hormonal treatment, useful to overcome the low libido problem of Sahiwal bulls and semen production performance of problematic Sahiwal bulls. It was found that Sahiwal male calves having higher birth weight and bigger scrotal circumference has better semen production ability.

» The project under "Incentivizing Research in Agriculture" Project V: "Semen Sexing in Cattle"



was launched on 13th January, 2015 in ICAR-NRRI, Cuttack, Odisha. ` 2.52 cr budget was released for the financial year 2016-2017. New initiatives were taken up in sexed semen technology like, low dose insemination, sperm immobilization, fertility marker for high fertile bull selection, spermatogonial stem cell transplantation to explore newer areas of research in semen biology to develop technology for sexing of sperm.

» The semen freezing of first cloned buffalo bull (Shresth) in the world was further strengthened and 6847 doses of frozen semen available at ABRC for fertility evaluation. Pregnancy was established with frozen semen of world's first cloned Murrah buffalo (Shresth) bull. A calf was born on 29th March, 2015 from the semen of cloned bull (Shresth).

New Initiatives

» The center has also strengthened the facilities for scientific management of male animals/ dairy bulls, cryopreservation facility for storage of germplasm, semen processing laboratory, advance training facility on animal breeding / reproduction management and frozen semen technology and dissemination of superior germplasm of cattle and buffaloes.

» The centre has screened sexually transmitted bacterial, viral and protozoan diseases viz., TB, JD, Brucellosis, IBR, Campylobacteriosis and Trichomoniasis of all breeding bulls as well as semen straws for IBR.



» The centre has screened microbiological load of semen with the help of Dairy Microbiology Division for 80 breeding bulls and all bulls' semen found within the acceptable range of microbial load as per MSP for frozen semen.

Research, Extension & Education Achievements

» Four Murrah breeding bulls were selected under Network Project on Buffalo Improvement for the 16th set of progeny testing programme and 10 Sahiwal bulls were selceted under AICRP on 'Genetic improvement of Sahiwal cattle'

» Cryopreservation of semen of breeding bulls: During 2015-16, frozen semen of nine 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 centers. 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 centres in the country for test mating, collection of data on conception rate and progeny testing parameters etc.

Production of Superior Germplasm

The centre is involved in production and conservation of superior male germplasm of cattle and buffaloes. During 2015-16, a total number of 1, 23,939 doses of frozen semen were produced.

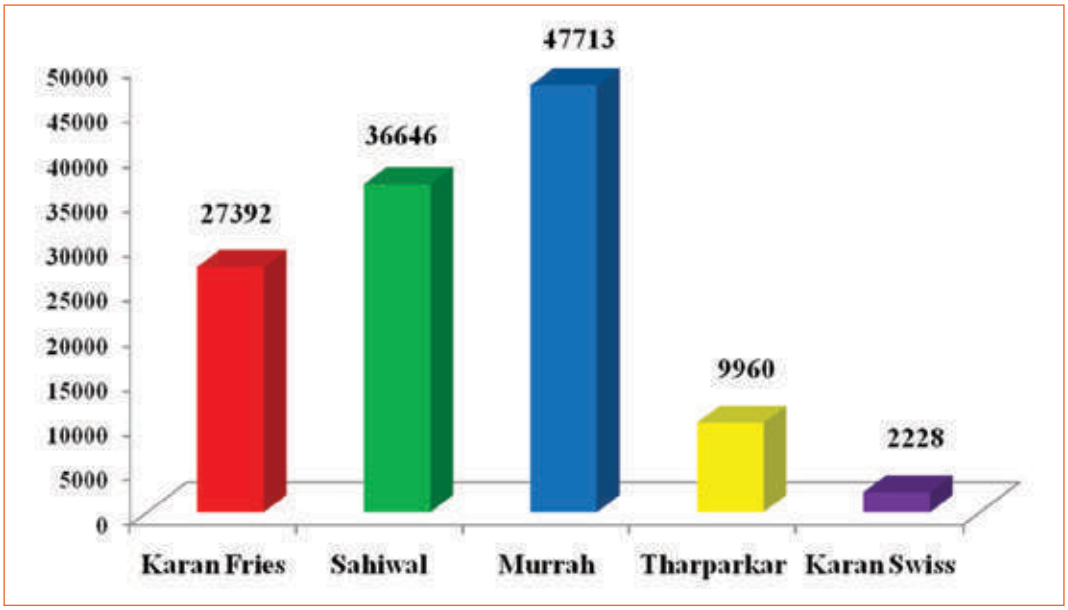


Fig.: Breed wise production of superior germplasm (April, 15 - March, 16)

Dissemination of Superior Germplasm

The Centre is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes. ABRC disseminated 66,257 ml doses liquid semen of Sahiwal, KF and Murrah bulls to local farmers and also disseminated / supplied 72,298 doses frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers and various dairy development organizations / institutes/ gaushalas of 10 states viz., Haryana, Punjab, Uttarakhand, Delhi, U.P., Rajasthan, Bihar, Himachal Pradesh, Madhya Pradesh and Tamilnadu.

Training Organized

ABRC conducted one training programme on "Laboratory Techniques for Frozen Semen Lab for Lab Technician" during 18th - 23rd January, 2016 under NDP-1 to the semen station officials and technical staff for 8 participants of 5 states.

» ABRC conducted one exposure visit-cum-training programme on "Good Dairy Farming Practices" from 29th - 30th September, 2015 for farmers of Kalahandi Odisha.

» ABRC conducted exposure visit cum training programme on "Recent Technologies for Augmenting Productive and Reproductive Performance of Murrah Buffaloes" from 17th to 22nd April, 2015 for technical personnel from ICAR Complex for NEH region, Tripura centre.

» ABRC conducted one exposure visit cum training programme for veterinary officers from Eastern Regional Demonstration and Training Centre, NDDB, Siliguri, Darjeeling from 8th - 9th December, 2015.

» ABRC has conducted orientation training of ARS scientist Dr. M. M. Ansari of NRC-Camel from May, 2015 to 7th August, 2015.

Services Rendered

» Distribution of breeding bulls: The centre distributed 21 surplus breeding bulls (Karan Fries - Five, Sahiwal - Six, Tharparkar – Five, Murrah - Four and Gir - One) to government agencies/ farmers.

» ABRC is doing straw testing of empty frozen straws for different animal husbandry departments.

» Advisory service to the farmers in use of A.I., different breeding activities and other aspects of dairy bull management were the regular activities of the centre.

» ABRC is supporting research activity of more than thirty students of NDRI to carry out research work in various aspects on sperm biology.

Dissemination of Frozen Semen

The Centre disseminated/supplied frozen semen to following organizations:

» Srikrishna Goushala, Bhavan, Delhi.
» IVRI, Bareilley, U.P.
» College of Veterinary Science, Mathura, U.P.
» Govt. Livestock Farm, Hisar, Haryana.
» Srikrishna Goushala, Janakpuri, Karnal.
» ICAR-CIRC, Meerut, U.P.
» Jagjyoti Gaushala, Sahabad, Kurukshetra.
» Divyajyoti Jagrati Sansthan, Noormahal, Punjab.
» Kamdhenu Hitkari, Bilashpur, H.P.
» Inex Natural Pvt. Ltd. Jaipur, Rajasthan.
» RSS Gaushala, Dayalbagh, Agra, U.P.
» Gaumata Dairy Farm, Mohali, Punjab.
» Gau Vigyan Kendra, Patiala, P.B.

Forage Production Section

The primary responsibility of Forage Production Section is to produce adequate quantity of good quality green fodder to meet the nutritional requirements of the Institute herd. After meeting the day to day requirement of fodder, some area is utilized for production of fodder seed and other grain crops to meet 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 of 1,82126.25 quintal good quality green fodder was produced from high yielding varieties of fodder crops of Maize, Sorghum, Sorghum x Sudan hybrids and Cowpea during Kharif season and lucerne, Berseem, Oats Chinese Cabbage, Turnip and winter Maize in Rabi season. Similarly, grain crops of Oats, and Barlay were also grown. A total of 216150.00 q of fodder including 213558.00 q. green fodder 2455.00 q. silage and 137.00 q. dry fodder was supplied to Livestock Research Centre. Total production of grains of Barley, Oats was 2108.75 q.

