वार्षिक प्रतिवेदन
ANNUAL REPORT

2018-19

भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान
(मान्य विश्वविद्यालय) करनाल - 132 001 भारत
ICAR-NATIONAL DAIRY RESEARCH INSTITUTE
(Deemed University) Karnal - 132 001 India

VISION

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

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

MANDATE

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

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ICAR-NDRI Annual Report 2018-19

2019

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CONTENTS

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.

1957 B.Sc. Dairying commenced at NDRI, Karnal.

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.

1994 The Institute got recognition as Centre of Advanced Studies in Dairy Technology and Dairy Cattle Breeding.

1996 A two-year National Dairy Diploma (NDD) course introduced at Southern Regional Station of NDRI at Bangalore.

The ICAR award (1993-94) for outstanding KVK conferred on the KVK located at NDRI.

1997 A state-of-the-art Auditorium having seating capacity of 950 and 2 conference rooms and 2 meeting rooms made functional.

A commercial Model Dairy Plant with a capacity of 60,000 lit./ day commissioned for providing practical training to the students of NDRI University and to serve as an interface between Institute and Industry.

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

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

2000 A Guest House with two suites named as "Kamdhenu" was constructed at SRS, Bangalore.

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

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

2002 International Students' Hostel equipped with modern facilities and amenities constructed at NDRI, Karnal.

Feed Quality Control Lab. set up to help keep-strict quality check on feeds being fed to bovine livestock.

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

2004 First IVF goat kid born at NDRI.

ATIC centre made functional at NDRI.

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.

A new extension programme "Dairy Education at Farmers' Door" started.

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.

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

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

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

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

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

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

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

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

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 extension educational approach "Farmers' Farm School" of NDRI was started at village GorgarhNDRI, Karnal.

NDRI got ISO 9001: 2008 certification.

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

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

2017 Foundation stone of KVK laid at Eastern Campus, Kalyani.

ICAR - NDRI ranked first among all Agricultural Universities and four Deemed Universities of ICAR (2016-17).

One month Foundation Course for newly admitted students of 2017-18 batch introduced.

Automation of the 'Academic Management System' implemented

2018 A mega world-bank funded Institutional Development Plan (IDP) of National Agricultural Higher Education Project initiated.

National Referral Center for Milk Quality and Safety (NRCMQS) granted accreditation by National Accreditation Board for Testing and Calibration Laboratories (NABL).

ICAR-NDRI ranked first among all Agricultural Universities of ICAR second time in the year of 2017-18.

Set up Atal incubation Centre at Southern Campus of NDRI, Bengaluru.

PREFACE

It gives me immense pleasure to present before you the Annual Report of NDRI for the period 2018-19. This report chronicles the significant achievements of the Institute in the areas of Dairy Research, Education, Extension and Infrastructure development during the last one year. The information has been so arranged that it provides a complete panoramic view of this premier dairy Institute of the country and its functioning.

To our pride, ICAR-NDRI secured **FIRST RANK** consecutively for the second time amongst Agricultural Universities. The Institute was privileged to receive this honor on ICAR Foundation Day, July 16, 2018 at NASC Complex, Pusa, New Delhi. In line with the Institute's philosophy, "the development starts from within", the goal of the Institute has been to create an enabling environment for the students and the faculty alike. The Institutional Development Plan under the National Agricultural Higher Education Project with a budgetary outlay of Rs. 2477.66 lakhs facilitated several initiatives to strengthen the B.Tech (Dairy Technology) program. Thirty one undergraduate students underwent internships at 9 universities in 4 different countries. Likewise, 16 faculty members were selected to visit foreign universities for training. MoU was signed with Institute of Rural Management Anand (IRMA), Anand, Gujarat for offering Integrated Postgraduate Diploma in Dairy Management as a Dual Degree for B.Tech (Dairy Technology) students of NDRI. MoU was signed between NDRI and Nestle India for Soft Skill Enhancement of ICAR-NDRI students. Linkage was developed with Future Group, India for training of B. Tech. (DT) students on aspects *viz.* consumer buying behaviour, optimization of operational process, customer segmentation, optimization of supply chain channel, new product development and enhancement. Development of MOOCs in commercial dairy farming and milk processing was initiated in collaboration with ICAR-NAARM, Hyderabad.

Under the area of Animal Production research, whole genome sequencing of Malnad Gidda, Hallikar and Deoni cattle was carried out. Novel transcripts and proteins related to several production traits were identified in these Zebu breeds using high-through put technologies and proteo-genomic approaches. Fertility associated sperm proteins and transcripts were identified and fertility prediction equations were developed for cattle and buffalo bulls based on sperm function tests. Treatment of cloned embryos with miR-21 mimic or miR-29b mimic improved their quality and reduced the level of apoptosis, while treatment with miR-145 inhibitor improved their developmental competence and quality. Comparative sequence analysis of β-defensins from different species by bioinformatic analysis revealed that buffalo β-defensins have unique conserved functional motifs. Mesenchymal stem cells were successfully used to cure mastitis and metritis in cattle. Seminal plasma nitric oxide and MDA levels could serve as markers of semen quality in buffalo bulls. Feeding a consortium of selected probiotic bacteria to Murrah buffalo calves improved the digestibility, body weight, growth performance and immune status.

Significant outcomes in the area of dairy processing research during the year were: developments of manufacturing protocols for products such as Ricotta cheese from buffalo milk, milk protein concentrates with increased solubility from buffalo milk, gluten-free pasta from a composite dairy-millet base, probiotic fermented mango whey drink, spray dried colostrums, spiced cheese rolls from goat milk etc. Electrospun smart oxygen leak indicator for food packaging applications was developed and characterized. Oil-in-water and water-in-oil micro/nano-emulsions were prepared for the encapsulation of herbal extracts for incorporation into traditional and other dairy foods. Whey derived bioactive peptides having antioxidative and angiotensin-converting enzyme inhibitory activities showed osteo-protective potential in osteoporotic rats. Under the area of processing of milk of minor species, protocols were developed for products such as yoghurt and cheese rolls from goat milk. Defined strain starter formulation was developed for preparation of Gouda Cheese for the dairy industry. A total of twelve lactic acid bacteria were

isolated, identified and characterized for its antifungal activity. Among different Indian breeds, panchgavya prepared from Gir and Sahiwal cows showed better antifungal activity followed by panchgavya prepared from Tharparkar and Karan Fries cows. A PANI-PEC colorimetric paper strip assay was developed for rapid detection of coliforms in milk. Strip based technology was successfully applied for screening of pesticide residues in milk, cereal based foods, processed fruits, feed, fodder, soil and water. A strip based test was also standardized for sub clinical mastitis milk detection.

In the area of mechanization, automated controlled incubator system was developed for the commercial production of dahi and other fermented milk products. Other machines developed include: Machine Vision System (MVS) Colour Desk D1- a portable bench-top model machine vision system for colour measurement of dairy and food products; a *rabri* making equipment comprising a rapid milk concentrator and milk flake formation system; an equipment for mechanized production of *kheer*; a skid-mounted plate heat exchanger module with nanocoated plates and; an electro-spinning unit for production of peptide and resveratrol-loaded nanofibers and a prototype for whey removal for handling 20 l milk during *chhana* production.

Four patents were filed and four granted during 2018-19. Two new courses i.e. Industrial Automation and Robotics and Engineering Properties of Foods were introduced in course curriculum of M. Tech. (Dairy Engineering) programme. A remedial course on Engineering Mathematics was also introduced in course curriculum for B. Tech. (DT) I year students. Twelve technologies developed at the Institute were transferred to 8 commercial houses through 18 different License agreements during 2018-19. Mobile App on "Environment Friendly Dairy Farming Practices" was developed in Hindi and English to educate dairy farmers. A bilingual (Hindi and English) mobile App on "Brucellosis Advisor" was developed. This App is under field testing. As per the suggestions/ Feedback from the users in field, this App would be finalized and uploaded in the Google Store as well as ICAR- NDRI Websites.

Training programmes were conducted regularly for varying periods for the benefit of milk producers, prospective entrepreneurs and farmers by Business Planning & Development Unit, Dairy Extension Division, Krishi Vigyan Kendras and both the Regional Campuses of the Institute. Thirty five Kisan Sangoshthies were organized on various aspects of dairying and allied subjects at village level. The third batch of Farmers' Farm School passed out and the fourth batch comprising 20 landless farm women has been started. KVK of NDRI conducted 275 training programmes (on- and off-campus), which benefitted over ten thousand farmers from 16 states. Under Entrepreneurship Development Programme, 14 trainings were organized on Commercial Dairy Farming, Milk and Milk Product Processing and Novel Dairy Products for 300 participants from across the country.

A New laboratory on "Engineering Properties of Foods" was set up for evaluating the physical, electrical, chemical and other engineering properties of the food products. Setting up of Atal Incubation Centre AIC-SRS-ICAR-NDRI was initiated in partnership with Atal Innovation Mission, NITI Aayog with a project outlay of around Rs 1000 lakhs with the objective of supporting innovative technology-based start-up enterprises in India at ICAR-NDRI Southern Campus, Bengaluru. New laboratories viz., Proteo-Genomic Laboratory and Theriogenology Laboratory with state-of-the- art equipments were created at the southern campus. A new wing of ladies hostel and a new office cum animal health management building at Livestock Research Centre at SRS, Bengaluru are under construction.

NDRI is all set to bring in new reforms to keep its activities aligned to the trends in global institutions of higher learning. For the past three years, NDRI has been organizing one month Foundation Program at the start of the semester and before commencement of regular coursework to tap the innate talents of the freshers and nurture them into outstanding professionals and accomplished human beings. Automation of Academic Management System is in place encompassing the entire academic activities starting from registration, payment of fees and regulation of progress of academic and research work of the students and uploading of results. The entire admission process including conduct of admission test for Ph. D program has been made online.

Seventeenth Convocation of NDRI was organized on March 23, 2019. Dr. Trilochan Mohapatra, Hon'ble Secretary, DARE and Director General, ICAR was the Chief Guest on the occasion and delivered the Convocation Address. Sixth Dr. D. Sundaresan Memorial Oration Award was bestowed upon Prof. Hitesh Bhatt, Director, Institute of Rural Management Anand, Gujarat. Dr. K. K. Iya Memorial Oration Award was given to Dr. Ashok Dalwai, Chief Executive Officer, National Rainfed Area Authority, Department of Agri. Coop. & Farmers Welfare, New Delhi. Dr N. N. Dastur Memorial Oration Award for the year was bestowed upon Mr. R. S. Sodhi, Managing Director, Gujarat Co-operative Milk Marketing Federation Ltd., (GCMMF) (AMUL) Anand, Gujarat.

All this could be achieved by the Institute with the dedication, hard work, cooperation and understanding of the entire NDRI fraternity. The Institute is committed to become a world-class model campus for promoting dairy research, education and outreach as dairying is emerging as a major game changer for transforming socio- economic lives of millions of farmers. I sincerely hope that NDRI Annual Report 2018-19 would serve as a valuable source of information to the professionals of the Dairy Development Organizations and other Institutions of Higher Learning in the country.

(R. R. B. Singh)

EXECUTIVE SUMMARY

ICAR-National Dairy Research Institute is a premier research organization of the nation dedicated to provide Research and Development (R&D) and Human Resource Development (HRD) support dairy development programmes in the country. Established in 1923 at Bangalore, the headquarter of the Institute was 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. ICAR-NDRI has the distinction of being a Deemed University for implementing its academic programmes since 1989. The Institute has been ranked first among all Agricultural Universities of India including 4 Deemed Universities consecutively for the second time in the year 2017-18.

ORGANISATIONAL STRUCTURE

In consonance with the administrative pattern of the Deemed University System of the ICAR, the Institute is managed through various policy/decision making bodies, viz. Board of Management, Research Advisory Committee, Academic Council, Executive Council and Extension Council. The Director is the Chief Executive Officer assisted by the Joint Directors for managing research, academic and extension functions. The Institute has three major areas of R & D activities viz. i) Dairy Production, ii) Dairy Processing and iii) Dairy Extension/Management. All the R & D activities are managed through thirteen Research Divisions/Sections, namely, Animal Genetic & Breeding, Livestock Production and Management, Animal Nutrition, Forage Research and Management, Animal Physiology, Animal Biochemistry, Animal Biotechnology, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, Dairy Extension and Dairy Economics, Statistics and Management. The Institute also has an Agricultural Technology Information Centre (ATIC), Krishi Vigyan Kendra and Dairy Training Centre, Artificial Breeding Research Centre, Krishi and Dairy Vikas Kendra at KVK, Piprakothi, East Champaran, Motihari, Bihar and Model Dairy Centre at Lalukheri in Muzzafarnagar, U.P. The Institute has infrastructure consisting of central facilities such as Livestock Research Centre, Forage Research and Management Centre, Animal Health Complex, Model Dairy Plant, Technology Business Incubator, Business Planning and Development Unit, National Referral Laboratory for Milk Quality and Safety, Experimental Dairy Plant, Consultancy Unit, Library and National Bio-informatic Centre, Computer Centre, Estate Section and Maintenance Engineering Section. The administrative functions viz. purchase, stores and security are under the administrative control of the Joint Director (Admn.) and Registrar, whereas finance division is under the administrative control of Comptroller (Finance). The Institute presently has strength of 155 scientists, 163 technicians, 130 administrative staff and 367 skilled supporting staff.

BUDGET OUTLAY

The financial outlay of the Institute in terms of actual expenditure during the year 2018-2019 was Rs. 21728.35 lakhs and budget sanctioned for the year 2018-2019 was Rs. 21770.11 lakhs. These figures also include the financial outlays for strengthening of the Regional Campuses.

RESEARCH

A total number of 78 in-house and 78 externally funded research projects were in operation during the year 2018-19. 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-SERB); Science and Engineering Research Board (SERB); National Agriculture Science Fund (NASF); Ministry of Food Processing Industries (MOFPI); Food Safety and Standards Authority of India (FSSAI); Indian Council of Social Science Research (ICSSR); Indian Council of Medical Research (ICMR); Ministry of Environment, Forests and Climate Change (MOEF & CC); National Dairy Development Board (NDDB); Space Application Centre (SAC); Council of Scientific and Industrial Research (CSIR) and National Innovation Foundation- India (NIF-India). The support from funding agencies has encouraged Scientists to work on stem cell, buffalo cloning, transcriptome, embryogenesis, semen sexing, biosensors, 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. Some of the research highlights during the period under report are given as under:

- Elite Sahiwal cow (Sw-2233) produced peak yield of 23.5 kg in 3rd lactation.
- Best 305 Days Milk Yield (DMY) for Gir cow (G-32) was 2546 kg.
- Best 305 DMY for Tharparkar cow (TP-1306) was 2210 kg.
- Average of best Lactation Milk Yield of elite Murrah buffaloes was 3284 kg.
- Exploration of genetic polymorphism in Bovine VDR, PTPRR and HMGA2 Gene revealed that the genotype AA at SNP locus rs135884509 and genotype AA at SNP locus rs383429860 of IL22 gene in Karan Fries cattle and the genotype AA at SNP locus rs454303072 (VDR gene) in Sahiwal cattle, could be used as an aid for selection of higher milk production with desired udder conformation and lesser susceptibility to mastitis after validation in larger population.
- The identified variants by ddRADseq approach could be used as baseline information to study domestication history, population structure and Genome Wide Association Studies. The SNPs mapped to different QTLs and the gene pathways enriched in selective sweeps could be further explored for studying the underlying genetic variation and molecular mechanism of production, reproduction and tropical adaptation traits in indigenous cattle breeds.
- AG genotype of α-s1CN, CC/ CT genotype of α-s2CN and CC genotype of β-CN could be used as an aid for selection of better milk production performance of Karan Fries cattle.
- Genotype TC at SNP locus rs135318665 of GC gene in Karan Fries cattle and the genotype CG at SNP locus rs42551805 of PRLR gene in Sahiwal cattle could be used as an aid for selection of higher milk production with desired udder conformation and lesser susceptibility to mastitis after validation in larger population.
- Treatment of cloned embryos with miR-21 mimic or miR-29b mimic was shown to improve their quality and reduce the level of apoptosis.
- Treatment of cloned embryos with miR-145 inhibitor was shown to improve their developmental competence and quality, increase histone acetylation and expression level of several pluripotency-related genes.
- Specific miRNAs associated with maternal and fetal placentomes were identified in early pregnant buffaloes.
- Comparative sequence analysis of β-defensins from different species by bioinformatic analysis revealed that buffalo β-defensins have unique conserved functional motifs although their sequences are quite different from those of other closely related mammals.
- Eight novel variants of goat kappa casein were revealed from seven different Indian goat breeds.
- Approximately 7000 proteins were identified in the skin proteome of Pashmina goats.
- Recombinant buffalo sperm lysozyme like protein 5 (SPACA5) was produced using *E. coli* expression system.
- More than 12000 proteins were profiled in buffalo mammary epithelial cells, and 6 novel proteins were found to be involved in lactogenesis.
- Three different isoforms of buffalo pregnancy associated glycoproteins (PAG-1, PAG-2 & PAG-18) were produced in *E. coli* expression system.
- An innovative microfluidic device was developed for partial enrichment of live and motile sperm cells.
- In pursuit to discover bovine urinary peptidome, approximately 15000 peptides were discovered in the urine of Sahiwal cows.
- Mesenchymal stem cells were successfully used to cure mastitis and metritis in cattle.
- Seminal plasma nitric oxide and MDA levels could be used as markers of semen quality in buffalo bulls.
- Whole genome sequencing of Malnad Gidda, Hallikar and Deoni cattle was carried out. Novel transcripts and proteins related to several production traits were identified in these Zebu breeds using high through put technologies and proteo-genomic approaches.
- Fertility associated sperm proteins and transcripts were identified and fertility prediction equations were developed for cattle and buffalo bulls based on sperm function tests.
- Out of twenty six plant extracts, *Bacopa monnieri* was found to be the most promising in enhancing the growth and linoleate isomerase activity of *Butyrivibrio fibrisolvens,* which resulted in increased conjugated linoleic acid (CLA) production by manipulating rumen bio-hydrogenation with no adverse effect on rumen fermentation.
- Dietary supplementation of *Bacopa monnieri* @ 1% in goats increased the ruminal population of *Butyrivibrio fibrisolvens* by 2.2 times, which in turn enhanced the nutraceutical value of milk by increasing conjugated linoleic acid (CLA) and total polyunsaturated fatty acids whereas total saturated fatty acid was decreased.

- *Lactobacillus reuteri* was found in majority of the buffalo fecal samples and served as a pool for probiotic candidates, thus, it is a major part of the normal microflora of the GIT of young buffaloes. Probiotic bacteria of buffalo calf-origin *L. reuteri* strain BF-H9 and BF-E7 could be applied successfully for probiotic animal trials.
- Selected probiotic bacteria *Lactobacillus* spp. of buffalo calf-origin *L. reuteri* strain BF-E7 and *L. salivarius* strain BF-17 grow syngerstically without any antagonistic effect and feeding of these probiotics and its consortium to Murrah buffalo calves improved the digestibility, body weight, growth performance and immune status.
- The *Bifidobacterium* strains isolated from buffalo rumen samples are potential CLA producers, though the conversion from linoleic acid are strain specific i.e. between 1 to 42%. Addition of potential CLA producing bifidobacterial isolates to mixed rumen culture increased the CLA content without affecting digestibility and fermentation parameters. These *Bifidobacterium* strains could have the potential to be used as probiotics to enhance the nutraceutical value of ruminant food products.
- Inclusion of *Leucaena leucocephala* leaves at different levels (0,10, 25 and 50%) increased the *in vitro* DM and OM digestibility, total gas production, NH_3-N concentration and microbial biomass and reduced CH_4 production (ml/100 mg DDM) by 15, 24 and 36% at 10, 25 and 50% inclusion levels, respectively.
- Niger Seed is a potential lipid source at 5% supplemental level to improve the productive and reproductive performance of periparturient buffaloes without any compromise on rumen fermentation.
- Supplementation of monensin ((350 mg/head/day) to non pregnant non-lactating Murrah buffaloes increased blood glucose concentration, indicating more available energy and could reduce faecal nitrogen excretion, which reduced the contribution of buffaloes to green house gases emissions and their impact on the environment .
- Depotash vinasse @ 8% in the concentrate mixture could be utilized for pellet making and subsequent feeding of the pellet to the early lactating buffaloes without any adverse effect on yield and composition of milk, digestibility of nutrients and blood biochemicals.
- Most of the semen quality parameters were improved with dietary supplementation of inorganic form of Zn, Cu, Mn and Co @ 80 ppm, 20 ppm, 30 ppm and 0.2 ppm, respectively, to the basal diet of Sahiwal bulls during winter and rainy seasons.
- Dietary supplementation of inorganic form of Mn, Cr and Co @ of 30 ppm, 0.22 ppm and 2 ppm was beneficial in improving blood antioxidant enzymes, semen qualitative parameters viz., individual motility, live sperm, intact acrosome and lipid peroxidation in fresh and frozen semen of Murrah bulls.
- Inclusion of *K. alverazii* based seaweed product at 1.5 or 3.0% level of diet did not influence feed intake, nutrient utilisation, milk production and composition, however, antioxidant and immunity status and persistency of lactation improved in group of cows provided with 3% *K. alverazii* based seaweed product in the ration.
- Supplementation of 10 nano Zn was comparable to 40 ppm inorganic Zn in terms of feed intake, nutrient utilization, growth, antioxidant status and relative gene expression of MT-2A in female Murrah buffalo calves.
- Feeding of 30% extra energy and 40% extra protein during last trimester of pregnancy improved calf birth weight and it was significantly higher in the group 33.18 kg. and 36.28 kg, respectively as compared to control group 31.26 kg.
- Feeding of 30% ME and 40% MP above ICAR 2013 recommended levels from pre-partum to puberty resulted in higher birth weight, growth and lower age at puberty in Murrah buffalo heifers.
- Metabolizable protein (MP) content of Sahiwal heifers could be safely reduced by 15% as compared to ICAR (2013), however, best performance was obtained while metabolizable energy (ME) content of the diet was increased by 15%.
- CXLP (*Cellulase+ Xylanase+ L. plantarum*) and CXLPLF (*Cellulase+ Xylanase+ L. plantarum + L. fermentum*) were the most effective additive combinations for improving silage quality of Maize as exogenous enzymes and bacterial inoculated additives for minimizing DM loss (%) and NH_3-N (% TN) in comparison to control (c) silage.
- Potassium sorbate and sodium benzoate at 0.1% FM basis were the most effective additives for improving maize silage quality as these were effective to reduce the dry matter loss (potassium sorbate, 0.1% fresh matter basis), ammonia-N content (sodium benzoate, 0.1% in maize silage). Sodium benzoate or potassium sorbate (0.1% fresh matter basis) increased the ME content.
- Cows in first parity/lactation had the highest persistency than those in other parities. The persistency values tended to decrease with advancing age (parity), until the fifth lactation. Older cows were less persistent than the young ones.

- Genotype (genetic group) X environment (THI) interaction showed significant effect (P<0.05) for milk production traits and had non-significant effect on reproduction traits of crossbred dairy cows reared at ERS, ICAR-NDRI herd.
- Vitamin E supplementation at the rate of 250 IU/kg DMI/head had provided some relief from the toxic effects of arsenic with increased body weight gain. Vitamin E supplementation alone or along with *Saccharomyces cerevisiae* improved the oxidative enzyme status of the animals and also reduced the extent of liver damage by reducing SGPT and SGOT concentration in blood.
- Utilization of *Spirodela* meal in dairy cattle ration @ 5 % (DM basis) of concentrate mixture economized the ration without any adverse effect on voluntary feed intake, nutrient digestibility, growth performance and feed conversion efficiency.
- Kamela *(Mallotus philippensis)* and *Ficus hookerai* tree leaves showed a potential for manipulating rumen fermentation to improve body weight gain by 13.5 and 6.1% and feed efficiency by 2.0 and 0.8%, respectively in crossbred calves.
- Thermo comfortable housing (with ridge ventilation, more central height, thatched roof, etc) showed favorable improvement in milking behavioural features and better milk composition. Housing effect showed that milk yield was higher in thermo-comfortable shed (6.83 ± 0.04) as compared to existing shed (6.64 ± 0.05).
- Body Condition Score (BCS) technique was developed and standardized for Jersey crossbred animals at lower Gangetic region by using ultra-sonographic technique along with other methods. This inferred that this BCS technique could be used as a reliable criterion in choosing Jersey crossbred cows for higher milk production with better udder health status in this region.
- Using tri-iodothyronine as a media supplement in *in vitro* culture media, the cleavage rate and morula formation rate were significantly higher for *in vitro* cattle embryo development.
- Artificial insemination of goats 24 hours after onset of estrus with frozen thawed semen resulted in kidding rate of 51.56% in the field.
- Monitoring the risk assessment factors like milk pH, EC, SCC, Cl- and lactose in combination or alone could be used as a marker of subclinical mastitis in lactating cows.
- In-house keeping of buffaloes alleviate cold stress and lower physiological responses (respiration rate and pulse rate) as compared to the loose housing and resulted in higher milk yield by 9.92%.
- Dietary Cu and Zn supplementation in Murrah bulls improved the activity of super oxide dismutase enzyme in blood plasma and LPO activity in seminal plasma.
- Up-regulation of interferon stimulated genes (ISG15, OAS1, MX, IFI 16) had its association with successful implantation in pregnant cows.
- Prilled fat supplementation (100 g/d) during transition and early lactation increased milk production by 10 and 22 % in crossbred cows and buffaloes, respectively.
- Astaxanthin supplementation @ 0.25 mg/kg body weight improved the milk production performance by 7% in Murrah buffaloes.
- Fermented potato protein supplementation @ 50 g/day increased milk production through increased plasma IGF-1 and glucose levels.
- KF cows showed the lowest Fat, SNF, total protein and urea contents whereas Tharparkar cows showed the highest magnitude of these parameters during winter and thermoneutral zone.
- Feeding of polyherbal formulation containing *Boswellia serrata (Burseraceae)* and *Berginia ciliata (Saxifragaceae)* to peripartum cows improved immunity and reduced cortisol levels.
- A Neutrophil lysate based enzyme-linked immunosorbant assay was developed to detect ISG15 for pregnancy diagnosis in bovine.
- Milk NAGase level constituted a potential candidate for detecting clinical and subclinical mastitis in cows.
- Wastage of water could be reduced up to 70% by fitting simple devices in the troughs meant for providing drinking water to animals.
- High serum free fatty acids and low leptin levels were found to be the plausible objective metabolic indicators of negative energy balance in early lactating buffaloes.
- Transcriptome analysis uncovered the possibility of immune tolerance as a major adaptive mechanism in the liver during early postpartum period of buffaloes.

- It was found that there were tissue-specific patterns of variation in mitochondrial activity between different types of tissues from buffalo.
- Recombinant Cysteine Synthase (CS) Protein of *Haemonchus contortus* was successfully expressed in *E. coli.*
- Zinc Nanoparticle Fertilizer could affect the innate immune system by decreasing phagocytosis, increasing nitric oxide production and increasing inflammatory response through increase in the expression of TLR6 and decrease in Arginase expression.
- Quality fodder production with higher profit was obtained round the year from forage based cropping system. Higher biomass yield with cropping sequence 'Napier grass+Cowpea-Berseem' (167 t/ha) followed by 'Multicut Sorghum-Berseem' (129 t/ha) under irrigated conditions recorded the higher B: C ratio 3.16 and 2.95, respectively.
- Standardized the package and practices of baby corn and baby-cowpea sequence for higher production under different tillage practices and nitrogen management. Raised bed and zero tillage planting of baby corn gave highest baby corn and fodder yield as compared to conventional tillage.
- Substantial saving about 10-15% of chemical fertilizer (Nitrogen) was recorded through biofertilizers application in baby corn. Saving in cost of cultivation through adoption of zero tillage was recorded around ₹ 3500-4500 as compared to conventional tillage.
- Compromised probiotic supernatant possesses enhanced steroidogenic property on TM3 Leydig cells by an increasing conversion of cholesterol to pregnenolone via the P450scc enzymes. TM3 cells treated with compromised probiotics supernatant markedly enhanced the viability of cells and up-regulated the expression of p450scc and 17β-hsd gene, thus, improving steroidogenesis and as a corollary, improving the fertility status.
- Two lactobacillus strains (*L. rhamnosus* MTCC-5897 and *L. fermentum* MTCC-5898) were established to initiate immune signaling towards maintenance of immune homeostasis in epithelial cells with considerable degree of variations. Both strains of lactobacilli appeared to perform better during exclusion and competition than displacement of live *E.coli* as well as its LPS.
- No toxic effects were observed due to feeding probiotic *Lactobacillus fermentum* (MTCC 5898) @ 10^{7}-10^{11} cfu/day/animal continuously for 28 days. Optimum gut barrier integrity was also detected during routine exposure of this probiotic.
- Whey derived bioactive peptides having antioxidative (YVEEL) and angiotensin-converting enzyme inhibitory (YLLF) activities showed osteo-protective potential similar to parathyroid hormone (PTH) in osteoporotic rats.
- The HPr dependent pathway of acquiring nisin resistance in *Enterococcus faecalis* was delineated.
- Pepsin hydrolysates of whey proteins exhibited increased insulin secretion by RIN-5F beta cells.
- Manufacturing protocols were developed for products such as Ricotta cheese from buffalo milk, milk protein concentrate 60 with increased solubility from buffalo milk, gluten-free pasta from a composite dairy-millet base, spray dried colostrums, spiced cheese rolls from goat milk etc.
- Electrospun smart oxygen leak indicator for food packaging applications was developed and characterized.
- Oil-in-water and water-in-oil micro/nanoemulsions were prepared for the encapsulation of herbal extracts into traditional and other dairy foods.
- Protocols for products such as yoghut and cheese rolls from milk of minor species (goat) were developed.
- A method was standardized for assessment of proteolysis in UHT milk using Attenuated Total Reflectance-Fourier Transform Infrared (ATR–FTIR) spectroscopy.
- The LC-MS peptide profiling data indicates that generation of bioactive peptides during ripening are more in sodium substituted Cheddar cheese as compared to control.
- A Method for preparation of whey protein iron complexes was optimized. Milk fortified with the WPC–Fe complex (γ (iron) =15 mg/L) showed non-significant difference in physico-chemical attributes as compared to control milk.
- A RP-HPLC method for separation and quantification of milk protein genetic variants was standardized.
- Milk protein-Vit D complex fortified milk showed higher *in vitro* bio-accessibility of vitamin D as compared to free vitamin D (fat soluble form) fortified milk.
- Among different Indian breeds, panchgavya prepared from Gir and Sahiwal cows showed better antifungal activity followed by panchgavya prepared from Tharparkar and Karan Fries cows.
- ISO 17678(2010) method was evaluated for ghee and results showed that limits specified for pure milk fat in ISO method cannot be adopted as such for cow, buffalo and mixed ghee (Indian origin).

- Conditions were optimized for preparation of low-cholesterol ghee using butter and ghee as base material.
- Anti-inflammatory effect of surface proteins of probiotic *lactobacilli* in colitis mouse model demonstrated that surface proteins could offer a safer preventive and therapeutic option for combating inflammatory disorders.
- Live and heat killed cells of probiotic *lactobacilli* were found to reduce the inflammatory response through down regulation of the pro-inflammatory cytokine TNF-**α** secretion.
- Defined strain starter formulation was developed for preparation of Gouda Cheese for dairy industry.
- EPS producing culture *L. fermentum* NCDC 400 with maximal removal of cholesterol upto 85.81±0.50% and *L. helveticus* MTCC 5463 strain with bile tolerance of 1.5% up to 6 hr were characterized.
- A total of twelve lactic acid bacteria belonging to *Lactobacillus fermentum, L. plantarum, L. salivarius, Pediococcus pentocaseus, Weissella cibaria* and *E. faecium* were isolated, identified and characterized for its antifungal activity. Strains belonging to *L. salivarius, W. cibaria* and *P. pentosaceus* exhibited wider spectrum of antibacterial activity against Gram positive and negative micro-organisms.
- Growth media for rapid detection of microbial quality in milk was optimized for components, concentration and pH using PANI-PEC particles.
- Rapid PANI-PEC colorimetric paper strip assay was developed for rapid detection of coliforms/ *E. coli* in milk.
- Multi drug resistance upto 3-8 antibiotics was observed in 38 isolates of *E. coli.* Four isolates of *E. coli* were found to be resistant to extended-spectrum beta-lactamase (ESBL) by both phenotypic and genotypic methods.
- Fermentation of sheep, goat and camel milk by *L. rhamnosus* 25 produced bioactive peptides having antimicrobial, ACE inhibitory, Immunomodulatory, DPP IV inhibitory and anticancer activities.
- Peptides from colostrum fermented by *L. rhamnosus* C25 showed higher antimicrobial activity as compared to those from colostrum fermented by *L. rhamnosus* C6 and *L. casei* NCDC 17.
- Technology was developed for the preparation of probiotic fermented mango whey drink.
- Surveillance work on presence of antibiotic residues in milk was carried out under outreach programme and data was shared with FSSAI for standard setting.
- The optimized HPLC methods for tetracycline group (tetracycline and oxytetracycline) and novobiocin antibiotics for the determination of antibiotic residues in raw and market milk samples were able to detect them at or below MRL levels and could be applied for routine analysis of milk samples. The method is selective and could be used in routine analysis of antibiotics.
- Antimicrobial active films prepared by coating the antimicrobial peptides and AFS (C25+195) in combination used for packaging market *khoa* and NDRI *khoa* samples enhanced shelf life of khoa.
- Strip based technology was successfully applied for screening of pesticide residues in milk, cereal based foods, processed fruits, feed, fodder, soil and water.
- *Desulfotomaculum ruminis* X-44a was identified as a potential hydrogen sequester and could be used to mitigate methane emissions after *in-vivo* investigations.
- A strip based test was standardized for sub clinical mastitis milk detection and examined for cross reactivity with antibiotic, heavy metals, pesticides and aflatoxin M1.
- Fortified whey kefir drink with fibre and micronutrients i.e. Zinc and Iron, was developed to enhance the bio-functionality and nutritional value in addition to its inherently present novel polysaccharide i.e. Kefiran. Technology is ready for commercialization.
- An eco-friendly packaging material using beeswax-coated coconut shell container was developed for packing of Dahi.
- A skid-mounted plate heat exchanger module with nanocoated plates was developed.
- An electro-spinning unit was fabricated for production of peptide and resveratrol-loaded nanofibers.
- A prototype for whey removal was designed and developed for handling 20 l milk during *chhana* production.
- Automated controlled incubator system was developed for the commercial production of dahi and other fermented milk products.
- Machine Vision System (MVS) Colour Desk D1- a portable bench-top model machine vision system was developed for colour measurement of dairy and food products.
- A *rabri* making equipment comprising of a rapid milk concentrator and milk flake formation system was developed.

- Equipment for mechanized production of *kheer* was developed. The equipment has milk concentrator, rice pre-conditioning system, concentrated milk, rice mixing system, and flash heater.
- An average farmer in Gujarat was making total expenditure of ₹ 1813 per standard animal unit (SAU) per annum (2013-14) on livestock services related with animal health, breeding and insurance. Among these support services, animal health services were accounting for 67% of the total expenditure.
- For animal health services, the overall willingness to pay (WTP) was estimated at about ₹ 74 per service at the centre and ₹ 206 per service at doorstep, which was 1.23 times and 1.02 times higher than the existing charges per service, respectively.
- The growth rate of total factor productivity (TFP) of livestock sector in Gujarat was recorded at 5.32% per annum during the last decade from 2005-06 to 2014-15. This growth rate in TFP was realized due to the high growth of output index and deceleration in input index, which revealed an improvement in input efficiency ratio.
- Food safety adoption index developed based on 47 practices was meagerly 59% of the standard practices for commercial farms of dairy start-ups. Among these practices, improvement is required in milking hygiene and milk handling categories due to lower level of food safety adoption (57%) in these categories.
- Among the prominent homestead farming systems in Kerala, the profitability was the highest (₹ 1,97,174) in the farming system comprised of Crop+ Dairy+ Goat+ Poultry (C+ D+ G+ P). The mean availability of calories at the household level was also highest in this farming system (2810 kilocalories per consumer units per day) ensuring better food and nutritional security.
- The sustainability index Gaushalas was 0.32 for small, 0.40 for Medium and 0.49 for the large sized Gaushalas. The economic sustainability was significantly dependent upon productive animals and autonomy of the Gaushalas while social sustainability (SSI) was dependent upon total number of animals kept in the Gaushalas, autonomy and Net income per animal. The environment sustainability index (EnSI) was impacted significantly by autonomy and housing space available in the Gaushalas.
- The average annual revenue of Gaushala was ₹ 1.79 crores comprising donations plus grants (80%), sales (6.5% and miscellaneous income (14.5%). The annual expenditure of Gaushala was ₹ 1.73 crores out of which 49.8% was going for feed and fodder only. The net income of Gaushala was ₹ 5.6 lakh/ year whereas net income per SAU was Rs. 283 only.
- Livestock insurance under Bengaluru Milk Union Group Cattle Insurance scheme was found viable after a study to evaluate the alternate animal identification techniques and livestock insurance products in Karnataka arrived at an overall claim amount to premium collected ratio of 0.89. Plastic tag as identification techniques alone was found to be more efficient in case of application ease, cost and labour requirement.
- The head count index of food insecurity in Uttrakhand showed that the incidence of food insecurity came down to 52% in 68th round from 61% of 61st round of National Sample Survey in the plains and from 39% and 46% in the hills respectively, during the same period.
- Based on NSSO data, the income from dairy in Haryana had increased for farmers of all farm-size categories, but marginal farming households were earning 30% less than the state average of ₹ 2400 per month. Dairying was more profitable in western Haryana where households earned 29% more than the state average.
- Machine learning algorithms performed reasonably well for modeling rheological behaviour of paneer in comparison with classical regression methods especially in case of non-linear relationship of the data attributes.
- A total number of four patents were filed and four patents were granted during 2018-19.

EDUCATION

- ICAR-National Dairy Research Institute, Karnal secured **FIRST RANK** amongst Agricultural Universities in the Ranking of Agricultural Universities by the ICAR. The certificate was presented on ICAR Foundation Day i.e. July 16, 2018 at NASC Complex, Pusa, New Delhi.
- The outgoing students of NDRI got gainful employment in Dairy/ Food Industry (Govt./Cooperative/Multinationals).
- Seventeenth Convocation of ICAR-NDRI Deemed University was held on March 23, 2019. A total of 249 students (including 95 girls) were conferred degrees i.e. B.Tech. (Dairy Technology) -25, Masters -144 and Doctoral – 80.
- The Institute celebrated 'Agricultural Education Day' on December 3, 2018 to commemorate the Birth Day of Bharat Ratna, Dr. Rajendra Prasad, and first President of India.

- The Institutional Development Plan under the National Agricultural Higher Education Project facilitated several initiatives to strengthen the B.Tech. (Dairy Technology) program. Some of these initiatives are global internships for students, faculty improvement program held at universities abroad, motivational and professional talks for the benefit of the students, collaborations with industry and universities, among others. Thirty one undergraduate students underwent internships at 9 universities in 4 different countries. Under the same programme, 16 faculty members were selected to visit foreign universities for training.
- MoU was signed with Institute of Rural Management Anand (IRMA), Anand, Gujarat for offering Postgraduate Diploma in Dairy Management as a Dual Degree Program to B.Tech. (Dairy Technology) students of NDRI.
- MoU was signed between NDRI and Nestle India for Soft Skill Enhancement of ICAR-NDRI students.
- Linkage was developed with Future Group, India for training of B. Tech. (DT) students on aspects *viz.* consumer buying behaviour, optimization of operational process, customer segmentation, optimization of supply chain channel, new product development and enhancement.
- Development of MOOCs in commercial dairy farming and milk processing was initiated in collaboration with ICAR-NAARM, Hyderabad.
- A study tour was conducted for M.Sc. and Ph.D. students of Agronomy at Rajasthan (Bikaner and Jaislmer) for better understanding and practical exposure in forage and pasture crops as well as practiced forage dominant farming system under offered course curriculum.
- Two new courses i.e. Industrial Automation and Robotics and Engineering Properties of Foods were introduced in course curriculum of M. Tech. (Dairy Engineering) programme.
- A remedial course on Engineering Mathematics was also introduced in course curriculum for B. Tech. (DT) I year students.

EXTENSION

- Twelve technologies developed at the Institute were transferred to 8 commercial houses through 18 different License agreements during 2018-19.
- Mobile App on "Environment Friendly Dairy Farming Practices" was developed in Hindi and English to educate dairy Farmers.
- A bilingual (Hindi and English) mobile App "Brucellosis Advisor" was developed. This App is under field testing. As per the suggestions/ Feedback from the users in field, this App would be finalized and uploaded in the Google Store as well as ICAR- NDRI Websites.
- Thirty five Kisan Sangoshthies were organized on various aspects of dairying and allied subjects at village level.
- Farmer candidates enrolled in the 3rd batch of the Farmers' Farm School passed out in the month of July 2018. The 4th batch consisting 20 marginalized and landless farm women of village Deepo started from August 10, 2018.
- KVK conducted 275 training programmes (on- and off-campus) and a total of 10513 farmers of 16 states benefited during these programmes.
- KVK organized training programmes on skill development in the field of vermi-compost for 20 rural youth of Karnal district. The participants were evaluated for 'gain in skill' by Agriculture Skill Council of India. The successful participants will be awarded certificates by Govt of India.
- KVK organized five training programmes for 225 rural youth and farmers of Karnal district on crop residue management. The farmers were sensitized on crop residue management using machineries and their benefits on the soil health and resource conservation.
- A special training programme on youth leadership & community development was organized by KVK along with Nehru Yuva Kendra, Karnal from March 18-20, 2019.
- KVK organized 23 field visits on the front line demonstration plots laid down under various schemes during the year 2018-19 in different villages of Karnal district to create awareness about new varieties.
- KVK celebrated Kisan Kalyan Divas at village Kulwehri on May 2, 2018 in which more than 65 farmers participated.
- KVK arranged web telecast of Prime Minister for farmers on June 20, 2018 where more than 150 farmers participated. Further, another web cast was also arranged for the members of Self Help Groups on July 12, 2018 at NDRI, where about 50 women participated.

- KVK celebrated the World Breast-Feeding Week in village Rindal on August 7, 2018 to educate women about importance of breast-feeding to new born and infants and its effect on their health. The programme was attended by 50 women.
- KVK celebrated Kisan Mahila Divas on October 15, 2018 where 95 women from six villages participated.
- Two one-day training programmes were organized on Milk Processing for women of Karnal district on November 1, 2018 and Sonipat district on November 14, 2018.
- KVK organized "Soil Health Day" on December 5, 2018 in which more than 90 farmers and farm women from different villages of Karnal district and other states participated.
- KVK celebrated Kisan Divas on December 23, 2018 during the Swachhata Pakhwara (December 16-31, 2018). Approximately 30 farmers from Karnal district and other states attended the programme.
- KVK arranged direct telecast of Hon'ble Prime Minister's address for farmers and farm women on February 24, 2019 while launching of Prime Minister-Kisan Scheme (Pradhan Mantri Samman Nidhi). A total of 70 farm women participated in this programme on International Women's Day.
- A total of 3722 advisory services on various aspects of dairying were rendered to the 5597 farmers during 2018-19.
- A total of ten on-campus women empowerment-training programmes and demonstrations were organized with the objective to create awareness in the field of dairying. A total of 115 farmwomen were trained in these programmes.
- Scientists regularly visited villages as a part of the 'Education at the Farmers' Door' and *Mera Gaon Mera Gaurav* programmes.
- Twelve Scientists-Farmers Interaction Sessions were organized under TSP project. In the interaction sessions teams of scientists and experts of NDRI-ERS, Kalyani interacted with the farmers (dairy/goat and other animals) on different areas of scientific livestock farming.
- A 'Livestock and Agriculture Mela' under the TSP project was organized in the tribal dominated Ajodhya Hills area of Purulia district in West Bengal on November 22, 2018 in support with CADC, Govt. of West Bengal.
- Two training programmes on 'Scientific Dairy Farming Practices for Tribal Unemployed Youth' were organised during the period under report and 40 tribal farmers participated in those training programmes.
- Several visits were arranged and inputs such as livestock (poultry birds, goats, piglets etc.), veterinary medicines, mineral mixture, concentrate mixture, fodder seeds, extension literatures etc. were distributed among the farmers. In the scientists-farmers interaction sessions, several aspects of animal husbandry were explained to the farmers of the North Eastern States.
- In the adopted villages (Muratipur and South Chandamari) of ERS of ICAR-NDRI, veterinary health care facilities were provided regularly to the dairy farmers. Experts from ERS visited farmers' home and solved their problems. Through the *'Dairy Vikas Kendra'* at Muratipur village, Artificial Insemination of 156 animals was done.
- Two training programmes on Artificial Insemination and Veterinary First Aid were organized for 17 participants.
- Two training programmes on 'Scientific Dairy Farming' were organized for 39 trainees from different parts of West Bengal.

CAPACITY BUILDING

- Fourteen trainings/courses were organized under the Entrepreneurship Development Programme in the areas of Commercial Dairy Farming, Milk and Milk Product Processing and Novel Dairy Products for 300 participants across the country.
- Two training programmes were organized on 'Milk Processing and Value Addition' for prospective entrepreneurs during June 21-30, 2018 and August 27 to September 5, 2018.
- Training programmes were organized on 'Milk Processing' for prospective entrepreneurs during November 12 to December 11, 2018.
- Training programme organized on 'Technology of Cheese Making' for prospective entrepreneurs during March 23-30, 2019.
- Two training programmes were organized for the faculty of ICAR Institutes and SAUs under the aegis of the Centre for Advanced Faculty Training in Dairy Processing during December 1-21, 2018 and January 4-24, 2019.

- An International Training Programme on "Ultrasonography and Reproductive Disorder Management in Dairy Animals" was organized at Southern Campus of ICAR-NDRI, Bengaluru from July 16-20, 2018.
- A Seminar on "Entrepreneurship in Dairy and Food Industry: Concept to Commercialization" was organized from September 14-15, 2018.

INFRASTRUCTURE

- Setting up of Machine Vision Laboratory for determining the colour properties of dairy and food products. The instruments and software have been developed indigenously by the scientists of the Dairy Engineering Division.
- Setting up of the new laboratory on "Engineering Properties of Foods" for evaluating the physical, electrical, chemical and other engineering properties of the food products.
- Construction of three waste water tanks of size 10'x10'x7' at Artificial Breeding Research Centre at ICAR-NDRI
- Premix carpeting of office area roads at ICAR-NDRI, Karnal.
- Renovation of seminar room of Dairy Technology Division at ICAR-NDRI, Karnal.
- Renovation of Exhibition Unit at ICAR-NDRI, Karnal.
- Painting work of AGL-1 & AGL-2 laboratories and creation of storage facility at Animal Biotechnology Centre, ICAR-NDRI, Karnal.
- Electrical works of Kaveri Hostel and Cattle Yard Shed of Animal Nutrition Division at ICAR-NDRI, Karnal.
- Repair of damaged boundary wall at ICAR-NDRI, Karnal.
- Repair of dry-fodder shed of Artificial Breeding Research Centre at ICAR-NDRI, Karnal.
- Renovation, whitewash and painting of Kisaan Bhawan of KVK, Brahamputra Hostel, Sutlaj Hostel, Alaknanda/ Married Hostel, International Hostel at ICAR-NDRI, Karnal.
- Repair and maintenance of parapet-wall of roof of the Library Building of the Institute.
- Providing and fixing of vitrified tile flooring/Kota stone flooring in corridors of research divisions at ICAR-NDRI, Karnal.
- Repair and complete whitewashing and painting of Experimental Dairy building including Milk Parlour at ICAR-NDRI, Karnal.
- Providing and laying of new L.T. XLPE power cable from generator house to switch room of production building at ICAR- NDRI, Karnal.
- Repair and renovation of Joint Director (Academic) office at ICAR-NDRI, Karnal.
- Setting up of Atal Incubation Centre AIC-SRS-ICAR-NDRI initiated in partnership with Atal Innovation Mission, NITI Aayog with a project outlay of around ₹ 1000 lakhs with the objective of supporting innovative technology-based start-up enterprises in India at ICAR- NDRI Southern Campus, Bengaluru.
- Creation of new laboratories viz., Proteo-Genomic Laboratory and Theriogenology Laboratory with state-of-the- art equipments at ICAR- NDRI Southern Campus, Bengaluru.
- Inauguration of Krishna wing of ladies hostel at ICAR-NDRI Southern Campus, Bengaluru.
- Foundation stone laid for a new office cum animal health management building at Livestock Research Centre and construction initiated at ICAR-NDRI Southern Campus, Bengaluru.

कार्यकारी सारांश

भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित संगठन है जो देश में डेरी विकास कार्यक्रमों के लिए अनुसंधान विकास तथा मानव संसाधन विकास में सहयोग के लिए पूर्ण रूप से समर्पित रहा है। वर्ष 1923 में बंगलौर में संस्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में इसके मौजूदा स्थान करनाल में स्थानान्तरित किया गया था। इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो बंगलौर तथा कल्याणी में स्थित हैं। दक्षिण एवं पूर्वी क्षेत्रीय केन्द्र स्थानीय क्षेत्र में कृषि वातावरण के अनुरूप डेरी विकास के लिए अनुसंधान एवं सहयोग प्रदान करने में लगे हुए हैं। भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान को वर्ष 1989 से शैक्षणिक कार्यक्रमों के संचालन हेतु मानद् विश्वविद्यालय का दर्जा प्राप्त हुआ है। संस्थान को वर्ष 2017–18 के लिए भारतवर्ष के सभी कृषि विश्वविद्यालयों जिनमें चार मानद् विश्वविद्यालय भी शामिल हैं, में लगातार दूसरी बार प्रथम स्थान प्राप्त हुआ है।

संगठनात्मक स्वरूप

संस्थान की प्रबंध प्रणाली भारतीय कृषि अनुसंधान परिषद के मानद् विश्वविद्यालय की प्रशासनिक पद्धति के अनुरूप ही है। संस्थान के अनुसंधान, शिक्षण, प्रशिक्षण, विस्तार, शिक्षा तथा प्रशासनिक कार्यकलाप के क्षेत्र में नीति निर्धारण और निर्णय का दायित्व प्रबंध मंडल, अनुसंधान सलाहकार परिषद, शिक्षा परिषद, कार्यकारिणी परिषद तथा प्रसार परिषद समितियों को सौंपा गया है। संस्थान के निदेशक इसके मुख्य कार्यकारी अधिकारी हैं तथा प्रबंधन, अनुसंधान, शैक्षणिक तथा प्रसार कार्यकलापों के लिए संयुक्त निदेशक उनकी सहायता करते हैं। संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र, (i) डेरी उत्पादन (ii) डेरी प्रसंस्करण तथा (iii) डेरी विस्तार/प्रबंधन हैं। सभी अनुसंधान एवं विस्तार कार्यकलाप तेरह अनुसंधान प्रभागों/अनुभागों–पशु आनुवांशिकी एवं प्रजनन, पशुधन उत्पादन एवं प्रबंधन, पशुपोषण, चारा अनुसंधान एवं प्रबंधन, पशु शरीर क्रिया, पशु जीव रसायन, पशु जैवप्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी अभियांत्रिकी, डेरी रसायन, डेरी सूक्ष्म जीवविज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र, सांख्यिकी एवं प्रबंधन प्रभाग के अन्तर्गत संपन्न होते हैं। संस्थान में एक कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक), कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण केन्द्र, कृत्रिम प्रजनन अनुसंधान केन्द्र, हैं। पीपराकोठी, पूर्वी चम्पारन, मोतीहारी, बिहार में कृषि विज्ञान केन्द्र के अन्तर्गत कृषि तथा डेरी विकास केन्द्र तथा मुज्जफरनगर (उ.प्र.) में लालूखेड़ी में मॉडल डेरी केन्द्र भी संस्थान के कार्यक्षेत्र में आते हैं। संस्थान में पशुधन अनुसंधान केन्द्र, चारा अनुसंधान एवं प्रबंधन केन्द्र, पशु स्वास्थ्य परिसर, माडल डेरी संयंत्र, टैक्नोलॉजी बिजनेस इनक्यूबेटर, व्यवसाय नियोजन एवं विकास एकक, दुग्ध गुणवत्ता एवं सुरक्षा के लिए नैशनल रैफरल प्रयोगशाला, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय तथा राष्ट्रीय जैव सूचना केन्द्र, कंप्यूटर केन्द्र, संपदा अनुभाग, राजभाषा एकक एवं अनुरक्षण अभियांत्रिकी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे क्रय, भंडार एवं सुरक्षा अनुभाग आदि संयुक्त निदेशक(प्रशासन)/कुलसचिव के नियंत्रण में हैं जबकि वित्त विभाग नियंत्रक (वित्तीय) के प्रशासनिक नियंत्रण में हैं। संस्थान में इस समय 155 वैज्ञानिक, 163 तकनीशियन, 130 प्रशासनिक एवं 367 निपुण सहायक कर्मचारी है।

बजट परिव्यय

संस्थान का वर्ष 2018–19 के लिए वास्तविक व्यय बजट ₹ 21728.35 लाख रूपए था तथा वर्ष 2018–19 के लिए स्वीकृत बजट ₹ 21770.11 लाख रूपए था। इन आंकड़ों में क्षेत्रीय केन्द्रों के सृदृढ़ीकरण का बजट परिव्यय भी शामिल है।

अनुसंधान

वर्ष 2018–19 के दौरान कुल 78 अन्तः संस्थानीय (इन हाउस) तथा 78 बाह्य पोषित अनुसंधान परियोजनाएं परिचालन में रहीं। राष्ट्रीय डेरी अनुसंधान संस्थान लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेन्सियों जैवप्रौद्योगिकी विभाग (डी.बी.टी.), विज्ञान एवं प्रौद्योगिकी विभाग (डी.एस.टी) एवं विज्ञान एवं इंजीनियरी अनुसंधान बोर्ड (ई.आर.बी), राष्ट्रीय कृषि विज्ञान निधि (एन.ए.एस.एफ), खाद्य प्रसंस्करण उद्योग मंत्रालय (एम.ओ.एफ.पी.आई), भारतीय खाद्य सुरक्षा एवं मानक प्राधिकरण (एफ.एस.एस.ए.आई.), भारतीय सामाजिक विज्ञान अनुसंधान परिषद (आई.सी.एस.एस.आर.), भारतीय आयुर्विज्ञान अनुसंधान परिषद (आई.सी.एम.आर), पर्यावरण वन एवं जलवायु परिवर्तन मंत्रालय (एम.ओ.ई.एफ एण्ड सी.सी.) तथा राष्ट्रीय डेरी विकास बोर्ड (एन.डी.डी.बी), पशुपालन पशुचिकित्सा अनुसंधान विभाग (डी.ए.एच.वी.एस), अन्तरिक्ष अनुप्रयोग केन्द्र (एस.ए.सी.), वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद (सी.एस.आई.आर), नैशनल इनोवेशन फाउंडेशन इंडिया (एन.आई.एफ–इंडिया) से बाह्य वित्तीय सहायता प्राप्त करने में सफल रहा है। फंडिंग एजेन्सियों से प्राप्त सहायता ने वैज्ञानिकों को स्टैम कोशिकाओं, भैंस की क्लोनिंग, ट्रांसक्रिप्टोम, एम्ब्रायोजेनेसिस, सीमनसैक्सिंग, बायोसैंसर्स, नैनोप्रौद्योगिकी, फार्म पशुओं में अबायोटिक स्ट्रेस, न्यूट्रास्यूटिकल्स तथा प्रकार्यात्मक आहारों पर कार्य करने के लिए प्रोत्साहित किया है। फंडिंग एजेन्सियों से प्राप्त अनुदानों ने छात्रों को अपने शोध लेखन में आधुनिक उपकरणों एवं तकनीकियों के चयन के लिए भी सहायता प्रदान की है। रिपोर्टाधीन अवधि में हुए अनुसंधानों के कुछ मुख्य बिन्दुओं का उल्लेख नीचे दिया गया है :

- श्रेष्ठ साहीवाल गाय (एस डब्ल्यू–2233) ने तीसरे ब्याँत में उच्च दुग्ध उत्पादन 23.5 कि.ग्रा. किया।
- गीर गाय (जी–32) का 305 दिन का श्रेष्ठ दुग्ध उत्पादन 2546 कि.ग्रा. था।
- थारपारकर गाय (टी.पी.1306) का 305 दिन का श्रेष्ठ दुग्ध उत्पादन 2210 कि.ग्रा. था।
- विशिष्ट मुर्राह भैंसों का श्रेष्ठ ब्याँत का श्रेष्ठ ब्याँत दुग्ध उत्पादन का औसत 3284 कि.ग्रा. था।
- गोपशुओं के वी.डी.आर, पी.टी.पी.आर.आर. तथा एच.एम.जी.ए2 जीन में आनुवांशिक पोलिमारफिज़्म की खोज से प्रकट होता है कि करन फ्रीज गायों में एस.एन.पी. लोकस rs135884509 पर ए.ए. जीनोटाइप तथा एसएनपी लोकस rs383429860 पर ए.ए. जीनोटाइप के आई एल 22 जीन तथा साहीवाल गोपशुओं में एस.एन.पी. लोकस rs454303072 (वीडी.आरजीन) पर ए.ए.जीनोटाइप पाए गए इनका प्रयोग वांछित अयन विरूपण और थनैला की कम संवेदनशीलता के साथ उच्च दुग्ध उत्पादन के चयन के लिए एक सहायक के रूप में किया जाता है।
- ddRADseq दृष्टिकोण द्वारा पहचाने गए असंगतियों को डोमेस्टिकेशन इतिहास, जनसंख्या संरचना तथा जीनोम वाइड एसोसिएशन अध्ययनों के लिए आधारभूत जानकारी के रूप में इस्तेमाल किया जा सकता है। एसएनपी ने विभिन्न क्यू.टी.एल (QTL) के लिए योजना बनाई तथा चुनिंदा विनिमय में भरपूर जीन पैथवे को स्वदेशी गोपशुओं की नस्लों में उत्पादन, प्रजनन एवं ऊष्णकटिबंधीय लक्षणों के अन्तर्निहित आनुवांशिक भिन्नता और आण्विक तंत्र का अध्ययन करने के लिए आगे और अविष्कार किए जा सकते हैं।
- करन फ्रीज गोपशुओं में बेहतर दुग्ध प्रदर्शन के लिए चयन के लिए a-SICN, के ए.जी जीनोटाइप α-s2CN के CC/ CT जीनोटाइप तथा β-CN के CC जीनोटाइप को सहायता के रूप में प्रयोग किया जा सकता है।
- करन फ्रीज गोपशुओं में सी.सी.जीन के एसएनपी लोकस rs135318665 पर जीनोटाइप सीसी तथा पी.आर.एल.आर.जीन के एसएनपी लोकस rs42551805 पर जीनोटाइप सी.जी. का वांछित अयन अनुरूपता तथा बड़ी आबादी में मान्यीकरण के बाद थनैला के लिए कम संवदेनशीलता के साथ उच्च दुग्ध उत्पादन के चयन के लिए एक सहायक के रूप में प्रयोग किया जा सकता है।
- miR-21 मिमिक अथवा miR-29b मिमिक के साथ क्लोन्ड भ्रूण के उपचार के लिए उनकी गुणवत्ता में सुधार तथा एपोपटोसिस के स्तर को कम करने के लिए दिखाया गया था।
- miR-145 अवरोधक के साथ क्लोन्ड भ्रूणों के उपचार उनकी विकासात्मक क्षमता तथा गुणवत्ता में सुधार करने के लिए किया गया था तथा हिलस्टीन एसीटाइलेशन तथा कई प्लुरीपोटेंसी संबंधी जीनों की अभिव्यक्ति के स्तर को बढ़ाता है।
- मादा पशु एवं भ्रूण के अपरा से जुड़े विशिष्ट miRNAs की पहचान गाभिन भैंसों की प्रारम्भिक स्थिति में की गई थी।
- जैवसूचनात्मक विश्लेषण द्वारा विभिन्न प्रजातियों से β-डिफेन्सिन्स के तुलनात्मक अनुक्रम विश्लेषण से पता चला कि भैंस β-डिफेन्सिन्स में अद्वितीय संरक्षित कार्यात्मक मोटिफस हैं यद्यपि उनके अनुक्रम अन्य निकट संबंधी स्तनधारियों से काफी भिन्न हैं।
- बकरियों की सात विभिन्न नस्लों से बकरी कप्पा केसीन के आठ नवीन भिन्न रूप सामने आए।
- पशमीना बकरियों की त्वचा के प्रोटिओम से लगभग 7000 प्रोटीन की पहचान की गई थी।
- ई.कोलाई अभिव्यक्ति प्रणाली का उपयोग करके प्रोटीन 5(एसपीएसीए5) की तरह पुनरावर्त्ती भैंस शुक्राणु लाइसोजाइम का उत्पादन किया गया।
- भैंस की स्तनीय एपीथिल कोशिकाओं में 12000 से अधिक प्रोटीन थे तथा 6 नवीन प्रोटीन लेक्टोजेनेसिस में शामिल पाए गए थे।
- भैंस की गर्भावस्था के तीन विभिन्न आइसोफार्मस को ग्लाइकोप्रोटीन (पी.ए.जी–1, पी.ए.जी–2 तथा पी.ए.जी.–18) ई.कोलाई अभिव्यक्ति प्रणाली में उत्पादन किया गया था।
- जीवित एवं गतिशील शुक्राणु कोशिकाओं के आंशिक संवर्धन के लिए एक नवीन माइक्रोफ्लुडिक डिवाइस विकसित किया गया था।
- गोजातीय मूत्र के पेप्टीडोम की खोज के लिए साहीवाल गायों के मूत्र में लगभग 15000 पेप्टाइड पाए गए।
- गोपशुओं में थनैला तथा मेट्राइटस का उपचार करने के लिए मेसेनचाइमल स्टेम कोशिकाओं का सफल उपयोग किया गया।
- भैंस के बैलों (झोटों) में वीर्य की गुणवत्ता के मार्कर के रूप में सेमिनल प्लाज़्मा नाइट्रिक आक्साइड तथा एम.डी.ए. स्तरों का उपयोग किया जा सकता है।
- मलनाद गिदा, हालीकर तथा डिओनि गोपशुओं का संपूर्ण जीनोम अनुक्रमण किया गया। कई उत्पादन लक्षणों से संबंधित प्रोटीन तथा नवीन प्रतिलिपि की पहचान की गई तथा इन जेबू नस्लों में हाई–थ्रू–पुट प्रौद्योगिकियों तथा प्रोटिओ जीनोभिक दृष्टिकोणों का प्रयोग करके की गई।

- शुक्राणु संबंधी परीक्षणों के आधार पर गोपशुओं तथा भैंस के बैलों (झोटों) के लिए प्रजनन संबंधी शुक्राणु प्रोटीन तथा ट्रांसक्रिप्ट की पहचान की गई तथा प्रजनन पूर्वानुमान समीकरण विकसित किए गए।
- छब्बीस पौधों के सत्त्व में से बैकोपा मोननेरी को ब्यूटिवीब्रियो फाइबरीसोल्वेनस की वृद्धि एवं लिनोलिएट आइसोमेरेज गतिविधि को बढ़ाने में सबसे अधिक आशाजनक पाया या जिसके परिणामस्वरूप बिना किसी प्रतिकूल प्रभाव के रूमेन जैव हाइड्रोजनीकरण में वृद्धि करके संयुग्मित लिनोलेइक अम्ल (सी.एल.ए.) तथा कुल पोलिअनसेटयूरेटिड वसीय अम्लों के उत्पादन में वृद्धि हुई जबकि कुल सेप्युरेटिड वसीय अम्लों में कमी हुई।
- बकरियों में 1% की दर से बैकोपा मौनीरी के आहारीय सम्पूर्ण ने ब्यूटीरिविबरियों फिबरीसोल्वन के रयूमिनल संख्या में 2.2 गुना की वृद्धि हुई जो कि बदले मे संयुग्मित लिनोलिक अम्ल (सीएलए) और कुल पोलिअनसेट्युरेटिड वसीय अम्लों को बढ़ाकर दूध के पौषणिक मूल्यों को बढ़ाती है जबकि कुल संतृप्त वसीय अम्ल की कमी हुई।
- लैक्टोबेसिलस रियूटरी अधिकतर भैंसों के मल नमूनों में पाया गया तथा प्रोबायोटिक उम्मीदवारों के लिए एक पूल के रूप में काम किया, इस प्रकार यह युवा भैंसों के जी आई टी के सामान्य माइक्रोफ्लोरा का एक प्रमुख हिस्सा है। भैंस के कटड़े की उत्पत्ति के प्रोबायोटिक बैक्टीरिया एल रिटरेरी स्ट्रेन बीएफएच.9 तथा बीएफ–ई–7 को प्रोबायोटिक पशु परीक्षणों के लिए सफलतापूर्वक लागू किया जा सकता है।
- भैंस के बछड़े की उत्पत्ति एल.रियूटरी स्ट्रैन बीएफ–ई7 तथा एल.सलवेरियस स्ट्रैन बी.एफ–17 चयनित प्रोबायोटिक बैक्टीरिया लेक्टोबैसिलस एसपीपी. इन प्रोबायोटिक्स के किसी भी विरोधी प्रभाव तथा आहार के बिना समान रूप से बढ़ता है तथा मुर्राह भैंसों के कटड़ों को इसके कनसोर्टियम से पाचन क्षमता शरीरभार, विकास प्रदर्शन तथा प्रतिरक्षण स्तर में सुधार करता है।
- भैंस के रूमेन के नमूनों से वियोजित बिफिडोबेक्टीरियम स्ट्रेन संभावित सीएलए उत्पादक हैं, यद्यपि लिनोलिक अम्ल से परिवर्तन तनाव विशिष्ट है अर्थात् 1 से 42% है। संभावित सीएलए उत्पादक बिफिडोबेक्टीरियल को मिश्रित रूमेन में मिलाने से पाचकता तथा किण्वन पैरामीटरों को प्रभावित किए बिना सीएलए अंश में वृद्धि होती है। इन बिफिडोबैक्टीरियम उपभेदों में रोमन्थक खाद्य उत्पादों की पौषणिक मान में वृद्धि के लिए प्रयोग किया जा सकता है।
- विभिन्न स्तरों (0,10, 25 तथा 50%) ल्यूकेना ल्यूकोसेफेला के पत्रों को शामिल करने से इन विट्रो शुष्क पदार्थ (डी.एम.) तथा ओ. एम. पाचनशक्ति, कुल गैस उत्पादन, एनएच$_3$.एन. सान्द्रण तथा सूक्ष्मजैवीय बायोमॉस में वृद्धि हुई तथा सी.एच$_4$ स्तर (एमएल/100 एमजी.डी.डी.एम) क्रमशः 15, 24 तथा 36% तक 10, 25 और 50% समावेश स्तर कम हुआ।
- रूमेन किण्वन पर बिना किसी समझौते के पेरीपारटयूरैंट भैंस के उत्पादन एवं प्रजनन प्रदर्शन को बेहतर बनाने के लिए 5% पूरक स्तर पर नाइजर बीज संभावित लिपिड स्त्रोत है।
- अगाभिन दूध न देने वाली मुर्राह भैंसों के लिए मोनेसिन (350 मि.ग्रा./प्रति भैंस/प्रतिदिन) के सम्पूरण से रक्त शर्करा की मात्रा में वृद्धि हुई। जो कि अधिक उपलब्ध ऊर्जा को इंगित करता है तथा मल के नाइट्रोजन उत्सर्जन को कम कर सकता है जो कि ग्रीन हाउस गैसों के उत्सर्जन में भैंस के योगदान को तथा पर्यावरण पर उनके प्रभाव को कम कर सकता है।
- सान्द्रण मिश्रण में 8% की दर से डिपोटैश विनैसे का उपयोग गोली बनाने और बाद में स्तनपान करने वाले भैंसों के बिना किसी प्रतिकूल प्रभाव के दूध की उत्पादकता और संरचना, पोषक तत्वों एवं रक्त जीव रसायनों की पाच्यता के उपयोग किया जा सकता है।
- साहीवाल सांडों के सर्दियों एवं बरसाती मौसम के दौरान मूल आहार के लिए वीर्य की गुणवत्ता के अधिकांश मानकों Zn, Cu, Mn तथा Co क्रमशः 80 पीपीएम, 20पीपीएम, 30 पीपीएम 0.22 पीपीएम तथा 2 पीपीएम के अकार्बनिक रूप के आहारीय संपूरकों के साथ संशोधित किए गए।
- मुर्राह भैंसों के सांडों (झोटों) के ताजा तथा प्रशीतित वीर्य में अलग–अलग गतिशीलता, जीवित शुक्राणु, अक्षत एक्रोसोम तथा लिपिड पैराक्सीडेशन जैसे रक्त प्रतिआक्सीकारक किण्वकों, वीर्य गुणात्मक मापदण्डों में सुधार के लिए एमएन, सीआर तथा सीओं 30पीपीएम, 0.22 पीपीएम तथा 2 पीपीएम की दर से अकार्बनिक रूप के आहीय संपूरक लाभप्रद थे।
- के.अल्वरेजी आधारित समुद्री शैवाल उत्पाद को 1.5 अथवा 30% स्तर तक आहार में शामिल करने से आहार अन्तर्ग्रहण, पोषक तत्त्व उपयोग, दुग्ध उत्पादन तथा संरचना को प्रभावित नहीं किया गया तथापि राशन में समुद्री शैवाल उत्पाद आधारित 3% के.अल्रेजी के साथ गायों के समूह में संशोधित दुग्ध स्त्रवण की प्रति आक्सीकर स्तर पर प्रतिरक्षा स्तर में सुधार हुआ।
- मुर्राह भैंसों की कटड़ियों में एम.टी.–2ए के सापेक्ष जीन अभिव्यक्ति तथा आहार अन्तःग्रहण, पोषक तत्व उपयोग, विकास, प्रतिआक्सीकर स्तर के संबंध में 40 पी.पी.एम. अकार्बनिक Zn की तुलना में 10 नेनो Zn के संपूरक थे।

- गर्भकाल के अंतिम तीन महीनों में 30% अतिरिक्त ऊर्जा तथा 40% अतिरिक्त प्रोटीन खिलाने से बछड़ों के जन्मभार में सुधार हुआ तथा यह नियंत्रित वर्ग 31.26 कि.ग्रा. की तुलना में यह समूह में क्रमशः 33.18 कि.ग्रा. तथा 36.28 कि.ग्रा अधिक था।
- 30% एमई, 40% एमपी से ऊपर का आहार/भाकृअनुप 2013 में प्रसवपूर्व से युवावस्था तक के स्तरों की सिफारिश की, जिसके परिणामस्वरूप मुर्राह भैंसों के ओसरों में जन्म भार तथा विकास दर अधिक थी तथा ओसर कम आयु में युवा हो जाते थे।
- साहीवाल ओसरों के चयापचीय प्रोटीन (एम.पी.) की मात्रा को भाकृअनुप (2013) की तुलना में 15% में सुरक्षित रूप से कम किया जा सकता है, तथापि श्रेष्ठ प्रदर्शन प्राप्त किया गया जबकि आहार का चयापचय योग्य ऊर्जा की मात्रा में 15% तक की वृद्धि हुई।
- एक्सोजीनियस किण्वक के रूप में मक्का की साइलेज गुणवत्ता में सुधार के लिए CXLP(सेल्यूलेज+ क्जाइलानेस+एल.प्लानटेरम) तथा सीएक्सएलपीएलएफ (सेल्युलेज+क्जाइलानेस+एल.प्लानटेरम+एल.प्लानटेरम) तुलना में प्रतिशत शुष्क पदार्थ (डी.एम.) क्षति तथा एनएच$_3$–एन(% कुल पोषक तत्व) न्यूनतम करने के लिए जीवाण्विक इनओक्यूलेटिड संयोजक सबसे प्रभावी योज्य संयोजक थे।
- मक्का साइलेज की गुणवत्ता में सुधार के लिए 0.1% एफएम आधार पर पोटाशियम सोरबेट तथा सोडियम बेन्जुएट अधिक प्रभावी संयोजक थे चूंकि ये मक्का साइलेज में शुष्क पदार्थ क्षति (पोटाशियम सोरबेट, 0.1% ताजा पदार्थ आधार पर) अमोनिया एन अंश (सोडियम बेंजुएट 0.1% की क्षति को कम करने के लिए प्रभावी थे। सोडियम बेंजुएट अथवा पोटाशियम सोरबेट (0.1% ताजा पदार्थ आधार) ने एम.ई. की मात्रा को बढ़ाया।
- प्रथम समतुल्यता/ब्याँतकाल में गायों की अन्य समतुल्यताओं की तुलना में अधिक दृढ़ता थी। पांचवें ब्याँतकाल तक आयु की वृद्धि के साथ दृढ़ता मूल्यों में कमी आई। बूढ़ी गायें कम उम्र की गायों की तुलना में कम दृढ़ थी।
- जीनोटाइप (आनुवांशिक समूह) एक्स पर्यावरण (टी.एच.आई)समन्वय ने दूध उत्पादन लक्षणों के लिए महत्वपूर्ण प्रभाव (पी<0.05) प्रदर्शित किया तथा पूर्वी क्षेत्रीय केन्द्र भाकृअनुप–राडेअनुसं के पशु समूह पर संकर डेरी गायों के प्रजनन क्षेत्र पर कम महत्वपूर्ण प्रभाव रहा।
- 250 आई यू/कि.ग्रा. डी.एम.आई./प्रति पशु की दर से विटामिन ई के सम्पूर्ण से आर्सेनिक के विषाक्त प्रभाव से कुछ राहत प्रदान हुई तथा शरीर भार बढ़ने में वृद्धि हुई। विटामिन ई के सेक्रोमाइसिस केरीवाइसि के साथ अथवा अकेले सम्पूरण से पशु के आक्सीकारक किण्वन स्तर में संशोधन हुआ तथा रक्त में एसजीपीटी तथा एसजीओटी सान्द्रण द्वारा यकृत क्षति की संभावना को भी कम कर दिया।
- डेरी गोपशुओं के राशन में सान्द्रण मिश्रण में 5% (शुष्क पदार्थ आधार) की दर से स्पिरोडेला आहार के उपयोग से स्वैच्छिक आहार अन्तर्ग्रहण, पोषक तत्व पाच्यता, विकास प्रदर्शन तथा आहार संरक्षण क्षमता पर कोई प्रतिकूल प्रभाव नहीं पड़ा।
- कामेला (मैलोटस फिलिपिन्सिस) तथा फिक्स हूकेरी पेड़ के पत्तों ने संकर बछड़ों में क्रमश : शरीर भार वृद्धि 13.5 तथा 6.1% तथा आहार क्षमता में 2.0 तथा 0.8% रूमेन किण्वन में हेर फेर के लिए संभावना प्रदर्शित की।
- धर्मों आरामदायक आवास (रिज वायु संचार सहित, अधिक केन्द्रीय ऊंचाई, छप्परदार छत आदि) ने दूध दुहने में व्यवहार पहलुओं तथा श्रेष्ठ दुग्ध संरचना में अनुकूल सुधार प्रदर्शित किए। आवासीय प्रभावों ने प्रदर्शित किया कि मौजूदा शैडों (6.64 ± 0.05) की तुलना में धर्मों आरामदायक शैडों (6.83 ± 0.04) में दुग्ध उत्पादन अधिक था।
- अन्य विधियों के साथ अल्ट्रा सोनोग्राफिक तकनीकी का प्रयोग करके निम्न गंगातटीय क्षेत्रों में जर्सी संकर पशुओं के लिए बाडी कंडीशन स्कोर (बीसीएस) तकनीक विकसित एवं मानकित की गई। इससे यह अनुमान लगाया गया कि इस बीसीसी तकनीकी से इस क्षेत्र में श्रेष्ठ अयन स्वास्थ्य स्तर के साथ उच्च दुग्ध उत्पादन के लिए जर्सी संकर गायों को चुनने का नजरिया विश्वसनीय है।
- इन विट्रो कल्चर मीडिया में मीडिया संपूरक के रूप में ट्राई–आयोडोथाइरोनाइन का प्रयोग इन विट्रो गोपशुओं के भ्रूण के विकास के लिए क्लीवेज दर तथा मौकला संरचना दर महत्वपूर्ण रूप से काफी अधिक पाई गई।
- प्रशीतित वीर्य को पिघलाने के बाद उस वीर्य से मदकाल आरम्भ होने के 24 घंटे बाद बकरियों को कृत्रिम गर्भाधान विधि से गाभिन करने से क्षेत्र में परिणामस्वरूप गर्भास्थापन दर 51.56% रही।
- चारा आधारित फसल प्रणाली से पूरे वर्ष उच्च लाभ के साथ अच्छी गुणवत्ता का चारा उत्पादन प्राप्त किया गए। फसल अनुक्रम के साथ उच्च बायोमास उपज 'नेपियर घास + काउपी–बरसीम (167 टी/एच.ए), उसके बाद 'बहुकार सोरगम–बरसीम' (129टी/हैक्टेयर) सिंचाई परिस्थितियों में उच्चतम क्रमशः बी: सी 3.6 तथा 2.95 रही।
- विभिन्न टाइलेज (जुताई) प्रक्रियाओं तथा नाइट्रोजन प्रबंधन के अन्तर्गत उच्च उत्पादन के लिए बेबीकार्न तथा बेबी–काऊपी. अनुक्रम की पैकेज एडं प्रक्टिस प्रक्रियाओं को मानकीकृत किया गया। परम्परागत जुताई की तुलना में बेबीकार्न की ऐजड बैड तथा जीरो टाइलेज रोपण ने अधिकतक बेबीकार्न तथा चारा उत्पादन दिया।

- बेबीकार्न में जैव उर्वरकों का उपयोग करके रासायनिक उर्वरकों (नाइट्रोजन) का लगभग 10–15% बचत हुई। परम्परागत जुताई की तुलना में जीरो टिलेज को अपना कर फसल की लागत में लगभग 3500–4500 रूपए की बचत रिकार्ड की गई।
- दुधारू गायों में उपनैदानिक थनैला के मार्कर के रूप में दुग्ध पीएच, ई.सी., एससीसी, सीएल तथा लेक्टोज जैसे जोखिम मूल्यांकन कारकों को मानीटर करने के लिए अकेले अथवा संयोजन में प्रयोग किया जा सकता है।
- खुले आवास की तुलना में घर के अन्दर भैंसों को रखने से ठंड के आघात को कम तथा शारीरिक प्रतिक्रियाओं (श्वसन दर तथा नब्ज दर) को कम किया जा सकता है तथा परिणामस्वरूप 9.92% अधिक दुगध उत्पादन होता है।
- मुर्राह सांडों में आहारीय सीयू तथा जेडएन सम्पूर्ण ने वीर्य प्लाज़्मा में एलपीओ गतिविधि तथा रक्त प्लाज़्मा में सुपर आक्साइड डिसम्युटेज़ एन्जाइम की गतिविधि में सुधार हुआ है।
- इन्टरफेरन उत्तेजित जीनों के उपनियमन (आईएसजी 15, ओएएसआई, एन.एक्स, आईएफआई 16) से गाभिन गायों में सफल आरोपण के साथ इसका संबंध था।
- परिवर्तन एवं प्रारंभिक ब्याँत के दौरान प्रिल्ड वसा संपूरण (100 ग्रा./दिन) से संकर गायों तथा भैंसों में क्रमशः दुग्ध उत्पादन में 10 तथा 22% वृद्धि हुई।
- एसटेक्सन्थिन संपूरण 0.25 मि.ग्रा./कि.ग्रा. शरीर भार की दर से मुर्राह भैंसों में दुग्ध उत्पादन प्रदर्शन में 7% तक सुधार किया।
- किण्वित आलू प्रोटीन 50 ग्रा./प्रतिदिन की दर से सम्पूरण से बढ़ते हुए प्लाज़्मा आईजीएफ–1 तथा ग्लुकोज स्तर द्वारा दुग्ध उत्पादन में वृद्धि हुई।
- करनफ्रीज गायों ने सबसे कम वसा, एसएनएफ, कुल प्रोटीन तथा यूरिया की मात्रा दर्शायी जबकि थारपारकर गायों ने सर्दियों तथा थर्मोन्यूट्रल जोन के दौरान इन मानकों का अधिकतम परिमाण दर्शाया।
- पेरीपारटम गायों को बोसवेलिया सरेटा (ब्यूरसरऐकी) तथा बरजीनिया किलिआटा (सेक्सीफ्रेगकेसी) युक्त पोलिहर्बल सूत्रीकरण के आहार खिलाने से रोग प्रतिरोधक क्षमता में सुधार हुआ है तथा कार्टिसोल स्तरों में कमी आई है।
- गोपशुओं में गर्भाधान निदान के लिए आईएसजी 15 का पता लगाने के लिए एक न्यूट्रोफिल लाइसेट आधारित एन्जाइम लिंकड इम्यूनोसोरबेंट विधि का विकास किया गया।
- गायों में नैदानिक एवं उपनैदानिक थनैला की जांच के लिए दुग्ध एन.ए.गेज़ स्तर ने एक संभावित अभ्यर्थी का गठन किया।
- पशुओं को पीने का पानी प्रदान करने के लिए बनाई गई कुंडो नांद में साधारण उपकरणों को फिट करके पानी के अपव्यय को 70% तक कम किया जा सकता है।
- भैंसों के प्रारम्भिक ब्याँत के दौरान उच्च सीरम रहित वसीय अम्ल तथा अल्प लेप्टिन स्तर नकारात्मक ऊर्जा संतुलन के प्रशंसनीय उद्देश्य चयापचय संकेतक पाए गए।
- भैंसों के प्रारंभिव प्रसवोत्तर के दौरान जिगर में एक प्रमुख अनुकूली तंत्र के रूप में प्रतिरक्षा सहनशीलता की संभावना को उजागर किया।
- यह पाया गया कि भैंस के विभिन्न प्रकार के ऊतकों के बीच माइटोकोन्ड्रियल गतिविधि में भिन्नता के ऊतक विशिष्ट पैटर्न थे।
- ई.कोलाई में हेमोनचस कोनटोरटस के पुनः संयोजक सिस्टीन सिन्थेज (सीएस) प्रोटीन सफलतापूर्वक अभिव्यक्त किए गए।
- जिंक सूक्ष्मआण्विक उर्वरक फेगोसाइटस को कम करके, नाइट्रिक आक्साइड उत्पादन में वृद्धि करके संदूषक प्रतिक्रिया को बढ़ाते हुए जबकि आर्जिनेस अभिव्यंजना में कमी करते हुए जन्मजात प्रतिरक्षा प्रणाली को प्रभावित कर सकता है।
- जोखिमपूर्ण प्रतिजैवीय सुपनेटैंट टीएम 3 लाइडिंग कोशिकाओं पर स्टीरायडजैनिक गुणों में वृद्धि हुई पी 450 एससीसी किण्वकों के द्वारा प्रेगनिनोलोन पर कोलस्ट्रोल के रूपांतरण में वृद्धि हुई जोखिमपूर्ण प्रतिजैवीय सुपरनेटैंट मार्केडलि इनहैंसड ने कोशिकाओं की जीवनक्षमता बढ़ाई तथा P450 एसीसीसी तथा 17β एचएसडी जीन की अभिव्यंजना को विनियमित किया, इस प्रकार स्टीराइडोजेनेसिस में सुधार तथा एक कोरोलरी के रूप में प्रजनन क्षमता में सुधार हुआ।
- दो लेक्टोबेसिलस उपभेदों (एल रेहमनोसस एमटीसीसी 5897) तथा एल.फरमेंटम एमटीसीसी–5898) को विभिन्न प्रकार की विविधताओं के साथ उपकला कोशिकाओं में प्रतिरक्षा होम्योस्टेसिस के रखरखाव की दिशा में प्रतिरक्षा संकेत देने के लिए स्थापित किया गया था। लेक्टोबेसिल के दोनों उपभेद लेक्टोबेसिली अपवर्जन तथा प्रतिस्पर्द्धा के दौरान बेहतर प्रदर्शन करते हुए जीवित ई.कोलाई के साथ–साथ इसके एलपीएस के रूप में दिखाई दिए।

- प्रतिजैवीय लेक्टोबेसिलस फरमेंटम (एमटीसीसी 5898) 10^{7}–10^{11} सीएफयू/दिन/पशु की दर से निरन्तर 28 दिन तक आहार खिलाने के कारण कोई विषाक्त प्रभाव नहीं देखा गया। इस प्रतिजैवीय के रोजमर्रा के प्रदर्शन के दौरान अनुकूलतम आंत अवरोध अंखडता का भी पता लगाया गया था।
- व्हे व्युत्पन्न जैव सक्रिय पेप्टाइड जिसमें प्रतिआक्सीकर (वाईवीईईएल) तथा एंजियोटेनसिन–परिवर्तित किण्वक अवरोधक (वाईएलएलएफ) गतिविधियां है ने आस्टिओपोरोटिक चूहों में पैराथायरायड हार्मोन (पीटीएच) के समान ओस्टिो–संरक्षात्मक संभाव्यता को दर्शाता है।
- एन्टीरोकोकस फेकलिस में निसिन प्रतिरोध प्राप्त करने के एचपीआर आश्रित पैथवे का परिसीमन किया गया।
- व्हे प्रोटीन के पेप्सिन हाइड्रोलाइसेटस ने आरआईएन–5एफ बीटा कोशिकाओं द्वारा बढ़े हुए इन्सुलिन स्त्राव को प्रदर्शित किया।
- भैंस के दूध से रिकोटा चीज, भैंस के दूध से बढ़ती हुई घुलनशीलता के साथ दुग्ध प्रोटीन सान्द्रण 60, सम्मिश्रित डेरी–बाजरा आधारित से ग्लूटोन–मुक्त पास्ता, स्प्रे ड्राइड कोलस्ट्रोम, बकरी के दूध से मसालेदार चीज़ रोल आदि जैसे उत्पादों के लिए विनिर्माण प्रोटोकॉल विकसित किए गए।
- खाद्य पैकेजिंग अनुप्रयोग के लिए इलेक्ट्रोसपन स्मार्ट आक्सीजन रिसाव संकेतक विकसित एवं अभिलक्षित किए गए।
- परम्परागत एवं अन्य डेरी खाद्य पदार्थों में औषधीय सत्त्वों के अतिक्रमण के लिए ऑइल–इन–वाटर तथा वाटर–इन–ऑयल माइक्रों/नेनोइम्लशन तैयार किए गए थे।
- मिहोर प्रजाति (बकरी) के दूध से योघर्ट तथा चीज़ रोल जैसे उत्पादों के लिए प्रोटोकाल विकसित किए गए थे। ऊँटनी के दूध का प्रसंस्करण शुरू किया गया है।
- एटीन्यूएटिड टोटल रिफलेक्टैंस–फोरियर ट्रांस फोर्म इनफेरेयरड (एटीआर–एफटीआईआए) स्पेक्ट्रोस्कोपी का प्रयोग करके यूएचटी दूध में प्रोटियोलाइसिस के मूल्यांकन के लिए एक विधि मानकित की गई।
- एलसी–एमएस पेप्टाइड प्रोफाइलिंग डैटा इंगित करता है कि पकने के दौरान जैव सक्रिय पेप्टाइडों का उत्पादन का सोडियम अवस्थापित चेड्डार चीज़ में नियंत्रित करने की तुलना में अधिक है।
- व्हे प्रोटीन लौह सम्मिश्रकों को तैयार करने की विधि को अनुकूलित किया गया। दूध को नियंत्रित करने की तुलना में भौतिक–रासायनिक गुणों में डब्ल्यूपीसी–एफई (γ (iron) =15 mg/L) सम्मिश्रकों के साथ फोर्टिफाइड दूध में गैर महत्वपूर्ण अन्तर दिखाया गया।
- दुग्ध प्रोटीन आनुवांशिक विसंगतियों को पृथक करने तथा मात्रात्मक के लिए एक आरपी–एचपीएलसी विधि मानकित की गई।
- विटामिन डी रहित (वसा घुलनशील रूप) फोर्टिफाइड दूध की तुलना में दुग्ध प्रोटीन–विटामिन डी सम्मिश्रित फोर्टिफाइड दूध ने अधिक इन विट्रो जैव–सुलभता प्रदर्शित की।
- विभिन्न भारतीय नस्लों में से, गिर तथा साहीवाल गोपशुओं से तैयार पंचगव्य ने श्रेष्ठ एंटीफंगल क्रिया प्रदर्शित की। इसके पश्चात् थारपारकर तथा करनफ्रीज गोपशुओं से तैयार पंचगव्य का स्थान रहा।
- घी के लिए आईएसओ 17678(2010) विधि को मूल्यांकित किया गया तथा परिणामों से पता चला कि आईएसओ विधि में शुद्ध दूध वसा के लिए विनिर्दिष्ट एस–सीमा को गाय, भैंस तथा मिश्रित घी (भारतीय मूल) के लिए नहीं अपनाया जा सकता है।
- मक्खन और घी को आधारभूत सामग्री के रूप में प्रयोग करने अल्प–कोलस्ट्रोल घी तैयार करने के लिए परिस्थितियां अनुकूल बनाई गई।
- कोलाइटिस माऊस माडल में प्रतिजैवीय लेक्टोबेसिलि के सतहीय प्रोटीन के एंटी–इनफ्लेमेटरी प्रभाव ने प्रदर्शित किया कि सतहीय प्रोटीन प्रतिरोधक उत्तेजक विकारों के लिए सुरक्षित निवारक एवं चिकित्सीय विकल्प प्रदान कर सकता है।
- प्रतिजैवीय लेक्टोबेसिलि की जीवित एवं ऊष्मा से मृत कोशिकाएं प्रो–इनफ्लामेटरी साइटोकिन टीएनएफ–α स्त्राव के डाऊन रेगुलेशन के द्वारा उत्तेजक प्रतिक्रियाओं को कम करते हुए पाई गई।
- डेरी उद्योग के लिए गौडा चीज़ की तैयारी के लिए डिफाइन्ड स्ट्रेन स्टार्टर सूत्रीकरण विकसित किया गया।
- ईपीएस उत्पादन करने वाली कल्चर एल.फरमेन्टम एनसीडीसी 400 जिसमें 85.81±0.50% तक कोलस्ट्रोल को अधिकतम हटा दिया जाता है तथा एल.हेलवेटिकस एमटीसीसी 5463 स्ट्रेन को 6 घंटे तक 1.5% पित्त सहन करने की शक्ति की विशेषता थी।

- लेक्टोबेसिलस फरमेंटम, एल.प्लारेन्टम, एल.सेलिवेरियस, पीडियोकोकस पेंटोकैसेस, वीसेला सिबेरिया तथा ई.फेकियम से संबंधित कुल बारह लेक्टिक एसिड बैक्टीरिया को इसकी एंटीफंगल गतिविधि से वियोजित, पहचाना तथा जाना जाता है। एल.सलवेरियस, डब्ल्यू सिबेरिया तथा पी.पेंटोसैसस से संबंधित जातियों में ग्राम सकारात्मक (पोजिटव) तथा नकारात्मक सूक्ष्म अवयवों के विरूद्ध जीवाणुरोधी गतिविधि का व्यापक स्पेक्ट्रम का प्रदर्शन किया।
- दूध में सूक्ष्मजैवीय गुणो की तीव्र जांच के लिए ग्रोथ मीडिया को पीएएनआई–पीईसी कणों का उपयोग करते हुए संघटकों, सान्द्रण एवं पीएएनआई–पीईसी कणों का उपयोग करते हुए संघटकों, सान्द्रण एवं पी.एच. के लिए अनुकूलित किया गया।
- दूध में कोलिफार्म/ई.कोलि की तीव्र जांच के लिए तीव्र पीएएनआई–पीईसी क्लोरोमीट्रिक पेपर स्ट्रिप विधि विकसित की गई।
- ई.कोलि के 38 वियोजकों में 3–8 रोगप्रतिरोधक तक मल्टी ड्रग प्रतिरोधशक्ति देखी गई।
- ई.कोलाई के चार वियोजक फीनोटाइपिक तथा जीनोटाइपिक विधियों द्वारा विस्तारित स्पेक्ट्रम बीटा लेक्टामेज़ (ईएसबीएल) के लिए प्रतिरोधी पाया गया।
- एल रहेमनोसस 25 द्वारा भेड़, बकरी तथा ऊँटनी के दूध के किण्वन से जैव सक्रिय पेप्टाइड जिसमें प्रतिसूक्ष्मजैवीय, एसीई निरोधात्मक इम्यूनोमोडयूलेटरी, डीपीपी IV निरोधात्मक, तथा कैंसर विरोधी गतिविधियाँ सम्मिलित हैं, उत्पन्न किए गए।
- एल.रहेमनोसस सी 25 द्वारा किण्वित कोलस्ट्रोम से पेप्टाइड ने एल.रहेमनोसस सी 6 तथा एल.केसी. एनसीडीसी 17 से किण्वित कोलस्ट्रोम की तुलना में अधिकतम प्रति सूक्ष्मजैवीय गतिविधि प्रदर्शित की।
- प्रतिजैवीय किण्वित आम व्हे पेय तैयार करने के लिए प्रौद्योगिकी विकसित की गई।
- दूध में एंटीबायटिक अवशेषों की विद्यमानता पर निगरानी कार्य सेवा संस्थानों की सहायता कार्यक्रमों के अन्तर्गत किया गया था और मानक सेंटिंग के लिए एफएसएसएआई के साथ डाटा सांझा किया गया था।
- कच्चे दूध एवं बाजार के दूध में एंटीबायटिक अवशेषों की जांच के लिए टेट्रासाइक्लिन समूह (टेट्रासाइक्लिन तथा आक्सीटेट्रासाइक्लिन) एवं नोवोबायोसिन एंटीबायटिक्स के लिए अनुकूलित एचपीएलसी विधियां एमआरएल स्तर पर अथवा उससे नीचे का पता लगाने में सक्षम थे तथा दूध से नमूनों के रोजमर्रा के विश्लेषणों के लिए प्रयोग किए जा सकते है। यह विधि चयनात्मक विधि है तथा एंटीबायटिक दवाओं के नियमित विश्लेषण में प्रयोग की जा सकती है।
- प्रतिसूक्ष्मजीवय पेप्टाइडों की कोटिगं तथा एएफएस (C25+195) के संयोजन में प्रतिजैवीय सक्रिय फिल्में तैयार की गई जिनका प्रयोग बाजार के खोआ को पैक करने तथा एनडीआरआई के खोआ नमूनों की शेल्फ लाइफ बढ़ाने के लिए किया गया।
- दूध, अनाज आधारित खाद्य पदार्थों, प्रसंस्कृत फल, आहार, चारा, मिट्टी तथा जल में कीटनाशी अपशिष्टों की जांच के लिए स्ट्रिप आधारित प्रौद्योगिकी को सफलतापूर्वक लागू किया गया।
- डिसल्फोटोमेक्सूलम रूमिनिस एक्ल–44 ए को एक संभावित हाइड्रोजन सीक्वेसटर के रूप में पहचाना गया तथा इन–विवो जांच के बाद मीथेन उत्सर्जन को कम करने के लिए इस्तेमाल किया जा सकता है।
- उपनैदानिक थनैला दूध का पता लगाने के लिए एक स्ट्रिप आधारित परीक्षण को मानकीकृत किया गया तथा एंटीबायटिक, भारी धातुओं कीटनाशकों तथा अफलाटाक्सिन एम1 के साथ क्रास प्रतिक्रिया के लिए जांच की गई।
- रेशे एवं सूक्ष्म पोषक तत्वों अर्थात् जस्ता एवं लौह के साथ फोर्टिफाइड व्हे केफीर पेय उसके मौजूदा नवीन पोलिसेकेराइड अर्थात् केफेरन के अतिरिक्त जैव–कार्यक्षमता एवं पोषण मूल्यों को बढ़ाने के लिए विकसित किया गया था। प्रौद्योगिकी व्यवसायीकरण के लिए तैयार है।
- दही की पैकिंग के लिए मधुमक्खी की मोम की परत लगाया गए कंटेनर का प्रयोग करके एक इको–फ्रैंडलि पैकिंग सामग्री विकसित की गई।
- नेनोकोटिड प्लेट्स के साथ एक स्किड–मांऊटिड प्लेट हीट एक्सचेंजर मॉडयूल विकसित किया गया।
- पेप्टाइड तथा रिसवरेटरोल–लोडिड नेनोफाइबर्स के उत्पादन के लिए एक इलेक्ट्रो–स्पिनिंग यूनिट सुसज्जित किया गया।
- छैना उत्पादन के लिए 20 लीटर दूध संचालन के लिए व्हे हटाने के लिए एक प्रोटोटाइप डिजाइन किया गया तथा विकसित किया गया।
- दही तथा अन्य किण्वित दुग्ध उत्पादों के व्यावसायिक उत्पादन के लिए यंत्रचालित नियंत्रित ऊष्मायित्र प्रणाली विकसित की गई।

- डेरी तथा डेरी उत्पादों के रंग मापन के लिए मशीन विजिन सिस्टम (एमवीएस) कलर डेस्क डी1–एक पोर्टेबल बेंच–टाप माडल मशीन विजिन प्रणाली विकसित की गई।
- रबड़ी बनाने का एक उपकरण जिसमें तीव्रता से दूध को सान्द्रित करने वाला मिल्क कनसन्ट्रेटर तथा मिल्क फ्लेक फारमेशन सिस्टम (दूध की पपड़ी बनाने की प्रणाली) भी सम्मिलित है, विकसित किया गया।
- खीर के यंत्रीकृत उत्पादन का उपकरण विकसित किया गया। उपकरण में दुग्ध सान्द्रक, चावल की प्री–कंडीशनिंग करने की प्रणाली, सान्द्रित दूध तथा चावल मिलाने की प्रणाली तथा फलैश हीटर हैं।
- गुजरात में एक औसत किसान पशु स्वास्थ्य, प्रजनन एवं बीमा संबंधी पशुधन सेवाओं पर (2013–14) में प्रतिवर्ष प्रति स्टैंडर्ड एनीमल यूनिट (एस.ए.यू.) 1813 रू कुल व्यय कर रहा था। इन सहायक सेवाओं में पशु स्वास्थ्य सेवाओं पर कुल व्यय का 67% खर्च हो रहा था।
- पशु स्वास्थ्य सेवाओं के लिए ओवरआल विलिंगनैस टू पे (डब्ल्यूटीपी) केन्द्र पर 74 रू प्रति सर्विस तथा घर पर 206 रू प्रति सर्विस अनुमानित की गई, जो कि प्रति सर्विस मौजूदा चार्ज से क्रमशः 1.23 गुना तथा 1.02 गुना अधिक थी।
- गुजरात में पशुधन सैक्टर की कुल फैक्टर उत्पादकता (टीएफटी) की विकास दर पिछले दशक 2005–06 से 2014–15 के दौरान प्रति वर्ष 5.32ः रिकार्ड की गई। टीएफपी में इस विकास दर को आउअपुट इंडेक्स की उच्च वृद्धि और इनपुट इंडैक्स में गिरावट के कारण महसूस किया गया था, जिससे इनपुट दक्षता अनुपात में सुधार हुआ।
- खाद्य सुरक्षा अंगीकार सूचकांक 47 प्रक्रियाओं पर डेरी स्टार्टअप्स के व्यावसायिक खेतों के लिए मानक प्रक्रियाओं का 59ः था। इन प्रक्रियाओं के बीच इन श्रेणियों में खाद्य सुरक्षा अपनाने के 57ः स्तर के कारण दुग्ध स्वच्छता तथा दुग्ध संचालन वर्गों में सुधार की आवश्यकता है।
- केरल में प्रमुख कृषि फार्म फार्मिंग प्रणाली में लाभप्रदता सबसे अधिक (1, 97, 174) थी। इस फार्मिंग प्रणाली में फसल+डेरी+बकरी+मुर्गीपालन (सी+डी+जी+पी) मौजूद थी। पारिवारिक स्तर पर कैलोरी की औसत उपलब्धता भी इस फार्मिंग प्रणाली में अधिकतम (2810 किलोकैलोरी प्रति उपभोक्ता यूनिट प्रतिदिन थी) जो कि श्रेष्ठ भोजन एवं पौषणिक सुरक्षा सुनिश्चित करती है।
- स्थिरता सूचकांक गोशाला लघु आकार के लिए 0.32 मध्यम आकार के लिए 0.40 तथा विशाल गोशाला के लिए 0.49 था। आर्थिक स्थिरता महत्वपूर्ण रूप से पशु की उत्पादकता तथा गोशालाओं की स्वायत्तशासिता पर निर्भर थी जबकि सामाजिक स्थिरता (एसएसई) गोशाला में रखे गए पशुओं की कुल संख्या, स्वायत्तशासिता तथा प्रति पशु शुद्ध आय पर निर्भर था। पर्यावरणीय स्थिरता सूचकांक गोशालाओं में उपलब्ध आवास स्थान तथा स्वायत्तशासिता पर महत्वपूर्ण रूप से प्रभावी था।
- गोशालाओं का औसत वार्षिक राजस्व 1.79 करोड़ रूपये था जिसमें 80% अनुदान, बिक्री 6.5% तथा विविध आय (14.5%) था। गोशाला का वार्षिक व्यय 1.73 करोड़ रूपये था जबकि 49.8% आहार एवं चारे के लिए थे। गोशाला की शुद्ध आय 5.6 लाख रूपये प्रतिवर्ष की जबकि प्रति एसएयू केवल 283 रूपये थी।
- बैंगलुरू दुग्ध संघ समूह गोपशु बीमा योजना के अन्तर्गत पशुधन बीमा वैकल्पिक पशु पहचान तकनीकियों का मूल्यांकन करने के लिए एक अध्ययन के बाद व्यावहारिक पाई गई। और कर्नाटक में पशुधन बीमा उत्पाद 0.89 के प्रीमियम एकत्रित अनुपात के लिए एक समग्र दावा राशि तक पहुंचा। पहचान तकनीकियों के रूप में केवल प्लास्टिक टैग ही प्रयोग में सरल, लागत तथा श्रम आवश्यकताओं के मामले में अधिक सक्षम पाए गए।
- उत्तराखंड में खाद्य असुरक्षा के प्रमुख गणना सूचकांक से पता चला कि मैदानी इलाकों में राष्ट्रीय नमूना सर्वेक्षण के 61वें दौर के 61% से 68वें दौर में 52% तक खाद्य असुरक्षा नीचे आई तथा इसी अवधि में पहाड़ी क्षेत्रों में यह क्रमशः 39% तथा 46% हो गई।
- एनएसएसओ के आंकड़ों के अनुसार हरियाणा में डेरी से होने वाली आय सभी आकार वर्गों के किसानों के लिए बढ़ गई लेकिन सीमान्त कृषक परिवारों की आय राज्य की औसत 2400/– रू. प्रति माह की आय से 30% कम रही।
- मशीन लर्निंग एलगोरिदम ने विशेष रूप से डेटा विशेषताओं के गैर–रैखिक संबंध के मामले में क्लासिकल प्रतिगमन विधियों की तुलना में पनीर के माडलिंग रिओलोजिकल व्यवहार के लिए काफी अच्छा प्रदर्शन किया।
- वर्ष 2018–19 के दौरान कुल चार पेटेंट फाइल किए गए तथा चार पेटेंट दिए गए।

शिक्षण

- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल को भारतीय कृषि अनुसंधान परिषद द्वारा कृषि विश्वविद्यालयों की रैंकिंग में कृषि विश्वविद्यालयों में प्रथम स्थान प्राप्त हुआ है। इसके लिए भाकृअनुप के स्थापना दिवस के अवसर पर 16 जुलाई 2018 को नास परिसर, पूसा, नई दिल्ली में प्रमाणपत्र प्रदान किया गया।

- राष्ट्रीय डेरी अनुसंधान संस्थान से उत्तीर्ण होकर बाहर जाने वाले छात्रों को डेरी/खाद्य उद्योग (सरकारी/सहकारी/बहुराष्ट्रीय) में लाभप्रद रोजगार प्राप्त हुआ।
- भाकृअनुप– राष्ट्रीय डेरी अनुसंधान संस्थान मानद् विश्वविद्यालय का सत्रहवां दीक्षान्त समारोह दिनांक 23 मार्च 2019 को संपन्न हुआ। कुल 249 छात्रों (जिनमें 95 छात्राएं थी) को बी.टैक (डेरी प्रौद्योगिकी), 25 मास्टर्स एवं 80 डाक्टरल उपाधियां प्रदान की गई।
- संस्थान ने भारत के प्रथम राष्ट्रपति, भारत रत्न, डा. राजेन्द्र प्रसाद के जन्मदिन की स्मृति में दिनांक 3 दिसम्बर, 2018 को कृषि शिक्षण दिवस के रूप में मनाया।
- राष्ट्रीय कृषि उच्च शिक्षण परियोजना के अन्तर्गत संस्थानीय विकास योजना ने बी.टैक (डेरी प्रौद्योगिकी) कार्यक्रम को सुदृढ़ करने के लिए कई प्रस्तावों में मदद की। इनमें से कुछ प्रस्ताव छात्रों के लिए विश्वव्यापी प्रशिक्षण, विदेशी विश्वविद्यालयों में आयोजित संकाय सुधार कार्यक्रम, छात्रों के हित के लिए प्रेरणादायक एवं व्यावसायिक वार्त्ताएं, उद्योगों तथा विश्वविद्यालयों के साथ समन्वय हैं। संस्थान के 31 पूर्वस्नात्तक छात्रों को 4 विभिन्न देशों के 9 विश्वविद्यालयों में प्रशिक्षण दिया गया। इसी कार्यक्रम में 16 संकाय सदस्यों को विदेशी विश्वविद्यालयों में प्रशिक्षण के लिए चयनित किया गया।
- ग्रामीण प्रबंधन संस्थान, आनन्द (आई.आर.एन.ए) आनन्द, गुजरात के साथ राष्ट्रीय डेरी अनुसंधान संस्थान के बी.टैक (डेरी प्रौद्योगिकी) के छात्रों के लिए दोहरी उपाधि के रूप में एकीकृत डेरी प्रबंधन में स्नातकोत्तर उपाधि कार्यक्रम प्रदान करने के लिए एम.ओ.यू. पर हस्ताक्षर किए गए।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान के छात्रों के लिए राडेअनुसं तथा नेस्ले इंडिया के बीच सॉफ्ट स्किल में वृद्धि के लिए एम.ओ.यू. पर हस्ताक्षर किए गए।
- कंज्यूमर बायिंग बिहेवियर, आप्टिमाइजेशन आफ आपरेशनल प्रोसैस, कस्टमर सेगमैनटेशन, आप्टिमाइजेशन आफ सप्लाई चेन चैनल, न्यू प्रोडक्ट डवैलपमैंट एडं इनहैंसमैंट जैसे पहलुओं पर बी.टैक (डी.टी.) के छात्रों के प्रशिक्षण के लिए फयूचर ग्रुप इंडिया के साथ सम्पर्क विकसित किए गए।
- भाकृअनुप–नार्म, हैदराबाद के समन्वय में व्यावसायिक डेरी फार्मिंग तथा दुग्ध प्रसंस्करण में एम.ओ.ओ.सी के विकास प्रारम्भ किए गए।
- सस्य विज्ञान के एम.एससी तथा पीएच.डी छात्रों के लिए एक यात्रा संगोष्ठी शिक्षण दौरा कार्यक्रम राजस्थान(बीकानेर एवं जैसलमेर) के लिए आयोजित किया गया। इस कार्यक्रम का उद्देश्य प्रदत्त पाठ्यक्रम के अन्तर्गत प्रेक्टिस्ड फोरेज डोमिनैंट फार्मिंग सिस्टम तथा चारा एवं चरागाह फसलों में ज्ञान को बढ़ाना तथा प्रयोगात्मक प्रदर्शन है।
- एम.टैक (डेरी अभियांत्रिकी) के शिक्षण पाठ्यक्रम में दो नए पाठ्यक्रम अर्थात् इंडस्ट्रियल आटोमेशन एवं रोबोटिक्स एडं इंजीनियरिंग परापट्रीज़ आफ फूडस प्रारम्भ किए गए।
- बी.टैक (डी.टी.) प्रथमवर्ष के छात्रों के लिए शिक्षण पाठ्यक्रम में रेमिडियल कोर्स ऑन इंजीनियरिंग मैथेमैटिक्स भी प्रारम्भ किया गया।

विस्तार

- वर्ष 2018–19 के दौरान 18 विभिन्न लाइसेंस अनुबन्धों के द्वारा 8 व्यावसायिक सदनों को संस्थान द्वारा विकसित 12 प्रौद्योगिकियां हस्तांतरित की गई।
- डेरी उत्पादकों को शिक्षित करने के लिए 'इनवायरनमैंट फ्रेंडली डेरी फार्मिंग प्रेक्टिसेस'' विषय पर एक मोबाइल ऐप अंग्रेजी तथा हिंदी में विकसित की गई।
- 'बूसिलोसिस एडवाइजर'' पर एक द्विभाषी (हिंदी एवं अंग्रेजी) मोबाइल ऐप विकसित की गई। यह ऐप क्षेत्र स्तर पर परीक्षणाधीन है क्षेत्र में उपभोक्ताओं से प्राप्त सुझावों/फीडबैक के अनुसार ऐप को अन्तिम रूप दिया जाएगा तथा इसे गूगल स्टोर तथा भाकृअनुप–एनडीआरआई की वेबसाइट पर अपलोड किया जाएगा।
- ग्रामीण स्तर पर डेयरिंग तथा संबंधित विषयों के विभिन्न पहलुओं पर (पैंतीस) किसान संगोष्ठियां आयोजित की गई।
- फारमर्स फार्म स्कूल के तीसरे बैच के लिए जिन कृषक अभ्यार्थियों ने नाम लिखवाया वे जुलाई 2018 में उत्तीर्ण हो गए। दीपो गाँव के 20 सीमान्त कृषकों एवं भूमिहीन कृषक महिलाओं के चौथे बैच का प्रारंभ दिनांक 10 अगस्त 2018 को हुआ।
- कृषि विज्ञान केन्द्र ने 275 प्रशिक्षण कार्यक्रम (परिसर पर तथा परिसर से बाहर) आयोजित किए तथा इन कार्यक्रमों के दौरान 16 राज्यों के कुल 10,513 कृषक लाभान्वित हुए।
- कृषि विज्ञान केन्द्र ने करनाल जिले के 20 ग्रामीण युवाओं के लिए वर्मी कम्पोस्ट के क्षेत्र में स्किल डवैलपमैंट पर प्रशिक्षण कार्यक्रम

आयोजित किए। प्रतिभागियों का भारतीय कृषि कौशल परिषद द्वारा कौशल प्राप्त करने मूल्यांकन किया गया। सफल प्रतिभागियों को भारत सरकार द्वारा प्रमाणपत्रों से पुरस्कृत किया जाएगा।

- कृषि विज्ञान केन्द्र ने फसल अपशिष्ट प्रबंधन पर करनाल जिले के 225 ग्रामीण युवाओं एवं कृषकों के लिए पांच प्रशिक्षण कार्यक्रम आयोजित किए। कृषकों को मशीनों का प्रयोग करके फसल अपशिष्ट प्रबन्धन तथा मृदा स्वास्थ्य एवं संसाधन संरक्षण पर इसके लाभों पर संवेदनशील बनाया गया।
- कृषि विज्ञान केन्द्र द्वारा नेहरू युवा केन्द्र करनाल के साथ मिलकर दिनांक 18–20 मार्च 2019 को युवा नेतृत्व एवं सामुदायिक विकास पर एक विशेष प्रशिक्षण कार्यक्रम आयोजित किया गया।
- कृषि विज्ञान केन्द्र में नई किस्मों के बारे में जागरूकता पैदा करने के लिए करनाल जिले के विभिन्न गाँवों में वर्ष 2018–19 के दौरान विभिन्न योजनाओं के अन्तर्गत फ्रंट लाइन प्रदर्शन प्लाट पर 23 फील्ड विजिट आयोजित की।
- कृषि विज्ञान केन्द्र ने गाँव कुलवेहड़ी में दिनांक 2 मई, 2018 को किसान कल्याण दिवस मनाया जिसमें 65 किसानों ने भाग लिया।
- कृषि विज्ञान केन्द्र ने दिनांक 20 जून, 2018 को किसानों के साथ प्रधानमंत्री जी का कार्यक्रम वेब दूरदर्शन पर प्रसारित करने की व्यवस्था की जिसमें 150 से अधिक किसानों ने भाग लिया। इसके अतिरिक्त स्वयंसेवी समूहों के सदस्यों की सहायता से एक अन्य वैब प्रसारण दिनांक 12 जुलाई, 2018 को करने की व्यवस्था की गई जिसमें लगभग 50 महिलाओं ने भाग लिया।
- कृषि विज्ञान केन्द्र ने दिनांक 7 अगस्त 2018 को रिंडल गाँव में 'वर्ल्ड ब्रैस्ट फीडिंग वीक' मनाया। इस आयोजन से महिलाओं को नवजात बच्चों एवं शिशुओं को ब्रैस्ट फीडिंग करने के महत्व तथा उनके स्वास्थ्य पर इसके प्रभाव के बारे में शिक्षित किया गया। इस कार्यक्रम में 50 महिलाओं ने भाग लिया।
- कृषि विज्ञान केन्द्र ने दिनांक 15 अक्तूबर 2018 को किसान महिला दिवस आयोजित किया जिसमें 6 गाँवों की 95 महिलाओं ने भाग लिया।
- करनाल जिले की महिलाओं के लिए दिनांक 1 नवम्बर 2018 को तथा सोनीपत जिले की महिलाओं के लिए दिनांक 14 नवम्बर 2018 को दुग्ध प्रसंस्करण पर दो एकदिवसीय प्रशिक्षण कार्यक्रम आयोजित किए गए।
- कृषि विज्ञान केन्द्र ने दिनांक 5 दिसम्बर 2018 को 'मृदा स्वास्थ्य दिवस' आयोजित किया जिसमें अन्य राज्यों तथा करनाल जिले के विभिन्न गाँवों के 90 से अधिक कृषकों तथा ग्रामीण महिलाओं ने भाग लिया।
- कृषि विज्ञान केन्द्र ने स्वच्छता पखवाड़ा (दिसम्बर 16–31,2018) के दौरान दिनांक 23 दिसम्बर, 2018 को किसान दिवस मनाया गया। करनाल जिले तथा अन्य राज्यों के लगभग 30 किसानों ने इस कार्यक्रम में भाग लिया।
- कृषि विज्ञान केन्द्र ने माननीय प्रधानमंत्री की किसानों एवं किसान महिलाओं के लिए दिनांक 24 फरवरी 2019 को प्रधानमंत्री–किसान योजना (प्रधानमंत्री सम्मान निधि) के शुभारंभ पर सीधे प्रसारण की व्यवस्था की। अन्तर्राष्ट्रीय महिला दिवस पर इस कार्यक्रम में कुल 70 ग्रामीण महिलाओं ने भाग लिया।
- वर्ष 2018–19 के दौरान 5597 किसानों को विभिन्न पहलुओं पर कुल 3722 परामर्श सेवाएं प्रदान की गई।
- डेयरिंग के क्षेत्र में जागरूकता पैदा करने के उद्देश्य से संस्थान परिसर में कुल 10 महिला सशक्तिकरण–प्रशिक्षण कार्यक्रम एवं प्रदर्शन आयोजित किए गए। इन कार्यक्रमों में कुल 115 कृषक महिलाओं को प्रशिक्षित किया गया।
- 'कृषकों के द्वार पर शिक्षण' एवं 'मेरा गाँव मेरा गौरव'' कार्यक्रमों में वैज्ञानिक नियमित रूप से गाँवो का दौरा करते हैं।
- टी.एस.पी. परियोजना के अन्तर्गत बारह वैज्ञानिक–कृषक पारस्परिक व्यवहार सत्र आयोजित किए गए। इन व्यवहार सत्रों में राडेअनुसं पूर्वी क्षेत्रीय केन्द्र, कल्याणी के विशेषज्ञों एवं वैज्ञानिकों की टीमों ने वैज्ञानिक पद्धति द्वारा पशुपालन के विभिन्न क्षेत्रों (डेरी/बकरी तथा अन्य पशु) पर किसानों से सम्पर्क किया।
- टी.एस.पी. परियोजना के अन्तर्गत एक 'पशुधन एवं कृषि मेला' सी.ए.डी.सी. पश्चिमी बंगाल सरकार के सहयोग से पश्चिमी बंगाल में पुरूलिया जिले के जनजातीय अजोध्या पहाड़ी क्षेत्र में 22 नवम्बर, 2018 को आयोजित किया गया।
- रिपोर्टाधीन अवधि के दौरान जनजातीय बेरोजगार युवाओं के लिए 'वैज्ञानिक ढंग से डेरी फार्मिंग प्रक्रियाएं' विषय पर दो प्रशिक्षण कार्यक्रम आयोजित किए गए तथा इन प्रशिक्षण कार्यक्रमों में 40 जनजातीय किसानों ने भाग लिया।

- कई दौरों की व्यवस्था की गई तथा पशुधन जैसे निवेशों (कुक्कुटादि, बकरियां, सूअर के बच्चे), पशु–चिकित्सा दवाइयाँ, खनिज मिश्रण, सान्द्र मिश्रण, चारा बीज, विस्तार साहित्य आदि कृषकों में वितरित किया गया। वैज्ञानिक–कृषक परस्पर समन्वय सत्रों में पशुपालन के विभिन्न पहलुओं पर उत्तरी पूर्वी राज्यों के किसानों को स्पष्ट किया।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र के अपनाए गए गाँवों में (मुरातीपुर एवं दक्षिण चांदमरी) डेरी कृषकों को पशुचिकित्सा स्वास्थ्य देखभाल सुविधाएं नियमित रूप से प्रदान की जा रही हैं। पूर्वी क्षेत्रीय केन्द्र से विशेषज्ञ किसानों के घरों का दौरा करते हैं तथा उनकी समस्याओं का समाधान करते हैं। मुरतीपुर गाँव में 'डेरी विकास केन्द्र' द्वारा 156 पशुओं का कृत्रिम गर्भाधान किया गया।
- कृत्रिम गर्भाधान तथा पशुचिकित्सा प्रथम उपचार विषय पर 17 प्रतिभागियों के लिए दो प्रशिक्षण कार्यक्रम आयोजित किए गए।
- 'वैज्ञानिक ढंग से डेरी फार्मिंग' विषय पर दो प्रशिक्षण कार्यक्रम पश्चिमी बंगाल के विभिन्न भागों से 39 प्रशिक्षणार्थियों के लिए आयोजित किए गए।

क्षमता निर्माण

- उद्यमशीलता विकास कार्यक्रम के अन्तर्गत 'वाणिज्यिक डेरी फार्मिंग', दुग्ध एवं दुग्ध उत्पाद प्रसंस्करण तथा 'नवीन डेरी उत्पादों' पर 14 प्रशिक्षण कार्यक्रम आयोजित किए गए, जिसमें देशभर के 300 प्रतिभागी शामिल हुए।
- भावी उद्यमियों के लिए दुग्ध प्रसंस्करण एवं मूल्य संवर्धन पर दो प्रशिक्षण कार्यक्रम दिनांक 21–30 जून, 2018 तथा 27 अगस्त से 5 सितम्बर, 2018 तक आयोजित किए गए।
- भावी उद्यमियों के लिए 'दुग्ध प्रसंस्करण' विषय पर दिनांक 12 नवम्बर से 11 दिसम्बर 2018 तक प्रशिक्षण कार्यक्रम आयोजित किए गए।
- भावी उद्यमियों के लिए 'चीज़ निर्माण की प्रौद्योगिकी' पर दिनांक 23–30 मार्च, 2019 को प्रशिक्षण कार्यक्रम आयोजित किया गया।
- प्रगत संकाय प्रशिक्षण केन्द्र के तत्वावधान में भाकृअनुप के संस्थानों तथा राज्य कृषि विश्वविद्यालयों के संकाय सदस्यों के लिए डेरी प्रसंस्करण में दिनांक 1–21 दिसम्बर 2018 तथा 4–24 जनवरी, 2019 तक दो प्रशिक्षण कार्यक्रम आयोजित किए गए।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, बंगलौर परिसर में जुलाई 16–20, 2018 तक 'डेरी पशुओं' में अल्ट्रासोनोग्राफी तथा प्रजनन विकार प्रबंधन' पर एक अन्तर्राष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- 'डेरी तथा खाद्य उद्योग में उद्यमशीलता : व्यावसायीकरण संकल्पना' पर एक सेमीनार दिनांक 14–15 सितम्बर, 2018 को आयोजित किया गया।

आधारभूत संरचना

- डेरी एवं खाद्य उत्पादों के रंग गुणों के निर्धारण के लिए मशीन विजिन प्रयोगशाला को प्रतिष्ठित किया। डेरी अभियांत्रिकी प्रभाग के वैज्ञानिकों ने उपकरण एवं साफ्टवेयर को स्वदेशी ढंग से विकसित किया गया।
- खाद्य उत्पादों की भौतिकी, विद्युत्तीय, रासायनिक एवं अन्य अभियांत्रिकी गुणों के मूल्यांकन के लिए 'खाद्यों के अभियांत्रिकी गुण' पर नई प्रयोगशाला की स्थापना की गई।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान के कृत्रिम प्रजनन अनुसंधान केन्द्र में 10'X10'X7 आकार के तीन व्यर्थ जल टैंकों का निर्माण।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में कार्यालय क्षेत्र की सड़कों की प्रीमिक्स कारपैटिंग।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के डेरी प्रौद्योगिकी प्रभाग के सेमीनार कक्ष का नवीकरण।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की प्रदर्शनी यूनिट का नवीकरण।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की पशु जैव प्रौद्योगिकी केन्द्र पर संग्रहण सुविधा का सृजन एवं एजीएल–1 तथा ए.जीएल–2 प्रयोगशालाओं को पेंट कराने का कार्य।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में पशु पोषण प्रभाग के पशुशाला शैड तथा कावेरी छात्रावास में बिजली का कार्य।

- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की क्षतिग्रस्त चारदीवारी की मरम्मत।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के कृत्रिम प्रजनन अनुसंधान केन्द्र के शुष्क चारा शैड की मरम्मत।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में कृषि विज्ञान केन्द्र के किसान भवन, ब्रहपुत्र छात्रावास, सतलुज छात्रावास, अलकनंदा/विवाहित छात्रावास, अन्तर्राष्ट्रीय छात्रावास की मरम्मत, सफेदी एवं पेंटिंग का कार्य।
- संस्थान के पुस्तकालय भवन की छत की पैरापीट दीवार की मरम्मत एवं रखरखाव।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के अनुसंधान प्रभागों के कारीडोरों में विटरिफाइड टाइल फ्लोरिंग/कोटा स्टोन फ्लोरिंग को फिक्स करना।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में मिल्क पार्लर सहित प्रयोगात्मक डेरी भवन की मरम्मत तथा संपूर्ण सफेदी एवं पेंटिंग का कार्य।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में प्रोडक्शन भवन के स्विच रूम से जनरेटर हाऊस तक नई एल.टी. एक्सएलपीई पावर केबल डाली गई।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में संयुक्त निदेशक (शैक्षणिक) के कार्यालय की मरम्मत एवं नवीकरण।
- भाकृअनुप–राडेअनुसं दक्षिण परिसर, बंगलुरू में अटल इनोवेशन मिशन नीति आयोग के साथ सहभागिता से प्रारंभ किए जाने वाले अटल इनक्यूबेशन केन्द्र एआईसी–एसआर एस–आईसीएआर–एनडीआरआई की स्थापना। इसका उद्देश्य स्पोर्टिंग इनोवेटिव टैक्नोलोजी बेस्ड स्टार्ट–अप एंटरप्राइजिस इन इंडिया का लगभग 1000 लाख रूपये की परियोजना का प्रारम्भ करना है।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, दक्षिणी परिसर, बेंगलुरू में अत्याधुनिक सुविधाओं वाले प्रोटिओ–जीनोमिक प्रयोगशाला तथा थीरिओजिनोलोजी प्रयोगशाला जैसी नवीन प्रयोगशालाओं का सृजन।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, दक्षिणी परिसर, बेंगलुरू में महिला छात्रावास के कृष्णा खण्ड का उद्घाटन।
- भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, दक्षिणी परिसर, बेंगलुरू में पशुधन अनुसंधान केन्द्र के पशु स्वास्थ्य प्रबन्धन भवन एवं नए कार्यालय की नींव रखी गई तथा यह निर्माणाधीन है।

INTRODUCTION



ICAR-National Dairy Research Institute (NDRI) at Karnal, Haryana is one of the premier Institutes in dairy sector. The Institute has contributed tremendously in the growth of the Indian dairy industry and played a crucial role in India's development in milk production with its continuous research. Over ninety year old, NDRI's lineage goes back to the Imperial Institute for Animal Husbandry & Dairying which was set up in Bangalore in 1923 as a center for dairy education. It was shifted to its present site in Karnal in 1955 and renamed as National Dairy Research Institute. The infrastructure of Imperial institute was retained as Southern Regional Station of NDRI and later in 1964 Eastern Regional Station was set up at Kalyani in West Bengal. NDRI was brought under Indian Council of Agricultural Research in 1970. The Institute has the distinction of being a Deemed University for implementing its academic programmes since, 1989. NDRI secured First Rank among all Agricultural Universities in India in the ranking of these Universities by ICAR in 2016-17 and 2017-18. The Institute has been accredited by National Agricultural Education Accreditation Board, ICAR up to 2021. The Institute also finds a place in the Special Mention Category of Institutions by National Institute Ranking Framework (NIRF), Ministry of Human Resources Development, Ranking (2018).The Institute is also ISO 9001:2008 certified and the process for obtaining ISO 9001:2015 is in progress. The primary goal of the Institute is to provide R&D support towards generation and dissemination of knowledge for development of national milch herd, milk production enhancement, greater productivity of the dairy industry and upliftment of the dairy profession, leading to socio-economic and environmental benefits to the nation as well as contribution towards manpower development programme. This is a unique campus, which alongside Deemed University and residential buildings, has various well equipped research laboratories as well as green spaces with perennial plants and gardens. Well equipped sports facilities and attractive leisure time opportunities are offered to the students and employees of the Institute.

Southern Campus, Bengaluru

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

Eastern Campus, Kalyani

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

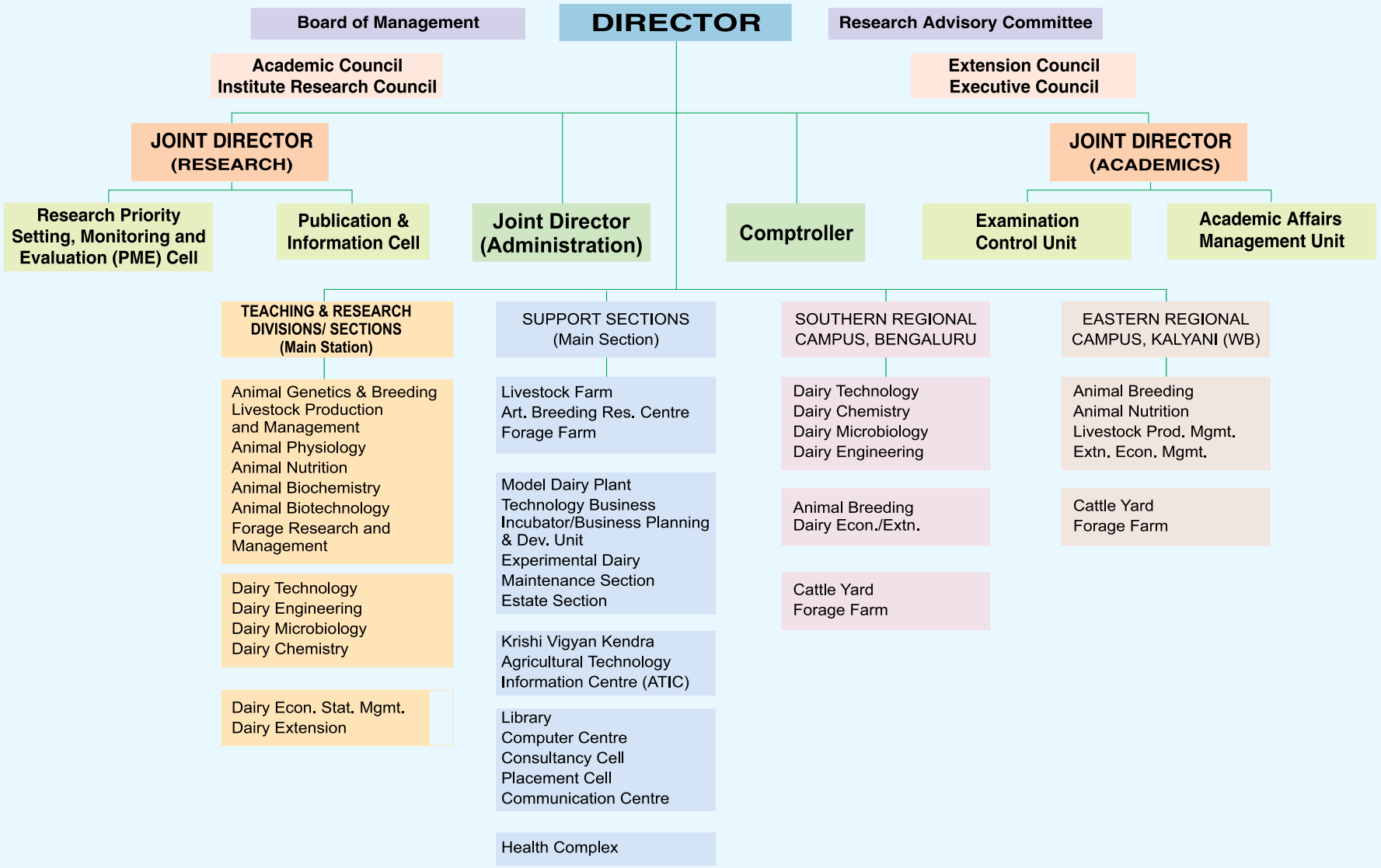
Krishi and Dairy Vikas Kendra, Piprakothi - Motihari

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

Model Dairy Centre, Lalukheri - Muzzafarnagar

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

Organizational Structure of NDRI



ORGANISATIONAL SETUP

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

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

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

BOARD OF MANAGEMENT

Chairman : Director, NDRI Karnal

Member Secretary : Joint Director (Admn. & Registrar)

Members

Joint Director (Research), NDRI

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

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

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NEW INITIATIVES IN RESEARCH, TEACHING AND EXTENSION

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

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

RESEARCH ACHIEVEMENTS

BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY

Identification of Casein Genes Variants and their Association with Milk Production Traits in Karan Fries Cattle

Casein variants (α-s1CN, α-s2 CN, β –CN) were identified in 129 Karan Fries cows. PCR-RFLP analysis of α-s1, α-s2 and β-CN genes was performed using *Tsp*451, *Mbo*II and *Dde*I restriction enzymes, respectively. For gene α-s1CN, two genotypes AA and AG were found with the allele frequency of A and G as 0.87 and 0.13, respectively. For gene α-s2 CN, genotypes CC, CT and TT were observed with C and T allelic frequency being 0.79 and 0.21, respectively. For gene β-CN, all the three genotypes viz. CC, CA and AA were observed with C (A2) and A (A1) allelic frequency being 0.63 and 0.34, respectively. Significant association was observed between various genotypes of αS1-CN, αS2-CN and β-CN genes with first lactation milk production traits viz. 305 day Milk Yield, Test Day Milk Yield, Test Day Fat Yield and Test Day Protein Yield. Animals with AG genotype of α-s1CN showed better performance than AA genotype in all the Test Day traits. In α-s2CN, performance of animals with CC and CT genotype was at par with each other, followed by TT genotype. The β-CN genotypes CC>CA>AA showed significant association in a linear trend with all the milk production traits in all the test days with a descending manner. The AG genotype of α-s1CN, CC/CT genotype of α-s2CN and CC genotype of β-CN may be used as an aid to selection for better milk production performance of Karan Fries animals.

Genetic Polymorphism in Candidate Genes and their Association with Udder Type Traits, Clinical Mastitis and Milk Production in Sahiwal and Karan Fries Cattle

Eighty seven Sahiwal and 166 Karan Fries cows were analyzed to explore the genetic polymorphism in GC, NPFFR2, PRLR, VDR, PTPRR and IL22 genes and their association with 14 udder type traits and 11 visual traits, milk production and incidence of clinical mastitis. Parity and stage of lactation had significant (P<0.05) effect on FUA (Fore udder attachment), RUW (Rear udder width), UD (Udder depth), UW (Udder width) and TD (Teat diameter) while stage of lactation had significant (p<0.05, P<0.01) effect on TC (Teat circumference), DFR (Distance between fore and rear teats), DLR (Distance between left and right teats), SDR (Shortest distance from front teat end to floor) whereas season had significant effect on TC in Sahiwal. In Karan Fries also parity had significant (p<0.01) effect on FUA, RUH ,UL, UW , TC , FTL, RTL and TD where as stage of lactation had significant effect on DFR and DLR. Pearson correlation between 305 MY and RUH, RUW, CL, FTL, RTL were significant (p<0.05) and positive in Sahiwal. In Karan Fries, correlation of 305MY was highly significant (p<0.01) and positive with RUH, UL, UC and CL, whereas analysis resulted in significant (p<0.01) and negative correlation with RUW and UD. Logistic regression revealed significant effect (p<0.05) of parity on mastitis in both the breeds, whereas level of production had significant (p<0.05) effect on clinical mastitis in Sahiwal. Point bi-serial correlation of clinical mastitis with other continuous traits was significant (p<0.05) with 305MY and TMY in both the breeds, where as negative and significant (p<0.05) correlation with FUA and CL in Sahiwal and UD in Karan Fries has been observed. The DNA sequencing of amplicons, using eight primer sets, revealed six and four polymorphic SNPs in Karan Fries and Sahiwal cows, respectively. Karan Fries animals with TT genotype at T88711829C locus of GC gene and GG genotype at G89059253A locus of NPFFR2 gene were highly susceptible to mastitis. The T88711829C SNP had significant association with milk yield and most of the udder type traits in both the breeds. The CG genotype of C39073730G SNP locus and GG genotype of A39136310G locus of PRLR gene were highly significant (p<0.001) for milk production and udder type traits in Karan Fries and Sahiwal cows.

In Karan Fries cattle, genotype GG at SNP locus rs454303072 of VDR gene, genotype AA at SNP locus rs383429860 and genotype AA at SNP locus rs135884509 of IL22 gene were less susceptible to mastitis and were associated with udder type traits. Genotype AA at SNP locus rs382671389 of PTPRR gene was associated with udder type traits. Genotype TT at SNP locus rs136785910 of IL22 gene had significant association with type traits and milk production. Genotype CC at SNP locus rs435289107 of PTPRR gene was associated with healthy udder and type traits. In Sahiwal cattle, the genotype AA at SNP locus rs454303072 (VDR gene), rs135884509 (IL22 gene) and rs382671389 (PTPRR

gene) was less susceptible to mastitis and had a significant association with major type traits. The genotype TT at SNP rs435289107 (PTPRR gene) was observed to have lower values of udder type traits (smaller udder and teat), 305Day milk yield and monthly milk yield. The genotypes AA and AG at SNP rs383429860 (IL22 gene) were less susceptible to mastitis and have positive effects on udder type traits.

Identification and Annotation of Genome-Wide SNPs and SSRs in Sahiwal cattle

The genomic DNA of 10 Sahiwal animals were sequenced using a reduced representation (ddRADseq) approach and raw sequence reads were obtained to identify and annotate the genome wide SNPs and SSRs in Sahiwal cattle and to compare the efficacy of the ddRAD approach with bovine SNP chip and whole genome sequencing. The coverage of the sequenced regions was found to be 3.27% of the whole genome. Genome-wide novel SNPs were identified in Sahiwal cattle (450431 and 25821 SNPs) with reference to *Bos taurus* and *Bos indicus* genomes, respectively. Total 22,762 and 42,314 SNPs were mapped to QTLs associated with production and reproduction traits respectively. Less than 1% of SNPs identified in Sahiwal cows were mapped to the existing bovine SNP chips, indicating scope for inclusion of indigenous SNPs in the existing SNP chips for its efficient use in zebu cattle. The reduced representation approach was found to have higher efficiency for simultaneous discovery and genotyping of SNPs.

MicroRNA-145 Inhibitor Treatment of Cloned Buffalo Embryos Improves their Developmental Competence and Quality

The quality of cloned embryos is perhaps the most important factor which determines the live birth rate obtained with these embryos. In order to use treatment with miRNAs for improving cloning efficiency, expression level of 13 miRNAs was compared between cloned and IVF blastocysts. The expression level of miR-22, miR-145, miR-374a and miR-30c was higher, that of miR-29b, miR-101, miR-302b, miR-34a, miR-21 and miR-25 was lower whereas, that of miR-200b, miR-26a and miR-128, was similar in cloned and IVF embryos. Based on this, miR-145, which is involved in regulating pluripotency, was selected for treatment of cloned embryos. miR-145 expression was lowest at the 2-cell stage, increased through the 4-cell stage and was highest at the 8-cell or morula stage in a pattern which was similar in cloned and IVF embryos. Its expression was lower in cloned embryos than in IVF counterparts at all the stages examined. Treatment of reconstructed embryos with miR-145 inhibitor was found to increase the blastocyst rate and improve the embryo quality as indicated by lower apoptotic index, higher total cell number and increased inner cell mass:trophectoderm cell number ratio. It also increased the global level of H3K18ac and expression level of *KLF4*, *OCT4* and *SOX2* in blastocysts. Treatment with miR-145 mimic elicited opposite effects. Treatment with miR-145 inhibitor can be used for improving the blastocyst rate and quality of cloned embryos.

Treatment of Cloned Embryos with miRNA-21 or miRNA 29b Mimic Improves their Quality

When reconstructed buffalo embryos were treated with miRNA-21 (miR-21) mimic for 1h after 1h of electrofusion, there was an improvement in embryo quality as indicated by higher total cell number (TCN), lower apoptotic index and improved inner cell mass (ICM):trophectoderm (TE) cell number ratio of blastocysts compared to controls, to values similar to those observed in IVF blastocysts although this treatment did not affect the blastocyst rate. miR-21 mimic treatment increased the expression of several apoptosis-, pluripotency- and development-related genes in blastocysts compared to untreated controls. Treatment of reconstructed embryos with miR-29b mimic had similar beneficial effects including higher TCN, lower levels of apoptosis, reduced DNA methylation and improved ICM:TE cell number ratio of blastocysts compared to controls without any effect on the blastocyst rate. miR-29b mimic treatment decreased the expression level of epigenetic-related genes *DNMT3A* and *DNMT3B*, but not *DNMT1*, and increased that of many pluripotency- and development-related genes in blastocysts than in untreated controls. These results suggest that treatment of cloned embryos with miR-21 mimic or miR-29b mimic can be used for improving the blastocyst quality and reducing the level of apoptosis.

Validation of Pregnancy-associated miRNAs in spent Media of Cultured Trophectoderm Cells

There is a crosstalk between the embryo and the mother through several signature molecules, including miRNAs, during establishment of pregnancy. To prove the hypothesis that miRNAs, secreted by trophectoderm cells, are essential for remodeling of endometrial cells, trophectoderm (TE) cells were produced from hatched buffalo blastocysts. Pregnancy-associated miRNAs were quantified in the spent medium collected at different days of culture. Out of several miRNAs, two miRNAs namely miR1246 and miR-let-7b were found to be present in high abundance on 21 days in the spent medium of cultured TE cells. These miRNAs may have an important role in remodeling of endometrium for implantation of embryos. To explore the biological role of miR 1246 in establishment of pregnancy by endometrial remodeling, the cultured endometrial epithelial cells (EECs) were transfected with miR-1246 mimic. This resulted in a sharp decrease in mucin-1 (Muc1) expression in EEC, which favors the attachment of the blastocyst to the endometrium. The results indicate the importance of miR1246 in endometrium modulation

as crucial indicator of preparedness of EECs towards initiation of implantation. These results reinforce the proof of concept that miR1246 secreted from TE cells could be a probable marker for pregnancy establishment.

More than 12000 Proteins Profiled in Buffalo Mammary Epithelial Cells; 6 Novel Proteins found to be Involved in Lactogenesis.

Mammary gland development is accompanied by rapid proliferation of the mammary epithelial cells (MECs). To gain insight into the proteomic changes occurring during proliferation of MECs, deep proteome profile of buffalo MECs (BuMECs) was explored using mass spectrometry (MS). MS analysis identified 8330, 5970, 5288 and 4818 non-redundant proteins in the fractions SCF I, II, III and IV, respectively. To evaluate the secretory proteins in these cells, gel-based proteome approach was used which revealed a total of 792 non-redundant proteins. Altogether, combined analysis of all the five fractions including four sub-cellular fractions and secretome resulted in the identification of 12,609 non-redundant proteins. A total of 325 molecular pathways were identified after extensive analysis. The most enriched pathways associated with these proteins were metabolic, PI3-AKT, MAPK, mTOR, insulin and oxytocin signalling. This is the highest number of proteins which have been reported so far in MEC. These results will help understand the molecular events that take place during the developing of mammary gland in buffalo.

Evaluation of the Antimicrobial Properties of Peptides Derived from Cow Urine

Cow urine is believed to possess many beneficial properties for application in agriculture and human health. Several constituents of urine such as proteins, peptides, amino acids, hormones, metabolites etc. may contribute to its bioactive properties. Urinary peptides were investigated to identify the active principles behind the antimicrobial activity of urine. Antibacterial Susceptibility Test (AST) against *S. aureus* revealed that the peptide fraction possessed significant antimicrobial action. Total urinary urinary peptides were isolated from pooled urine samples of 10 Sahiwal cows. Approximately 6,147 peptide sequence could be identified by nLC-MS/MS analysis. Further investigations on these peptides will help us to identify those peptides which possess antimicrobial activity.

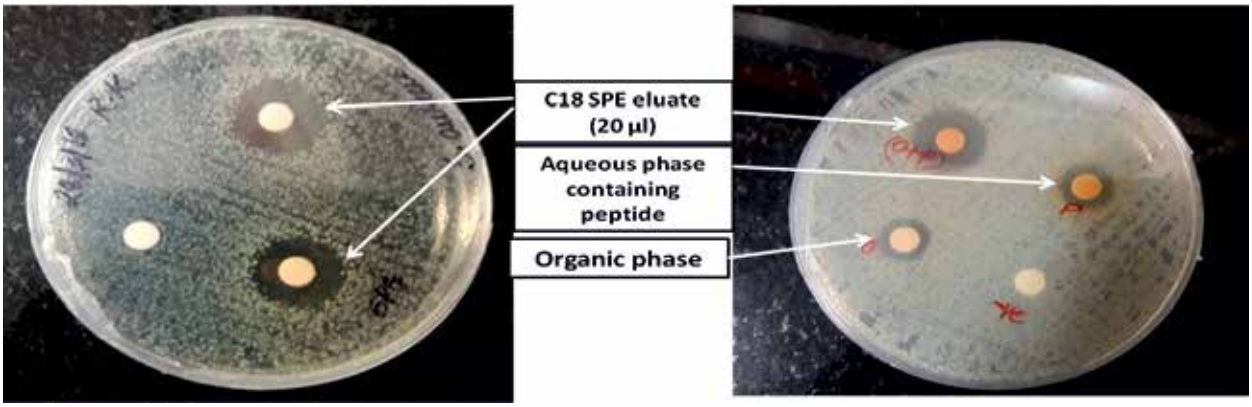
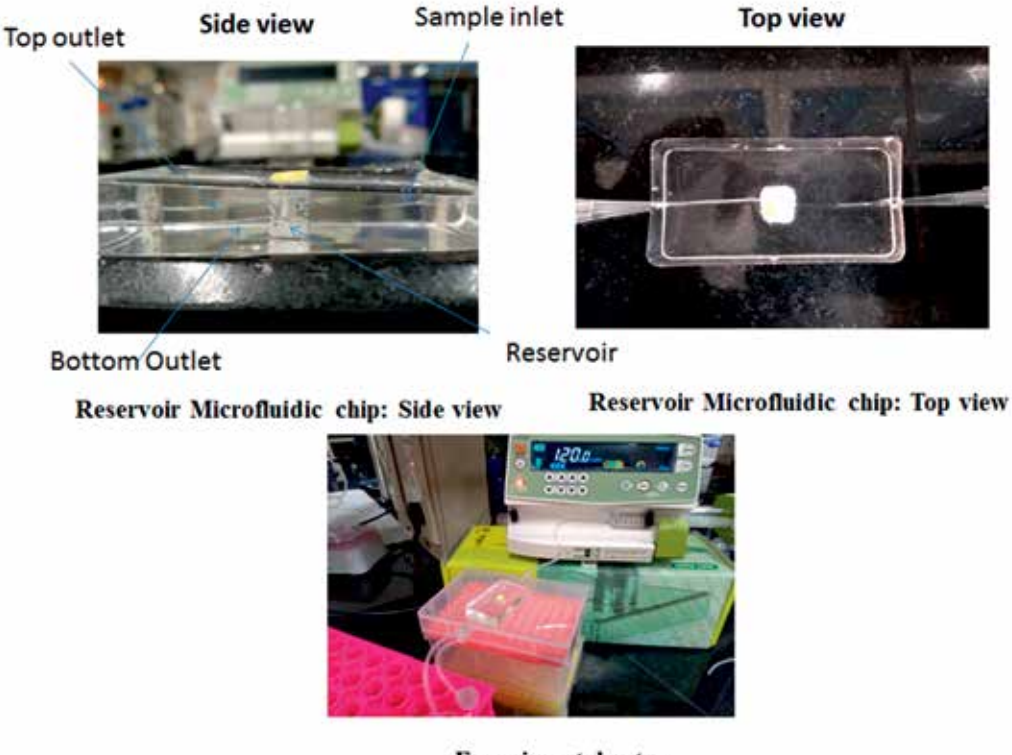


Fig. 1: Antibacterial sensitivity test on Staphylococcus aureus using urinary peptide extract. Zone of inhibition is observed around the disk coated with peptide while disk carrying carrier of the peptide doesn't show any such effects.

An Innovative Microfluidic Device Developed for Partial Enrichment of Live and Motile Spermatozoa

Removal of dead and non-motile spermatozoa from semen before artificial insemination (AI) could help improve pregnancy rates. The conventional methods suffer from low efficiency and cause mechanical damage to the spermatozoa. A method was developed to separate live and dead sperm cells by using an innovative microfluidic device for improving the quality of semen before AI. The device comprises an inlet, a separating reservoir and two outlets. This method involves the delivery of micro volumes of semen into a separating reservoir through an inlet micro channel. The live sperm cells, which are motile and can swim up in the separating reservoir, pass through the top outlet in the fluid flow direction. The dead cells which cannot swim up in the reservoir settle down and pass through the bottom outlet in the flow direction. The samples collected from top outlet, enriched with live and motile cells, can be used for AI. The quality characteristics of semen sample collected form top out let were greater than those of control and bottom outlet samples. More than 10% enrichment of live cells and more than 15% enrichment of motile cells could be achieved from cattle semen samples. This device is portable, simple and inexpensive, and can be helpful to dairy farmers for quality semen sample preparation with minimal training.



Experimental setup

Genetic Variation in kappa casein (CSN3 exon 4 region) of Indian Goats

Milk from minor dairy species such as goat and sheep helps in supplementing the nutritional requirement of the rural people. In addition, it offers several advantages such as easy digestibility, hypoallergenic properties, high content of vitamins and trace elements etc. In order to explore the variability in Indian goat milk, a total of 192 unrelated goat blood samples from seven Indian goat breeds were used to study the kappa casein gene variation. A 437-bp fragment of exon 4 in the goat CSN3 gene containing amino acid residues 23–145 was screened for possible sequence variations. The PCR-amplified DNA was subjected to single strand confirmation polymorphism (SSCP) analysis. Different SSCP patterns revealed 12 new kappa casein variant types. At the protein level a total of 12 variants were found, 8 of which are novel. All the novel CSN3 variants were named according to the newly proposed nomenclature. This study demonstrated that Indian goat and sheep breeds possess new genetic variants of casein protein and many of which remain unexplored.

Tissue-dependent Alterations in Mitochondrial Activities in Buffalo

Mitochondria play a central role in the production of ATP through the oxidative phosphorylation reactions. In the present study, we investigated, whether any tissue-specific difference exists in mitochondrial OXPHOS activity and enzymatic activity of the mitochondrial marker enzyme, citrate synthase (CS) in isolated mitochondria from six different tissues (liver, kidney, heart, muscle, ovary, and brain) of adult buffalo. Liver, kidney, heart, muscle, ovary, and brain of same slaughtered buffaloes (n = 4) were collected according to strictly defined sample collection protocols from the slaughterhouse. Mitochondria were isolated and measured total mitochondrial protein concentrations using Bradford assay in six different tissues using bovine serum albumin as standard. The mitochondria were made up to a concentration of 5-50 mg of protein per ml of assay buffer for measuring of individual OXPHOS complexes activity and CS activity. Functional activity of individual OXPHOS complexes (I, II, IV and V), and enzymatic activity of CS were measured spectrophotometrically in isolated mitochondria. The investigated tissues showed striking differences in OXPHOS activities and citrate synthase specific activities. The functional activity of individual OXPHOS complex I and IV were significantly higher in liver as compared to muscle, and brain. Tissue dependent correlation was not observed for functional activities of OXPHOS complex II and V. The citrate synthase specific activities vary differently among the compared tissues, and ovary values were significantly higher than that of the rest of the tissues. The finding suggests that there are tissue-specific patterns of variation in mitochondrial activity between different types of tissues from buffalo.

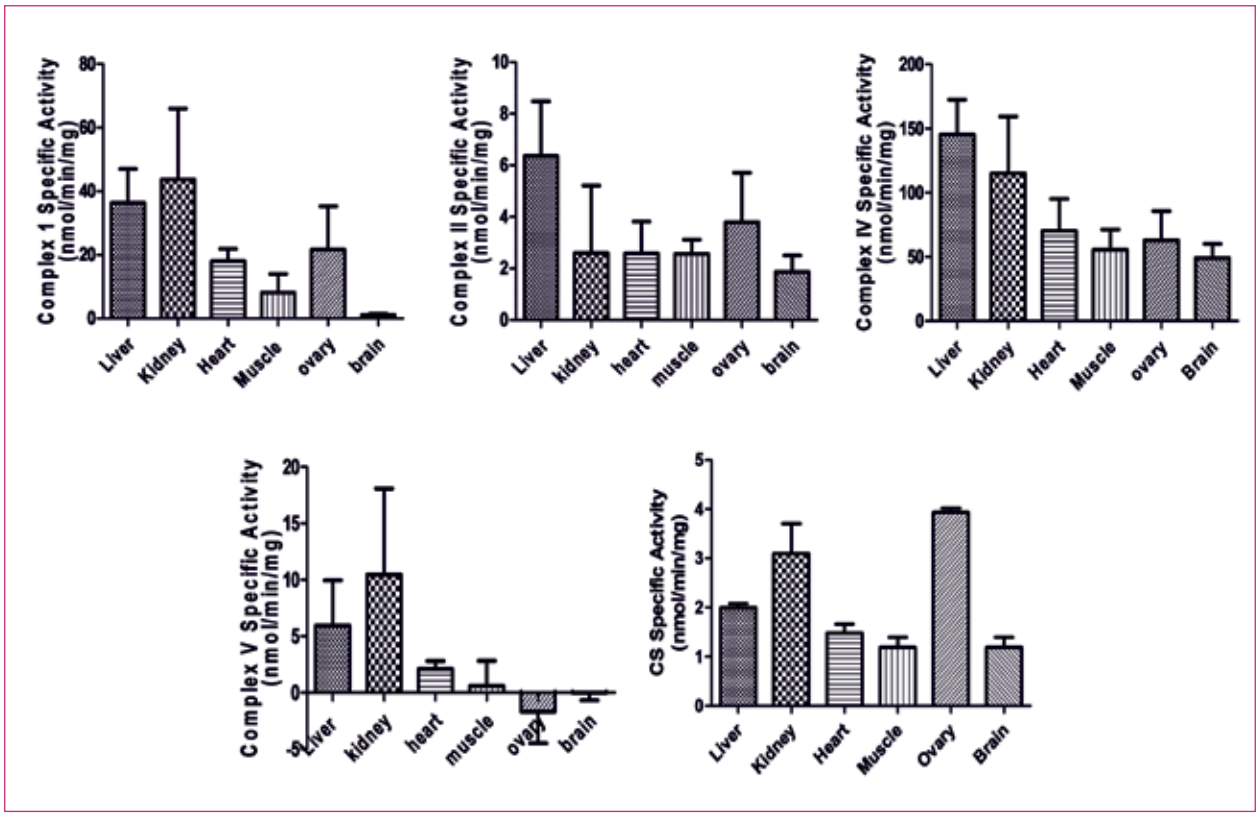
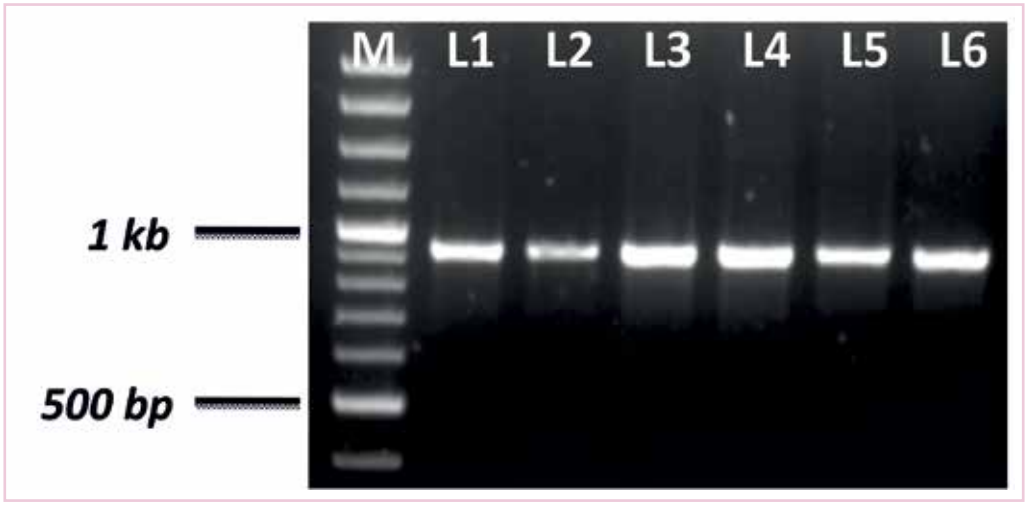


Fig: Mitochondrial OXPHOS activities and citrate synthase (CS) specific activity measurements in liver, kidney, heart, muscle, ovary, and brain from buffalo. The data are presented as the mean ± SEM (n = 4).

Mitochondrial DNA (mtDNA) Isolation and PCR Amplification of mtDNA D-loop Region from Buffalo Ovarian Tissues

One thousand and sixty eight ovaries from abattoir buffaloes were collected for mtDNA isolation. The collected ovaries were transported to the laboratory in saline solution within 4 h. The samples were collected without the knowledge of the animal's breed. The collected ovaries were rinsed in sterile phosphate buffered saline before removal of the tissue slices from the individual ovary. Ovaries with prominent follicles and corpora lutea were discarded. Tissue slices from the individual ovary of each animal were transferred to DNA/RNA shield (Zymo, USA), and stored at -20 °C until mtDNA extraction was performed. Mitochondrial DNA was extracted directly from tissue slices using mitochondrial DNA purification kit (Biovision, USA), according to the manufacturer's protocol. Quality of the mtDNA was checked at 260/280 ration by nanodrop, was 1.7 to 1.99. Mitochondrial DNA from each ovarian tissue was used for PCR amplification of the mtDNA D-loop region using specific primers, following the standard protocol. The amplification of mtDNA D-loop region was confirmed by running the PCR product in agarose gel (1.8 %) with 100 bp ladder, and visualized under UV light. Amplified PCR product size was 900 bp length. The amplicon was purified for sequencing using the Nucleospin Gel and PCR cleanup kit (Macherey Nagel, Germany), according to the manufacturer's instruction.



Recombinant Cysteine Synthase (CS) Protein of *Haemonchus Contortus* Expressed in *E. Coli*

Putative CS gene was amplified by two sets of primers (Fig.1.). One set of primers led to incorporation of the gene with a C-terminal His tag (IS-1) and the other set was designed to include an N-terminal as well as C-terminal His tag (IS-2). The gene was cloned in pET303 vector and transformed initially into the DH5alpha strain of *Eschericia coli*. Positive clones were selected using colony PCR on both the plates containing transformed colonies of IS-1 (CS) and IS-2 (CS) gene (Fig. 2). The positive clones were further confirmed by RE double digestion using enzyme XbaI and XhoI. The plasmids containing IS-1 (CS) and IS-2 (CS) were transformed into P-lys strain of *E. coli* to produce recombinant protein under rigid control as well as to reduce the degradation of protein by proteases. The miniprep induction was done on a small scale culture (3 ml) to check the presence of expressed protein. Both the clones were induced in 100 ml of culture using 1mM IPTG and the recombinant proteins purified using Ni-NTA affinity chromatography. Specifically, IS-1 CS protein (C-terminal his tag) was eluted at 250 mM imidazole concentration and the Insert-2 CS protein (NC-terminal his tag) was eluted at 500 mM imidazole concentration. The purified fragments of inserts 1 and 2 were checked on 10% SDS-PAGE gel (Fig.4). Western blot using anti-His tag antibody was used for the confirmation of the expressed proteins (Fig.5).

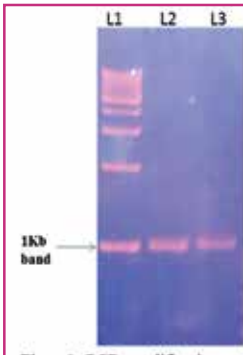


Figure1: PCR amplification of Cysteine synthase gene.
L1 : 1kb DNA Ladder.
Lane2: Insert1, C-terminal histidine tagged primer
Lane3: Insert2 with histidine tagged primer on both N and C-terminal ends

Figure2: Colony PCR confirmation of the cloned gene. First 4 wells are of insert-1 in which three clones are positive whereas remaining three positive are of insert-2.
Lane9 : 100bp DNA ladder.

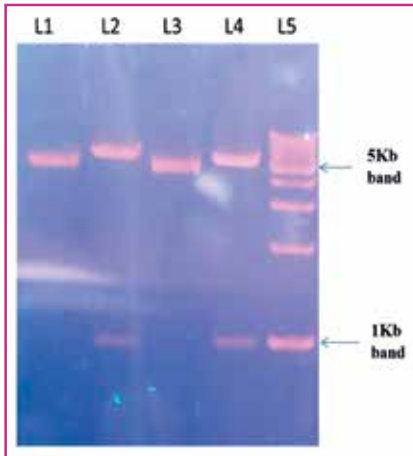


Fig.3 Confirmation of clones of Insert-1 and Insert-2 by RE digestion (XbaI and XhoI)

Development of Cattle Embryos through In Vitro Technique Using Epidermal Growth Factor as a Media Supplement

The present study was conducted to produce cattle embryos through *in vitro* culture by supplementing media with epidermal growth factor. Immature cattle oocytes were collected from slaughter house ovaries, washed 5-6 times and cultured in maturation media (TCM-199 + 10% FBS + 5 µg/ ml FSH-P + 0.33 mM sodium pyruvate + 50 µM β-Mercaptoethanol + 50µg/ml gentamicin sulfate) supplemented with epidermal growth factor with three different concentrations (5, 10 and 20 ng/ml) for 24 h. in 5% CO_2 incubator at 38.5ºC with maximum humidity. After 24 h matured oocytes were allowed for fertilization with capacitated sperms in Fert-BO media at 38.5 ºC in CO_2 incubator. After 15-18 h of sperm-oocyte co-incubation, the cumulus cells were washed off from the oocytes by gentle pipetting in washing medium. The oocytes were then washed 1-2 times with modified Charles Rosenkrans 2 amino acid (*mCR2aa*) media and cultured in 100 µl droplet supplemented with epidermal growth factor, and cultured for cleavage. After 48 h cleavage was checked and further co-cultured with oviductal cells for development. In the present study the cleavage rate and morula formation rate were significantly higher in the treatment groups as compared to control group. The mean percentage of cleavage rate was 41.63 ± 1.92 in control group. The highest mean percentage of cleavage rate was 55.13 ± 1.45 in 10 ng/ml treatment groups. From the present study it is concluded that the epidermal growth factor may have induced the cleavage after fertilization.

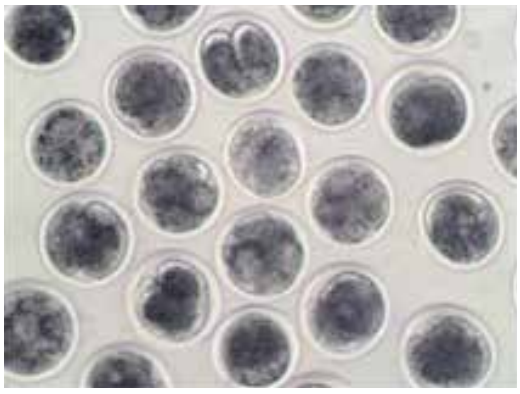


Fig. Cattle embryos produced in vitro

GENETIC IMPROVEMENT OF DAIRY ANIMALS

Indigenous Cattle Improvement Programme

Sahiwal Cattle

The herd strength of Sahiwal at the institute was 330 including 214 breedable females. A total of 35 growing males and breeding bulls were available at the germplasm unit of the institute. During the year (2018), out of total 106 normal calving, 51 male and 55 female calves were born.

The average AFC, FLMY, TLMY, PY, LL, DP, CI and SP have been recorded as 1326.94± 20.63 days, 1720.57±140.04 kg, 1810.39± 84.75 kg, 11.86±0.33 kg, 267.27±6.83 days, 129.75± 8.87 days, 404.15±6.85 days and 121.71±7.14 days, respectively. In Sahiwal herd, wet average of 6.32 kg and herd average of 4.29 kg has been recorded.

Initial selection of Sahiwal young males for future breeding was done on the basis of EPD, dam's best 305 days lactation yield, breed characteristics and physical conformity. With high intensity of selection, a total of 10 out of 42 males were selected having EPD percent superiority of 4.84% and average of dam's best lactation yield as 3158.83 kg which is 1,160 kg higher than the herd average.

A total of 48 out of 179 Sahiwal females were identified as elite cows with the selection criteria of either 305FLY ≥2500 kg or Best 305-LY ≥3000 kg. The average of Best 305LY, average LY and EPA were 3223 kg, 2725 kg and 2445 kg against herd average of 1999 kg and average EPA of 2083 kg.

During the period (January-December, 2018), the Sahiwal germplasm unit have produced 7,680 doses of frozen semen from six bulls of Set-III. Semen doses were supplied to DRU units at GADVASU, Ludhiana, GBPUA&T, Pantnagar and LUVAS, Hisar for the purpose of Artificial Insemination at these centers. During the period, 251 (Set-II) and 4385 (Set-III) semen doses of high genetic merit bulls were supplied to farmers/ developmental agencies through sale in addition to routine supply of semen in the institute/ extension activities.

Gir Cattle

Present herd strength of Gir cows is 116. Based on growth, production and reproduction records of Gir cattle, Birth Weight (kg), TLMY (kg), 305DMY (kg), LL (D), CI (D), SP (D), Fat (%), Protein (%), SNF (%) and Best 305DMY were recorded as 21.84±0.47, 1511.31±92.36, 1471.49±84.02, 275.35±0.24,122.29±7.16, 146.42± 10.55, 4.29±0.53, 3.34±0.11, 8.85±0.16 and 2546 kg, respectively. Overall Conception Rate (CR) was 39.21%. A total of six (31.58%) out of 19 males were reserved for breeding based on dam's best lactation yield, EPD, growth and libido. During the period, dam's best lactation milk yield ranged from 2091 to 2269 kg against the herd average of 1676 kg. The EPD percent superiority of reserved males ranged from 2.48 to 3.54%.

Germplasm Production and Dissemination of Gir Bulls

Nine breeding bulls have been kept under training for semen donation and/ or under regular semen collection at ABRC section of the institute. During this period, a total of 4,200 doses of frozen semen were produced from high pedigreed Gir bulls. A total of 4,261 doses of frozen semen including sale of 3,961 doses were supplied to farmers/ developmental agencies.

Tharparkar Cattle

The herd strength of Tharparkar cows is 129 at the institute herd. Based on growth, production and reproduction records of Tharparkar cows, the Birth Weight (kg), TLMY (kg), 305DMY (kg), LL (D), CI (D), SP (D), Fat (%), Protein (%), SNF (%) and Best 305DMY were recorded as 22.84 ± 0.47, 1379 (9), 1370 (9), 285 (9), 502 (8), 210 (10), 4.29 ± 0.53, 3.34 ± 0.11, 8.85 ± 0.16 and 2210 kg, respectively. The Overall Conception Rate (CR) in Tharparkar cattle is 42.74%. Seven Tharparkar cows were identified and selected as elite cows, with best lactation yield ranging from 2,038 to 2,821 kg, which was 20.70% higher than average lactation yield.

Germplasm Production and Dissemination of Tharparkar Bulls

Presently, 19 breeding bulls are being reared and maintained at ABRC, under training for semen donation and/or under regular semen collection. During this period, a total of 3,510 doses of frozen semen were produced from high pedigree/ genetic merit bulls of TP cattle. A total of 4,441 doses of frozen semen including sale of 2,531 were supplied to farmers/ developmental agencies.

Murrah Buffaloes

Network Project on Buffalo Improvement-Institute Herd

Murrah herd strength is 516 which comprises of 357 females and 159 males. A total of 52.3% Murrah buffaloes were in milk with wet and herd average of 7.4 kg and 3.9 kg, respectively. During the period, average best lactation milk yield of elite Murrah buffaloes was 3,284 kg, and dam's best 305 day milk yield of selected bulls ranged from 3,036 to 3,991 kg. Average Age at First Calving (AFC), Service Period, Dry Period and Calving Interval recorded were 44.39 months, 118.39 days, 115.62 days, 415.22 days, respectively. The overall CR of 43.71% was recorded during the period in institute buffalo herd; further the conception rates for heifers, first calvers and multipara animals were recorded as 44.62%, 50% and 40.44%, respectively. Two breeding bulls were selected for test mating under Set-XVII, and four breeding bulls were preliminary selected for 18th Test Mating.

Network Project on Buffalo improvement- Field

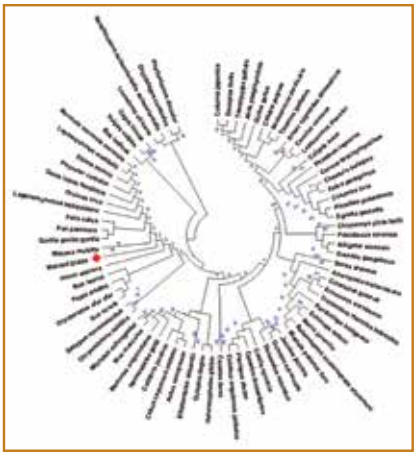
A total of 4,315 AI were performed using semen of Murrah bulls under field conditions and as a result, 47.02% conception rate was obtained. During the year, 17 breeding bulls belonging to the Set-XVII and Set-XVIII were used for AI. Across the villages, the highest conception rate (50.00%) was observed in Shekhpura and lowest (44.88%) was observed in the Kamalpur village. A total of 1,030 Murrah buffalo calves (574 males and 456 females) were born in the farmers' herds and performance data on 115 daughters from Set-XIII and Set-XIV have been recorded. The records of daughters under field condition will be used for the genetic evaluation of Murrah breeding bulls. During the period, progeny of Set-XIV and Set-XV are under 1st time calving stage. As a result, 76 calving were reported from daughters of eight bulls of Set-XIV whereas eight daughters calved, belonged to seven bulls of Set-XV. The CR ranged from 45.79 % to 47.96 % in August and December, respectively.

Success Stories

- The major success is the enhancement of adoption of AI practice in buffaloes under field conditions. Presently AI is practiced in 100% households and has played a very important role in upgrading the Murrah breed in the area under the project.
- There are many good qualities Murrah buffaloes produced under NWP using high pedigree germplasm under field conditions, yielding 21-23 liters milk per day. Under the project area, large number of farmers are benefitted with production of very good quality Murrah buffaloes as they are getting 25-35 % higher milk production and fetching very attractive prices on sale of these buffalo / buffalo heifers.