Production and Productivity of Forage Crops (Green Fodder)

Crop	Area (ha)	Average Yield (q/ha)	Production (q)
Berseem+Mustard	15.22	815.63	12,414.00
Oats+Berseem+Mustard	43.58	904.57	39,421.25
Sugergraze	2.22	248.08	550.75
Oats/Oats + Mustard	70.16	432.09	30316.00
Oats + Maize	3.76	418.21	1572.50
Mustard	4.05	243.20	985.00
Maize (Hybrid)	12.42	169.74	2108.25
Maize	113.99	276.62	31533.00
Jowar (Multicut)	8.96	522.07	4677.75
Jowar (S.C.)	36.23	253.92	9199.75
Mackchari	13.44	423.38	5690.25
Maize + Makchari Jowar (S.C.)	2.97	366.66	1089.00
Cowpea	2.43	301.44	732.50
Cowpea + Maize	17.59	297.45	5232.25
Jowar (S.C.)+ Makchari	22.16	388.57	8610.75
Sugargraze	167.10	334.54	22448.00
Maize + Makchari	16.15	343.35	5545.25
Total	552.43	-	1,82,126.25

Production and Productivity of Grain Crops

Crop	Area (ha)	Average Yield (q/ha)	Production (q)
Oats	11.70	9.67	113.25
Barley	22.40	24.59	551.00
Mustard	45.00	12.33	555.25
Wheat	21.13	42.08	889.25
Total	**100.23**	**-**	2108.75

Production and Productivity of Bhusa

Crop	Yield (q)	Area (ha)	Average Yield (q)
Oats Bhusa	163.05	11.70	13.93
Wheat Bhusa	486.85	21.13	23.04
Barley Bhusa	502.60	28.03	17.93
Total	**1152.50**		

Month-wise Fodder Supply to Livestock Research Centre during (2015-16)

Month	Green (q)	Silage (q)	Dry (q)	Total (q)
April	14054.25	-	-	14054.25
May	12712.00	-	-	12712.00
June	15217.25	-	-	15217.25
July	19827.75	-	-	19827.75
August	17518.50	-	-	17518.50
September	15789.00	-	-	15789.00
October	14203.75	144.50	30.50	14378.75
November	16616.50	54.00	49.50	16720.00
December	22246.00	-	-	22246.00
January	23254.75	-	-	23254.75
February	20659.25	-	8.00	20667.25
March	21459.00	2256.50	49.00	23764.50
Total	**213558.00**	**2455.00**	**137.00**	216150.00

Forage Conservation

Sufficient quantity of green fodder of oats was conserved as silage 2455.00 q. & 137.00 q. of dry fodder as wheat, barley and oats straw in the form of by-product of these crops was produced. To fulfill the nutritional requirements of the herd during lean period and to provide required dry matter during winter months, when DM content in the lush green forages is very low, silage and wheat/oats straw were supplied.

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 338.26 q seeds of improved varieties of fodder crops, 1597.49 q grains and 48242.75 q green fodder and 1328.75 q dry fodder were produced and total ₹ 14918101.25 Revenue was generated under Revolving fund scheme on Seed Production during the report as per given below:

Production of Seed under Revolving Fund Scheme (RFS) Seed Production

Kind of seed	Quantity of seed (q.)	Rate (₹/q.)	Amount (₹)
Oats kent	327.00	4000/-	1308000.00
Mustard Chinese Cabbage	11.26	6000/-	67560.00
Total	338.26		1375560.00

Production of Grains under Revolving Fund Scheme (RFS) Seed Production

Kind of Grain	Quantity of Seed (q.)	Rate (₹/q.)	Amount (₹)
Barley	484.50	1250/-	605625.00
Mustard Chiness Cabbage	6.74	3800/-	25612.00
Mustard	218.20	3800/-	829160.00
Mustard	23.30	3100/-	72230.00
Oats	14.50	1500/-	21750.00
Wheat	841.00	1450/-	1219450.00
Wheat	9.25	1650/-	15263.00
Total	1597.49		2789090.00

Green Fodder Supplied to Cattle Yard (q.) under Revolving Fund Scheme (RFS) Seed Production

Kind of Fodder	Quantity (q.)	Rate (₹./q.)	Amount (₹)
Green Fodder	48242.75	205/-	9889763.75
Total Green Fodder	48242.75		9889763.75

Dry Fodder Supplied to Cattle Yard (q) under Revolving Fund Scheme (RFS) Seed Production

Kind of Fodder	Quantity (q)	Rate (₹) (q)	Amount (₹)
Bhusa, Oats, Wheat	1328.75	650/-	863687.50
Total	1328.75		863687.50

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 91,881 volumes which includes 52,010 books, 33,457 bound journals, 4,646 theses, 268 microfiches and 1,500 CDs. Library has an excellent computer section having fifty workstations for students and staff of the institute. Students use this facility to get current information in the advanced research areas and for communication.



The Library provides Internet, e-mail, 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. It also provides instant Document Delivery Services to users of ICAR sister Institutes, State Agricultural Universities and other participating Institutions on their request.

Document Delivery Requests

Sr. No.	Name of Institute/University	Total Requests Received	Total Requests Fulfilled
1.	Acharya NG Ranga Agricultural University	1	1
2.	Anand Agricultural University	12	8
3.	Bidhan Chandra Krishi Viswavidyalaya	8	5
4.	Central Arid Zone Research Institute	8	6
5.	Central Inland Fisheries Research Institute	2	2
6.	Central Institute for Cotton Research	1	0
7.	Central Institute of Fisheries Technology	13	12
8.	Central Plantation Crops Research Institute	2	2
9.	Chaudhary Charan Singh Haryana Agricultural University	12	11
10.	Directorate of Oilseed Research	5	5
11.	Indian Agricultural Statistics Research Institute	2	2
12.	Indian Institute of Pulses Research	1	1
13.	Indian Veterinary Research Institute	5	4
14.	Kerala Agricultural University	1	1
15.	National Bureau of Animal Genetic Resources	2	2
16.	National Institute of Animal Nutrition and Physiology	13	12
17.	Total Document Requested/ Delivered	88	74

The Library is also an active partner of Agricat (a sub-portal under WorldCat). Presently 50,502 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 -2000 contents/ records of institute outputs, which includes valuable books, publications, 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.



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 system such as Unix/Linux, MS-Windows; and statistical/ scientific computing system like SAS 9.3, MATLAB, etc. Also, compliers for various programming languages including FORTRAN, C, C++, Visual Studio, etc., are available. There is a campus-wide well established Local Area Network (LAN) connecting all the research Divisions and Sections through optical fiber/UTP cabling to cover the main buildings; and through Asymmetric Digital

Subscriber Line (ADSL) switches for distantly located buildings, thereby providing connectivity to across the campus. Students' hostels are also connected to Institute LAN through Wi-Fi network to enable them to access the Internet and library resources round the clock. A video conferencing facility is also operational at the Institute. Besides, the Centre imparted training on advanced topics in computing to several externally sponsored students of M.Tech./M.Sc. (CSE/IT) and B.Tech. (CSE/EEE).

New Systems Implemented

» Aadhaar Enabled Biometric Attendance System (AEBAS) has been installed and commissioned at Main Campus, Karnal.

» The Payroll Processing Module of the ICAR – ERP (MIS/FMS) system has been successfully implemented thereby replacing the in-house developed old software, at this Institute.

» Web-enabled Interactive Information Delivery System (WIIDS) for dairy farmers has been developed and linked to the Institute Website.