Whole Genome Sequencing and Hybrid Assembly of Malnad Gidda Cattle–a Dwarf Breed from Western Ghats of Karnataka, India

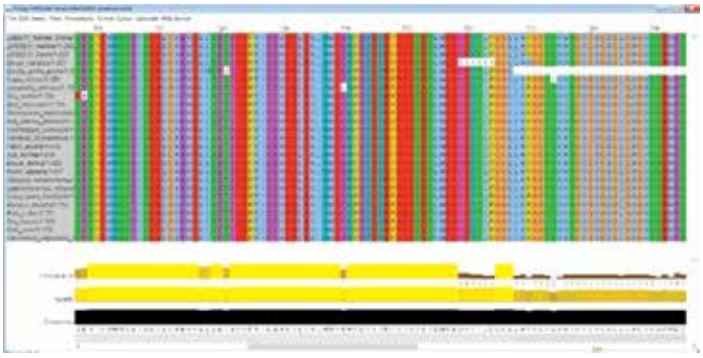
The Malnad Gidda is a dwarf cattle breed possessing an array of unique physiological adaptations but not much information is available at molecular level. Therefore, a draft map of genome of Malnad Gidda cattle was established. Genomic DNA from the blood was obtained and sequenced with paired-end and mate-pair reads on an Illumina HiSeq-2500 with long reads using PacBio platforms. MS/MS-based proteomics of semen of bulls from this breed was performed using high-resolution Orbitrap fusion mass-spectrometer. Hybrid *de novo* assembly of the raw sequencing reads were drafted using MaSuRCA tool and obtained ~2.1Gb of genome size with N50 of ~50Kb consisting of 108,453 scaffolds. Augustus software was employed to predict genes from the assembly and was integrated with proteomics data using Proteome Discoverer 2.2 for improved genome annotation. Identified 1,974 and 2,816 proteins in seminal plasma and spermatozoa, respectively. Also, with reference to *Bos taurus*, ~700 genes are found to be unique to this genome, of which 171 proteins are supported by proteomic data and



orthology evidence. Further, reference-based alignment against *Bos taurus* resulted in ~92% concordant mapping and harbour ~51,049 non-synonymous variants using BWA and GATK pipelines. Phylogenetic tree for the protein SOX 2 between Malnad Gidda and 76 mammalian species was obtained by MEGA tool by maximum likelihood methodshown in Figure. Draft map of Malnad Gidda genome would provide a valuable resource for accelerated research to identify molecular underpinnings for the unique biological traits in Malnad Gidda cattle in particular and *Bos indicus* cattle in general.

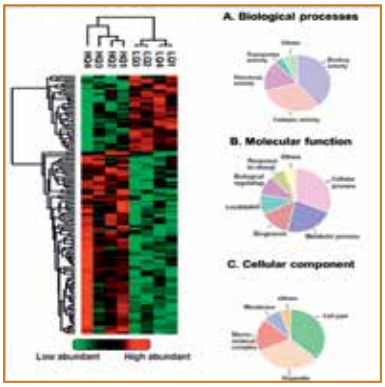
Genome Annotation and Variant Analysis of Hallikar and Deoni Breeds of Cattle (*Bos indicus*) of India Using Whole Genome Sequencing Approach

Deoni and Hallikar breeds of cattle in India are endowed with qualities of heat tolerance, disease resistance and the ability to thrive under extreme climatic stress. Genomic DNA was extracted from each breed and sequenced at the coverage of 50x paired-end and 20x mate-pairon Illumina HiSeq-2500 platform. Denovo assembly was performed to generate the draft genome sequence of these breeds using ABySS. The assembly resulted in ~2.1Gb with 4.7 and 4.5 million long scaffolds with a weighted average N50 of 4Kbp and 5Kbp for Deoni and Hallikar, respectively. Further, genome annotation revealed ~40,000 protein-coding genes. Reciprocal BLAST of these predicted proteins was carried out against the Bos taurus reference database. About 700 proteins novel to the assembled genomes were identified. Out of which, 132 proteins from Deoni and 144 proteins from Hallikar were further supported by orthologous evidence obtained from BLAST against non-redundant database. The raw Illumina reads were aligned to the reference genome using the Burrow-Wheeler Aligner and obtained 89.70% and 90.40% of concordant mapping for Deoni and Hallikar, respectively. Further, downstream variant analysis of the mapped reads was performed using Genome Analysis Toolkit (GATK). The variant annotation was carried out using snpEFF and identified 51,000 and 51,096 non-synonymous variants for Deoni and Hallikar, respectively. SOX2 Protein alignment between different species (1st three organisms are Malnad Gidda, Hallikar and Deoni) obtained by Jalview software is shown in the figure. In this analysis, candidate genes involved in the production of testosterone (HSD17B3) and semen quality (CATSPER2) harbour breed specific non-synonymous homozygous variants with higher read depth with reference to Bos taurus. The genome drafts of these indigenous breeds of Indian origin can help to understand the geneticmarkers associated with traits of interest in cattle.



High-resolution Mass Spectrometry-Based Quantitative Proteomics of High-and Low-Quality Spermatozoa in Murrah Buffaloes

Identified differentially regulated proteins in motility impaired low-quality semen in comparison to the high quality semen in Murrah buffalo bulls. Proteins extracted from buffalo spermatozoa (48 ejaculates from 8 bulls) were subjected to in-solution digestion followed my TMT labelled quantitative LC-MS/MS analysis. A total of 333868 peptide spectral matches belonging to 26337 peptide groups pertaining to 3706 protein groups were identified, where 174 proteins were identified as differentially regulated at 1.5-fold changes between the two groups. Among the differentials 47 were up-regulated and 128 were down-regulated in low-quality semen. Further analyses of these proteins showed that 20 proteins are involved in ribosomal pathway and 12 were involved protein processing in endoplasmic reticulum. These findings provide insights of the sperm proteome and depict the possibilities of developing protein-based tests to identify buffalo bulls with capacity to produce quality semen.



Transcriptome Profiling of Milk Somatic Cells in Relation to Milk Yield in Deoni Cows

Being Deoni as native dual-purpose cows, with a wide range of lactation yield of 260 to 1600 kg in a lactation length of 110 to 430 days draws attention to understand about genetic control and functional attributes of mammary gland cells in the process of mammogenesis and lactogenesis. Milk somatic cells transcriptome profiling was done in Deoni and HF crossbred cattle. Out of 25668 expressed genes, 7172 were differentially expressed genes between Deoni and HF crossbreds whereas, 722 were up regulated and 6450 were down regulated in Deoni cows. Further,

19 genes were significantly up regulated and 107 genes were significantly down regulated in Deoni cows. Besides, 414 genes were detected only in Deoni but not in HF crossbreds. Similarly, 6050 genes were detected only in HF crossbreds but not in Deoni. Gene ontology was done for differential expressed genes in Deoni which revealed majority of genes were involved in catalytic activity, immune response related pathway and body metabolic process probably indirectly governing milk synthesis and composition.

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

Data on part lactation yields (50-days, 70-days, 1st 100, 2nd 100 days, 3rd 100, 182 days), 305-days milk yield and reproductive traits (viz., calving Interval, gestation length, and conception rate) comprising all lactations of 378 Jersey crossbred cattle maintained at the Eastern Regional Station of ICAR-NDRI, Kalyani over a period of 35 years (1982-2016) were collected and used. Five lactation persistency indices of animals (P_{21}, P_{31}, P_{32}, P_4 and P_5) were calculated using ratio method. Five lactation persistency indices for each animal was calculated by using the formulae: (i) P_{21} = 2nd 100 day milk yield / 1st100 day milk yield, (ii) P_{31}= 3rd 100 day milk yield / 1st100 day milk yield, (iii) P_{32}= 3rd100 day milk yield/ 2nd100 day milk yield, (iv) P_4= 305 day milk yield/ 50 day milk yield and (v) P_5= (182 – 70) day milk yield/ 70 day milk yield. In the present study, the least squares means of P_{21}, P_{31}, P_{32}, P_4 and P_5 were 0.76±0.01, 0.59±0.01, 0.80±0.01, 4.70±0.06 and 1.30±0.02 respectively. In this study, the different persistency indices of animals were significantly influenced by random effect of sire and also by different environmental factors like season of calving, period of calving and parity. The heritability estimates for P_{21}, P_{31}, P_{32}, P_4 and P_5 using paternal half-sib method were 0.10±0.05, 0.05±0.06, 0.07±0.06, 0.17±0.08 and 0.10±0.05, respectively in Jersey crossbred cattle. The direct heritability estimates obtained from the best animal model for P_{21}, P_{31}, P_{32}, P_4 and P_5 were 0.09, 0.09, 0.02, 0.14 and 0.12, respectively. The permanent maternal environmental (c^2) effects of different lactation persistency indices accounted for 2-9% of the total phenotypic variance in this study.

Evaluation of Reproductive and Productive Performance of Crossbred Cows in relation to Heat Stress under Tropical Climate

Existence of genotype (genetic group) environment (THI) interaction in crossbred dairy cows reared at Institute herd of ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani, West Bengal was studied. A total of 12364 records of each monthly milk yield (MMY) and average daily milk yield in a month (AMY) of crossbred cows spanned over twenty two years (1994-2015) and weather parameters for the corresponding years were collected from institute records. The data were classified into 8 genetic groups according to the genetic composition (CB cattle with ≥50% Holstein inheritance, 50% Jersey and 50% Red Sindhi, 50% Jersey and 50% Tharparkar, 50% Jersey and 25% exotic inheritance from Holstein/Brownswiss and 25% indigenous inheritance, 50% Jersey and 50% indigenous inheritance form more than one breed, 25% Jersey and 25% Holstein with 50% indigenous inheritance, >50% to <75% Jersey inheritance, ≥75% Jersey inheritance). The effect of genetic group X THI was significant ($P<0.05$) on both MMY and AMY. Genetic Group bearing 50% Jersey and 50% Red Sindhi or Tharparkar were the most heat tolerant breeds. However, for reproduction traits like service period and conception rate the effect of THI and Genotype X THI was found to be not significant. Jersey crossbred cows were more heat tolerant than Holstein crossbred cows in relation to the effect of heat stress (THI) on the milk production traits. Crossbred cows with 50% Jersey inheritance performed better than higher Jersey inheritance during periods of THI above 72. The estimates of genetic parameters (heritability and repeatability) did not exhibit significant variation across the three THI zones. There was no significant difference between the ATP1A1 gene and house keeping gene (18 s rRNA) at thermal comfort and heat stress periods.

ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS

Studies on Cryo-survivability of Low Sperm Doses and *In Vitro* Sperm Function Tests in Sahiwal Bulls

Bulls selected after rigorous breeding soundness evaluation differed among themselves in conception rates (CRs) by 20% to 25%. Insemination of females with frozen-semen of low-fertilizing capacity accounts for a significant economic loss to the dairy industry. A comprehensive assessment of different aspects of sperm functions in relation to bull fertility may help us to identify a battery of tests that have the potential to predict bull fertility. AI-doses containing low sperm numbers are increasingly widespread to optimize the benefit of elite bulls, as well as to accommodate an eventual wider application of sex-sorted semen. AI-doses containing low-sperm numbers result in reduced post-thaw viability. The experiment was designed to evaluate the cryosurvivability of low sperm doses and *in vitro* sperm function tests in Sahiwal bulls. The ejaculates were collected from high and low fertile Sahiwal bulls and diluted to 80 million sperm/mL. In another experiment, the semen of low and low fertile bulls was diluted to 80, 60, 40, and 20 million sperm / mL. In another three experiments, one part of semen was kept as control and diluted to 80, 60, 40, and 20 million sperm / mL, and another part of semen was diluted to 80, 60, 40, and 20 million sperm / mL, and treated individually with anandamide, tocopherol or CLC. The semen samples were filled in French mini straws, equilibrated, cryopreserved and evaluated post-thaw for various sperm functions. In another experiment, the low sperm doses were packed in normal and modified French mini straws, and sperm functions at post-thaw were evaluated. The sperm kinetics such as VAP, VSL, VCL, TM, PM, & RM, and functional attributes such as live sperm with intact membrane & intact acrosome and non-capacitated sperm were significantly ($P<0.05$) higher, while as SM and moribund sperm, dead acrosome intact sperm, dead acrosome reacted sperm, protamine deficient sperm, capacitated (pattern B) sperm, apoptotic sperm, and necrotic sperm were significantly ($P<0.05$) lower in high fertile bulls compared to low fertile bulls. In tocoferol, anandamide or CLC treated 20, 15, 10, and 5 million sperm doses, the post-thaw motility, live sperm with intact membrane & intact acrosome, and HOS response were significantly ($P<0.05$) higher as compared to corresponding control sperm doses. The SOD, CAT, and TA were higher in tocopherol treated sperm doses as compared to control ones. In sperm doses packed in French mini straws, no significant ($P>0.05$) difference in sperm kinetic and functional attributes were observed among 20, 15, 10, and 5 million sperm doses. It is concluded that sperm function tests such as those related to membrane integrity, acrosome reaction, capacitation status and protamine deficiency have been found to be related to fertility (Adjusted $R^2 = 0.74$). The non-significant ($P>0.05$) changes in most of the sperm functions of high fertile bulls from 20 to 10 million sperm dose, revealed that sperm dose in high fertile Sahiwal bulls might be reduced up to 10 million. Adding additives such as tocopherol, anandamide and CLC significantly enhanced cryosurvival of low sperm doses.

Effect of Dilution Rate on Sperm Quality of Sahiwal Bulls

In India, the gap between production and demand of frozen semen for bovine artificial breeding is large. The best and easiest way to bridge this gap would be to dilute semen to low sperm AI doses, maintaining optimum fertility. Dilution to low sperm numbers necessitates the selection of high fertile bulls, and harvest of quality ejaculate from males, for which employment of preputial washing is recommended. However, the volume of liquid generally used for preputial washing is inadequate for proper flushing of the preputial cavity as it has higher volume, particularly in indigenous breeds of cattle. Hence the current investigation was aimed at studying the effect of preputial washing using the different volume of normal saline and *Moringa oleifera* leaf extract on the seminal profile of Sahiwal bulls, and also, the effect of low sperm numbers in AI doses on post-thaw sperm quality in high fertile Sahiwal bulls. *M. oleifera* aqueous extract was used for flushing preputial cavity on its merit of comparatively broad-spectrum antibacterial activity against organisms commonly reported in semen. The average volume of preputial cavity in

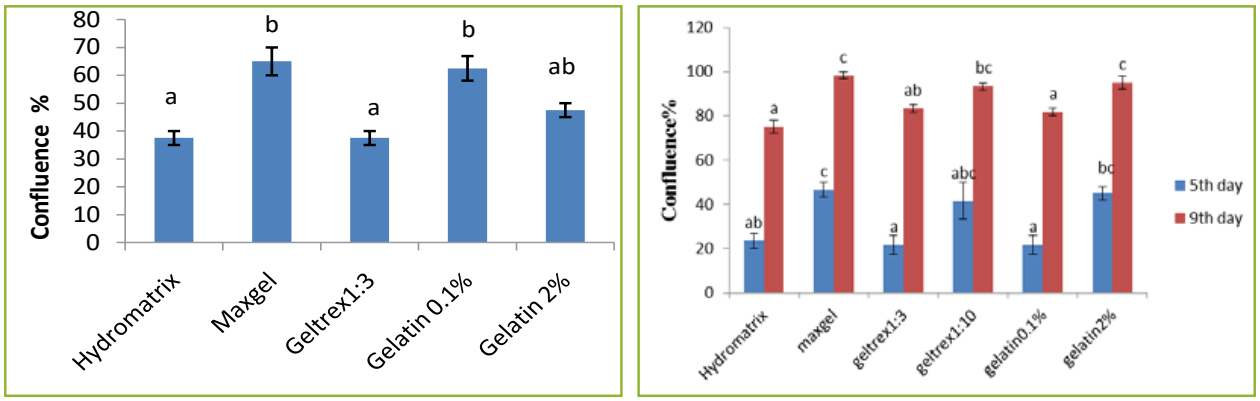
Sahiwal bulls was found to be 700mL. Further, a total of 12 Sahiwal bulls were divided into three groups. In Group I, 100mL. NS was used for preputial washing, in Group II, average volume i.e., 700 mL NS was used, while in Group III 700 mL solution of NS and *M. oleifera* leaf extract in the ratio of 10:1 was used. Average microbial load in the preputial cavity of all the 12 experimental bulls before preputial washing was found significantly ($P<0.05$) higher than all the three groups. Significant ($P<0.05$) decrease in microbial load, both in the preputial wash as well as semen, was observed in Groups II and III, as compared to Group I. However no significant ($P>0.05$) difference was observed between Groups II and III. None of the fresh seminal parameters except, individual sperm motility varied significantly ($P<0.05$) amongst the three groups. The post-thaw sperm motility and viability were significantly ($P<0.05$) higher in Groups II and III compared to Group I. Acrosome integrity and HOST positive sperm were significantly ($P<0.05$) higher in Group III compared to Group I, however, the mean values in Group II differed non-significantly ($P>0.05$) from both the other groups. Total abnormal sperm percentage in Group I was significantly ($P<0.05$) higher than Groups II and III. No significant ($P>0.05$) change was observed in lipid peroxidation, chromatin integrity and cryocapacitation status amongst the groups. In another experiment, to improve the quality of low sperm AI doses, initial diluted semen was subjected to filtration for removing dead and abnormal sperm. Post-thaw motility, live sperm, acrosome integrity and HOST positive sperm, decreased, while as moribund and dead sperm, and also cryocapacitation increased with increase in dilution, in low sperm doses of 20, 15, 10, 8, 6, 4 and 2 million sperm per 0.25mL straw. The changes were higher in magnitude at higher dilutions and low sperm concentrations. Lipid peroxidation and protamine deficient sperm showed statistically non-significant ($P>0.05$) increase with an increase in dilution. It was concluded from the study that using a higher volume of flushing liquid (700 mL NS / NS + *Moringa oleifera* extract) for preputial washing results in improvement of post-thaw sperm quality in Sahiwal bulls. Also, semen quality gets reduced in terms of *in-vitro* sperm function assays with the increase in dilution, and this effect is much more marked and higher in magnitude at dilutions beyond 8 million sperm concentration per dose, packed in 0.25mL French mini straws.

Effect of Different Extra-Cellular Matrices and Certain Modulators on Proliferation and Function of Buffalo Endometrial Stromal Cells Cultured *In Vitro*

In buffalo species, embryonic mortality is considered one of the major causes of fertility loss. In all mammalian species, the uterine endometrium is central to normal fertility. The endometrium mainly consists of stromal cells and epithelial cells (luminal and glandular). Endometrial stromal cells were cultured using different matrices to study the structural and functional characteristics and to find out the suitable matrix for further experimentation based on growth characteristics and expression of certain genes related to proliferation and receptivity. Regulation of PGE2 production and PGES expression by endometrial stromal cells using steroids and IFN tau and their combinations followed by modulation of PGE2 production and PGES expression using an ethanolic and aqueous extract of Murraya Koenigii and *Aegle marmelos* and LPS was studied. LPS as immune modulator was used alone and in combination with plant extracts to study its effect on IL-1β and TNF-α. Among different matrices Geltrex 1:10 and Maxgel was most suitable for stromal cell culture based on growth characteristics and functional properties. PGE2 production was significantly ($P<0.05$) higher in progesterone (10nM) +IFN-τ (1µg/ml) treated groups . (56.35 ± 1.9 pg/µg protein). PGES gene expression was significantly ($P<0.05$) higher in P_4+IFN-τ treated group (5.82 fold). Treatment of stromal cells with aqueous extract of *Aegle marmelosa* extract has significantly increased ($P<0.05$). TNF-α gene expression was significantly ($P<0.05$) higher in stromal cells pretreated with ethanolic and aqueous extract of *Aegle marmelos* in response to LPS stimulation (31.9 & 41.73 fold). IL-1β gene expression was significantly ($P<0.05$) higher in stromal cells pretreated with ethanolic and aqueous extract of *Aegle marmelos* in response to LPS stimulation (17.46 & 14.29 fold) in comparison to control with LPS stimulation. On the basis of structural, growth and functional characteristics, Maxgel and Geltrex 1:10 were found best suitable matrix material for the culture of buffalo endometrial stromal cells. Progesterone in combination with IFN-τ has shown a synergistic effect on PGE2 production and PGES expression by buffalo endometrial stromal cells. Addition of aqueous extract of Aegle marmelosa increased PGE2 production and PGES expression in buffalo endometrial stromal cells. Addition of aqueous and ethanolic extracts of *Aegle marmelosa* and *Murraya koenigii* significantly increased TNF-α and IL-1β by buffalo endometrial stromal cells indicated their promising effect on modulation of endometrial immunity.

Development of Structurally and Functionally Competent 2D-Endometrial Cell Culture System to Understand Uterine-Pathogen Interaction in Buffalo

The primary endometrial epithelial (EEC) and stromal cells (ESC) culture system was established separately using double enzymatic digestion method. A panel of commercially available extracellular matrices (Geltrex, Maxgel, Hydromatrix, Gelatin) were selected to find out the best matrix for growth of these cells. These matrices at different concentrations such as Geltrex (GT; 1:3-1:10), Gelatin (GL, 0.1-2%), Hydromatrix (HX 1:10) and Maxgel (MX, 1:30) showed successful growth potential for epithelial and stromal cells.



A B

Fig. Growth Characteristics of EECs on day 5 and ESCs on day 5 & 9 of culture in presence of different extracellular matrices

Further, PGE_2 production by ESCs stimulated with IFN-τ (@1µg/ml was significantly (P<0.05) higher in MX, GT and HX groups compared to GL group. Further, expression analysis of keys genes involved in its functionality viz., PGES, PCNA, SSP-1, Integrins -ITGA3, ITGB3 revealed a significant (P<0.01) up regulation of PGES, PCNA, SSP-1, ITGA3, ITGB3 (P<0.05) genes. Similarly, the growth characteristics and $PGF_{2\alpha}$ production by epithelial cells stimulated with oxytocin (OT @100 ng/ml) was significantly (P<0.05) higher in GT, HX, GL: 0.1% groups compared to other matrices. There was higher (P<0.01) expression of Cox-2, PGFS, PCNA, SSP-1, ITGB3 and ITGA3 mRNA in OT treated epithelial cells grown on GT/ GL Epithelial cells.

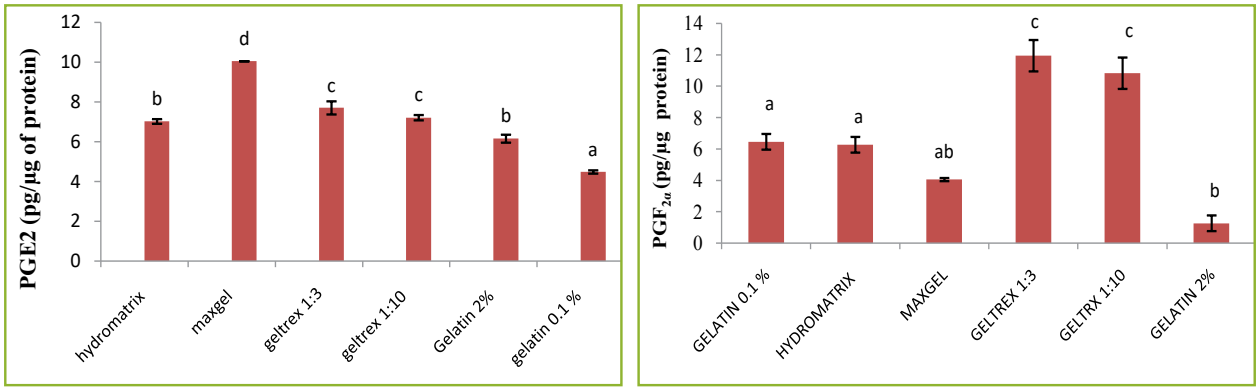
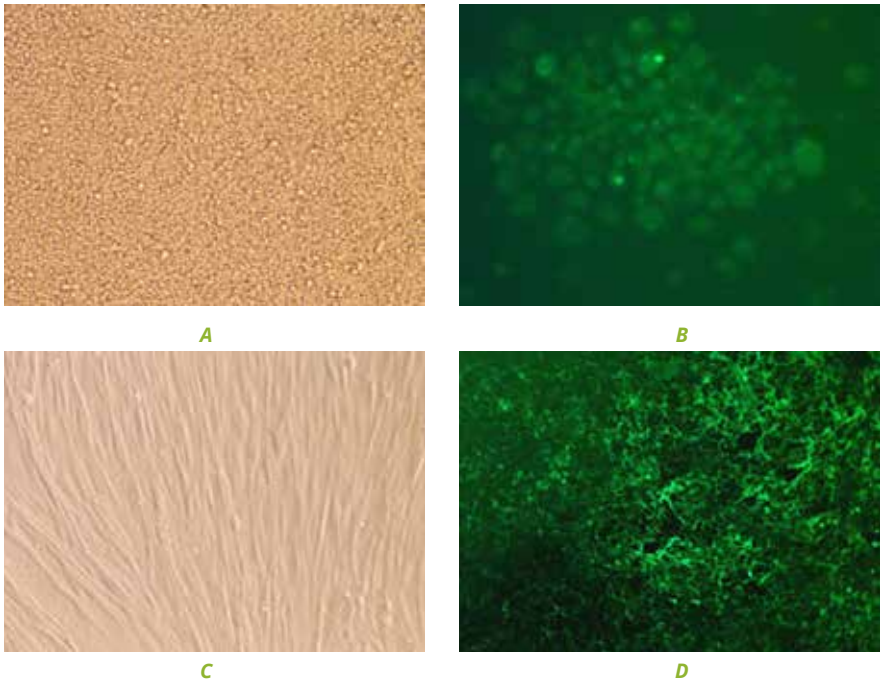


Fig. Effect of different extracellular matrices on PGE_2 and $PGF_{2\alpha}$ production by buffalo ESCs (A) and EECs (B) stimulated with IFN- τ and OT in 2D-culture system



A B

C D

Fig. Endometrial epithelial and stromal cells on confluence (A & B) stained positive with anti-cytokeratin (C & D) and anti-vimentin in 2D-culture system.

Effect of Leave Extract *Aegle Marmelos* (Bel) and *Murraya Koengii* (Curry Leaves) on Modulation of Function of Endometrial Cells in 2D-Culture

Both aqueous and alcoholic extract of plant leaves were used at a concentration after testing their cytotoxicity effect on endometrial cells. Treatment of endometrial cells with aqueous as well as alcoholic extracts of *Aegle marmelos* and *Murraya koenigii* has significantly increased ($P<0.05$) prostaglandin (PGE_2 & $PGF_{2\alpha}$) production with the concomitant increase in PGFS, PGES, TNF-α and IL-1β gene expression, indicated their promising effect on modulation of endometrial immunity.

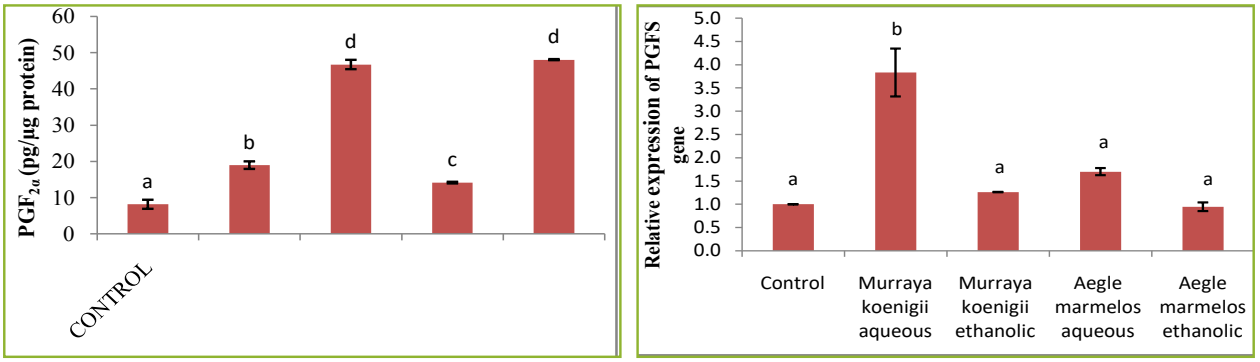


Fig.$PGF_{2\alpha}$ production and PGFS expression of endometrial epithelial cells treated with aqueous and alcoholic extract of Aegle marmelos and Murraya koenigii plant leaves in 2D-Endometrial culture

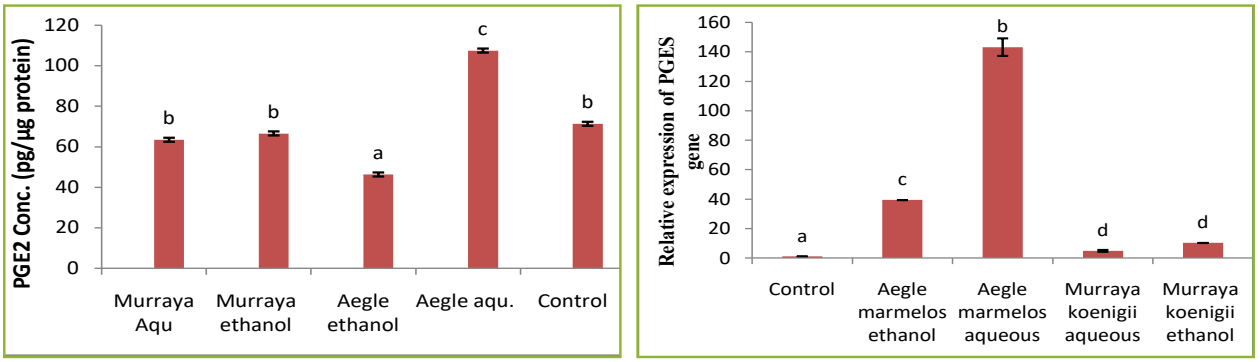


Fig.PGE_2 production and PGES expression of endometrial stromal cells treated with aqueous and alcoholic extract of Aegle marmelos and Murraya koenigii plant leaves in 2D-Endometrial culture.

Nitric oxide (NO), Malondialdehyde (MDA) in Serum and Uterine Fluid as Indicators of Uterine Health in Cross-Bred (CB) Cows

The concentration of NO and MDA was estimated during peripartum period in serum and during postpartum period in uterine fluid to understand their relationship with postpartum uterine health in crossbred (Karan Fries) cows. Study was conducted in 24 crossbred cows and divided into two groups of; control healthy cows (n=9) that did not develop uterine infection and those developed uterine infection during postpartum period (n=15). NO concentration was significantly ($P<0.05$) higher during peripartum i.e. on day -7 to +35 in serum and on day +7 to +35 in uterine fluid of CB cows that developed uterine infection compared to healthy cows without uterine infection. Similarly, MDA concentration in uterine fluid was significantly higher on day +7 to +35 in CB cows that developed uterine infection compared to healthy, control cows. Further, significant correlation for NO (0.769) and MDA (0.789) with uterine health from day +7 onwards suggest it as a promising indicator for predicting uterine health before clinical onset of uterine infection in CB cows.

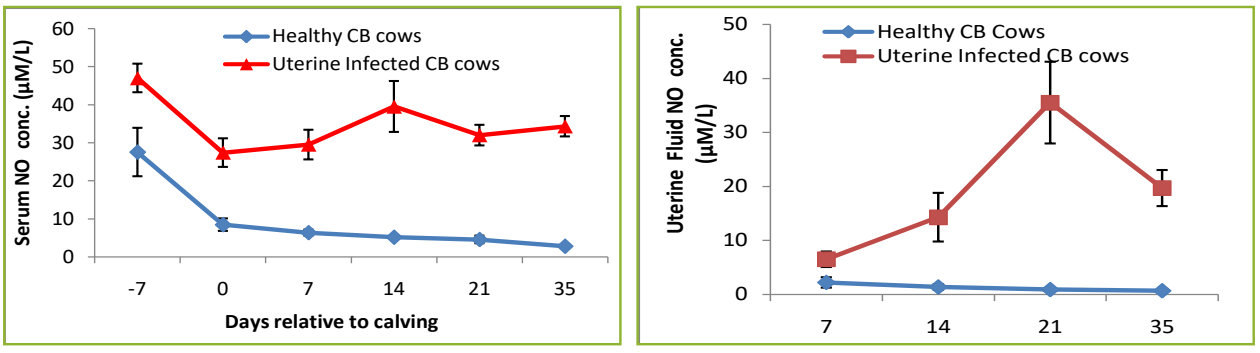


Fig. Nitric oxide conc. in serum during peripartum period and in uterine fluid during postpartum period of crossbred cows

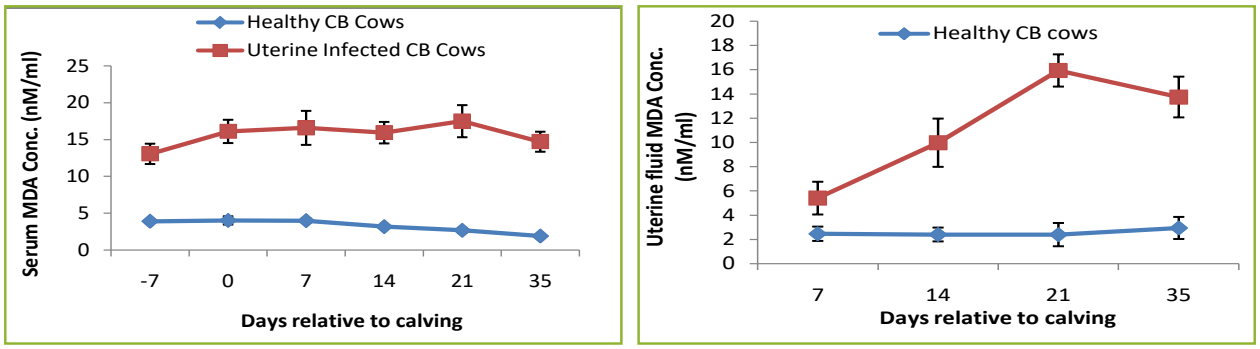
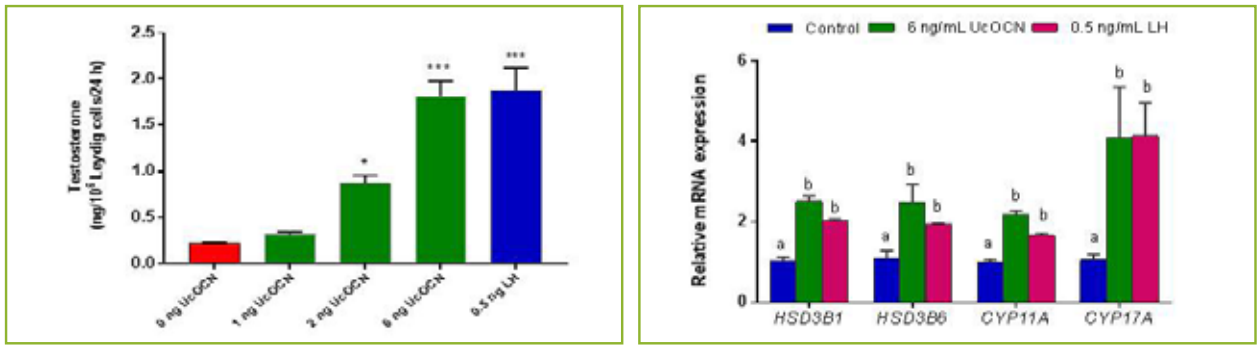


Fig. MDA conc. in serum during peripartum period and in uterine fluid during postpartum period of crossbred cows

Uncarboxylated Osteocalcin Regulates Testosterone Production

In one of the pioneering experiment the localization of the receptors for uncarboxylated osteocalcin have been identified on leydig cells of buffaloes. *In vitro* experiments revealed that an increasing amount of uncarboxylated osteocalcin resulted in a dose-dependent increase in testosterone secretion by leydig cells. Uncarboxylated osteocalcin (6 ng/mL) significantly increased the expression of 3β-HSD1, 3β-HSD6, CYP17 and CYP11a in Leydig cells leading to higher testosterone level.

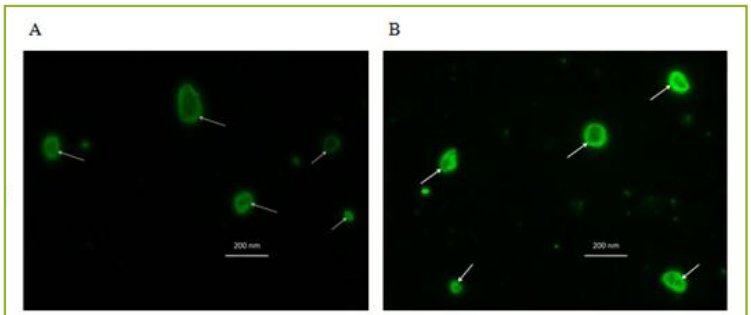


Seminal Plasma Reactive Nitrogen Species as Biomarkers of Semen Quality

Nitric oxide concentration in semen plasma was higher (P<0.01) in samples collected during hot-humid season (60.97±4.50 µM/L) as compared to winter season (37.11±3.80 µM/L). Significantly higher malonaldehyde level (P<0.01) were found in seminal plasma collected during hot humid season (1.23±0.13 µM/ml) in comparison to winter (0.89±0.09 µM/ml). It was found that ALT and AST enzyme activity in semen served as a good indicator of acrosomal damage while ALP indicated sperm cell integrity and metabolic activity of sperm. Concentration of all three enzymes was higher during hot humid season.

Seminal Plasma Prostasomes and its Effect on Spermatozoa

Prostasomes were isolated from seminal plasma of KF and Sahiwal cows to study its effect on semen quality. Caveolin-1 and CD 26 surface markers were present on the prostasomes. The prostasomes interacted with spermatozoa in semen and enhanced different sperm functional parameters like motility, ATP production, viability, mitochondrial membrane potential of spermatozoa and maintenance of acrosome integrity to improve the semen quality. Leptin concentration, matrix metalloproteinase activity in the spermatozoa also increased with prostasome incubation. Prostasomes enhanced the calcium signalling approximately 3-fold in cryopreserved semen spermatozoa and 5-fold in fresh spermatozoa.



Fluorescent micrograph of binding of **(A)** FITC –conjugated Caveolin-1 antibodies **(B)** FITC –conjugated CD 26 antibodies with the prostasomes membrane (indicated by arrows).

Oxidative Stress Markers in Semen of Murrah Bulls

Reactive nitrogen species viz. nitric oxide and nitric oxide synthase concentration in seminal plasma were significantly (P<0.01) higher in samples collected during hot humid seasons compared to winter. The respective values for NO were 20.12±1.29 and 12.60±1.35 µM/L and for NOS the values were 0.46±0.03and 0.28±0.02 ng/ml. The higher values of NO were associated with higher morphological abnormalities. Malonaldehyde concentration in seminal plasma was higher (P<0.01) during hot humid season indicating pronounced damage to plasma membrane due to oxidative stress as compared to winter. Mean concentration was 2.26±0.69 and 1.04±0.30 µM/ml respectively, during the two seasons.

Antioxidant Status of Semen

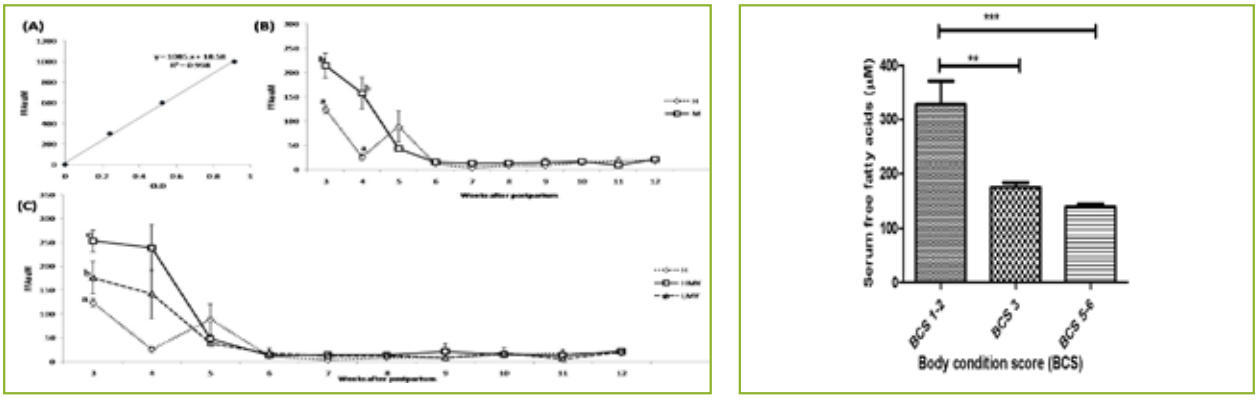
Seminal plasma *glutathione peroxidase* and superoxide dismutase (SOD) levels were significantly higher in hot humid season as compared to winter months while catalase was non-significantly higher during hot humid months (7.42±0.87 ng/ml) as compared to winter months (3.89±0.43 ng/ml). Zinc and copper were significantly higher (P<0.01) in seminal plasma collected during hot humid as compared to winter season. Total antioxidant capacity in seminal plasma was significantly (P<0.01) higher during hot humid months (619.60±42.25 µM) as compared to winter months (500.84±54.22 µM).

Plasma RNS and its Association with Sperm Functions

Exposure of buffalo cryopreserved spermatozoa to SNP decreased sperm quality in a time dependent manner. Exposure of sperms to low levels (up to 1 µM of SNP) were detrimental at 60 minutes while in case of high concentration, decline in the quality of semen began as early as 15 minutes. Detrimental effects were more pronounced in cryopreserved semen than fresh ejaculates. The incubation with L-NAME (10uM) improved sperm quality of buffalo. Sodium nitropruside (1µM) and L-NAME (10uM) proved beneficial for post-thaw sperm motility and viability up to 1 hours and that reduction of lipid peroxidative damage to sperm membranes was the mechanism for these benefits**.**

High Serum Free Fatty Acids and Low Leptin Levels as the Plausible Objective Metabolic Indicators of Negative Energy Balance in Early Lactating Buffaloes

Lactation is the critical transition period from pregnancy in female buffaloes. High energy demands and lower feed intake during this period lead to negative energy balance (NEB), which sometimes make the inefficient animals susceptible to diseases. To cope up with the energy demands, the stored fat is mobilized and the body condition appears to be compromised. Hence, a subjective Body Condition Score (BCS) has been used to understand the NEB in dairy animals, especially in the field conditions. To provide objective NEB indicators in buffaloes, we estimated a few serum biochemical (BHBA and FFAs) and endocrine (GH, IGF1, insulin and leptin) parameters in high milk yielders (HMY), low milk yielders (LMY) and heifers (H). The HMY showed significantly (P<0.05) higher serum FFA levels than LMY and H during the 3rd and the 4th weeks of postpartum. On the contrary, the HMY showed significantly (P<0.05) lower serum leptin levels than LMY during the 3rd week of postpartum. The other parameters were not significantly different between lactating buffaloes and heifers. A validation study in the field conditions also supported that the serum FFA levels were significantly (P < 0.001) higher in the postpartum buffaloes with the BCS < 3 than that of >3. These observations suggest that simultaneous higher FFA and lower leptin levels could act as direct plausible metabolic indicators of NEB in buffaloes, and they may be good candidates for the development of future NEB determination animal-side tests.



A B

Fig: Serum fatty acids in early lactating experimental buffaloes (A) and postpartum field buffaloes (B). HMY: High milk yielders (> 1500 kg in 26 weeks); LMY: Low milk yielders (< 1500kg in 26 weeks); H: Heifers; BCS: Body Condition Score. (Reference: Golla et al., J Cell Physiol. 2019 Jun; 234(6):7725-7733)

Immune Tolerance as a Major Adaptive Mechanism in the Liver during Early Postpartum Period of Buffaloes

Liver is the exclusive supplier of glucose for milk synthesis in ruminants. During early lactation, dairy animals generally undergo negative energy balance because of less feed intake and more energy demands towards the maintenance of lactation and other physiological functions. Hence, the metabolic load on the liver would be very high, especially in high yielding ruminants. In addition to glucose supply, the liver initiates lipolysis in the adipose tissue and metabolizes the products of lipolysis such as non-esterified free fatty acids (NEFA or FFA). Additionally, it is the first organ after the intestine to be exposed to the digestive materials including toxicants and microbial products. Therefore, it also needs to play a balancing role between immune tolerance and immune susceptibility by both the immune cells and hepatocytes. Further, it is the main organ for steroid metabolism. Therefore, to understand its molecular pathways, networks and adaptive mechanisms during early postpartum, the liver transcriptome was analyzed in dairy buffaloes during early postpartum. Liver biopsies were performed on three lactating buffaloes on the 15th and the 30th day of early postpartum and three heifers (controls) at the diestrous stage. Using a novel RNA isolation method, total RNA was isolated and subjected to paired-end next generation sequencing (NGS). A total of 509 genes were significantly differentially expressed in the liver among the three groups. Bioinformatics analysis including functional annotation and network analyses supported the upregulation of immune tolerance and fat accumulation, and downregulation of gluconeogenesis and estrogen metabolism on the 15th day of lactation. Taken together, the liver showed immune tolerance as a key adaptive mechanism during early lactation in buffaloes.

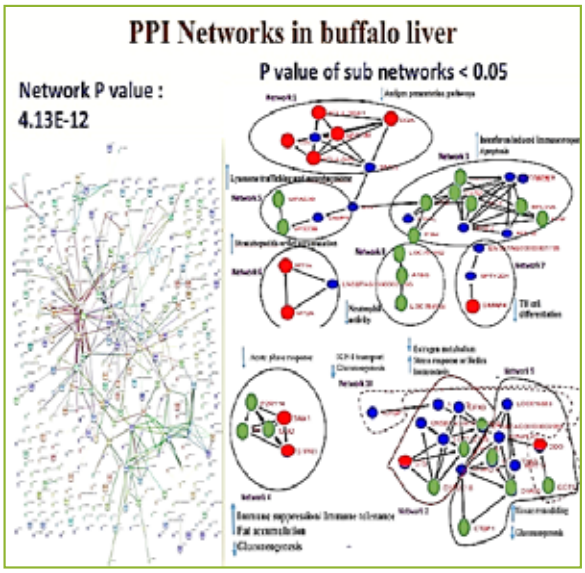


Fig: Network analysis of the differentially expressed genes in the buffalo liver during early lactation (Reference: Singh et al., 2009, Functional & Integrative Genomics 19(5): 759-773.

Role of Withaferin A (*Withania somnifera*) on Zinc Oxide Nanofertilizer Altered Innate Immune response

Nanoscience and Nanotechnology has become popular in various field including agriculture over the past decade. Zinc oxide nanoparticles (ZNPs) are being explored for applications ranging from medicine to agriculture. Indeed the interest in developing novel nano agrochemicals in the form of "nanofertilizers" has brought ZNPs to the forefront. However, investigation to evaluate their safety is mandatory. The effect of ZNPs on the immune system is poorly documented. Positively charged ZNPs possess higher inflammatory potential than negatively charged or neutral nanoparticles. Macrophages have a negatively charged sialic acid on their surface and they readily interact with cationic substances. So, a dire need was felt to characterize the ZNPs using state of the art techniques including DLS

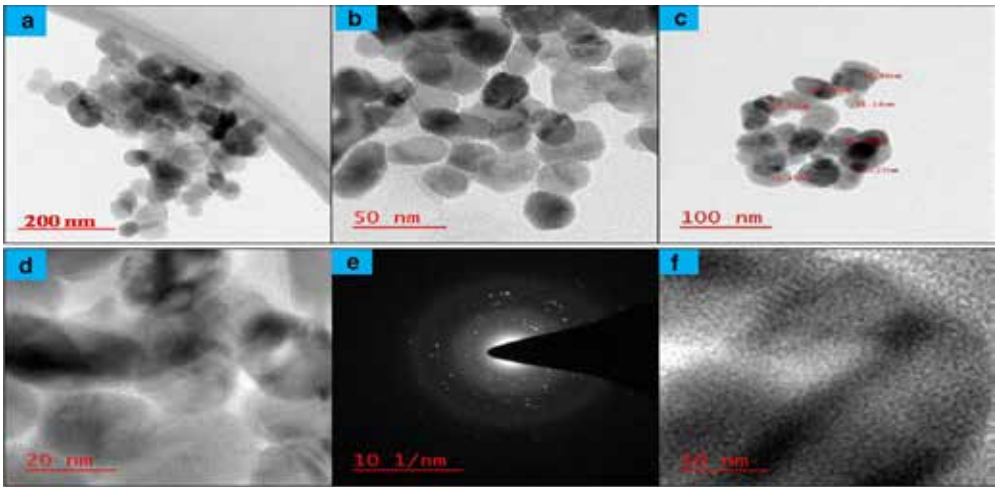


Fig. *(a) ZnO NPs crystalline structure and size shown by manufacture (b–d) TEM images and corresponding particle size distribution at different nanometer scale (nm) shown in respective images. The image (e) shows the selected area electron diffraction (SAED) pattern of the ZnO NPs at 101 nm scales and (f) shows particle size at 10 nm scale. Particles size determined by high resolution transmission electron microscope (HR-TEM) was 17.27–31.45 nm.*

and HR-TEM. Withaferin A is a steroidal lactone found in the leaves and roots of *Withania somnifera*. The biological properties of crude extracts have been largely reported but only a few are concerned with the pure compound Withaferin A. Recent reports have provided evidence of its anti-tumor, anti-inflammation, anti-oxidant and immune-modulatory activities. The goal of this work was to assess the effect of Withaferin A (*Withania somnifera*) on Zinc Oxide Nanofertilizer (ZNF) altered innate immune response of Balb/c mice in terms of macrophage viability, nitric oxide production, phagocytosis and inflammatory response genes. Mice were orally given 5 and 50 mg/kg b.w ZNFs alone or in combination with 3.3 mg/kg b.w. *Withania somnifera* (WS) extract as well as (twice a week) 2.0 mg/kg b.w Withaferin A (WA) for 28 days. There was no significant change in the body, liver and kidney weight in ZNF treated mice compared to control or when compared to the ZNF in combination with Withaferin A (*Withania somnifera*). A significant increase of 75% in spleen weight was observed in 50 mg/kg b.w. ZNF dose compared to the control. There was no significant change reported in viability of macrophages as suggested by MTT and WST assay in all groups. Nitric oxide production in ZNF50 mg/kg treated group showed a significant decrease of 37% as compared to control but increased by 41% in WS+ZNF5 and 30% in WA+ZNF5 compared to ZNF 50 mg/kg treated group. In addition, phagocytosis of yeast by macrophages was markedly reduced in the presence of 50 mg/kg ZNF dose compared to control. A significant increase (24%) in phagocytic activity of macrophages was observed in WS+ZNF50 treated mice and 27% in WA+ZNF50 group. TLR6 gene expression increase significantly fourfold in ZNF 50 mg/kg treated group while it decreases 1.5 fold in WS+ZNF5 group. A fold change of 1.38 in Arginase expression occurs in WA+ZNF50 group as compared to control and 2.09 fold change was seen in WA+ZNF50 as compared to ZNF50 mg/kg. Together, these observations suggest that Withaferin A (*Withania somnifera*) have the potential to counter balance the altered effects of ZNFs on Innate Immune response.

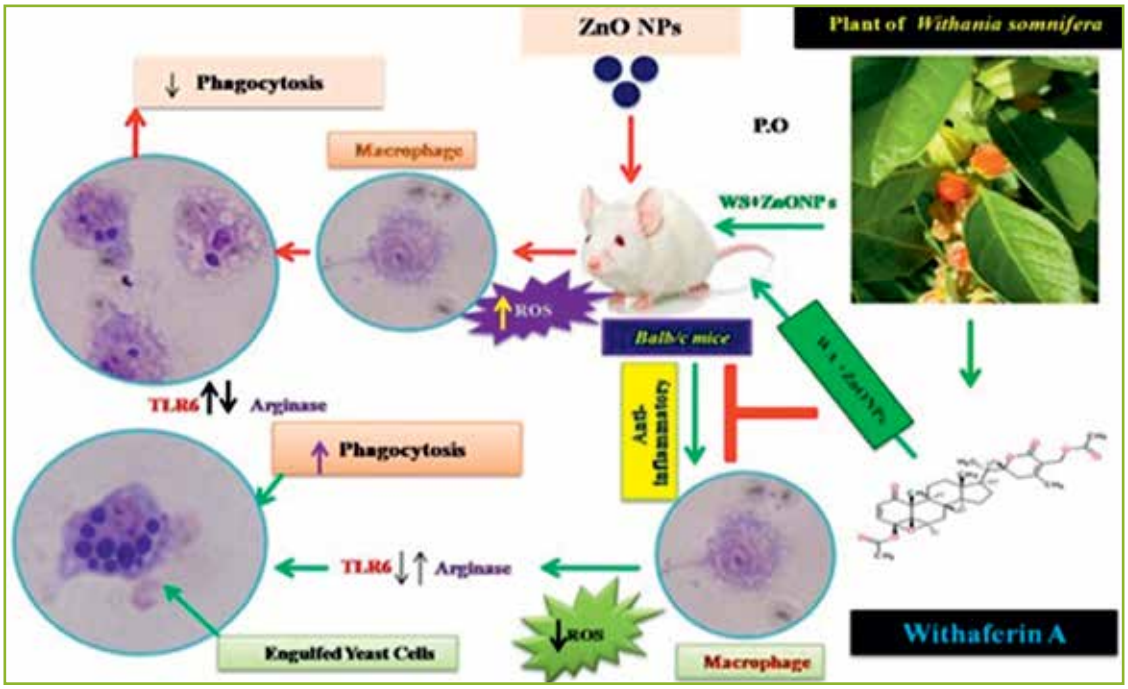


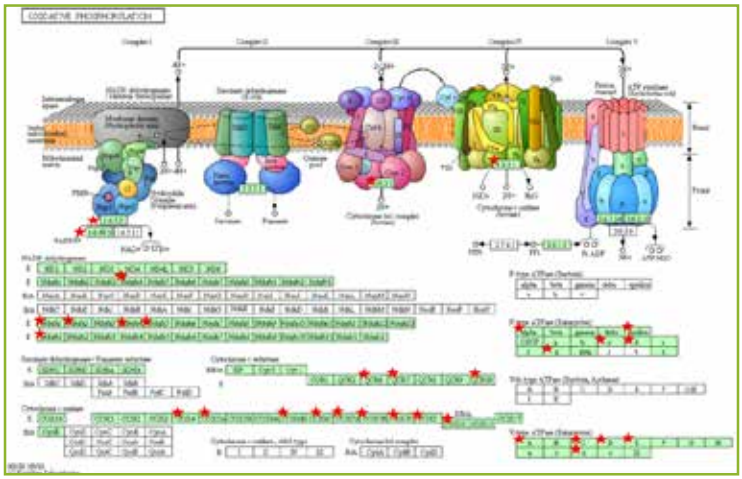
Fig. Mechanism of toxicity induced by Zinc oxide nanoparticles ZnO NPs and immunomodulatory protective effects of Withania somnifera extract (WS) and Withaferin A (WA), in Balb/c mice modal of peritoneal macrophages. Red arrows: effect of ZnO NPs independently leads to ROS production which attenuated the phagocytosis of yeast by macrophages through, up-regulation of TLR6 and down-regulation of arginase gene expression. Green arrows: co-treatment, Impact of Withania somnifera extract with zinc oxide nanoparticles (WS + ZnO NPs), Withaferin A along with zinc oxide nanoparticles (WA + ZnO NPs)-enhance phagocytic activity by counteracting mechanism of ZnO NPs toxicity. Black arrows: increasing ordecreasing effects. Per oral (P.O).

Transcriptome Profile of Murrah Buffalo Spermatozoa

Global transcriptomic profile of buffalo spermatozoa was performed using Agilant microarray platform. A total of 51,282probes were designed against 32430 genes in the chip. Elimination of the compromised, undetected and redundant transcripts resulted in 5460 functional transcripts. Functional gene ontology analysis of these transcripts was done using PANTHER online gene ontology analysis software including biological process, cellular component, molecular function and pathways. The transcripts involved in important biological processes such as, cellular process (33%), biological reaction (15.5%) and metabolic processes (19.3%). The major molecular functions were binding (33.7%), catalytic activity (31.41%) and molecular transducer activity (16%). The cellular components majorly involved were cell (42.7%), Organelle (26.2%) and protein containing complex (11.1%). The important pathways detected were GnRH receptor pathway, Wnt signaling pathway and integrin signaling pathway. The most abundant genes having signal intensity of >1000 were MOCS3, ART1, PMEPA1, CWC25, CTU1, ITPR1, CAPN1, CAV2, CFDP2,

CCDC8, CCDC22 and GCC1.These findings lay a foundation for more detailed investigations on sperm RNAs for identification of sperm-based biomarkers for fertility.

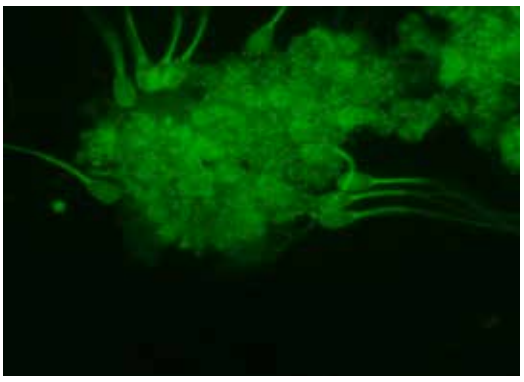
Microarray Analysis of Spermatozoa from High- and Low-Fertile Buffalo Bulls Reveals a Significantly Different Transcriptome



Using microarray, a total of 51284 transcripts were detected in buffalo spermatozoa; among which 950 transcripts were up regulated while 3100 were down regulated in low-fertile buffalo bulls.When the fold change was considered at >2, a total of 32 transcripts were up regulated while 489 transcripts were down regulated in spermatozoa of low-fertile bulls. More than 50% of the differentially expressed transcripts were related to cell receptor pathway, nucleic acid binding, protein folding and metabolic processes. Among the most differentially expressed genes, 10 most relevant genes in terms of sperm functions and fertility included YBX1, RPL39, PGAM1, CASP4, TFAP2C, H3F3B, ZAR1, CHRNA3, MAP2K6, and ORAI3. Validation of few genes deduced from microarray, using qPCR indicated that transcriptional abundance of YBX1, ORAI3 and TFAP2C geneswere 18.43, 138.22 and 10.8 times higher in low-fertile bull spermatozoa as compared to high-fertile bull spermatozoa. It was concluded that sperm transcript profile differed between high- and low-fertile buffalo bulls and the gene ORAI3 may be incorporated in the panel of markers (or in combination with other tools) to discriminate low- from high-fertile buffalo bulls, once validated on large number of bulls.

Effect of Season on Spermatozoa Functional Attributes and Oviduct Explants Binding Ability in Buffaloes

Season has a pronounced effect on buffalo reproduction. To find out the functional differences between spermatozoa ejaculated during favourable (winter) and unfavourable (summer) season were compared in Murrah buffalo bulls. Further, the effect of season on fertility associated genes in spermatozoa and sperm-oviduct binding was also studied. Spermatozoa were assessed for motility, membrane integrity, acrosome reaction and lipid peroxidation status in winter and summer ejaculates. Oviduct explants were prepared by overnight culture of epithelial cells in TCM- 199 and washed spermatozoa (2 million) were added to the oviduct explants and incubated for 1 hour. Then, sperm-oviduct explants were stained with a fluorescent stain (JC-1) and sperm binding index (BI – No. of bound spermatozoa/unit area of oviduct explants) was assessed. The proportion of motile and membrane intact spermatozoa were significantly higher ($p<0.05$) in winter as compared to summer ejaculates. The proportion of moribund and lipid peroxidated spermatozoa were significantly lower ($p<0.05$) in ejaculates collected during winter as compared to summer. Winter ejaculates had significantly higher ($P<0.05$) live acrosome intact spermatozoa than summer ejaculates. The expression of fertility associated genes did not differ significantly between the two seasons in both fresh and frozen semen. The BI was significantly lower ($P<0.01$) when spermatozoa collected from summer season were incubated with oviduct explants as compared to spermatozoa collected from summer season. In conclusion, it was observed that season affects the semen quality and sperm-oviduct binding in the water buffalo but has no effect on fertility associated genes in Murrah buffaloes.



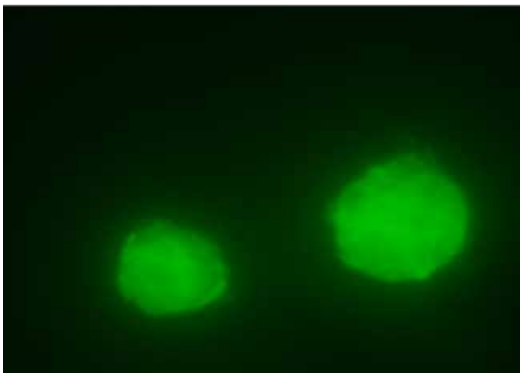
Endometrial Expression of Immunity and Energy Related Genes as Influenced by Energy Balance in Cyclic Buffaloes

Negative energy balance is considered to be an important reason for reduced reproductive efficiency in dairy animals including the buffalo, especially under field conditions. The endometrial expression of calgranulins, IGF1, IGFBP1 and β-defensin genes in buffaloes with different levels of circulating NEFA, BHBA and IGF1was studied. Endometrial expression of S100A8 and S100A9 was significantly ($P<0.05$) up regulated while expression of S100A12

and IGF1 gene was significantly (P<0.05) down regulated in buffaloes with either high circulating NEFA and BHBA concentrations. The expression of BDEF4 and BDEF5 was significantly (P<0.05) up regulated in buffaloes with high circulating concentrations of NEFA. The expression of IGF1 and IGFBP1 was significantly (P<0.05) up regulated in buffalos having high circulating concentrations of BHBA. The expression of BDEF5 was significantly (P<0.05) up regulated in buffaloes with high circulating concentrations of BHBA. Peripheral IGF1 concentration did not have any significant influence on endometrial expression of calgranulin, BDEF4 and BDEF5 genes. No significant relationship was observed between circulating NEFA, BHBA and IGF1 concentrations, and endometrial expression of any of the genes studied. The endometrial expression of S100A8 gene was significantly and positively related to the endometrial expression of S100A12 and IGF1 genes while expression of S100A9 gene was significantly and positively related to expression of DEF4 and DEF5 genes. Further a strong positive relationship was observed between endometrial expression of DEF4 and DEF5 genes. It was concluded that endometrial expression of certain calgranulins and β-defensin was up regulated while the expression of IGF1 gene was down regulated in buffaloes having high circulating concentrations of NEFA and BHBA indicating an ongoing active uterine inflammatory response and alterations in IGF1 mediated reproductive events in buffaloes with negative energy balance.

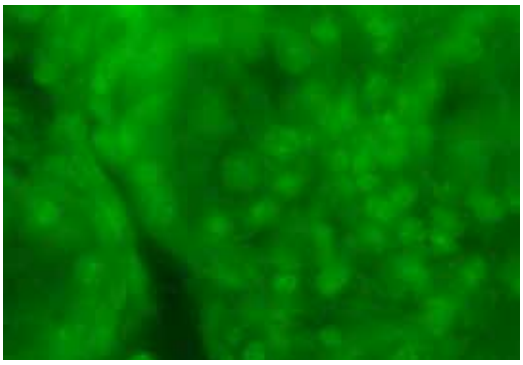
Effects of Glial Cell Derived Neurotrophic Factor on Putative Spermatogonial Stem Cell Culture Dynamics in Crossbred Bovine

The effect of glial cell derived neurotrophic factor (GDNF) on *in vitro* culture dynamics of bovine spermatogonial stem cells (SSCs) was assessed. In treatment groups, SSCs were cultured in medium supplemented with GDNF (10 ng/mL or 40 ng/mL) or co-cultured with Sertoli cells layer, while in control group SSCs were grown without exogenous addition of GDNF or co-culture. Number of cells and colonies were counted on days 4,7,10 and 13 of *in vitro* culture. There was a significant (p< 0.05) increase in the number of cells in GDNF (40 ng/mL) group and Sertoli cells co-cultured group than the control group on days 4,7,10 and 13 of culture. There was no significant (p<0.05) difference in the number of colonies between control and GDNF (10 ng/mL or 40 ng/mL) supplemented groups. However, the number of colonies were significantly (p> 0.05) higher in Sertoli cells co-cultured group as compared to other groups on day 10 and 13 of culture. Both supplementation of GDNF at 40ng/mL and co-culture of SSCs with Sertoli cells increased the surface area of SSCs colony significantly during the entire period of *in vitro* culture as compared to control and 10 ng/mL GDNF supplemented groups. Only on day 7 of culture, a significant difference (p <0.05) in surface area of colonies was observed between GDNF (40 ng/mL) and Sertoli cells co-cultured group. It was concluded that supplementation of GDNF at 40 ng/mL or co-culture of SSCs with Sertoli cells enhanced the growth and multiplication of SSCs during *in vitro* culture, indicating their possible role in proliferation or self-renewal of bovine SSCs.



Homologous Spermatogonial Stem Cell Transplantation in Busulfan Induced Bovine Recipients

Spermatogonial stem cells (SSCs) are the foundation of spermatogenesis and male fertility. Off late, a lot of information has been generated on the basic biology of SSCs and new prospects for fertility preservation using SSCs. Keeping in view the high incidence of infertility in crossbred bulls and need for standardization of transplantation technique, a study was undertaken to assess the possibility of restoration of fertility by homologous SSCs transplantation using crossbred calf models. The effect of different doses (3, 6, 9 mg/kg body weight) of intra-venous administration of busulfan, an alkylating agent, on health and depletion of SSCs reserve in recipient animals was studied. It was observed that although the depletion of SSCs was greater in animals that received high dose of busulfan, the side effects were also high and even mortality was also recorded in this group. It was concluded that busulfan at 3 mg/kg body weight was safe to the animal and induced moderate depletion of SSCs reserve. Finally, the efficiency of ultrasound guided SSCs transplantation was assessed in terms of colonization of donor SSCs in recipient testis by tagging the donor SSCs with CFDA- SE. It was observed that the average efficiency of homologous transplantation was 7.34% respectively in terms of cell number recovery while in terms of colonization it was 8.33%. Taken together, the preliminary finding of the present study indicates the possibilities of fertility restoration in infertile males using SSCs from a fertile donor.



Anti-sperm Antibodies Concentration in Blood and Cervical Mucus of Dairy Cattle and its Impact on Fertility

Immunological infertility is gaining momentum not only in Human being but also in animals. Anti-sperm antibody (ASA) is one such factor contributing significantly to female infertility, especially in cases of infertility due to unexplained aetiology. To understand the prevalence of ASA in dairy cattle and to assess its impact on fertility, blood serum and cervical mucus from 69 cattle including heifers, pleuriparous normal cows and repeat breeders were ASA in serum of repeat breeders were significantly ($P<0.05$) higher (at least two times more) when compared to normal breeder and heifers. Similarly, ASA concentration in cervical mucus of repeat breeders were significantly ($P<0.05$) higher when compared to normal breeder and heifers. The concentration of ASA in serum and cervical mucus had positive correlation with age, parity and strong positive correlation with number of inseminations. Further, a positive correlation ($r=0.551$) was observed between serum and cervical mucus ASA concentrations. In repeat breeding cows the conception rate was only 25% as against the CR in normal breeding cows (76%) and heifers 6 (85%). These results clearly indicate the ASA adversely impact the female fertility in dairy cattle.

Effect of Polyherbal Mixture Supplementation on Incidence of Mastitis and Milk Production in Postpartum Murrah Buffaloes

The effect of polyherbal mixture supplementation on incidence of mastitis and milk production in postpartum Murrah buffaloes was assessed. Buffaloes in the control group were fed with the routine ration as per the feeding schedule of NDRI (NRC, 2001+ 10% extra energy). Buffaloes in the treatment group were supplemented with polyherbal mixture containing 25g each of Ajwain, Haldi, Jeera, Methi, Saunf, Sowa and Sundh along with 25g of kala namak and 250g jaggery from the day of calving till day 10 of postpartum. The polyherbal mixture was grounded into fine powder, mixed in the concentrate and fed once a day. Milk samples were at different days till day 28 postpartum and California Mastitis Test was carried out. Proportion of Murrah buffaloes that were suspicious for mastitis were 20% (day 7), 10% (day 14), 3.3% (day 21) and 0% (day 28) in supplemented group while it was 36.6% (day 7), 26.6% (day 14), 10% (day 21) and 6.6% (day 28) in control group; there was significant difference ($P<0.05$) between control and supplemented group on day 7, 21 and 28. The average total milk yield in supplemented group was 2642.87±75.45 kg, while it was 2292.27±77.65 kg in non-supplemented group. The total milk yield was significantly ($P<0.05$) higher in the supplemented group as compared to control group. It is inferred that supplementation of polyherbal mixture in postpartum Murrah buffaloes minimized the incidence of buffaloes suspicious for mastitis and favoured an increase in the milk production.

An Investigation on Anti-Müllerian Hormone as a Predictive Biomarker of Fertility in HF Crossbred and Indigenous Deoni Cows

Anti-Mullerian Hormone (AMH) concentration in relation to breed, reproductive performance in HF crossbred and Deoni cattle were studied and association between AMH and fertility response on controlled breeding in HF crossbred cattle was investigated. Deoni cattle had significantly ($p<0.05$) higher AMH levels (6737.86 ±299.24pg/mL) than HF cross bred cattle (5862.3 ±307.90pg/mL).When cattle were classified according to high- or moderate -or low-AMH concentration based on the average within each genetic group, majority of cattle in both the breeds had medium levels (range) of AMH i.e. 4665-8810and 4093-7630 pg-mL inDeoni and HF crossbred cattle, respectively. Association of AMH level on reproductive performance revealed that the Deoni cattle with moderate levels of AMH showed lesser months of age at first AI (32.86 ± 1.20) and age at first calving (43.03 ± 1.21). However, cattle with higher levels of AMH showed higher (87.55 ± 0.12 per cent) first service conception rate than cattle with medium (75.0 ± 0.05 per cent) to low (75.88 ± 0.09 per cent) levels of AMH. Similarly, association of AMH levels with the age at first calving and first service conception rate in HF crossbred cattle revealed that cattle with higher AMH levels in blood showed less age at first calving (29.66 ± 1.64 months) and higher first service conception rate (75.0 ±0.14 per cent) than cattle with medium to low levels of AMH. Similarly, in both breeds, the cows which conceived on first AI showed higher levels of AMH than cows conceived with more than one AI. Association of antral follicle population and AMH levels between high- and low-level group in HF crossbred & Deoni cattle revealed that cattle with higher level of AMH had significantly ($p<0.01$) higher antral follicular population as observed by ovarian ultrasonography indicating that serum AMH level could be used as an indicator of ovarian follicular reserve in both breeds. On the other hand, AMH concentration did not influence immediate fertility response in terms of conception rate in timed AI programme.

Comparative Efficacy of Indirect Tests to Milk Somatic Cell Count Method for Diagnosis of Subclinical Mastitis in Lactating Dairy Cows

We estimated the prevalence of subclinical mastitis (SCM) and compared the efficacy of indirect diagnostic tests [California Mastitis Test (CMT), Differential Electrical Conductivity (DEC), EC meter, Tanucheck kits and Brothymol Blue strip (BTB) tests] to milk somatic cell count (SCC) method using $200x10^3$ cells/ml as a cutoff value in Deoni

and HF crossbred cows. We found the cumulative prevalence of SCM was 38% and 63% in Deoni and HF crossbred cows, respectively on milk SCC basis (n= 215). Breed (p=0.001), udder health status (p=0.001) and its interaction (p=0.006) had significant effects on SCC level. The overall sensitivity and specificity of above indirect tests were 38% & 99%; 52% & 72%; 52% & 69%; 76% & 31% and 1% & 50%, respectively. Screening through CMT, DEC and EC methods alone in Deoni (n=41) and crossbred (n=105) cows revealed, prevalence rate of 30%, 50% and 64% at cow level (n=784), and 15%, 21% and 49%, at quarter level (n=3083) respectively. Efficacy and threshold values of EC and DEC were also analyzed by receiver-operating-characteristic (ROC) curve and kappa analysis considering SCC as reference test. We found higher values of AUC for DEC than EC indicated the better accuracy of DEC, particularly in crossbred cows. DEC was also found to be better agreement with SCC (0.32) than EC (0.25) or other tests (< 0.2), though the level of agreement was low. We studied innate immunity of SCM and healthy cows and found that mRNA expression of SAA, IL-1β and TNF-α genes were significantly up-regulated while, TNF-α gene was significantly down-regulated in PBMC of SCM affected HF crossbred and Deoni cows, respectively. It is concluded that, DEC is more suitable indirect method to detect SCM and mRNA expression of SAA and TNF-α was strongly related to SCM in HF crossbred and Deoni cows, respectively.

Seminal Proteins and their Correlation with Sperm Characters and Freezability in Buck Semen

Semen ejaculates from nine Black Bengal bucks were collected by artificial vagina (n=20/buck). *In vitro* sperm characters were evaluated immediately after collection, after completion of equilibration period and after freeze thawing in Tris- citrate extender. Seminal plasma proteins were precipitated by ice cold ethanol method and sperm proteins were extracted by detergent extraction method from the neat semen. Heparin binding proteins (HBP) were isolated by heparin column chromatography and SDS-PAGE was performed to assess the molecular weight of seminal proteins. Significant difference (P<0.01) among the bucks were observed in sperm characters and freezability. Progressive loss of sperm motility, membrane integrity and other *in vitro* sperm characters were noticed during cryopreservation. A total of 10 protein bands in the molecular weight ranging from 17 to 180 kDa were found in the SDS-PAGE of seminal plasma proteins and nine bands of 17 to 134 kDa were observed in sperm proteins. While HBP of seminal plasma and sperm showed eight and seven protein bands, respectively. Seminal plasma protein of 180-134 kDa showed negative correlation with individual motility (- 0.716) and functional membrane integrity (-0.724) in post freeze thaw analysis and 48 kDa protein had positive correlation with individual motility (0.649) and functional membrane integrity (0.664) in post thaw samples. Sperm proteins of 63 kDa had negative correlation (-0.616) with sperm concentration in neat semen.180-136 kDa HBP of seminal plasma and 134-101 kDa of sperm had showed high correlation with *in vitro* sperm characters. It is concluded that variations among the bucks were noticed in the *in vitro* sperm characters and semen freezability. Seminal proteins influence the sperm characters, freezability and they could be used as a tool to select breeding bucks.

Follicular and Luteal Growth and its Relationship with Blood Flow in Cyclic Crossbred Cows

Growth of the follicles on each ovary was monitored regularly from the day of follicular emergence till ovulation and thereafter on alternate day till one (dominant) follicle underwent ovulation or atresia using color Doppler ultrasound machine. A large number of follicles were found to be growing from the day of emergence and most of which disappeared throughout the process of development and one follicle (pre-ovulatory dominant follicle) reached to the preovulatory stage and ultimately ovulated. The blood flow to a particular follicle which

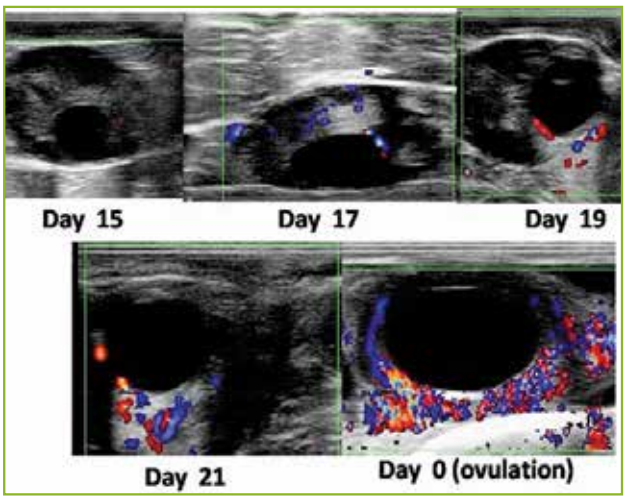


Fig: Representative images of follicular growth and blood supply to the dominant follicle during different days of estrous cycle of crossbred cows as captured through CFM of ultrasonography

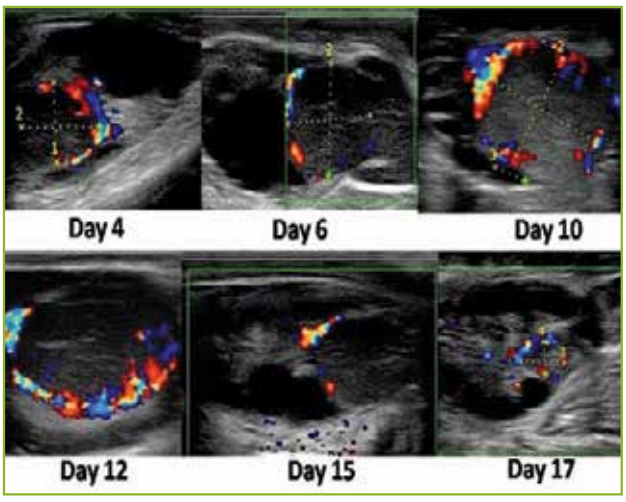


Figure 2. Representative images of luteal growth and blood supply to the corpus luteum during different days of estrous cycle of crossbred cows as captured through CFM of ultrasonography

was later found to be dominant from day 15 through the day of ovulation has been depicted in the Fig. 1. We found that the flow of blood to the follicle increased gradually as it grew up and became the highest on the day of ovulation (Fig. 1).

On the other hand, blood supply to the growing corpus luteum (CL) increased till the day it obtained the maximum size and decreased gradually thereafter and became the lowest when it below 2 mm in size till disappeared (Figure 2).

Expression Patterns of Transcripts Encoding Kiss1 and Kiss1R Genes during Different Days of Estrous Cycle in Crossbred Cow

The relative abundance of the transcripts encoding Kiss1 and Kiss1R genes were found to be higher (P<0.01) on day- (-) 1, 6 and 12 than day-18 of the estrous cycle (Figure 3) and it was found to be corresponded to the plasma kisspeptin concentrations. Kisspeptin concentration on the day before onset of estrus (day – 1) was recorded to be the highest and correspondingly the two genes KiSS1 and its receptor gene (KiSS1R) have also been expressed more abundantly than any other days of the cycle.

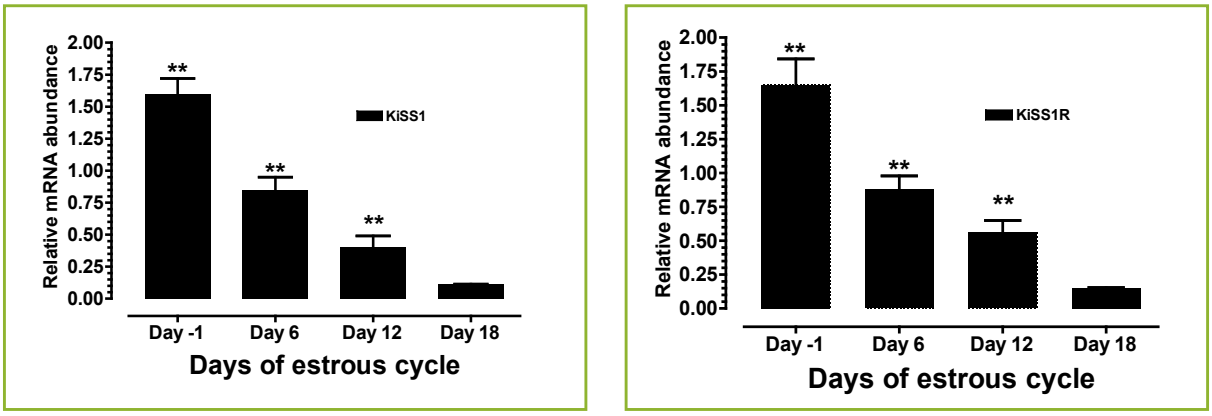


Figure 3. Expression patterns of KiSS1 and KiSS1R genes during different days of estrous cycle in crossbred cows

Our results showed that KP-10 enhanced the growth of follicles in all animals of treatment than control group. Higher number of medium and large follicles was recorded in the ovaries of kp-10 treated animals than controls. Though a large number of small follicles of <4mm in diameter were observed in control animals, no medium (<8mm) or large (<10mm) follicles were found.

Expression Patterns of Transcripts Encoding KiSS1 and KiSS1R Genes during Different Phases of Estrous Cycle in Crossbred Cows Treated with KP-10

Expression patterns of KiSS1 and KiSS1R genes studied during different stages of estrous cycle in crossbred heifers have been depicted in Figs. 4 & 5. It has been found that these two genes have expressed more abundantly during proestrus and estrus stages than any other phases of estrous cycle.

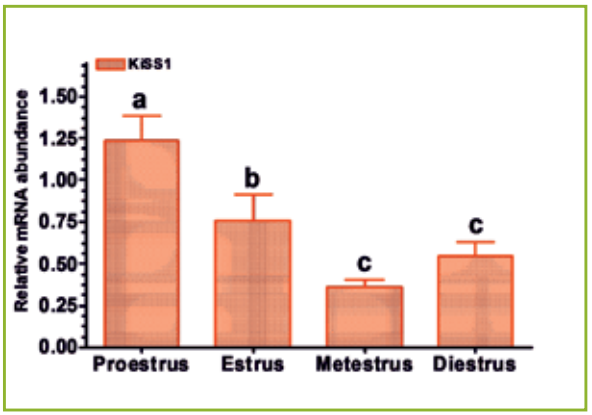


Figure 4. Expression patterns of KiSS1 gene during different stages of estrous cycle of crossbred cows

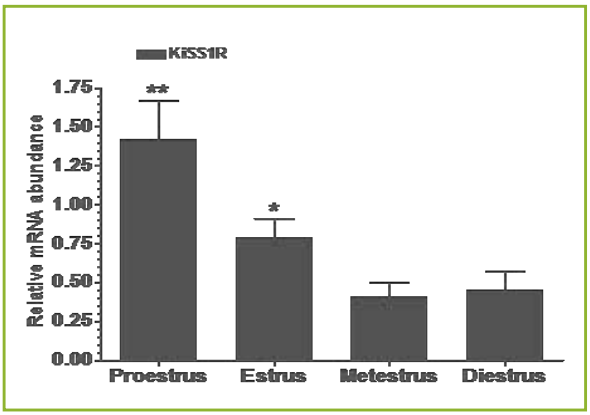


Figure 5. Expression patterns of KiSS1R gene during different stages of estrous cycle of crossbred cows

FEED, FODDER AND PRODUCTIVITY

Supplementary Effect of Seaweed Product (SWP) on Feed Intake, Milk Yield, Antioxidant Status and Immunity in Lactating Crossbred Cows

A nutritional trial was conducted under the scheme "CSIR-New Millennium Indian Technology Leadership Initiative" sponsored by CSIR, New Delhi. Eighteen crossbred cows were procured and divided into 3 groups of 6 animals each based on milk yield (13.5 kg/d), body weight (410 kg), parity (2.0) and days in milk (52 d) to study the effect of SWP (*Kappaphycus alvarezii* powder:*Gracilaria salicornia* powder:*K. alvarezii* sap powder in 1:1:1 ratio) on nutrient utilisation, milk yield, milk composition, antioxidant and immunity status. The cows in group T_1 were fed rations as per their nutrient requirements (ICAR, 2013). The cows in treatments T_2 and T_3 were fed the similar rations as per the control (T_1), however, the diets of T_2 and T_3 were supplemented with 1.5 and 3% of *K. alverazii* based SWP on DM basis. Supplementation of *SWP* at 1.5 or 3.0% level of diet did not influence feed intake, nutrient utilisation, milk production or milk composition. However, persistency of lactation (Fig. 1) was better in group T_3. The glutathione peroxidase activity (Fig. 2) and total antioxidant capacity (Fig. 3) was higher ($P<0.05$) in group supplemented with SWP @ 3.0% of ration as compared to other two groups. The values of plasma total Ig and IgG (Fig. 4) concentration, lymphocyte proliferation and neutrophil viability (Fig. 4) were higher ($P<0.05$ in treatment T_3 (3% SWP) as compared to other treatments. Therefore, antioxidant and immunity status improved in group of cows provided with 3% *K. alverazii* based seaweed product in the ration of lactating dairy cows. Hence, persistency of lactation was better in group given 3% of SWP particularly after 5th fortnight of the experiment. The Ca level in milk, liver function, antioxidant and immunity status improved significantly in group of cows provided with 3% *K. alverazii* based seaweed product in the ration.