» Information management software has been developed for processing applications received for ongoing recruitment to various technical positions.

» Scientists/officers have been provided with new email addresses (<...>[at]icar.gov.in) for official correspondence.

Management Information Service

Computer Centre continued to prepare daily fortnightly and monthly MIS reports such as herd performance, animal management system, etc., for decision support at appropriate management levels 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.

Scientific Data Processing

The Centre processed scientific data pertaining to several research projects of the Institute including students' dissertations/theses data. The sophisticated statistical computing software, SAS is extensively utilised for the purpose.

Agriculture Knowledge Management Unit

The ICAR – 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.

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-16,099 kg., Pasteurized Butter (200 gm) - 1,835 kg., Ghee - 16,740 kg., Paneer - 43,439.5 kg., Burfi - 6,827.5 kg., Kalakand - 34,012.5 kg., Lassi (200 ml) - 1,97,703 pkts., Ice-cream (100 ml) - 1,30,500 cups, Flavored Dairy Drink (200 ml) - 3,86,544 pkts., Processed Cheese Slices (200 gm) - 1,591 pkts., Gulab Jamun Mix – 22,109.5 kg., Pizza Cheese (200 gm) - 4154 plastic container etc. These products are sold through the Milk Parlour located at the

Institute's main entrance. 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 44 students from several institutions was provided training during the financial year 2015-16. 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 2015-16 was ₹5,48,91,665.

Communication Center

Exhibitions Organised (2015-16)

Sr. No .	Exhibition	Place	Date
1.	International Conference on Sustainable "Innovation in Dairying".	Rajgir, Bihar	2nd - 5th April, 2015
2.	Kharif Kisan Sammelan.	KVK, NDRI, Karnal	14th July, 2015
3.	Foundation Stone of ICAR-IARI, Jharkhand.	Barhi, Distt. Hazari bagh, Jharkhaand	27th -28th June, 2015
4.	Agricultural Exhibition.	Piprakothi, Motihari, Bihar	20th -21th August, 2015
5.	Ganna and Makka Kisan Mela.	CCS, HAU, Uchani, Karnal	6th October, 2015
6.	International Exhibition on Agriculture and Horticulture.	DWR, Karnal	7th - 9th October, 2015
7.	Krishi and Gramin Vikas Exhibition.	Faraha , Mathura	9th -11th October, 2015
8.	I.A.S.O. W.A, IAS Officers Wife Association (IASOWA).	Pandara Park, Delhi	31st October to 1st November, 2015
9.	Trade Fair at Pragati Maidan.	Delhi	14th - 27th November, 2015
10	World Soil Day.	KVK, NDRI, Karnal	5th December, 2015
11.	Jai Vigyan Jai Kisan Mela.	NDRI, Karnal	26th December, 2015
12	Buffalo Mela.	CIRB, Hisar	1st February, 2016
13	Ganna Kisan Mela.	Sugar Cane Breading Institute, Karnal.	3rd March, 2016
14	Rabi Kisan Mela.	CSSRI, Karnal	5th March, 2016
15	Krishi Unnati Mela 2016.	IARI, Delhi	19th - 21st March, 2016
16	Animal Fair Cum Farmers'-Scientists Interaction".	Kotwa Block Motihari, Bihar	29th - 30th March, 2016

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, such as Max Healthcare, B. L. Kapoor Hospital, Cygnus Hospital, Glenmark Pharmaceuticals, etc. following camps/programmes have been organized free of cost during the current year wherein on an average more than 100 persons have taken consultation in each camp.

» Check-up Camp for specialist Neuro and Orthopedic consultation: **11.05.2015**

» Health talk on Diabetes- Prevention and Management: **02.06.2016**

» Bone Mineral Density (BMD) check up Camp: **16.09.2015, 17.11.2015 & 12.01.2016**

» Dental Camp: **19.09.2015**

» Health Check-up for Cardiology and Orthopedic Consultation : **26.11.2015**

» Cardiology Consultation Camp: **26.02.2016**

» Orthopedic Consultation, Physiotherapy and Mineral Density Test: **11.03.2016**

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 area in case of power failure; Liaison works with HSEB, 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; maintenance of STP and Bio Gas Plants and other miscellaneous works of the Institute.

Model Dairy Plant



A state-of-the-art Commercial Dairy Plant was established in 1996 at NDRI, Karnal through the financial assistance and installed on turnkey basis by the National Dairy Development Board. The Plant has been designed to handle 60,000 liters (Ltrs.) of milk per day and is presently running in full capacity. Model Dairy Plant is presently certified under the Food Safety Management System **ISO 22000:2005.**

Special Features

» Model Dairy Plant provides one year in-plant training to the students of B.Tech. (DT) of the NDRI Deemed University during the 4th year of the course curriculum.

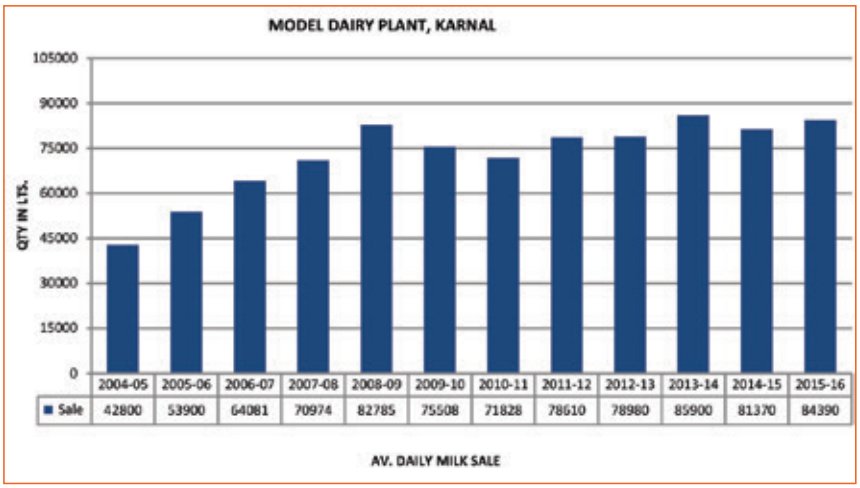
» The students are provided with complete infrastructure for training, which helps them in gaining sufficient experience in managing the modern commercial Dairy Plant and instills confidence in handling real life problems in production management.

» It also provides infrastructure facilities to the scientists of NDRI for scaling up R & D concepts from laboratory scale to industrial scale under commercial environment.

» 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 (Capacity 60,000 LPD)

MDP is currently engaged in processing and packaging of milk for Mother Dairy in five different variants (Full Cream, Standard, Toned, Double Toned and Skim Milk). MDP is presently processing / packing 70 – 75 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 thereby utilizing the plant to more than its full capacity.



Ice Cream Manufacture (Capacity 7000 LPD)

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. 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 (Capacity 800 kg per day)

MDP manufactures Cow Ghee from Cow Butter purchased from different State Federations and its production is not 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 (Capacity 1500 kg per day)

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.

Procurement of Milk

MDP does not have its own infrastructure for milk procurement and is receiving milk on behalf of Mother Dairy from the units of Punjab / Rajasthan / Uttar Pradesh State federations on NMG rates. 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.