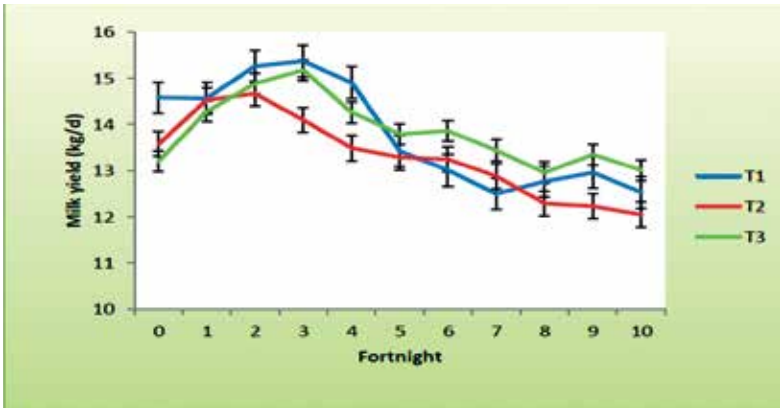


Fig.1. Effect of supplementation of K. alvarezii based feed additive on fortnightly milk yield (kg/d)

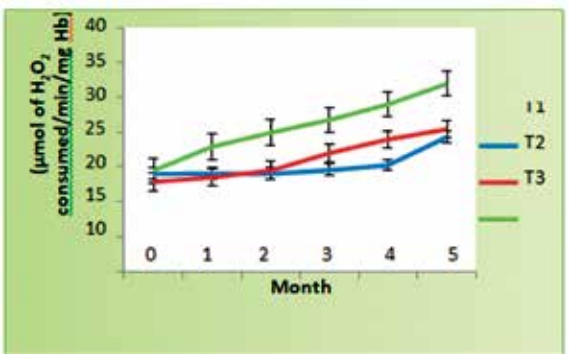


Fig.2. Effect of supplementation of K. alvarezii based SWP on GP_x activity

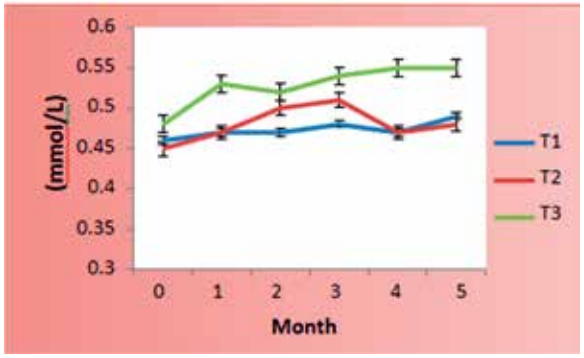


Fig.3. Effect of supplementation of K. alvarezii based SWP on total antioxidant activity (mmol/L)

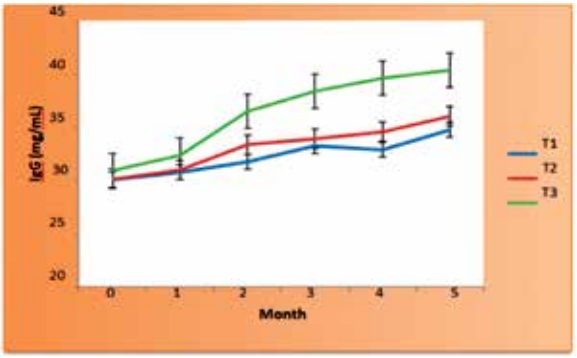


Fig. 4. Effect of supplementation of K. alvarezii based SWP on IgG (mg/mL)

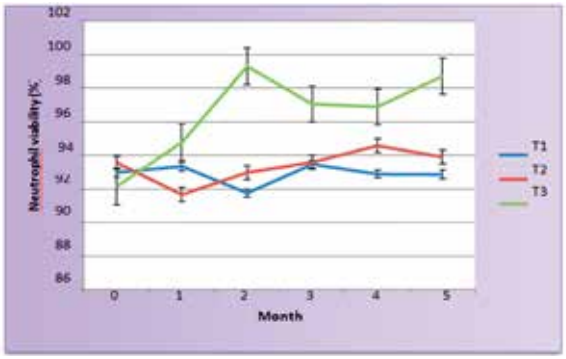


Fig. 5. Effect of supplementation of K. alvarezii based SWP on neutrophil viability (%)

Effects of *Moringa oleifera* Leaves on *in vitro* Rumen Fermentation Parameters and Methane Production under Different Planes of Nutrition in Crossbred Kids

The aim of the study was to observe the effect of *Moringa oleifera* leaf powder (ML) replacing compound feed on *in vitro* fermentation parameters and methane production under different planes of nutrition. Under three planes of nutrition *viz* 80:20, 70:30 and 60:40 roughage to concentrate ratio, compound feed was replaced with 0, 10, 20, 30 and 40% ML in all three planes of nutrition on crude protein basis. Rumen fermentation parameters viz., total gas production, truly digestible dry matter (TDMD), truly digestible organic matter (TDOM), microbial biomass production (MBP) and ammonia nitrogen (mg/dl) were determined by *in vitro* gas production technique to observe the best level of ML to be added in the diet. Total gas production was increased (P<0.05) in 20 % replacement with ML in 80:20 and 70:30 roughage to concentrate ratio (163.95 and 165.95 ml/g DM, respectively) as compared to control (0% replacement) and thereafter there was no change. In 60:40 roughage to concentrate ratio, total gas production increased (P<0.05) at 10 % (156.41 ml/g DM) level and no difference was observed above this level. TDMD was increased (<0.05) in 20% replacement with ML in both 70:30 (73.19%) and 80:20 (70.99%) planes of nutrition. Under 60:40 plane of nutrition, TDMD was increased (P<0.05) in 10% replacement than 20, 30 and 40%. TDOM was increased (<0.05) in 20% replacement in 80:20 (72.34%) and 70:30 (74.24%), respectively. There was no difference in 30% and 40% replacement in both planes of nutrition with 20% replacement. MBP increased (<0.05) in 20% replacement in both 80:20 (51.34 mg) and 70:30 (53.17 mg) and 10% level in 60:40 roughage to concentrate ratio. No improvement was observed above this level. There was no change in ammonia N (~14 mg/ dl) production in any plane of the nutrition. It was concluded that 20% compound feed may be replaced with *Moringa* leaf under 80:20 and 70:30 roughage to concentrate ratio while 10% from 60:40 roughage to concentrate ratio for better nutrient digestibility and microbial biomass production in kids.

Effect of *Moringa oleifera* Leaf Powder on Performance of Kids under different Plans of Nutrition

Objective of the study was to observe the effect of *Moringa oleifera* leaf powder replacing compound feed in various levels in kids' ration on certain blood biochemicals and its performance. Twenty four crossbred (Alpine x Beetal) male kids of 2.5-3.0 months of age were divided into four groups with six animals each. In control group (Group I) animals were fed with 70:30 roughage (berseem) concentrate ratio without any *Moringa oleifera* leaf supplementation. Group II, Group III and Group IV were fed with 60:40, 70:30 and 80:20 roughage to concentrate ratio and the compound feed was replaced by 10%, 20% and 20% by *Moringa oleifera* leaf powder, respectively. The initial body weight was around 13 kg while the final body weight of GI, GII, GIII and GIV were 26.88, 28.60, 28.36 and 27.41 kg, respectively (shown in the figure). The average daily gain of Group I, Group II, Group III and Group IV were 78.44, 87.13, 86.06 and 79.29 g, respectively. There was improvement (P<0.05) in Group II and Group III than Group I and IV due to the supplementation. There was no change in glucose (~65 mg/ dl), globulin (~3.50 g/ dl) and ALT (~29.3 IU/ L) levels among the groups.

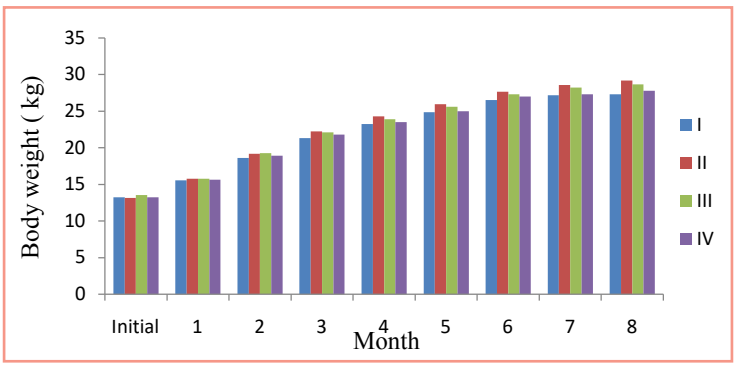
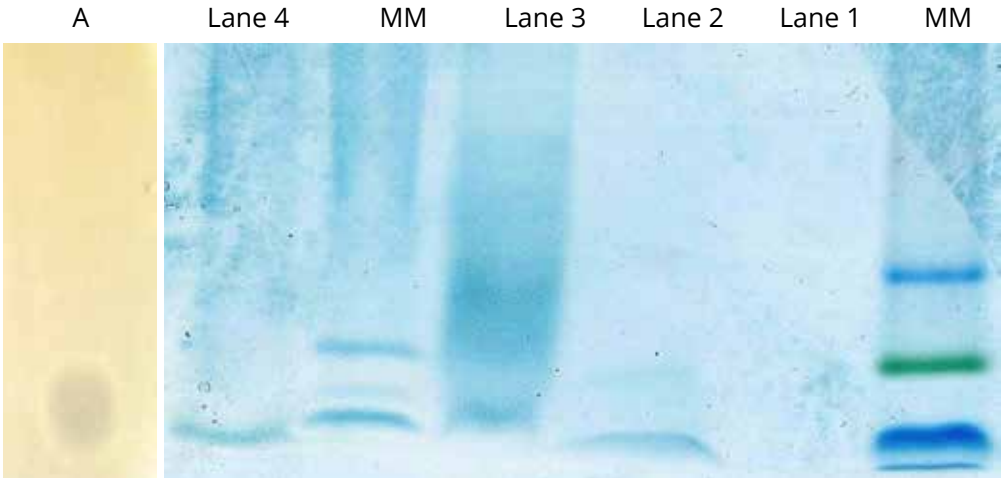


Fig: Monthly body weight in different groups supplemented with Moringa oleifera leaf powder

Group IV (6.69 g / dl) and Group I (6.72) had similar protein level while higher (P<0.05) level was observed in Group II (6.91g/ dl) and Group III (6.93 g/dl). Plasma albumin was increased (P<0.05) in Group II (3.44) and Group III (3.49) than Group I (3.22) and Group IV (3.30). No effect was observed in glutathione peroxidase activity which was around 14.59 µmol of NADPH Oxidized/g Hb/min and SOD activity which was 90.83 U/mg Hb) among the groups. It can be concluded that *Moringa oleifera* leaf powder can be replaced with compound feed upto 10% in 60:40 roughage to concentrate ratio; and 20% in 70:30 and 80:20 roughage to concentrate ratio for better performance of kids.

Biochemical and Molecular Characterization of Bovicin from *Streptococcus bovis* having Anti-Methanogenic Activity

Out of a total of 90 isolates recovered from rumen liquor samples of fistulated non-lactating Murrah buffaloes, 16 exhibited antimicrobial activity against indicator strains of Streptococci. The genotypic identification of the isolates was done through PCR and 16S rDNA revealing that isolates RLI, RLV, RLIX, RLA and RLB were strains of *Streptococcus bovis*. The conditions for maximum production of bovicin from the selected *S. bovis* RLA strain were optimized, and bovicin was purified. Purity of bovicin after ammonium sulfate precipitation was increased by 3.3-fold and further after ion-exchange chromatography by 5.7-fold. SDS-PAGE analysis revealed molecular weight of inhibitory protein as ~ 2-4 kDa. Bacteriocin was fully or partially inactivated by pronase E and trypsin and it was fully resistant to α-chymotrypsin, pepsin and lysozyme. The inactivation of antimicrobial activity by proteases suggested that the BLIS produced by RLA was indeed an antimicrobial protein or peptide. The SDS-PAGE and in-situ gel activity revealed that the protein band corresponding to the inhibition zone has a molecular weight of about 2-4kDa. The effect of bovicin on methane production and other nutritional and fermentative parameters was evaluated using a standard diet (R:C::60:40). Results showed that inoculating bovicin into *in vitro* rumen incubations noticeably alleviated methane production. The bovicin can be used in feed as a feed additive in ruminants to reduce methane emissions.



SDS-PAGE of bovicin produced by S. bovis RLA. Lane MM (Molecular Weight Markers); Lanee-2 and 4: purified bovicin fractions using Ion-Exchange chromatography (A) Gel overlay of purified bovicin like substance showing zone of clearance using an indicator strain.

Comparison of Molasses and Depotash Vinasse as Pellet Binder on *in vitro* Rumen Fermentation Parameters

Objective of the experiment was to evaluate *in vitro* rumen fermentation parameters in the compound feed and pellet prepared from molasses and depotash vinasse (by-product of distilleries) and total mixed ration (TMR) with compound feed, pellets of either molasses or vinasse. Compound feed, pellet prepared from either molasses or depotash vinasse (8%) as pellet binder and TMR (maize green-40 parts, wheat straw 20 parts and compound feeds/ pellets- 40 parts) were incubated with rumen liquor and buffer using in vitro gas production technique for 24 h and rumen fermentation parameters were evaluated for evaluating feasibility of depotash vinasse incorporation in the dairy ration. Total gas production increased with vinasse pellets compared to concentrate and pellets (M) while lowest gas production was observed in TMR with depotash vinasse. *In vitro* dry matter digestibility was similar in both TMRs which was around 60%. The total organic matter digestibility was 68.69% in depotash vinasse pellets while variable results (61-65%) were observed in TMRs. Microbial biomass production was around 40 mg (P>0.05) in different groups. Partitioning factor and ammonia nitrogen was similar in all the samples. It may be concluded that depotash vinasse, a distillery byproduct can be ustilised in pellet @8% and it does not have any adverse effects on digestibility and fermentation parameters, however, *in vivo* trial need to be conducted for validation.

Effect of Fibrolytic Enzyme and Lactic Acid Bacteria Combinations on Sugarcane Tops Silage

Present study was conducted to examine the effect of exogenous fibrolytic enzyme (EFE) Lactic acid bacteria (LAB) inoculant combinations to improve quality, nutritive value and fermentation characteristic of Sugarcane tops silage (SCT). SCT (301g DM/kg FM) was harvested, wilted, chopped at 2-4 cm length. For *in vitro* analysis, small scale sugarcane tops silage were prepared in plastic jar of capacity 5 kg fitted with by cycle valve. Combinations were prepared by mixing exogenous fibrolytic enzyme (cellulase or xylanase or both in mixture) along with LAB inoculants (*Lactobacillus fermentum* or, *Pediococcous acidilactici* or their combination) in 9 treatments. Plastic silo jars were opened for chemical analysis at 4 and 30 days of ensiling. All treatments had a higher ($p<0.001$) lactic acid, acetic acid, propionic acid (%DM) and LAB count ($p<0.05$), but lower ($p<0.001$) pH, butyric acid, yeast and mould counts. The results provide the evidence that EFE and LAB inoculant combinations specifically *L. fermentum*, and xylanase were effective for improvement in silage quality, fermentation characteristics and it is supposed to be used for better SCT silage preparation at large scale.

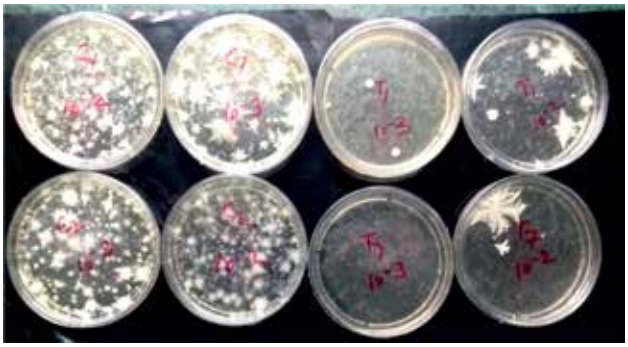
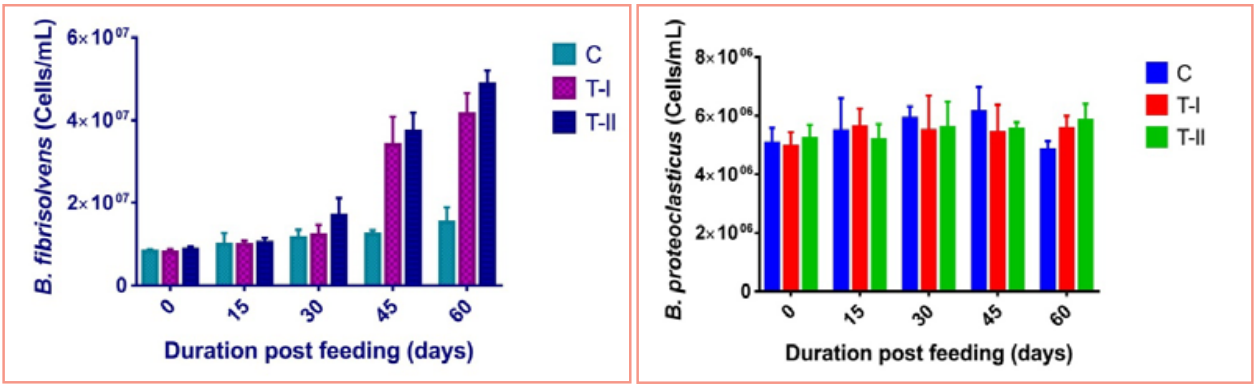


Fig: Yeast and mould colonies for different sugarcane tops silage

Fig: Lactic acid bacterial colonies for different sugarcane tops silage

Manipulation of Rumen Microbes using Medicinal Plants Extract to Enhance the Nutraceutical Value of Milk (DBT Funded)

Supplementation of *Bacopa monnieri* extract in the ration of goats enhanced dry matter and organic matter digestibility, reduced methane production (g/kg of IVOMD) and increased CLA (*cis*-9 *trans*-11) production. Supplementation of *Bacopa monnieri* extract at 0.5 and 1% decreased the saturated fatty acids, C16:0 and C18:0 and increased unsaturated fatty acids C18:1 *t*-11, C18:2 n6, C18:2 *c*-9 *t*-11 (Conjugated Linoleic acid) and C18:3 n6 at both the levels in milk of goats. Total saturated fatty acids (SFA) content and saturation index of milk were reduced in supplemented groups. Total polyunsaturated fatty acid (PUFA), monounsaturated fatty acid (MUFA), stearoyl-CoA desaturase (SCD) and Δ^{-9} desaturase enzyme index were higher in treatment groups. Inclusion of *Bacopa monnieri* in diet enhanced the ruminal population of *Butyrivibrio fibrisolvens*, whereas, population of stearate forming *B. proteoclasticus* bacteria remained unchanged throughout the experimental period. The mRNA expression of lipogenic genes like acetyl Co-A carboxylase (ACC), fatty acid synthase (FAS) and lipo-protein lipase (LPL) were not influenced by dietary supplementation of *Bacopa monnieri* extract. However, expression of Steroyl Co-A Desaturase (SCD) showed an increasing trend in the supplemented groups as compared to control. Increase in SCD and δ^{-9} DSI index with reduction in saturation index was observed with dietary inclusion of *Bacopa monneri* extract indicated the better quality of milk fat. The relative abundance of *B. fibrisolvens* increased by 1.7 and 2.1% at 45th and 60th day in rumen sample of goats supplemented with 1% of *Bacopa monnieri* extract. The population density of *B. proteoclasticus* was 4.83 x 10^6, 5.55 x 10^6 and 5.84 x 10^6 cells/mL in C, T-I and T-II respectively, at 60th day of trial.



C- Control; T-I - @ 0.5% Bacopa monnieri; T-II - @ 1% Bacopa monnieri

Fig: Relative abundance of [A] B. fibrisolvens and [B] B. proteoclasticus in rumen fluid of goats supplemented with B. monnieri extract

Dietary Supplementation of Prebiotics, Probiotics and Synbiotics to Augment Health of Calves

A study of 60 days was undertaken to ascertain the effects of synbiotics supplementation on growth performances, nutrient utilization, faecal characteristics, faecal metabolites and immune status in Murrah buffalo calves. Eighteen Murrah buffalo calves of 5-7 days old and 33±2 kg of body weight were randomly assigned in 3 groups (six in each group). Group 1 served as Control (CON) in which basal diet was provided without any supplementation. Group 2 served as treatment-I, (SYN1) which was fed basal diet along with synbiotic formulation-I (chicory powder 8g/calf/day + *Lactobacillus acidophilus* NCDC15 as fermented milk at 200 mL having 108 CFU per mL). Group 3 served as treatment-II (SYN2), which was fed basal diet along with synbiotic formulation-II (chicory powder 8g/calf/day + *L. reuteri* BFE7 as fermented milk at 200 mL having 108 CFU per mL). Final BW (kg), Dry matter intake, average daily gain and body structural measurements were improved significantly in treatment groups (SYN1 and SYN2) as compared to control. Faecal score, faecal pH, and faecal moisture values were significantly decreased ($p<0.001$) in treatment group as compared to control. Faecal ammonia and lactate were also altered favourably in treatment groups. Immune status in terms of cell mediated immune response was significantly improved in treatment groups. The incorporation of synbiotics in diet has the potential to improve the performance, faecal characteristics, faecal metabolites and immune status in Murrah buffalo calves. However, the observed responses among the treatment groups were more evident in the SYN2 compared to SYN1, revealing the fact that both *L. reuteri* BFE7 and chicory powder worked more synergistically and significantly as compared to that of combined effect of *L. acidophilus* NCDC15 and chicory powder.

Ration Balancing Programme under National Dairy Programme-1

Ration balancing programme (RBP) was successfully completed in 106 villages of Muzzafarnagar district of Uttar Pradesh under NDP-1. Under this project, 106 local resource persons (LRPs) have been trained about the ration balancing software. A total 4667 farmers have been covered including 305 women farmers, 4362 male farmers, out of which 40 were SC, 428 were ST, 823 were general and 3322 were OBC farmers. A total of 6049 animals were covered including 3046 cows and 3003 buffaloes. A total of 270 farmer's meetings were conducted during this period. Quantity of mineral mixture supplied in RBP villages was about 100 quintals. Monthly stipend given to LRPs was Rs. 2020/- and average monthly income per LRPs was Rs. 4000/- . Improvement in milk production and fat per animal was 380 g and 0.15, respectively. Reduction in cost of feeding per kg of milk was Rs. 2.55/-. Decrease in cost of feeding per day per animal was Rs.11.76/-. Increased in net income of a farmer per animal per day was Rs. 42.76/-.

Studies on Vanadium and Boron for their Role in Immuno-Endocrine Functions, Bioavailability of Minerals and Production Performance in Dairy Animals

Boron supplementation increased osteoblastic activity as evident from the increase in bone metabolic biomarker e.g. BALP and osteocalcin. There was a decrease in the osteoclastic activity as evident by decrease in NT_x value. Boron upregulated the Vitamin D_3 level in blood plasma at the same time there was no change in parathyroid and calcitonin level indicating the role of boron in Ca metabolism through vitamin D mediated pathway. Antioxidant activity (SOD, catalase and GP_x) and immune response (IgG) were observed to be improved.

Boron supplementation upto 200 ppm increased the osteoblastic activity and antioxidant activity. Supplementation above 200 ppm level had no additional improvement. Thus dietary supplementation @ 200 ppm can be recommended.

Performance of baby corn-fodder cowpea sequence cropping system under different tillage practices and nitrogen management

In this study, package and practices are standardized and developed for fodder production of Baby corn- Cowpea under different tillage practices with enhancing input use efficiency. It was observed that zero tillage or raised bed sowing of baby corn-cowpea increased green and dry fodder yield as compared to conventional planting. Higher nutrient uptake by both the crops was observed which reflect superior quality fodder was produced it terms of total nutrient harvest. Input saving in terms of fertilisers, seed, cost of cultivation and energy besides higher returns was recorded under zero tillage and raised bed sowing in comparison to conventional sowing.

Evaluation of Different Fodder Crops for Higher Biomass yield, growth performance and Quality

This project had the objectives to study the growth parameters and fodder yield of different fodder crops, to estimate the quality parameters of different fodder crops and soil nutrient status at initial and final stage and workout the system productivity and economics of different fodder crops. Results of the study indicated that among different fodder crops NBH+Cowpea intercropping row ratio produced significantly higher green biomass and dry matter yield. Quality parameters like, crude protein yield, ether extract yield and ash yield were also recorded significantly higher in NBH+Cowpea intercropping, which was indicative of good quality fodder. In terms of economic parameters Baby corn performed significantly superior over all the fodder crops. Higher gross return, net return and B: C ratio was recorded and it was followed by NBH+ Cowpea intercropping.

Fodder Productivity and Profitability of Different Maize and Legumes Intercropping Systems

The present study was conducted to evaluate the fodder productivity and economics of maize with legumes under varying intercropping combinations. Three different forage crops *viz*. maize, cowpea and guar sown in sole as well as in 1:1 and 2:1 intercropping combinations of forage cereal with legume crop components were compared. Among the different forage crops, maximum green fodder yield (449.72 q/ha) and dry matter yield (94.89 q/ha) were obtained in maize+cowpea (2:1) and maize+guar (2:1) row ratio respectively. In terms of economics of different treatments, the highest net income (₹ 38747.27) and B:C ratio (1.78) were recorded with maize+cowpea (2:1) followed by (₹ 37724.21 and B:C 1.74) in maize+cowpea (1:1) intercropping combinations. So, to realize higher productivity and farm profitability, planting of 2:1 row ratios was found to a viable option which may prove quite helpful in sustaining the performance of livestock in terms of health and milk production.

Dual Purpose Baby Corn Production under Varying Crop Establishment Methods and Nitrogen Management

A research experiment on "Different nitrogen management options and contrasting tillage practices to evaluate the agronomic performance of dual purpose baby corn (*Zea mays L.*)" was conducted during two consecutive *kharif* seasons of 2016 and 2017 at ICAR-NDRI, Karnal. The experiment consisted of 3 contrasting tillage systems *viz*., Zero tillage (ZT), Conventional tillage (CT) and Raised Beds (RB) and 6 nitrogen management practices *viz*., N0, N75%, N75+Azotobactor, N100%, N100+Azotobactor and N125%. Results revealed that among contrasting tillage options, Raised bed (RB) showed significantly higher growth parameters and yields (green, dry fodder and baby corn) over conventional tillage (CT) and it was at par with zero tillage (ZT). Amongst the nitrogen (N) management options, increasing levels of N increased growth and yields up to 100% N with application of azotobactor. However, highest fodder yield was recorded with 125% N, while highest green, dry fodder and baby corn yields was observed with 100% N with application of azotobactor. The maximum mean cost of cultivation was recorded under CT followed by RB and lowest in ZT (Rs 25,258/ha) while mean net return was observed highest under RB (Rs 112,907/ha) followed by ZT (Rs.104,976/ha) and lowest in CT (Rs 90,666/ha). The saving in total cost of cultivation due to ZT was Rs 2,500/ha and 2,100/ha, as compared to CT and RB, respectively. Based on two years of study, it can be concluded that to realize higher productivity and profitability of dual purpose maize, planting under raised bed with application of 100% N with Azotobactor are quite helpful, which will further strengthen and sustain the performance of livestock in terms of fodder availability and crop diversification.

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

'Baby corn-Cowpea-Chinese cabbage-seed' performed superior over all other fodder crops and generated around Rs. 2.29 lakh/year net return with B:C ratio 3.05. For higher green fodder production 'Napier grass+Cowpea-Berseem' crop sequence was found more productive, this sequence produced 167 t/ha.

Diversity in Biochemical Quality of Fodder as Influenced by Weather and Soil Fertility Forcing Variables

Fortnightly fodder quality, seasonal soil fertility and daily weather forcing parameters were studied for 3 consecutive years to understand the dependency relation. Biochemical quality of perennial; Par, Guinea and Hybrid Napier were finite, symmetric to soil fertility and reflexive to weather forcing parameters. Biochemical quality of grasses was transitive and tolerance space is greater for hybrid Napier followed by guinea and para grass. Cultivate grasses biochemical quality is quasitransitive and largely dependent on seasonal weather forcing parameters.

Crude glycerol was harvested from non-edible oil seed (NEOs) viz., Pongamia, Simaruba, Mahua, Jatropha, Neem and also using waste cooking oil during the process of biodiesel production. It was fortified as glucogenic substrate to total mixed ration. Glycerol fortification improved rate of fermentation and kinetic rate of fermentation was peak between 12 to 18 h. A negligible concentration of tannins, alkaloids and flavonoids were present in the glycerol (table) harvested from the NEOs, no incriminating affect observed on the fermentation. Glycerol harvested from the source of Simaruba was superior to other sources. Crude glycerol as energy yielding supplement improved TVFA concentration in the inoculum under *in vitro* condition. It could be used as alternative energy supplement at the rate of 10% in the concentrate supplements of dairy cows.

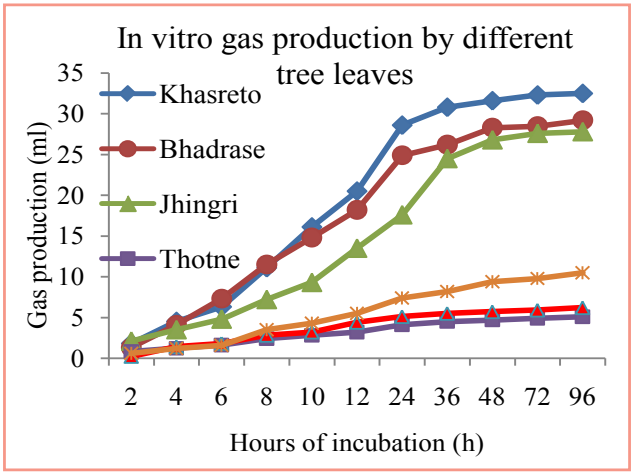
Table: Secondary plant metabolites in crude glycerol harvested from non-edible oils seeds

Glycerol Source	Tannins (µg/ml)	Alkaloids(µg/ml)	Flavonoids(µg/ml)
Pongamia	28.03±2.14	25.00±1.44	7.75±0.47
Simarouba	32.53±4.63	16.23±0.73	8.41±0.27
Mahua	32.15±0.76	17.36±0.09	7.52±0.25
Neem	60.86±4.81	15.63±1.05	9.04±1.60
Jatropha	31.15±0.23	16.23±0.73	8.41±0.27

Evaluation of Eastern Himalayan Forest Tree Leaves as Herbal Feed Additives to Manipulate Rumen Fermentation

Tree leaves generally used as animal feed particularly in hilly as well as arid and semi arid region of our country. North-eastern states of our country having wide variety of tree leaves which are generally used for feeding to the livestock. Seventeen tree leaves e.g., Nevaro (*Ficus roxburghii*), Chuletro (*Brassiopsis hainla*), Cheple (*Boehmeria macrophylla*), Khaniyun (*Ficus cunia*), Lutekhanew (*Ficus clavata*), Kabra (*Ficus infectoria*), Kutmero (*Litsea polyantha),*

Dudilo (*Ficus nerrifolia*), Gogun (*Saurauvia nepalensis*), Titlecawala (*Boehmeria glomerulifera*), Khasreto (*Ficus hispida*), Jhingri (*Eurya japonica*), Bhadrase (*Elaeocarpus lancifolius*), Amaro (*Spondus mangifera*), Guahelo (*Callicarpa arborea*), Cheplecawale (*Boehmeria hamilforiana*) and Thotne (*Aconogonum molle*) were collected from Sikkim and nutritional evaluation as well as potential as a rumen manipulator of these collected tree leaves were done by *in vitro* gas production technique using cattle rumen liquor. OM and CP content of these collected tree leaves varied from 79.8 to 96.3% and 5.8 to 19.8%, respectively where as EE content varied from 1.7 to 3.9% on DM basis. Highest protein content was observed in *Callicarpa arborea* (19.8%) followed by *Aconogonum molle* (18.4%) and *Boehmeria macrophylla* (16.3%) tree leaves. Highest cellulose content (28.4%) was observed in *Ficus hispida* while highest lignin content (13.8%) was observed in *Litsea polyantha* tree leaves. *In vitro* gas production (ml/96h) of these collected tree leaves varied from 5.1 to 32.5 ml. Maximum gas production (32.5 ml/96h) was observed in *Ficus hispida* followed by *Elaeocarpus lancifolius* tree leaves while lowest gas production was observed in *Aconogonum molle* followed by *Ficus clavata* tree leaves. *In vitro* methane production was lowest due to incubation of *Ficus roxburghii* (9.5 ml /g DDM/24h) followed by *Ficus clavata* (10.4 ml/ g DDM/24h) and *Aconogonum molle* (17.3 ml/ g DDM/24h) tree leaves. IVTDMD of theses tested tree leaves varied from 28.1% to 73.5%. IVTDMD% was highest in *Boehmeria macrophylla* (73.5%) followed by *Elaeocarpus lancifolius* (72.8%), *Ficus hispida* (70.9%) and *Boehmeria hamilforiana* (68.9%) tree leaves. TDN content was highest (61.3%) in *Callicarpa arborea* followed by *Ficus hispida* (59.9%), *Eurya japonica* (57.1%) and *Elaeocarpus lancifolius* (56.6%)g. Methane production was reduced by 24.7, 45.7 and 62.9% due to inclusion of Lutekhanew (*Ficus clavata*) tree leaves @ 12.5, 25 and 50% of incubating substrate, respectively as feed additives in paddy straw based diet *in vitro.* The results indicated that Guahelo (*Callicarpa arborea*) is the best followed by Khasreto (*Ficus hispidia*), Jhingri (*Eurya japonica*), Bhadrase (*Elaeocarpus lancifolius*), Dudilo (*Ficus nerrifolia*) and Cheple (*Boehmeria macrophylla)* are good tree fodder in Sikkim for feeding to the livestock. Further, Lutekhanew (*Ficus clavata*) may be used as herbal feed additive to reduce ruminal methanogenesis for improving animal productivity.



Guahelo (Callicarpa arborea)

Lute Khamew (Ficus clavata)

Effect of Feeding *Azolla Microphylla* on Growth Performance and Blood Parameters in Black Bengal Kids

In order to mitigate the shortage of feeds and fodder and to make animal production viable and profitable, the conventional sources of feeds are not enough. The gap between the demand and supply is also increasing. Azolla (mosquito fern, duckweed fern, fairy moss and water fern), a genus of seven species of aquatic ferns of the family Azollaceae, holds the promise as a sustainable feed substitute for livestock. *Azolla microphylla* has been reported to the most suitable for hot humid climate of India. The present investigation was carried out to study the effect of feeding dried *Azolla microphylla* on growth performance, blood parameters,

feed conversion efficiency and economics of feeding in black Bengal kids. A growth trial of 90 days excluding 10 days adaptation period in 15 Black Bengal kids was carried out by distributing the kids into 3 groups (T_0, T_1 and T_2) based on the bodyweight so that the initial average body weight of three groups did not have any significant difference. Kids of T_0 group were fed with mixed fodder supplemented with control concentrate mixture, in T_1 and T_2 groups, replacement of control concentrate mixture with Azolla meal was done at the rate of 10% and 20%, respectively. No significant difference was observed in total dry matter intake and CP intake among three groups. But the average daily live weight gain (ADLG) was significantly ($P < 0.01$) higher in T_2 (41.57 ± 1.65), and T_1 (38.68 ± 1.40) groups than T_0 (32.94 ± 1.81) group. Similar trend was observed in feed conversion efficiency (kg live weight gain/100 kg DMI). In case of blood biochemical parameters, no significant difference were observed for any of the studied parameters such as plasma glucose, urea nitrogen, total protein, albumin, ALT, AST. It can be concluded that, feeding of Azolla meal replacing concentrate mixture up to 20 percent had significantly improved the growth performance of Black Bengal kids without any adverse effect on intake and blood parameters and thus improved the economics of feeding taking into consideration much lower price of Azolla meal in comparison to concentrate mixture.

Effect of Supplementing Dried Meal of *Jussea repens* and *Enhydra fluctans* on Growth Rate and Blood Parameters of Black Bengal Goats

In India, 7 million ha. area is covered by inland water bodies. Wetland vegetation/ aquatic macrophytes are widely available in these water bodies throughout India. Most of these wetland vegetation grow naturally in water bodies or in marshy areas and become weeds in many water bodies Utilization of these plants as animal feed, will not only be helpful to fulfil the gap between demand and supply of fodder to some extent but also will help to clean the water bodies. West Bengal has extensive varieties of wetland plants as compared to other states in India. *Jussea repens* and *Enhydra fluctans* are two very common wetland plants available in lower Gangetic region of West Bengal. Some earlier researchers have reported the chemical composition, medicinal value and antioxidant properties of *Enhydra fluctans* and *Jussiea repens.* There is very little or no information available on utilization of these two aquatic plants in livestock, goats in particular. The present experiment was carried out to study the effect of supplementing the dried meal of *Jussea repens* and *Enhydra fluctans* on intake, growth, blood parameters, feed conversion efficiency and economics of feeding in Black Bengal goats. A ninety days growth trial was conducted on eighteen growing black Bengal goats divided equally into three groups (T_0, T_1 and T_2). Kids of T_0 group were fed with mixed fodder supplemented with control concentrate mixture. Concentrate mixture of T_1 and T_2 were prepared by replacing 20% of wheat bran with dried *Jussea* and *Enhydra* meals, respectively. Average daily gain and feed conversion efficiency were significantly ($P<0.01$) higher in T_1 and T_2 than T_0 without affecting DMI, CPI, TDNI. Blood parameters (Glucose, BUN, total protein, albumin, globulin, AST and ALT) were within the normal range having no significant difference ($P>0.05$). Utilization of *Enhydra fluctans* and *Jussea repens* as alternative feed resources improved average daily gain and also economized the goat ration without any adverse effect on intake and blood parameters.

Enhydra fluctans

Jussea repens

INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS

Effect of Management Enrichment on Cognitive Performance of Murrah Buffalo Calves

The cognitive performance of young calves may be improved if they are provided with special management in the modern rearing system at dairy farm. Therefore, this study was undertaken to investigate the influence of social interaction and management enrichment on cognitive performance of Murrah buffalo calves. For this, 24 Murrah buffalo calves were selected at birth and randomly allotted to four treatment groups (n=6, control, groomed, partly isolated and artificial nipple) for three months experiment. Calves in control were provided with recommended standard management practices wherein calves were kept in individual pens with free contact to each other and allowed to suckle required amount of colostrum during first five days of life thereafter milk of their respective dams was fed with bottle during whole experiment, second group (groomed) calves were provided with two times grooming with brush (10 minutes each in the morning and evening), third group (partly isolated) calves were kept in individual pens and separated each other with barrier of ply board between calf pens to avoid direct contact but they can feel the presence of the adjoining mates (these pens were open from top as this provision was made within a big shed) and fourth group (artificial nipples) calves were provided with rubber nipples fixed permanently in the pens. Calves of all the groups were allowed to suckle colostrum in first five days of life after that required amount of milk of their respective dams was fed by bottle.

Calf located the correct side (reward- milk) Calf received the reward

Artificial nipple fitted in calf pen

Calves were trained for initial learning (bottle with milk hidden at white side) followed by reversal learning (bottle with milk hidden at black side) in a Y maze, the training sessions were comprised of twelve trials each. Results revealed that enriched groups took less number of sessions (artificial nipples: 5.33 ± 0.21 and groomed: 5.67 ± 0.42) than the partly isolated (6.00 ± 0.63) and control (6.17 ± 0.60) groups in initial learning. In reversal learning, calves of artificial nipples took significantly ($P<0.05$) less sessions (7.17±0.30) compared to groomed (9.17±0.30), partly isolated (9.33±0.61) and control (9.33±1.09) groups to learn the task. When compared across the groups, calves took significantly ($P<0.0001$) less sessions in initial (5.79±0.21) compared to reversal (8.75±0.36) learning. Comparing the two enriched groups, calves enriched with artificial nipples performed task in less sessions (5.33 ± 0.21 and 7.17±0.30) compared to groomed calves (5.67 ± 0.42 and 9.17±0.30) in initial and reversal learning, respectively. It was concluded that calves provided with artificial nipples inside the calf's pen, a simple, easy and economical management intervention, improved cognitive performance of buffalo calves.

Effect of Microclimatic Conditions in Different Housing Systems on Performance of Murrah Buffalo Bull Calves

The study was undertaken on Twenty four Murrah male buffalo calves of about six months age to find out the effect of different housing management on performance of Murrah buffalo bull calves. The animals were selected and put into two groups of 12 calves each on the basis of body weight and age. Animals of control group were housed under the existing shelter (of recommended 10-12 ft height and 10 ft width) in the LRC and provided general management conditions. Animals of treatment group were provided modified shelter (15 ft height and 20 ft width), also were provided time controlled mist cooling with fan during dry summer and only fans during hot-humid season, mosquito net on shed to protect animals from insects and rubber mats as bedding to make floor comfortable. The micro climatic data interms of THI, ranged from 78.17 ± 0.63 to 80.28 ± 0.74 and 76.34 ± 0.55 to 77.38 ± 0.39 during hot-dry and 78.17 ± 0.63 to and 76.56 ± 0.40 to 79.77 ± 0.23 during hot-humid season in control and modified shelter, respectively. The body weight gain was 668.79 ± 130.25 gm in control and 813.57 ± 89.78 gm in treatment group of animals. The higher body weight gain was obtained in bull calves of modified shelter, hence modified shelter helped in providing thermal comfort to the calves for better growth.

Average daily gain of bull calves under control and modified shelter

Parameters	Control (n=12)	Treatment (n=12)
Initial BW (kg)	108.14 ± 43.16	112.8 ± 29.73
Final BW (kg)	185.32 ± 54.64	225.95 ± 47.57*
Gain in weight (kg)	77	113
DMI (%/100kg)	2.49 ± 0.06	2.77 ± 0.06
ADG (g)	668.79 ± 130.25	813.57 ± 89.78*

Means bearing * differ significantly at P<0.05

Effect of Precision Feeding and Housing Modifications on Growth and Attainment of Puberty in Murrah Buffalo Heifers

Effect of precision feeding and housing modifications on growth and attainment of puberty in Murrah buffalo heifers was studied. Experiment was carried out for a period of 365 days during May, 2017 to April, 2018. A total 24 Murrah buffalo heifers of average 12 months age were selected and distributed randomly into four groups as T1, T2, T3 and T4. Where T1 provided with existing housing with standard feeding (ICAR, 2013), T2 was given existing housing with precision feeding (Standard feeding + 20% higher energy and protein), T3 was kept under modified housing with standard feeding and group T4 was provided with modified housing with precision feeding. The average daily gain in T1, T2, T3 and T4 was 0.552 A ±0.03, 0.637B ±0.03, 0.575A ±0.05 and 0.694B±0.03 gm and puberty was attended at 22.4, 21.1, 21.8 and 19.7 months, respectively (table). It may be concluded that modified shelter and precision feeding have improved the growth rate and also reduced the age at puberty in buffalo heifers.

Parameter Expt was started ~ 12 months of age	T1 Existing Management + Energy & Protein (Equals to ICAR, 2013)	T2 Modified Management+ Energy & Protein (Equals to ICAR)	T3 Exiting Management+ Energy & Protein (120% of ICAR)	T4 Modified Management +Energy & Protein (120% of ICAR)
Number of animals attained puberty	5 (6)	5 (6)	5 (6)	6 (6)
Age at puberty (days)	671.40^{a}±8.91 (22.4 mo)	634.40^{ab}±26.90 (21.1 mo)	654.20^{ab}±17.10 (21.8 mo)	591.20^{b}±9.06 (19.7 mo)
Body weight at puberty (kg)	344.93±17.77	320.19±15.06	359.76±13.86	320.54±7.19
Number of heifers conceived	2(6)	3(6)	2(6)	4 (6)
Conception rate (%)	40.00 (2 out of 5)	60.00 (3 out of 5)	40.00 (2 out of 5)	66.66 (4 out of 6)
Age at conception (days)	696.50±5.50 (23.2mo)	733.00±21.22 (24.4 mo)	729.00±10.00 (24.3 mo)	664.67±20.22 (22.1 mo)
Body weight at conception (kg)	404.65±6.15	398.98±9.32	393.73±18.38	373±19.22

Effect of THI on Milk Production in Indigenous Cows

The data analysis on environmental variables and milk production of Sahwial (SW) and Tharparkar (TP) cows for the last 15 years duration revealed that both high and low temperature humidity index (THI) influence milk production performance of indigenous cows. Analysis indicated that comfort THI at which milk production does not influence were between 61-72 for Sahiwal and 68- 76 for Tharparkar cows. However per unit increase in THI beyond 72 and 76 declines milk production @ 406 g and 304 g/day in SW and TP cows. Tharparkar cows can withstand rigors of environment up to THI 76 in comparison to SW exhibiting decline in milk yield at THI 72. Further, TP cows had higher circulatory aldosterone level and low magnitude of change in RT than SW, thereby showing more resistance to thermal stress. Milk composition showed no significant difference. Similarly cold stress of winter also influenced milk production performance of both the cows. Per unit decrease in THI from 60 to 54 led to decrease in milk yield by 404 g/d in SW vis a vis 155 g/day in TP cows with decrease of THI from 67 to 54.

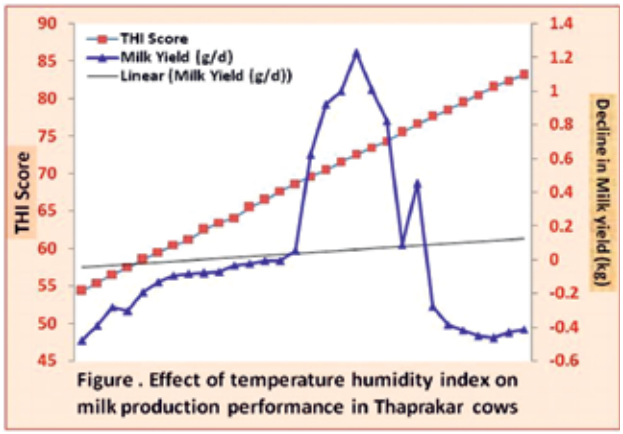


Figure . Effect of temperature humidity index on milk production performance in Thaprakar cows

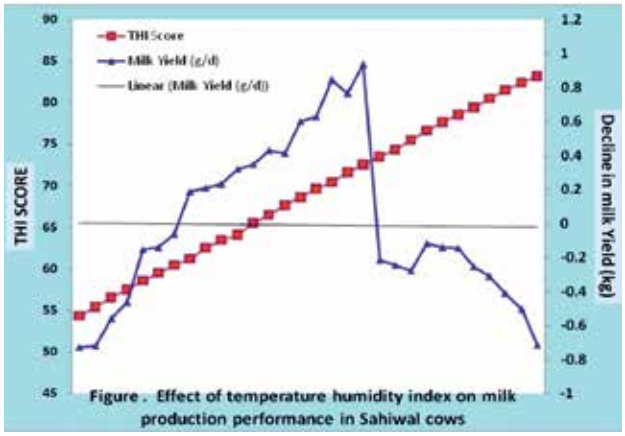


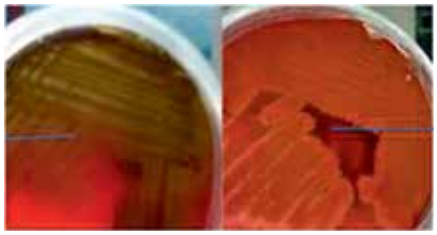
Figure . Effect of temperature humidity index on milk production performance in Sahiwal cows

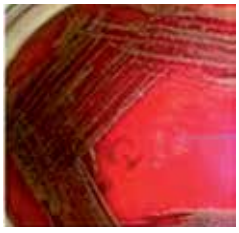
Resistant Map for Mastitis Prevalence in Karnal District

A mastitis resistance map has been developed based on survey in Karnal and Assand district by collecting the mastitis milk samples and testing the resistance against major pathogens. All the commonly used antibiotics (gentamycin, streptomycin, ciprofloxacin, auricin and penicillin) showed higher antibiotic resistance than the old/ uncommon antibiotics. Surveillance helped to know the status of predominant pathogens prevailing in these areas and extent and pattern of resistance. Based on the resistance pattern the Animal Husbandry workers were sensitized by delivering lecture on the global burning issue like AMR in the area of prevalence.

Mastitis Pathogens and Somatic Cell Counts in Buffaloes

In milk samples of Murrah buffaloes, the major agents involved in bacterial intra-mammary infection (IMI) were *Staphylococcus aureus*, *Staph. epidermidis*, *Staph. saprophyticus, Streptococcus agalactiae* and *S. uberis*. The culturally


Colonies of Staphylococcus


Colonies of Streptococcus

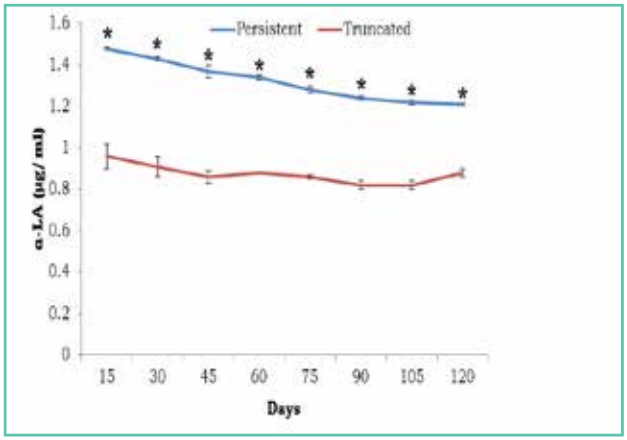
examined and characterized samples revealed *Staph. aureus* (35.29%) as the predominant bacteria followed by *S. agalactiae* with an isolation rate of 25.49%. Coliform bacteria were not detected. Milk SCC ranged between 1.28-1.48x10^5 cells/ml in normal milk samples as compared to 3.85-6.21x 10^5 cells/ml in mastitis milk samples.

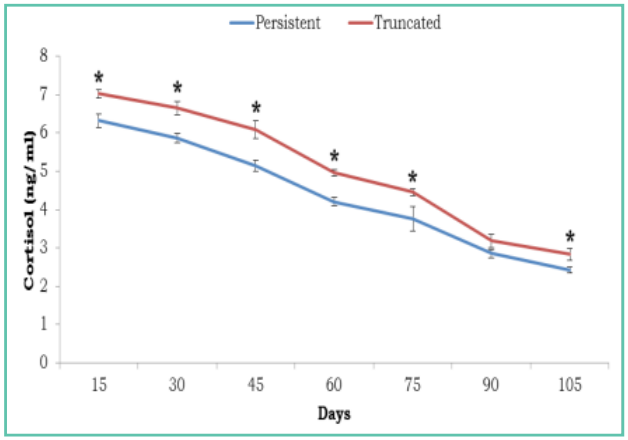
Lymphocyte Proliferation Response to Immuno-Modulators

Three different immune-modulators viz. SNAP, L-NAME and cortisol at different levels and PHA-P (2.5 ug/well) were used for the lymphocyte blastogenic response in young buffaloes *in vitro*. Lymphocyte proliferation response to PHA-P in culture increased significantly with age of buffaloes (P<0.01). Blastogenic response of lymphocytes to 0.5, 2 and 10 ng/ml of cortisol was significant (P<0.02) at 10 ng/ml in buffalo calves. The response also increased significantly with advancing age (P< 0.02). Low SNAP level (0.01 and 0.1 mM) enhanced the lymphocyte blastogenic response but high dose (1 mM) was cytotoxic in growing calves (P<0.05) irrespective of the age. L-NAME, an inhibitor of nitric oxide synthase enzyme, produced inhibition at 6 months at highest dose level of 5 mM thus demonstrating the absence of active NOS in calves up to 3 months of age.

Causes of Truncated Lactation in Sahiwal Cows

The Sahiwal cows calving in the rainy and autumn season were more persistent according to estimate based on persistency (186.52 ± 4.68), whereas those calving in autumn season were least persistent (184.48±4.83). The effect of period of calving was significant (P<0.01) on persistency of lactation. The persistency was highest in 7th parity (206.05±4.85). There was a significant difference (P<0.05) between persistent and truncated cows in α-lactalbumin levels on 15th, 30th, 45th, 60^{th,} 90^{th,} 105th and 120th day postpartum. The plasma cortisol concentration varied from 2.42 to 6.32 ng/ml and 2.83 to 7.02 ng/ml during different periods in persistent and truncated cows respectively. Out of 79 samples, bGH-*Msp*1 resolved into three (CC, CT and TT), where the occurrence of TT genotype was more frequent as compared to the CC and CT genotype. In 67 samples bGH-*Alu*1 resolved into two genotypes (CC and CG), the GG genotype was not found in the samples analyzed. The occurrence of CC genotype was more frequent as compared to the CG genotype.





Astaxanthin Influence Growth, Immunity and Antioxidant Status

Dietary supplementation of Astaxanthin @ 0.25 mg/kg body wt./animal/day to Sahiwal (SW) and Karan Fries (KF) heifers decreased (P≤0.05) the physiological responses (RR, PR and RT) in comparison to control group during summer season (April to September). Circulating levels of plasma GH was higher (P≤0.05) and cortisol and leptin were lower (P≤0.05) in treatment than that of control groups. The biochemical parameter viz. TAC was higher (P≤0.05), whereas, TBARS, SOD, GPx, and catalase and IL-12 were lower (P≤0.05) in the treatment group of heifers. The DMI and ADG were found higher (P≤0.05), while; FCR was lower (P≤0.05) in the treatment group of heifers. The expression patterns of genes viz. NFκβ, HSP70, MnSOD, IL-2, and caspase-3 were down regulated (P≤0.05) and Nrf2 and Bcl-2 was up-regulated (P≤0.05) in the treatment group of heifers. The puberty was attained 33 and 48 days earlier in astaxanthin supplemented groups. It also improved the antioxidant status, growth rate and abates the apoptosis rate, which battens cell survival in animals of both the breeds during heat stress, which was resulted into early attainment of physiological body weight of puberty and hence estrus.

Physiological Responses and Blood Flow in Dairy Cows

Four healthy lactating cows from each of SW, TP, GR and KF breed were selected from the herd and fed as per the ICAR (2013) feeding standard. The mean rectal temperature during summer, winter and thermoneutral were 39.11±0.67, 38.50±0.32 and 38.91±0.49°C, respectively, at 30, 45 and 60 days postpartum. Rectal temperature was significant

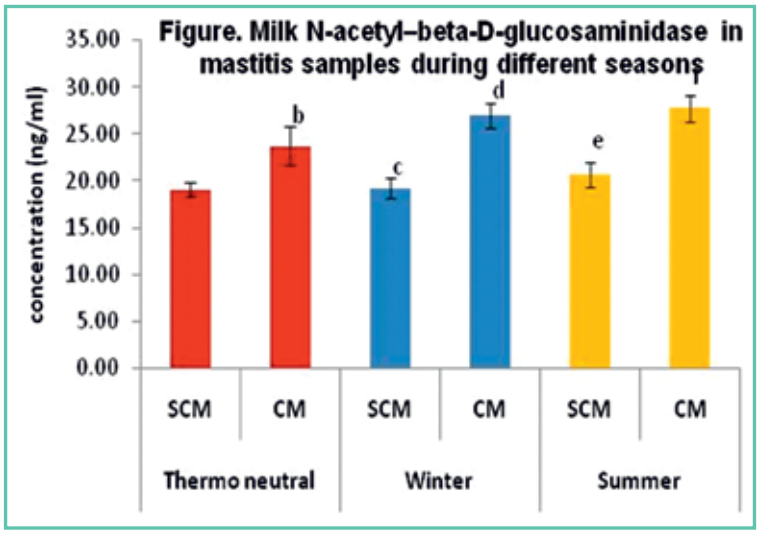
(p<0.05) between season and between days in all breeds but it was significant (p<0.05) in Gir, TP and KF. Respiration rate was highly significant (p<0.01) between seasons and was 29.60±0.63, 24.92±0.39 and 28.13±0.59 breath/minute in summer, winter and thermoneutral environment. Mean pulse rate was highly significant (p<0.05) between breeds and between days of experiment. The mean skin surface temperature in summer did not vary between breeds and was 36.76±0.39, 37.43±0.27 and 37.09±0.98°C at head, shoulder and ramp, respectively. In winter season, the value was 27.47±0.69, 30.55±0.40 and 30±1.12°C at dorsal, abdomen and middle ear, respectively and during thermoneutral it was 34.57±0.69, 35.13±0.40 and 35.19±1.12°C at dorsal, abdomen and middle ear, respectively. The mean blood pressure was 68.48/169.23 mmHg in summer, 55.02/158.54 mmHg in winter and 61.94/158.75 mmHg in thermoneutral, respectively. In the present experiment, both diastolic and systolic pressures differed significantly (P<0.05) in seasons and breeds. During summer, the mean blood flow was more than the winter and declined in thermoneutral condition and was 6.11±0.12, 5.41±0.52, 5.85±0.65 and 8.49±0.65 PU at dorsal, ventral, middle ear and mammary gland, respectively. It was concluded that the season influenced all the physiological parameters which resulted in significant change in pulse rate, blood pressure and blood flow in between breeds.

Bypass Protein Supplementation in Karan Fries Cows

Fermented potato protein supplementation in advanced pregnant Karan Fries cows supplemented with 25 (SG-1) and 50 g/day (SG-2) from -35 days before parturition till 65 day after parturition that treatment increased body weight and BCS (P<0.05) in prepartum period as compared to postpartum period in all the groups. Digestibility coefficient of CP was significantly (P<0.05) higher in SG-2 group as compared to SG-1 and control group. Milk yield and milk protein was highly significant (P≤ 0.001) in SG-2 as compared to SG-1 and control group of cows. Milk fat, plasminogen and pasminogen and plasmin level and their ratio was higher (P≤ 0.05) in SG-2 group as compared to SG-1 and control group. Higher plasma glucose, GH and IGF-I level (P≤0.05) in SG-2 group resulted in more milk yield than the remaining groups. Plasma GH and prolactin was higher (P≤0.001) on the day of calving in all the three groups. Plasma ghrelin was significantly (P<0.05) higher in control group as compared to supplemented groups. NEFA level was significantly lower (P≤0.001) in SG-2 group as compared to SG-1 and control group. On the peak day of lactation mRNA expression of IGF-1 was significantly (P<0.001) higher in both supplemented groups as compared to control group Days to first post-partum heat, service period and AI/conception was significantly (P<0.05) lowers in SG-2 as compared to SG-1 and control group. The conception rate (%) was significantly (P<0.05) higher in SG-2 in comparison to SG-1 and control group.

Effect of Season on Mastitogen Specific Acute Phase Protein in Cows

Frequency of occurrence of *Staphylococcus aureus* causing mastitis was greater than *Escherichia coli* in KF and Sahiwal cows and the pathological changes induced by these mastitogens were species specific. *S. aureus* and *E. coli* led to changes in acute phase proteins and NAGase activity in plasma and milk samples. Coliform mastitis was the most serious form as metabolic profile, Nagase enzyme and Acute Phase Proteins in plasma and milk were higher during *E.coli* infection. Plasma BHBA, NEFA, NAGase, SAA, Hpt in CM and SCM cases depicted seasonal variations and their release was significantly higher in clinical mastitis cases during summer.



Enhancement of Water Productivity

A half inches tap releases approximately 28,000 litres of water per day, out of which only 10-15% water is used for drinking by the animals, the remaining 80-90% of water becoming waste water. The waste water generation was effectively reduced upto 70% by using water saving devices in water troughs and hand controlled water jet

for washing and floor cleaning operations. The package of practices developed could be used for measuring the drinking water requirements of large groups of animals in a paddock.

Enhancement of Reproductive Performance under 'Farmer First' Program (3)

Two hundred and thirty two breedable bovine were inseminated at the time of estrus using the proven bull semen from NDRI, Karnal. These animals were supplemented mineral mixture @ 50-60 g/day/ animal. The conception rate was significantly higher during December to March than April to July and the corresponding THI varied from 63.05 to 75.16 and 81.37 to 82.72, respectively. The overall conception rate of the year was 50%. In another study, 18 repeat breeding buffaloes were selected at farmers' doorstep and supplemented with mineral mixture @ 50-60 g daily for 3 months. The per cent of animals inseminated and conceived after one, two and three months were 22.35%, 42.8% and 25% respectively. The overall conception rate of these buffaloes was around 66%.

Effect of Astaxanthin and Prill Fat Supplementation in Rural Buffaloes

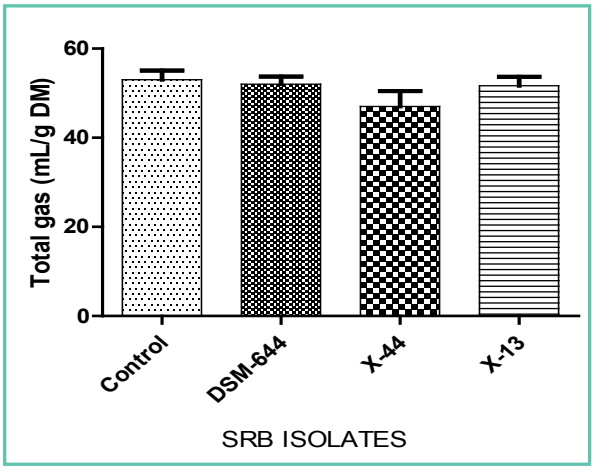
Twenty four lactating buffaloes (av. 60 days) in 2nd to 4th parity were selected from Kathwad village of Kaithal district and subjected to treatment as: group-I (control), group-II (supplemented astaxanthin @0.25 mg/kg BW/ day), group- III (prill fat @) 100 g/ day) and group-IV (astaxanthin @ 0.25 mg/kg BW/day and prill fat @) 100 g/ day). THI varied from 81.37 to 82.72 during summer season of the experiment. Physiological responses were lower in group-II followed by group-IV, III and I. Supplementation of astaxanthin, prill fat and their combination in group-II, III and IV enhanced the milk yield by 5.39%, 13.8% and 15.6% respectively, over control group. Milk fat was higher in group IV followed by groups III, II and I. Milk SNF content did not vary between the groups. Thermal imaging of buffaloes showed, higher udder temperature in supplemented group of buffaloes than control. The cost benefit ratio showed better return in group III followed by group IV and group II.

Effect of Betaine on Growth and Stress Markers

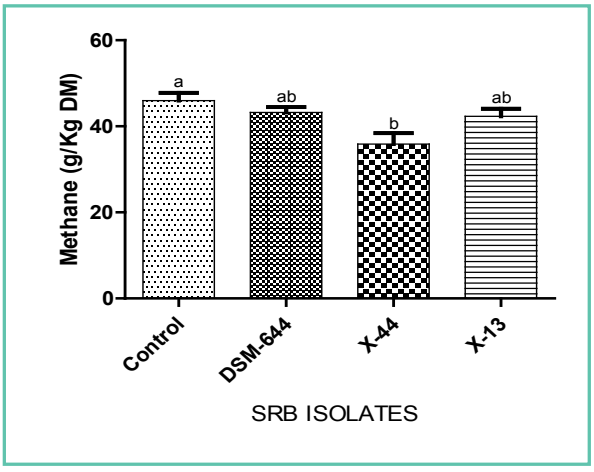
Fourteen buffalo heifers (8-10 months) were selected from adopted village - Kathwar under Farmers FIRST program and divided into control and treatment groups. Dietary betaine @ 25 g/animal/day was supplemented to treatment group during summer season. The average daily gain (ADG) and dry matter intake (DMI) was higher in treatment as compared to control group. Body measurements viz. body length, body girth, height at withers and growth rate was higher by 2%, 2.12%, 1.87% and 2.03% respectively in treatment group. Physiological response viz., rectal temperature, respiration rate, pulse rate and skin temperature declined by 2.22%, 11.52%, 9.85% and 2.44%, respectively in the treatment group.

Diversity and Role of Sulfate Reducing Bacteria in Rumen Hydrogen Sequestration *in vitro*

Role of sulfate reducing bacteria (SRB) to mitigate methane was investigated. Amongst 90 isolates obtained from rumen and sludge samples, 20 were designated as SRB by 16S rRNA sequencing. *Desulfotomaculum ruminis* X-44a and *Fusobacterium* sp. X-13 were selected for *in vitro* rumen fermentation trials with respect to methane, total gas, hydrogen sulfide, volatile fatty acids (VFA) production and dry matter digestibility. *In vitro* rumen fermentation trials on standard diet (roughage:concentrate; 60:40) revealed significant reduction in methane production (35.89±4.410 g /Kg DM) by *D. ruminis* X-44a. It also produced significant amount of H_2S (3.15±0.109 µg/mL gas) as compared to *Fusobacterium sp*. X-13 (1.78±0.217µg/mL gas). Thus, *D. ruminis* X-44a was finally selected for dietary modification



A



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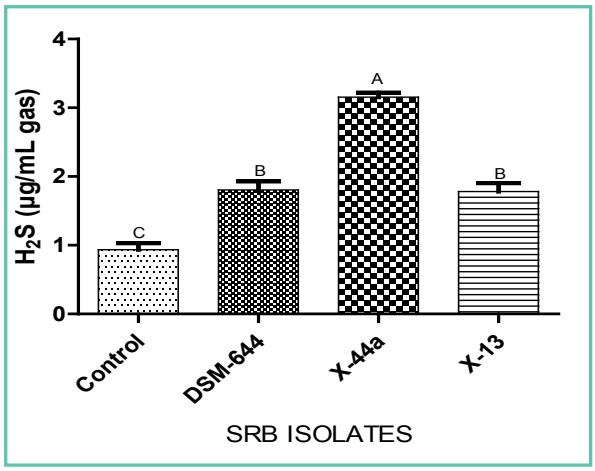

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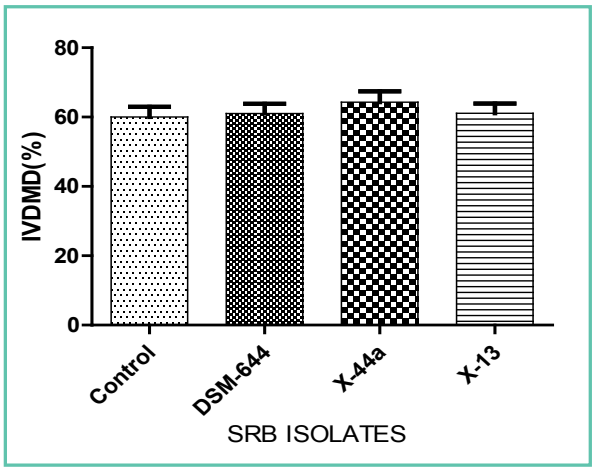
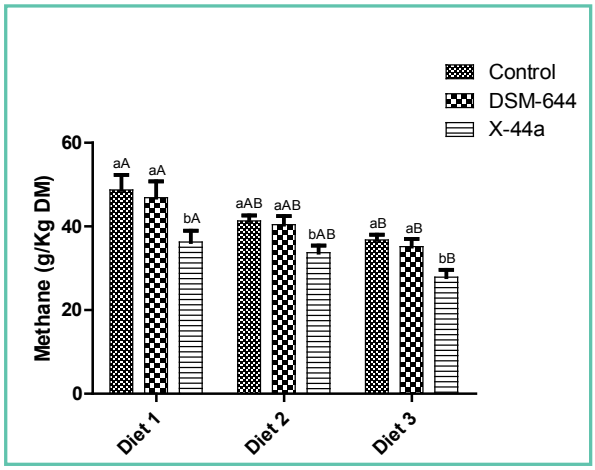
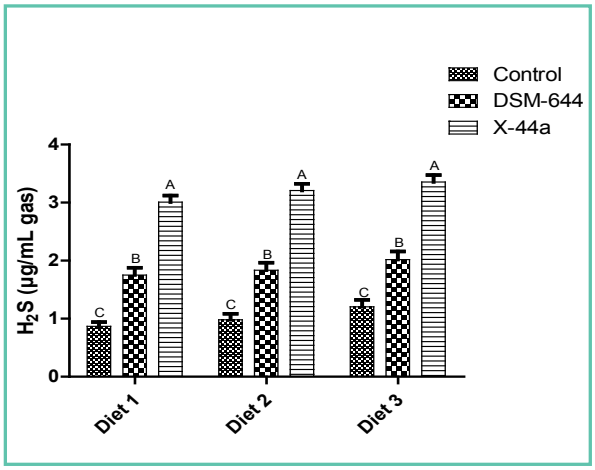


D

In vitro **effect of selected SRB isolates on total gas (A) methane (B), H_2S (C) production and dry matter diagestibility (D) using standard diet.** *Desulfovibrio vulgaris* ***DSM-644;*** *Desulfotomaculum ruminis* ***X-44a;*** *Fusobacterium* ***sp. X-13.***



A



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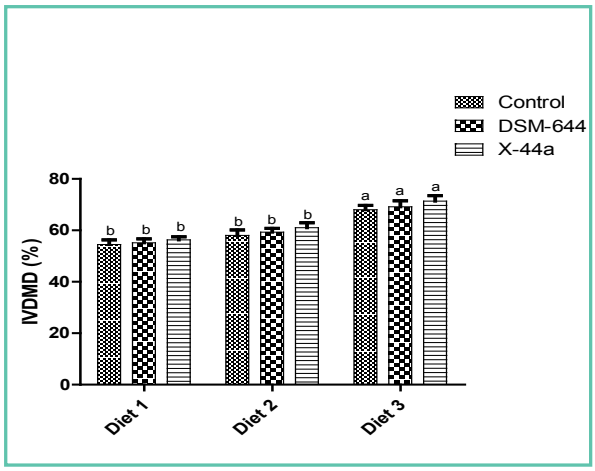

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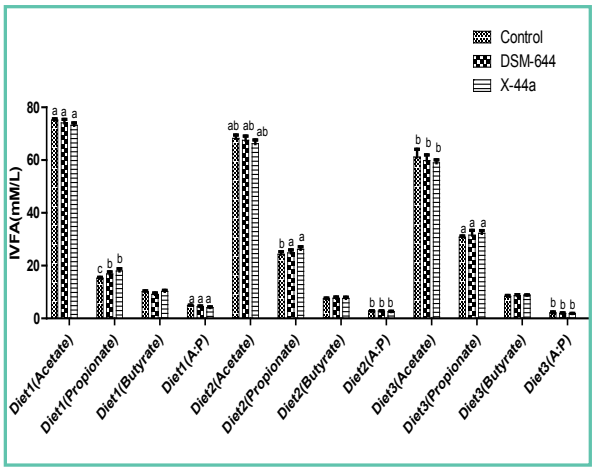


D

In-vitro **efficacy of selected SRB on net methane (A), H_2S (B), dry matter digestibility (C) and VFA (D) production using modified diets.** ***Diet 1- Roughage: Concentrate 80:20; Diet 2- Roughage: Concentrate 50:50; Diet 3- Roughage: Concentrate 20:80.***

trials i.e. diet 1, 2 and 3 (roughage:concentrate; 80:20, 50:50, 20:80). A significant ($p<0.05$) effect of modified diets on methane reduction was observed with diet 3 (20:80 roughage:concentrate) with increased propionate levels and decreased A:P as compared to diet 1. Significant ($p<0.05$) levels of H_2S was produced by *D. ruminis* X-44a. However, no significant effect of modified diets was observed on H_2S production. Significant ($p<0.05$) increase in dry matter digestibility was observed in diet 3 (20:80) as compared to diet 2 (50:50) and diet 1 (80:20). *In vitro* trials indicated *D. ruminis* X-44a as potential hydrogen sinker to mitigate methane production.

Evaluation of Alternative Identification Techniques and Livestock Insurance Products in Karnataka

In India, majority of the farmers are small and marginal (85.01%) with average size of operational land holding (1.15 hectares), which does not provide a decent livelihood to the family. The income from sale of milk supplements the farming income. The Government of India introduced the livestock insurance scheme on a pilot basis during 2005-06 providing subsidy to the extent of 75% on premium. The study evaluated alternate animal identification techniques and livestock insurance products in Karnataka, based on data collected from 120 livestock insurance adopter households. It was found that heifer had been insured for an average value of Rs. 29,324 whereas it was Rs. 58,318 in case of milch animal. The overall claim amount to premium collected ratio was found to be 0.89 indicating the financial viability of livestock insurance under Bengaluru Milk Union Group Cattle Insurance. Plastic tag alone was found to be more efficient in case of application ease, cost and labour requirement whereas plastic tag with branding was found to be more readable and durable. The Garrett ranking technique of alternate insurance products revealed that mastitis was the most preferred product with highest score of 67.04 and the least was theft with a score of 46.50.

Carbon Footprint of Milk Production from Commercial Dairy Farms in Haryana

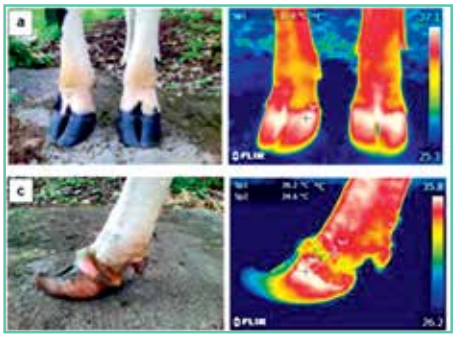
A study was conducted in Haryana state to assess the total amount of carbon dioxide and other green house gases (GHG) such as CH_4, N_2O emission through the life cycle of milk production up to the farm gate level of 50 commercial dairy farms. The average herd size was about 68 dairy animals (mostly HF cross)/commercial farm with, 252 liter average daily milk production and mostly the dung including animal waste was managed in dry lot system. Forty four per cent dairy farmers had low awareness but 18% respondents were highly aware about the emission of GHGs from dairy farming. The carbon footprint value per commercial farm was 126.21 tonne CO_2 eq/year and carbon footprint value per kg fat and protein corrected milk was calculated 1.21 kg CO_2 eq/FPCM/ year. Methane from enteric fermentation (71.62%) and manure management (11.66%) was contributing more in emission of GHGs. Dairy farmers were willing to reduce the emission of GHGs at their farm level. There is urgent need to educate the farmers about the emission of GHGs and mitigation measures.

A Study on Management of Dairy Animal Waste and its Effect on Environment in Urban and Peri-Urban Areas of National Capital Region (NCR), India

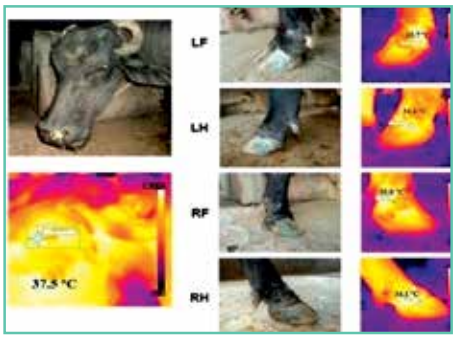
The study was conducted in four sub regions of NCR *viz*., Haryana, Delhi, Uttar Pradesh and Rajasthan, among 252 dairy holders through semi structured interview schedule. About 35.71% of respondents had low level of awareness regarding dairy animal waste management and 39.68% of respondents had medium level of risk perception. The production of dung and urine from 4493 animals in the study area was found to be 104083.24 Kg/day and 29447.84 litre/day; respectively. A total quantity of 187.26 Kg/day methane was emitted from the dung produced by the animals in the study area. Enteric methane emission was found to be 747.23 Kg/day based on the assumptions from literature and 829.1 Kg/day based on the actual feeding pattern. Among the positive effects of dairy animal waste, 'Dung and Urine of Bovines add nutrient content of soil when used as manure' and among the negative effects 'Methane and nitrous oxide gases emitted from animal and dung causes global warming and climate change' stood first as perceived by the farmers. About 38.49% of dairy units were having medium level of waste management efficiency in NCR. The major strength in the dairy animal waste management was found to be the use of dung and urine as nutrient source and the major weakness was unscientific dumping of dung in public places. The major opportunity was found to be the establishment of community level biogas production plants and the major perceived threat was dealing with the environmental issues due to improper waste handling. Huge scope of utilizing the dairy animal waste exists which can increase the farmer's income significantly.

Infrared Thermal Imaging Technology to Monitor Hoof Surface Temperature to Assess Hoof Health Status in HF Cross Bred, Deoni Cattle and Buffaloes

We established the infrared thermographic profile in relation to hoof health status in cattle and buffaloes and evaluated Infrared thermal imaging technology (IRT) as a tool for detection of foot lesions in cattle and buffaloes. For establishing thermographic profile, Deoni lactating cows, HF crossbred lactating cows and Murrah lactating buffaloes were monitored for body temperature (BT) (i.e. eye), coronary band temperature (CBT) and hoof skin surface temperature (HSST) prior to evening milking using IRT camera. Results of the present study revealed that, CBT and HSST did not differ significantly between hooves and

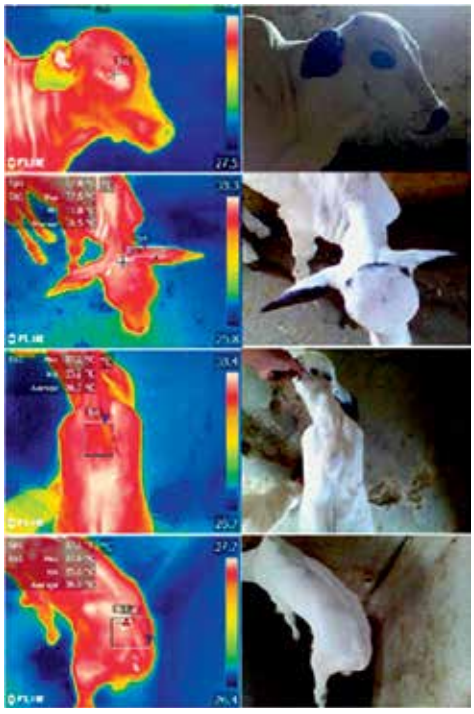


within animal (P>0.05). BT, CBT and HSST were significantly influenced by the type of breed, species, parity, lactation stage and milk yield. CBT and HSST were greatly influenced by ambient temperature. Affected hooves showed significantly higher CBT (ºC)than healthy hooves both in Holstein-Friesian crossbred (2.22) and Deoni (1.78). ROC curve analysis revealed that the area under curve (AUC), sensitivity and specificity of CBT was higher than HSST between healthy and affected hooves, indicating CBT is the best predictor of hoof health status. It is concluded that, CBT was the best indicator to monitor hoof health. This would be useful in developing thermographic signature for individual animal and predictive model for early detection of affected hooves.



Infrared Thermal Imaging Technology (IRT) to Monitor Perinatal Thermal Adaptation & Thermogenesis in Calves

The transition from the in utero to an environmental temperature leads to hypothermia i.e. sudden drop in body temperature which is leading cause of mortality in new-born and neonatal (day 1 to 28) calves, especially in adverse weather conditions. In this line, we established thermographic profile in neonatal calves and investigated the association thyroid profile with temperature to evaluate the role in neonatal thermal adaptation. For establishing thermographic profile Deoni and HF crossbred neonatal calves, were monitored for body (eye) temperature and other body parts skin surface temperatures at 6 hourly in a day throughout neonatal period using IRT camera. Blood samples were collected on 0, 1, 7, 14, 21 and 28 days of calf age for thyroid profile. The body surface temperature differed significantly (P < 0.01) between Deoni and HF crossbred. Surface temperature of body parts such as eye, back of the ear, shoulder, rump and rectal temperature differed significantly (P < 0.01) in both the breeds. Throughout neonatal period, body surface temperature between days differed significantly (P < 0.05) in both the breeds. It was also observed that body temperature significantly differed (P < 0.01) between different times of (6-hour interval) observations. T3 and T4 hormone level was significantly (P < 0.01) higher on day 0 and 1 than later stages of calves' life (days). TSH did not show significant difference in Deoni, however in HF crossbred significant difference (P < 0.01) was observed between days. Perinatal thermal adaptation during first 24 hours of birth might be due to high level of thyroid hormones leading to intense thermogenesis. The eye temperature was consistent and observed to be the best indicator of core body temperature during neonatal period in calves.



Development and Standardization of Body Condition Scoring Technique for Jersey Cross Bred Cows in Lower Gangetic Region

The present study was conducted to develop and standardized BCS technique (Fig-1) for Jersey crossbred animals that prevail at lower Gangetic region with an objective to get higher milk production along with restoration of body condition. BCS of animals were assigned by using ultra-sonography machine along with vernier calipers, measuring tape, visual and palpation technique at fortnight interval from important anatomical regions (critical points) which were taken into account meticulously from 69 Jersey crossbred cows. With the advent of ultra-sonography, back/ramp fat thickness (BFT/RFT) can be objectively measured and used to assess energy status of dairy cows. BFT/RFT was determined by using USG machine (Mindray, Model- DP6600vet) and USG images were taken in B-mode, using 5 MHz frequency with a linear transducer. Statistically analyzed data revealed that BCS, HG, THT were significantly (P<0.05) less in group-2 than group-3 and group-1. The RFT /BFT differences were found to be significant (P < 0.05) among three groups. More RFT was found in high BCS group followed by medium and low BCS group. The BCS was having strong and significant (P<0.01) correlation with RFT and body weight of animals. The RFT was significantly (P<0.01) correlated with body weight, milk yield, HG, THT and AG. The higher BCS group looses RFT, BCS and BW faster than other 2 groups to support milk production. It can be concluded that this BCS technique can be used as a reliable criterion in choosing Jersey crossbred cows for higher milk production with restoration of body condition and high producing animals, mobilized greater amount of body condition and RF / BF than low producing cows, in early lactation, which was having adverse effect on udder health and overall milk yield at this lower Gangetic region.

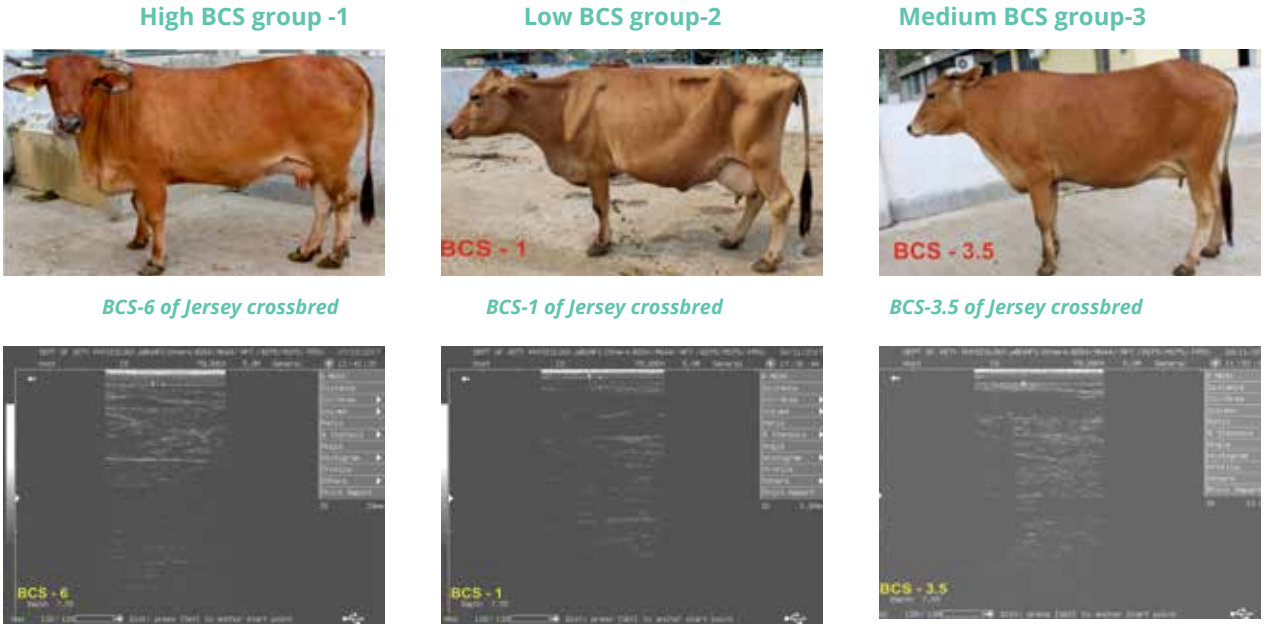


Fig 1: USG and real images of different BCS groups of Jersey lactating cows

BCS 6	I (mm)	E (mm)	Changes	BCS1	I (mm)	E (mm)	Changes	BCS 3.5	I (mm)	E (mm)	Changes
RFT / BFT	33.2	23.9	- 28.1%	RFT / BFT	3.87	3.55	- 8.27 %	RFT / BFT	16.5	13.25	- 19.7%

Investigation of Association among Management Measure, Milk Production and Udder Health Status of Lactating Jersey Crossbred Cows

Farm experimentation was carried out on 44 lactating Jersey crossbred during two calving seasons (rainy and winter). The experimental animals were observed from calving to 120 days post-partum. Based on BCS at calving animals were grouped into 3 class group i.e. low (9), medium (23) and high (12) group. However cows were free from all physiological, anatomical and infectious disorder. To assess the BCS of animals, recently developed technique at ERS was applied and udder health status of cow was evaluated by milk somatic cell count, MCMT, MBRT, pH, milk composition etc. Statistically analyzed data revealed that mean BCS of lactating Jersey cross bred cows for primiparous varied from 2.82 to 4.18 where as for multiparous it was ranged from 2.88 to 4.31. During calving at rainy season mean BCS varied from 3.39 to 3.90 where as during winter it was ranged from 3.08 to 4.27 for lactating cows. The overall BCS significantly ($p<0.05$) influenced by parity of lactating Jersey crossbred cow. Average total milk yield was significantly ($p<0.05$) affected by BCS group. For high BCS animal group, mean milk yield varied from 11.0 to 12.8 Kg/day/animal. The mean milk production of medium BCS group ranged from 8.81 to 12 Kg/day/animal where as low BCS group produced average milk from 8.77 to 11.2 Kg/day/animal. Milk SCC was significantly ($p<0.05$) affected by BCS of animal. For high BCS animal mean milk SCC varied from 4.21 to 4.78 $x10^5$cells / ml. The mean milk SCC of medium BCS animal ranged from 1.80 to 2.54 $x10^5$cells /ml whereas low BCS animal showed average milk SCC from 3.32 to 3.82 $x10^5$Cells / ml. Comparatively higher values were observed in modified California mastitis test (MCMT), pH and methelene blue reduction test (MBRT) of milk samples of high and low BCS than medium BCS group. The milk composition viz: fat (%), SNF(%), protein(%) and milk quality varied among different BCS groups. It can be concluded that increase of BCS at calving had a positive effect on daily milk production, with a negative effect on udder health status. Higher milk production along with better udder health status was found in medium BCS (3–4.5) of Jersey crossbred cow. Therefore, suitable management practices should be provided to lactating Jersey crossbred cows during lactation to avoid negative energy balance and lose body condition and udder health status.

Thermo-comfortable Thatched Roof Influences Cow-Shed's Micro-environment, Milk Yield and Milking Behaviour of Dairy Cows

Livestock housing plays an important role in buffering the effects of external environment on animals' body. A thermo-comfortable model shed was established at Eastern Regional Station, Kalyani for amelioration of thermal stress and to provide better housing comfort to cows. Thermo-comfortable shed was made up of thatched roof with ridge ventilation roofing design. The main axis orientation of the shed was East-West direction. Due to changes in roofing material, design and axis orientation, the micro environment of presently developed cow-shed became cooler, more ventilated, thermal radiation protective and comfortable than the existing traditional asbestos roofed

cow-shed. The microclimatic conditions of the experimental shed were compared to existing shed having asbestos roof. Over all floor surface temperature of thermo-comfortable shed was 0.68 to 2.33°C less in morning and 1.33 to 4.05°C in afternoon. The ceiling surface temperature was 6.10 to 12.28°C less than that of existing shed in morning and 3.87 to 10.53°C in afternoon. The average respective daily environmental temperature and humidity in the morning were 0.80 to 1.52°C and 0.4 to 2.29% less in experimental shed compared to existing shed. The corresponding values in the afternoon were 1.34 to 2.03°C and 1.00 to 2.23%.

Experiment was conducted on 40 Jersey crossbred cows divided in two groups, each containing 20 animals and they were kept in two different housing patterns i.e., existing shed (control group) and thermo-comfortable shed (experimental group). Average daily milk yield /cow in the thermo-comfortable shed were significantly higher than that of existing shed (control group). Milk composition of cows kept in thermo-comfortable house was superior as compared to that of control group. Feed intake between control and experimental groups did not show any significant difference. Housing significantly influenced the cardinal physiological parameters of Jersey crossbred cows. In control group, morning body temperature was 0.2°C higher and respiration rate was 16.16% higher in morning and 14.53% higher in afternoon compared to experimental group. The results indicated that cows kept in experimental shed were more comfortable and produced more milk /per cow /day than that of existing shed.

The study revealed that cow-shed designs and comfort not only affect milk production but also influence expression of cows' behaviour in the milking parlour. Dairy cows kept in thermo-comfortable sheds were more docile and exhibited less temperament score ($P<0.01$) as compared to those kept in existing shed. Milk flow rate, milking durations and milk parlour exit score were also higher, though the differences were non-significant. Incidence of vocalization and expression of eliminative behaviours such as defecation and urination in milking parlour were of lower range in cows of experimental shed as compared to that of control. The study concluded that use of paddy straw as roofing material and changes in roof design and axis orientation of cow-shed favourably changed the micro-environment of shed, augmented the milk yield, enhanced comfort indices and positively modulated the expression of milking behaviours of dairy crossbred Jersey cows.

NOVEL APPROACHES IN VALUE ADDITION AND FUNCTIONAL FOODS

Preparation of Low Cholesterol Ghee Using Butter and Ghee as Base Material

A maximum of 93.86% cholesterol could be removed from butter using β-cyclodextrin. However, the yield obtained using this combination was only 70.93%. Therefore, another combination was selected which gave 90.4% cholesterol removal and 76.5% yield vis-à-vis 79.09% in control. The maximum cholesterol removal and yield obtained using ghee as a base material `were 97.65% and 84.04%, respectively. Most of the physico-chemical properties of ghee were not affected by the process of cholesterol removal from butter. The low-cholesterol ghee made using butter as a base material had lower shelf-life as predicted by rancimat study with an induction period of 7.66 h and 1.85 h at 120ºC and 140ºC, respectively. However, the storage study of low-cholesterol ghee done at 37ºC/5 months revealed no major difference in FFA value, peroxide value, TBA value and conjugated dienes content of control and low-cholesterol ghee.

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

The three traditional Indian dairy products (TIDPs) *viz.* paneer, khoa based burfi and chhana based sandesh were first evaluated for prevalence of different microflora and also its respective spoilage microflora at room temperature. The spoilage of paneer was brought about by a myriad of microflora dominated chiefly by coliform group (5 log), Gram positive cocci (5 log) and yeast and molds (4 log). However chhana based sandesh had a better shelf life of 6 days, after which fungal growth were visible. Although, fresh sandesh sample contained different kinds of microflora, during storage the coliforms declined sharply. The Gram positive cocci (6 log) thrived during the storage period and the numbers did not change significantly, however yeast and mold increased sharply (7 log) and were majorly responsible for sandesh spoilage. Similarly, in burfi, the major spoilage organisms were found to be yeast and mold along with Gram positive cocci which also increased to a certain level during storage. A total of more than 400 isolates were isolated from 34 diverse samples, out of which a total of 4 LAB isolates showing activity against *E. coli* K12 and 12 best LAB isolates against the fungal indicators were selected. Two of the antibacterial isolates have been identified as *Lactococcus* spp., whereas three antifungal isolates as *Lactobacillus fermentum* by 16S rRNA gene sequencing.

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

The study was aimed at formulation of defined strain techno-functional starter cultures isolated from fermented foods of 'cold desert region' in concentrated direct form for preparation of fermented milks. Total 38 samples comprising dahi (23), lassi (8), pickles (6) and goat milk (1) were collected from cold desert region (Lahaul and Spiti District, and Bharmaur of Chamba District) of Himachal Pradesh. A total of 399 LAB species were isolated from these products. Out of these, 49 lactic cultures, namely *Lactococcus* (33), *Lactobacillus* (5), *Leuconostoc* (5) and *Pediococcus* (6) cultures with good technological properties viz. acidification and flavour profile, hetero-fermentation, antimicrobial and phytase activities were deposited with National Collection of Dairy Cultures (NCDC), Dairy Microbiology division, ICAR-National Dairy Research Institute, Karnal. Promising cultures exhibiting better technological properties were identified by 16S rDNA gene partial sequencing which showed 91-100% similarity with *Lactococcus lactis*, *Lactobacillus plantarum*, *L. casei, Pediococcus pentosaceus* and *Leuconostoc*. The partial sequences of 16S rDNA of 20 different cultures was submitted to NCBI and deposited under accession numbers MH109682 to MH109701. For preparation of Dahi, single strain culture of *L. lactis*, CDM 038, was formulated. Culture combination of *L. lactis* subsp. *lactis* CDM 104 and *Leuconostoc mesenteroides* ssp. *lactis* CDG 21 has been formulated for Gouda cheese preparation. Process of *dahi* and Gouda cheese preparation and technology for production of DVS cultures has been standardized.

Technology of Gluten-Free Pasta from a Composite Dairy-Millet Base

Pasta is an important food product, consumed as a staple food over many countries around the world. Durum wheat semolina flour containing gluten is the ideal source for preparation of pasta. Although gluten-free products have been developed from cereals such as rice, maize, millets etc., it is very difficult to find a perfect alternative to replace techno-functional role of gluten in the pasta. The current investigation was aimed at developing gluten free pasta from depigmented pearl millet flour in combination with milk proteins, hydrocolloids and transglutaminase (TG) enzyme. The rennet casein added pasta samples had superior quality than sodium caseinate added pasta samples. The inclusion of WPC further improved the cooking and textural properties of pasta, but sensory properties were not improved. Addition of hydrocolloids and TG showed profound effect on all the properties and were found useful in development of gluten-free pasta. The selected formulations were subjected to different drying temperatures to improve the quality of gluten-free pasta. The gluten-free pasta packed in metallized polyethylene and stored at 38ºC/90% RH was found acceptable till 45 days of storage. The costs of production of one kg of TG- and hydrocolloids-added gluten-free pasta were Rs. 269.93 and 268.00, respectively.

Properties evaluated:

Sensory, Cooking loss, Water absorption, Firmness, Colour, Pasting properties, Protein solubility, SDS-PAGE

Depigmented pearl millet flour | Blending with milk protein, enzyme, hydrocolloids & water | Extrusion & drying | Gluten free pasta

Figure: Protocol of gluten-free pasta from a composite dairy-millet base

Technology of Buffalo Milk Protein Concentrate 60 (BMPC60) with Increased Solubility

Milk Protein Concentrate 60 (MPC60) powder was manufactured from pasteurized buffalo skim milk (PBSM) followed by its characterization for physico-chemical, functional and reconstitution properties. To standardize the UF retentate, PBSM was subjected to change in pH and different heat treatment combinations, after which effect of different stabilizing salts in isolation and combination were studied based on zeta potential, heat stability and viscosity values of UF retentate. The standardized UF retentates obtained after salt addition or from carbonation of milk/UF retentate were spray dried to obtain treated MPC powders with improved functional properties. The applied interventions i.e. salt addition and carbonation significantly ($P<0.05$) improved the solubility (by 15-20%) of resultant fresh powders over control powder. Rheological modelling and micro-structure of all MPC powders were also studied. Storage induced changes in properties of control and optimized MPC60 powder (with maximum solubility) were studied. It was observed that after 12 month of storage, solubility of control and optimized MPC60 powders decreased, but rate of decrease was drastic in control powder. During storage, solubility, dispersibility, flowability, foaming, oil and water binding properties of control and optimized powders showed a decreasing trend while noticeable increase was observed in their hydroxy methyl furfural (HMF) contents.

Properties evaluated: Chemical composition, Physical, Reconstitution, Functional, and rheological properties, Microstructure of MPC60 powders.

Buffalo Milk | Separation & Pasteurization | UF | Spray Drying | BMPC60

Figure: Protocol of Buffalo Milk Protein Concentrate 60

Studies on Structure, Rheology and Functional Properties of Paneer

Experimental data on effect of processing parameters on viscoelastic characteristics of paneer and kinetics of changes in quality attributes of paneer during cooking in model gravy system was obtained. This research data may serve as package for the industry for designing and operation of mechanized paneer manufacturing plants.

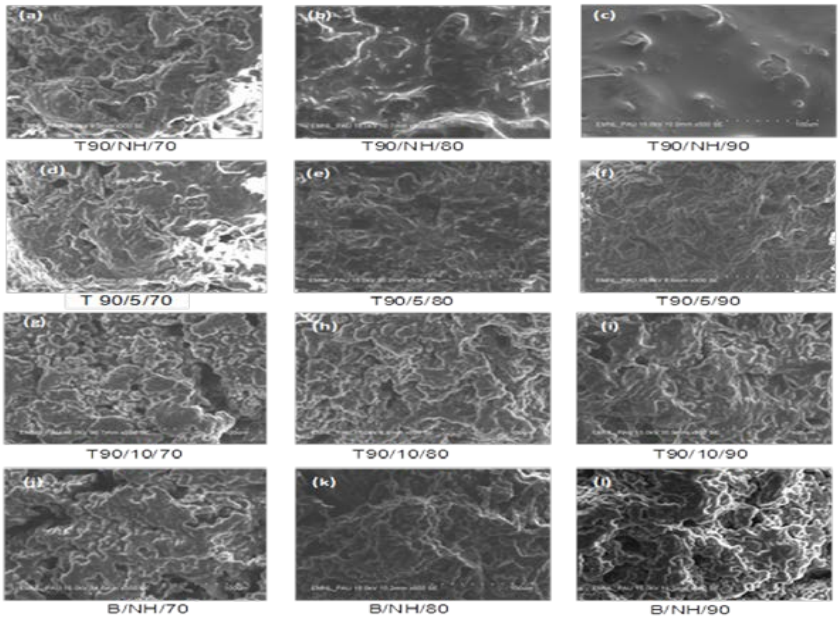


Figure: Effect of processing parameters on microstructure of paneer. Microstructure of paneer samples coagulated at lower coagulation temperatures (70°C) shows more voids (a, d, g & j) when compared to samples coagulated at higher temperature (90°C) (c, f, i& l).

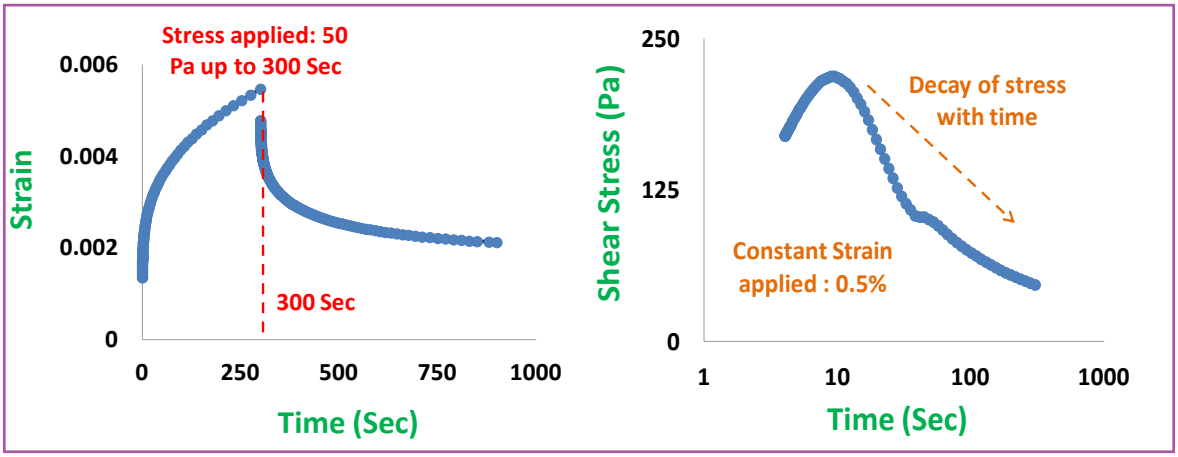


Figure: Creep compliance tests (A) revealed that rate of deformation after the application of a constant stress was higher when lower coagulation temperatures were employed during paneer preparation. Stress relaxation study (B) indicated that decay of stress was lower when coagulation temperatures of milk increased (70-90°C) during paneer preparation.

Volatile Compounds as Marker of Freshness of *Khoa* during Storage as Affected by Packaging and Storage Conditions

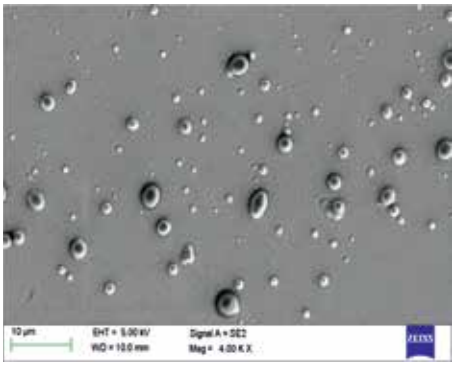
The freshness of *khoa* is lost during storage, due to metabolites that are generated from biochemical and microbial changes. Despite the extreme importance of aroma as an indicator of quality and product conformity, information related to the key quality indicating aroma compounds in *khoa* is not available. In this study, the effect of three different packaging materials and three different storage temperatures on the concentration of volatile organic compounds in the headspace of packaged *khoa* during storage across three different storage periods was monitored. Headspace solid phase micro-extraction in conjugation with gas chromatography mass spectrometry (HS-SPME-GCMS) was used for extraction, identification and quantification of volatile compounds from the package headspace. Simultaneously, the stored *khoa* was analysed for biochemical quality parameters (thio-barbituric acid, free fatty acids, peroxide value) and microbial and sensory attributes. Higher contents of alcohols, acids, carbonyls and other compounds were found at the end of the study in all packages. The levels of these compounds increased with storage in proportion to their biochemical, microbial and sensory quality. It was found that 2-ethyl-1-hexanol, ethanol, 1-hexanol and odd carbon numbered short chain methyl ketones were

key compounds for providing quantitative and qualitative information about deterioration of *khoa* and could be considered as a markers of freshness loss during storage.

Figure: Characterization of volatile organic compounds as affected by storage conditions

Bioactive Peptides Loaded Niosomes: Preparation and Characterization

Casein was hydrolysed with flavourzyme and the hydrolysates were subjected to ultrafiltration to obtain 3, 5 and 10 kDa permeate biopeptides. A process was optimized for the preparation of stable biopeptide loaded niosomes by using these peptide fractions and by optimizing the concentration, type of non-ionic surfactants (Tween 60 and Span 60, singly or in combination) and stabilizer (lauryl alcohol and cetyl alcohol), as well as method of niosomes preparation.Prepared biopetides-niosomes were characterized for their hydrodynamic diameter (particle size), polydispersity index (PDI) and zeta potential. It is observed that Tween 60 showed lower mean hydrodynamic diameter (149.04 nm) compared to Span 60 (251.3 nm) and combination (1:1 ratio) of Tween 60 and Span 60 (167.21 nm). The PDI and zeta potential were 24% and -32.0 mV for Tween 60 niosomes, while they were 21.3% and -34.6mV for Span 60 and 28.7% and -32.3 mV for combination, respectively.A lower particle size, as well as PDI and zeta potential (48.59 nm, 23.7% and -29.5 mV) were observed for lauryl alcohol than cetyl alcohol (377.7 nm, 23.7% and -28.4 mV), respectively. These niosomes could serve as potential delivery vehicle of biopeptides through fortification of milk.



Preparation and Morphological Characterization Of Catechin Loaded Niosomes

Catechins belong to class of flavonoid known as flavan-3-nols. Green tea is the major source; catechins provide multiple health benefits, but they have limited efficacy due to poor absorption, bioavailability and stability. Niosomes are a novel type of nanovesicles formed by the self-assembly of non-ionic surfactants in aqueous media resulting in closed bilayer structures. Therefore, a process for preparation of catechin loaded niosomes was standardized by optimizing different concentrations of catechins, surfactants and method of niosomes preparation. Prepared catechin loaded niosomes were characterized for morphological studies. The SEM image has shown the formation of bi-layered catechin-niosomes.

Deoni and Malnad Gidda Cow Ghee: Study of Physico-chemical Properties

Deoni and Malnad Gidda cow ghee samples were prepared by creamery butter method after subjecting to clarification at 120°C. Fat content in milk, cream and ghee samples was analyzed as per the standard methods. Ghee samples were separated into solid and liquid fractions at 29°C. It was observed that Malnad Gidda cow ghee has shown maximum solid fractions (91.8%) than Deoni cow ghee (86.6%). The following observations were made for Deoni and Malnad Gidda cow ghee, respectively; Butyro refractometer reading: 41±0.004 and 42±0.004; specific gravity: 0.903±0.007 and 0.915±0.004; free fatty acid content (% oleic acid): 0.3±0.1 and 0.3±0.08; Reichert Meissl value: 29.66±0.3 and 27.5± 0.2; Polenske value: 1.3± 0.09 and 1.7±0.06; saponification value: 229.4±3.8 and 205.6±2.5 and melting point (°C): 31-33.6 and 30.7-33.4.

Preparation of Biodegradable Film from Coconut Shell Powder

Cellulose has been extracted from coconut shell powder (CSP) after washing CSP with sodium hydroxide, bleaching with sodium hypochlorite, and acid hydrolysis. The extracted cellulose and casein and were blended at 3:6 ratio and the films were prepared by solution casting method and dried at 40°C. The pre-conditioned films (27°C and 65% RH) were evaluated for their moisture content, thickness, and tensile properties such as tensile strength, tensile strain and modulus of elasticity. The mean thickness of casein film was 214µ and was lower compared to cellulose reinforced casein film (287µ). Addition of cellulose increased the tensile strength and elastic modulus from 4.980 to 8.609 MPa and 9.99 to 105.18 MPa, respectively as compared to casein films. However, the tensile strain decreased from 51.64 to 8.74%. The moisture content decreased with addition of cellulose from 18.90 to 15.71%. The whiteness index and transparency too decreased with addition of cellulose.

DEVELOPMENT AND VALIDATION OF HEALTH PROMOTING DAIRY FOODS

Enhanced Gene Expression and Improved Cell Viability at Different Concentration of Probiotic Secreted Proteins in the Compromised Supernatant

The TM3 Leydig cell line used in this study is derived from mouse testis which is a good model system to mimic the process of steroidogenesis taking place in Leydig cells. It has been observed that dietary supplementation of probiotic bacterium *Lactobacillus reuteri* to aged mice makes them appear to be younger than their matched untreated sibling mice. In accordance, Levkovich *et al.* also reported that aged mice consuming purified *L. reuteri* organisms had particularly larger testicular size and show dominant male behavior due to incresead concentarion of testosterone. *L. rhamnosus* GG (LGG) treatment on TM3 Leydig cell cultures showed high increase in cell viability at 1 µg/ml of protein concentration ($P<0.05$) after 3 hours of exposure while at 6 hours the cell viability significantly increased ($P<0.05$) at 100 µg/ml of protein concentration and at 12 hours exposure the highest viability was observed at 0.1 µg/ml. In case of *L. gasseri* NCDC-688, 3 hours of exposure leads to highest cell viability without any significant increase. After 6 and 12 h of exposure similar effects were observed as in *L. rhamnosus* GG (LGG) secreted proteins. Treatment of TM3 cells with *L. fermentum* NCDC-400 at 3 hours showed a significant ($P<0.05$) increase in cell viability at 0.1, 1 and 10 µg/ml of protein concentration with the highest value obtained at 10 µg/ml concentrations. At 6 hours of exposure, the cell viability increased significantly ($P<0.05$) at 10 and 100 µg/ml of protein concentration with the highest value at 100 µg/ml concentration. After 12 hours of treatment there was a significant ($P < 0.05$) increase in TM3 cells viability at 0.1, 1 and 10 µg/ml of protein concentration with the highest viability observed at 0.1 µg/ml of *L. fermentum* proteins in compromised media (Fig 1). Fig 2 indicates a significant ($P<0.05$) increase in cell viability at all (0.1, 1 10 and 100 µg/ml) the concentrations with the highest value observed at 1 µg/ml concentration at 3 h of exposure with *L. rhamnosus* RSI3 NCDC-610 secreted proteins. At 6 hours of exposure, a similar trend was observed as in case of 3 hours of RSI3 exposure, but with the highest value obtained at 100 µg/ml concentration.

Expression analysis of 17-βhsd and p450scc gene in TM3 cells: Fig 3 showed that, after 6 hours of exposure to the different probiotic supernatant, the expression of p450scc gene in LH stimulated TM3 cells tended to increase with increasing concentration in LGG and *L. fermentum*. However, in case of *L. gasseri* and RSI3 upto 1 µg/ml concentration expression of p450scc gene significantly increase afterword it decreases. Fig 4 illustrated the results of the 17-βhsd gene expression in LH stimulated TM3 Leydig cells, in which there is a significant increase in the expression from 0.1 to 1 µg/ml concentrations in all the four different probiotic strains after which there was a decreasing trend of the gene expression at higher concentration i.e. at 10 µg/ml.

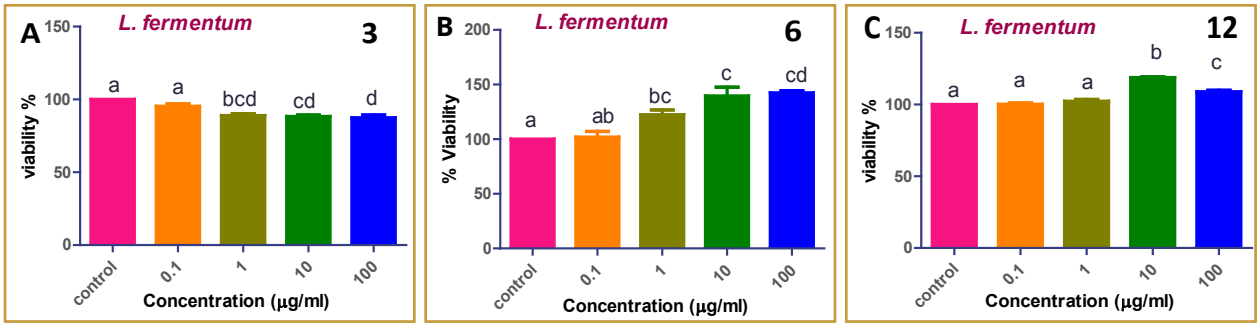


Fig 1. Effect of L. fermentum-EPS on TM3 cell viability at 3 h, 6 h and 12 h exposure. The data are expressed as the mean viability ± SEM of three independent experiments performed in duplicate. Bar with different superscripts represents the significant different at p<0.05

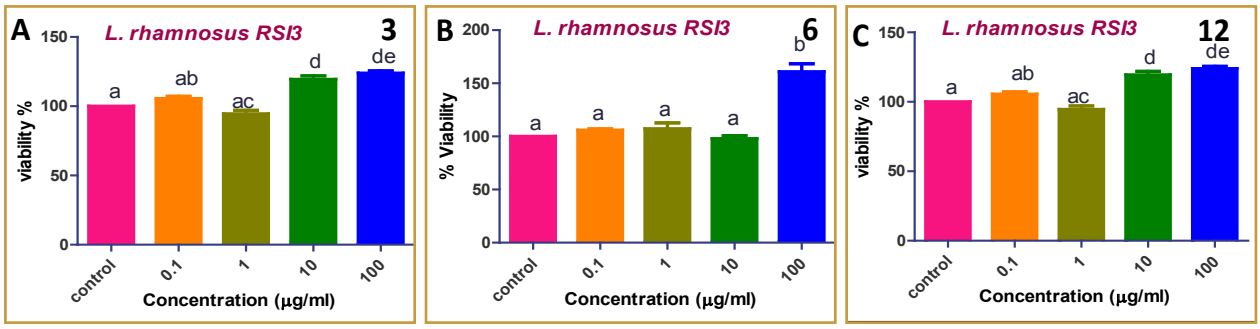


Fig.2. Effect of L. rhamnosus RSI3-EPS on TM3 cell viability at 3 h, 6 h and 12 h exposure. The data are expressed as the mean viability ± SEM of three independent experiments performed in duplicate. Bar with different superscripts represents the significant different at p<0.05

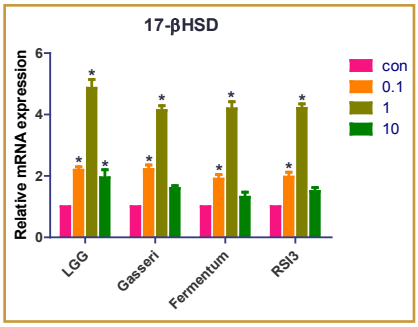


Fig. 3. Effect of compromised supernatant on gene expression of 17-βHSD gene in different probiotic strains. Results are presented as the mean relative gene expression ± SEM of three independent experiments performed in duplicates. Anasterisk (*) represents P<0.05 compared with the control group

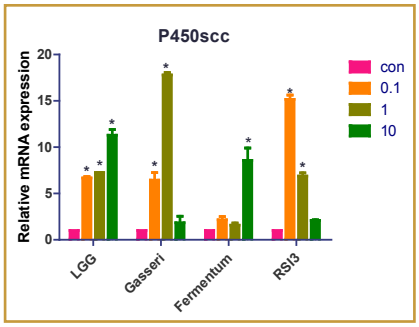


Fig. 4. Effect of compromised supernatant on gene expression of p450scc gene in different probiotic strains. Results are presented as the mean relative gene expression ± SEM of three independent experiments performed in duplicates. An asterisk (*) represents P<0.05 compared with the control group

Maintenance of Immune Homeostasis in Intestinal Epithelial Cells by Probiotic Bacteria

The specialized epithelial cells of gastrointestinal tract is amongst the largest barrier surfaces that separate hosts from the external environment and adapted to colonization by bacteria that markedly influence the development and function of the mucosal immune system in addition to aid in digestion. However, microbial colonization carries with it the risk of infection and inflammation if epithelial or immune cell homeostasis is disrupted. Furthermore, intestinal epithelial cells (IECs) can sense and respond to microbial stimuli to reinforce their barrier function and participate in the coordination of appropriate immune responses, ranging from tolerance to anti-pathogen immunity. For mechanistic overview of immune-modulation during probiotic treatment, varying amount of changes in mRNA expression of immune signals were observed during exclusion, competition and displacement assays in presence of inflammatory agents (live *Escherichia coli* or its LPS). Over-expressions of inflammatory cytokines (TNF-α, IL-8 and IL-23), TLR-4 and NFkβ in intestinal (caco-2) cells due to live *E.ccoli* treatment were reduced near to normal values during exclusion and competition assays in contrast to displacement by probiotic *Lactobacillus fermentum* MTCC 5898 and *L. rhamnosus* MTCC-5897. Interestingly, suppressed mRNA expression of Single Ig IL-1-related receptor (SIGIRR), which is a negative modulator of TLR-4 mediated immune response, stimulated significantly during treatment with inflammatory agents in presence of either of probiotic bacteria irrespective of exclusion, competition or displacement assays. Exposure of probiotic bacteria to intestinal cells also stimulated the expression of TLR-2 during exclusion and competition with inflammatory agents.

In vivo Safety Assessment of Probiotic *Lactobacillus Fermentum* (MTCC:5898) and Maintenance of Gut Barrier Integrity

Safety assessment of probiotic *Lactobacillus fermentum* MTCC-5898 (LF) with three doses (10^7, 10^9, and 10^{11} cfu/day/animal) was carried on Swiss albino mouse weanlings for 28 days using oral route. Health status of animals was monitored by physical assessment of body weight, organ indices, and histological appearances of liver and intestine along with measurement of hematological parameters (Hb, WBC, RBC count, MCHC, MCV, MCH), biochemical analytes in blood involving glucose, serum enzymes (ALT,AST and LDH), urea, creatinine and lipid profile (totalcholesterol, triglycerides, HDL, VLDL, LDL, and atherogenicindex). LF showed no adverse effects on above parameters of general health status after continuous consumption for the experimental period. On the other hand, significant increase ($p \leq 0.05$) in TGF-β (regulatory cytokine) and considerable decrease ($p \leq 0.05$) in IFN-γ (pro-inflammatory cytokine) without any major changes in IL-4 and IL-12 in intestinal fluid on consumption of 10^9cfu/animal/day confirmed its dose-specific response for immune homeostasis. Further, safety of LF was also confirmed by insignificant changes

in release of FITC-dextran (4 kDa) in blood on its consumption than control group where only saline was given orally. Moreover, significantly ($p \leq 0.05$) increased mRNA expression of claudin-1 and MUC-2 in intestinal epithelial cells on feeding *L. fermentum* further supported FITC-dextran permeability data which otherwise showed increased flux of FITC-dextran in blood on consumption of *E. coli* (10^9 cfu/animal/day) due to intestinal damage. Thus, *in vivo* results confirmed that *L. fermentum* MTCC 5898 is safe and non-toxic to weanling mice and may be considered for functional food application after clinical testing.

Osteoprotective Potential of Whey Derived Anti-Oxidative and Angiotensin-Converting Enzyme Inhibitory Peptides

The study investigates the osteoprotective potential of whey derived anti-oxidative (AO) (P1- MHIRL, P2- YVEEL) and angiotensin-converting enzyme inhibitory (ACE inhibitory) (P3- YLLF, P4-ALPMHIR, P5-IPA, P6- WLAHK) bioactive peptides. The proliferation and osteogenic activity of osteoblast cells in presence of these peptides were determined by MTT assay, DNA quantification study, ALP activity and staining, Alizarin red activity and staining, and secretory osteocalcin measurement. The expression of osteogenesis-related genes (*COLI-α, ALP, OCN and RUNX2*) were determined by RT-PCR analysis over a period of 21 days. The peptide treated osteoblasts showed a significant increase in viable cell density and proliferation in the order of P2>P6>P3 at optimized concentration. Furthermore, the osteoblastic differentiation markers in response to these peptides were found to be significantly up-regulated in the order of P2>P6>P3 when compared to the controls.

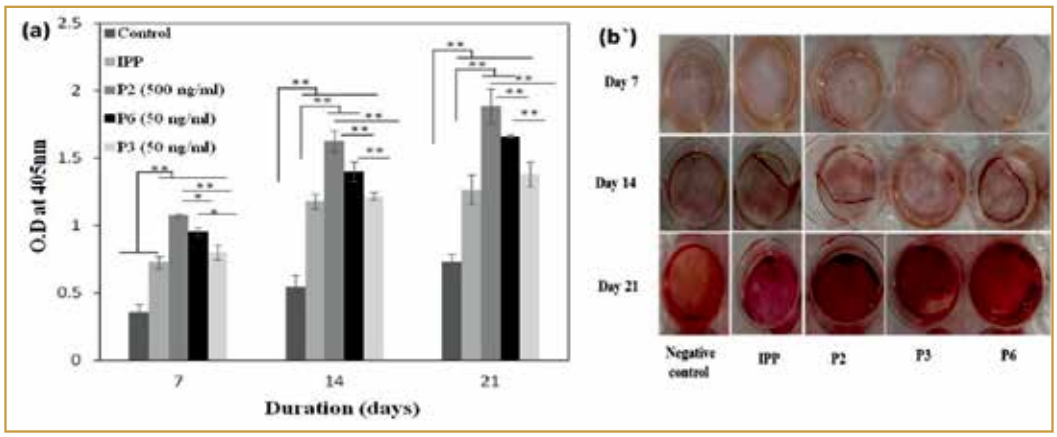


*Fig 1: (a) Quantification and (b) staining of minerals deposited by osteoblasts determined using Alizarin Red method. Statistical analysis: Significance level ** p < 0.01, * p < 0.05. P2- YVEEL; P6- WLAHK; P3- YLLF*

Based on the results obtained by preliminary *in vitro* analysis, the comparative osteoprotective potential of the best AO (P2-YVEEL) and ACE inhibitory (P3-YLLF) bioactive peptides were investigated on bone remodelling in osteoporotic OVX rat model. OVX animals were administered with AO (500µg/kg/day) and ACE-inhibitory (50Mg/kg/day) peptides for eight weeks. Trabecular morphometric parameters of femoral and tibial bone were determined using micro-CT scan. Bone resorption, turnover markers (ALP, RANKL, OCN) and inflammatory cytokines were determined by ELISA. Oxidative parameters were also evaluated in peptide administered rats (MDA, GSH, CAT, SOD). Both AO and ACE inhibitory peptides inhibited the increase in bone turnover and inflammatory cytokines while increased the bone formation markers. The altered morphometric parameters of femoral and tibial bones were strikingly attenuated by the peptide administration. The results indicated that AO peptide exerts more osteoprotective potential than ACE-inhibitory peptide by suppressing osteoclastogenic inducing factors and inflammatory status.

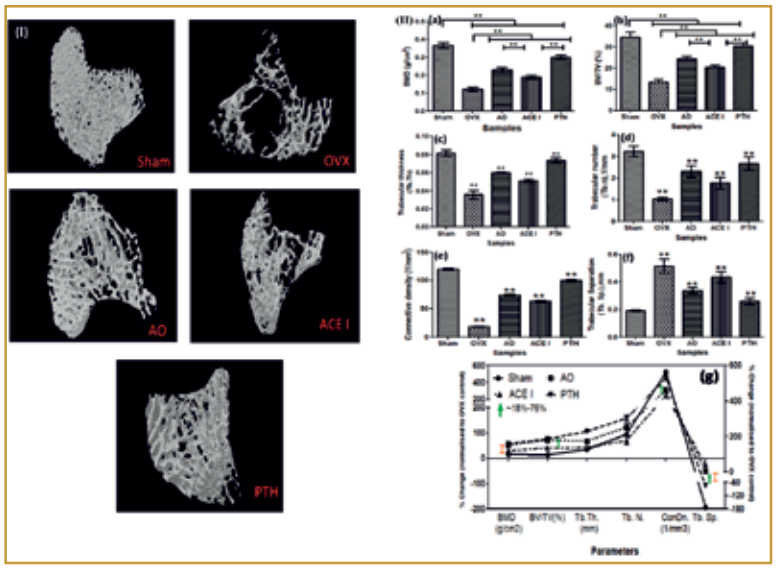


*Fig 2: Effect of AO (antioxidative) and ACE I (ACE-inhibitory) whey peptides on bone mass and tibia trabecular micro-architecture of OVX rats (I) A representative 3D-microCT images of proximal tibia metaphys region. (II) MicroCT analysis: quantification of micro-architecture parameters (a) BMD, (b) % BV/TV, (c) Tb.Th, (d) Tb.N, (e) connective density, (f) Tb.Sp and (g) overall % change in all micro-architecture parameters. Significance level ** p < 0.01, * p < 0.05.*

Role of HPr Dependent Pathways in Acquiring Nisin Resistance in *Enterococcus faecalis*

The Histidine carrier protein (Hpr) dependent pathways as a new mechanism(s) of nisin resistance in *Entreococcus faecalis* and the strategy to combat the resistance were explored. The raw buffalo milk samples were found to be contaminated with nisin resistant *E. faecalis*. The isolates were also found positive for virulence factors like aggregation substances, UST and surface anchor protein, while no gelatinase and hemolysin activity was observed. In addition, the nisin resistant *E. faecalis* showed cross-resistance to clinically used antibiotics. Nisin resistance was found to be correlated with decreased negative surface charge and membrane permeability in addition to increased biofilm formation and hydrophobicity. The nisin resistant variants utilize more glucose in comparison to the sensitive strain, however the expression of enzyme-I EI and HPr remain unaltered. It means that bacteria are using alternative non-PTS system i.e. glucose permease (*glcU*). The expression of *glcU* was found to be increased along with histidine kinase and response regulator that regulate the *glcU* transcription. Enhanced glucose uptake leads to enhanced concentration of fructose 1,6-bisphosphate inside the cell that induced the activity of HPrK/P involved in serine phosphorylation of HPr. Western blot analysis confirmed the increased serine phosphorylation of HPr with the progression of nisin resistance. In the presence of HPrK/P inhibitors, reduced growth and clump formation were observed in the resistant strains. In addition, serine phosphorylation of HPr also decreased. In conclusion, the present investigation showed that HPr Pathway plays an important role in acquisition of nisin resistance and inhibitors of HPrK/P might act as a new drug to control resistance.

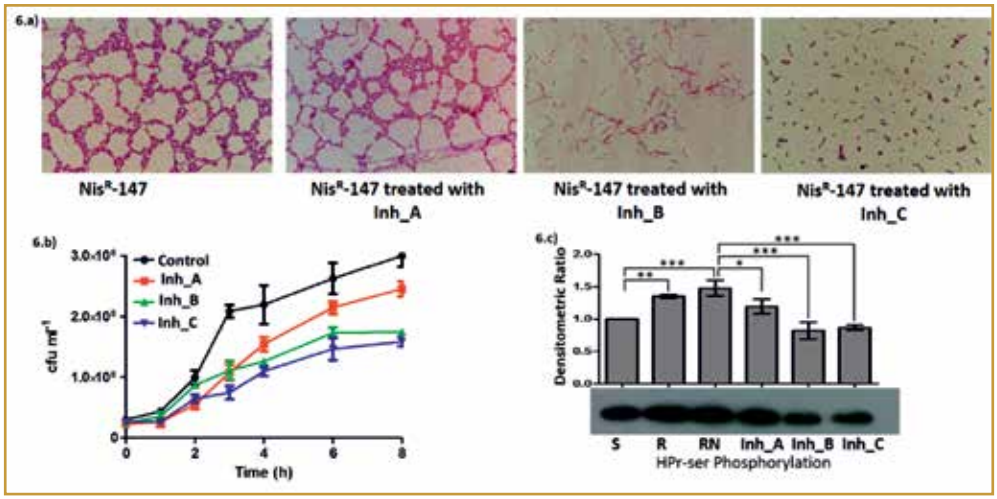
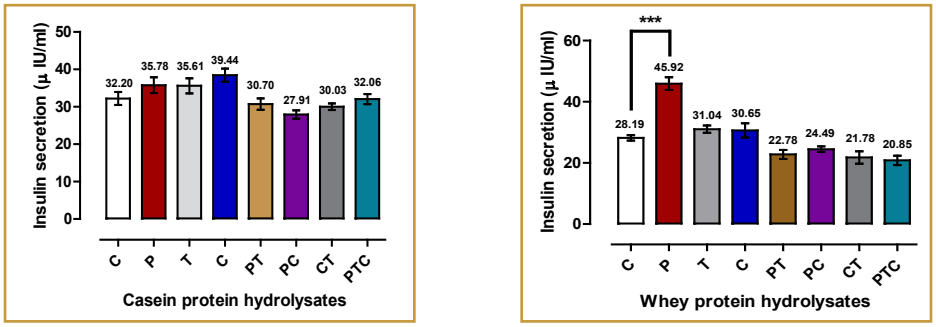


Fig: Effect of inhibitors on clump formation (a), effect of inhibitors on growth (b) of highly resistant E. faecalis strain, Nis^R-147. Western blot analysis of HPr Ser phosphorylation of E. faecalis (c): S; sensitive, R; highly nisin resistant Nis^R-147, RN; Nis^R-147 grown in the presence of nisin, Inh_A; Nis^R-147 grown in the presence of Inh_A, Inh_B; Nis^R-147 grown in the presence of Inh_B, Inh_C; Nis^R-147 grown in the presence of Inh_C

Stimulatory effects of Casein and Whey Protein Hydrolysates on Insulin Secretion by RIN-5F Beta Cells

The stimulatory effect of camel casein and whey protein hydrolysates on RIN-5F beta cells for insulin secretion was assessed. The concentrations of different hydrolysates that showed maximum proliferation of pancreatic beta cells were analyzed for insulin secretion. The secretion of insulin by RIN-5F beta cell line in the presence of different hydrolysates of casein protein is shown in fig. Pepsin, trypsin and chymotrysin casein hydrolysates increased insulin secretion and the amount of insulin secreted were 35.78, 35.61 and 39.44 µ IU/ml, respectively as compared to the control (32.20 µ IU/ml). But in case of PT, PC, CT and PTC hydrolysates the insulin secretion



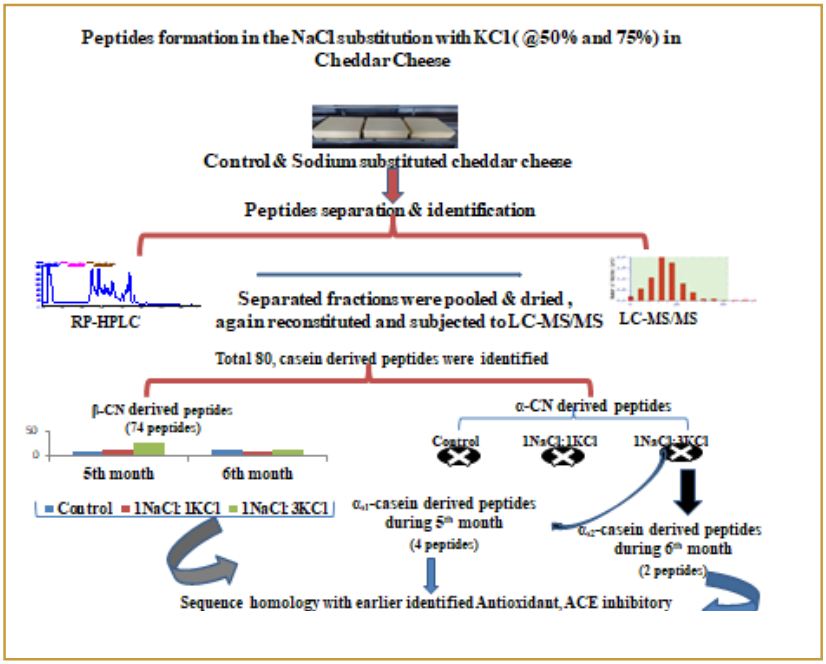
A B

*Fig: Effect of casein (a) and whey proteins (b) hydrolysates on the secretion of insulin hormones from RIN-5F pancreatic beta cell line. The values are expressed as mean ± S.E.M, (n=3). Significant level ***P < 0.001 in comparison to the control group.*

from the pancreatic beta cell was less. Whey protein hydrolysates also affected insulin secretion by the pancreatic beta cells. Pepsin hydrolysate significantly increased insulin secretion. The amount of insulin secreted was 45.92 µ IU/ml as compared to the control (28.19 µ IU/ml) and in case of trypsin and chymotrypsin hydrolysates slight increase in insulin secretion was observed in comparison to the control whereas in all other hydrolysates there was decline in insulin secretion by the pancreatic beta cells (Fig 4.10. b).

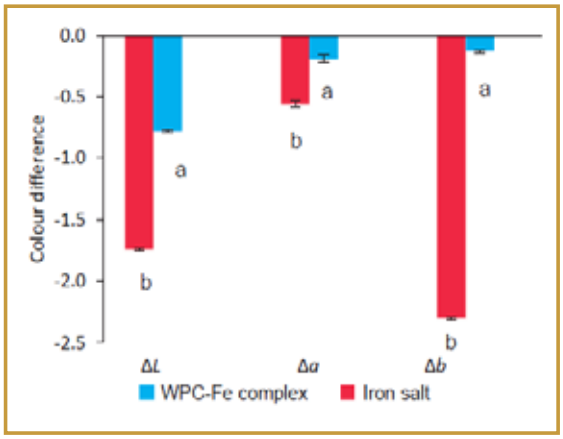
Peptide Profiling of Sodium Substituted Cheddar Cheese

Control Cheddar cheese and low sodium Cheddar cheeses were prepared by substituting sodium chloride (NaCl) with the potassium chloride (KCl) @ 50% and 75% level along with flavor enhancer (HVP) and bitter blocker (AMP). Peptides released during the ripening process were screened via RP-HPLC and LC-MS/MS techniques. A total of 80 water soluble peptides in control, 1NaCl:1KCl and 1NaCl:3KCl Cheddar cheeses were estimated during the 5th and 6th month of ripening period. Out of these, 74 peptides were β-casein derived and observed to be present in all types of cheeses. However two αs_2-casein derived peptides and 4 αs_1-casein derived peptides were observed to be released only in 1NaCl:3KCl Cheddar cheese. Control and 1NaCl:1KCl Cheddar cheeses were found to enrich only with β-casein fractions. Based on the sequences of the identified peptides, the bioactivity corresponded to antioxidant, ACE inhibitory and antimicrobial activity. Cheddar cheeses prepared with the high concentration of potassium chloride (>50%) leads to more release of these peptides.



Characterization of Whey Protein-Iron Complexes

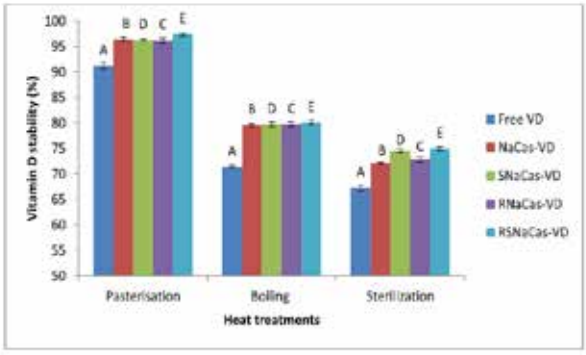
Whey protein–iron complexes were prepared using spray drying. In order to remove the free iron from the bound iron, standardised method involving centrifugation and ultrafiltration was employed. Further, the retentate was subjected to spray drying to produce WPC–Fe complex. Milk fortified with WPC–Fe complex (γ (iron) = 15 mg/L) showed non-significant difference in heat stability, rennet coagulation time, colour estimation, curd tension, viscosity and sensory attributes as compared to control milk. *In vitro* bioaccessibility of iron and induction period of the fat from milk fortified with WPC–Fe complex were found to be slightly higher ($p<0.05$) than that of milk fortified with iron alone. Therefore, milk can be fortified with up to 15 mg/L iron in the form of WPC–Fe complex without significantly affecting its physicochemical properties. The study was also conducted in male Wistar weaning rats as per the recommendations of Institutional Animal Ethical Committee (IAEC), ICAR-NDRI, Karnal. WPC-Fe complex supplementation enhanced haemoglobin level, % ADC and % retention/ intake of iron in both normal and anaemic conditions. It also improved anti-oxidative defense system indicated by increased SOD and catalase enzyme activity. There was a reduction in the nitric oxide production in both normal and anaemic conditions. Its supplementation reduced lipid peroxidation (MDA level), low density and very low density lipoprotein level and enhanced the level of high density lipoprotein in both normal and anaemic conditions. Results revealed that the developed WPC-Fe complex successfully reduced the prevalence of iron deficiency anaemia in animal models and hence can fight against anaemia and different iron deficiency related disorders.



Legend: Colour differences (sample minus control) for different colour parameters (L, a and b) of milk fortified with WPC–Fe complex compared to the milk fortified with iron salt. Samples designated with different letters were significantly ($p<0.05$) different

Characterization and Application of Milk Protein-Vitamin D Complexes

Milk protein-Vitamin D complexes i.e. NaCas-VD, succinylated NaCas-VD, reassembled NaCas-VD and reassembled succinylatedNaCas-VD were prepared and evaluated on the basis of vitamin D binding ability of milk proteins and solubility of milk protein-Vit D complexes. Physicochemical characteristics such as particle size, zeta potential and flouresence intensities confirmed the structural modification of both native and modified proteins upon complex formation with vitamin. Milk protein-Vit D complexes and free vitamin D (fat soluble form) were added to milk @ 500 IU vitamin D/Litre. Fortification of milk with milk protein-Vit D complexes did not have significant influence on sensory and physicochemical properties of fortified milk. Vitamin D stability was lowest in sterilized milk followed by boiled and pasteurized milk. The stability of vitamin D was lowest for free vitamin D (fat soluble form) fortified milk followed by NaCas-VD, SNaCas-VD, RNaCas-VD, RSNaCas-VD fortified milk and control (unfortified) milk. Pasteurized milk fortified with vitamin D showed higher recovery from transparent glass bottles as compared to LDPE pouches during storage at 4-7°C for 7 days. Milk protein-Vit D complex fortified milk showed higher in-vitro bioaccessibility of vitamin D as compared to free vitamin D (fat soluble form) fortified milk.



Error bars show the variations of three determinations in terms of standard error of mean.

A-ESamples represented with different letters are significantly different ($p<0.05$) from each other

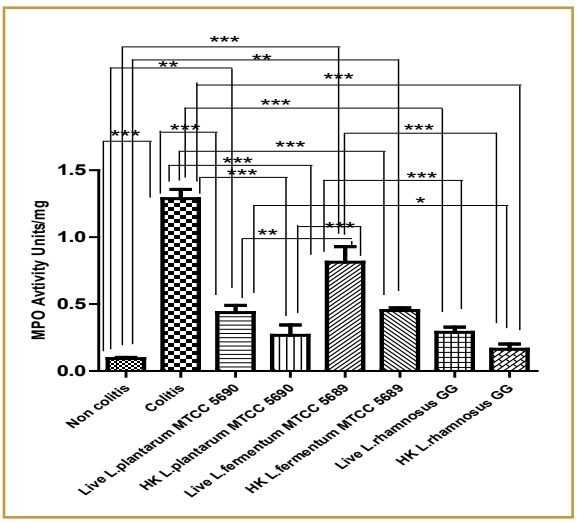
Fig. 1. Vitamin D2 stability in free VD and milk protein-vitamin D2 complexes fortified milk samples as affected by different heat treatments

Standardization of Panchgavya Formulation for Antimicrobial Activity

The panchgavya formulation prepared by mixing the five basic ingredients obtained from sahiwal cows viz., cow milk, ghee, curd, urine and dung in equal ratio and used to standardize methods of analysis for compositional parameter. The method for estimation of crude lipid, nitrogen, reducing sugar, urea, uric acid and creatinine etc has been standardized. Further, the standardized method has been used to analysis composition of panchgavya formulation prepared from different indigenous and cross breed cows. Panchgavya formulation prepared from different breeds of cows was analyzed for antimicrobial activity. Significantly higher zone of inhibition was observed in the panchgavya formulation prepared using dung and urine of heifer as compared to the lactating animal. Among different breeds, panchgavya sample of Gir and Sahiwal cow showed better antifungal activity followed by panchgavya sample of Tharparkar and Karan Fries cow.

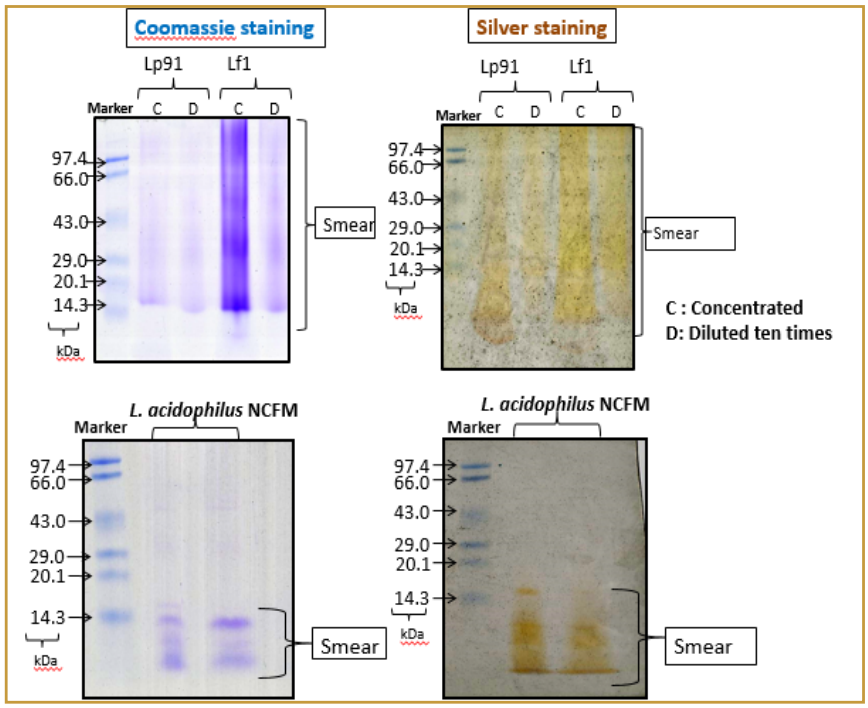
Cell Wall Components of Probiotic Lactobacilli as Therapeutics for Amelioration of Inflammatory Gut Diseases

The anti-inflammatory efficacy of three live and heat killed probiotic cultures (*Lactobacillus plantarum* MTCC 5690, *L. fermentum* MTCC 5689 and *L. rhamnosus* GG) and their surface proteins was investigated in DSS (Dextran Sulfate Sodium; 5%) induced colitis mouse model. Mice in six different treatment groups were orally gavaged with the heat killed and live preparations of *L. plantarum* MTCC 5690, *L. fermentum* MTCC 5689 and *L. rhamnosus GG*, respectively, for 7 days before starting DSS treatment and continued for 7 days after DSS induction. The activity of myeloperoxidase (MPO) decreased remarkably in the colon of treated mice as compared to colitis group. Maximum reduction in the activity was found for heat killed *L. rhamnosus* GG group followed by heat killed *L. plantarum* MTCC 5690. On the other hand, average histological score which determines the severity of histological damage was also determined



*Comparative evaluation of MPO levels in the colon tissues of different mice groups (P value=0.0015) *HK = Heat Killed*

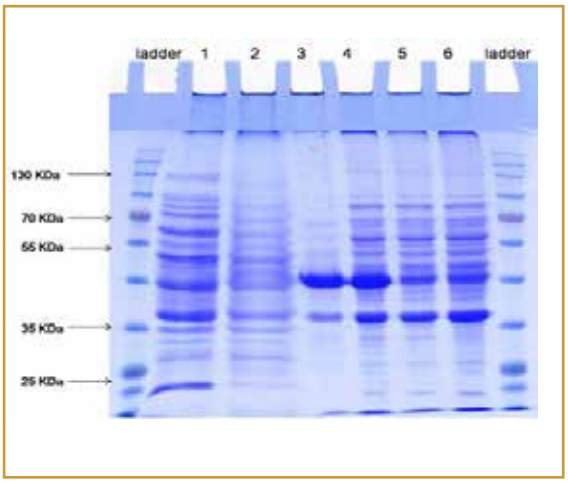
on the basis of the structure and architecture of colon tissue. In addition, the levels of pro-inflammatory cytokine, TNF-α were also considerably suppressed in the colonic homogenate of mice treated with live *L. plantarum* MTCC 5690 followed by live *L. rhamnosus* GG and heat killed *L. fermentum* MTCC 5690. The secretion of IL-10, an anti-inflammatory cytokine was significantly elevated in heat killed *L. rhamnosus* GG group followed by live *L. fermentum* MTCC 5690. Surface proteins from the three strains also demonstrated anti-inflammatory effect in colitis mice model. Peptidoglycan has also been extracted from all the three probiotic strains for investigating their effect in colitis mice model.



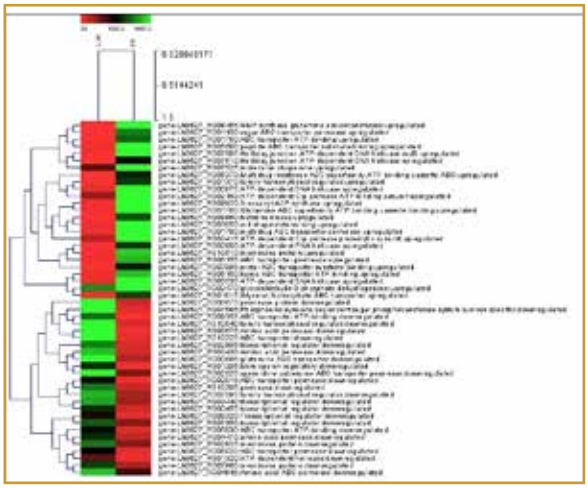
SDS-PAGE of peptidoglycan isolated from L. plantarum MTCC 5690 (Lp91), L. fermentum MTCC 5689 (Lf1) and L. acidophilus NCFM

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

In order to study bile stress induced proteins from *Lactobacillus helveticus* MTCC5463, the stationary phase entered MTCC 5463 cells were grown in varying concentration of bile salts (0.3 to 1.5%) for 2 h. Proteins were isolated from different bile stress induced bacterial cells through lysis buffer followed by sonication. Protein concentrations were obtained in the range of 2800-3520 µg/ml and size ranged between 35-70 kDa. Quantitative transcriptomics analysis at three bile concentrations (0, 0.9 & 1.2%) was also performed. Cells were treated and high quality RNA was purified for the NGS sequencing. All the isolated RNA samples showed the RIN values above 8.0 in Bioanalyser. The sequence NGS transcriptome data for MTCC5463 at three bile concentrations (0, 0.9 & 1.2%) is already been submitted to SRA database with accession number SUB5129941. Bioinformatics analysis resulted in the creation of the Heatmap for differentially expressed bile stress gene for conditions including control VS 0.9%, control VS 1.2% and 0.9% VS 1.2% for top 50 significantly expressed transcripts/genes (highly up and highly downregulated genes). The represented genes were involved in the bile exclusion signaling as shown by heat map using hierarchical clustering. Mostly the processes identified are cellular metabolism specific carbohydrates, lipids, nucleotides, amino acid, genetic information processing, and environmental information processing.



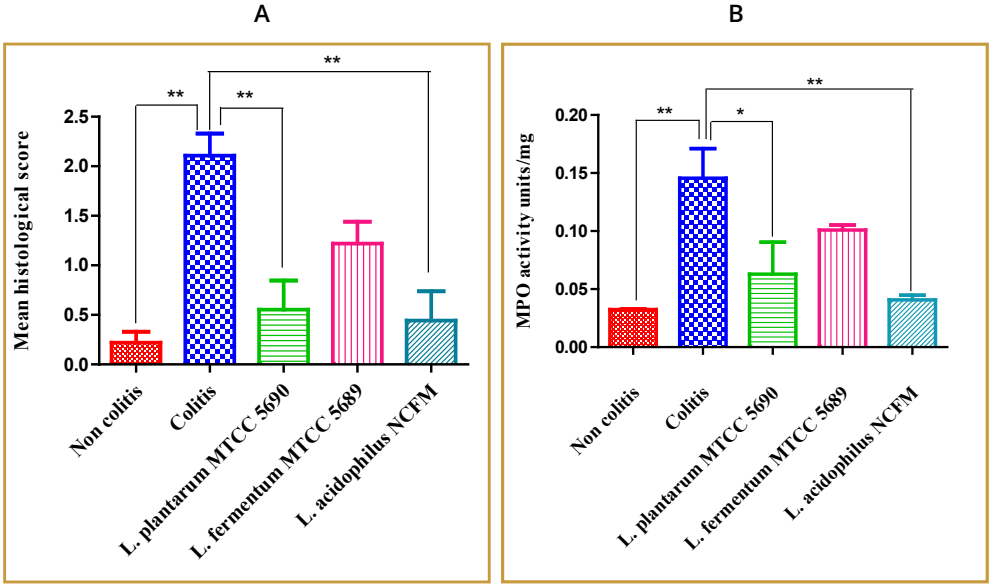
PAGE Profile of proteins extracted from MTCC 5463 grown in the presence of different bile concentrations (1= NCDC292 Control, 2= NCDC292 0.3%, 3= MTCC5463 Control, 4= MTCC5463 0.9%, 5= MTCC5463 1.2%, 6= MTCC5463 1.5%)



Heatmap representing top 50 upregulated and downregulated bile stress genes

Effect of Surface Proteins of Probiotic *Lactobacilli* in Colitis Mouse Model

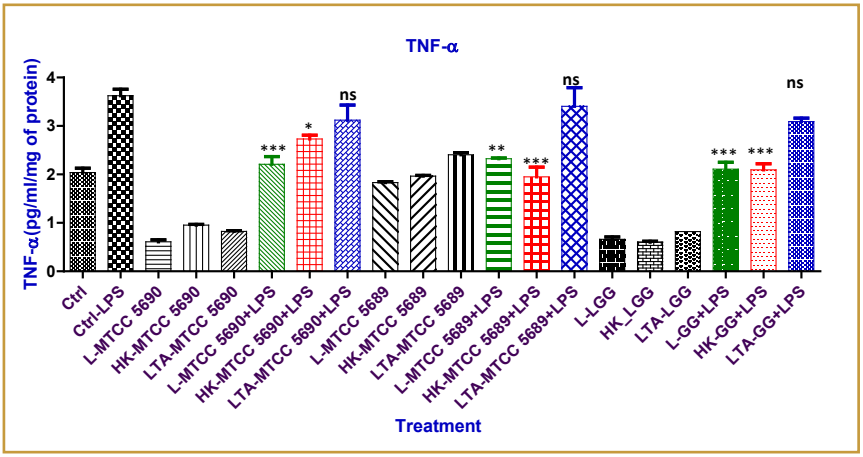
The surface protein preparations derived from the three probiotic strains viz. *Lactobacillus plantarum* MTCC 5690, *L. fermentum* MTCC 5689 and *L. acidophilus* NCFM were tested for anti-inflammatory effects in DSS (Dextran Sulfate Sodium) induced colitis mouse model. The three treatment groups were orally gavaged with respective surface proteins of probiotic lactobacilli for first 7 days alternatively followed by DSS challenge and again fed with surface proteins of the respective cultures for further 7 days, alternatively. The intervention with probiotic test strains was observed to exhibit the anti-inflammatory effects in terms of disease parameters. The highest reduction in Myeloperoxidase activity and maximum improvement in histological score was observed for *L. acidophilus* NCFM followed by *L. plantarum* MTCC 5690 and then *L. fermentum* MTCC 5689. In terms of expression of pro and anti-inflammatory cytokines, secretion of TNF-α, a pro-inflammatory cytokine, was suppressed in *L. acidophilus* NCFM surface proteins treated group followed by *L. fermentum* MTCC 5689 as compared to the colitis group. On the other hand, the level of IL-10 was found to be significantly increased in surface proteins treated groups of probiotic lactobacilli than the colitis control group. The study indicated that surface proteins may offer a safer preventive and therapeutic option for combating inflammatory disorders.



*Histological score (A) and MPO activity (B) in the colonic tissue of different mice groups (The values are expressed as means ± SD (n = 8). Asterisk indicates the significant difference ** p<0.01)*

Anti-Inflammatory Potential of Postbiotics in Cell Line Model

Postbiotics like heat-killed cells (HK) of indigenous probiotic strains MTCC-5690 (*Lactobacillus plantarum* Lp91), MTCC-5689 (*L. fermentum* Lf1) and standard reference strain LGG (*L. rhamnosus* GG) were prepared by heat treating the probiotic cell suspension containing 10^9 cfu/ml probiotic cells. The anti-inflammatory potential of aforesaid postbiotic preparations (heat killed probiotic cells) along with live probiotics was studied *in vitro* in LPS (Lipopolysaccharide) stimulated inflammation model with standardized/optimized LPS concentration of 100 ng/ml in HT-29. Like probiotics, postibiotic preparations of heat killed cells of MTCC-5690, MTCC-5689 and LGG were able to improve the inflammatory conditions with significantly (P<0.05) decreased secretion of TNF-α from induced level of 3.63±0.26 pg/ml/mg of protein to 2.73±0.11, 1.95±0.28 and 2.1±0.18 pg/ml/mg of protein respectively. In case of anti-inflammatory cytokine IL-10, although no statistically significant improvements in secretion were observed in both probiotic and postbiotic preparations, increase

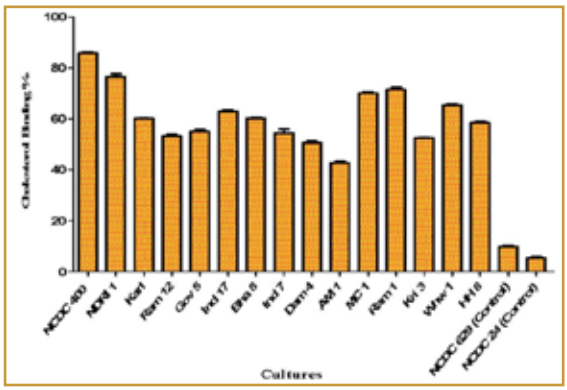


Effect of probiotics and postbiotics on TNF-α secretion in LPS-stimulated HT-29 cells

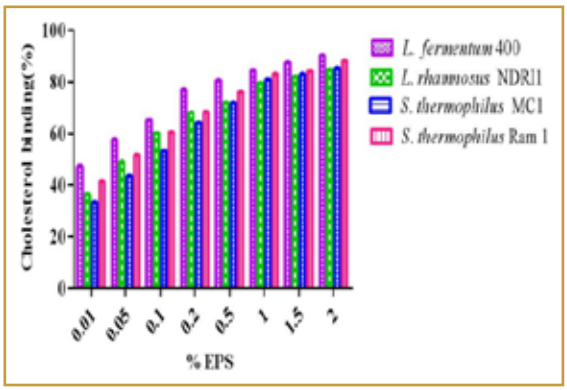
in IL-10 production was observed. From the outcome of the study, it can be concluded that postbiotics like heat killed cells could be used as safer alternative therapy in place of probiotics for inflammatory conditions like IBD. However, the anti-inflammatory potential of postbiotics needs to be further validated in animal and human clinical trials for the development of safe and stable alternative therapy for the management of inflammatory conditions.

Production of Cholesterol Binding Exopolysaccharides from Lactic Acid Bacteria

Lactic acid bacterial cultures were used for cholesterol binding assay to determine their inherent capability to lower cholesterol. Among all the test *Lactobacillus* cultures, *L. fermentum* NCDC 400 was reported to produce highest EPS content. Concordant to the EPS, it was found to be the supreme culture for the maximal removal of cholesterol (85.81±0.50%) followed by *L. rhamnosus* NDRI 1 (76.59±1.01%). Among *Streptococcus* cultures, *S. thermophilus* AM1 was shown to produce greater amounts of EPS (259.39 mg/L) but showed low cholesterol binding affinity. *S. thermophilus* Ram 1 demonstrated highest cholesterol removal (75.99±0.7566%) followed by *S. thermophilus* MC1 (70.17±0.36). Based on the cholesterol lowering effect, four EPS producing cultures were selected. Purified EPS was checked for *in-vitro* cholesterol binding assay and it was observed that EPS of *L. fermentum* NCDC 400 showed highest cholesterol lowering effect (90.32±0.2 %). *L. fermentum* NCDC 400 removing greater cholesterol may be used to develop hypocholesterolemic dairy foods to benefit human health.



Cholesterol binding by EPS producing LAB



Cholesterol binding by purified EPS

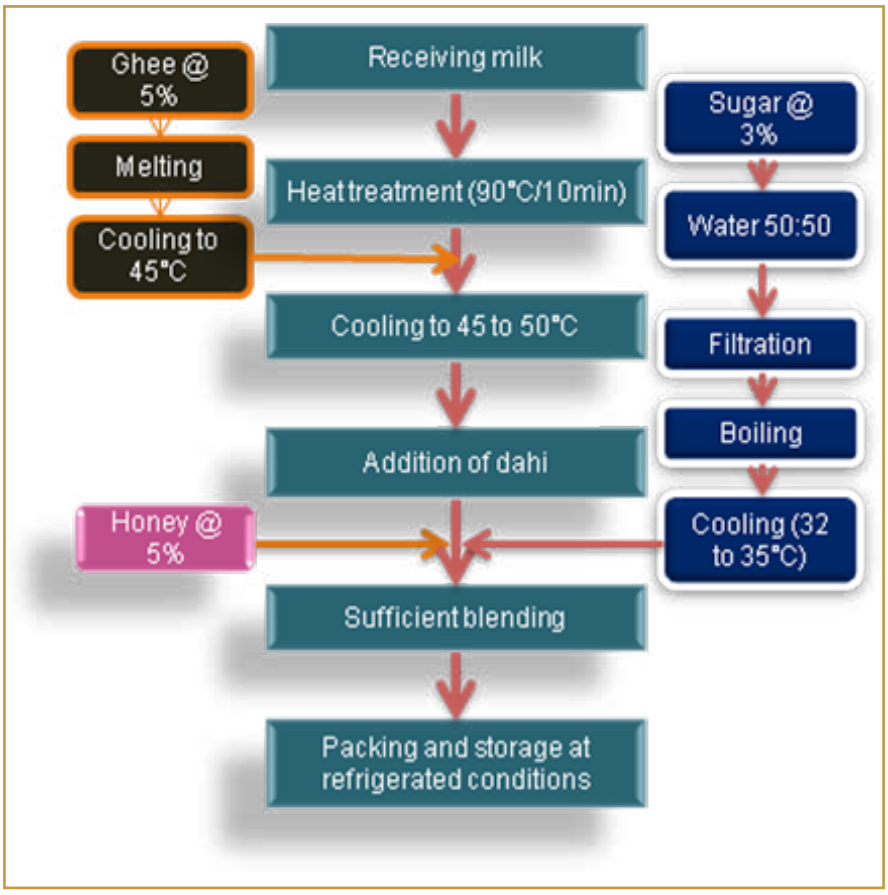
Production of Antimicrobial Bioactive Peptides from Bovine and Non-Bovine Milk by Proteolytic *Lactobacillus* Fermentation

Peptides identified in sheep milk comprised of 24 antioxidant peptides, 21 antimicrobial peptides 21 and 30 ACE inhibitory peptides. Goat milk released 82 peptides during fermentation with ACE inhibitory and antioxidant activities. Similarly, in fermented camel milk, 34 peptides with ACE inhibitory activity were released. Sheep milk fractions had antimicrobial, antioxidant and ACE inhibitory activities. The sheep milk fermentation generated various antimicrobial, antioxidant and ACE inhibitory peptides, which were used as functional ingredients in Shrikhand. ACE inhibitory peptides sequence identified in fermented milk-derived peptides were VRGPFPIIV and IPYVRYL (ovine); AVPYPQR, (camel), FLPYPY, KAVPYPQR, LPYPY and PQKAVPYPQ (caprine). Peptides with Antioxidant activity were AVPYPQR (Ovine), SRYPSYGIN (camel) and PQQVSALPPPPMQY (caprine). Potent antimicrobial peptides were QPKTKVIPYVRYL, YQEPVLGPVRGPFPII, IPIQYVL, LYQEPVLGPVRGPFPII (ovine), PVVVPPFLQPE, (caprine) and immuno-modulatory activity YQEPVLG (ovine, caprine and camel). DPP-IV activity Peptides were IPIQY (ovine), LHLPLPL, (camel) and FLPYPY, LPYPY (caprine). Opioid peptides were ERYLGYLE, VPSERYLGYLE (ovine), SRYPSYGIN (camel), anticancer peptides were LPDQSLVYPFPGPIPNS, PGPIPN (ovine).

Preparation and Evaluation of Panchamrit for Immunomodulation

Panchamrit is, in essence, a traditional product of India, with a concoction of cow milk, dahi, ghee, honey and sugar. Dahi culture was selected based on the growth pattern, titratable acidity and pH. Three formulations of panchamrit i.e., I, II and III with varying concentrations of dahi and milk have been prepared with remaining being constant. pH, titratable acidity, total solids, fat %, protein % were observed to be 5.34, 0.49% Lactic acid LA), 26.73%, 10.5%, 4.0%; 5.23, 0.50% LA, 26.37%, 12.105%, 3.6%; and 5.62, 0.46% LA, 25.91%, 8.96, 3.5%, respectively for formulation I, II, and III. Total plate count, total lactic bacterial count, proteolytic and lipolytic were 9.05, 9.07, 8.54 log cfu/gm; 9.20, 9.16 and 8.37 log cfu/gm; and 8.82, 8.75 and 8.47 log cFU/gm in the formulation I, II and III, respectively. Coliforms and yeast and molds were found to be absent per g in all the three formulations of panchamrit. Among all the three formulations, II was optimized considering high antimicrobial activity against both gram positive and

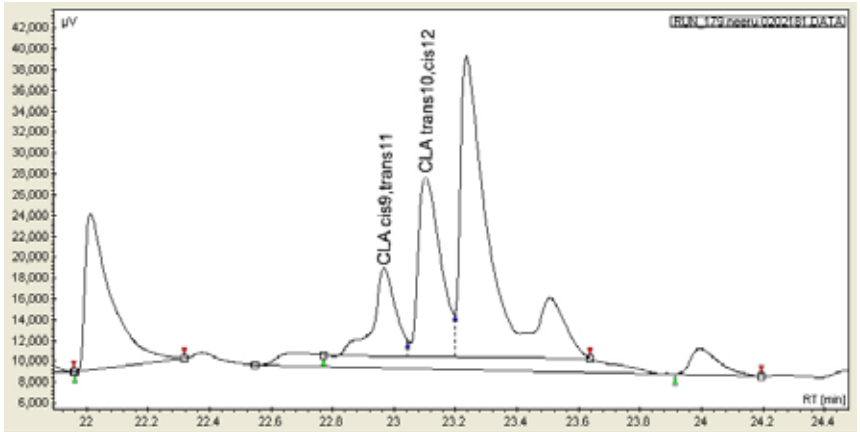
gram negative pathogens exhibiting around 28 mm and 25 mm zone of inhibition respectively in comparison to the other two formulations.



Flow Chart for preparation of Panchamrit

Isolation, Identification and Characterization of CLA Producing *Bifidobacteria* spp. Isolated from Rumen Origin

Rumen microorganisms are major influencing factors in the biohydrogenation process of fatty acids that ultimately leads to the formation of conjugated linoleic acid (CLA). In the present study, we investigated the potential of Bifidobacterium spp. isolated from ruminal fluid samples of Murrah buffaloes (*Bubalus bubalis*) for bioactive CLA production. For this, a total of 294 isolates were isolated from rumen fluid (n=86) samples in Bifidus Selective medium (BSM) and based on phospoketolase assay, 24 isolates were presumptively confirmed to be Bifidobacterium species. Further, the isolates were confirmed morphologically, biochemically and PCR based approaches both by genus-specific PCR targeting 16S rDNA and transaldolase gene. All these strains were found positive for conversion of linoleic acid to CLA by UV-spectrophotometric assay. Gas chromatographic methods showed that the strains were observed to produce cis9, trans11 and tran10, cis12 CLA isomers in linoleic acid supplemented MRS broth. The positive isolates were subjected to 16S rDNA sequencing and observed to be different species of *B. thermophilum* (n=21) and *B. pseudolongum* (n=03). The study reflects that bifidobacterial strains present in rumen fluid samples of Murrah buffaloes have the ability to produce CLA and may be applied as probiotics to enhance the nutraceutical value of ruminant food products.



Efficacy of Buttermilk as an Encapsulating Agent for Omega 3 Fatty Acids

Buttermilk obtained as a by-product of butter manufactured from standardized cream (40% fat) was used as raw material. Deodorized flaxseed oil was used as omega 3 source. Flaxseed oil-buttermilk emulsions were prepared and evaluated for emulsion stability, particle size, zeta potential and thermal stability. Upto 4% oil loading, emulsions remained stable. As the oil content of emulsions increased, particle size also increased, though reverse trend was found for zeta potential. In order to evaluate behaviour in processing condition, thermal stability was checked which was found good. There was no visible separation in the emulsion. Spray drying of the emulsions is in progress.

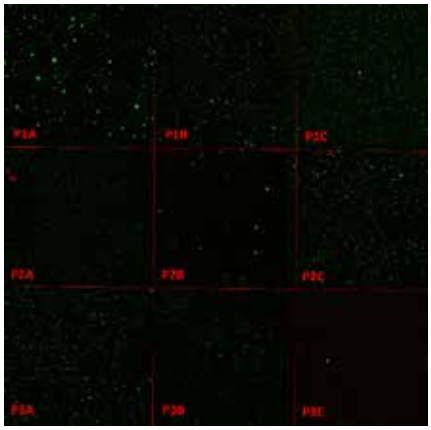


Figure: Confocal images of emulsion prepared at different homogenization pressure (150-200 kgcm^{-2}) and oil concentration (2-4%)

Preparation of Spray Dried Whey Protein-Based Curcumin Encapsulates

Curcumin could be loaded @ 0.4% in buffalo milk butter oil. Gum Arabica in combination with maltodextrin was found to be the best suitable gum for stable curcumin emulsion preparation at core:wall and protein:carbohydrate ratio of 1:2 and 1:2, respectively. Spray drying at 180°C (inlet air temperature) was found optimum for curcumin encapsulate powder preparation with encapsulation efficiency of 96.96%. Curcumin encapsulate stored at 37±1°C deteriorated rapidly compared to storage at 25±1°C. Curcumin encapsulate addition enhanced the free radical scavenging activity in burfi.

Development of Probiotic Ricotta Cheese from Buffalo Milk System

Ricotta cheese (RC) is a soft, unripened variety of whey cheese, which may offer a number of advantages in terms of delivery vehicle of probiotic, because of high moisture, pH and low salt content. RC can also provide added protection to probiotic organism due to protein matrix during gastro-intestinal (GI) transit. RC prepared with low fat buffalo milk, preset coagulation temperature and whey to milk proportion had protein recovery of 97%. The product contained 25.64% total solids, 12.17% protein and 6.54% fat and firmness value of 1898.20 g. Five probiotic organisms were evaluated for their antimicrobial property against *Escherichia coli* and *Micrococcus luteus.* On the basis of maximum activity, *Lactobacillus acidophilus* NCDC-291 was selected and inoculated into cheese matrix to maintain the count. Probiotic RC had good sensory attributes with overall acceptability score of 90. Probiotic NCDC-291 showed better survival under simulated GI conditions in cheese matrix (89.23%) as compared to free cells (71.32%). Probiotic Ricotta had a shelf life of 12 days, as revealed through several analyses. Probiotic RC showed 23% inhibition of contaminants (*E. coli*) as against control Ricotta cheese matrix during 8 days of storage. Probiotic RC can be a good source of nutrition for wide segment of population.

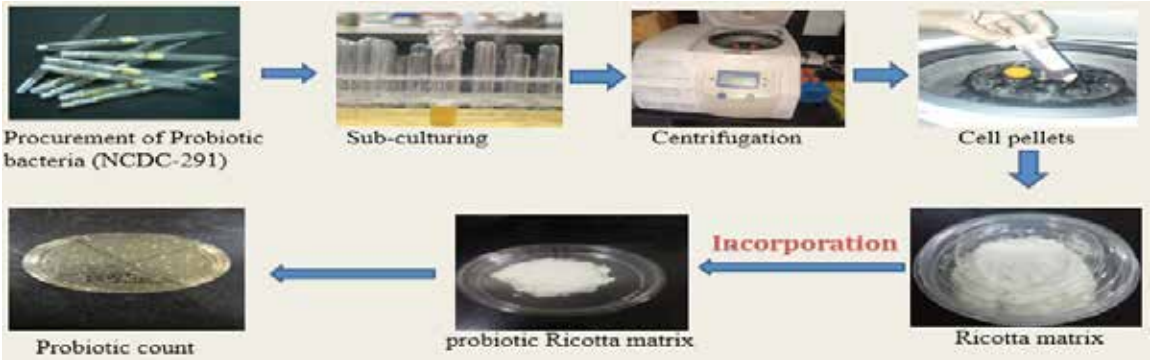


Figure: Protocol of probiotic Ricotta cheese formulation

Evaluation of Plasmin Activity and its Relation with Bio-Functional Attributes of Gouda Cheese

Plasmin, the most important proteolytic enzyme present in bovine milk, plays an important role in proteolysis of casein during Gouda cheese ripening. Activity of the plasmin system, comprising of plasmin, plasminogen, plasmin-inhibitors and plasminogen activator inhibitors is significantly dependent on the processing parameters and ripening time of Gouda cheese. Proteolysis helps in generation of bioactive peptides which influences the bio-activity (BA), development of characteristic texture as well as flavor of Gouda Cheese. In the current study, plasmin activity (PA) and its relation with physico-chemical, bio-functional and sensory attributes of Gouda cheese was evaluated. Gouda cheese was prepared from cow milk subjected to three different heat treatments and brined (18%) using three different brining treatments. Cheese samples were analysed for PA, physico-chemical, biochemical, textural, bio-functional [antioxidant

(ABTS and DPPH) and ACE-inhibitory activity] and sensory attributes at initial days of ripening and correlation was established among these parameters. Increment in heat treatment increased PA, whereas NaCl content decreased PA. Heat treatment and type of brining significantly affected physico-chemical attributes. Antioxidant activity (AA) in terms of ABTS and DPPH decreased with increment of heat treatment. Higher AA activity was observed in samples with higher NaCl content. ACE-inhibitory activity increased with increment in NaCl content. The sample with lower heat treatment and higher NaCl content showed higher acceptability. A negative correlation was observed between PA with physico-chemical, bio-functional and sensory attributes of Gouda Cheese.

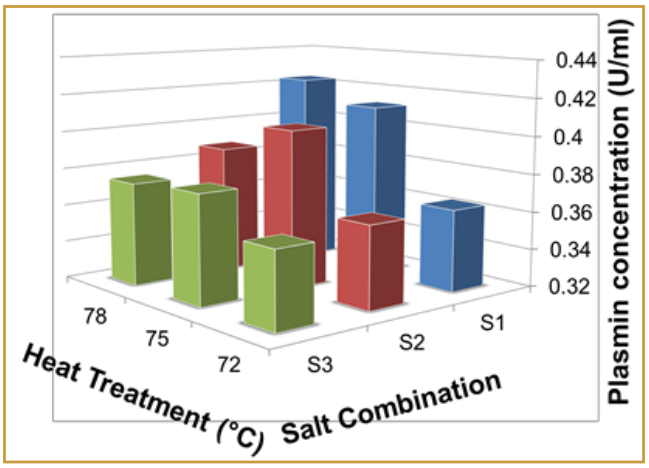


Figure: Plasmin activity as affected by heat treatment and salting

Development of Goat Milk Based Functional Beverage

The study aimed at developing a goat-milk based functional beverage incorporated with *giloy,* a herb. Analysis of *giloy* juice revealed non-significantly lesser anti-oxidant activity and flavonoid content than *giloy* powder. Process protocols were standardised for preparing the alcoholic extract of the herb. Three preparations *viz*., juice, extract and powder were analysed for processing stability at pasteurisation, boiling and sterilisation temperatures. Ultrasonication was found to be better than magnetic stirring and sonicator bath for debittering *Giloy* juice using β-cyclodextrin.

Omega-3 Fatty Acids Fortified Functional Butter and Curd

Curd lacks in certain essential fatty acids like omega-3 fatty acid. The microencapsulated flaxseed oil powder was used at 2, 3 and 4% level for fortification of curd with alpha linolenic acid. The samples were evaluated for water holding capacity, pH, acidity, firmness, consistency index, and sensory parameters. The firmness value was more for the control sample (0.92 N) and the values decreased with increasing level of microcapsules from 0.90 to 0.75 N. Based on higher sensory acceptability, 3 % level of flaxseed microcapsules was found optimum. With the selected level of microcapsule fortification, two servings (100g each) of fortified curd would provide more than 50% RDA of alpha linolenic acid.

The process for making omega-3 fatty acid fortified butter was optimized by studying the effect of level of flaxseed oil and flaxseed oil emulsion addition into cream at two different stages i.e. before ageing and after ageing. Flaxseed oil was added @ 2.9 to 5.1% while, emulsion was added @ 4.8 to 8.6% on cream basis. Ripening of cream was done by addition of 2% culture NCDC 193. The process was optimised on the basis sensory acceptability and textural attributes. The sensory quality of product obtained by adding 4.1% oil and 6.8 % emulsion before ageing of cream was at par with the control butter. The fat and moisture in the optimized butter containing flaxseed oil and emulsion were 85.22% and 14.06% and 87.371% and 12.16%, respectively. Churning time decreased from 40 to 25 min upon increasing level of oil and emulsion. Hardness decreased from 6.46±0.646 N to 4.36±0.429 N, yield stress from 0.722±0.015 N to 0.644±0.016 N and retardation time from 1.81±0.11 sec to 1.47±0.086sec with increasing level of oil and emulsion. Thus, fortification of butter with alpha linolenic acid provided an additional benefit of improved spreadability.