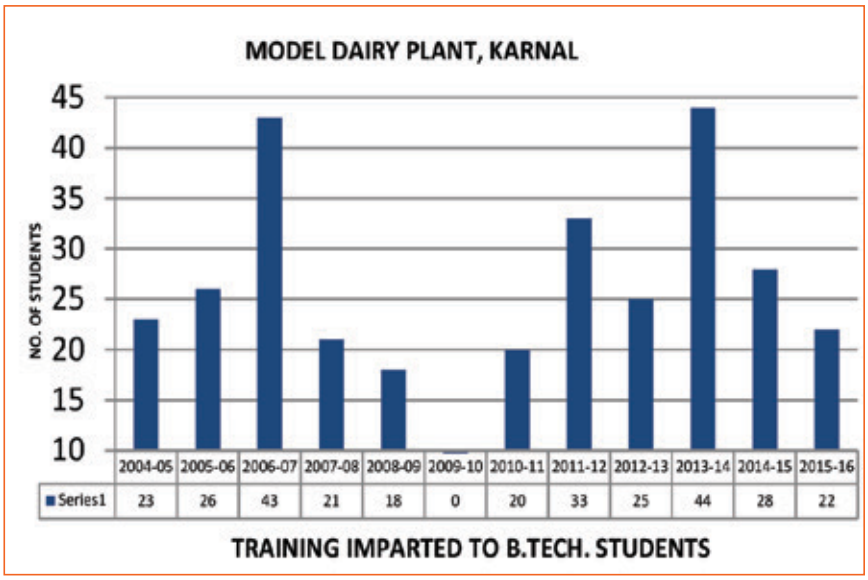
Training to the Students

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 fourteen batches of B.Tech. (DT) students. The student trainees are provided Rs.1500/- per month as stipend. So far, 511 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 2015-16

» Average milk dispatch per day was 84390 lt.
» Ghee sale is approximately 278 MT this year.
» Nutritious Pinni is launched.



» New bio-waste fired boiler installed.
» The operational profit is 127.00 lakh for the year 2014-15.
» De-superheater in ammonia line is installed to heat the water for boiler.
» New PLC based ghee filling and packing machine installed.



REGIONAL CAMPUSES

SOUTHERN CAMPUS, BANGALORE

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 Station functions with the following mandate and objectives.

Mandate

- Identify the region specific problems of dairy production, processing and management on continuing basis and evolve suitable solutions.
- Establish centers for technology development, assessment and dissemination.
- Establish centers of advanced studies for R & D and HRD with the Station as the Southern Campus of NDRI Deemed University.

Objectives

- Faster multiplication of superior germplasm of region specific breeds of cattle and buffaloes through interventions.
- Process upgradation for the industrial production / packaging of region specific dairy products.
- Establishment of the regional referral centre for quality assurance of dairy products.
- Economic analysis of various aspects of dairying and establishment of data bank for strategic development of dairying in the region.
- Establishment of model villages with integrated development focused on dairying.
- Transfer of technologies suitable for the crop-livestock production systems prevalent in agro-climatic conditions of the region.
- Training of farmers and industrial entrepreneurs at technology development centers.
- Undertake advanced HRD programmes to meet the needs of the industry.

Infrastructure

The Campus is endowed with necessary infrastructure in terms of qualified staff, farmland, dairy herd, laboratories, library, staff dispensary, hostel facilities etc. The Campus has a land area of about 46 hectares. About 16 hectares of land is utilized for the cultivation of various forage crops for meeting the feeding requirement of the dairy herd of the institute. About 162 zebu cattle of Deoni breed and 49 crossbred cattle constitute the dairy herd of the institute.



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, effluent analysis etc. There are network connected computer facilities to facilitate data analysis, documentation, e-mail communication and programming packages for students.

A LAN with a modern web server networks the computers of different sections and Internet facilities are provided to all the sections through the server. An effluent treatment plant and effluent-testing laboratory are established and are functioning at the station. A sensory evaluation laboratory for evaluation of dairy products has also been established.

The library 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. In addition, few journals were also received on gratis basis from different Institutions / organizations of the country and abroad. Library Automation Software procured for facilitating the automation of library functions and 9450 Bibliographical details have been updated in to the software. Library also provides Internet services, photo copying facility, news paper clipping services, reference services to readers. The Library serves as a referral centre for many students and professionals in the field of dairying and food science across the country.



There is a good hostel and guest house facility for the stay of students and visitors. The staff dispensary at the Campus caters to the medical needs of students, staff and retired employees.

The research, training and transfer of technology programmes at the Campus are carried out through different sections viz., Animal Breeding & Artificial Insemination, Cattle yard & Forage Production, Dairy Technology, Dairy Chemistry & Bacteriology, Dairy Engineering, Dairy Economics & Statistics, Dairy Extension and Education & Training. The Campus has staff strength of about 150 including 24 Scientific and 27 Technical staff.



The renovated experimental dairy of the Institute has the facilities for manufacturing various milk and milk products. The Dairy Technology Section is involved in regular training programmes and also providing in-plant training to the students from various institutions. Training is also imparted to the entrepreneurs. The surplus milk is being sold as market milk and some quantity of milk is also converted into various dairy products for sale through the parlour of the Institute.

Education and Training

Educational Programmes

The course work for Ph.D (Dairy Engg.), M.Tech (Dairy Engg.), M.Tech (DT), M.Tech (FQSA) and Diploma (DT) are being conducted at the station. The students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Animal Nutrition, Agricultural Economics and Dairy Extension Education are being guided for their Doctoral and Masters' dissertation work.

Short term Training Programmes are being imparted in 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.



The Southern Regional Station of National Dairy Research Institute, Bangalore is serving 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 counseled for Practical and Theory classes.

Academic Programmes

Scholarships and Fellowships

The Ph.D. and M.Tech Students are awarded with NDRI Fellowship/ and External fellowship as shown below:

Scholarship/Fellowship	Ph.D	M.Tech.
NDRI Fellowship	21	27
ICAR-SRF/JRF	-	03
CSIR-SRF Fellowship	01	--
Moulana Azad National Fellowship	01	--
INSPIRE (SRF)	02	--
In-service Candidates	03	--

Training Programmes

Short-term Trainings/In-plant & In-lab trainings/ Project Work	No. of Batches	No. of Participants
Commercial Dairy Production	03	23
Orientation Programme on Dairy Products	01	05
Production of Cheese and Related Products	02	13
Internship	01	03
Project Work	06	11

Events

» **Gandhi Jayanti and Swachh Bharath:** Gandhi Jayanti was celebrated on 2nd October, 2015. All the Staff & Students of SRS of ICAR-NDRI Bengaluru assembled in the Gandhi Park and Head of the Station garlanded the statue of Mahatma Gandhi. All the Staff & Students of SRS of ICAR-NDRI took part in the Swacch Bharat Abhiyan and planted trees.

» All the Diploma, P.G and Ph.D. students attended the talk on **'Integrated Personality Development'** on 8th May, 2015 held at SRS, Bangalore.

» All the PG and Ph.D. students attended the VI International Conference on **'Emerging Technologies in Food and Nutrition for Health Management'** from 14th – 15th May, 2015 held at SRS, Bangalore.

» All the PG and Ph.D. students participated in the competitive events of oral presentation and poster presentation during National Seminar on **"Quality- A Tool for Value Addition of Dairy Foods"** from 23rd – 24th June, 2015 held at Bengaluru.

» **Hindi Week/Day:** Hindi Week was celebrated in the Institute from 5th – 12th September 2015. During the celebrations, Hindi competitions were conducted for the Staff members as well as for their Children and Students of the Station. Hindi Day was celebrated at the Station on 14th September 2015. The occasion was graced by Prof. Y. Chittaranjanrao, Retd (Sr. Hindi Officer) & Engineering Consultant, MECON Ltd., (Ministry of Steel), Bengaluru..

» **World Food Day:** World Food Day was celebrated on 16th October, 2015 on the theme 'Protection and Agriculture – Breaking the Cycle of Rural Poverty' at our Institute. A food quiz, poster painting contest and a food judging event were conducted for the students of the Station.

» **Literary, Cultural and Sports Activities:** Literary, Cultural and sports competitions were held for students and staff of the Campus during Independence Day and Republic Day Celebrations and National Integration and Kannada Rajyotsava Day.

Extension Activities

» Advisory services / technical advice was rendered to twenty seven needy clientele on dairy production and dairy processing aspects, information regarding dairy inputs, dairy development schemes, credit availability for dairy projects, 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.