Characterization, Process Optimization and Shelf Life Evaluation of *Mohanthal* - A Traditional Milk Sweet from Gujarat

Mohanthal is one of the region-specific traditional dairy products, popular in Gujarat. *Mohanthal* samples were collected from reputed manufacturers from three cities of Gujarat and evaluated for physico-chemical, sensory, textural and microbiological parameters. The variation in chemical composition of the market samples was: 8.64-13.86 % moisture, 18.21-28.12 % fat, 7.91-13.00 % protein, 0-12.1 % lactose, 19.00-29.56 % sucrose and 0.81-1.81 % ash. Based on the observations of sensory panel, typical characteristics of *Mohanthal* were judged as:light brown to medium brown colour with rectangular shape, soft, cohesive and firm body with little crumbliness, small grains preferred over smooth texture, pleasant, nutty, roasted and caramelized flavor with rich ghee flavour. During the experimental trials for product optimization, 145-148 °C roasting temperature, 75 °Brix sugar syrup and 100 °C temperature of mix at which sugar syrup was added, were found optimum. The effects of ghee levels (80 to 120 g), khoa levels (20 to 40 g) and sugar levels (80 to 120 g) were studied by conducting experiments in central composite rotatable design. The final product formulation consisting of combination of variables of ghee at 100 g, khoa at 30 g and sugar at 100 g was selected on basis of results of Response Surface Methodology. The chemical composition of the optimized product was: 10.20 % moisture, 31.05 % fat, 7.88 % protein, 1.70 % lactose, 26.02 % sucrose, 0.98 % ash and 22.17 % other carbohydrates. The shelf life of *Mohanthal* in LDPE pouches and laminated cardboard boxes was 16 days and in polystyrene tubs and laminates it was 20 days at 30±1 °C.

Development of Enzyme Modified Ghee Flavor

Enzyme Modified Ghee (EMG) flavour was developed using three substrates like cream, butter and ghee. Addition of lipase MER in cream was most acceptable for EMG preparation followed by its addition in butter and ghee. Addition of 0.05% lipase enzyme in cream and its incubation at 45 °C for 3 hours with continuous stirring resulted in best flavour production. The flavouring compounds detected through Gas chromatography-Mass Spectrometry (GC-MS) showed an increase in intensity of aldehydes, ketones, esters, acids, alcohols and hydrocarbons in EMG. The most ideal combination of citrate, glucose and lactose for flavour enhancement was identified. GC-MS analysis of flavouring compounds with additives showed an increase in intensity of aldehydes, ketones, esters, acids, alcohols and hydrocarbons. The yield of EMG sample was also approximately 8% more than control sample. A higher shelf life of about 4 days at 65 °C was found in EMG than control sample when packed in 100 ml poly-ethylene terephthalate jars with screw cap and stored at 65°C for 24 days. No noticeable impact on shelf life was found in EMG with the addition of anti-oxidant, Butylated hydroxyl anisole. EMG and control were blended at 20 % with refined sunflower oil to perceive ghee flavour on its use. This was tested to fry *gulabjamun* and *jalebi*. The perception of ghee flavour in the product fried in 20 % blended EMG was superior to 20 % blended control ghee.

Technology for the Preparation of Fortified Whey Kefir Drink

Kefir is a lactic fermented milk. It is an acidic, viscous and self-carbonated beverage containing very small amount of alcohol. Utilization of whey in the preparation of Kefir will potentially enhance the functionality of the product and also reduce its pollution potential. Whey Kefir was prepared from both paneer whey and cheese whey inoculated with kefir grains of two different origin (U.S. and Australia). Flavour and taste of Whey Kefir made from cheese whey with U.S. grains was significantly ($p < 0.05$) better than the other Whey Kefir samples. Sugar was added to improve the palatability and flavour for the preparation of Whey Kefir drink. Addition of inulin and WPC individually and in combination resulted in an increase in acidity, viscosity and turbidity. Flavour and Colour & appearance decreased with increase in iron (20, 30 & 40 ppm) addition which was mainly due to the development of metallic flavour and brownish discoloration. Whey Kefir drink prepared with addition of 20 ppm iron produced moderate flavour, minimum acidity and optimum viscosity similar to that of control. Micro-biological analysis of the Whey Kefir drinks obtained after each optimization revealed that the microbial count of all the samples were at par with the Codex standards for Kefir and the TPC (8.64 ± 0.13 log CFU/mL) and yeast & mold (6.58 ± 0.02 log CFU/mL) counts increased significantly ($p < 0.05$) with the addition of fortificants. Mineral estimation of the final fortified Whey Kefir drink was done using ICP-OES and the zinc and iron content were quantified as 6.11 and 5.24 ppm respectively. The alcohol content was 0.043 g/100mL in control and 0.82 g/100mL in fortified Whey Kefir drinks. Physico chemical analysis of the developed fortified drink showed significantly ($p < 0.05$) higher TS, carbohydrate and ash contents. The flavour and overall acceptability of fortified Whey Kefir drink was better than control and had shelf life of 12 days stored at 7-8° C in polyethylene pouches. Total Plate Count of fortified Whey Kefir drink was more than that of control leading to increased acidity. Pilot scale consumer study revealed that the developed fortified Whey Kefir drink was well acceptable among the consumers for its thirst-quenching effect and prickly sensation.

Application of Antifreeze Compounds for Sub-Zero Temperature Storage of Paneer

The effect of incorporation of antifreeze compounds (AFCs) viz. glycerol, polypropylene glycol (PG) and glycerol monostearate (GMS) and an enzyme viz. transglutaminase (TG) on protection of textural damage to paneer during sub-zero storage was studied. The anti-freeze compounds were incorporated into milk during paneer manufacture. Glycerol and PG were added at three levels viz. 1, 2 and 3% whereas GMS was added at 0.3%, 0.5% and 0.7% of the expected yield of product. AFC incorporated paneer samples were stored at -15±1°C in polypropylene containers for 60 days and textural and sensory evaluation was conducted at 10 days interval. It was found that among all AFCs added, glycerol 3% addition showed minimum textural and sensory perception loss. In further trials, 3%glycerol was used in conjunction with microbial transglutaminase (TG) enzyme at 2U/g level and found less reduction in textural and sensory acceptability as compared to control samples. Based on the results obtained, glycerol 3% in conjunction with TG can be recommended as potential intervention for protection of textural damage in paneer during frozen storage.

Omega-3 Fatty Acid Fortified Milk Using Microencapsulated Flaxseed Oil Powder

Milk is often referred as a complete food, but it lacks certain essential fatty acids like omega-3 fatty acids. For fortification of milk with omega-3 fatty acid, microencapsulated flaxseed oil powder prepared using flaxseed oil, modified starch and soy protein isolate was added to provide at least 25% RDA of α-linolenic acid (ALA) in one serving of milk. The sensory scores of plain fortified milk were non-significantly ($p>0.05$) different from that of control milk. The fortified pasteurized and sterilized milk were evaluated for pH, acidity, viscosity and sensory characteristics during 6 and 28 days of storage, respectively. The moisture, fat, protein, ash and total carbohydrates for fortified sterilized milk and pasteurized milk were 87.30 and 87.23%, 3.42 and 3.37%, 3.57 and 3.62%, 0.85 and 0.79%, 4.85 and 4.99%, respectively. Three grams of microcapsules added to 240 mL of milk provides 0.612 g of ALA.

MECHANISATION AND PROCESS ENGINEERING

Development of Mechanized Whey Dewatering System for *Chhana*

Chhana is a product obtained by heat-acid coagulation of milk followed by draining whey. Conventional whey drainage using muslin cloth during Chhana manufacture often results in product of varied composition, higher acidity and higher microbial counts. A prototype of whey removal system was designed and developed for handling 20 L milk. It was observed that by controlling the speed and spin time, chhana of desired quality can be manufactured. The performance evaluation of developed system for whey removal showed a high desirability at 80 rpm, 9.5 min for 20 kg milk. The developed equipment for rapid whey removal for chhana reduces the production time and yields chhana with optimum moisture content and soft body. The developed equipment fulfils the requirement of small-entrepreneurs for time saving and hygienic production.

Fig. Set up for whey removal

Development of Automatic Endo-exo Thermal Unit for Dahi

Automated controlled Incubator system for the commercial production of dahi and other fermented milk products is developed besides minimizing manpower requirements, offer better process control and improve quality characteristics of finished product. It will help in saving the time and energy consumption. Prevention of post acidification followed by whey separation remains a major challenge among processors as problem arises owing to slow cooling of fermented products and mechanical agitation encountered during its shifting from incubator to cold store. The equipment is having provision for both automatic heating and cooling of product in the same unit. In the developed automated unit, the blast air-cooling starts automatically immediately after the completion of incubation period in the same cabinet without disturbing the cups of set curd. Process control is achieved by fixing the incubation period and automatic cut-off of heating process which is followed by cooling cycle.

Machine Vision System (MVS) Color Desk D1

Machine vision is an engineering technology that combines mechanics, optical instrumentation, electromagnetic sensing, digital video and image processing technology. Machine Vision System (MVS) Color Desk D1 is a portable benchtop model developed for colour measurement of dairy and food products. It enables user to view colour on the basis of entering numerical CIE Lab values. Graphic user interface integrated with the program for making the software user friendly. It is capable of colour measurement of solid, semi-solid, liquid and powder material. The system measures surface colour and is based on reflectance measurement principle. Colour values of food product of variable moisture content and surface properties can be measured. Moreover, the instrument is quite handy for monitoring the colour during processing as well.

Fig. Machine Vision System (MVS) Color Desk D1

Determination of Engineering Properties of Ghee in relation to Frying oil Quality Management

A test rig was developed and fabricated to carry out study on quality of ghee during frying. The system comprised of heating unit, temperature controller, frying unit, imaging unit, pump and piping system. The frying unit was fabricated of SS304 and has a square truncated pyramid shape. The volumetric capacity of the frying unit is 4.5 L with operational capacity of 1-2 L. The imaging unit is based on an integrated 2 MP camera with the frying unit and the program for image analysis was developed. Function of the imaging unit is to determine the colorimetric properties of ghee. During trials of frying oil test rig, it was observed that the operating environment was smoky. The test rig was upgraded with a smoke removal mechanism. Electrical properties measurement unit was developed using parallel plate system, two wire system and two rod system. The purpose of this unit was to select and optimize the sensor for measuring properties of oil. The fryer can be cleaned by rinsing using any alkali to remove any tar buildup on the surface.

Development of low cost Farm level Milk Cooling System

In the first phase of the study, environment test chamber was designed so as to allow for testing of refrigeration system round the year without having a significant effect of seasons. The purpose of the test chamber was to evaluate the refrigeration system of low cost farm level milk cooling system. The testing chamber has provision for venting to enable complete exposure to the external environment, if required. The temperature of the system can be elevated up to 48-50 °C to simulate severe hot weather conditions. An automatic temperature controller monitors and regulates the temperature. Refrigeration system was designed and installed in the test chamber of milk cooling system. The cooling tank was installed outside the test chamber. A multiple channel data logger was installed to record temperature of test chamber.

Fig. Low cost Farm level Milk Cooling System

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

On the basis of the determined hold-up volume of 50 L, a multi-partition CIP tank with total volume of 700 L was designed and fabricated by using SS-304. There are five different compartments in one CIP system (square block) which is having 231, 178, 178, 56, 56 L capacity for water, diluted acid, diluted lye; concentrated acid, concentrated lye, respectively. The design of experiment was carried out using the response surface methodology (RSM) and studied the effect of scrapper speed (300, 225, 150 RPM), temperature of solution (80, 70, 60° C) and concentration of solution (2%, 1.375%, 0.75%) on CIP performance. The lye time, total CIP time, total plate count (TPC) and coliform count were determined as responses. The optimized operational parameters for CIP were as follows: concentration 0.85%; temperature, 72.70° C and scraper speed, 150. This CIP system is mobile (wheel mounted) and may be used for multiple dairy processing equipment.

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

On the basis of designed parameters and dimensions, double jacketed Mozzarella cheese stretching unit was fabricated by using SS-304. The effect of hot water temperature (80-90 °C), paddle speed (30-40 rpm) and residence time (120-300 s) for the stretching of *Mozzarella* cheese in developed double jacketed working unit was studied. The responses i.e. stretchability, meltability, flowability, moisture, yield, hardness, overall acceptability were determined and ranged from 14 to 29.66 cm, 5 to 8.55 cm, 15.78 to 24.24 %, 50.27 to 57.82%, 7.3 to 13.78%, 25.98 to 40 N and 69 to 86.5, respectively. There was significant ($p \leq 0.05$) effect of processing variables on above-mentioned attributes. Under optimized conditions (temperature: 83.5°C; speed: 30 rpm; time: 200 s), the responses i.e. stretchability, meltablity, flowablity, moisture, yield, hardness, overall acceptability were determined and found to be 27.11±0.53 cm, 7.46±0.11 cm, 21.30±0.45%, 52.31±0.29%, 12.71±0.28%, 34.23±0.49 N, 84.10±2.43 respectively. The predicted values were compared with experimental values by Student's t-test and found non-significant ($p>0.05$). Developed machine could be effective for Mozzarella cheese manufacturing at small scale and it can be up-scaled for larger capacity as well.

Design and Development of Heat Exchanger for Controlling the Matting in Automatic Paneer Press

An electrically heated (of rating 1 kW) flooded water jacket was designed, fabricated and evaluated for controlling the matting temperature of paneer (at capacity of 3 kg coagulum) during pressing in an automatic press. The

fabricated heat exchanger to control matting temperature of paneer, when integrated to the automatic press and the assembled control unit, controlled the process parameters at the set levels of pressure, temperature and time. Experiments for 3 levels of pressure (2, 3 and 4 kg/cm2) in combination with 3 levels of pressing time (8, 10 and 12 min) at 3 matting temperature (63, 66 and 69°C) were designed as per a face centered Central Composite Design to obtain 20 random runs of trials and the quality of paneer pressed for each of these 20 runs were evaluated in terms of its physico-chemical, textural and sensory attributes (responses). Optimal process conditions for pressing of paneer under controlled matting temperature in the automatic press were identified using Response Surface Methodology as: pressing - 2.5 kg/cm2; time - 9 min and matting temperature - 67°C. Paneer pressed with control of matting temperature under the optimal process parameters reported marginally lower moisture content, but recorded higher hardness, springiness and overall acceptance when compared to samples pressed without controlling the matting temperature. The study demonstrated that the matting temperature of paneer during pressing could be controlled using the developed heat exchanger and the control of matting temperature during pressing resulted in paneer with good textural quality and sensory acceptability.

Application of Pulsed Electric Field in Raw Milk and Its Effect on Quality of Select Indigenous Dairy Products

A batch type lab scale PEF applicator, with 5 major components, namely, the transformer, pulse generating circuit, control unit, treatment chamber and oscilloscope to generate 20-60 kV voltage with a pulse width of up to 1000µs at a frequency of up to 100 Hz to milk in the treatment chamber was designed and assembled. The MOSFETs based driver operated switching system was successful in generating bipolar square waves at the set process parameters of voltage, pulse width and frequency, with no heat generation. The combination of the most optimal process conditions for PEF treatment of milk using the developed PEF applicator was determined using Response Surface Methodology (RSM) as a voltage of 55kV/cm for 50 s at a pulse width of 900 µs and frequency of 90 Hz and the interactive effect of double pass PEF treatment and refrigerated storage was found to extend the shelf life of raw milk to 35 h. Three indigenous dairy products, namely paneer, khoa and curd were selected for evaluating the effect of milk subjected to PEF treatment and 3 treatment protocols for milk, namely, (i) Conventionally heat treatment of milk, (ii) PEF treated milk subjected to conventional heat treatment and (iii) PEF treated milk were compared for its effect on the quality and shelf life of the products. The study demonstrated the potential of employing PEF treatment as a method to extend shelf life of raw milk during operations such as transit and handling before conventional processing operations, without impacting the quality and shelf life of the products.

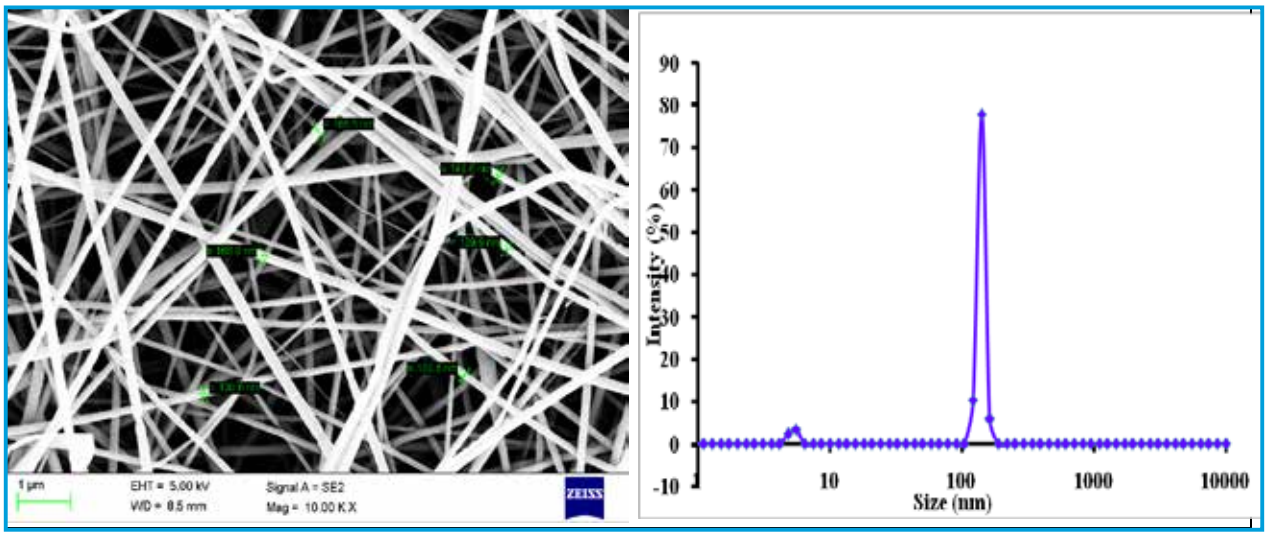
Modelling the Kinetics of Thermal Degradation of Ghee under Conventional and Sub-Baric Frying Conditions

Frying experiments were conducted using ghee as a frying medium across 3 shifts spaced 8 h apart, each shift comprised of 5 frying cycles, wherein gulabjamun was fried in ghee. The process conditions identified for the study were sub-baric frying at 120, 135 and 150°C for 5 min at 400 mm Hg and conventional frying at 145°C for 5 and 10 min. The thermal degradation of ghee samples were quantified in terms of its physico-chemical indices and select indices were modeled to evaluate its kinetics against progression of frying cycles, using four kinetic models, namely, zero, first, fraction first order and Weibull model. An interactive effect of temperature and sub-baric environment on the physico-chemical indices was deduced from the trends of the experimental data and established by statistical significance. Sub-baric frying was observed to significantly slow down the degradation

changes; at higher temperatures the rate of changes equilibrated for the 3rd shift The study revealed that ghee as a frying medium was more stable during repeat frying cycles under sub-baric frying process when compared to conventional frying, especially at the lower temperatures recommended for sub-baric frying. Modelling of the kinetics of changes in the ghee samples subjected to sub-baric frying process helped gain an insight in to the rates of the changes across the 3 shifts evaluated and quantified the rate constants.

Optimization of Electrospinning of Casein-derived Peptides

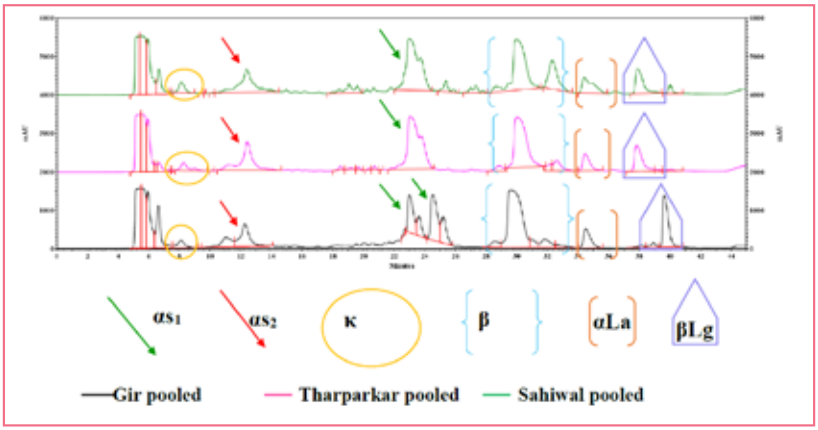
Casein-derived peptides of <10 kDa were obtained by enzymatic hydrolysis of casein using pronase-E enzyme and ultrafiltering the hydrolysate. The permeate was blended with gelatin in the ratio of 1:3 (v/v), and the effect of voltage and concentration was studied using Taguchi's L_{16} orthogonal array design. The levels considered were polymer solution concentration (13, 18 and 23%), flow rate (0.5 and 1 µL/s) and voltage (13, 18 and 23 kV) with mean fibre diameter and encapsulation efficiency as responses. In order to determine the optimum production conditions for electrospun nanofibres, the signal-to-noise (S/N) ratio was used. Among the three control factors, concentration of polymer solution had the highest influence on both mean fibre diameter and encapsulation efficiency. The mean diameter of the nanofibres ranged from 91.63 to 292.15 nm and the encapsulation efficiency ranged from 51.66 to 96.87%. Lowest mean fiber diameter of 91.63 nm and the highest encapsulation efficiency of 96.87% were observed at the optimized conditions of 18 kV, 0.5 µL/s flow rate and 23% polymer solution concentration.



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

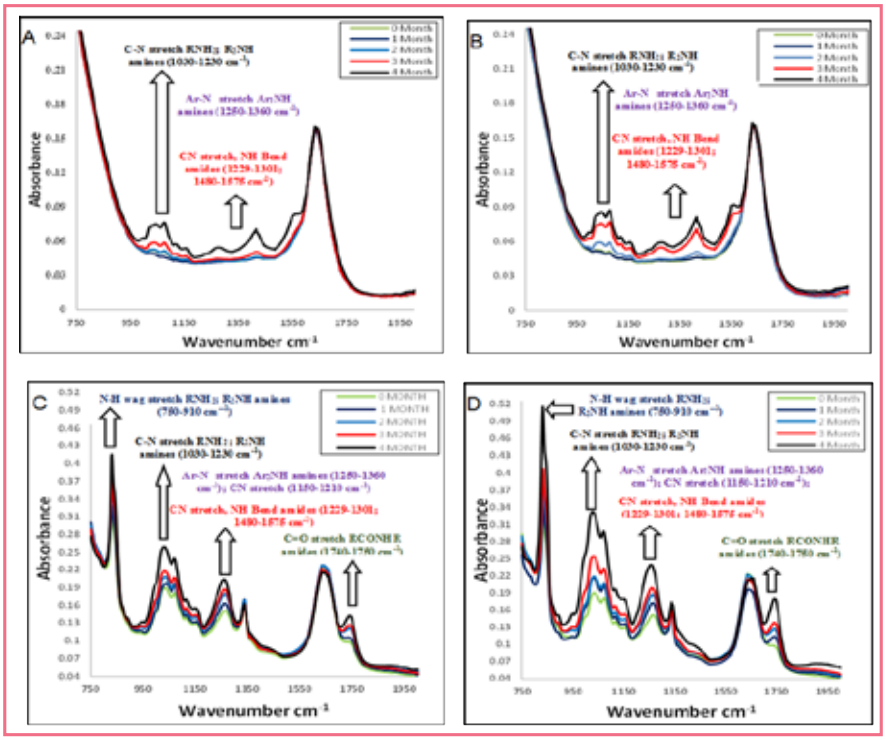
Protein Profiling of Milk from Indigenous Cattle

A RP-HPLC method for separation and quantification of protein fractions from milk of indigenous breeds of cattle was standardized. The method allows simultaneous separation of casein fractions (α_{s1}-, α_{s2}-, β- and κ-CN) and whey protein fractions (α-lactalbumin and β- lactoglobulin) from milk. The results indicated that the α_{s1}- casein fraction from pooled milk of Gir cattle showed two peaks unlike single peak corresponding to Sahiwal and Tharparkar.



Assessment of Proteolysis in UHT Milk by ATR–FTIR Spectroscopy

A method is standardized for assessment of proteolysis in UHT milk using Attenuated Total Reflectance-Fourier Transform Infrared (ATR–FTIR) spectroscopy. The method involves treatment of milk samples either with acetic acid to pH 4.6 or trichloroacetic acid (6% final concentration) to obtain milk extract containing peptides followed by their concentration. The concentrated extract was applied on ATR-FTIR and spectrum was obtained from 400-4700 cm^{-1}. Principle component analysis was carried out in spectral range 750-1500 cm^{-1}. Results were compared with other prevailing techniques like RP-HPLC, fluorescamine and 2-4-D-trinitrobenzene sulphonic acid (TNBS) based methods. The study indicated that FTIR based method can be used as an alternative to available methods for assessing proteolysis in UHT milk.



Legend: *FTIR spectra of extracted UHT milk samples stored at different temperature for four months. The samples (A) and (B)*

were stored at 5°C and 30°C, respectively and extracted by isoelectric precipitation. The samples (C) and (D) were stored at 5°C and 30°C, respectively and extracted by 6% TCA precipitation. Green line for 0-month, Dark blue line for after 1 month, Light blue line for after 2 months, Red line for after 3 month and Black line for after 4 months' storage of UHT milk sample.

Evaluation of GC Analysis Method ISO 17678: 2010 for Determination of Milk Fat Purity in Ghee

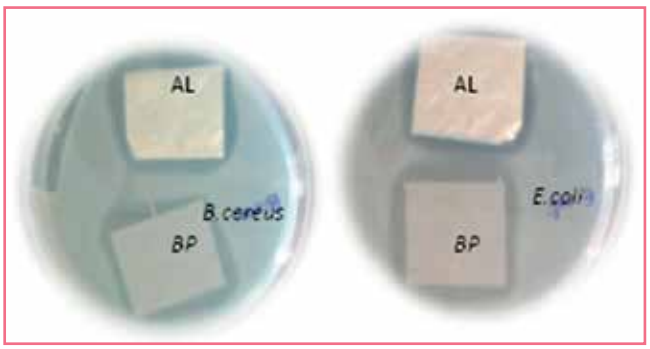
In the present investigation, ISO: 17678 (2010) method was evaluated for ghee (Anhydrous milk fat of Indian origin). Results showed that S- limits specified for pure milk fat in ISO method cannot be adopted as such for cow, buffalo and mixed ghee (Anhydrous milk fat of Indian origin). Hence, modified S- limits have been calculated in the Indian context. S- limits calculated for buffalo and mixed ghee were slightly different from the S- limits calculated for cow ghee. Level of detection of different oils/ fats in ghee was also found to be above 5% except buffalo body fat.

Evaluation of Bronopol and Kathon based formulation for chemical analaysis of Khoa and Paneer

The feasibility of prepared optimized formulation (Combination of bronopol and kathon) was evaluated for preservation of khoa and paneer samples kept for chemical analysis. In khoa and paneer samples added with different concentration of preservative formulation (0.6, 0.8, 1.0 and 1.2%), at 1.0 and 1.2% respectively, all microbiological counts (TPC, LAB, Coliform and YMC) were nil in first dilution. In case of khoa samples during storage at 37°C, there was no significant effect of optimized formulation on estimation of fat, moisture and lactose content corresponding to 75, 90 and 75 days, respectively. In case of paneer samples during storage at 37°C, there was no significant effect of optimized formulation on estimation of fat and moisture content for 90 days.

Antimicrobial Packaging System for Enhancing Shelf Life of Khoa

Bioactive peptides were produced by microbial fermentation of cow milk with *Lactobacillus rhamnosus* C25, *L. acidophilus* NCDC195 and *L. casei* NCDC17. The peptide fractions were separated using ultrafiltration membranes of 10 and 5 kDa. The fermentate and the peptide fractions of all the lactobacilli showed antimicrobial activity against *Salmonella enterica* NCTC 6017, *Enterococcus faecalis* ATCC 27736, *Bacillus cereus* ATCC 13061, *Escherichia coli* ATCC 25922, *Listeria monocytogenes* ATCC 15303, *Staphylococcus aureus* MTCC 1144 and *Shigella dysenteriae* NCDC 107. For the antifungal substance (AFS) production, skim milk was supplemented with peptone (1%), maltose (0.5%), Tween 80 (0.1%) and fermented with *L. acidophilus* NCDC195 and *L. casei* NCDC 17 for 48 h at 37°C. Antifungal activity was observed against *Rhodotorula glutinis* NCDC 51, *Aspergillus niger* NCDC 267, *Kluyveromyces marxianus* NCDC 41, *Candida gullerimondii* NCDC 44 and *Penicillium roquefortii* NCDC 170. Combination of bioactive peptides of C25 and AFS of 195 (1:2) showed maximum antifungal activity against *R. glutinis.* Aluminum foil and glassine paper coated with 10 kDa bioactive peptides of C25 and AFS of 195 in combination showed maximum inhibition of test organisms. Market khoa and NDRI khoa samples were wrapped in coated antimicrobial packaging materials and stored at 37°C and 5°C for 30 days. The shelf life of market khoa was enhanced by 5 days in active glassine paper and Al foil. On the other hand, the shelf life of NDRI khoa sample wrapped in active Aluminium foil was enhanced by 10 days and in glassine paper by 5 days.

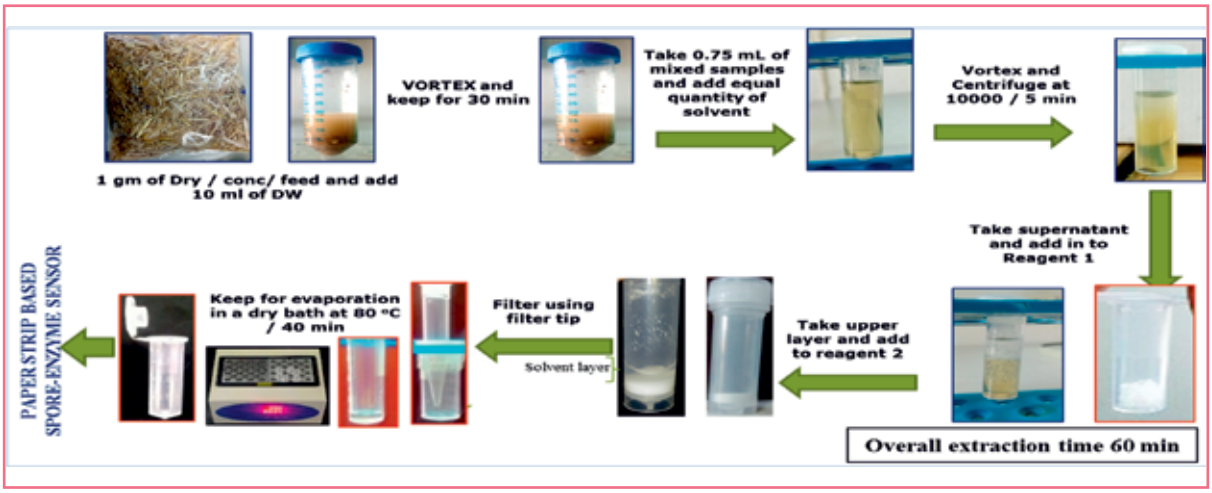


Antimicrobial activity of bioactive peptides and AFS (C25+195) in combination coated on packaging materials

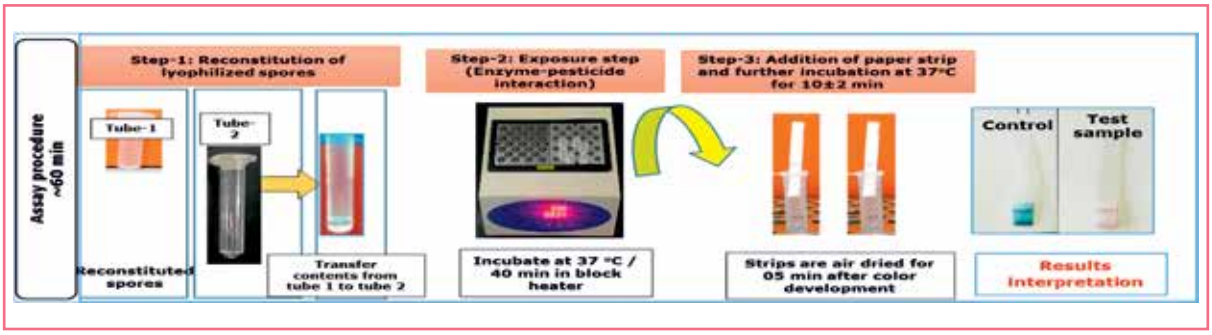
Development and Evaluation of Spore based Biosensors for Monitoring of Pesticide Residues in Milk

Spore based sensor for detection of pesticides employing some novel enzymes in *Bacillus* spores was developed, validated and technology was commercialized for its field application for detection of pesticide residues in milk and other food matrices. Initially expression of enzymes like α-glucosidase, α-galactosidase, β-glucosidase, esterase and α-amylase was evaluated in six different strains of *B. megaterium*. The expression of "esterase enzyme" was found in real time and used for development of "three steps" assay protocol on paper strip. The extraction protocol was optimized with milk and subsequently, optimized with fruit juices, and cereal based foods. Refinement of strip based test for its application in detection of pesticides in dairy farm was carried out with 12 new pesticides legally

recommended for cattle feed / fodder. The extraction protocol for these pesticides in cattle feed/fodder used in dairy farm was also optimized and evaluated with spiked samples and LODs were established. Further, the working of strip was evaluated under field conditions with feed, fodder, soil, manure and water samples (300), wherein 17 samples were observed positive for pesticide residues (5.66%). Overall, paper strip test was evaluated with more than 50 pesticides belonging to OP, OC, carbamates, herbicides and fungicides, covering a wide range of food matrices including dairy and non-dairy foods. The performance was found satisfactory in terms of detection at MRL level set by regulatory agencies.



Extraction procedure of pesticide residues from feed, and fodder samples



Paper strip sensor for pesticide detection

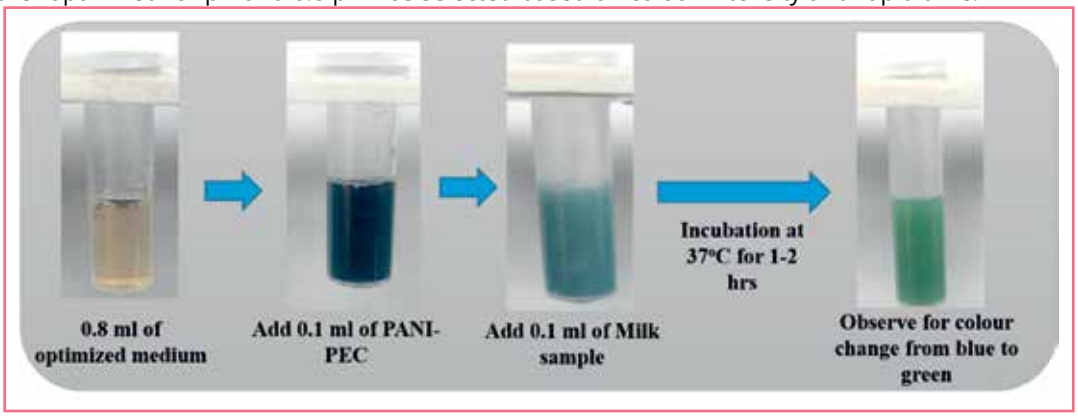
Assessment of Antimicrobial Residues and Resistance in Dairy Animals in India

Qualitative and quantitative screening of milk samples for presence of antimicrobial residues was carried by taking milk samples from organized (254) v/s unorganized sector (753). Comparative data on antibiotic residues in Assam and Haryana indicates low prevalence of antibiotic residues in milk collected from un-organized sector compared to organized sector. For understanding the use of antimicrobials at state and farm level in the dairy sector, study was conducted by randomly selecting 4 urban and 4 rural villages in Haryana. The pilots were preceded by focus group discussions with the farmers and key informant interviews for veterinarians and field assistants/para vets. The results of the intervention study indicate little effects on farmers for understanding the complex issue of AMR. Work on antimicrobial resistance carried out at NIVEDI on 2 isolates of *Staphylococcus saprophyticus* isolated from Haryana, carried the MecC gene, which is the first observation of this in India. Extension material developed during the final year of the project will definitely be a scientific tool to understand antimicrobial agents and mitigate the continuously increasing AMR problem in dairy sector.

PANI-PEC Polymer Based Test for the Detection of Microbial Quality of Milk

Synthesized Polyaniline–Pectin nanoparticles (PANI-PEC) were characterized for the development of paper strip assay for detection of microbial quality of milk using FTIR, UV-Vis, Particle size analyzer and electrical conductivity. A PANI-PECTIN colorimetric sensor strip was constructed using Whatman filter paper Grade 4 and 3mg/ml PANI-PEC particles based on its colour intensity and rapid colour change. By using the developed rapid PANI-PEC particle colorimetric strips, initially, *Escherichia coli* (EC) and coliforms were analysed in milk system using already developed EC/coliform selective medium with a detection sensitivity of <1.0 log cfu/ mL within 12 h of incubation time. Further, a growth medium for the rapid detection of microbial quality in milk system was optimized for its components using four different media including Nutrient broth, Brain Heart infusion broth, plate count broth and Luria Bertani (LB)

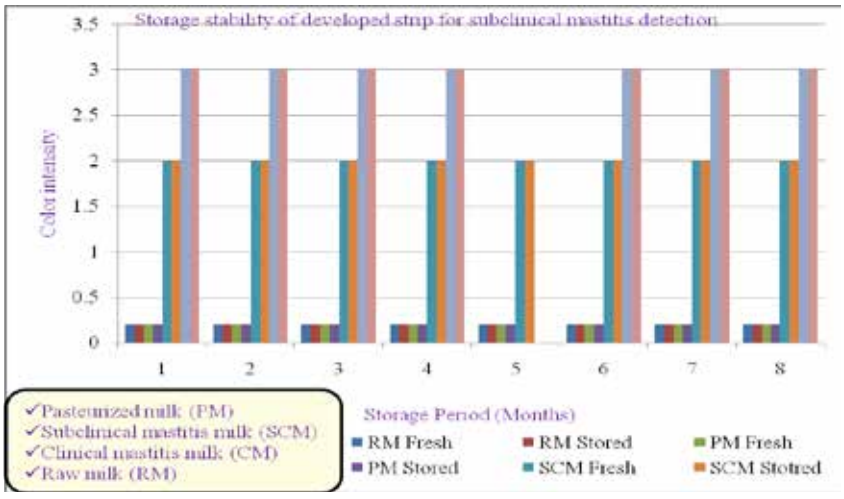
broth. LB broth medium was selected among four growth media screened for the evaluation of microbial quality of milk based on rapid colour change and color intensity. Further, selected medium was optimized for different components and combination 4 selected based on its rapid colour change within 60 min. The optimized medium was further optimized for pH and 6.8 pH was selected based on colour intensity and rapid time.



PANI-PEC polymer based test for the detection of Microbial quality of milk

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

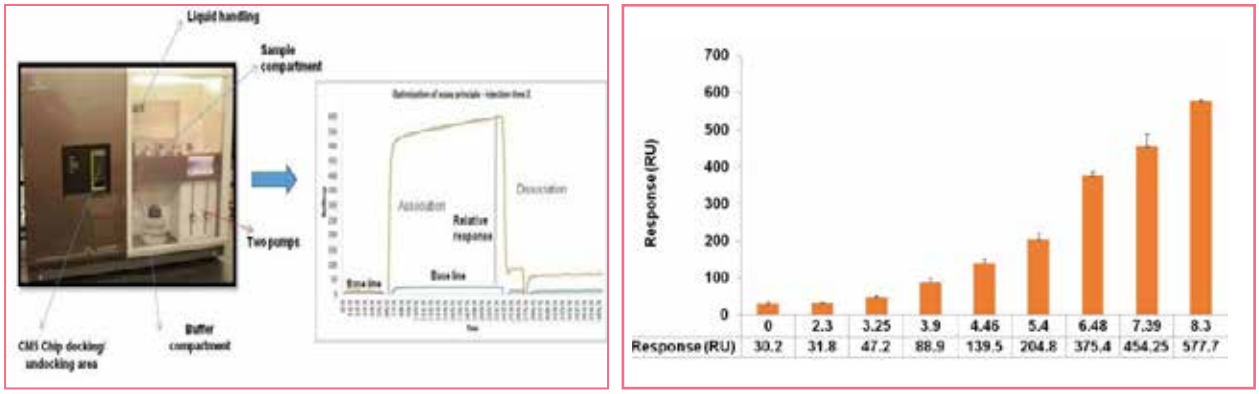
Strip test has been developed for detection of subclinical mastitis. Performance of developed strip was evaluated, validated and correlation was established with conventional tests (SCC, CMT, pH). Cross reactivity studies of milk contaminants *viz.,* antibiotics (penicillin, ampiciilin, tetracycline, oxytetracycline, streptomycine aminoglycosides and amphenicol), pesticides (organoposhpate, carbamates & organochlorine), heavy metals (lead, mercury & cadmium), aflatoxin M1 and diseases (brucellosis) were conducted to check their interference with performance of developed strip test. Observations of subclinical milk samples spiked with varied levels of above contaminants and milk from diseased animals indicated non-interference of these contaminants with the performance of developed strip test. Developed strip test was also assessed for its performance using milk samples from different breeds of crossbred (Karan Fires, Karan Swiss) and indigenous (Sahiwal, Tharparkar, Gir and Murrah) milch animals. Inter laboratory validation also indicated satisfactory performance of samples of cow and buffalo milk analysed. The storage studies on developed test were also evaluated for its performance upto eight months in two coextruded and laminated aluminium foils at different temperatures. Results revealed that performance of strip remains unaffected even after eight months in both the packaging materials at -20°C and 4°C.



Surface Plasmon Resonance Based Detection of *Listeria monocytogenes* on Biochip

Initially, 10 different types of lectins viz. were screened for their agglutination potential against six different strains of *Listeria monocytogenes viz.* 15313, 19111, 19115, 19118, 13932 and BAA 751. Amongst these, the lectin Wheat Germ Agglutinin (WGA) lectin showed maximum agglutination activity in the range of 80-90% against all the test strains with least cross reactivity and was selected for further binding interaction study using Biacore Surface Plasmon Resonance (SPR) system after immobilizing on CM5 chip. The pH of the sodium acetate buffer system was optimized to pH 5.0 and the WGA concentration was standardized to 750 µg/ml based on the highest SPR response of 2989.1 RU in Biacore SPR 3000 system. Under above optimized conditions, *L. monocytogenes* 19115 has generated a highest response of 479±49 RU at 7.4 log cfu/100ul with least cross reactivity. Further, the WGA immobilized chip was evaluated for sensitivity with the different log CFU/ 100µl of *L. monocytogenes* 19115 (2.3 to 8.0 log CFU/ 100 µl) in broth system. The sensitivity of the WGA lectin immobilized chip was found to be 3.25 log

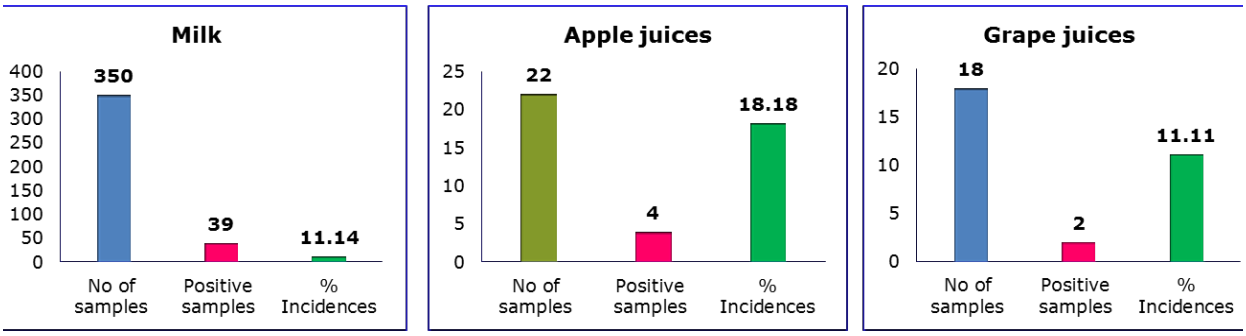
CFU/ 100µl *L. monocytogenes.* Then, the WGA immobilized chip was evaluated in milk system enriched with LSEM developed at ICAR-NDRI and the response (RU) was again found to be significant and could detect up to 3.0 log CFU/ 100 µl.



SPR based detection of Listeria monocytogenes using WGA lectin with a detection limit of 3.25 log cfu/100µl

Screening of Processed Fruit Juices for the Detection of Pesticide Residues Using Paper Strip Based Sensor

Spore based novel enzymes sensor was successfully developed for pesticide detection in processed fruit juices as well. PSA (Primary Secondary Amine) was supplemented with $MgSO_4$ in 1:2 ratio for efficient removal of pigments and to reduce the cost of extraction protocol. The results obtained with revised extraction protocol indicates no interference of matrix in terms of extraction of pesticide and the developed assay was found suitable for screening of pesticide residues in all processed/raw fruit juices products available in the market. LODs of 16 pesticides from three different groups after spiking in processed fruit juices were established with developed spore-based enzyme sensor. LODs achieved for insecticides group were in the range of 1-10 ppb, 1-10 ppb for fungicides and 10ppb for herbicides. Seventy three samples of fruit juices comprising of mixed fruit, apple, grape and pomegranate were evaluated for pesticide detection using revised assay protocol under field condition. Four samples of raw apple juice and two of grape juice showed the presence of pesticide residues. The optimized extraction protocol along with developed strip based assay can be successfully applied for rapid detection of pesticides in different processed / raw fruit juices under field conditions.

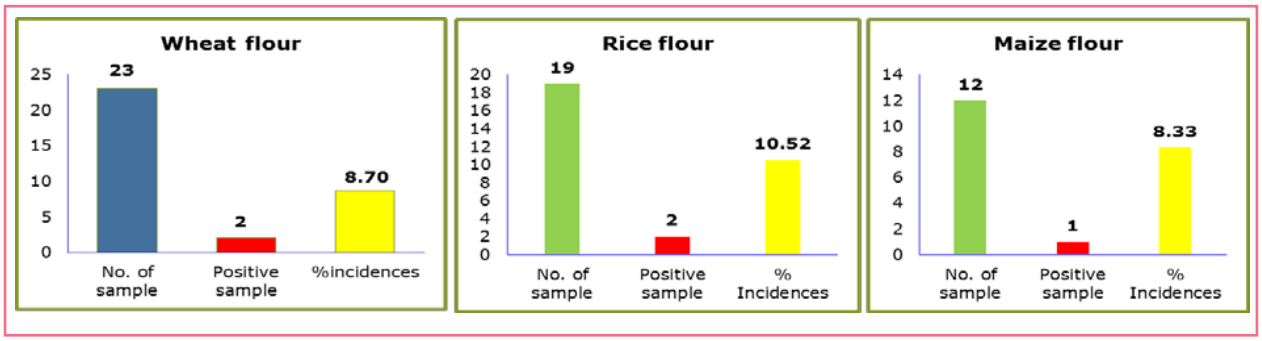


Screening of milk and fruit juices for pesticides under field conditions

Screening of Cereal Based Foods for Pesticide Residues Using Paper Strip Based Sensor

The current investigation included the development of extraction protocol of pesticide residues from cereal based foods. Interventions were explored using activated charcoal, PSA and MgSO4 in existing extraction protocol for removal of pigments from cereal based foods to prevent their interference in enzyme-pesticide interaction leading to color development on strip. PSA in combination with $MgSO_4$ in 1:2 ratio was found successful in extraction of pesticide from cereal based foods with no interference of pigments in assay working on strip. Using developed extraction protocol and strip based assay, LODs for 15 pesticides belonging to different groups were established in pure solvent as well as spiked cereal based foods. The LODs were 1-100 ppb, 10 ppb, 1ppb, 1ppb and 1-100ppb for OP, OC, Fungicide, Pyrethroid ester, Herbicide group respectively. 70 samples of cereal based foods comprises of wheat flour, rice flour, maize flour, corn flakes and different cookies collected from different sources were evaluated for pesticide residues using developed assay protocol under field condition. Out of these 5 samples were found positive for pesticide

residues. The current investigation study also includes validation work with VIMTA and FRAC LAB etc. The developed extraction protocol is working well for detection pesticide residues in different variant of cereal based foods.



Screening of cereal based foods for pesticides

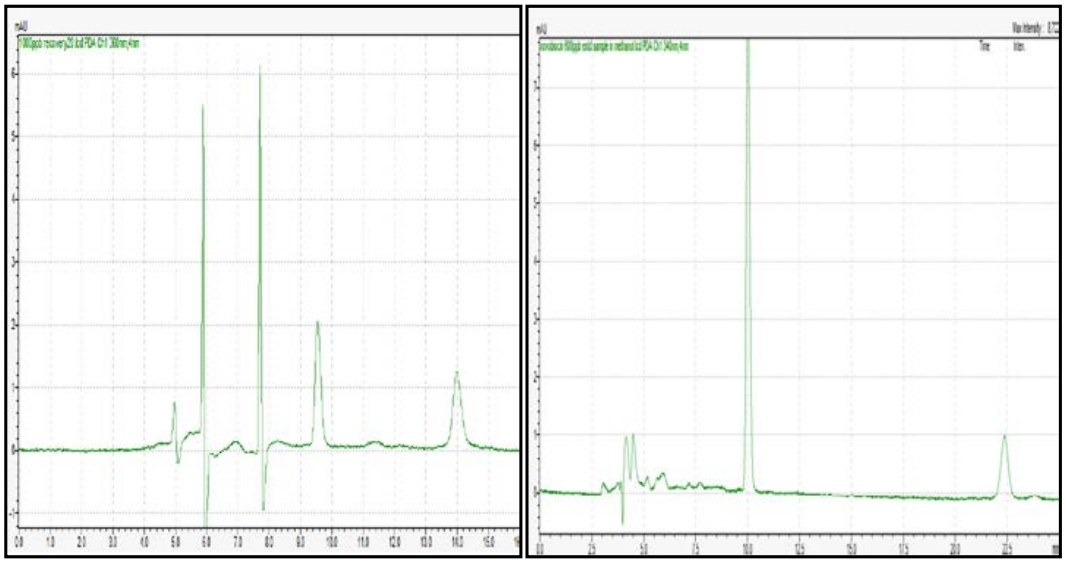
Detection and Quantification of Antibiotic Residues in Selected Raw and Market Milk Samples Using the Optimized HPLC protocol

HPLC analytical protocols were standardized for detection and quantification of different antibiotic residues (tetracycline, oxytetracycline, novobiocin, sulphadimidine and sulfamerazine) from raw and pasteurized milk samples. Simple liquid-liquid extraction protocols were also optimized for extraction of these residues from the fluid milk. It was found that the detector responses were linear over the selected concentration range from 0.1-1µg/ml with correlation coefficients between 0.995-0.9996 for all the antibiotics. Following extraction protocol, average recoveries were obtained in the range of 90.314 to 94.385% for tetracycline, 85.68 to 92.32% for oxytetracycline, 93.63 to 102.61% for novobiocin, 92.27 to 96.03% for sulphadimidine and 89.224 to 94.17% for sulfamerazine, respectively. Repeatability was also assessed and the RSD values for all the antibiotics were within the specified range (<2%) indicating that the method was suitably precise. A total of 182 raw and 50 pasteurized milk samples were screened for the presence of antibiotic residues, of which 32 raw milk samples and none of the pasteurized milk samples were found to be positive. These HPLC methods were successfully applied for the determination of antibiotic residues in raw and market milk samples, were able to detect them at or below MRL levels and can be applied for routine analysis of milk samples. The method is selective and can be used in routine analysis of antibiotics.

Quantitative estimation of antibiotic residues in random raw and market milk samples

	Positive samples				
Total number of samples tested	TET	OTC	N	Sulpha	SLZ
Raw milk- 182	7	13	-	3	9
Pasteurized milk- 50	-	-	-	-	-

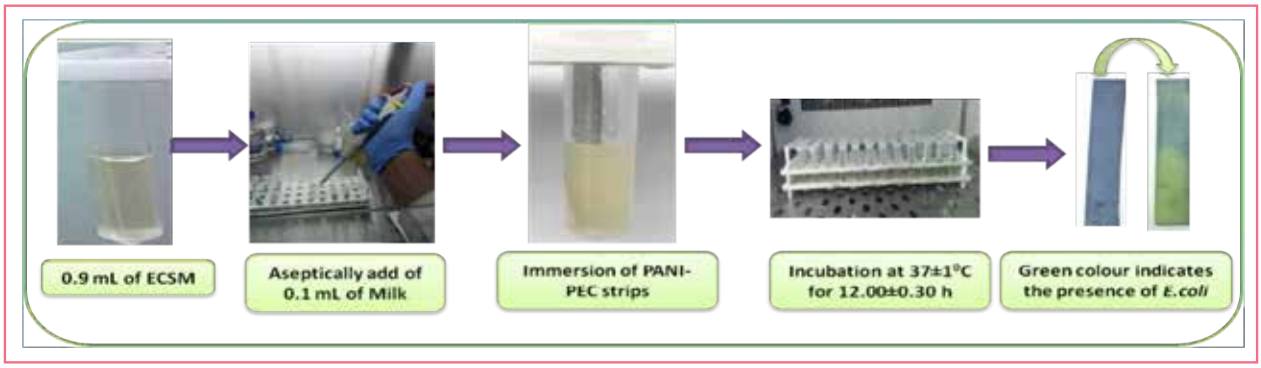
Note: *TET: Tetracycline; OTC: Oxytetracycline; N: Novobiocin; Sulpha: Sulphadimidine; SLZ Sulfamerazine*



Chromatogram of milk spiked with 1000ppb (a)tetracycline (b) novabiocin

Polyaniline–Pectin Nanoparticles Based Paper Strip Assay for Detection of *E. coli* / Coliforms in Milk

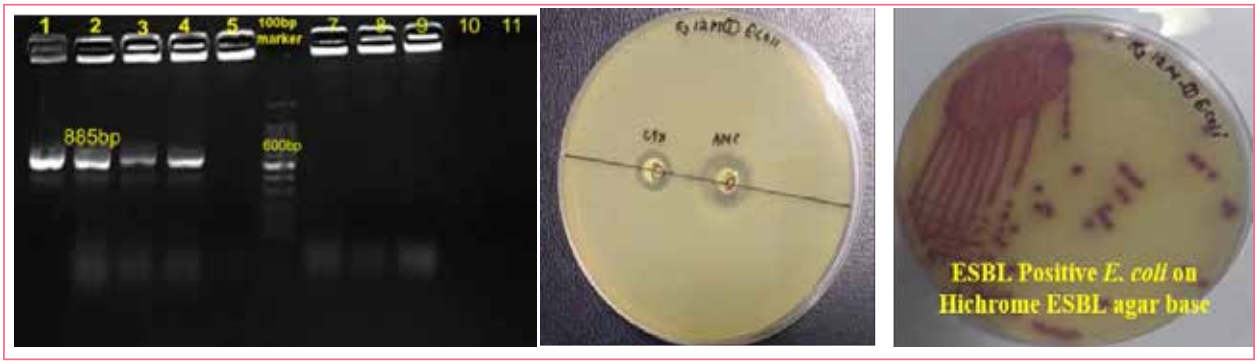
PANI-PEC colorimetric sensor strips were fabricated with selected Whatman filter paper grade 4 immobilized with PANI-PEC nanoparticles solution of optimized concentration 3 mg/mL. PANI-PEC strip based sensor assay developed for *Escherichia coli*/coliforms employing ECSM/CSM as selective medium can detect 0.62±0.15 log cfu/ mL of *E. coli* within 11.45±0.30 h and 0.55±0.15 log cfu/mL of coliforms within 12.00±0.15 h at 37±1°C. No interference of contaminants such as *Salmonella*, *Shigella*, *Yersinia*, *Proteus*, *Serratia*, *Citrobacter*, *Enterobacter* and *Klebsiella* was observed at 7.86±0.10, 8.68±0.30, 5.74±0.10, 3.70±0.10, 1.73±0.10, 3.47±0.25, 6.45±0.15 & 3.35±0.25 log cfu/mL. Further, the developed assays were evaluated in milk system and validated under field conditions with 55 milk samples by simultaneously testing with approved IS: 5887-1 (1976), IS: 5401-1 (2012) methods and AOAC official methods 991.14 & 989.33. Out of 25 raw milk samples analysed, 15 samples showed positive for *E. coli* and 21 samples showed positive for coliforms, whereas all 30 pasteurised milk samples showed negative for both *E. coli* and coliforms. Based on the above findings, the developed assay(s) could be used for routine monitoring of *E. coli*/ coliforms in milk at various stages of production and processing after thorough evaluation under field conditions.



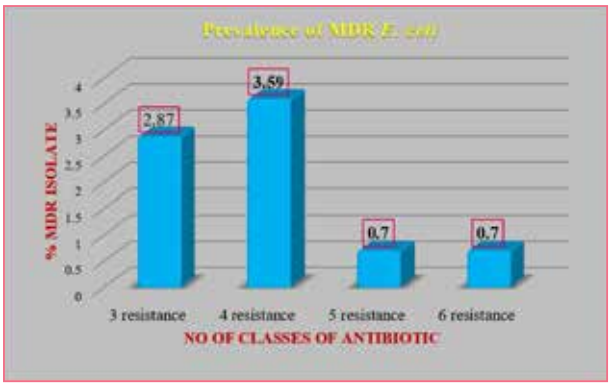
PANI-PEC nanoparticle based paper strip assay for detection of E. coli and coliforms in milk samples

Risk Assessment of Antibiotic Resistant *E. coli* in Milk

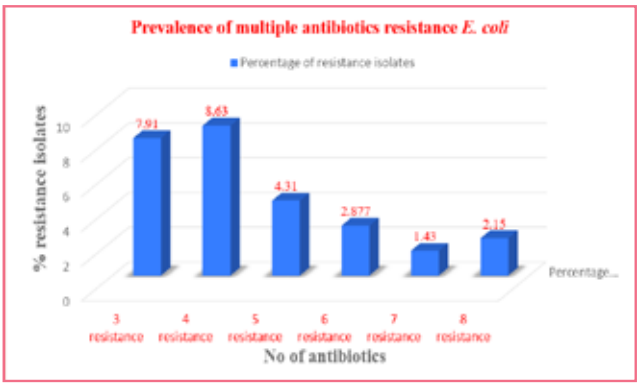
A total of 190 samples comprising of raw milk, pasteurized milk, infant food and human handlers were processed microbiologically to isolate *Escherichia coli* using IS/ISO approved methods. A total of 139 *E. coli* isolates from raw milk, pasteurized milk, and human handlers were identified by phenotypic methods. Among these, 22 isolates were confirmed as *E. coli* using species specific primers by PCR. All these *E. coli* (n=139) and *Staphylococcus aureus* (n=10) isolates were checked for their antibiotic resistance pattern by Kirby-Bauer method. All *E. coli* isolates were found to be resistant to penicillin, oxacillin, erythromycin and clindamycin. The dominant type of resistance to cefotaxime and amoxiclave was detected in 18.7% isolates followed by ampicillin in 17.98%, trimethoprim 15.82%, tetracycline 10.79%, nalidixic acid 7.91%, piperacillin 7.79%. Total 11 *E. coli* isolates were found to be multidrug resistant and 4 isolates were phenotypically as well as using PCR confirmed as extended spectrum β-lactamase (ESBL) producer using CTX M gene. Pathogens cycling through food are very common and might impose a potential risk health to consumer. Therefore, in order to prevent food safety health risk problems caused by antibiotic resistant food borne pathogens, good hygienic practices in the food chain are essentially adopted in the dairy sector.



ESBL positive E. coli isoaltes on Chromogenic medium and by gel electroporesis



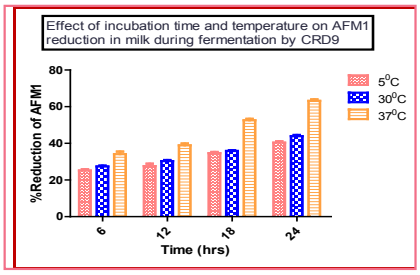
Prevalence of Multi-drug resistance E. coli

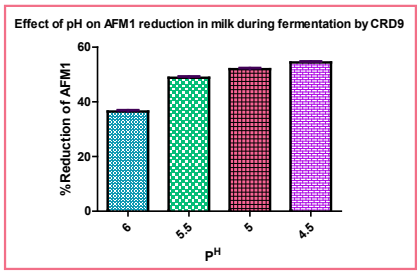


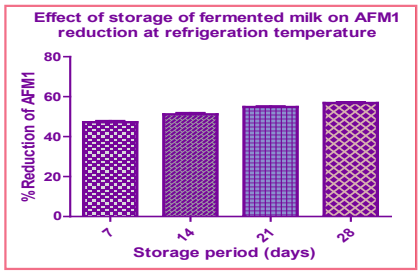
Prevalence of multiple-antibiotic resistance E. coli

Bio-mitigation of AFM1 by *Lactobacillus rhamnosus* CRD9

Aflatoxins are potent carcinogenic and immunosuppressive agents. Acute exposure to high level of aflatoxins leads to aflatoxicosis. Aflatoxin M1 (AFM1) most frequently encountered in milk and dairy products impose serious health concern in consumers. Probiotic lactic acid bacteria exhibit detoxification ability in natural foods. Cultural growth conditions of native *Lactobacillus rhamnosus* CRD9 probiotic strain for bio-mitigation of AFM1 in milk were optimized. AFM1 levels in milk and fermented milk were determined by ELISA kit. Highest AFM1 reduction of 63.16±0.81% was recorded at 37˚C followed by 30˚C (43.90±0.65%) and 5˚C (40.39±0.71%) after 24 h of incubation. Maximum AFM1 reduction of 54.41±0.37% at 37˚C of milk was observed at pH-4.5 during fermentation after 20h, whereas it was 36.49±0.48%, 48.83±0.44% and 51.99±0.38% at pH 6.0, 5.5 and 5.0, respectively. Highest AFM1 reduction of 62.42±0.45% was recorded at inoculum levels of 10^{10}cfu/ml. Refrigerated storage at 5±1˚C resulted continuous reduction in AFM1 levels i.e. 69.83±0.52, 78.37±0.56, 83.91±0.19 and 86.48±0.35% after 7, 14, 21 and 28 days, respectively.







Food Safety Adoption by Dairy Start-ups Established with Proper Technical Guidance of ICAR-NDRI

Food safety adoption index was developed based on 47 practices, categorised into four sections, viz., i) Milking Hygiene, ii) Milk Handling, iii) Animal Health Care and iv) Management Practices, to assess adoption of food safety measures by commercial dairy farms. The opinions of 50 experts (research /field experience, ranged 2 to 35 years) from various institutes of ICAR, SAUs, KVKs, state governments' line departments having acquaintance in the fields of Animal Nutrition, Livestock Production Management, Dairy Technology, Dairy Microbiology, Animal Genetics and Breeding, Animal Physiology, Dairy Extension, etc., were ascertained to finalize default scores. All the collected scores were pooled to obtain appropriate weightage for each section and scores for dairy practices to arrive at the "Food Safety Adoption Index". The index has been used to evaluate the level of food safety practices adopted by 10 dairy farms (among the aforesaid sample start-ups). It was found that, the level of food safety adoption was merely 59% of standard practices with respect to food safety. The level of adoption was found to be 57% each for Milking Hygiene and Milk Handling categories. However, adoption of management practices was comparatively better than animal healthcare practices (69% and 65%, respectively). The overall level of adoption indicated scope for improvement by way of emphasizing better milking hygiene and milk handling practices in order to minimize food safety adoption gap of 41%.

DAIRY DEVELOPMENT: POLICY ANALYSIS, STRENGTHENING DATABASE AND IMPACT ASSESSMENT

Assessment of Dairy Cattle Welfare at Commercial Dairy Farms in Punjab

There appears to be a paradigm shift in dairy farming in recent years from traditional small scale, subsistence and extensive farming towards commercial scale intensive farming based on high yielding crossbred cows and improved breeds of buffaloes in many parts of India especially in the state of Punjab. The intensification of husbandry practices, although desirable for meeting the food needs of our burgeoning population, puts the animals under varied type of stresses that compromise their welfare. Therefore, in the recent times, there is a growing interest and concern about the welfare of dairy cattle managed under intensive systems. There is also an ethical challenge how to reconcile the welfare needs of the animals and the needs of the farmers for economics returns and the needs of the people for safe and cheaper food. In this backdrop, an investigation was undertaken with to assess the level of dairy cattle welfare at commercial dairy farms in Punjab and to study relationship between performance and dairy cattle welfare

The data were collected from crossbred cattle based 60 commercial dairy farms categorized as small (10-19 animals), medium (20-49 animals) and large (≥50 animals), 20 dairy farms in each group which were distributed into five agro climatic zones of Punjab. From each category, dairy farms were distributed into each zone by using probability proportional to size sampling method. Cattle welfare was assessed using Dairy Cattle Welfare Scale (DCWS) described by Kamboj and Kumar (2016). This scale is based on 20 welfare indicators grouped into three components; A) Housing and other facilities, B) Feeds and feeding practices and C) Animal health, performance and behaviour. Principle Component Analysis was performed for identifying key welfare indicators and the linear regression function was used for establishing relationship between welfare score and production economics of the selected dairy farms.

Overall Welfare Ranking of Commercial Dairy Farms in Punjab

Welfare category	Welfare score	Percent of farms (N=60)			Overall (%) (N=60)
		Small sized (10-20 cows)	Medium sized (21-50 cows)	Large sized (> 50 cows)	
Very good	> 80	-	-	30	10.0
Good	60 - 80	55	80	65	66.6
Average	40 - 59	40	20	5	21.6
Poor	< 40	5	-	-	1.6

From the results obtained, it was concluded that the production performance of crossbred dairy cattle at commercial dairy farms in Punjab was the highest at large dairy farms while reproductive performance was better at medium and large dairy farms as compared to small dairy farms. The net returns per liter of milk were also the highest at large dairy farms (11.01 Rs/Litre) as compared to medium (8.15 Rs/Litre) and small (5.24 Rs/Litre) dairy farms. The cattle welfare status at commercial dairy farms in Punjab was assessed to be acceptable (in the category of 'good to excellent') at 76.67 per cent of the total dairy farms whereas cattle welfare status was acceptable at 55, 80 and 95 per cent of the small, medium and large dairy farms, respectively. The productive and reproductive performance

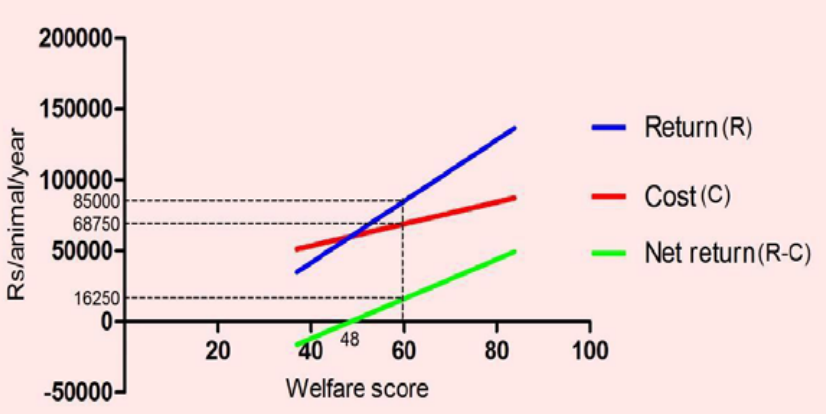


Fig. Relationship between cow welfare and economic returns from dairy farming (farmer's welfare)

of dairy cattle at commercial dairy farms in Punjab was positively associated with their welfare status. It was good at dairy farms having improved dairy cattle welfare. The improvement in dairy cattle welfare at commercial dairy farms of Punjab resulted in higher net returns for dairy farms. The farms falling in "poor to average" welfare category with a welfare score of below 48, were found to be in loss whereas at farms with a welfare score of more than 48 but less than 60, the farmers were earning profit but cattle welfare was found to be still compromised. At welfare score of more than 60 ('good to excellent' welfare category dairy farms) both profit and welfare was positive. The overall assessment of cattle welfare at commercial dairy farms in Punjab revealed that housing system and space availability, floor type, microclimate protection measures, cow cleanliness, average productivity, reproductive efficiency and body condition indicators were most compromised welfare issues at commercial dairy farms of Punjab.

Assessment of Welfare of Cattle in Gaushalas in Haryana

The Gaushalas symbolise the Indian cultural heritage of love and compassion for animals. The Gaushalas are meant to rescue, shelter, protect, feed, treat and rehabilitate the weak, sick, injured, handicapped and abandoned homeless (stray) cattle. The Gaushalas have also been identified as the centers for conservation of declining indigenous cattle breeds which are at the risk of extinction. There are more than 4000 Gaushalas having the capacity to conserve the indigenous cattle throughout the country. In Haryana the total population of indigenous cattle is 8.12 lakhs out of which 37.7 % are maintained in a total of 408 Gaushalas in the state. Generally it is believed that the welfare of cattle in Gaushalas in not satisfactory and the performance of productive cows maintained in Gaushalas is also observed to be poor.

The aim of the this study was, therefore, to study to assess the status of cattle welfare in Gaushalas and to study the performance of cattle in Gaushalas which will help in developing strategies for the improvement of welfare and performance of these cattle. For this study the data were collected from 30 Gaushalas selected and grouped into 3 categories based on total number of animals as small (100-500 animals), medium (501-1000 animals) and large (>1000 animals), 10 Gaushalas in each category. The welfare of cattle was assessed based on 20 input and output based welfare indicators using Calamari and Bertoni (2009) scale as modified by Kamboj and Kumar (2014). The salient finding emerged from the study are presented as under:

- Overall average daily milk yield of milch cows at selected Gaushalas was found to be 3.41±0.32 kg and it was significantly (P<0.05) higher at large Gaushalas (4.17±0.27 kg) than the small (2.88±0.40 kg) and medium Gaushalas (3.17±0.29 kg). Overall average lactation length of milch cows was found to be 241±12 days and it was significantly (P<0.05) higher at large Gaushalas (258±13 days) than the small Gaushalas (222±10 days) and there was no significant (P<0.05) difference between small and medium Gaushalas (243±12) as well as medium and large Gaushalas. Overall average lactation yield for milch cows was 830.07±82 kg and it was significantly (P<0.05) higher at large Gaushalas (1034.67±68 kg) than the small (684.33±79 kg) and medium Gaushalas (771.22±99 kg).
- Overall average age at first calving for milch cow was found to be 37.50±1.40 months and there was no significant (P<0.05) difference among small, medium and large Gaushalas. Overall average service period for milch cow

was found to be 152.67±9.23 days and it was significantly (P<0.01) lower in large Gaushalas (135.50±6.08 days) than the small Gaushalas (166.00±9.54) and there was no significant (P<0.05) difference between small and medium Gaushalas (56.50±12.07), as well as medium and large Gaushalas. Overall average calving interval was found to be 439.00±14.30 days and it was significantly (P<0.05) lower in large Gaushalas (441.00±9.00 days) than the small Gaushalas (492.00±18.55 days) and there was no significant (P<0.05) difference between small and medium Gaushalas (456.00±15.36), as well as medium and large Gaushalas.

- Overall mean welfare score of all components (A, B and C) out of total score 100 was 49.98±5.23 and it was significantly (P<0.05) higher in large Gaushalas (58.86±5.07) than the small Gaushalas (42.59±4.72) and there was no significant difference between small and medium Gaushalas (48.47±5.9) as well as medium and large Gaushalas. Overall percentage of Gaushalas under good, average and poor welfare categories was 20, 53.33 and 26.67 percent, respectively. Thus, 20 percent of the total Gaushalas had an acceptable welfare level and remaining 80 percent of the Gaushalas had an unacceptable welfare level.
- Overall assessment of level of cattle welfare in Gaushalas in Haryana revealed that the type of floors, cows comfort, availability of quality feeds and fodders, system of housing & availability of floor space, facilities for rescue, transport and treatment, type and height of roof, feeding practices for different categories of animals, body condition, breeding practices and cow cleanliness were most compromised indicators where improvement was needed as percent of their obtained average score was less than 60%.

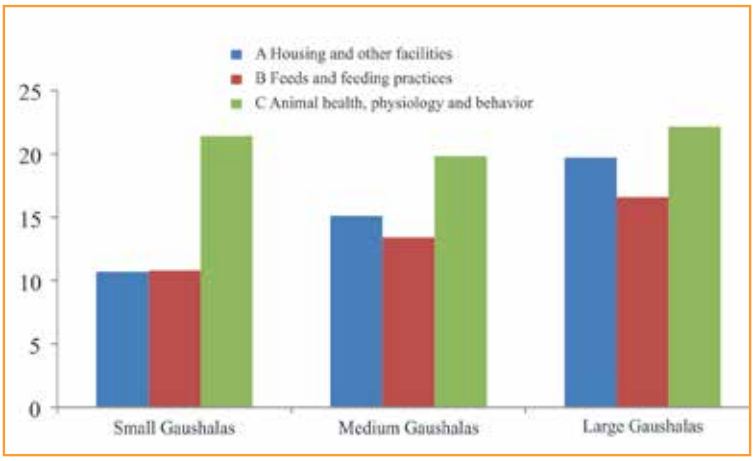


Fig. Overall welfare scores of different welfare components in different sized Gaushalas in Haryana

It was concluded that productive performance of milch cow at Gaushalas in Haryana was highest at large Gaushalas than the small and medium Gaushalas, and reproductive performance were better in large Gaushalas than the small Gaushalas. The overall welfare of cattle at 20 % of the Gaushalas was acceptable and at the remaining 80% of Gaushalas the cattle welfare was unacceptable. One half of the large Gaushalas were found to be in acceptable welfare category level, whereas, all the small Gaushalas and 90 percent of the medium Gaushalas were found to be in the unacceptable welfare level. The most compromised welfare indicators in all Gaushalas were type of floors, cows comfort index, availability of quality feeds and fodders, system of housing & availability of floor space, facilities for rescue, transport and treatment, type and height of roof, feeding practices for different categories of animals, body condition score, breeding practices and cow cleanliness score.

Impact Assessment of Livestock Services and their Delivery Mechanism

Recognizing the paramount importance of livestock support services in increasing production and productivity of animals, the study conducted impact assessment of livestock services and economic analysis of their delivery mechanism in Anand, Junagadh, Sabarkantha and Surat districts of Gujarat**.** Primary data were collected (2013-14) for 200 selected households and secondary data on veterinary institutions, total output of livestock products and inputs used especially feed, labour and interest of population stock. The contingent valuation (CV) was used to estimate WTP and Tornqvist-Theil Index was used to estimate total factor productivity (TFP) which was further decomposed to find out the effect of factors other than inputs. The number of livestock population served by one veterinary institution was 20,000, which was too large from all standards. The coverage of livestock insurance was low as only 0.55% of the livestock population was insured. An average farmer was making total expenditure of Rs 1813 per standard animal unit (SAU) per annum on livestock services in which animal health services were accounting for 67% of the total expenditure and remaining was on AI services. The expenditure incurred by cooperative institutions on providing the services of case treatment, vaccination, emergency visits and AI were Rs 71, Rs 66, Rs 267 and Rs 49 per service on an average, respectively. For animal health services, the overall WTP was about Rs 74 per service at the centre

and Rs 206 per service at doorstep, which was 1.23 times and 1.02 times higher than the existing charges per service, respectively. The TFP of livestock sector in Gujarat was found to be ever increasing except during mid eighties to mid nineties when the state faced severe drought. The highest growth rate in TFP was recorded 5.32% per annum during the last decade from 2005-06 to 2014-15. This growth rate in TFP has been realized due to the high growth of output index and deceleration in input index which revealed an improvement in input efficiency ratio. A one per cent increase in R&D investment (proxy for technology) significantly increased the TFP by 0.1237%. Another major variable explaining the positive growth in TFP was the rural literacy which was proxy for skill of farmers. The study concluded that in spite of growth in institutions of livestock services, it is not commensurate with the increase in livestock population. The number of animals served by one institute or veterinary doctor was substantially higher by all standards and could be one of the reasons for poor livestock services. The role of government institution in providing services was still dominating even after multi-agency approach recommended by policy planners and scientists. The share of cooperatives and private agencies was lower especially in treatment of animals and vaccination which are crucial services for overall improvement in production and productivity of animal. The cooperatives were better in improving the germplasm of the livestock through AI services and were also cost effective. The private agencies can play a complementary role in providing livestock services if made more reliable and cost & quality effective.

Economic Analysis of Homestead Farming Systems in Kerala

This study was conducted with the specific objectives to identify and analyse the economic viability and sustainability, food and nutritional security and allocative efficiency of different homestead farming systems. Three districts, namely, Kottayam, Kozhikode and Thrissur were selected from Kerala state and primary data from 240 homestead farms were collected by interview method in the year 2016-17. The prominent farming systems identified in the area were in order FS-I to FS-V, which included Crop+Poultry (C+P), Crop+Dairy+Poultry (C+D+P), Crop+Dairy+Goat+Poultry (C+D+G+P), Crop+Goat+Poultry (C+G+P) and Crop+Fishery+Poultry (C+F+P), respectively. The economic analysis of farming systems indicated that the annual gross returns in FS-III was Rs 461126 while total cost was Rs 263951 with net returns of Rs 197174, which was found to be most profitable. Higher net returns were due to the adoption of more enterprises in the FS-III, followed by FS-II, FS-IV, FS-V and FS-I. The magnitude of diversification index varied from 0.21 on C+P farming system to 0.77 on C+D+G+P farming system. This implied that C+P farming system was less diversified as compared to C+D+G+P farming system. The assessment of food and nutritional security of the households revealed that the mean availability of calories at the household level was highest in C+D+G+P farming system with 2810 kilocalories per consumer units per day followed by C+D+P farming system (2733 kcal/cu/day). The number of available calories increased with increase in income and diversification. The analysis of the determinants of food security status of households also revealed that per capita income, quantity of food from homestead farm, educational status of household head and membership of co-operatives had significant positive influence on food security. Resource productivity analysis showed that farm yard manure and livestock feed had a positive and significant influence on gross farm income in all the farming systems. The major constraints reported by the homestead farmers were limited availability of farm yard manure, limited availability of fodder and high cost of concentrate feed for dairy animals, low price realisation, difficulties in breeding of goats and limited scope in expansion of the area of fish pond.

Economic Study of Sustainability of Gaushalas in Haryana

While determining sustainability of Gaushalas in Haryana, it was found that the Gaushalas were being run under three management systems: (1) by the NGOs and/or trusts, (2) by the village Panchayats and (3) by the registered societies. The Gaushalas run by NGOs and/or the trust were having more commercial orientation, while those backed by the village Panchayats were having cow protection as the major motive and were supported heavily out of sheer devotion for the indigenous cow. The third category of Gaushalas was being run by the registered societies made for the specific purpose only. The small, medium and large Gaushalas had an average size of 1306, 3003 and 5208 animals, respectively. The number of animals kept by these Gaushalas varied from 350 (Rewari) to 6570 (Farrukh Nagar). The average intake of green fodder, dry fodder and concenterate in these Gaushalas was 4.3 kg/ animal, 6 kg/animal and 0.26kg/animal, respectively. The average annual revenue of Gaushala was Rs 1.79 crores which comprised of donations plus grants (80%), sales (6.5%) and miscellaneous income (14.5%). The annual expenditure of Gaushala was Rs 1.73 crores out of which 49.8% was spent on feed and fodder only. The net income of Gaushala was Rs 5.6 lakh/ year whereas, net income per SAU was Rs. 283 only.

The sustainability of Gaushalas was analysed on the basis of three dimensions, namely economic, social and environmental sustainability, combined using weights assigned by the experts. Gaushalas were classified in to low, medium and highly sustainable categories using cumulative square root frequency method of classification. The social indicators were better in rural and bigger Gaushalas. The sustainability index was 0.32 for small Gaushalas, 0.40 for medium and 0.49 for the large sized Gaushalas. The critical limits for the sustainability index were 0.37

and 0.52 to rank Gaushalas as low and highly sustainable. The regression of these indices revealed that economic sustainability index (ESI) was significantly dependent upon productive animals and autonomy of the Gaushalas while social sustainability depended (SSI) upon total number of animals kept in the Gaushalas, autonomy and Net income per animal. The environmental sustainability index (EnSI) was impacted significantly by autonomy and housing space available.

The animal welfare level was estimated among the Gaushalas using 20 indicators of animal welfare under three dimensions *viz*. housing, feed and health. The health indicator was better in NGO category whereas, housing and overall score was less in the Gaushalas run by the registered societies.

Assessment of Livelihood Diversification and Food Security in Farm Households of Uttarakhand Hills

Diversification has become a common term associated with small farms due to low profitability and higher risk involved in farming. Involvement in non-farm occupations reduces risk by combining activities having different risk profiles; it can also ameliorate the labour and consumption smoothing problems associated with seasonality. The study used secondary data from the NSSO under Schedule 1.0 and Schedule 10, for two rounds, *viz*., 61st and 68th round, while primary data were collected for two seasons, *i.e*., winter in 2016-17 and summer in 2017-18. A sample of 200 farm households was drawn using multistage random sampling technique. The results revealed that from 61st to 68th round, total labour force and work force declined in usual status by 7.58% and 7.87%, respectively. Sector-wise distribution of workforce showed a sharp decline of 17.28% workforce in primary sector from 61st to 68th round. The relative share of workforce engaged in cereal and pulse production declined hugely by 20.65%. On the other hand, mixed farming showed a positive momentum over the years. Food security status of the state revealed that hilly region fared well in terms of calorie intake than the plain region in each round. The head count index of food insecurity showed that the incidence of food insecurity came down to 52% in 68th round from 61% of 61st round in plains and 39% from 46% in hills during the same period. Results, thus, obtained from primary data observed 0.39 average value of diversification index, which suggested a moderate level of livelihood diversification among sample households. Approximately 19% of the sample households belonged to low, 49.50% to moderate and 31.50% to high level of livelihood diversification. Regression analysis revealed that household structure, dependency ratio, education of household, organization membership and training had positive effect while age of household head and farm size had negative effect on livelihood diversification. At an overall level, deficiency of all the nutrients, *viz*., energy, protein and fat was observed for men, women and children, but was more prominent among children. Approximately 65% households in the study area were found food insecure with an average calorie intake of 2336.08 kcal per day and rest of the households (35%) had average calorie intake of 2829.04 kcal per day. Factors such as sex of household head and dependency ratio had negative effect on food security while other factors *viz*., transfer income, number of livelihood activities, age of HH head, food aid recipient, extension utilization and technology had a positive effect. A major challenge identified was to promote livelihood and retain work force through local employment and income generation to enhance quality of life of the people living in rural areas of the state. Provision of extension services is one of the prime factors for educating farmers regarding adoption of new technology and nutritional aspects.

Level and Trends in Sources of Income of Rural Farm Households in Haryana

Income earned from the four sources, wages and salaries, farming of animals, cultivation and non-farm enterprises by farm households in Haryana were analyzed over two time points, *i.e*., 2003 and 2013. High regional disparities were found in the level of incomes. Farming households in western Haryana earned Rs. 2.52 Lakh per annum, the same earned Rs. 1.18 Lakh per annum in eastern Haryana. The scheduled farming households in eastern Haryana were found to be highly dependent (93%) on wages and salaries for their income. It was found that about 56% of total farming households in Haryana belonged to the near-landless and marginal category, but their income levels were 48-89% lower than the state average. The income distribution among different land-size categories in western Haryana was found to be highly skewed, and the share of non-farm business was negligible in the region. There was a stark difference in the per hectare incomes of marginal (Rs. 43,000) and large farmers (Rs. 1,00,000). Looking at the real income estimates, it was found that real growth had been much higher in western (10.27%) as compared to eastern Haryana (1.36%). The per capita income across land classes was also generally higher in western Haryana. It was found that income from dairy had increased for farmers of all farm-size categories, but marginal farming households were earning 30% less than the state average of Rs. 2400 per month. Dairy was more profitable in western Haryana where households earned 29% more than the state average. In eastern Haryana, households earned 41% less than the state average.

Integrating Production with Processing and Converting Waste into Wealth: A Success Story of NDRI Dairy Start up

A success story of a dairy start-up M/s Chitturi Agro Lactating Foods Pvt. Ltd., with total 375 dairy animals including 70 cows and 85 buffaloes in milk; and milk processing plant of 2800 litres/day capacity has been documented by DES&M Division under the ICAR-NIAP project entitled 'Policy Imperatives for Promoting Value Chains of Agricultural Commodities in India with Special Reference to Dairy Start-up'. The company owned by Shree Ch. V. K. Narasimha Rao, hailing from an agricultural family of Kulla Mallavaram village in East Godavari district of Andhra Pradesh has had proper technical guidance from ICAR-NDRI. Apart from own dairy farm daily milk production of 1200 litres, the company also procures 1800 litres of milk daily from farmers. The main products processed on regular basis are pasteurised milk (1800 litres/day), curd (300 litres/day) and butter milk (100 litres/day). Further, the products processed on demand/order basis include full cream milk, ghee, paneer and khoa. These products are sold under the brand name 'Madhura'. The integrated dairy farm encompasses Dairy Farm, Milk Processing Unit, Feed Mixing Plant, Bio Gas Unit, Bio Gas based Power Generation Plant, Vermi Compost Farm, Azolla Farm and Organic Vegetable Farm.

The by-products of the dairy farm such as dung and urine are collected systematically and used to produce biogas that is utilized to further generate electricity and cooking gas. The bio gas plant has six digesters and generates bio gas of volume 510 m^3/per day. It is partly used for power generation (600-800 units a day), while the remaining gas is processed to produce green cooking gas. The power generation plant is one of the biggest bio gas based power generating plant in Andhra Pradesh, which is unique in drawing visitors from all over India. He has designed a system to flow a part of the digested slurry to feed his in-house agriculture farm as organic fertiliser and the remaining is converted to solid organic fertiliser. The liquid residue separated from the slurry is utilized to grow azolla crop that acts as a good nutrient feed for the cattle. A part of the slurry is also used to feed the in-house vermin-compost facility.

The annual vermi compost production is 180 MT and the annual organic compost, i.e., the slurry and dairy farm waste produced is 320 MT.

In order to reduce the cost of milk production, the company started preparing self-formulated alternative cattle feed at farm by procuring good quality of all ingredients like maize, rice bran, ground nut husk, bengal gram husk, tapioca skin, wheat husk, palm oil, etc., in bulk from across the country.

The success of the company in dairying has been possible only by integrating production with processing and selling products directly to consumers in the market and by proper utilisation of dairy farm by-products like dung, urine, etc. Shree Narsimha Rao has proved that dairying is profitable and sustainable with his "Integrated Dairy Farm, a complete cycle-a zero waste initiative" model.

Apart from developing dairy farm, the company has also trained selective rural youth free of cost to the extent of 90 days training to 120 members, 30 days training to 150 members and 1 day training to 1440 members. He has provided Internship Training Programme to 17 students of Veterinary College, Tirupati. Approximately 6500-7000 farmers have visited his dairy farm from various states like Chhattisgarh, Odisha, Karnataka, Telangana and Andhra Pradesh. NABARD has felicitated Narsimha Rao during the year 2012 for his valuable contribution towards

Agriculture and Rural Development. Government of India honoured him with "National Dairy Farmer Award" during Krishi Vasant in February, 2014.

Placement Scenario and Career Aspiration of the Dairy Graduates in India

A study was designed to assess placement scenario of dairy graduates in the country including their career aspiration to suggest a policy framework for better career opportunities. Twelve Dairy Science Colleges which had produced at least 10 batches were randomly selected throughout the country. It was found that dairy graduates of NDRI, Karnal and AAU, Anand were having better placement scenario in comparison to the other dairy science colleges. Average salary of the dairy graduates widely varied from 1.63 to 3.71 lakhs per annum during last 10 years. Dairy graduates of the premier institutes like NDRI, Karnal and AAU, Anand were comparatively higher paid than the other graduates. Educational aspects of the future aspiration were suppressed over the achievement aspiration, which indicated that dairy graduates were highly motivated to join service immediately after graduation rather than pursue higher studies. Finally a five point policy framework was suggested for better career opportunities of the dairy graduates.

Bovine Population Dynamics, Milk Production and Contribution of Dairy Sector in Southern India: A Spatio - Temporal Analysis

The dynamics of bovine population, milk production and contribution of dairy sector in southern India was assessed based on the secondary data. Over all, the share of crossbred in-milk population to total in-milk bovine population increased significantly over the years, while the share of buffalo and indigenous in-milk population decreased. Milk production from crossbred has shown increasing exponential trend in Andhra Pradesh, Karnataka, Kerala and Tamil Nadu during 1993-94 to 2016-17. Noticeably, the highest CAGR was exhibited by Andhra Pradesh in Species wise milk production as well as in total bovine milk production. Andhra Pradesh and Tamil Nadu had increasing exponential trend in total bovine milk production, whereas, Karnataka and Puducherry had increasing linear trend. In all the four states and Puducherry, average milk yield of crossbred exhibited increasing exponential growth. Highest CAGR for crossbred milk yield was observed in Kerala followed by Tamil Nadu. Andhra Pradesh, Karnataka and Tamil Nadu had population-led growth in crossbred milk production, whereas, Kerala and Puducherry had productivity-led growth. Share of crossbred and milk price were found to be strongly influencing determinants of milk production in southern India. The causal relationship between endogenous factors, like milk yield and herd efficiency ratio, and milk production were established and forecasting done using VECM, in the case of buffalo milk production in Andhra Pradesh, indigenous milk production in Karnataka and crossbred milk production in Kerala, Tamil Nadu and Puducherry. The changes in composition of dairy species in favour of crossbred cows and expanding network of dairy cooperatives contributed significantly to the growth of dairy sector. Despite a shift in herd composition in favour of high-yielding crossbred cows, growth in crossbred milk production is population led in few states. For the sustainable development of dairy sector in southern India, special effort should be taken to fully exploit the potential of crossbred cows and better pricing mechanisms.

A Temporal Analysis of Prices of Feed, Milk and Milk Products in Karnataka State

The trends in the prices of feed, fodder, milk and milk products in Karnataka state was analysed to develop a Feed Price Index (FPI) and Consumer Dairy Product Price Index (CDPI), besides developing models for price forecasting. The CAGR of inflation adjusted (real) procurement and retail prices of milk were 1.4% and 3.6 %, respectively, indicating that the rate of growth of procurement prices of milk was not at par with the retail prices of milk. The rise in the real retail prices of milk and curd was 6% to 7%. The trends in the prices of butter and ghee had more volatility with the CAGR of 3% and 4.1%, respectively. The CAGR of feed was around 6%. The FPI was developed based on feed and imputed fodder prices. The FPI was found to increase at 16% during the period 2011 to 2016. This was notably higher than the CAGR of procurement prices of milk (<4%). On the lines of FAO-Dairy Products Index, the CDPI was developed based on the volume of milk used to produce different milk products. It was found that CDPI increased at 7% during the period 2011 to 2016. Among the various univariate and multivariate candidate models for forecasting the procurement and retail prices of milk, the Vector Auto Regressive with lag period one- VAR (1) model was the most appropriate model. The predictors in the VAR (1) were its own previous year milk prices, previous year values of feed cost and agriculture labour wage. The forecasted prices suggested that the procurement and retail prices of milk should be revised for the current year. The price database, FPI and CDPI developed in the present study are useful in tracking the price movements of feed, milk and milk products. The VAR model developed could be a useful tool in forecasting the prices of milk. This model could also assist in dynamic pricing of milk in relation to trends in the feed cost and labour wages.

Economic Analysis of Production, Consumption and Marketed Surplus of Milk in Northern Dry Zone of Karnataka State

A study was carried outon economic analysis of production, consumption and marketed surplus of milk in northern dry zone (4 districts, 16 villages and 240 households rearing dairy animals) of Karnataka state. Overall average daily milk production per households per day was 17.68 litres (9.61 litres in the case of small farmers to 26.73 litres in the case of large farmers).The marketed surplus of milk was 81.82 % in the case of marginal farmers, 78.77 % in the case of small, medium (76.92 %) and large (74.41 %) farmers. The share of un-organized sector in total procurement of marketed surplus of milk was highest in the case of landless farmers (78.37%) followed by marginal farmers (75.45%), small farmers (68.38%), medium farmers (39.38%) and large farmers (26. 89%). The variables like quantity of milk production and price of milk were found to be positively correlate with marketed surplus of milk. The analysis of cost of milk production for crossbred cow, local cow and buffalo were found to be Rs 18.38, 31.87 and 25.88 per litre, respectively. The net return per litre of milk from local cow was found to be -4.71, while it was 6.91 and 10.64 for crossbred cow and buffaloes, respectively. The mean technical efficiency was estimated 86.32, 77.41 and 84.49% for crossbred cow, local cow and buffaloes, respectively. Among the constraints faced by the farmers in dairying, high cost of feed and fodder, inadequate availability of quality feed and fodder round the year, susceptibility of crossbred animals to disease were major three constraints with the mean score of 93.75, 91.66 and 87.91 respectively. Distant location of milk collection center (96.25%), low price of milk (92.50%) and non-availability of regular market (91.25%) were the major constraints faced by farmers in disposal of milk.

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

In the present study one resilience scale and one livelihood security index were developed to measure resilience and livelihood status of tribal and non-tribal population with respect to adverse weather event situations. Items for construction of 'Resilience scale' were selected and 29 items sent to different judges. Principal Component Analysis (PCA) was run to group different items into different components by taking responses from 102 respondents from non-sample area. According to the results of rotated component matrix, five components were retained and different items under each dimension were identified. From Livelihood Security Index developed under the study, it was found that tribal farmers from Jhargram were in most distressed condition (mean score 41.36) in terms of livelihood security when compared to other districts, though the mean difference (1.68) of tribals from Jhargram and Birbhum districts was not significantly different. Significant variation of livelihood security scores was observed zone wise (F-value- 110.67, $p<.01$), group wise (F-value- 477.81,$p<.01$) and zone*group wise (F-value- 69.85, $p<.01$). In case of resilience, the non-tribal farmers from Birbhum district were found to be worse than other non-tribal farmers from other regions though their scores were comparable with non-tribal farmers from Jhargram and farmers of Block-2 from South 24 Parganas districts. Significant variation of 'Resilience scores' was observed zone wise (F-value- 10.66, $p<.01$), group wise (F-value- 62.71,$p<.01$) and zone*group wise (F-value- 38.42, $p<.01$). Correlation value of ranks given by non-tribal and tribal farmers suggested that they were not correlated (Kendall's tau_b= -.47 and Spearman's rho= -.60).

EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING

Goat Husbandry Practices, Performance and their Role in Livelihood Security of Tribal Farmers in Rajasthan

In the state of Rajasthan goat farming is a major source of livelihood especially in the tribal areas. Despite large goat population and economic dependence of tribal people on goat farming, the development and animal extension efforts in goat improvement has been meager. For strategizing any livestock development programme and preparation of policy framework, it is of utmost importance to benchmark the prevailing situation of the area with respect to the existing husbandry practices, the levels of animal productivity and the role of livestock in the agrarian economy. In view of this the study was undertaken with the objective to assess the goat husbandry practices, performance and their role in livelihood security of tribal farmers in Rajasthan. The study was conducted purposely in three districts namely, Banswara, Dungarpur and Udaipur in southern part of Rajasthan which have a preponderance of tribal population. Further two blocks from each district and two villages from each block were randomly selected. From each selected village 10 goat farmers were selected at random with a total sample size of 120 farmers. They were categorized on the basis of flock size into three categories such as i) Small farmers (Less than 25 goats), ii) Medium farmers (25-50 goats) and iii) Large farmers (above 50 goats). The livelihood security of the respondents was calculated by developing one 'Livelihood Security Index'. A list of seven components was prepared by referring to literature Lindenberg, 2002 and Sulivan *et al*. 2006) and Livelihood Monitoring Unit (LMU), Rural Livelihoods Programme, CARE, Bangladesh. The structured interview schedule was developed and collected relevant information on the different aspects of goat husbandry. The observations were collected through on-farm measurement and through interview schedule. The salient finding emerged from the study are presented here as under:

- Majority of goat farmers in tribal area of Rajasthan hold a small flock size with the average flock size as small, medium and large categories of farmer was 22.63± 0.210, 33.72± 1.05 and 58.54 ±1.28 respectively. A half of goat farmers (51.57 %) were adopting partial grazing followed by complete grazing (48.33%) and none of the selected farmers was practicing complete stall feeding.
- About a half of the farmers (49.17 %) offered grasses, fodders followed by 34.16 per cent goat farmers feeding tree leaves and 16.67 per cent farmers were feeding weeds and grass. The overall average amount of green fodder offered to milking goats, dry goats, goatlings, kids and breeding buck was 1.33 ± 0.07, 0.85 ± 0.07, 0.45±0.03, 0.37±0.02 and 1.71±0.10 kg/day respectively. The overall available of dry fodders to milking goats, dry goats, goatlings, kids and breeding buck was 0.95±0.67, 0.93±0.07, 0.87±0.06, 0.37±0.02 and 1.72±0.11 kg/day respectively. Overall average amount of concentrate mixture offered to milking/pregnant goats, dry goats, goatlings, kids and breeding buck was 210.09±14.26, 85.37±6.84, 86.76±5.83, 85.65±5.86 and 246.11±16.89 g/day respectively.
- The overall daily milk yield (ml/goat), total lactation yield (lit), lactation length (days) and weight of buck at sale (kg) was 608.41 ± 10.62, 75.73 ± 0.81, 137.27 ± 2.66 and 25.40 ± 0.35, respectively.
- The overall total cost of rearing per goat per year was Rs. 790.45±14.18. In small, medium and large categories of farmers total cost of rearing per goat per year was Rs. 862.29**± 9.76**, 813.03±27.93 and 576.99±15.26 respectively being significantly (p<0.05) higher in case of small group of farmers.
- The overall net income from goat farming per goat per year was Rs. 2549.30**±143.77. In small, medium and large categories of** farmers net income per goat per year was Rs. 2653.07±144.75, 2787.05±404.28 and 1933.28±76.88 respectively. The net income per goat per year was significantly (p<0.05) higher in medium and small group of farmers as compared to large group of farmers.
- The highest percentages of respondents were having very low level of livelihood security i.e. 43.33 per cent. It was also found that 35.00 per cent were having medium level of livelihood security and 13 respondents (21.67%) were having high level of livelihood security.

It was concluded that the breeding, feeding, housing and healthcare practices were mostly traditional without much regard to scientific recommendations. However, these management practices in general were better in case of small farmers as compared to medium and large farmers. Being meat type goats, the overall growth, production and reproductive performances were in general low across all flock sizes. However, these performances were better in case of small and medium flocks as compared to large flocks. The interventions of vaccination, deworming and supplementation of mineral mixture improved the production and reproduction performance of lactating goats. The tribal goat farmers in Rajasthan earned on an average a net income of about Rs. 2550 per goat per year, However, the small and medium farmers earned more (Rs. 2653 & 2787 per goat /year) than the large farmers (Rs. 1933 per goat /year). Livelihood security of farmers through goat farming was found to be low in about a half of the farmers, medium in about 1/3rd farmers and high in only about 1/5th of the farmer.

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

Dairy farming has become an important component of rural development, and is considered as an instrument to enhance the income and quality of life with equity. The improvement of dairy production will be important in the coming years, as future demand of milk and milk products is expected to increase, while the natural resources that sustain agriculture will become increasingly scarce and degraded. Available evidences suggest that a better integration of crop-dairy and fishery has potential to increase resource use efficiency, sustainability and overall resilience of dairy production systems. Keeping this in view, the present project was undertaken with following objectives: i) To develop dairy based integrated farming system model for small farms ii) To assess the performance of different sub components and their resource use under integrated farming system

A comprehensive assessment of farming system was done in a cluster of villages of Muzaffaranagar and Shamli district to characterize the status of smallholder dairy production in order to generate information that would assist in designing of technological options for dairy development. Primary data on various aspects of dairy farming were collected with the use of validated structured questionnaires, and qualitative data through Participatory Rural Appraisal techniques. Interactions were also held with farmers/farm women in Karnal, Jind, Sonipat, Panipat, Shamali and Muzzafar Nagar districts to have overview of dairy based farming system being practiced, problems faced by them and opportunities for improvement in the existing system. Results revealed that majority of the households reared graded Murrah buffaloes and crossbred cattle depending on the land availability. The quantity of milk production on farm depends on the total number of milch animal in the herd. The proportion of animals in milk was generally higher in Shamli district than in Muzaffaranagar. The average number of milk animals kept by farmers were 3.5, ranging from 1 to 18. More than half of the selected households had 3-5 milk animals; fewer kept more than 10 milk animals. The average milk yield / household and per lactating animals differs significantly. There is tremendous scope of increasing milk production and productivity of dairy animals by improving nutrient availability from locally available feed and fodder resources. Availability of key inputs and veterinary services needs to be strengthened and improved to enable the farmers for dairy development. To enable the dairy farmers to take the benefit of market demand, a favorable policy environment and support services needs to be provided and technical constrains to be addressed. Based on meta analysis, discussion with farmers and experts, crop and animal components were selected for conducting research at institute farm. Wheat (cv-HD 3086) in 0.4 ha and Berseem (cv-BL-42) in 0.6 ha was sown during rabi season. Two Sahiwal cattle, two Murrah buffaloes and six goats were kept for feeding from the system. Urea molasses blocks were also prepared for supplementary feeding to the animals during summer months.

Farmers' Willingness to Pay for Sexed Semen Technology of Dairy Animal in Eastern Haryana

A study was designed to explore 'willingness to pay' by the commercial dairy farmers of eastern Haryana, for sexed semen technology by Contingent Valuation Method and its determinants by Interval regression model. Three fourth of the dairy farmers (75.38%) were willing to pay for sexed semen technology and were ready to pay Rs. 339.39±16.04 per sexed semen straw, whereas, almost all (98.89%) the commercial dairy farmers were willing to pay Rs. 769.66±33.33 per sexed semen straw. However, in case of commercial dairy farmers, education level, herd size and attitude were the positive and significant contributors towards their willingness to pay for the sexed semen technology. Findings may help to re-institutionalize breeding policy of dairy animal at the farmers' doorstep by introducing newest livestock production technology like sexed semen with the greater participation of the dairy farmers.

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

It was observed that though large and medium farmers were only 23% in population, yet were possessing 66.44% of the total land in Punjab, leading to deagrarianization by other farmers. The landless farmers (58.76%) were engaged in Dairy+Non-farm enterprises combination. Similarly, marginal and small farmers (29.55% and 20.78%, respectively) were

following Dairy+Crop+Other enterprises combination and rearing about three dairy animals. The main pull factors of deagrarianization were 'Higher education leads to farm deagrarianization', 'Sustained economic growth', 'Rising per capita income' and 'Mechanization of agriculture'. The push factors were 'Seasonality of agricultural activities', 'Less family labour due to old age/migration to foreign countries', etc. The large farmers were obtaining more than 67.27% of their income from crop farming. The share of income from Dairy increased with the decline in operational land area. Landless, marginal and small farmers were earning through wage labor, shopkeeper, private jobs and other jobs (traders, commission agents etc.). The overall index of income diversification was 0.63 and employment diversification was higher among land less, marginal and small farmers who switched over towards nonfarm activities to secure their livelihood. The value of livelihood security index was 0.74. The main pros of deagrarianization were "Unemployment is reduced and checks on seasonal employment" and "Deagrarianization helps in learning skillful jobs which reduced the vulnerability", whereas, 'Rural to urban migration increased due to deagrarianization' and 'People are decreasing their interests towards agriculture' were the main cons of deagrarianization. The satisfaction of landless and marginal farmers towards their new occupation was up to 89.63% and 88.33%, respectively. Further, they perceived their new job as enjoyable and easier than agriculture (88.53%) and new occupation provided more income as compared to agriculture (87.22%). Most of the farmers reported a decline in the soil health as additional chemical fertilizers were required to achieve the higher yield. Punjab soils were moderately alkaline, non-saline, and medium to high in organic carbon, available Phosphorus, and Potassium.

Sustainability of Dairy Based Organic Farming System in Uttarakhand

Sustainability of dairy based Organic Farming System was investigated in Uttarakhand state and information was gleaned from 240 respondents comprising both organic and non-organic farmers. The organic farmers were comparatively younger (average age 45.5 years) with higher economic motivation, risk orientation and were more knowledgeable than non-organic farmers. Sustainability of farming system was found to be highest in plain regions for organic farming system (72.08%) followed by organic farming system in hilly regions (68.47%). In organic dairy enterprise "huge natural resource base to ensure feed and water availability" was the most important strength factor (with a global priority score of 0.084); whereas "low productivity of dairy animals and production loss" with global priority of 0.091, "easy convertibility of traditional and integrated crop livestock based farming system to organic system" (0.113) and "lack of organized certification system and certification standards for organic dairy farming" (0.071) turned out to be the most important weakness, opportunity and threat factors, respectively.

Specialized Dairy Extension Services Demanded by the Farmers of Haryana, India

Demand driven dairy extension services were appraised among the dairy farmers of Haryana. Incomplete Order of Merit Rating as suggested by Garret was used to assess the degree of importance of the identified demand driven dairy extension services. A total of 26 dairy extension services were demanded by the farmers amongst which, three services were for specialized breeding, five for animal feeding purposes, seven for livestock production and management, six were healthcare related and five services towards marketing and extension. Farmers expressed highest demand for conventional dairy extension services such as, timely AI services, vaccination services and non-conventional extension service like demonstration-cum-training programme on Azola production and conservation. Dairy farmers were highly interested to grow as an entrepreneur, whereas, commercial dairy farmers were highly interested to strengthen their farm by securing credit accessibility.

Adaptation Strategies to Climate Change Followed by the Farming Community of the Indian Sunderbans.

The study documented 26 adaptation strategies adopted by the farmers of the Indian *Sunderbans* to cope up with changing climatic scenario. Amongst the identified adaptation strategies, indigenous knowledge-based adaptation strategies were highly preferred by the farmers of climate sensitive Indian *Sunderbans*. The quantitative importance of each of the components of farming *i.e.* crop, livestock, fisheries and other farming practices in decision making were determined by using Analytical Hierarchy Process, amongst which crop farming was found as most preferred. Based on the intensity of importance of one over another adaptation strategy, the most substantial one was "Practicing of integrated farming system". The prospective consequences of the adaptation strategies in long term was appraised by the stakeholder analysis and it was revealed that "Withdrawal of ground water using shallow tube well for irrigation during rabi season" had the most negative consequences in environmental, societal and economical aspects. Findings of this study have opened new vistas of research for the highly climate sensitive 'World Heritage Site', the *Sunderbans.*

Return Migration of Rural Youth vis-à-vis Agriprenuership Development in Southern India

Return Migration, the "voluntary movement of migrants back to their place of origin" was studied in three states of southern India, namely Tamil Nadu, Karnataka, and Kerala. 'General Decision Making Styles' scale of Scott and Bruce (1995) was used. Attitude scale and two indices were developed, to measure attitude, interest and aspiration

level of return migrated rural youths towards agriprenuership, respectively. While deciding for return migration and engagement in agripreneurship, the rural youths had planned very carefully and logically. Low salary and non-availability of better jobs were the most important factors that influenced the rural youths to leave the urban area, whereas, the decision to continue the family occupation was the most significant 'pull' factor, which influenced return migration. Besides, 47.78, 31.66 and 20.56% of rural youths had medium, high and low levels of interest in agripreneurship, respectively. Further, 53.89, 30.00 and 16.11% of respondents had medium, high and low levels of aspiration in agripreneurship, respectively. Lack of land availability and lack of technical guidance in agripreneurship were major technical and input constraints. Among the psycho-social constraints, low social recognition in agripreneurship was the foremost constraint perceived by the respondents.

Critical Appraisal of Farmers' Mental Health vis-à-vis Agricultural Sustainability in Green Revolution Belt of India

On the occasion of the Golden Jubilee year of 'Green Revolution (GR)' in India, the study was undertaken in the GR belt of the country to know the sustainability of rice-wheat and dairy farming, to explore the farmers' mental health and the reasons behind deagrarianization. Two indisputably green revolution states of India *viz*., Punjab and Haryana were purposively selected. To study deagrarianization, 120 respondents were selected through snowball sampling method. To unravel the research problems, all three research designs viz., exploratory, descriptive and experimental were combined. Finally, there was a strong link amongst sustainability, deagrarianization and mental health and the determining factors were: land-holding, income diversification and adoption.

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

The project is implemented in Karnal district of Haryana in a cluster of five villages namely: Kamalpur Roran, Garhi Gujran. Nagala Roran, Churni and Samora having more than 1000 farm families. To overcome the farmers' problems, 20 technological interventions were implemented among 724 households covering 179.4 hectare area in the crop component and 2869 animals for dairy based interventions. Due to systematic and scheduled application of various pesticides, herbicides and micronutrients crop was healthier and weeds free. Recorded production was found to be in the range of 22-25q/acre rice production and 26-29q/acre wheat production at farmers' field. Farmers were able to get round the year green fodder to the tune of 1150-1225 q/ha in maize-barseem rotation and 950-1100q/ha in maize-oat. Average increase in milk yield was recorded at 1-1.5 litre per animal due to feeding of by-pass fat and 1.30-1.65 litre per animal due to feeding of rumen protective amino acids. All the animals were completely free from ecto/endo-parasitic infestation due to endo-ecto parasite control campaign in the project area. No case of Theileriosis disease was found in the project area after vaccination of 300 cross bred animals. Pusa Pragati variety of peas gave more yield i.e. 56-60q/acre over the earlier Pencil variety of pea i.e. 49-50q/acre. One entrepreneur is successfully running a dairy unit named Viren Dairy in Samora village by handling on an average 450 L of milk daily and converting raw milk into dairy products such as Dahi, Paneer, Ghee and Khoa. Every week, SMS on all aspects of farming like crop, animal husbandry, weather forecasting and latest information of dairy and agriculture field are being sent to farmers.

Improving Livelihood of Rural Women through Dairy Based Secondary Agriculture

The project is being implemented in five villages of Karnal district, two villages of Panipat and two villages of Sonipat to promote women-led entrepreneurship through preparation of value added dairy products. Farm women groups comprising 6 to 10 members have been formed in each village. Thirty one trainings were organized in which 460 rural women from selected villages were trained on value added dairy products. Market survey was conducted in Karnal and Panipat urban areas in addition to assessing the feasibility of promoting products in canteens of school, college and restaurants. Forty demonstrations were organized to build capacity on value added dairy products at Women Empowerment lab, KVK and Dairy Technology Division of NDRI and at villages also. Initial rapport building and gender sensitization trainings were completed. KVKs and NGOs in all three districts have been mobilized to facilitate the group dynamics in the villages. The partnership with Haryana State Rural Livelihood Mission (HSRLM) could help for fast facilitation of entrepreneurial ventures apart from tactical support of Sarva Haryana Grameen Bank, NABARD, NGOs, KVKs and social entrepreneurs.

Effectiveness of Public Private Partnership (PPP) Model for Dairy Farming in Haryana

The study was carried out to ascertain the effectiveness of PPP model in dairy farming and the constraints in executing PPP model. This study was conducted in Kaithal, Hisar and Mahendragarh districts of Haryana state representing three different agro-climatic zones as classified by Haryana Kisan Ayog. The sample size of 225 included ten veterinary officers and 15 private field functionaries from each district along with five clients from each Integrated Livestock Development Centers. An effectiveness index was developed to evaluate the PPP model.

Farmers (73.33%) who had sizable land and educational backgrounds showed a keen interest for PPP. Effectiveness index score of farmers about utility and access to technical services was highest (0.62) indicating higher utility. Credit availability and market access were major constraints of public extension functionaries. Lack of rewards and recognition of good work, inadequate monthly income and poor opportunity for training were major constraints of private extension functionaries. Major findings suggest periodical meetings between public and private extension players, adequate remuneration and recognition of good work and monitoring of AI charges.

Entrepreneurship Development among Trainees of Krishi Vigyan Kendra (NDRI)

A study was undertaken to ascertain the effectiveness of enterprises established by KVK trainees of NDRI. The study was conducted on 20 entrepreneurs covering six major enterprises *viz*. seed production, dairy processing, beekeeping, vermicomposting, fish farming and home science. An effectiveness Index was developed to ascertain the effectiveness of ventures established by trainees. Findings of the study revealed that 44.83% of the trainees used their own capital to financially support the enterprise. About 55% trainees sold products in local market. About 28.57% trainees used poster/banner as source of advertisement. In the case of judging the effectiveness of the ventures established by trainees, majority of the respondents got high index value (>0.53), followed by 35% with low index value (<0.27) and remaining 25% were falling under medium index value (0.27-0.53), indicating the need and enormous scope for improvement in the farm business ventures. Major implications include reorientation of trainings at KVK, promoting inter-sectoral coordination to give fillip to aspirations of entrepreneurs and hand-holding support especially for market expansion and credit agencies.

Development of Extension Strategy for Managing Reproductive Problems in Animals under Different Dairy Production Systems

A study was undertaken to assess the prevalence of reproductive problems under different dairy production systems and also their management by different extension strategies. Dairy Production System Index (DPSI) was developed to classify 20 Indian states into three categories *i.e.* dynamic, transient and subsistence dairy production systems. Haryana, Madhya Pradesh and Chhattisgarh were selected randomly to represent these three categories, respectively. Assessment of prevalence of reproductive problems with 240 dairy farmers and 30 veterinary officers from the three states revealed high prevalence of anoestrus (19.19%), repeat breeding (18.15%) and prolapse (15.83%) in Hisar and Bhiwani districts of Haryana; late sexual maturity (15.22%), anoestrus (12.20%) and repeat breeding (10.58%) in Rewa and Satna districts of Madhya Pradesh; and late sexual maturity (16.07%), anoestrus (11.96%) and RFM (8.91%) in Raipur and Durg districts of Chhattisgarh. The results revealed that the reproductive management adoption index was 0.56, 0.42 and 0.35 in Haryana, Madhya Pradesh and Chhattisgarh, respectively. Further, a Booklet and Video on management of reproductive problems in dairy animals were developed and tested with 60 respondents. Video+booklet combination was found to result in knowledge gain of 15.23%. The study suggests developing comprehensive data base on prevalence of reproductive problems and localized effective combination of appropriate extension methods in each production system.

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

Information and technological needs, and manpower requirement of selected dairy production and processing units were assessed in select districts of Karnataka state. The Information needs of the dairy production units in the study area included, balanced feeding of dairy animals (75%), Package of Practices on Clean Milk Production (62%) and Access to Quality Inputs (60%). The technology needs of dairy production units were focused on good quality cost-effective feed (70%), farm level testing kits for mastitis detection (65%) small scale dairy machinery/ equipments for small production (50%) and cost effective mini-chilling units at production level for extended shelf-life of milk (45%). The information and technology needs of dairy processing units in the sample processing units included: in case of public sector, the felt needs were requirement of technical know-how of preparation of dairy products (70%) specialised and skilled manpower at various levels: operational, supervisory & management (65%). The technology needs of dairy processing units comprised cost-effective-eco-friendly packaging technology (60%) and utilisation of dairy by-products and management of dairy wastes (50%). The manpower requirement of dairy production units as expressed in the study area were unskilled / casual farm labour for dairy farm activities (70%), Vets / Para-Vets for breeding and health care services (50%) skilled supervisors and managers (25%) while in case of dairy processing units for operational level skilled manpower (60%), supervisory and managerial technical manpower (35%) and Food safety and quality assurance manpower (25%). The constraints in dairy production units as expressed by the respondents included, high cost of critical inputs cattle feed (86%), acute water scarcity (82%), non remunerative milk procurement price (70%) and limited veterinary services (68%).

Farmers FIRST Project

Under the collaborative Farmer FIRST project, four dairy cattle health and infertility camps were organised in the adopted villages. The Institute interventions included introduction of improved varieties of green fodder in 16 acres of land which included fodder maize (10 acres), jowar (5 acres) and fodder cowpea (2 acres), which resulted in increased fodder yield with more number of cuttings and quality fodder. Mineral mixture and urea molasses mineral blocks were also given to the dairy households. The issues related to quality of milk leading to low fat & SNF problem were addressed by advocating balanced feeding of dairy cattle. For augmenting quality milk production, two units of hand-operated milking machines were provided to co-operative societies for shared and common use among DCS member farmers. To address the hoof-related problems, cow mats were provided to needy and selected households and animal shed cleaning units was provided for common use. Package of recommendations for clean milk production, and for mastitis prevention and management on farm demonstration at society and village level were also carried out.

Technology Reach among Dairy Farmers of Kerala-A Multi-Stakeholder Analysis

The dynamics of linkage among the stakeholders in technology reach in dairy farming, the extent of technology reach among the dairy farmers and the constraints faced by the stakeholders in technology reach were studied in Kerala state. Overall linkage index was strong in case of extension-clientele linkage, moderate in research- extension linkage and weak in research-clientele linkage, which was predominant in training, workshop/seminar and farm publication. With regard to extent of technology reach, more than two third of the respondents (69%) had medium level of overall adoption level of selected technologies, while the rest of the respondents had low (19.50%) and high (11.50 %) levels of adoption. Major constraints faced by the dairy farmers as expressed by the respondents were high cost of cattle feed (75%), veterinary service and medicine (73%) and round the year availability of green and dry fodder (64%). Constraints experienced by extension and research system included time constraint for executing extension activities (74%) and mandate priorities for teaching and research activities (69%).

Management of Gaushalas in Karnataka State: An Exploratory Study

The functioning and extent of adoption of good management practices by different gaushalas in Karnataka State was studied. Forty selected gaushalas were categorized as small (<50 cattle; n=12), medium (51-150 cattle; n=18) and large size (>150 cattle; n=10) based on the herd size. Majority of large sized gaushalas had more grazing lands (30%) followed by cultivable land (20%) as compared to small and medium sized gaushalas. The major source of financial support in large sized Gaushalas were from 'government funding' (45.00%) and 'sale of milk' (20.00%) whereas, in the case of medium sized gaushalas 'government funding' (25.00%) and 'sale of FYM' (20%), while small sized gaushalas received 'financial support from individual donations' (50%). The major expenditure in all the gaushalas was incurred on 'feeding' (40%) followed by 'labour wages' (30%) and 'animal shed/infrastructure' (12%). More than 66% of manpower used in all the gaushalas comprised of daily labour. Majority of large gaushalas (60%) maintained gaushalas 'to protect cattle along with their economic utility' whereas, majority of medium (67%) and small size (42%) gaushalas maintained 'to serve the needs of charitable institutions'. In the case of overall level of adoption of Good Management Practices in gaushalas, 60% of the large sized gaushalas belonged to high adopter categories, 56% of the medium sized gaushalas belonged to medium adopter categories and half (50%) of the small sized gaushalas belonged to low adopter categories. The major constraints faced by the gaushalas were: 'inferior quality of breeding bulls', 'limited access to veterinary services' and 'inadequate funds/capital and training'.

ICT TOOLS AND SOFT COMPUTING APPLICATIONS IN DAIRYING

Modelling of Rheological Behaviour of Selected Dairy Products using Machine Learning Approach

Intelligent modelling of rheological properties of paneer has been investigated with Machine Learning (ML) algorithms vis-à-vis conventional regression methods. Data on viscoelastic behaviour of paneer (432 records) were generated in three batches and compiled, which included input parameters, i.e., Protein to Moisture ratio (P/M) as per actual observation in the sample, Temperature of coagulation [(T), °C (70,80,90)], and Frequency (F), Hz (16 levels × 3 replicates); and output parameters such as Storage modulus (G'), Pa, Loss modulus (G"), Pa and Complex viscosity (h*), Pa.s. Preliminary statistical analysis of the data indicated non-linearity among the input and output variables. Thus, necessary log transformations were applied to the raw data and resultant dataset was utilised for developing various intelligent predictive models using emerging ML algorithms such as Artificial Neural Network (ANN), Random Forest (RF), Support Vector Regression (SVR) and the hybrid method, i.e., Adaptive Neuro-Fuzzy Inference System (ANFIS) in contrast to conventional linear/non-linear regression models to predict aforementioned output variables for the paneer samples. The open source R software environment was used for implementing the models. A comparative analysis of the developed models' predictive accuracy (in terms of Root Mean Squared Error) is briefly summarised. The storage modulus of paneer was better predicted by ML models with accuracy as 0.0036 (ANN), 0.0035 (RF), 0.0052 (SVR) and 0.0026 (ANFIS), against 0.0427 of the conventional regression model. Also, the Loss modulus of paneer was predicted by ML models with higher accuracy as 0.0037 (ANN), 0.0037 (RF), 0.0040 (SVR) and 0.0049 (ANFIS) as against 0.0479 of conventional regression model. Furthermore, the complex viscosity of paneer predicted by ML models was, generally, found to have higher accuracy as 0.0065 (ANN), 0.0057 (RF), 0.0027 (SVR) and 0.0272 (ANFIS) against 0.0424 of the conventional regression models. Evidently, all the ML models exhibited superior predictive potential as compared to that of the conventional regression models. Hence, it was deduced that the machine learning algorithms performed reasonably well for modelling rheological behaviour of paneer in comparison with classical regression methods especially in case of non-linear relationship of the data attributes.

Effect of Multimedia on Preparation of Traditional Dairy Products at the Household Level

The tropical nature of the Indian climate renders it difficult to maintain quality and increase the shelf-life of milk without converting it into products. Therefore, ancient Indians had developed more stable traditional milk products having more shelf-life. Here, the role of the extension personnel becomes important in order to impart knowledge and skill to those who need knowledge pertinent to the value-addition in milk/dairy products. Therefore, a multimedia was developed by NDRI on the production procedure of traditional dairy products to upgrade the knowledge regarding preparation of traditional dairy products at the household level. A total of 96 respondents were selected from the eight villages of Karnal district of Haryana, to test the validity of the developed multimedia. In order to quantify the effect of developed multimedia on knowledge gain and knowledge retention and to document the changes in production procedure of traditional dairy products due to exposure of the multimedia, an exclusive 'knowledge test' was also developed. A significant gain was found in the knowledge level and considerable change in retention of the gained information regarding production procedure of the traditional dairy products due to exposure to the multimedia.

Improving Knowledge in Preparation of Traditional Milk Products through Multimedia

Multimedia [Bilingual (Hindi and English)] on the production procedures of six traditional dairy products (Paneer, Ghee, Khoa, Gulab Jamun, Dahi, and Lassi) were developed. Validity of the developed multimedia was tested on 12 parameters: Relevancy of information, Preciseness of content, Simplicity of content, Content presentation and information coverage, Relatedness of visuals, Suitability of information, Synchronisation of audio and video, Ease in obtaining desired information, Effectiveness of information, Navigation in getting information, Suitability to counter the field level problem, and Credibility of information. Further, an exclusive Knowledge Test on the production procedure of six traditional dairy products was developed to quantify the knowledge gain and knowledge retention due to the exposure of the multimedia.

RESEARCH PRIORITIZATION, MONITORING AND EVALUATION (PME)

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

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

Research Advisory Committee (RAC)

The main functions of the RAC are:

- To suggest research programmes based on national and global context in the thrust areas.
- To review the research achievements of the Institute and to see that these are consistent with the mandate of the Institute.

Institute Research Committee (IRC)

The key functions of Institute Research Committee (IRC) are to critically review the on-going and completed research projects, to consider the new research proposals and to advise on fostering of linkages between the groups/ divisions of the Institute in respect of multi-disciplinary/multi-locational projects. The IRC meetings to evaluate the outcome of the completed research projects and to consider new research projects proposals were held on April 16 to 18 and 21, 2018 at NDRI, Karnal, May 10, 2018 at ERS, Kalyani and May 22, 2018 at SRS, Bengaluru. The completed and new research projects were critically discussed in order to address current emerging issues of the dairy sector. The mid-term review of IRC projects of NDRI was taken up on October 15, 17, 18 and 20, 2018 at NDRI, Karnal, October 7, 2018 at SRS, Bengaluru and November 20, 2018 at ERS, Kalyani. The meetings were conducted under the Chairmanship of Director and convened by Joint Director (Res.), NDRI, Karnal.

Project Information Management System (PIMS)

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

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 research projects proposals were held on June 15, 2018, July 20, 2018, November 6, 2018 and December 12, 2018. MoUs were also sighned with the concerned organizations.

- Consultancy Project proposal entitled, "To evaluate Nutrifeed, Makhan Grass, BMR Rocket, Mega sweet, Jumbo gold and sugargraze as green fodder for yield, insect infestation on crop, palatability, productive and reproductive performance of dairy animals over a range of production environments in Karnal (Haryana)".

- **Contract Proposal entitled, "**Comparative evaluation of De Potash Vinasses and cane sugar molasses as cattle feed pellet binder and its effect on performance in lactating cows".
- **Consultancy Project proposal entitled, "**Testing and evaluation of two analyzers developed by Everest instruments Pvt. Ltd."
- **Consultancy Proposal entitled, "**Effect of Virginiamycin in lactation performance & health status of cross bred cows in India".

PME Cell also considered the proposal for organization of Training Programs to be conducted at Southern Campus, Bengaluru.

Research Projects Database Management

A database through PIMS package of research projects was updated for all the research projects in operation during the year 2018. The database of research projects containing the targets and achievements of the preceding six months and targets fixed for the next six months was updated in HYPM package.

Technical Screening Committee Meetings

Technical Screening Committee constituted under the Chairmanship of Joint Director (Res.) evaluated the manuscripts for publication in the form of books, technical bulletins, manuals etc. Based on the recommendations of the committee, the manuscripts were also sent to outside experts for evaluation. The same were again evaluated in light of the comments received from experts and the contents of the publications got modified and subsequently got published as Institute publications. During the period under report, four meetings of Technical Screening Committee were held on 20.7.2018, 27.9.2018, 22.2.2019 and 20.3.2019.

Research Documentation and Publication

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

- Annual Report 2017-2018.
- NDRI News Letter - a quarterly newsletter in English.
- Director's Report for the 17th Convocation.
- Research Projects (2018).
- Institute Research Committee (IRC) Proceedings (2 No) under the identified research programmes of the Institute.
- Research achievements of NDRI for inclusion in ICAR/DARE Annual Report 2018-2019.

Research Information Management

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

- Proceedings of the RAC Meeting held on January 22 to 24, 2018 submitted to the Chairman, RAC for the approval and after approval, the counter comments of the Institute were communicated to the Council for approval.
- Additional information with respect to NDRI, Karnal for inclusion in the ICAR/DARE Annual Report (2018-2019).
- Information on major technologies developed/ transferred/ commercialized by NDRI through (ITMU) Unit of the Institute.
- Information on research achievements of the Institute for the period of last three years (2014-2017).
- Information on significant events for the period April to June, 2018.
- Information on skill development trainings imparted to rural youth and farmers during- 2018.
- Information on agricultural research products including varieties/hybrids/breeds/species etc. and technologies developed and commercialized by the Institute.
- Report on the significant achievements and technologies developed by the Institute.
- Information on transfer of technology in the area of animal sciences.
- Monthly Progress Reports consisting of significant events.
- Six Monthly Progress Reports of the research achievements and targets for next six months.

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

» Formulated Revised Cost Estimate (RCE) Plan document for the period (2017-20) under the theme No. 24: "Dairy Production & Technology" with total outlay of (Rs.16737.23 lakhs as ICAR share and Rs. 770.18 lakhs as state share) to Rs. 18161.17 lakhs (ICAR share) and 784.95 lakhs as (State share) comprising sub schemes- 24(i): ICAR- NDRI, Karnal, **(From Rs. 9031.76 to Rs. 9599.01 Lakhs)**, 24 (ii) ICAR-CIRB, Hisar) including Network project on Buffalo Improvement) and 24 (iii) ICAR-CIRC, Meerut including All India Co-ordinated Research Project (AICRP) on Cattle.

Research Co-ordination

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

» Mid Term Review Meeting of ICAR Regional Committee- II held on November 13, 2017 at CIFRI Barrackpore, Kolkata.
» Complied and consolidated success stories of the Institute.
» Actionable points endorsed by the office of the Director General, ICAR.
» Meeting held under the Chairmanship of Agriculture and Farmers' Welfare Minister with MoS and Senior Officers of the Ministry on May16, 2018 at Krishi Bhawan New Delhi, regarding action plan for TSP works in three districts of Jharkhand, Tripura, Meghalaya.
» Meeting held under the Chairmanship of Agriculture and Farmers' Welfare Minister with MoS and Senior Officers of the Ministry on May 30, 2018 at Krishi Bhawan New Delhi regarding action plan for organic farming and implementation of Krishi Kalian Abhiyan in adopted villages of the Institute.
» Prime Minister's Vision on Agricultural Research at ICAR for onward transmission to Animal Science Division of ICAR, New Delhi.
» Waste Management Systems being followed at the Institute.
» XXIV Meeting of ICAR Regional Committee- II held on June 22–23, 2018 at IMAGE, Bhubaneswar for onward transmission to Animal Science Division of ICAR, New Delhi.
» Proceedings of the Senior Officers' Committee meeting held on October 3, 2018.
» Minutes of the meeting held under the Chairmanship of Agriculture and Farmers' Welfare Minister with MoS and Senior Officers of the Ministry held on November 28, 2018 at Krishi Bhawan New Delhi.
» Meeting of ICAR Directors' conference held on March 8– 9, 2018 at NASC Complex, New Delhi.
» Recommendations made by SGoS -1 (Agriculture & Allied Sector) for XV Finance Commission.
» Proceedings of ECM- 02, 2018 regarding the position in All India Co-ordinated Research Projects withdrawn in various for onward transmission to Secretary General, IAUA & VC- Panjab Agricultural University, Ludhiana.
» Recommendations made during the meeting held on August 30, 2018 on ICAR success stories.
» Recommendations made during the meeting of ICAR Directors' Conference held on March 8– 9, 2018 at NASC Complex New Delhi.
» Observations and suggestions/ status as on November 12, 2018 regarding the printing presses that existed in different Ministries/ Departments of the Country.
» Recommendations that emerged from XXIV Meeting of ICAR Regional Committee- IV held during September, 14-15, 2018 at ICAR- IINRG, Ranchi, Jharkhand.
» Review meeting of Agri-CRP on water.
» Regional Committee meeting held during November 2-3, 2018 at ICAR- CSSRI, Karnal.
» Proceedings of the ICAR- Directors' Conference held on January 31 to February 1, 2019 at NASC Complex, New Delhi.

Collation

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

» Information on mechanism of interaction with commodity boards with respect to NDRI, Karnal.
» Inputs regarding the schematic interventions in the aspiration districts of NER.
» Information on mechanism of interaction with commodity boards with respect to NDRI, Karnal.
» Performance indicators unit numbers/ quantity (kg/ qtl) of last ten years (2008-09 to 2017-18).
» Information in prescribed format for inclusion in 25th meeting of ICAR Regional Committee- V scheduled held on Oct. 26 – 27, 2018 at ICAR- CSSRI, Karnal and submitted the same to the Secretary of ICAR Regional Committee- V.
» Quarterly reports in terms of financial and physical targets of TSP activities being carried out at Eastern Campus, Kalyani.
» Information on NDRI for inclusion in ICAR- Publication (Coffee Book).
» Information for XV Finance Commission regarding a status note on most significant achievements in XII Plan and current plan phase (2017-18 to 2019-20); present status of milk and technologies development and challenges

in the sector and future research thrust during the period 2020-25 and submitted the same to the in revised template to the Council.

- Information on rationalization of ICAR Institutions/ centers in prescribed format covering performance indicators with unit numbers/ quantity (kg/qtl./l).
- Information on salient achievements of the Institute with effect from June 27, 2018 for presentation in Governing Body Meeting at ICAR.
- Information on NEH/TSP and women component for annual plan (2018-19).
- Year wise programmes/ targets set for the period (2017-20) approved in the EFC document of the Institute.
- Achievements of the Institute regarding number of patents applied/ granted/number of agri-entrepreneurs incubated new and graduated / skills imparted to farmers/number of young farmers trained through training programmes, dissemination of superior male germplasm/technologies transferred to the dairy stake holders and farming community.
- Additional information on the slides sent earlier to DDG (AS) regarding the major achievements of NDRI during 2018.
- Technologies transferred during last three years by NDRI.
- Training programmes conducted by NDRI, Karnal for the period (2017-20).

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

Parliament Questions: During the period under report, a total number of 24 parliament questions (Lok Sabha & Rajya Sabha) were attended.

Parliamentary Standing Committee (PSC) on Agriculture: Prepared a document in English and Hindi on Examination of Subject by Parliamentary Standing Committee on Agriculture ensuring quality of milk and consumer grievance redressal mechanism in dairy sector (2017-18) held at Parliament House, New Delhi on November 26, 2018 and the same was submitted to Parliamentary Standing Committee and ICAR-DARE, New Delhi. Prepared Action Taken Report on 10 point agenda items in English and Hindi asked by Parliamentary Standing Committee on Agriculture and submitted the same to the ICAR-DARE, New Delhi.

Promotion of National and International Linkages

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

Activities of PME Unit at a Glance

» In-house Research Projects	:	78
» New Research Projects	:	19
» Externally Funded Projects (National)	:	70
» Externally Funded Projects (International)	:	08
» Contract/ Consultancy Projects Screened Proposals	:	04
» IRC Meetings Convened and Co-ordinated	:	02
» Manuscripts of Technical Bulletins/Books Scrutinized/ Evaluated	:	07
» NDRI- Annual Report (2017-2018)	:	01
» Quarterly NDRI News Letter (4 Issues)	:	04
» Proceedings of IRC	:	02
» Proceedings of RAC	:	01
» Various Write-ups on NDRI	:	17
» Action Taken Reports/Status Reports	:	20
» Six Monthly Reports	:	02
» Parliament Questions Attended	:	24
» Monthly Reports	:	12
» Six Monthly Reports/Annual Progress Reports	:	02
» Retention Cases of Scientists Handled	:	08
» Assessment Cases of Scientists Handled	:	06
» Visits Co-ordinated	:	16

Research Projects-2018-19
(In-house)

SL. No.	Project Title	PI
1.	Identification and targeted validation of unique proteins expressed during subclinical mastitis in Sahiwal and Karan Fries cattle (Lead Division: Animal Biotechnology Centre)	Sudarshan Kumar
2.	Genetic evaluation of reproductive and productive efficiency of crossbred cattle in relation to heat stress under tropical climate (Lead Station: ERS-Kalyani).	Rajalaxmi Behera
3.	Genetic diversity and evaluation of Gir and Tharparkar cattle (Lead Division: Animal Genetics & Breeding).	Archana Verma
4.	Mastitis related bacterial antibiotic resistance pattern mapping in Karnal district (Lead Division: Animal Biotechnology).	S. De
5.	Characterization of beta-defensin genes and their relation with bull fertility (Lead Division: Animal Biotechnology).	Rakesh Kumar
6.	Selection of Deoni cattle using QTN data mining for faster genetic improvement (Lead Station: SRS, Bengaluru).	D. N. Das
7.	Influence of different growth promoting factors and macromolecules on *in vitro* development of cattle embryos (Lead Station: ERS, Kalyani).	S. K. Das
8.	Screening the role of seminal proteins and antioxidants on cryopreservation of buck semen (Lead Station: ERS, Kalyani).	M. Karunakaran
9.	Orchestrating reproduction in bovine: Crosstalk between phoenixin (PNX) and Kisspeptin (KiSSI) (Lead Station: ERS, Kalyani).	Mohan Mandal
10.	Genetic analysis of lactation persistency and its relationship with economic traits of crossbred cattle (Lead Station: ERS, Kalyani).	Ajoy Mandal
11.	Use of mesenchymal stem cells for treatment of mastitis and metritis in bovine (Lead Division: Animal Biotechnology Centre).	D. Malakar
12.	Production of CRISPR-Cas9 mediated β-lactoglobulin gene edited buffalo embryos (Lead Division: Animal Biotechnology Centre).	Satish Kumar
13	Exploration of buffalo estrus specific salivary miRNA for LAMP color reaction development (Lead Division: Animal Biochemistry).	Suneel Kumar Onteru
14.	Development of suitable housing for dairy cows in lower Gangetic regions of West Bengal (Lead Station: ERS-Kalyani).	D. K. Mandal
15.	Studies on seminal plasma reactive nitrogen species as biomarkers of semen quality in crossbred cattle and buffaloes and its association with seminal hormones and sperm functions- (Lead Division: Animal Physiology).	Sujata Pandita
16.	Strategies to improve semen production performance in indigenous dairy bulls - (Lead Division: LPM).	Mukesh Bhakat
17.	An investigation on anti-mullerian hormone as a predictive biomarker of fertility in HF crossbred & indigenous Deoni cows - (Lead Station: SRS, Bengaluru).	S. Jeyakumar
18.	Diversity in bio-chemical quality of fodder influenced by weather and soil fertility forcing variables - (Lead Station: SRS, Bengaluru).	B. Srinivas
19.	Studies on the causes of truncated lactation in Sahiwal cows (Lead Division: Animal Physiology).	A. K. Roy
20.	Development of suitable management measures to augment milk production, quality and udder health status in dairy cattle at lower Gangetic region (Lead Station: ERS, Kalyani).	Champak Bhakat
21.	Harnessing geothermal energy for cooling and Heating of Animal Shed (Lead Division: Livestock Production & Management).	Pawan Singh
22.	Effect of biostimulation on puberty and reproductive performance of dairy cattle and buffaloes (Lead Division: Livestock Production & Management).	M. L. Kamboj
23.	Elucidating the effect of Kisspeptin on onset of puberty and induction of estrus in Murrah buffaloes (Lead Division: Livestock Production & Management).	Nishant Kumar
24.	Development of dairy based integrated farming system for income enhancement of small farmers (Lead Division: Livestock Production & Management).	A. K. Mishra

25.	Studies on vanadium and boron for their role in immuno-endocrine functions, bioavailability of minerals and production performance in dairy animals (Lead Division: Animal Nutrition).	Veena Mani
26.	Dietary supplementation of prebiotics, probiotics and synbiotics to augment health of calves (Lead Division: Animal Nutrition).	Sachin Kumar
27.	Role of certain trace minerals on semen quality of cattle and buffalo (Lead Division: Animal Nutrition).	Gautam Mondal
28.	Development of feeding module to reduce the age at first conception in Murrah buffalo (Lead Division: Animal Nutrition).	Raman Malik
29.	Optimizing the performance of crossbred calves by synbiotic feeding in existing farm conditions (Lead Station: ERS-Kalyani).	Saroj Rai
30.	Development of diversified fodder cum seed production systems for sustainable production and profit maximization of dairy farmers in Indo-Gangetic plains of India (Lead Division: Animal Nutrition).	Rajesh Kumar Meena
31.	Performance of fodder Maize and Cowpea intercropping followed by Oats for seed production under different nutrient management practices (Lead Division: Animal Nutrition).	Magan Singh
32.	Development and evaluation of additives for small scale silage production (Lead Division: Animal Nutrition).	Nitin Tyagi
33.	Nutritional evaluation of some aquatic macrophytes available in lower Gangetic Plain Region for utilization as ruminant feed resources- (Lead Station: ERS, Kalyani).	A. Chatterjee
34.	Evaluation of eastern Himalayan forest tree leaves as herbal feed additives to manipulate rumen fermentation for improving animal productivity (Lead Station: ERS, Kalyani).	A. Santra
35.	Evaluation of oat and berseem varieties under different agronomic practices vis-à-vis management of nitrate toxicity (Lead Division: Animal Nutrition).	Rakesh Kumar
36.	Crop diversification through fodder crops to maximization of fodder yield, profitability and sustain soil health (Lead Division: Animal Nutrition).	Hardev Ram
37.	Effect of organic nutrients management on different fodder crops (Lead Division: Animal Nutrition).	Sanjeev Kumar
38.	Formulation and evaluation of milk replacers for kids with special reference to black Bengal Goat (Lead Station: ERS, Kalyani).	M. K.Ghosh
39.	Design and development of universal turbo disperser for dairy products (Lead Station: SRS, Bengaluru).	M. Manjunatha
40.	Process development for production of banana based *pediococcus* and *pediococcus* fermented whey powders (Lead Division: Animal Biochemistry).	S. K. Sood
41.	Evaluation of osteogenic potential of milk derived peptides in osteoporosis model (Lead Division: Animal Biochemistry).	Suman Kapila
42.	Effect of probiotic administration on male reproductive parameters and semen characteristics in male mice model (Lead Division: Animal Biochemistry).	Gautam Kaul
43.	Technology of goat milk based functional beverage (Lead Division: Dairy Technology).	Heena Sharma
44.	Efficacy of buttermilk as an encapsulating agent for omega 3 fatty acids (Lead Division: Dairy Technology).	Gunvantsinh Rathod
45.	Technology of ricotta cheese from cow and buffalo milk system (Lead Division: Dairy Technology).	Sangita Ganguly
46.	Evaluation of coconut shell and areca sheath as packaging material for select dairy products (Lead Division: SRS, Bengaluru).	Sathish Kumar M. H.
47.	Elucidation of physico-chemical quality and neutraceutical properties of select indigenous cattle milk and ghee (Lead Station: SRS, Bengaluru).	Laxman Naik N.
48.	Preparation and evaluation of panchamrit for immunomodulation (Lead Division: Dairy Microbiology).	Shilpa Vij
49.	Protein profiling of milk from native indigenous breeds (cow and buffalo) in relation to their bioactive potential (Lead Division: Dairy Chemistry).	Rajesh Kumar
50.	Comparative evaluation of camel milk protein hydrolysates in combating diabetes (Lead Division: Animal Biochemistry).	Sunita Meena
51.	Preparation and characterization of micro/nano delivery system for 'green' carotenoids (Lead Division: Dairy Technology).	Neelam Upadhyay

52.	Technology development for the production of milk protein concentrate (MPC60) from buffalo milk (Lead Division: Dairy Technology).	Ganga Sahay Meena
53.	Omega-3 fatty acids fortified functional butter and curd (Lead Station: SRS, Bengaluru).	Monika Sharma
54.	Preparation of spray dried whey protein based curcumin encapsulates. (Lead Division: Dairy Technology).	Writdhama G. Prasad
55.	Studies on structure, rheology and functional properties of paneer (Lead Division: Dairy Technology).	Shaik Abdul Hussain
56.	Development of automatic endo-exo thermal unit for dahi (Lead Division: Dairy Engineering).	Chitranayak
57.	Design and development of whey dewatering mechanisam for intermediate Indian dairy product-chhana and chakka (Lead Division: Dairy Engineering).	Vairat Amita Dinkar
58.	Development of low cost mechanized stretching and portioning unit for mozzarella cheese production at small scale (Lead Division: Dairy Engineering).	P. Barnwal
59.	Development of electrochemical sensing system for automation of CIP in dairy plants (Lead Division: Dairy Engineering).	Ankit Deep
60.	Modelling of rheological behavior of selected dairy products using machine learning approach (Lead Division: DES&M).	A. P. Ruhil
61.	Technology of spray dried camel milk preparations (Lead Division: Dairy Technology).	Sanket Borad
62.	Preparation of polyphenols rich whey powder (Lead Division: Dairy Technology).	Manoj Kumar C. T.
63.	Development of low cost farm level milk cooling system (Lead Division: Dairy Engineering).	P. S. Minz
64.	Formulation of new preservative as an alternative to formalin for chemical analysis of milk and milk products (Lead Divison: Dairy Chemistry).	Richa Singh
65.	Preparation and characterization of panchgavya from indigenous cow (Lead Division: Dairy Chemistry).	Priyanka Singh Rao
66.	Conducting polymer based rapid detection of microbial quality of milk (Lead Division: Dairy Microbiology).	Raghu H. V.
67.	Evaluation and validation of enzyme substrate based strip test for detection of sub clinical mastitis (Lead Division: Dairy Microbiology).	Chand Ram
68.	Determination of engineering properties of ghee in relation to frying oil quality management (Lead Division: Dairy Engineering).	P. S. Minz
69.	Technological needs and manpower requirement of dairy production and processing units in Karnataka (Lead Station: SRS, Bengaluru).	M. C. A. Devi
70.	Development & application of multi-market model for policy analysis in Indian Dairy Sector (Lead Division: DES&M).	B. S. Chandel
71.	A Study on sustainability of Gaushalas in Haryana (Lead Division: DES&M).	Ajmer Singh
72.	Career dynamics of dairy graduates in India: A stakeholders analysis (Lead Division: D. Extn.).	Sanjit Maiti
73.	Livelihood security vis-à-vis resilience to adverse weather events among tribal and non-tribal livestock farmers (Lead Station: ERS-Kalyani).	Asif Mohammad
74.	Level and trends in sources of income of rural farm households in Haryana (Lead Division: DES&M).	Udita Chaudhary
75.	Modeling production and reproductive performance in dairy cattle using time series analysis (Lead Division: DES&M).	R. Malhotra
76.	Dairy farmers' willingness to pay for need-based dairy extension services in Haryana (Lead Division: D. Extension).	Sanchita Garai
77.	Automation on commercial dairy farm in North India: Farmers perspective appraisal (Lead Division: D. Extension).	H. R. Meena
78.	Dairy extension delivery system in Karnataka state: A stakeholder analysis (Lead Station: SRS, Bengaluru).	S. Subhash

EXTRA-MURAL FUNDING AND COLLABORATIONS

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

SL. No.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
International Collaborations					
1	Development and application of lactic acid bacteria as designer probiotics.	S. K. Tomar	-	Indo-UK Collaboration	2012-2018
2	ICAR-ILRI Collaborative project on development of goat milk and meat value chain in Bihar and Uttar Pradesh.	Latha Sabikhi	A.K. Singh & B. S. Meena	ICAR-ILRI Kenya	2016-2018
3	Regulation of the Gonadotrophin-ovarian Axix by Kisspeptin-KISSI/R System in Cattle and buffaloes.	Mohan Mandal	-	Indo-Egyptian Collaboration	2017-2018
4	Understanding enzymatic activities in concentrated milk system.	Yogesh Khetra	-	Indo-Denmark)	2017-2018
5	Assessment of antimicrobial residues and resistance in dairy animals in India.	Naresh Kumar	-	ICAR/ILRI	2017-2019
6	Nutrient utilization, milk production and accretion of acetamide in milk of cows supplemented with ammoniated paddy straw pellet.	Bandla Srinivas	A.Manimaran	Michigan State University USA	2018-2019
7	DOSA- Diagnostics for one health and user driven solutions for AMR.	Naresh Kumar	Raghu H. V.	Indo-UK DBT	2018-2021
8	Molecular markers for improving reproduction of cattle and buffaloes (MMIRCB).	T. K. Datta	Rakesh Kumar, Dheer Singh, Suneel Onteru, Rubina K. Baithalu, A. K. Mohanty, Sudarshan Kumar, T. K. Mohanty and A. Kumaresan	Bill & Melinda Gates Foundation, USA	2018-2023
National Collaborations					
9	Scheme on dairy microbes under network mode	S. K. Tomar	Surajit Mandal and P. V. Behare	ICAR	2010-2022
10	Niche Area of Excellence (NAE) Scheme on 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
11	Controlled release dispensers for delivery of semiochemicals.	Gautam Kaul	K. Subaharan (IISC, Bengaluru) M. Eshwar Morthy (NBAII, Bengaluru	DBT	2014-2018
12	Development of mammalian cell based biosensor prototypes for toxins in commercial milk.	Suneel Kumar Onteru	Dheer Singh and A. K.Singh	DBT	2014-2018

13	Elucidating the mechanism of pashmina fibre development: An OMICS approach.	J. K. Kaushik	-	NASF	2015- 2018
14	Delineating beta casein variants in Indian cows and potential health implications of A1 A2 milk.	A .K. Mohanty	Sudarshan Kumar	NASF	2015-2018
15	Bio-prospecting of lactic acid cultures from cold dessert region to develop functional fermented milk products with potential health benefits.	S. K. Tomar	Pradip V. Behare	DST	2015-2018
16	Lactation stress associated postpartum anestrus SNP array in buffaloes.	Suneel Kumar Onteru	Dheer Singh,	NFBSFARA	2015-2018
17	Water budgeting and improving water productivity livestock based farming.	Ashutosh	Mahendra Singh, SunitaMeena and Satish Kumar (CTO)	ICAR	2015-2020
18	Veterinary type culture collection-Rumen component.	Amrish K. Tyagi	Nitin Tyagi and Sachin Kumar	ICAR	2016-2017
19	Technology of heart friendly herbal-milk smoothie with prophylactic effects against CVD and associated risks.	S. A. Hussain	Latha Sabikhi, A.K. Singh, Sathish Kumar M. H., Rajan Sharma and Suman Kapila	MFPI	2016-2018
20	Social perspective of deagrarianization and its effect on livelihood security of farming community in Punjab.	B. S. Meena	H. R. Meena, Gopal Sankhala, and Rakesh Kumar	ICSSR	2016-2018
21	Study of fodder crop assessment for dairy industry and potential areas of intensification of state level.	Magan Singh	Rajesh Kumar Meena, Rakesh Kumar and V. K. Meena	Space Application Centre, Ahmedabad	2016-2018
22	To study the effect of Kappaphygusalvarezli based feed additive on production and health of dairy animals.	Chander Datt	A. K. Tyagi, Veena Mani and N. Kewalramani	CSIR	2016-2018
23	Capacity building of resource for farmers in paddy-wheat cum dairy production system through Farmer First Programme.	Gopal Sankhala	A. K. Singh, Sanket borad, Heena Sharma, Sangita Ganguly, B. S. Meena, Ajmer Singh, S. S. Lathwal, Rakesh Kumar, H. R. Meena, Nitin Tyagi and V. K. Pandita (IARI)	ICAR	2016-2018
24	Enriching knowledge-integrating technology and institutions for holistic village development in horticulture based farming system.	-	M. C. A. Devi and S. Subhash	ICAR	2016-2018
25	Risk and vulnerability analysis of rural farm households in drought prone and coastal regions of India.	Simita Sirohi	B. S. Chandel and Sanjit Maiti	ICSSR	2016-2018
26	Deciphering the circulating miRNAs from terminal stage pre-implantation embryos and placentomes for early detection of pregnancy in buffalo.	T. K. Datta	Rakesh Kumar and A. Kumaresan	DBT	2016-2019
27	Ration balancing programme under National Dairy Plan Phase I at Muzaffarnagar District.	Amrish K. Tyagi	Nitin Tyagi and Sachin Kumar	NDDB	2016-2019
28	Upgradation of methane emission factors for Indian livestock and preparation of inventory of GHGs emission from Indian livestock.	Madhu Mohini	Gautam Mondal and S. S. Thakur	MoE&F	2016-2019
29	Preparation, characterization and application of Vitamin A & D loaded milk protein nano-complexes.	Sumit Arora	Vivek Sharma, A. K. Singh and Suman Kapila	DBT	2016-2019
30	Role of probiotic lactobacilli in modulation of intestinal epithelium barrier functions and immune signals.	Rajeev Kapila	Suman Kapila and Ajay Dang	DBT	2016-2019

31	Validation and standardization of the GC analysis method given in ISO 17678:2010 for determination of milk fat purity in bovine milk other than cow's milk.	Vivek Sharma	Sumit Arora and Priyanka S. Rao	FSSAI	2016-2019
32	Synthetic Endometrium: A novel model to study early embryonic development and uterine health in ruminants.	Rubina K. Baithalu	M. K. Singh	NASF	2017-2019
33	Utilization of crude glycerol obtained in biodiesel production as an alternate to glycogenic feed supplement for dairy cows.	B. Srinivas	S. N. Sondur (KSCST, IISc, Bengaluru)	ICAR-NDRI & KSCST, IISc, Bengaluru	2017-2019
34	Whey protein-iron complexes: Preparation, characterization and application in biscuits, milk and dahi.	Kamal Gandhi	-	DST	2017-2019
35	Identification and characterization of peptidic antagonist to the recombinant cysteine synthase protein of *Haemonchus Contortus.*	Vedamuthy G. V.	-	DST	2017-2019
36	National facility on bioactive peptides from milk.	B. Surendra Nath	P. Heartwin Amaladhas, N. Laxmana Naik, F. M. E. Emerald, K. R. Ruckmani and Subramanian (Anna University)	DST	2017-2019
37	Development of phytopharmaceutical product for bovine mastitis.	A. K. Dang	T. K. Mohanty	DBT	2017-2019
38	Network project on buffalo Improvement-Field Unit (CIRB Hisar-125001)	A. K. Gupta	A. K. Chakravarty and Ombir Singh	ICAR	2017-2020
39	Network project on buffalo Improvement-Institute herd (CIRB Hisar-125001)	A .K. Chakravarty	Pawan Singh, T. K. Mohanty and Mukesh Bhakat	Network	2017-2020
40	Monitoring of drug residues and other environmental pollutants-outreach project of ICAR	N. K. Goel	Raghu H. V	ICAR	2017-2020
41	Indigenous breed program (Sahiwal Cattle)	Anupma Mukherjee	K. Chakravarty, A. K. Gupta, T. K. Mohanty, S. S. Lathwal and Mukesh Bhakat	ICAR	2017-2020
42	National innovations in climate resilient Agriculture.	Anjali Aggarwal	Mahendra Singh, Parveen Kumar, S. S. Lathwal, A. K. Mohanty, Nishant Kumar, Rajan Sharma, K. Ponnusamy, Ritu Chakravarty and Nitin Tyagi	CRIDA (ICAR)	2017-2020
43	Upliftment of socio-economic condition of tribal people through integrated livestock farming in north eastern hill region/ eastern part of India –ICAR	T. K. Dutta	M. K. Ghosh, S. K. Das, A. Santra, C. Bhakat, A. Chatterjee, D. K. Mandal, Mohan Mondal, M. Karunakaran, A. Mohammad, S. Rai and R. Behera	ICAR	2017-2020
44	Incentivizing Research in Agriculture Project-V: Semen sexing in cattle (Component A).	T. K.Mohanty	A.K.Chakravarty, Mukesh Bhagat, A. Kumaresan, A. K. Gupta and Pawan Singh	ICAR	2017-2020
45	Incentivizing Research in Agriculture-Project-V-Semen Sexing in Cattle (Component 'B')	A. K. Mohanty	Sudarshan Kumar	ICAR	2017-2020
46	Conservation of indigenous pig of Assam through handmade coning technique.	Manoj K. Singh	-	DBT	2017-2020

47	Genetic variability of milk protein and its characterization by proteomic approach in Indian goats.	S. De	Sunita Meena	NASF	2017-2020
48	Synthesis, characterization and effect of graged levels of nano-selenium supplementation on the performance of broiler chicken.	A.K. Mohanty	Sudarshan Kumar	NASF	2017-2020
49	Manipulation of rumen microbes using medicinal plants extract to enhance the nutraceautical value of milk as a functional food.	A.K. Tyagi	Sachin Kumar, Nitin Tyagi and Sumit Arora	DBT	2017-2020
50	Cell wall components of probiotic lactobacilli as therapeutics for amelioration of inflammatory gut diseases.	Sunita Grover	Rashmi H. M., J. K. Kaushik and Diwas Pradhan	ICMR	2017-2020
51	Bile responsive proteo-transcriptomics investigation of native probiotic strain lactobacillus helveticus MTCC 5463.	P.V. Behare	A.K. Mohanty, Sudarshan Kumar and J. B. Prajapati (AAU)	SERB	2017-2020
52	Resveratrol and catechins-loaded niosomes and nanoparticles as delivery vehicles for fortification of milk products.	B. Surendra Nath	-	NASF	2017-2020
53	Improving the livelihood through dairy farming in North Eastern region of India.	T. K. Dutta	M. K. Ghosh, S. K. Das, A. Santra, C. Bhakat, A. Mandal, A. Chatterjee, D. K. Mandal, Mohan Mondal, M. Karunakaran, A. Mohammad, S. Rai, R. Behera, Chander Dutt, S. Bandopadhyay (IVRI-ERS-Kolkata) Samiran Bandopadhyay (IVRI-ERS-Kolkata), S. Naskar (IVRI-ERS-Kolkata) and P. Dandapat (IVRI-ERS-Kolkata)	ICAR	2017-2020
54	Improving livelihood of rural women through dairy based secondary agriculture.	K. Ponnusamy	G. S. Meena and Parvinder Sharma/ Latha Sabikhi	DST	2017-2020
55	Development of edible antimicrobial packaging films for traditional dairy sweetmeats using metabolites of lactic and bacteria.	Diwas Pradhan	-	DST	2017-2020
56	Tissue-specific mitochondrial biogenesis, transcriptomics and proteomics studies in buffalo.	Sadeesh E M	-	DST	2017-2020
57	Proteo-genomic approach to elucidate productive and reproductive performance of Malnad Gidda, Deoni and Hallikar Breeds of Cattle.	K. P. Ramesha	M. A. Kataktalware, S. Jeyakumar, A. Manimaran, D. N. Das, A. Kumaresan, Keshavaprasad and H. Gowda.	DAHVS, Karnataka	2017-2021
58	Livelihood vulnerability to climate change among the Changpa Pastoral Nomads of Leh-Ladakh.	Sanjit Maiti	K. S. Kadian, Sanchita Garai and Mukesh Bhakat	ICSSR	2018-2019
59	Field application of Salivary Fern Pattern based Estrus Detection in Buffaloes using Foldscope.	Suneel K. Onteru	Dheer Singh and Vedamurthy	DBT	2018-2019
60	Policy imperatives for promoting value chains of agricultural commodities in India.	Smita Sirohi	A.K. Dixit, A. K. Singh and GunjanBhandari	ICAR	2018-2020
61	Amelioration of infertility in dairy cows through nutritional and biotechnological interventions.	M. Karunakaran	Asif Mohammad, M. K. Ghosh, Mohan Mondal and Ajay Mandal	DBT	2018-2020

62	Genome editing of MFGE8 and S100 genes in bovine mammary epithelial cells to understand their role in milk production.	A.K. Mohanty	Sudarshan Kumar, J. K. Kaushik and D. Malakar	SERB-DST	2018-2021
63	Global transcriptome and miRNA analysis for deciphering reasons for low cloning efficiency in buffalo.	P. Palta	M. K. Singh	SERB-DST	2018-2021
64	Surveillance of dairy products for Antibiotic resistant zoonotic bacterial pathogens under field conditions.	Raghu H. V.	Rashmi H.M	SERB-DST	2018-2021
65	Improving the usability of buffalo spermatozoa by sperm surface remodeling and immune acceptance in female reproductive tract.	T. K. Dutta	Rakesh Kumar, S. M. Deb, T. K. Mohanty, J. K. Kaushik and Sarika (IASRI)	NASF/ICAR	2018-2021
66	Valorization of industrially produced soybean and groundnut de-oiled meals/ cakes by extraction, purification and production of protein isolates.	Suman Kapila (CCPI)	Sanket Borad	NASF/ICAR	2018-2021
67	Development of a rapid and robust high throughput reporter cell-based bioassay for detection of xenobiotics in milk.	Dheer Singh (CCPI)	Suneel Kumar Onteru & Vedamurty G. V.	NASF/ICAR	2018-2021
68	Genomic and proteomics approaches to develop specific diagnostic assay for detection of estrus/silent estrus in buffaloes.	Rubina K. Baithalu	K. Mohanty, Sudarshan Kumar, T. K. Mohanty and A. Kumaresan	DBT	2018-2021
69	Process development for production of dipeptidyl peptidase-IV (DPP-IV) inhibitory peptides from milk of Gir Cows and their encapsulation through double emulsification technique.	Satish Kumar M. H.	Latha Sabikhi, Yogesh Khetra, Shaik Abdul Hussain and Sunita Meena	NASF/ICAR	2018-2021
70	Targeted immobilization of Y-bearing spermatozoa and modulation of oviduct milieu for skewing sex ratio towards female offspring in dairy cattle.	A. Kumaresan	Rakesh Kumar	NASF/ICAR	2018-2021
71	Mitochondrial DNA Haplotypes as candidate biomarkers for prediction of reproductive efficiencies in buffalo.	Sadeesh E. M.	Sudarshan Kumar, S. De	DBT	2018-2021
72	CRISPR/CAS9 guided functional analysis of genes regulation early embryonic in buffalo.	D. N. Das & D. Malakar	-	NASF	2018-2021
73	Development of early pregnancy diagnostic assay through discovery of biomarkers in cattle and buffalo.	A.K. Mohanty & A. K. Dang	Rubina K. Baithalu, T. K. Mohanty, Sudarshan Kumar, Rajiv Kapila	DBT	2018-2021
74	Production of multiple copies of elite buffalo bulls using animal cloning technology.	P. Palta	M. K. Singh, S. S. Lathwal and Subhash Chand T. O (Vety.)	NASF-ICAR	2018-2022
75	Exploring the dairy industry needs for research and better employability of dairy graduates.	Richa Singh	Bimlesh Mann and Rajan Sharma	ICAR	2019-2020
76	Farmer participatory assessment of cost effective solution for management of ticks and mites in dairy animals.	K. Ponnusamy	T. K. Mohanty and S. Raju	NIF-India	2019-2020
77	Mastitis related antibiotic resistance pattern mapping in three districts of Haryana.	S. De	Rakesh Kumar and Raghu H	SERB-DST	2019-2022
78	Modulating the immune-cellular components and their signaling molecules in bovine colostrum and milk after micro-nutrient interventions and their functional validation under ex-vivo and in vivo animal models.	K. Dang	Sujata Pandita, S. S. Lathwal and Rajeev Kapila	DBT	2019-2022

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 that takes decisions on the intellectual property management at NDRI viz., filing of patents, approval of technologies for commercialization, pricing of the technologies ready for commercialization etc. ITMC is chaired by the Director.

ITMC meetings conducted during the period:

- 39th ITMC meeting on May 1, 2018
- 40th ITMC meeting on September 25, 2018
- 41th ITMC meeting on January 16, 2019

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

Twelve technologies developed at the Institute were transferred to 8 commercial houses through 18 different license agreements during the year 2018-19. This earned a revenue of ₹ 41.85 lakhs (excluding service tax) for the Institute through technology transfer fee and fee for additional freeze dried cultures for previously sold technologies. One technology was transferred on more than one occasion. The lists of technologies transferred and other activities are as follow:

Technology Approved for Commercialization (2018-19)

1. **Probiotic Lactobacillus Strain LbS2 (MTCC 5953)** (Inventors: Sunita Grover, Rashmi, H. M. and V. K. Batish, Dairy Microbiology Division, ICAR-NDRI; Dr. S. Das and Mr. B. K. Thakur, National Institute of Cholera and Enteric Diseases, Kolkata).
2. **Technology on Bio-functional Probiotic Fermented Mango Whey Drink** (Inventor: Shilpa Vij) Dairy Microbiology Division, ICAR-NDRI.
3. **Microprocessor Based Automated Instrumentation System for Pneumatic Paneer Hoop Cum-press Unit** (Inventors: Chitranayak, M. Manjunatha, F. Magdaline E. E., and K. Jayraj Rao) Dairy Engineering Division, ICAR-NDRI.
4. **Equipment for mechanized production of rice based kheer** (Inventors: P.S. Minz, Chitranayak, P.N. Raju and A.K. Singh) Dairy Technology Division, ICAR-NDRI.
5. **Technology for the Preparation of Encapsulated Curcumin for its Applications in Dairy Foods** (Inventors: Bimlesh Mann, Rajan Sharma, Rajesh Kumar, Richa Singh, Ramesh Pothuraju) Dairy Chemistry Division, ICAR-NDRI.
6. **Technology for the Preparation of Caseinophosphpeptides Enriched Milk Protein Product** (Inventors: Bimlesh Mann, Rajan Sharma, Rajesh Kumar, Prabin Sarkar) Dairy Chemistry Division, ICAR-NDRI.
7. **Indigenous Probiotic *Lactobacillus* strain LrhS3** (Inventors: Rashmi, H. M., Sunita Grover and V. K. Batish) Dairy Microbiology Division, ICAR-NDRI.
8. **Indigenous Probiotic *Lactobacillus* Strain Lre120** (Inventors: Sunita Grover, Rashmi H.M. and V.K. Batish) Dairy Microbiology Division, ICAR-NDRI.

9. **Indigenous Probiotic *Lactobacillus* Strain LbS4** (Inventors: Sunita Grover, Rashmi H. M. and V. K. Batish) Dairy Microbiology Division, ICAR-NDRI.

10. **A Strip for Detection of Sodium Chloride in Milk** (Inventors: Rajan Sharma, Y. S. Rajput and Bimlesh Mann) Dairy Chemistry Division, ICAR-NDRI.

11. **Process Technology for Palada Payasam Mix Preparation by Dry Crystallization Method in a Mechanical Unit** (Inventors: Menon Rekha Ravindra, B. Surendra Nath, Gajanan P. Deshmukh) Dairy Engineering Division, SRS of ICAR-NDRI, Bengaluru.

12. **Indigenous Probiotic *Lactobacillus rhamnosus*NCDC 610** (Inventors: S. K. Tomar, Pradip Vishu Behare, Sandip Basu and A. K. Singh) Dairy Microbiology Division, ICAR-NDRI.

13. **Production of Milk Protein Concentrate 60 (MPC60), A High Protein Low Lactose Powder from Buffalo Milk (** Inventors: Ganga Sahay Meena, Ashwajit Tejram Patil, Neelam Upadhyay, Yogesh Khetra, Sanket G. Borad and A. K. Singh) Dairy Technology Division, ICAR-NDRI.

14. **Process Optimization of Cow Milk Protein Concentrate 70 (MPC70) with Improved Functional Properties**. (Inventors: Ganga Sahay Meena, Ashish Kumar Singh, Vijay Kumar Gupta) Dairy Technology Division, ICAR-NDRI.

15. **Food Colour Measurement System Colour Desk D1** (Inventors: P. S. Minz, I. K. Sawhney, Chitranayak Sinha and A. K. Dodeja), Dairy Engineering Division, ICAR-NDRI.

16. **Development of Whey Dewatering Mechanism for Chhanna (**Inventors: Vairat Amita Dinkar, Chitranayak Sinha, P. S. Minz, K. J. Dabas and Khushbu Kumari) Dairy Engineering Division, ICAR-NDRI.