» Extension literature on "Green Fodder Production" was prepared in English and others literatures 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.

» Visits Organized: A total 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.

» An Orientation Programme was organized on 22nd April 2015 for thirty eight elite farmers, secretaries and directors from Dairy Co-operative Societies under ATMA programme of Thrissur, Kerala. The trainees were briefed about the ongoing activities of the Institute and scientific dairy farming. An interactive session was organised to identify the specific problems in dairying and needed suggestions were provided.

» An exposure training programme was organised for the new recruits / gazetted rank Officers (53 nos.) of Karnataka Milk Federation on 28th May 2015.

» An Orientation Programme was organized on 2nd June, 2015 for 39 B.Tech. (Agril. Engineering) 25 students from MPKV, Rahuri and 14 students from VNMKU Parbhani, Maharastra who were on one month summer training programme.

» Dairy Education at Farmers' Door: The 'Dairy Education at Farmers' Door' as a new initiative was organized and visits were made by the multidisciplinary teams on Second Saturdays to Chikkanayakkanahalli, Aadhoor, Hanumanahalli, Gundur, Gattahalli and Huskur villages of Bangalore South and North Taluks, Valepura, Muthasandra, Bellikere and Thiruvaranga villages of Bangalore South and North Taluks during January - December 2015, respectively. The multi-disciplinary team visited individual households and interacted with the farmers regarding dairy farm management problems.

» Farmers' Interactive Meet & Animal Health Camp: A Farmers' interaction meet and dairy animal infertility camp was organised at Hanumanahalli village on 14th March 2015 for the benefit of the farming community. The multi-disciplinary team had interactions with the farmers on various aspects of dairy animal health care and scientific management with specific focus on reproductive problems. The dairy animals were examined for pregnancy diagnosis, reproductive problems such as delayed maturity, anoestrus, repeat breeding, poor and delayed conception. Necessary health care advice including mineral mixture supplementation was recommended as a corrective measure.

» Training Programme on "Commercial Dairy Production" for dairy entrepreneurs was organized during 20 -25th April 2015. On farm extension training programmes were also conducted on different aspects of scientific dairy farming viz, clean milk production, green fodder production and good management practices.

Exhibitions

» Participated in Dairy Tech India 2015, International Exhibition on Dairy Products & Technology held during 21st - 23rd August, 2015 at Bangalore International Exhibition Centre (BIEC), Bangalore.

» Participated in Krishimela 2015 organised by UAS Bangalore held during 19th- 22nd November, 2015 at GKVK Campus, Bangalore.

» The rural extension programme in adopted villages was initiated in new cluster of villages in Varathur Block of Bangalore Rural District.

Mera Gaon Mera Gaurav Programme

» A cluster of villages was indentified in Bangalore Rural Districts and six groups of scientists, comprising four scientists from different multi-disciplinary teams were formed to conduct the baseline survey and further implementation of need based institute interventions and other developmental activities on regular basis under MGMG.

A Success Story of Malnad Gidda Cattle of Karnataka

Malnad Gidda, a unique dwarf cattle primarily found in Malnad and Coastal districts of Karnataka, play an important role in the farming systems of the region by providing milk, manure and draft power. The adult Malnad Gidda cattle weighs around 80-120kg and birth weight of calves is 7.91 ± 0.58 kg. They mostly thrive on grazing and their rearing system is unique. During nights majority (85%) of them are housed in traditional sheds and left for grazing during daytime. Green or dry leaves are spread everyday as bedding material over the dung and urine and cleared once in one to two months. They are mostly bred by natural service and age at first calving is around 3 years and give milk for 8-9 months. Under the Karnataka Livestock Development Agency funded project Malnad Gidda cattle were characterized at phenotypic and genetic level. Based on the detailed information alongwith breed descriptor, submitted by the Scientists of SRS of ICAR-NDRI, Bengaluru, Malnad Gidda cattle was registered as a new cattle breed of India in July 2012 with Accession Number INDIA_CATTLE-0800MALNADGIDDA-03037.

The average lactation milk yield, daily milk yield, peak yield and inter-calving period among the elite Malnad Gidda cows under field condition was 522.33 ± 69.40 liters, 2.17 ± 0.29 liters, 3.42 ± 0.39 liters and 14.91± 0.93 months, respectively. The average fat and SNF of the milk was 4.18 ± 0.20 and 8.66 ± 0.13%, respectively. *Nagi* – the elite Malnad Gidda cow has already given 21 calves in 25 years. The incidence of many tropical diseases is rare. There is huge demand for their milk and other products particularly ghee due to preference for usage in Ayurvedic medicines. Malnad Gidda cow's milk was found to have higher lactoferrin (antimicrobial, antiviral and anti-carcinogenic substance) contents compared to other breeds of cattle and buffaloes and low somatic cell count.

Scientists of Southern Regional Station, Bengaluru identified interested farmers and NGOs and encouraged them to form Malnad Gidda Breeders Association and bull exchange programme was successfully introduced to avoid inbreeding. SRS of ICAR-NDRI produced and made available frozen semen from elite Malnad Gidda bulls to the farmers for the first time through State Animal Husbandry & Veterinary Services Department, Govt. of Karnataka and many calves have been born after Artificial Insemination using frozen semen. The effective dissemination of research output by arranging training programmes and usage of print and mass media helped to create awareness among large number of farmers and public and resulted in their genetic improvement through the use of elite superior germplasm as well as increased demand for their produce. Owing to scientific findings and its publicity, farmers have evinced more interest in rearing of Malnad Gidda cows and reap the benefits. Even at urban places, sporadic rearing of Malnd Gidda cattle has started.



Elite Malnad Gidda cow with calf



Nagi – a wonder cow gave 21 calves in 25 years

Sale of Milk and Milk Products (2015-16)

S. No.	Product	Quantity Sold	Amount (₹)
1.	Milk sweet, kg	358	86760
2.	Flavoured milk, pkt	4975	59700
3.	Process cheese, pkt	5079	383135
4.	Paneer, kg	1822	371550
5.	Butter, kg	238	71400
6.	Gulabjamun mix, pkt	286	12985
7.	Cheese puri mix, pkt	359	16330
8.	Chhana podo, pkt	1295	78170
9.	Kunda, cups	1057	25602
10.	Curd, pkt	1666	19992
11.	Khoa, kg	58	15280
12.	Cream, kg	1.6	304
13.	Milk, lit	32260	935540
Total			2076748

Livestock Research Centre

Livestock Research Centre, SRS comprises 211 animals in which 162 were Deoni and 49 Holstein Friesian (HF) crossbreds. The mean monthly milk yield of Deoni and HF crossbreds were found to be 1939.84 ± 166.002 and 6816.827 ± 438.40 kg, respectively. Mean daily milk yield was reported as 3.61 ± 0.10 and 13.04 ± 0.26 kg, respectively. The annual mortality rate is 3.17%. Mechanization on cleaning and washing of sheds and animals was taken up. TV and Radio talk were delivered by staff of LRC on Hydroponic fodder production and balanced feeding to dairy animals. One day workshop cum training on Veterinary Reproductive Ultrasonography was conducted for Veterinary Officers of Karnataka Milk Federation.

Parameters	Deoni	HF cross	Total
Monthly milk yield (kg)	1939.84 ± 166.002	6816.827 ± 438.40	8756 .66 ± 506.861
Average Milk Yield (kg/day)	3.61 ± 0.10	13.04 ± 0.26	-
No. of AI done	51	58	109
No. of Calves Born	43	22	65
Germplasm dissemination to Goushalas	41	09	50
Present Stock	162	49	211
Adult Females	50	24	74
Bulls	04	-	04
Bullocks	08	-	08
Young Stock 0 - 6 months	34	09	33
06 - 1 year of age	16	09	25
01 - 02 year of age	23	06	29
Above 2 year of age	27	01	28

Fodder Production (quintals)

Production of Green Fodder Crops and Supplied to the Cattle Yard (2015-16)

Month	Napier	Guinea	Para	Maize	Maize + cowpea	Jowar	Jowar + cowpea	Total(q)	Daily average
Apr,15	737.0	191.5	640					1568.5	52.28
May,15	477.5	766.5	623.0					1867.0	60.22
Jun,15	985.5	126.5	660.0					1772.0	59.07
Jul,15	430.5	840.5	511.0					1782.0	57.48
Aug,15	168.0	310.5	1011.5	175.5		165.0		1830.5	59.05
Sep,15	550.5	86.5	405.5	417.0	254.0	227.5		1941.0	64.70
Oct,15	676.0	92.5	497.5	102.0	301.5	259.0	80.5	2009.0	64.81
Nov,15	471.0	635.0	264.5	113.0		148.5	31.0	1663.0	55.43
Dec,15	411.5	486.5	733.5	19.0		7.5		1658.0	53.48
Jan, 16	377.0	87.5	1216.5					1681.0	54.22
Feb, 16	172.5	54.0	1252.5		17.0			1496.0	51.58

EASTERN CAMPUS, KALYANI

The National Dairy Research Institute (NDRI) is a premier institute devoted to research on dairying. The main institute is located at Karnal, Haryana. The main objective of establishing the Eastern Regional Station 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 technologies developed at the institute and provides appropriate feedback after trials 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 to Kalyani during 1966, 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 since 2005. The 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 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.

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.

Events and Extension Activities

Workshop-cum-Scientists' Dairy industry Partners' Meet

A one day workshop cum Scientists' Dairy industry Partners' Meet on "Commercialization of Dairying through Production and Traditional Processing" was organized by ERS-NDRI, Kalyani in association with Faculty of Dairy Technology, West Bengal University of Animal & Fishery Sciences, BCKV, Mohanpur, W.B. on 12th December, 2015 at ERS- NDRI, Kalyani campus.

World Veterinary Day Celebrated

World Veterinary Day was celebrated on 24th - 25th April, 2015 by the Indian Council of Agricultural Research-National Dairy Research Institute (ICAR- NDRI), Eastern Regional Station (ERS), Kalyani, Nadia, West Bengal, India with the theme of "Vector-Borne Diseases with a Zoonotic Potential" to create awareness on the importance of vector borne diseases in animals and its zoonotic potential.

Training Programme Organised

On Campus

» One day orientation cum training programme on 'Improved Dairy Farming practices' was organised on 13th December, 2015. A total of 23 farmers from Nadia, North 24 Parganas and Hoogly district of West Bengal participated.

» One eight day training programme on "Improved Dairy Farming Practices for Tribal unemployed youth" under TSP was organised during 16th – 23rd December, 2015. Sixteen unemployed rural youth from Nadia, South 24 Parganas and Birbhum participated in the training programme.

Off Campus

One workshop-cum-interaction session with farmers was jointly organized by Eastern Regional Station of ICAR-National Dairy Research Institute (ERS-NDRI), Kalyani and Rathindra Krishi Vigyan Kendra (RKVK), Sriniketan on 29th December, 2015 at Sriniketan in Birbhum district of West Bengal.

Training Programme on Artificial Insemination and Scientific Goat Rearing Practices

• Three day training programme on "Artificial Insemination and Scientific Goat Rearing Practices" was organized during 12th – 14th August, 2015 at the Institute Campus. A total number of 26 rural youths from different districts of West Bengal participated in the programme.

» One 43 day training programme on "Artificial Insemination &Veterinary First Aid" was organized at ERS, NDRI for selected farmers from 13th April to 25th May 2015. Fourteen selected farmers' from three different district of West Bengal actively participated.



Exposure Visits

» Twelve students from Palli Siksha Bhavan (Institute of Agriculture), Visva Bharati, Sriniketan visited the ERS of ICAR-NDRI on 12th October, 2015.

» Eight officials from IVRI, Belgachia Campus visited the Institute on 21st November 2015.

» Four board members from Ichhamati Cooperrative Milk Producers Union Ltd. took exposure visit on 3rd December, 2015.

» One day exposure visit was organized for Forty-three B.V.Sc. & A.H. 1st year students from Department of Livestock Production Management West Bengal University of Animal Sciences Faculty of Veterinary and Animal Sciences, Mohanpur, Nadia, on 23rd April, 2015 at ERS, NDRI.

Animal Health Camps

» Two one day vaccination camps were organized in Muratipur and Dakshin Chandamari villages of Nadia District on 19th June and 24th July, 2015, respectively. A total number of 90 farmers participated with 226 animals for treatment.

» Seven one day camps on "Anoestrous and Deworming" were organized at Muratipur, Dakshin, Chandamari, Charbirpur and Ghoshal Danga villages of Nadia District during the year (2015-16). A total number of 248 farmers participated with 925 animals for treatment in these camps.



» Team of ERS, ICAR-NDRI participated in Exhibition organized by National Horticultural Board from. 27th-28th June 2015 at Barhi, Hazaribagh, Jharkhand.

Activities under Tribal Sub-plan (TSP) Scheme

» One ten day training programme on "Improved Dairy Farming Practices" was organized at ERS, NDRI for Tribal unemployed youth from 28th July 2015 to 6th August 2015. Twenty one tribal unemployed youth from six different district of West Bengal actively participated in the Program.

» Inter institute collaboration programme on "Scientist-Farmers-Interface" was jointly organized by ERS of NDRI and Rathindra Krishi Vigyan Kendra, Birbhum on 28th August 2015 in the Rathindra krishi bigyan Kendra, Sriniketan, Birbhum. Total sixty two (62) farmers actively participated in this programme.



» One Health cum Vaccination camp was organized in the Bhuigara, Ajodhya Hills of Purulia district of West Bengal on 16th October, 2015 under TSP. In the camp, a total number of 1753 animals were vaccinated and dewormed. A total number of 141 farmers were benefitted by this camp.

Activities under NEH Scheme

A team from ERS of ICAR-NDRI, visited Barapani of Meghalaya and by collaborating with ICAR Research Complex for NEH Region, Umiam, organized animal health-cum-vaccination camp, interaction-cum-demonstration session with farmers on 21st January, 2016 and distributed medicines and mineral mixture for livestock and fodder seeds among the farmers of Smit village in Meghalaya. Another vaccination cum animal health camp, interaction cum demonstration session in Umlyngka village of Meghalaya was organized on 22nd February, 2016.

A team from ERS of ICAR-NDRI, Kalyani visited Tripura and by collaborating with ICAR Institute for NEH, Lembuchera, organized animal health camp, interaction cum demonstration session with farmers on 24th March, 2016 at Bagma village in Tripura. Another animal health camp, interaction cum demonstration session in Bamutia village of Tripura was organized on 25th March, 2016.

Special Animal Health & Nutrition Camp in Flood Affected Villages

A team of extension scientist of ERS, ICAR-NDRI visited the flood affected areas. A special animal health camp was organized on 8th August, 2015 (2nd Saturday) at village Muratipur,





Frontline Demonstration of Azolla Production

Frontline demonstration on Azolla production for animal feeding was organized at premises of one farmer's house in Muratipur village of Nadia District on 12th September 2015. Five farmers participated in step by step in practical demonstration of Azolla Cultivation methods.

Establishment of Common Interest Group

One common interest group consisting of 10 members namely "**Kamdhenu:** in Char birpara village of Nadia district was established on 12th September 2015 to do liaison and act as key communicator between ERS of NDRI and on that village, this group will also act as experimental group of various dairying and animal husbandry related extension activities of ERS, NDRI and as model group of dairy development programme.

TV Talks

TV talk on Semen Preservation and Artificial insemination in Goats was telecast in the ETV Bangla TV channel during September, 2015. Benefits of artificial insemination in goats, different methods of buck semen preservation such as chilled semen and frozen semen their advantages and disadvantages were discussed in the talk.

Decision Support System

Decision support system on Reproductive Management in Dairy Cows and Goat Farming was developed and published in the ICAR - Central Coastal Agriculture Research Institute web site http://www.icargoa.res.in/.

Inter institution Collaboration Programme

Two days Orientation /Induction programme on "Dairy cooperatives & advances scientific dairy farming practices" were organized in collaboration with Kishan cooperative milk producers Union Ltd. Krishnanagar from 4th June 2015 to 18th June 2015. A total number of 55 dairy farmers from different district of west Bengal actively participated in three batches.

Livestock Farm

Milk Production Performance at ERS-NDRI Herd (1.1.15-31.12.15)

Months (2015)	Milk Production (kg)	Wet Average (kg)	Herd Average (kg)	Average FAT %	Average SNF %
January	12292.5	7.62	5.94	4.72	8.66
February	12732.5	8.80	6.55	4.72	8.66
March	13707.5	8.37	6.25	4.73	8.65
April	13580.5	8.12	6.12	4.42	8.66
May	13514.0	7.47	5.81	4.76	8.67
June	12343.0	7.65	5.40	4.79	8.76
July	12009.5	7.72	5.53	4.76	8.67
August	12106.0	8.08	6.10	4.83	8.67
September	12305.0	8.04	6.46	4.87	8.68
October	13635.5	8.53	7.00	4.86	8.67
November	13519.5	8.92	7.27	4.78	8.66
December	13000.0	8.67	6.76	4.73	8.60
Overall Average	12895.46	8.17	6.27	4.75	8.66

Annual Performance of ERS-NDRI Herd (2015)

Particulars	Jersey Cross
Herd strength as on 31.12.2015	158
Total milk production (kg)	154745.5
Av. no. of cows in milk/day	52.0
Av. no. of cows in dry/day	16
Wet average (kg)/day	8.17
Herd average (kg)/day	6.27
Age at first calving (month)	35.2
No. of cows inseminated	110
No. of cows pregnant	45
Conception rate (%)	41.0
Service period (days)	119
Inter calving period (days)	454
Mortality (%)	7.0



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 machinery 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 for covering the theoretical and practical part of training on fodder crop production.

Production of Different Fodder Crops at ERS Fodder Farm during 2015-16

Sl. No.	Type of Fodder	Quantity (Qtl.)
1.	Berseem / Berseem + Mustard, Lucernr/Lucerne+ Mustard/ Sole Cowpea/ Sole Ricebean	2122.04
2.	Maize / Maize + Cowpea/Maize + Mustard	1979.51
3.	Oats/ Oats + Mustard/Barley	3112.76
4.	Sorghum /Sorghum + Ricebean/ Sorghum + Cowpea	4283.42
5.	Teosinte/Coix	303.68
6.	Hybrid Napier Grass/Hybrid Napier Grass + Cowpea/ Hybrid Napier Grass + Ricebean Guinea Grass/Para Grass	865.64
	Total	12667.05

BUDGET AND EXPENDITURE

The financial outlays in terms of actual expenditure for Plan and Non-plan for the year 2015-2016 was ₹ 16898.70 lakhs and the sanctioned budget for Plan and Non-plan in 2015-2016 was ₹ 16936.00 lakhs. These figures include the financial outlays for Regional Campuses.

Financial Outlays & Expenditure during 2015-16

NDRI (including Eastern Campus, Kalyani)

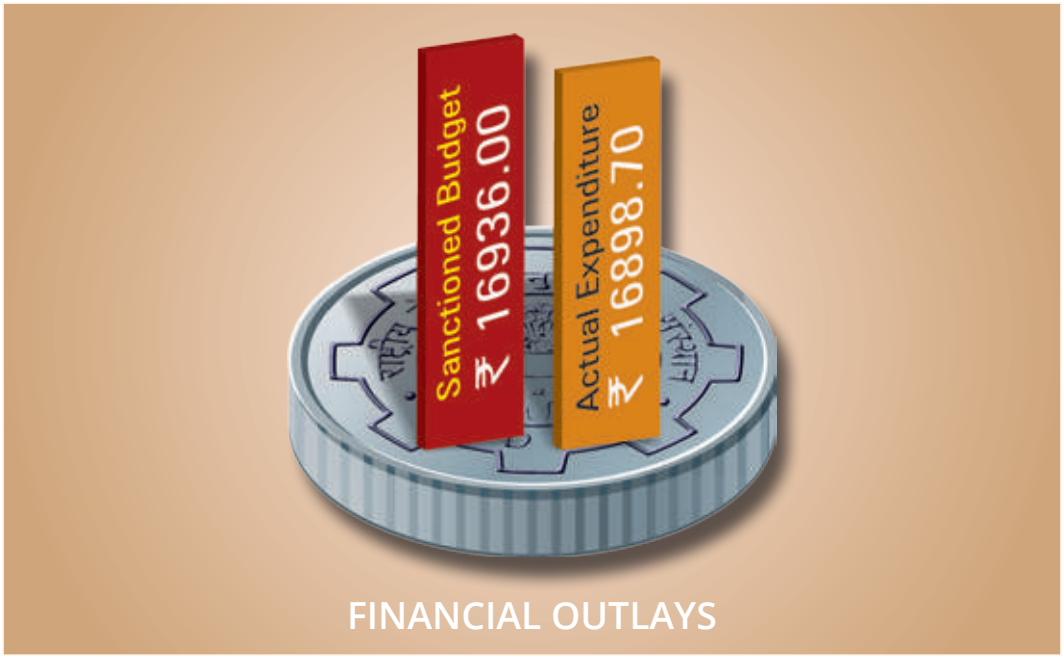
(₹ in lakhs)

Sr. No.	Head	Non-Plan		Plan	
		Budget	Expenditure	Budget	Expenditure
1.	Grant in Aid : Capital	106.00	103.18	469.60	468.42
2.	Grant in Aid : Salaries	5711.90	5701.81	-	-
3.	Grant in Aid : General	8284.00	8278.96	545.00	542.00
	Total	14101.90	14083.95	1014.60	1010.42

Southern Campus, Bangalore

(₹ in lakhs)

Sr. No.	Head	Non-Plan		Plan	
		Budget	Expenditure	Budget	Expenditure
1.	Grant in Aid : Capital	15.00	13.04	51.40	22.62
2.	Grant in Aid : Salaries	1000.10	989.24	-	-
3.	Grant in Aid : General	709.00	707.53	44.00	71.90
	Total	**1724.10**	**1709.81**	**95.40**	**94.52**



Revenue Generation

The Revenue Receipts of the Institute and the Regional Campuses for the year 2015-2016 were ₹ 1046.75 lakhs.

Sl. No.	Head	Amount (₹ in lakhs)
1.	Sale of Milk/Farm Produce	267.25
2.	Sale of Old Vehicle/Equipment etc.	9.27
3.	Sale of Livestock	20.78
4.	Sale of Publication	8.40
5.	License Fee	62.74
6.	Consultancy	19.85
7.	KVK Training Charges	22.69
8.	Other Receipts	635.77
	Total	1046.75

Position of Manpower at NDRI, Karnal and its Regional Campuses as on 31.03.2016

Type of Posts	Existing				Total	
	Approved by D/o Expenditure	In position	Vacant	Additional Proposed	Sanctioned + Additional	Existing + Additional
Scientific	194	160	34	20	194+20	157+20
Administrative (Group A&B)	36	33	03	-	-	-
Technical	352	220	132	15	352+15	220+15
Administrative (Group Non-gazatted)	127	99	28	Nil	127	99
Supporting	755	469	286	11	755+11	469+11
Total	1464	981	483	46	1428+46	945+46



राजभाषा कार्यकलाप

» 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 आकलन किया जाता है एवं भावी कार्यक्रमों हेतु रूपरेखा तैयार कर उन्हें कार्यान्वित किया जाता है।

» संस्थान में विगत वर्षो की भांति इस वर्ष भी 14 सितम्बर से 29 अक्तूबर 2015 तक राजभाषा मास का आयोजन किया गया। हिन्दी चेतना मास का शुभारंभ दिनांक 14.9.2015 को किया गया। दिनांक 15/9/2015 को संस्थान के सभी वर्गों के कार्मिकों हेतु 'टिप्पण एवं मसौदा लेखन' तथा दिनांक 24.9.2015 को संस्थान के वैज्ञानिकों, तकनीकी वर्ग के अधिकारियों एवं शोध–छात्रों हेतु 'शोधपत्र/पोस्टर प्रदर्षन प्रतियोगिता आयोजित की गई। इसके अतिरिक्त इस चेतना मास के दौरान नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों हेतु दिनांक 01.10.2016 को गीत–गायन प्रतियोगिता का आयोजन किया गया। इस कार्यक्रम में 16 कार्यालयों के 28 कार्मिकों ने भाग लिया। दिनांक 29.10.2015 को पुरस्कार वितरण समारोह आयोजित किया गया जिसमें सभी प्रतियोगिताओं के विजेताओं को प्रथम, द्वितीय, तृतीय एवं प्रोत्साहन नकद पुरस्कारों से पुरस्कृत किया गया।

» संस्थान के निदेशक महोदय जो कि नगर राजभाषा कार्यान्वयन समिति के अध्यक्ष हैं, उनकी अध्यक्षता में इस समिति की पहली छःमाही बैठक दिनांक 24 जून, 2015 को एवं दूसरी छःमाही बैठक 18 नवम्बर, 2015 को संस्थान में आयोजित की गई। इन बैठकों में संस्थान की ओर से निदेशक महोदय, मुख्य प्रशासनिक अधिकारी, उपनिदेषक(राजभाषा) वरिष्ठ तकनीकी अधिकारी, ने भाग लिया। प्रत्येक कार्यालय में सरकारी काम–काज राजभाशा हिन्दी में करने के लिए विभिन्न बिन्दुओं पर चर्चा कर निर्णय लिए गए।

» नगर राजभाशा कार्यान्वयन समिति, करनाल द्वारा संस्थान में किए जा रहे नगर राजभाषा कार्यान्वयन संबंधी उल्लेखनीय कार्यकलापों हेतु वर्श 2014–15 के प्रथम पुरस्कार से पुरस्कृत किया गया।

» संस्थान के प्रशासनिक वर्ग के सहायकों एवं सहायक प्रशासनिक अधिकारियों के लिए दिनांक 19 सितम्बर, 2015 को राजभाषा प्रशासनिक कार्यशाला आयोजित की गई।

» संस्थान के वैज्ञानिकों से प्राप्त वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, वार्षिक प्रतिवेदन, प्रशासनिक पत्र/परिपत्र/ज्ञापन, गोपनीय प्रश्नपत्र, विभिन्न समारोहों की प्रेस रिपोर्ट, गणमान्य अतिथियों, मंत्रियों आदि के उद्बोधन, व्याख्यान एवं अनेक प्रकार का अनुवाद कार्य इस एकक द्वारा किया जाता है।

» गैर हिन्दी क्षेत्रों से अध्ययन हेतु आए एम.एससी./एम.टैक./पीएच.डी. के छात्र जिन्हें मैट्रिक स्तर तक हिंदी का ज्ञान नहीं है उन्हें हिंदी शिक्षण का कार्य इस एकक के स्टाफ द्वारा दिया जाता है।

» मूल रूप से हिंदी में टिप्पण एवं मसौदा लेखन प्रोत्साहन योजना के अन्तर्गत राजभाषा हिंदी में अपना कार्य करने वाले संस्थान के 11 कार्मिकों को पुरस्कृत किया गया।

» संस्थान के वैज्ञानिकों एवं तकनीकी अधिकारियों को मूल हिंदी वैज्ञानिक लेख लेखन हेतु प्रोत्साहित करने के लिए 48 वैज्ञानिकों एवं तकनीकी अधिकारियों को पुरस्कृत किया गया।

SWACHH BHARAT ABHIYAN: CLEAN & GREEN NDRI

Swachh Bharat Abhiyan is a mission led by the government of India to make India a clean India. Cleanliness was very dear to Mahatma Gandhi and he had a dream of **Clean India**. He himself inspired thousands of volunteers through leading by example and swept the streets. The Honorable Prime Minister of India has given a call for "*Swacchha Bharat*", to realise Gandhi ji's dream of a Clean India by the 150th birth anniversary of Mahatma Gandhi in 2019. NDRI is supporting this drive of the Government of India by organising cleanliness drives, talks on cleanliness, awareness camps, etc. in the adopted villages of the Institute by focusing on spreading awareness about better sanitation and hygiene practices and disseminating information about the importance of cleanliness, through various programmes. The villagers are also educated to make the campaign truly effective and successful.

Tribute to *Gandhi Ji*: To commemorate the birthday of Mahtama Gandhi, NDRI organized a cleaning campaign on massive scale. More than 1200 employees of this Institute took the task to clean the every nook and corner of 1400 acre area of NDRI. More than 1000 students also participated in this cleaning drive. Residents of NDRI were sensitized for the making their surrounding 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 on Gandhi Jayanti Day (2nd October, 2015). The employees of the Institute took Swachh Bharat Sapath on this day.



Awareness Campaigns

A team of extension scientists also made many awareness campaigns in the adopted villages of the Institute. The team sensitized the villagers about the importance of cleanliness and villagers also contributed a lot to keep the villages neat and clean.

KVK also organized seven campaigns in the villages in Karnal district to popularize "Swacch Bharat Abhiyan". The farmers and farm women were sensitized to keep the surrounding environment neat and clean so that human and animals remain healthy.

The birthday of Mahtama Gandhi was also celebrated at our Regional Stations, Southern Regional Station, Bangalore and Eastern Regional Station, Kalyani. All the staff members and students cleaned the office and residential areas of the stations and planted the saplings in the premises of regional stations.

Green Campus Drive

Dairy Extension Division of NDRI organised the World Environment Day on 3rd June, 2015 at Dilawara and Suhana villages in Karnal district adopted under NICRA project of NDRI on the theme "Seven Billion Dreams, One Planet, Consume with Care". Scientists, research scholars and students participated in the event. In both villages, meetings were organised with farmers, farm women and village youth explaining the importance of the world-wide celebration of the day on 5th June, giving emphasis on maintaining cleaner environment, healthy lifestyle and sustainable livelihood. Later, participants were sensitized about climate resilient technologies and approaches. The interactions were followed by tree plantations in both the villages.

Special Drive for Plantation

A massive drive for planting 2500 saplings was made by the faculty, students and staff of the Institute with the co-operation of forest department of Haryana at NDRI. All Research Divisions and Sections allotted a place nearby their divisions/sections for plantation. All the staff members of the respective divisions/sections planted saplings. These plants are being taken care of by the jointly the Institute Staff and the Estate Section of the Institute.

Car Free Day

NDRI, Karnal is committed to celebrate every Tuesday as 'Car free day". All staff members &/ students of the Institute do not use car on this day. This step of the Institute is not only useful to reduce air pollution but also to save the fuel for next generations. All residents of NDRI's Campus are using cycles as means of transport on every Tuesday.



Tree plantation by students and staff



LOCATION AND TRAVEL

Location

Karnal is 250 mt above mean sea level, latitude 29.43 N and longitude 77.2 E.

Air

Domestic and international flights to and from Indira Gandhi Airport, Delhi are available.

Rail/Bus

Karnal is 133 km from Delhi and Institute is 1 km from Railway Station/Bus Stand

Climatic Information

Min. Temperature in winter : 10°C
Max. Temperature in summer : 45°C
Annual Rainfall : 70 cm

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