17. **Development of Automatic Endo-exo Thermal Unit for Dahi** (Inventors**:** Chitranayak Sinha, K. J. Dabas, P. S. Minz, Vairat Amita Dinkar, Khushbu Kumari) Dairy Engineering Division, ICAR-NDRI

Technology Transferred (2018-19)

S. No.	Name of the technology	Inventors	Date of Signing of MOU	Revenue Generated (Rs)
1.	Sugar tolerating lactic culture for preparation of Misti Doi (Misti Doi Culture-20 freeze dried ampoules)	Surajit Mandal, S. K. Tomar and Pradip V. Behare	20.04.2018	1.00 + 18% GST
2.	Strip based detection of neutralizers in milk	Rajan Sharma, Priyae Brath Gautam, Y. S. Rajput and Bimlesh Mann	28.04.2018	1.50 + 18% GST
3.	Strip based test for detection maltodextrin in milk	Rajan Sharma, Y. S. Rajput, Bimlesh Mann and Panchal Bhaveshkumar R.	28.04.2018	2.25 + 18%GST
4.	Strip based test for detection of urea in milk	Rajan Sharma, Priyae Brath Gautam, Y. S. Rajput and Bimlesh Mann	28.04.2018	1.50 + 18% GST
5.	New colour based test for rapid detection of detergent in milk	Rajan Sharma, Y. S. Rajput and Amit Kumar Barui	28.04.2018	7.50 + 18% GST
6.	Arjuna Herbal Ghee	Rajani Kant, G. R. Patil, R. R. B. Singh and A. A. Patel	15.05.2018	2.50 + 18% GST
7.	A new rapid test for detection of detergent in milk	Rajan Sharma, Y. S. Rajput and Amit Kumar Barui	17.07.2018	6.00 +18% GST
8.	A new strip based Test for detection of neutralizers in milk	Rajan Sharma, Priyae Brath Gautam, Y. S. Rajput and Bimlesh Mann	17.07.2018	1.50 +18% GST
9.	A new strip based test for detection of urea in milk	Rajan Sharma, Priyae Brath Gautam, Y. S. Rajput and Bimlesh Mann	17.07.2018	1.50 +18% GST
10.	Strip based test for detection of hydrogen peroxide in milk	Rajan Sharma, Y. S. Rajput, Bimlesh Mann and Panchal Bhaveshkumar R.	17.07.2018	1.00 + 18% GST
11.	Strip based test for detection of glucose in milk	Rajan Sharma, Y. S. Rajput, Bimlesh Mann and Panchal Bhaveshkumar R	17.07.2018	1.50 +18% GST
12.	A new strip based test for detection of sucrose in milk	Rajan Sharma, Priyae Brath Gautam, Y. S. Rajput and Bimlesh Mann	17.07.2018	1.50 +18% GST

S. No.	Name of the technology	Inventors	Date of Signing of MOU	Revenue Generated (Rs)
13.	Sugar tolerating lactic culture for preparation of Misti Doi (Misti Doi culture-20 freeze dried ampoules)	Surajit Mandal, S. K. Tomar and Pradip V. Behare	01.08.2018	1.00 + 18% GST
14.	Anionic mineral mixture for reducing post-partum problems in cattle and buffaloes	Veena Mani	19.09.2018 (Through Agrinnovate)	2.50 + 18% GST
15.	Spore based kit for detection of antibiotic residues in milk at dairy farm	Naresh Kumar, A. Khan, S. Arora, Raghu H. V., M Balhara, P. K. Sharma and S. Shaikh	13.03.2019 (Through Agrinnovate)	3.00 + 18% GST
16.	Technology of sour dahi using prolific acidifying lactic cultures	Pradip V. Behare, S. K. Tomar and Surajit Mandal	19.03.2019 (Through Agrinnovate)	1.50 + 18 % GST
17.	Misti Doi with fast acidifying high sugar tolerating lactic culture(s)	Surajit Mandal, S. K. Tomar and Pradip V. Behare	19.03.2019 (Through Agrinnovate)	1.60 +18%GST
18.	Process technology for palada payasam mix preparation by dry crystallization method in a mechanical unit	Menon Rekha Ravindra, B. Surendra Nath, Gajanan P. Deshmukh	28.03.2019 (Through Agrinnovate)	3.00 +18% GST
	Total = Rs. 41.85 Lakhs excluding Service Tax			

Transfer of technology of "Arjuna Herbal Ghee" to "M/s Ssvas Vittles Company Limited, Amreli, Gujrat" on 15-05-2018

Transfer of technology of "Spore based Kit for Detection of Antibiotic Residues in Milk at Dairy Farm" to "M/s Delmos Research Private Limited, Haryana" on 13-03-2019

Patents Filed (2018-19)

S. No.	Title of Patent	Inventors	Date of Filing	Application Number
1.	Design and development of nanofluids based extended surface module and milk cooling.	Ravi Prakash, Chikkamutharayappa Guruvanna, Mahesh Kumar, Kerekoppa Puttaiah Bhaatta Ramesha, Giriyapura Basavarajappa Darshan, Menon Rekha Ravindra, Battula Surender Nath and Pushpadass Heartwin Amaladhas	08.06.2018	201811021472
2.	A biopolymer based electrospun oxygen indicator for dairy products packing	Narender Raju Panjagri, Shivam Panwar, Ashish Kumar Singh, Preashant Saurab Minz, Richa Badola and Gaurav Kumar Deshwal	22.06.2018	201811023361
3.	An Indicator and the indicator impregnated strip for detection of neutralizers in milk	Rajan Sharma, Y. S. Rajput, Priyae Brath, Gautam and Bimlesh Mann	10.08.2018	201811030055
4.	A process for manufacture of low-fat chakka and Shrikhand by using exo-polysaccharides producing bacteria	Pradip V. Behare, S. K. Tomar, Sanket Borad and Harish M. R.	05.09.2018	201811033236

Request for Examination of Patents Filed (2018-19)

S.No.	Application/ Registration No	Name of Innovation/ Technology/ Product/ Variety	Date of Submission	Remark
1.	201611018434	Oil in water Curcumin nanoemulsion and method of preparation thereof.	21.01.2019	Submission of request for examination
2.	201711010975	Casinophosphopeptides – Divalent metal (Iron/Zinc) Nanocomplexes and method for preparation of thereof.	21.01.2019	Submission of request for examination
3.	201611018434	Rapid spores-enzyme based miniaturised assay (s) for detection of pesticide residues.	15.02.2019	Submission of request for examination

Patents Granted (2018-19)

S. No	Title of Patent	Inventors	Date of Filing	Patent grant No.	Grant date
1.	Estimation of tannin metabolites in blood serum and cow milk using HPLC (1831/DEL/2004).	Keshab Barman and S. N. Rai	27.09.2004	301155	19.09.2018
2.	Three stage thin film scraped surface heat exchanger for continuous manufacture of khoa (583/DEL/2010).	A. K. Dodeja, Dharm Pal and S. P. Agrawala	12/03/2010	304816	21.12.2018
3.	A Process for preparation of Feta cheese from buffalo milkusing microbial rennet (128/DEL/2011).	Sanjeev Kumar and S. K. Kanawjia	19/01/2011	305768	16.01.2019
4.	Process for shelf stable low-fat tomato-whey soup (1714/DEL/2006).	Sudhir Singh, Kamavaram Sudheer, Alok Jha, Ashok Ambalal Patel and G. R. Patil	26/07/2006	306128	23.01.2019

ENTREPRENEURSHIP DEVELOPMENT BUSINESS INCUBATION ACTIVITIES AND CONSULTANCY SERVICES

Contract Research

The Institute is engaged in active collaboration with industry, government agencies and other stakeholders for executing the research projects funded by them. In year 2018-19, five contract research projects were initiated. Two projects were completed during the period and three projects were being carried out.

Contract Research Projects during April, 2018 to March, 2019

S. No.	Name of the Bilateral / Multilateral Organization	Project under which Consultancy being Provided	Name of Consultant	Total Project Amount (Rs. in lakhs)
1.	M/s Chem Process Pvt. Ltd., 15, Natraj Industrial Estate, Vasna-Iyava, Sanand, Gujarat-382 170	Comparative Evaluation of De Potash Vinasses and Came Sugar Molasses as Cattle Feed Pellet Binder and its effect Performance in Lactating Cows.	Dr. Goutam Mondal, AN Division	11.91
2.	M/s Cadila Healthcare Ltd., Zydus Tower, Satellete Crossroad, Ahmedabad-380015	Effect of Virginiamycin in Lactation Performance & Healthcare Status of Crossbred Cows in India.	Dr. Nitin Tyagi, AN Division	8.95
3.	M/s Everest Instruments Pvt. Ltd., D-902, Ganesh Meridain Solahmedabad, Opp. Gujarat High Court SG Highway, Gujarat	Testing and Evaluation of two Milk Analyzers Developed by Everest Instruments Pvt. Ltd.	Dr. Rajan Sharma, DC Division	3.16
4.	M/s Schreiber Dynamic Dairies Pvt. Ltd. Baramati, Maharastra	Evaluation of Ash Content in SMP produced by Schreiber Dynamic Dairies Pvt. Ltd., Baramati.	Dr. Rajan Sharma, DC Division	2.93
5.	M/s PG Institute of Veterinary Education and Research, NH-11, Arya Road, Opposite Chanda Garden, Jamdoli, Jaipur-302031	Validation of Milk Adulteration Kit Developed by College of Rajasthan University and Animal Science.	Dr. Rajan Sharma, DC Division	0.23
	Total			**27.18**

Consultancy Projects

The Institute offered both general and advisory consultancy to individuals or organizations on various aspects. Besides, six short-term consultancy assignments were executed during the period.

Advisory / General Consultancy

S. No.	Name of the Firm	Consultancy	Scientist/Division Name
1.	M/s BENEO India Pvt. Ltd., A- 403-404, Spazedge, Sector-47, Sohna Expressway, Gurgaon	"Evaluation of ORAFTI®GR and ORAFTI FTX for partial fat replacement in dahi (Curd) and Lassi for texture, mouthful and shelf-stability"	Dr. Sanket Borad, DT Division
2.	M/s Life Style Collection Pvt. Ltd., 665, C-1 Block, Palam Vihar Sector-3, Gurgaon-122 017	Consultancy for making of Paneer & Curd/ Yogurt	Dr. Sanket Borad, DT Division
3.	M/s Abhaya International LLP, 2nd Floor, S 2, Pocket-S,Okhla Phase-2, New Delhi-110020	"Feasibility of Heat stability improvement of provided high protein & whey powder"	Dr. G. S. Meena, DT Division
4.	M/s Rich Graviss Products Pvt. Ltd., J-177, MIDC, Bhosari, Pune	"Technical expert opinion on emulsions like Non-dairy whip topping & vegetable creams"	Dr. A. K. Singh, DT Division

Capacity Building Programmes

Business Planning and Development (BPD Unit) also coordinated and organized short and long-term training programmes for entrepreneurs, students from other universities and Institutes, officials from industry and government organizations and other development agencies. A total number of 14 Entrepreneurship Development Programmes (EDPs) were organized in the area of commercial dairy farming, milk & milk product processing and Novel dairy products for 300 participants across the country. For promotion of entrepreneurship, one month specialized training programme was also initiated. A total of 137 students from other educational institutes were imparted training in different divisions and sections of the Institute.

Contract Services

The Institute assisted stakeholders through offering analytical services, supply of testing kits, cultures and custom hiring of equipments.

DAIRY EDUCATION

ICAR-National Dairy Research Institute is the premier Institution of international repute in the field of Human Resource Development for the growing dairy industry in India. ICAR-NDRI which has been conferred Deemed to be University status vide Govt. of India, Ministry of Human Resource Development, Department of Education vide Notification No. F.9-15/85-U.3 dated 28.3.1989, is well equipped and staffed to meet emerging HRD needs of the Dairy Industry of the 21st Century. The university offers academic programmes at Diploma, under-graduate and post-graduate levels in the field of Dairy Science and Technology. The following courses were offered by NDRI Deemed University during the academic session 2018-19. The courses have been designed to provide broad-based specialized training on different aspects of dairying.

Diploma in Dairy Technology and Animal Husbandry

The Diploma in Dairy Technology being offered at Southern Regional Station of ICAR-NDRI, Bengaluru, aims at providing intensive training in dairy processing and quality control of milk and dairy products, engineering aspects of dairy processing equipments and dairy business management. Ten students passed out during the academic year. The Diploma in Animal Husbandry and Dairying being offered at Eastern Regional Campus of ICAR-NDRI, Kalyani, offers intensive training in Animal Husbandry & Dairying and two students passed out during the academic year

B. Tech. (Dairy Technology)

The four year B. Tech. (Dairy Technology) programme offers intensive training in processing and quality control of milk and milk products and engineering aspects of milk processing plants.

Master's 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 Technology; vi) Dairy Engineering; vii) Animal Biochemistry; viii) Animal Biotechnology; ix) Animal Genetics and Breeding; x) Livestock Production and Management; xi) Animal Nutrition; xii) Animal Physiology; xiii) Agricultural Economics; xiv) Agricultural Extension Education; xv) Agronomy and xvi) Veterinary Gynaecology and Obstetrics. The Institute offers Doctoral degree programme in all the above disciplines except Food Technology.

Scholarship and Fellowships

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

Institute Scholarships

1.	Master's degree	Rs. 7560/- P.M. for two years plus Rs. 6000/- per annum as contingency (229)*.
2.	Ph.D.	Rs. 25,000/- P.M. for first two years, Rs. 28000/- during third year and Rs. 10,000/- per annum as contingency (216)*.
3.	Ph.D. (In-service)	Rs. 3000/- P.M. for three years and Rs. 10000/- per annum as contingency (30)*.

*Figures in bracket indicate number of students

ICAR Junior Research Fellowship

1.	Master's degree	Rs. 8640/- P.M. (For Non-veterinarians) and
		Rs. 12,000/- P.M. (For veterinarians) for two years and Rs. 6000/- per annum as contingency (59)*.

*Figures in bracket indicate number of students

National Talent Scholarship

The National Talent Scholarship (NTS) @ Rs.3000/- per month is awarded by ICAR on merit provided that the university/institute is located outside the state of his/her domicile.

Career Guidance, Training and Placement Cell

The Placement Cell provides career guidance, training and placement services for the graduating students in various disciplines of the Deemed University. B. Tech. (Dairy Technology) and Masters in Dairying students were provided employment in reputed Dairy/ Food Industry (Govt./Cooperative/Multinationals) through campus interviews. A number of students also opt for higher studies in India and abroad. Dr. Latha Sabikhi, Head, Dairy Technology Division is currently the Chairperson of the Placement Cell. The major functions of the Cell are as follow:

- 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 interactions/seminars/workshops/presentations to maintain closer liaison between student community and industry.

Counselling for Admissions

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

Entrance Examination

An all India Competitive entrance examination for admission to Diploma in Dairy Technology/Diploma in Animal Husbandry & Dairying and Ph.D. Programme for the session 2018-19 was conducted by NDRI on 20.5.2018 at five centers i.e. Karnal, Delhi, Mumbai, Bengaluru & Kolkata.

Admissions

Admission for the academic session 2018-19 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.

S. No.	Courses	No. of Students Admitted
1.	Diploma in Dairy Technology	05
2.	Diploma in Animal Husbandry & Dairying	05
3.	B. Tech. (Dairy Technology)	44
4.	Masters' programme	144 (including one foreign student from Nepal)
5.	Ph.D. Programme	99 (including one foreign student from Ethiopia)

Degrees Awarded during the 17th Convocation

1. B. Tech. (Dairy Technology) : 25
2. Masters in Dairying : 144
3. Ph.D. : 80

Meetings

- The 88th, 89th and 90th meetings of the Standing Committee on Course Curricula and Academic Affairs were held on 23.10.2018, 14.2.2019 and 7.3.2019, respectively.
- The 69th, 70th, 71st, 72nd and 73rd meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 30.7.2018, 24.8.2018, 3.1.2019, 5.1.2019 and 7.3.2019, respectively.
- The 45th and 46th meetings of Academic Council were held on 29.11.2018 and 22.3.2019.

Seventeenth Convocation of NDRI Deemed University

Seventeenth Convocation of ICAR-NDRI Deemed University was held on 23rd March, 2019. Hon'ble Dr. Trilochan Mohapatra, Secretary, DARE and Director General, ICAR presided over the Function and delivered the Convocation Address. Dr. R. R. B. Singh, Director & Vice Chancellor, NDRI Deemed University presented the Convocation Report.

Honble Director General congratulated the graduating students for their excellent academic performance and the Faculty for shaping the young minds. In his address, he emphasized the role of green revolution, Operation Flood, and Doubling Farmer's Income in growth of Indian Agriculture and the need to create a start up eco-system in the campus to enable graduates to be job givers instead of job seekers.

17th Convocation 2019

A galaxy of eminent guests including Dr. Joykrushna Jena, Deputy Director General (Animal Sciences), graced the occasion.

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

B.Tech. (Dairy Technology)

Sr. No.	Name of the Student	Position	Medal
1.	Sandeep Baruah	First	Gold Medal
2.	Nabil Alam	Second	Silver Medal
3.	Sovan Deb	Third	Bronze Medal

Masters' Programme

Sr. No.	Name of the Student	Discipline	Medal	Position
1.	Digvijay	M.Tech. (Dairy Technology)	Gold Medal	First
2.	Elizabeth Jose	M.Sc. (Agricultural Extension Education)	Silver Medal	Second
3.	Shreya Mehta	M.Sc. (Food Safety & Quality Assurance)	Bronze Medal	Third

Doctoral Programme

Sr. No.	Name of the Student	Discipline	Medal	Position
1.	Man Singh	Ph.D (Livestock Production Management)	Gold Medal	First
2.	Indu Devi	Ph.D (Livestock Production Management)	Silver Medal	Second
3.	Misha Madhavan M.	Ph.D (Agricultural Extension Education)	Bronze Medal	Third

Merit Certificates to 20% of the total graduating students in B. Tech. (DT) Programme, based on performance in course work, were awarded to six students.

Merit Certificates were awarded to toppers of each discipline in Masters' and Ph.D. degree programme for the performance in course work as per the eligibility criteria. A total of 16 masters and 14 Ph.D. students were given merit certificates.

Best Thesis Awards

Best Thesis Awards for Master's theses/Ph. D.theses (one each in Production, Processing and Management Groups) carrying a citation, a certificate and Rs. 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 Master's Thesis Awards

Group	Name of the student	Name of the Guide	Discipline
Production	Ms. Neeru Jaglan	Dr. A. K. Tyagi	Animal Nutrition
Processing	Mr. Shivam Panwar	Dr. P. Narendra Raju	Dairy Technology
Social Science & Management	Ms. Suchandra Dutta	Dr. Sanjit Maiti	Agricultural Extension Education

Best Ph.D. Thesis Awards

Group	Name of the student	Name of the Guide	Discipline
Production	Mr. Sushil Kumar	Dr. S. De	Animal Biotechnology
Processing	Mohd. Iqbal Bhat	Dr. Rajeev Kapila	Animal Biochemistry
Social Science & Management	Sudhanand Prasad Lal	Dr. S. K. Jha	Agricultural Extension Education

Gold Medals for best thesis research work in Ph.D. Programme of Production, Processing and Management Group were awarded. The award carried 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:

Dr. D. Sundaresan Memorial Oration Award-2019

Dr. D. Sundaresan Memorial Oration Award-2019 was bestowed on Prof. Hitesh Bhatt, Director, Institute of Rural Management Anand, Gujarat. Prof. Bhatt delivered the lecture on April 1, 2019 in Dr. D. Sundaresan Auditorium on the topic "**Preparing for Transition: What Does the World Expect from a Fresh Graduate"**. The award carries an amount of Rs. 20,000, a citation, shawl and a certificate.

Dr. D. Sundaresan Memorial Oration Award 2019 conferred on Prof. Hitesh Bhatt, Director, Institute of Rural Management Anand, Gujarat

Dr. N. N. Dastur Memorial Oration-2019

Dr. N. N. Dastur Memorial Oration-2019 was bestowed on Mr. R. S. Sodhi, Managing Director, Gujarat Co-operative Milk Marketing Federation Ltd., (GCMMF) (AMUL) Anand, Gujarat. Dr. Sodhi delivered lecture on 14.3.2019 on the topic "**Dairy Industry: Opportunities & Challenges".**

Dr. N.N. Dastur Memorial Oration -2019 conferred on Mr. R. S. Sodhi, Managing Director, Gujarat Co-operative Milk Marketing Federation Ltd., (GCMMF) (AMUL) Anand, Gujarat

Dr. K. K. Iya Oration award-2019

Dr. K. K. Iya Oration award-2019 was bestowed on Dr. Ashok Dalwai, Chief Executive Officer, National Rainfed Area Authority, Department of Agri., Coop. & Farmers Welfare, New Delhi. Dr. Dalwai delivered lecture on 19.3.2019 on the topic "**Doubling Farmers' Income (DFI): Perspectives in Animal Husbandry and Fisheries.** The award carries an amount of Rs. 20,000, a citation, shawl and a certificate.

Dr. K. K. Iya Memorial Oration Award 2019 conferred on Dr. Ashok Dalwai, Chief Executive Officer, National Rainfed Area Authority, Department of Agri., Coop. & FW, New Delhi

Best Division Award for Academic Achievements and Innovations in Teaching

Heads of Divisions presented the innovations and significant achievements during 2018-19 in education/research and consultancy during Academic Week Celebrations. On the recommendations of the committee, **"**Best Division Award" was presented to Southern Regional Station, ICAR-National Dairy Research Institute, Bengaluru (Karnataka).

"Best Teacher Award" for Excellence in Teaching

Best Teacher Award 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 was conferred upon Dr. Narendra P. Raju, Scientist, Dairy Technology Division.

Ranking among Agricultural Universities

ICAR-NDRI, Karnal secured **FIRST RANK** amongst Agricultural Universities in the Ranking of Agricultural Universities by the ICAR. The certificate was presented on ICAR Foundation Day Award Ceremony on July 16, 2018. at NASC Complex, Pusa, New Delhi.

ICAR First ranking Agricultural University Award-2018 conferred to NDRI

Celebration of Agricultural Education Day

ICAR-NDRI Karnal, celebrated **Agricultural Education Day** on December 3, 2018, to commemorate the Birth Day of Bharat Ratna Dr. Rajendra Prasad, the first President of India. The main purpose of Agriculture Education Day was to attract budding students towards agricultural education and strengthen agricultural human resources. An Inter-school Agricultural quiz competition was organized. The event hosted eight schools making a total of 80 student participants. The students were addressed by Dr. R. R. B. Singh, Director ICAR-NDRI, Karnal. The students were oriented to Dairy Technology as a career by Dr. Latha Sabikhi. Agricultural quiz was constituted in three rounds. Top three teams were awarded medals and merit certificates and a motivational books as token of memory by Dr. R. R. B. Singh, Director, ICAR-NDRI..

Institutional Development Plan Project

The Institute earned a competitive grant in the form of an ambitious Institute Development Plan (IDP) with a budgetary outlay of Rs. 2477.66 lakhs funded by National Agricultural Higher Education Project (NAHEP) of ICAR. The project has been formulated with the focus to improve and sustain quality of higher agricultural education. The project aims to support infrastructure development, faculty and student advancement and to provide means for better governance and management of the Institute.

Different activities were conducted under the IDP project, which includes organizing of training programmes, skill development courses, foundation programme for fresher students, workshop, conferences, alumni meet, etc. Establishing linkages with different industry and academic institutions is a prime focus of the project. Thirty one students of B. Tech. (Dairy Technology) underwent internship for 6-8 weeks at international universities. In addition, 15 faculty members were selected for international training programmes under this project. As a part of an outreach initiative, proposals were invited from different departments of NDRI to accommodate as many as 20

students from sister Dairy Science Colleges of India for summer internship to foster research and entrepreneurial temperament and skills in them. Other achievements include:

- MoU was signed with Institute of Rural Management Anand (IRMA), Anand, Gujarat for offering an integrated Postgraduate Diploma Program in Dairy Management as a dual degree option for selected for B. Tech. (Dairy Technology) students of NDRI.
- MoU was signed between NDRI and Nestle India for Soft Skill Enhancement of ICAR-NDRI students.

Mr. Shubhajit Ghosh, Nestle, India taking a session on 'importance of people management'

- Linkage developed with Future Group, India for training of B. Tech. (DT) students on aspects *viz.* consumer buying behaviour, optimization of operational process, customer segmentation, optimization of supply chain channel, new product development and enhancement.
- Development of MOOCs in commercial dairy farming and milk processing was initiated in collaboration with ICAR-NAARM, Hyderabad.

Director General, ICAR and Secretary DARE, Dr. T. Mohapatra interacting with overseas internship students of NDRI

Dignitaries releasing Souvenir of NGASM

Orientation Programme for the Freshers

NDRI organized an orientation programme for its fresher students on 8th October, 2018 to realise the vision of NDRI to produce excellent and accomplished human resource by helping students pursue both their professional and personal goals with greater self-awareness, self-esteem, understanding and focus. The orientation programme culminated into the Freshers' Day celebrations on November 6, 2018. The students were exposed to multifarious extra-curricular group activities such as Theatre & Dramatics, Dance, Music, Art & Craft, Literary, Soft Skills and Yoga. It was made mandatory for all the new comers to choose and participate in any group activity as per their interest, aptitude and liking, thus, throwing open to them a world of avenues for expressing their hidden talents and creativity. Besides academics, the month long Foundation Program included English & Hindi Diagnostic Tests, Team Building Exercises/ Games, Workshops on 'Competition and Excellence', 'Communication Skills' , 'Peer Pressure', 'Personality Development', 'Soft Skills', 'Entrepreneurial Skills', 'Leadership and Management', 'Gender Equality' and sessions on Poetry writing.

Trainers imparting Yoga training to students during the foundation programme

TECHNOLOGY DISSEMINATION AND EXTENSION PROGRAMMES

DAIRY EXTENSION DIVISION

Field/Farm Technician (FFT) Laboratory

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

» To organize fertility and veterinary aid campaigns.

» To provide necessary treatment to the animals.

» To provide vaccination against contagious diseases.

» To educate farmers regarding scientific methods of breeding, feeding, improved management practices.

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

Activities Conducted in Adopted Villages

Sl. No.	Activities	No. of Cases
1.	A.I. in Cows (Conception rate)	235 (39.83%)
2.	A.I. in Buffaloes (Conception rate)	170 (37.21%)
3.	No. of Crossbred. Calves Born	34
4.	No. of Buffalo Calves Born	21
5.	General Treatment Cases	75

Infertility and Veterinary Aid Campaigns

A total of 35 camps were organized in Shahpur, Hemda, Dadupur and Kulwaheri villages. During the campaigns, animals were treated for reproductive disorders and various other ailments such as ecto-parasitic and endo-parasitic control. Special attention was given to improve the productive & reproductive performance of animals by diagnosis and proper treatment. A total of 4865 animals were treated during these campaigns. The details are as follows:

Infertility (Anoestrus and Repeat Breeding) (445); Pregnancy diagnosis (126); General treatment (308); Dehorning (73); Diarrhea (80); Mastitis (213); Deworming (Endo-parasite) (1294); Ecto-parasite (1590); FMD Vaccination (349) and Hemorrhagic Septicemia (H.S.) 352

Kisan Sangoshthies

Thirty five Kisan Sangoshthies were organized at village level and following topics were discussed in detail:

» Clean milk production practices in rural areas

» Reducing inter-calving period in lactating animals

- Preparation of value added milk products
- Deworming of animals
- Preventive measures for control of mastitis
- Cutting management in multicut sorghum
- Role of mineral mixture in animal diet
- Adaptation practices during extreme climate variability
- Awareness on ecto-parasite infestation
- Correct Time of Breeding of dairy animals

Question/Answer sessions were also arranged in these sessions. These sessions provided excellent opportunities to the farmers to obtain solutions to their day to day problems. Feedback was also collected from the stakeholders on these extension programmes.

Dairy Education at Farmers' Door (DEFD)

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

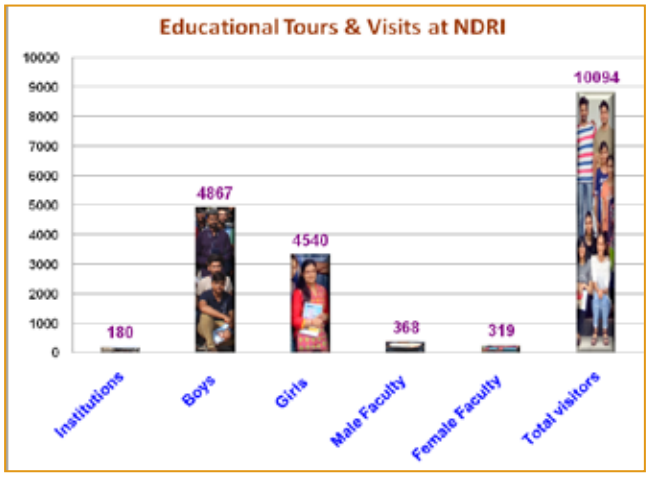
Farmers' Farm School: A New Initiative of NDRI for farmers

The Institute has started an ambitious programme wherein farmers of Karnal district are being provided formal Education in the field of Dairying, Horticulture and Agriculture through Farmers Farm School. In this School, farmers interact with the scientists of the Research Institutes through class room teaching as well as practical classes. There is a provision of enrolling 25 farmers in one batch on first come first basis and the course duration is for one year. The candidates enrolled in the 4th batch of the Farmers' Farm School passed out in the month of July 2018. The 5th batch consisting of 20 marginalised and landless farm women of village Deepo started from 10th August, 2018.

Dairy Samachar

Quarterly "Dairy Samachar" was compiled, edited and published by the Institute to make farmers well aware of newly developed dairy technologies of the Institute.

Educational Visits: A total of 10,094 visitors (students and faculty) from 180 colleges/ Institutions/Universities visited the Institute. The groups were sensitized about the different research, teaching and extension achievements and facilities available in the Institute. The details of educational tours are as follows:



Advisory Services

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

International Training

Management of Dairy Cooperatives

Dairy Extension Division of ICAR-NDRI organized an International Training programme on "Management of Dairy Cooperatives" from April 10 to 24 2018 sponsored by MANAGE, Hyderabad. The main objective of the training program was to acquaint the participants with the principles, planning and technical knowledge for establishing viable dairy farms, development of value chain in milk production, processing and marketing to minimize the marketing channels with emphasis on dairy cooperatives. There were 22 executives representing six countries viz., Kenya, Liberia, Malawi, Mongolia, Mozambique and Uganda. The programme was inaugurated by His Excellency Mr. George Crytone Mkondiwa, High Commissioner, Malawi.

Management of Modern Dairies for Established Agripreneurs

A training sponsored by MANAGE, Hyderabad entitled "Refresher Programme on Management of Modern Dairies for Established Agripreneurs under Agri-clinic and Agri-business Centre" was organized from December 26 to 29, 2018. In this programme 16 lecture cum practical classes on scientific dairy farming were organized for 34 participants.

Modern Dairy Technology, Management and Cooperatives

Dairy Extension Division of ICAR-NDRI organized an International Training Programme on Modern Dairy Technology, Management and Cooperatives sponsored by MANAGE, Hyderabad from February 5 to 19, 2019. The main objective of the training programme was to acquaint the participants with principles, planning and technical knowledge for establishing commercial dairy farms. There were 29 executives representing eight member countries viz., Afghanistan, Cambodia, Myanmar, Malawi, Liberia, Tanzania and Uganda.

TSP/NEH PROJECT AT ERS, KALYANI

TSP Activities: Livestock Development in Tribal Areas of West Bengal

TSP programme undertaken by Eastern Campus was being implemented in different agro-climatic zones of West Bengal and selected aspirational districts of Jharkhand, Tripura and Meghalaya. Special attention was given on red and lateritic soil zone of West Bengal due to high percentage of tribal population and harsh climatic conditions characterized by low rainfall and less fertile soil. Several interventions like veterinary health care facilities, deworming and vaccination (in case of cattle and buffalo FMD, HS, BQ; in case of goat and sheep PPR and in case of birds R_2B vaccine) and improved fodder seed distribution. Distribution of several inputs like mineral mixture, cattle feed and livestock etc. was regularly done in the adopted areas under TSP programme of the Institute. On and off campus training programmes were organized for upgradation of farmers' knowledge and regular dissemination of scientific information was done by using SMS portal developed under the project. For showcasing technologies developed by ICAR-NDRI and other research organizations, ERS participated in exhibitions and also organized one 'Krishi-cum-Dairy Mela' as well as 'Livestock and Agriculture Fair' in tribal village.

Twelve vaccination-cum-deworming camps and livestock health camps were organized. A total of 2630 cattle and 74 buffaloes were vaccinated against FMD, HS and BQ. Apart from that, 3329 goats and 92 sheep were vaccinated against PPR and 3834 birds were vaccinated with R_2B vaccine. In these camps, maize, oats and ricebean seeds, rooted slips of guinea grass and Hybrid Napier were distributed among tribal farmers. Apart from that propagation material of azolla was also distributed in these camps. From ERS of ICAR-NDRI, 4575 chicks, 500 ducklings, 23 piglets, 420 goats, 1150 kg mineral mixture, 7350 kg poultry feed were distributed among tribal farmers from the states of West Bengal, Jharkhand, Meghalaya and Tripura. Through these interventions, a total of 1610 tribal farmers got direct benefit.

Twelve scientists-farmers' interaction sessions were also organized under the project. A team of scientists and experts of NDRI-ERS, Kalyani interacted with the farmers (with dairy/goat and other animals) on the following

areas: Scientific animal- rearing practices, mastitis management and control measures, vaccination and deworming protocol, fodder production and feed resource development, breeding strategies, infertility/aneastrous/repeat breeding management, calf rearing and heifer management.

Two training programmes on 'Scientific dairy farming practices for tribal unemployed youth' were organised for 40 tribal farmers. Apart from that, one training programme on 'Scientific Goat Farming' was also organized for 20 tribal farmers from Purulia district of West Bengal.

Livestock-cum-Agriculture Mela

A 'Livestock and Agriculture Mela' under the TSP project was organized in the tribal dominated Ajodhya Hills area of Purulia district in West Bengal on November 22, 2018 in collaboration with CADC, Govt. of West Bengal. The Mela was presided over by Dr. Bimlesh Mann, the then Joint Director (Res.) of ICAR-NDRI, Karnal (Haryana). Around 600 tribal farmers visited the mela and the total footfall in the mela was more than 700. One veterinary health-cum-vaccination camp was organized in the mela, in which vaccination of livestock was carried out and veterinary medicines were distributed among the tribal farmers. Through the camp, 857 desi (indigenous) cows, 20 heifers, 39 calves, 53 buffaloes, 1595 goats, 5 sheep and 2243 birds were attended by the expert team of scientists/ veterinary officer. In the Mela, exhibition of agricultural technologies were showcased by ICAR-NDRI of Eastern Campus Kalyani, ICAR-Sister Institutions and several tribals. A total of 2200 chicks were distributed among 220 tribal farmers and 60 black Bengal goats were also distributed among 30 tribal farmers during the Mela. Livestock competition and Awareness Quiz were also organized and farmers were awarded for keeping good quality animals (cattle, buffalo and goat).

NEH Activities: Improving the livelihood through Dairy Farming in North Eastern Region of India undertaken by Eastern Campus

During the year 2018-19, six North Eastern states of India namely, Meghalaya, Tripura, Arunachal Pradesh, Sikkim, Nagaland and Mizoram were covered. Several visits were arranged and inputs such as livestock (poultry birds, goats, piglets etc.), veterinary medicines, mineral mixture, concentrate mixture, fodder seeds, extension literatures etc. were distributed among the farmers. In the scientists-farmers interaction sessions several aspects of animal husbandry were explained to the farmers of the North Eastern States. The topics which were covered in these sessions were as follows:

- Nutritional management of livestock
- Vaccination schedule of livestock
- Importance of deworming in livestock
- Important green fodder varieties and their cultivation practices
- Artificial insemination and heat detection
- Azolla production
- Clean milk production
- Health and housing management of animals
- Importance of record keeping in animal husbandry
- Different government schemes pertaining to animal husbandry

Activities Undertaken in Meghalaya

In the state of Meghalaya, two sessions of interaction with farmers were organized and several inputs like piglet (52 Nos.), mineral mixture (50 kg), pig feed (100 kg) and poultry birds (200 Nos.) were distributed among the farmers. Farmers were exposed to the knowledge of different facets of scientific dairy farming. A total of 170 farmers from Meghalaya were benefitted by these interventions.

Activities Undertaken in Tripura

One visit was organized in the state of Tripura during the year 2018-19. Scientists-farmers interaction sessions cum veterinary heath camp were organized during those visits. Several inputs like 30 black Bengal goats and 150

kg mineral mixture were distributed among 107 farmers. Apart from those programmes, regular SMS in Bengali language pertaining to various aspects of scientific dairy farming was sent to the registered farmers from Tripura.

Activities Undertaken in Sikkim

One visit to the state of Sikkim was organized in which two animal health camp cum scientists- farmers' interaction sessions were organized. Inputs like 2000 Day Old *Vanaraja* chicks, 1200 kg poultry starter feed and 200 kg mineral mixture were distributed among farmers. A total of 109 farmers were benefitted by the intervention provided by ERS of ICAR-NDRI.

Activities Undertaken in Mizoram

One camp was organized in Mizoram by collaborating with CAU, Aizwal. Several inputs like 350 kg pig feed, 900 kg poultry feed, 15 piglets and 1200 poultry birds were distributed among 150 farmers. Scientists-farmers interaction sessions cum veterinary heath camp were organized during these visits.

Activities Undertaken in Arunachal Pradesh

A team of scientists from ERS of ICAR-NDRI visited Namsai district of Arunachal Pradesh. One off-campus training programme on scientific management of pig was organized at Namsai KVK in Momomg, Arunachal Pradesh in which 35 trainees participated. The training programme was followed by inputs distribution camp in which 42 piglets (14 male and 28 female), mineral mixture and pig feed were distributed among 14 farmers.

Activities Undertaken in Nagaland

Two camps were organized in the villages in Nagaland. Several inputs like 95 piglets, veterinary medicines, 800 kg pig feed were distributed among 162 farmers. Scientists-farmers interaction sessions-cum-veterinary heath camp were organized during these visits.

KRISHI VIGYAN KENDRA (KVK)

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 poorest of the poor in the rural areas.

On Campus Training Programme (2018 to 2019)

Title of the course	Duration (days)	No. of courses	No. of beneficiaries
Dairy Production	5	48	2075
Dairy Processing	5	6	118
Dairy Production and Processing	5	6	109
Crop Production	1-4	5	116
Bee-keeping	4	3	80
Fish Farming	4	3	121
Home Science	1-12	7	191
Crop Residue Management	1-3	5	225
Skill Development training in vermicompost making	25	1	20
Sub-Total (a)		**84**	**3,055**
Short Visit cum Training Programmes (b)	**1-5**	**138**	**5,077**
Total (a+b)		**222**	**8,132**

State wise Beneficiaries of KVK Training Programmes

Sr No	State	No. of Beneficiaries
1	Haryana	1,801
2	Bihar	891
3	Jharkhand	111
4	Himachal Pradesh	75
5	Uttrakhand	60
6	Uttar Pradesh	53
7	Rajasthan	20
8	Madhya Pradesh	17
9	Delhi	11
10	Odisha	6
11	Assam	2
12	Maharashtra	2
13	Punjab	2
14	West Bengal	2
15	Andhra Pradesh	1
16	Kerala	1
	Total	**3055**

Category wise Beneficiaries of KVK Training Programmes

Category	No. of Trainees	Percentage
Practicing farmers/farm-women (49)	1401	45.86
Rural youth (34)	1641	53.72
Extension functionaries (1)	13	0.42
Total (84)	**3055**	**100.00**

Gender wise Beneficiaries of KVK Training Programmes

Gender	Beneficiaries	Percentage
Male	2524	82.62
Female	531	17.38
Total	**3055**	**100.00**

Category wise Beneficiaries of KVK Training Programmes

Category	No. of Trainees	Percentage
Others	2599	85.07
S.C./S.T.	456	14.93
Total	**3055**	**100.00**

Skill Development Training Programmes

KVK organized training programmes on skill development in the field of vermicompost for 20 rural youth of Karnal district. The participants were evaluated for gain in skill by Agriculture Skill Council of India and successful participants would be awarded certificates by Govt of India.

Special Training Programmes on Crop Residue Management

KVK organized five training programmes for 225 rural youth and farmers of Karnal district on crop residue management. The farmers were sensitized on crop residue management using machineries and its benefits on the soil health and resource conservation.

Special Training Programme alongwith Nehru Yuva Kendra

A special training programme on youth leadership & community development was organized by KVK alongwith Nehru Yuva Kendra Karnal from 18th to 20th March 2019. The programme was attended by 39 youth from Karnal district. They were imparted knowledge on the latest scientific practices in agriculture and allied activities so as to use them for community development.

Off Campus Training Programmes

KVK organized the following training programmes in Kachhwa, Kulwehri, Kaimla, Unispur, Nasirpur, Kutail, Kunjpura, Dabri, Daha Jagir, Nalbikhurd, Sambhali, Badarpur, Chiraon, Rindal, Badagaon, Bansa, Ratak (Assandh), Gharaunda, Indri villages of Karnal district.

Off Campus Training Programmes (2018-19)

Title of the Course	Duration (Days)	No. of Courses	No. of Beneficiaries
Dairy Processing	1	2	61
Dairy Production	1	2	19
Crop Production	1	19	382
Vermiculture	1	3	44
Home Science	1-3	8	208
Crop Residue Management	1	19	1667
Total		**53**	**2381**

Field Visits

KVK organized 23 field visits on the Front Line Demonstration plots laid down under various schemes during the year 2018-19 in different villages of Karnal district to create awareness about new varieties and to encourage them to grow oilseeds and pulses apart from preparation of silage in the farmers' fields. The detail of the field days organized by KVK during the year 2018 is given in the following table.

Field Days/Visits by KVK during 2018-19

Sl. No	Date	Village	Topic/Crop	No. of Participants
1.	05.04.2018	Badarpur, Khera	Gram	24
2.	06.04.2018	Kalampura	Gram	12
3.	01.05.2018	Kulwehri, Kachhawa	Moong, Silage	20
4.	02.05.2018	Kulwehri	Moong	68
5.	04.06.2018	Kaimla	Moong	12
6.	07.06.2018	Kulwehri, Nabipur and Kunjpura	Moong	14
7.	21.06.2018	Unispur	Moong	16
8.	21.06.2018	Kulwehri and Nasirpur	Moong, Sorghum	15
9.	03.07.2018	Kulwehri	Moong	15
10.	19.07.2018	Tarori	Sorghum	12
11.	21.07.2018	Dahajagir	Sorghum	12
12.	24.08.2018	Kutail	Paddy	11
13	25.08.2018	Kulwehri and Kunjpura	Paddy	14
14.	11.12.2018	Kulwehri	Mustard, Wheat	14
15.	21.12.2018	Dabri	Mustard, Wheat	14
16.	03.01.2019	Kulwehri	Mustard, Wheat	12
17.	07.01.2019	Nalbikhurd	Mustard	9
18.	29.01.2019	Kulwehri, Kunjpura	Mustard, Wheat	11
19.	30.01.2019	Nalbikhurd, Nasirpur	Mustard, Gram	16
20	08.03.2019	Mainmati, Mughal Majra	Mustard	8
21.	22.03.2019	Sambhli	Mutard, Gram	13
22.	28.03.2019	Unispur	Gram	12
23.	29.03.2019	Badarpur, Kalsora, Rindal, Gheer, Shahpur	Gram, Mustard	11

Exposure Visits cum Short Training Programmes Organized

KVK, being located in National Institute in Dairying and having live demonstration units attracts the attention of various State governments, NABARD and NGOs, which send various groups of farmers, farm women and youth on exposure and study visits to KVK. In total 138 visits were organized in which 5077 number of farmers and farm women participated from Haryana, Himachal Pradesh, Uttar Pradesh, Chattisgarh, Punjab, Gujarat, Jammu & Kashmir, Uttrakhand, Rajasthan, Madhya Pradesh, Kerala, Maharashtra, Tamil Nadu and Nepal.

Front Line Demonstrations on Oilseeds, Pulses, Cereals and Fodder

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

To popularize the latest released varieties of various crops and to promote crop diversification, during Rabi, Summer and Kharif seasons, the following demonstrations were organized by KVK in various villages of Karnal district.

Results of FLD 2018-19

Sl. No	Crop		Variety	Total No of Demo.	Area (ha.)	Av. Yield (q/ha)	BC Ratio
1.	Pulses	Gram	HC-5	59	20.00	18.22	1:2.82
		Summer Moong	MH 421	51	20.00	4.80	1:1.62
2.	Oilseed	Mustard	CS-58	38	15.00	21.50	1:3.84
			CS-56	38	15.00	19.21	1:3.43
3.	Fodder	Sorghum	PSC-4	20	5.00	735.00	1:3.23
4.	Cereal	Wheat	WB-2	4	1.62	59.28	1:3.25
			DBW-88	4	1.62	62.36	1:3.42
			PBW-723	1	0.40	62.24	1:3.41
			HD-2967	2	0.40	56.81	1:3.11
	Total			**217**	**79.00**		

Performance of Crop Demonstration Unit

This KVK maintains live demonstration units in fish farming, bee keeping, vermiculture, horticulture and crop production for imparting practical training for skill development, demonstration of technologies and production of quality seed material of latest varieties for sale to farmers. The produce from these units particularly seed is being sold through ATIC to farmers. The performance of instructional farm (Crops production) including seed production during the year 2018 is given in the following table.

Seed Produced at Crops Production Unit

Name of the Crop	Date of Sowing	Date of Harvest	Area (acre)	Details of Production		
				Variety	Type of Produce	Qty (Qtl.)
Seed						
Cereal (Wheat)	Nov, 2017	April, 2018	19.60	HD-2967	Seed	320.00
Paddy	June, 2018	Oct, 2018		PB-1504	Seed	143.50
	June, 2018	Oct, 2018		PR-114	Seed	63.10
Fodder Berseem Mustard	Nov, 2017 Oct, 2018	May, 2018 March, 2019	11.50 2.40	BL-42 Chinese Cabbage	Seed Seed	21.38 3.50 (approx)

Seed Production at Live Demonstration Units and Sale

Seed Sold during 2018-19

Sr. No	Crop/Fish	Variety	Quantity	No of farmers
1.	Paddy seed (produced in Kharif 2017)	PUSA 44	50.10 qtl	29
		CSR 30	58.50 qtl	73
		PB 1121	67.60 qtl	169
		PB 1509	59.00 qtl	119
2.	Wheat seed (produced in Rabi 2017)	HD-2967	320.00 qtl	113
3.	Berseem seed (produced in Rabi 2017)	BL 42	11.58 qtl (9.80 qtls available with KVK)	102
4.	Mustard (produced in Rabi 2017)	Chinese Cabbage	1.80 qtl (2.04 qtls available with KVK)	77
5.	Fish seed (fry size)	Rohu, Katla & Mrigul	2,80,000 No	6
6.	Fish Yearlings	-do-	3,000 No	1

Field Extension Activities

- KVK celebrated Kisan Kalyan Divas as per directions from ICAR in village Kulwehri on May 2, 2018 in which more than 65 farmers participated. The subject matter specialists of KVK delivered lectures on scientific techniques in agriculture and dairy farming.
- A workshop was organized on May 9, 2018 for farmers on oil and lubricant conservation in collaboration with Petroleum Conservation & Research Association (PCRA), Ministry of Petroleum, Delhi and was attended by more than 80 farmer's from different villages of Karnal district. In the workshop, experts delivered lectures on methods and practices for saving different forms of energy while using agriculture machinery resulting into enhancement of income.
- KVK arranged web telecast of Prime Minister with farmers on June 20, 2018 where more than 150 farmers participated. Also another web cast was also arranged with the members of Self Help Groups on July 12, 2018 in NDRI, where about 50 women participated.
- KVK celebrated the World Breast Feeding week in village Rindal on August 7, 2018 to educate women about importance of breast feeding to new born and infants and its effect on their health. The programme was attended by 50 women.
- KVK celebrated Kisan Mahila Divas on October 15, 2018 where 95 women from six villages Nabipur, Padhana, Rindal, Gir,, Charao and Barota participated. The theme of the Mahila Divas was "Kheto Ki Parali Khet Mein". The women were educated to impress upon male members of the farming community not to burn paddy straw and mix it in the fields using machines available in the market for the purpose to improve soil health. Dr. Latha Sabikhi, Head DT Division was the Chief Guest of the function.
- One day training programmes were organized on milk processing for ladies of Karnal district on November 1, 2018 and Sonipat district on November 14, 2018 under the ongoing DST Research Project on improving livelihood of rural women through dairy based secondary agriculture being run by Dairy Extension Division of NDRI, Karnal.
- KVK conducted a training programme for 12 students under Village Adoption Programme of NIFTEM in different villages of Karnal district. The students were made to interact with ex-trainees of KVK to motivate them to start their own enterprise. Students were able to assess the knowledge and requirement of the trainees. The programme was organized from November 26 to December 3, 2018.
- KVK organized "Soil Health Day" on December 5, 2018 in which more than 90 farmers and farm women from different villages of Karnal district and other states participated. In the programme, the farmers were educated about importance of assessing the soil health and linking it with productivity. Dr. R. R. B. Singh, Director NDRI Karnal was the Chief Guest of the function. The farmers who had done excellent work in conservation of soil health were honoured in the function by Chief Guest.
- KVK celebrated Kisan Divas on December 23, 2018 during the Swachhta Pakhwara (December 16-31, 2018) as per the programme decided by Institute. About 30 farmers from Karnal district and other states attended the programme.

» To expose the farmers to the latest developments in agriculture and allied fields, KVK arranged an exposure visit of 50 progressive farmers from Karnal district to Krishi Unnati Mela at ICAR-IARI New Delhi on March 6, 2018.

» KVK in its training programmes arranged for a lecture from Ministry of Petroleum, Petroleum Conservation & Research Association (PCRA) to educate farmers, rural youth and farm women on methods and practices to be followed for saving of oil and petroleum. So far 12 such programmes have been organized.

» Scientific Advisory Committee was held on January 29, 2019 under the Chairmanship of Dr. R. R. B. Singh, Director, NDRI, Karnal to review the progress of KVK during the year 2018 and action plan for the year 2019.

» KVK arranged Direct telecast of Hon'ble Prime Minister for farmers and farm women on February 24, 2019 launching of Prime Minister-Kisan Scheme (Pradhan Mantri Samman Nidhi). Dr Shiv Kumar Kimothi, ADG (TC), ICAR and ADC and Director NDRI attended the function. A total of 70 farm women participated in this programme on International Women Day.

Implementation of Project: Promotion of Agricultural Mechanization for In-situ Management of Crop Residue in the States of NCT Delhi and Haryana

KVK carried out following activities under the project:

» KVK procured the machines and used them for on farmers' fields for demonstration on In-situ management of paddy straw in the farmers' fields.

» Sowing of wheat was demonstrated in three adopted villages Dabri, Kunjpura and Kulwehri of Karnal district with the help of happy seeder and zero tillage to check the stubble burning.

» KVK demonstrated sowing of wheat in 112 acres area with the help of happy seeder and 204 acres area with zero tillage

» Subject matter specialists from KVK visited the demonstration plots in three adopted villages where sowing was done with the machines, happy seeder and zero tillage provided by KVK, to monitor the growth of crop and clear the doubts of farmers. During the year 2018-19, KVK organized 12 visits in villages.

» KVK created attractive jingles to be aired on FM radio for more than four months to sensitize on crop residue burning and to send the message to reach the maximum farmers.

» KVK organized three training programmes, of three days duration each, on "Agricultural Mechanization for *in-situ* Management of Crop Residue" to educate on farmers, from all the three adopted villages under the project, on ill effects of crop residue burning in the fields i.e. how it affects not only the soil health but also the environment. Farmers were given demonstrations on use of various machines like mulcher, reversible MB plough and shrub master for residue management in the fields and sowing of wheat with the machines like zero tillage and happy seeder in the fields where paddy straw has been managed in the fields itself. The farmers who had already adopted the soil conservation practices also shared their experiences with the farmers during the training programmes. Experts from CSSRI and CCS Haryana Agricultural University also delivered lectures to the farmers.

» KVK organized 16 awareness camps and kisan goshthies to sensitize 1556 farmers on burning of crop residue in the fields and use of machines to manage paddy residue in the fields itself and sowing of wheat.

Mobilization of School Students

The students of government schools of different villages of Karnal district were roped in to convey the message on crop residue burning in their respective villages. Students, along with the staff of KVK, took out 4 *prabhat pheris* in their villages with placards and banners in their hands. Students were given lectures on ill effects of crop residue burning by experts and were also encouraged to dissuade their farmer parents, neighbourers and relatives from burning of paddy residue in their fields. Drawing competition was also arranged on crop residue burning in a government school in Gharounda village of Karnal and best paintings were awarded. The detail of activity is given in following table.

Mobilization of School Students

S. No.	Name of activity	Date	Place of activity (Village)	No. of students participated
1.	Prabhat Pheri	08.10.2018	Dabri	115
2.	Prabhat Pheri	06.10.2018	Kunjpura	120
3.	Prabhat Pheri	28.08.2018	Kulwehri	95
4	Prabhat Pheri	13.11.2018	Nilokheri	130
5.	Drawing Competition	31.12.2018	Gharounda	56

Kisan Mela on Crop Residue Mangement

KVK organized Kisan Mela on December 28, 2019 to demonstrate various agriculture implements for in-situ management of paddy straw in the fields and also the latest techniques developed by various research Institutions in Karnal,. The mela was visited by about 500 farmers. The experts on crop residue management delivered the lectures to the farmers to highlight the importance of in-situ management of crop residue in the fields. The mela was inaugurated by Dr. Rajbir Singh, Director ICAR-ATARI Zone I Ludhiana, and Dr. R. R. B. Singh Director NDRI Karnal presided over the function. The farmers, who have done excellent work in in-Situ management of crop residue, were honored in the Mela by the Chief Guest.

Farmers Scientists Interface

KVK organized a Farmers Scientist Interface on November 16, 2018 to highlight the importance of in-situ management of crop residues. It was attended by 90 farmers from Karnal district. The experts in crop residue management delivered lectures to the farmers and clarified the doubts of the farmers related to crop residue burning.

Publicity on Crop Residue Management

KVK developed pamphlets and folders on in-situ crop residue management for distribution among farmers in villages and to those coming to KVK to attend various training programmes. KVK also created slogans to discourage farmers from paddy straw burning and encourage them for in-situ crop residue management using happy seeder, zero tillage and MB plough. Wall paintings were done in three adopted villages namely Kunjpura, Dabri, Kulwehri for wide publicity of crop residue management. Hoardings and banners, conveying the message on in-situ crop residue management were placed at prominent places for maximum outreach among farmers in the district.

Exhibitions

KVK regularly participated in field activities of other line departments by putting up stalls to showcase its activities and addressed to the queries of farmers and other visitors on dairying, milk processing, vermiculture, bee keeping, and fisheries. KVK put up an exhibition on crop residue management in IIWBR Karnal on Seed day on October 15, 2018, and December 28, 2018 on the eve of Kisan Mela in KVK NDRI Karnal.

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

Agricultural Technology Information Centre at NDRI Karnal became operational in November 2004. This centre is engaged in disseminating information on dairying and allied agricultural fields. Besides NDRI, relevant information available from other research stations of ICAR and state institutions located at Karnal are utilized by this centre for the farmers and other stakeholders visiting this centre. A large number of entrepreneurs, practicing farmers, extension workers and students avail the facilities of ATIC together with latest information related to dairying and allied fields.

Mandate

- To provide a single window delivery system for agricultural information as well as products and technologies developed by the research institute with a view to deliver quality services to the clientele.
- To strengthen the farm advisory services by adopting a multi disciplinary approach to problem solving.
- To provide mechanism for feedback from the end users to the research system.
- To function as a repository of agricultural information pertaining to farming skills and practices, farm inputs and agricultural education.
- To offer consultancy services to the different stakeholders in the state.
- To arrange training to unemployed youth to equip them to become job providers, rather than job seekers.

Dissemination of Technological Information

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

- Personal interaction with visiting farmers.
- Display of Models etc; organizing /participating in Melas and Exhibitions.
- Audio/Video shows
- Visits to Dairy farm

- Information through toll free telephone number (1800-180-1199)
- Providing Publications.
- Providing material inputs like improved seed varieties, Vermi compost etc.
- Through e-mail

Services Rendered in Agricultural Technology and Technology Products

Sr. No.	Detail of services	No. of Services	No. of Persons
1.	Dairy/Agriculture Related Information through Video Shows and Lectures	62	1905
2.	Personal Discussion with Subject-Matter-Specialists on Dairy Farming	20	52
3.	Information through Dairy/Agriculture Literature	85	85
4.	Information on Agriculture (Seed/Fertilizer/ Compost etc)	1871	1871
5.	Information through Telephone (Toll-free) on Agriculture & Dairying etc.	1510	1510
6.	Information through e-mail on Agriculture and Dairying etc.	174	174
	Total	**3722**	**5597**

Training Conducted

Two training courses on Integrated Farmer System and Management of Dairy Animals were conducted for Holistic Rural Development Program. Total 64 farm women from Alwar district of Rajasthan were participated in the programme.

Krishi and Dairy Vikash Kendra (KDVK), Piprakothi

ICAR-NDRI established KDVK in KVK, Piprakothi, East Champaran, Bihar in the premises of Dr. Rajendra Prasad Central Agriculture University, Pusa. The centre was established on July 10, 2016. A total of 2800 semen doses were supplied to farmers during the year (2018).

Training Programmes organised at (KDVK) in KVK, Piprakothi (January, 2018 to December, 2018)

Sl. No.	Date	Topic	Duration (Days)	Participant
1.	March 30, 2018	AI refresher course	(1 day)	15
2.	May 3 – 5, 2018	Dairy production and management	(3 days)	80
3.	July 23 – 31, 2018	Poultry production and management with KVK	(10 days)	25
4.	July 25 – 27, 2018	Management of dairy animal for better milk production with KVK	(3 days)	30
5.	August 30 to September 1, 2018	Commercial dairy farming and reproduction management	(3 days)	62
6.	September 5 – 17, 2018	Poultry production and management with KVK	(12 days)	33
7.	November 21_27, 2018	Goat production and management with KVK	(7 days)	30
		Total		**275**

Other Extension Activities

- A certificate course was conducted on A.I. and Veterinary first Aid for 10 AI workers working in Motihari district at Eastern Regional Campus, Kalyani from June 5 to July 6, 2018.
- Fodder Nursery of different varieties of hybrid Napier was established in the KDVK for demonstration and supply of saplings to the farmers.
- Animal camp organized by ATMA on May 5, 2018 and medicines from the NDRI-Piprakothi Centre were supplied for the treatment of animals.
- Seven Scientists with Director, NDRI, Karnal participated in Pashudhan Arogya Mela, Motihari, from December 23-25, 2018.
- Eight Scientists with Director, NDRI, Karnal participated in State Agricultural Fair at Zila School Maidan, Motihari, East Champaran, Bihar during April 13-15, 2018.
- An exhibition stall was also arranged for the farmers and extension literature was also distributed to the farmers.

WOMEN EMPOWERMENT AND MAINSTREAMING OF GENDER ISSUES

DAIRY EXTENSION

International Women's Day

International Women's Day was celebrated on March 8, 2019 at Dilwara village. Farm women showed keenness in understanding the scientific practices, which could help them increase the milk yield. They also showed interest in value addition of milk and milk products.

Improving Livelihood of Rural Women through Dairy Based Secondary Agriculture

Five villages of Karnal district, two villages of Panipat and two villages of Sonepat were selected to promote women-led entrepreneurship through preparation of value added dairy products. Farmwomen groups comprising 6 to 10 members were formed in each of the villages. Thirty one trainings were organized for 460 rural women from selected villages and trained on value added dairy products. Market survey was conducted in Karnal and Panipat urban areas in addition to assessing the feasibility of promoting products in canteens of schools, colleges and restaurants. Forty demonstrations were organized to build their capacity on value added dairy products at Women Empowerment lab, KVK, Dairy Technology Division and selected villages. Initial rapport building and gender sensitization trainings were completed. KVKs and NGOs in all three districts were mobilised to facilitate the group dynamics in the villages. The partnership with Haryana State Rural Livelihood Mission (HSRLM) could help in quicker facilitation of entrepreneurial ventures apart from strategic support from Sarva Haryana Grameen Bank, NABARD, NGOs, KVKs and social entrepreneurs.

Ten on-campus Women empowerment training programmes and demonstrations were organized with the objective to create awareness in the field of dairying and to impart skills in these areas so that farmwomen could generate more income from dairying and maintain a healthy environment in their respective families. A total of 115 farmwomen were trained in these programmes. The details are given below:

Training Programmes Organized for Women

S.N.	Name of Training Programme	No. of Trainings	Participants
1	Demonstration cum training programme on Value Added Milk Products For Rural Women for trainees of International Training Programme on Management of Dairy Cooperatives.	1	22
2	Training programme on Improving Livelihood of Rural Women - Dairy Based Secondary Agriculture for Women Dairy Farmers of Taprana village, Karnal under DST project.	2	25
3	Training cum demonstration programme on Value Added Milk Products for Improving Livelihood of Rural Women - Dairy Based Secondary Agriculture for Women Dairy Farmers under DST project.	1	15
4	Demonstration cum practical class on Value Added Indigenous Milk Products for rural woman.	1	12
5	Training programme on Value Added Milk Products under DST Project.	2	10
6	Exposure cum skill upgradation training programme on Preparation of Value Added Milk Products for farmwomen of Farmers' school participants.	2	19
7	Demonstration cum training programme on Preparation of Value Added Dairy Products at small scale for women dairy farmers of adopted villages.	1	12
	Total	**10**	**115**

» **World Breast Feeding Week** was celebrated in village Rindal on August 7, 2018 to educate women about importance of breast feeding to new born and infants and its effect on their health. The programme was attended by 50 women.

» **Kisan Mahila Divas** was celebrated on October 15, 2018 for 95 women from six villages Nabipur, Padhana, Rindal, Gir,, Charao and Barota. Awareness was created among the women to impress upon male members of the farming families not to burn paddy straw and mix it in the fields using machines available in the market for the purpose to improve soil health. Dr. Latha Sabikhi, Head Dairy Technology Division was the Chief Guest of the function.

» Two training programmes were organized on Milk Processing for ladies of Karnal district on November 1, 2018 and Sonepat district on November 14, 2018 for improving livelihood of rural women through dairy based secondary agriculture.

» A training programme was organized by Dairy Technology Division, NDRI Karnal for women entrepreneurs from Sonepat district on milk and milk products processing (*dahi, paneer, ghee).*

» Under Farmers' FIRST Project, two women SHGs were trained on various aspects of Improved Dairy Farming Practices. The identified SHG beneficiaries were apprised of improved green fodder production through supply of Fodder mini-kits, clean milk production practices through supply of Hand Operated Milking Machine and Pressure Washing Unit for cleaning the cattle and it premises. The Institute interventions included clean milk production campaign, demonstration of machine milking, interactive sessions with women self-help groups to address their farm-related problems, dairy cattle health and infertility camps, awareness campaigns and demonstration of CMT kits for mastitis management. The objective was to improve the milk production and hence, increase the income of women SHG members. An awareness campaign was organized on **Mahila Kisan Diwas** in village Balepura, for the members of women Self-Help Groups on October 15, 2018, on the occasion of Rashtriya Mahila Kisan Divas. A sensitization session on quality milk production and expert talk on dairy animal health care management was conducted.

HONOURS AND AWARDS

National/ICAR Awards

» ICAR-NDRI was **ranked first for the second time consecutively** among 72 Agricultural Universities of India including State Agricultural Universities, 4 Deemed Universities of ICAR and Central Universities with agriculture faculty. Dr R R B Singh, Director ICAR-NDRI Karnal received the award on July 16, 2018 from the Hon'ble Union Minister for Agriculture and Farmers Welfare during the 90th Foundation Day of ICAR received the award.

Dr R R B Singh, Director, ICAR-NDRI receiving the award from Sh. Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare

» **Dr. Sonika Ahlawat (**Guide: Dr. Sachinandan De, Principal Scientist, Animal Biotechnology Centre) received "**Jawaharlal Nehru Award"** for P. G. Outstanding Doctoral Thesis Research in Agricultural and Allied Sciences (2017) from Hon'ble Minister of Agriculture and Farmers' Welfare, Sh. Radha Mohan Singh on 90th Foundation Day & Award Ceremony of ICAR at NASC Complex, Pusa, New Delhi.

Dr. Sonika Ahlawat receiving Jawaharlal Nehru award from Sh. Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare

» **Dr. Ravi Kant,** Assistant Chief Technical Officer, Animal Biochemistry Division was awarded "**Best Employee Award"** under cash award scheme for technical category employee of ICAR on July 16, 2018 during 90th ICAR Foundation day at NASC Complex, Pusa, New Delhi.

Dr. Ravi Kant receiving award from Sh. Radha Mohan Singh, Hon'ble Union Minister of Agriculture and Farmers' Welfare

» **Ms. Parul**, M. Tech and **Mr. Akash Gill**, B. Tech students of ICAR-National Dairy Research Institute, Karnal secured the First Position in the National Dairy and Food Quiz Contest at Sheth M. C. College of Dairy Science, Anand Agricultural University (AAU), Anand, Gujarat on September7, 2018 amongst the 23 teams from various Dairy and Food Science Colleges and dairy industries throughout the country participated in this contest.

Dr. R. R. B. Singh, Director NDRI with the winning team

Fellowships and Associateship of National Academies/ Agricultural Societies

» **Dr. A. K. Tyagi**, Head, Animal Nutrition Division received **"Fellow of National Academy of Agricultural Sciences (India)"** from National Academy of Agricultural Sciences (India), NASC, DPS Marg, Pusa, New Delhi.

» **Dr Rakesh Kumar,** Principal Scientist, Forage Research & Management Centre was conferred "**Fellow of National Academy of Dairy Science"** (NADSI) held from 9th September 2018 at College of Dairy Technology, Sri Venkateshwara Veterinary University, Tirupati.

» **Dr. B. Surendra Nath,** Principal Scientist, Southern Regional Campus, Bengaluru was conferred with "**Indian Dairy Association Fellow"** for the year 2018 by Indian Dairy Association.

» **Dr. P. Heartwin Amaladhas**, Principal Scientist, Southern Regional Campus, Bengaluru was conferred with "**Fellow of National Academy of Dairy Science"** (NADSI) held from 9th September 2018 at College of Dairy Technology, Sri Venkateshwara Veterinary University, Tirupati.

» **Dr. Pawan Singh,** Principal Scientist, Livestock Production & Management received "**National Fellowship"** of ISAPM Society in ISAPM National Conference in January, 2019 held at Trissur (Kerala).

» **Dr. Pradip V. Behare**, Scientist (Sr. Scale), Dairy Microbiology Division was conferred NAAS Associateship on June 5, 2018 on the Foundation day ceremony of Academy.

» **Dr. Nishant Kumar** and **Dr. Rubina,** Scientists, Livestock Production & Management, **Dr. Pradip V. Behare**, Scientist (Sr. Scale), Dairy Microbiology Division, **Dr. Sachin Kumar**, Scientist, Animal Nutrition Division and **Dr. Narender Raju Panjagari,** Scientist, Dairy Technology Division received "**Associate Fellowship of the National Academy of Dairy Sciences, India (NADSI)"** on 9th September, 2018.

» ICAR-National Dairy Research Institute, Karnal received "**Best Exhibition Award"** in Krishak-Vgyanic Kayshala Evom Beej Diwas on October 15, 2018 at ICAR-Indian Institute of Wheat & Barley Research, Karnal.

Institute Awards

» **Dr. Narender Raju Panjagari,** Scientist, Dairy Technology Division received prestigious "**Best Teacher Award"** for the year 2018 at the 17th Convocation of ICAR NDRI Deemed University on March 23, 2019.

» **Best Division Award** 2017-18 was conferred on Southern Regional Station of ICAR-NDRI, Bengaluru for outstanding performance in Research and Education on March 23, 2019 during the 16th Convocation of ICAR-NDRI by Dr. T. Mahapatra Hon'ble Director General, ICAR & Secretary, DARE.

» **Dr. Yogesh Khetra,** Scientist, Dairy Technology Division, received "**International Travel Support"** from Department of Science and Technology for attending Cheese Symposium 2018 held at Rennes, France during April 4 -6, 2018

Professional Societies Awards

» **Dr. Pradip V. Behare,** Scientist (Sr. Scale), Dairy Microbiology Division received **"Young Scientist Award – 2017"** for his outstanding contribution in the field of Dairy Microbiology by Society for Upliftment of Rural Economy, Varnasi on November 1, 2018 during International Conference on Rural Livelihood Improvement for Enhancing Farmers Income through Sustainable Innovative Agri. and Allied Enterprises held at BIT, Patna.

» **Dr. Sanchita Garai**, Scientist, Dairy Extension Division conferred **"Young Scientist Award-2018"** by Indian Society of Extension Education during National Seminar held from December 5 -7, 2018 at Kolkata.

» **Dr. B. S. Meena,** Principal Scientist, Dairy Extension Division conferred **"SEE Fellow Award-2018"** by Society of Extension Education during 9th Extension Education Congress held from November 15 -17, 2018 at Gangatok.

» **Dr. A. K. Tyagi**, Head, Animal Nutrition Division received **"Vaisvik Industrial Research Award (Cash Prize 1.51 lakhs)"** from Vividhlaxi Audyogik Samshodhan Vikas Kendra, Mumbai.

» **Dr. A. K. Tyagi**, Head, Animal Nutrition Division received **"Fellow of Animal Nutrition Association (India)**" from Animal Nutrition Association (India) during 1[1th] Biennial Animal Nutrition Association Conference held from November 19-21, 2018 at Patna.

» **Dr. Writdhama Prasad** Scientist and **Dr. K. Khamrui,** Principal Scientist, Dairy Technology Division received "**Best Thesis (PhD) Award"** in processing group for the year 2017-18 by Society For Upliftment of Rural Economy (SURE) in International Conference on Rural Livelihood Improvement by Enhancing Farmers' income through sustainable Innovative Agri and Allied Enterprises (RLISAAe) held from October 30 to November 2, 2018 at BIT, Patna.

» **Dr. Satish Kumar,** Principal Scientist, Animal Biotechnology Centre received **"Middle Career Scientist Award"** by Indian Society of Sheep and Goat Production and Utilization (ISSGPU).

» **Mr. Rakesh Kumar Raman, Ms. Uma Karpurapu** and **Dr. Narender Raju Panjagari** Dairy Technology Division received "**All India 3rd Best Research Project Award"** under the Basic Sciences category along with a cash prize of Rs. 25,000/- at the National Students Research Convention (ANVESHAN-2019) held during March 12 -14, 2019 at Ganpat University, Mehsana, Gujarat and sponsored by the Association of Indian Universities, New Delhi.

» **Mr. Rakesh Kumar Raman, Ms. Uma Karpurapu,** and **Narender Raju Panjagari,** Dairy Technology Division received **"1st Best Research Project Award"** under the Basic Sciences category at the Students Research Convention (North Zone ANVESHAN-2019) and qualified for National event during February 27-28 2019 at National Institute of Food Technology, Entrepreneurship and Management (NIFTEM), Kundli and sponsored by the Association of Indian Universities, New Delhi.

» **Ms. Shabahat Mumtaz,** Animal Genetics & Breeding Division received "**Young Scientist Award"** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.

» **Mr. A. R. Paray, Dr. M. Bhakat, Mr. S. A. Lone, Dr. T. K. Mohanty, , Mr. H. P. Yadav, Mr. J. U. Rahman, Mr. Z. B. Khandday,** and **Mr. R. Sinha,** Artificial Breeding Research Centre received "**Young Scientist Award and Gold Medal (Oral Presentation)"** on Effect of Preputial Washing on Microbial Load of Preputial Cavity and Semen in Sahiwal Bulls from Zoological Society of India during National Seminar (Animal Science Congress: Horizons in Zoological Studies) held from August 4 - 6, 2018 at University of Kashmir, Srinagar.

» **Dr. Diwas Pradhan** Scientist, Dairy Microbiology Division received "**Dr. Rana Memorial Best Poster Award"** with a citation and cash prize (Rs. 4000/-) for the work on "Potent Reuterin Antimicrobial System Derived from

Isolated *L. reuteri* Strains Could Extend the Initial Raw Milk Quality under Ambient Farm Conditions" during 59th Annual Conference of Association of Microbiologists of India & International Symposium on Host-Pathogen Interactions on the theme "Microbial Diversity" held from December 9-12, 2018 at University of Hyderabad, at Hyderabad.

» **Dr Rakesh Kumar** Principal Scientist, Forage Research & Management Centre conferred **"Reviewer Excellence Award-2019"** by ARCC, Karnal.

» **Dr. Vikas Vohra,** Principal Scientist, Animal Genetics & Breeding Division and co-workers, received "**Prof. K. N. Sharma, Memorial Award"** for Best Paper of Journal of Livestock Biodiversity.

» **Dr. Rishika Vij.** got **Dr. P. K. Dwarikanath Memorial** Y**oung Scientist Award"** for the paper entitled "Bioavailable Bioactive Peptide Enables Bone Health and Ailment Recoveries through Osteoblast Interactive Pathways" in the 27th Annual Conference of Society of Animal Physiologists of India and National Symposium on Augmentation of Animal Productivity under Changing Socio-Economic Scenario held from November 27-28, 2018 at NDRI.

Awards Won by Students

» **Mr. Manpreet Singh** got the prestigious JENESYS fellowship (Japan-East Asia Network of Exchange for Students and Youths).

» **Ms. Mamta Joyaswal,** Ph.D. Scholar got PM Fellowship for her Ph.D. thesis work.

» **Mr. Mohd. Iqbal Bhat,** Ph.D. Scholar under the supervision of **Dr. Rajeev Kapila,** Principal Scientist was awarded "**Best Thesis Award"** in "Dairy Processing" during 16th convocation of ICAR-NDRI Deemed University on March 23, 2019.

» **Ms. Taruneet** got **"First Prize"** for her Ph.D. work entitled "Micro-RNAs as Potential Therapeutics in Osteoporosis" at all India level in **ANVESHAN**-Student Research Convention Launched by the Association of Indian Universities (AIU)

» **Mr. Suchandra Dutta** received **"Best M.Sc. Thesis Research Award"** (Social Science and Management Group) from ICAR-National Dairy Research Institute, Karnal for her M. Sc. Thesis Research entitled *"Adaptation Strategies to Climate Change followed by the Farming Community of the Indian Sunderbans".*

» **Mr. Mahesh Kumar G.** received **"Best Thesis Award (1st Place)"**, **Mr. F. Magdaline Eljeeva Emerald** received "**Best Thesis Award (2nd Place)"**, for Ph.D. while **Mr. Prateek Singh Panwar** received **"Best Thesis Award (1st Place)"**, **Mr. Suryawanshi Anup Arvind** received "**Best Thesis Award (2nd Place)"** and **Mr. Praveen Kumar, Y. S.** received "**Best Thesis Award (3rd Place)"** for M. Tech by Indian Dairy Engineering Association (IDEA) during the 11th National Convention and National Seminar at Indore, October 21 -22, 2018

Best Oral Presentation Awards

» **Dr. B. S. Meena**, Principal Scientist, Dairy Extension Division conferred "**Best Paper Presentation Award"** for paper entitled "Technological Change in Dairy Farming in Trans-Gangetic Plains and Its Effect on Employment Generation by Society of Extension Education during 9th Extension Education Congress held from November15-17, 2018 at Gangtok.

» **Dr. Sanjit Maiti,** Scientist, Dairy Extension Division conferred **"Best Paper Presentation Award"** by Indian Society of Extension Education during National Seminar held from December 5-7, 2018 at Kolkata.

» **Dr. Asif Mohammad, Dr. A. Chatterjee, Dr. C. Bhakat**, **Dr. S. Rai**, and **Dr. T. K. Dutta**, Eastern Regional Station, Kalyani got "**Best Paper Presentation Award"** for the paper entitled 'Analytical study on Resilience to Adverse Weather Events among Tribal and Non Tribal livestock Farmers: A Livelihood Security perspective' during International Conference on "Agriculture and Allied Sciences: The Productivity, Food Security and Ecology" held from August 13 - 14, 2018 at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal.

» **Mr. Bhagwat Sameer Kisan**, guided by **Dr. Sangita Ganguly** received "**Best Oral Presentation Award"** for paper entitled 'Milk Protein Matrix as Carrier of Probiotic Organism' in National Conference on 'Advances in Biopolymers' by Association of Food Scientists and Technologists, India (AFSTI), Srinagar chapter held from October 30-31, 2018.

» **Dr. K. Khamrui** and **Dr. Writdhama Prasad** Dairy Technology Division received "**Best Oral Presentation Award"** for the paper entitled "Development of Whey Protein Based Curcumin Encapsulate" presented at International Conference on Rural Livelihood Improvement by Enhancing Farmers' income through Sutainable Innovative Agriculture and Allied Enterprises (RLISAAe) held from October 30 to November 2, 2018 at BIT, Patna.

» **Ms. Swati Tiwari, Dr. Neelam Upadhyay, Dr. A. K. Singh** and **Dr. Bhavesh Baria,** Dairy Technology Division received "**Best Oral Presentation Award**" for the paper entitled "Green Biorefinery Approach: A Novel Way for the Extraction of Carotenoids from Carrot Bio-waste" presented at 50th Annual International Conference in

Food Science and Nutrition organised by Nutrition Society of India held from November 15 -17, 2018 at ICMR-National Institute of Nutrition, Hyderabad.

Ms. Swati Tiwari receiving award

- **Dr. Nishant Kumar,** Scientist, Livestock Production & Management Section received "**Best Oral Presentation Award"** for the paper entitled "Effect of Betaine Supplementation on Reproductive Performance of Karan Fries Cows during Heat Stress Condition" during International conference on Rural Livelihood Improvement by Enhancing farmer's Income through Sustainable Innovative Agri and Allied Enterprises (RLISAAe) organized from October 30 to November 1 2018 at BIT, Patna.
- **Dr. Rubina,** Scientist, Livestock Production & Management Section received "**Best Oral Presentation Award"** in Annual Conference of Society of Animal Physiologists of India held on November 27 - 28, 2018 at ICAR-National Dairy Research Institute, Karnal.
- **Mr. Ankush Shinde, Dr. Ganga Sahay Meena, Dr. Sanket Board, Ms Jyoti Handge, Mr. Minanath Giri** and **Dr. Ashish Kumar Singh** Dairy Technology Division received **"Best Oral Presentation Award"** for the paper entitled "Effect of Sodium Tripolyphosphate and Sodium Hexametaphosphate on Quality Properties of Buffalo Milk Protein Concentrate 60" during 11th National Convention and Seminar on "Dairy Process Engineering from Farm to Table" organized at Indore from October 21-22, 2018.
- **Dr. Sangita Ganguly,** Scientist and **Dr. Latha Sabikhi,** Head, Dairy Technology Division received "**Best Oral Presentation Award**" for the paper entitled "Efficacy of Probiotic Whey-cereal based Beverage in Shigella - Induced Pathogenicity" at SERB (DST, Govt. of India) sponsored by National Seminar on Emerging Role for Probiotics in Cognition, Autoimmunity and Metabolic Disorder held at April 13, 2018, Guntur.
- **Mr. A. Das, Mr. T. Tyagi, Dr. A. K. Singh, Dr. S. Borad,** and **Dr. H. Sharma,** Dairy Technology Division received "**Best Oral Presentation Award"** for the paper entitled "Technological Interventions for the Development of Value Added Fermented Goat Milk Products" presented in Asian Regional Conference on Goats' organised at Amity University, Jaipur from October 22-26, 2018.
- **Dr. K. Ponnusamy,** Principal Scientist, Dairy Extension Division received **"Best Oral Presentation Award"** at the National Conference on Revisiting Agricultural Research and Monitoring System for Developing Innovations: To Meet the Newer Challenges organised by ICAR and ARSSF from November 24-25 , 2018 at CIWA, Bhubaneswar.
- **Dr. H. R. Meena,** Scientist, Dairy Extension Division received **"Best Oral Presentation Award"** for the paper entitled "Automation in Commercial Dairy Farm for Precision Dairy Management" by Society of Extension Education during 9th Extension Education Congress held from November 15 -17, 2018 at Gangatok.
- **Mr. Mohd. Iqbal Bhat,** Ph.D. Scholar working under the supervision of **Dr. Rajeev Kapila,** Principal Scientist received "**Best Oral Presentation Award"** presented at National Seminar on "Fermented Dairy Foods and Their Health Benefits" organized by Swedish South Asian Network on Fermented Foods in association with NADSI and ICAR-NDRI, Karnal during May 26 -27, 2018.
- **Dr. Vikas Vohra,** Principal Scientist, Animal Genetics & Breeding Division and co-workers, received "**Best Oral Presentation Award"** during International Seminar on Recent Trends and Experimental Approaches in Science, Technology, Nature and Management (Society for Science and Nature) held from December 23 -24, 2018 at FDDI, Jodhpur.
- **Dr. Vikas Vohra,** Principal Scientist, Animal Genetics & Breeding Division and co-workers, received "**Best Oral Presentation Award"** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.

- **Mr. A. R. Paray, Dr. M. Bhakat, Dr. T. K. Mohanty** and **Mr. S. A. Lone,** Student, Artificial Breeding Research Centre got **"Best Oral Presentation Award"** presented at National Seminar on Smart Technologies to Boost Farm Profitability and Socio Economic Status of Rural India organized by RASSA, New Delhi and SKUAST of Jammu on November19-20, 2018 for the paper on Quality assessment of frozen-thawed low sperm doses of high fertile Sahiwal bulls using advanced *in-vitro* sperm function tests.
- **Ms. Rita, Dr. Bimlesh Mann, Dr. Rajan Sharma, Dr. Rajesh Bajaj,** and **Mr. Saurabh Gosewade,** Dairy Chemistry Division received **"Best Oral Presentation Award"** for the presentation entitled "Characterization of Bioactive Peptide in Sodium Substituted Cheddar Cheese during Storage" presented in the National Conference on "SLIETCON-2019 held from March 1 -2, 2019 at Chandigarh.
- **Mr. Ajay Kumar, Dr. Shaik Abdul Hussain, and Dr. P. N. Raju,** received **"1st Best Oral Presentation Award"** for the paper entitled "Shelf-life Extension of Aloe Vera Supplemented Probiotic Lassi using Non-thermal Interventions" presented at National Seminar on Fermented Dairy Foods and their Health Benefits organized by Swedish South Asian Network on Fermented Foods (SASNET-FF) in Association with NADSI National Academy Dairy Science (India) and ICAR-National Dairy Research Institute, Karnal, at ICAR-NDRI, Karnal, from May 26-27, 2018.
- **Ms. Neha Chaudhary, Dr. Latha Sabikhi, Dr. Shaik Abdul Hussain, Dr. Sathish Kumar, M. H.** and **Dr. Suman Kapila,** received "**Best Oral Presentation Award"** for the paper entitled "Preparation of *Emblica officinalis* (Amla) Encapsulated Stable W/O/W Double Emulsion and its Controlled Release Study" presented at International Conference on "Rural livelihood improvement for enhancing farmers income through sustainable innovative agri and allied enterprises (RLISAAe)" held at BIT, Patna, Bihar from October 30 to November1, 2018.
- **Dr. Sachin Kumar**, Scientist, Animal Nutrition Division received **"1st Oral Presentation Award"** during 11th Biennial Animal Nutrition Association Conference held from November 19-21, 2018 at Patna.
- **Dr. Abhisek Kumar Singh, Dr. Neelam Kewalramani, Dr. Veena Mani** and **Mr. Ravi Prakash Pal,** Animal Nutrition Division got **"Secured 1st Position"** for the paper presented on "Effect of Boron Supplementation on Plasma Mineral Status in Growing Cross Bred Calves and During International Conference, WRIAST-2018.
- **Er. Ankit Deep, Dr. P. Barnwal, Mr. P. Bhagat, Dr. S. De, Dr. P. Behare** and **Mr. B. Rajunaik,** received **"First Prize"** for oral presentation on Design and Performance Evaluation of CIP System for Three Stage Scrapped Surface Heat Exchanger during 11thNational Convention & Seminar of Indian Dairy Engineers Association on Dairy Process Engineering from Farm to Table held during October21-22, 2018 at Labh Ganga Convention centre, Bhopal Bypass, Indore (Madhya Pradesh).
- **Mr. Shubham Thakare, Dr. Chitranayak,** , **Mr. J. K. Dabas, Mr. Amita D. Vairat, Ms. Khushbu Kumari, Mr. Pavan Kumar** and **Er. Ankit Deep**, Dairy Engineering Division received **"Second Prize"** for oral presentation on "Engineering Interventions in Refrigeration System for Milk Cooling Applications" during 11th National Convention & Seminar of Indian Dairy Engineers Association (IDEA) on Dairy Process Engineering from Farm to Table held from October 21-22, 2018 at Labh Ganga Convention centre, Bhopal Bypass, Indore (Madhya Pradesh).
- **Dr. Ajoy Mandal, Dr. R. Behera, Dr. Champak Bhakat, Dr. M. Karunakaran,** and **Dr. M. K. Ghosh** were awarded **"Second Prize"** for oral presentation on topic entitled "Environmental Factors Affecting Lactation Persistency in Crossbred Cattle" during International Conference on Agriculture and Allied Sciences: The Productivity, Food Security and Ecology held from August 13-14, 2018 at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal.
- **Dr. Asit Das**, Principal Scientist, Animal Nutrition Division **"2nd Oral Presentation Award"** during 11th Biennial Animal Nutrition Association Conference held from November 19-21, 2018 at Patna.
- **Dr. S. Mondal, Dr. M. Bhakat, Mr. A. Singh,** , **Dr. T. K. Mohanty, Mr. M. Abdullah,** and **Mr. S. K. Yadav,** Artificial Breeding Research Centre got **"2nd Best Oral Presentation Award"** for the paper entitled "Libido Problem is Untraceable through Testosterone and LH Rhythm in Zebu Breeding Bulls presented at 19th Indian Veterinary Congress and 26th Annual Conference of IAAVR and National Symposium on Innovative Progress in Animal Health and Production for Safe and Secured Food Under one Health Perspective held from February1-2, 2019 at WBUAFS, Kolkata, WB.
- **Dr. Sachin Kumar**, Scientist, Animal Nutrition Division received **"3rd Oral Presentation Award"** during Asian Regional Conference on Goats held from October 22-26, 2018 at Jaipur.
- **Mr. Digvijay Singh, Dr. Chander Datt, Mr. Akash Mishra, Mr. S. H. Mir, Ms. Vandana Kumari, Mr. Anchal Keshari** and **Mr. Tariq A. Malik,** Animal Nutrition Division got "**Third Prize Oral Presentation"** for the paper entitled "Effect of Dietary Vanadium Supplementation on Plasma Mineral Levels and their Balance in Male Sahiwal Calves during International Conference on Worldwide Research Initiatives for Agriculture Science & Technology organized by National Agriculture Development Co-operative Ltd. held from October 24 -26, 2018 at University of Kashmir, Hazarbal, Srinagar.
- **Dr. Sangita Ganguly,** Scientist and **Dr. Latha Sabikhi,** Head, Dairy Technology Division received "**Appreciation Certificate"** for Oral Presentation at National Seminar on Fermented Foods and their Health Benefits held from 26th - 27th May, 2018 at Karnal.

Best Paper/Poster Awards

» **Dr. M. L Kamboj, Mr. Pranay Bharti, Mr. P. K. Singh, Ms. Mayamitta Saini** and **Dr. Sanjay Choudhary** received the "**Best Research Paper Award"** on their paper entitled, "Effect of Natural Suckling and Weaning on the Growth, Health and Behaviour of Murrah Buffaloes and Sahiwal Cow Calves" during Animal Welfare and Behaviour Session of the National Conference on "Innovation in Animal Production for Sustainability and Doubling Farmer's Income" organised by Indian Society for Animal Production Management at College of Veterinary and Animal Sciences, Munnuthy, Trissur, Kerela from January 23 -25, 2019.

» **Mr. A. Fahim**, **Dr. M. L Kamboj, Mr. S. Prasad, Mr. A. S. Sirohi** and **Mr. R. Bhaka,t** Livestock Production & Management Section received "**Best Research Paper Award"** for their paper entitled, "Preference of Side and Standing in Relationship with Milking Characteristics and Temperament Score of Crossbred Dairy Cows Milked in Herringbone Milking Parlour" during National Conference on "Innovation in Animal Production for Sustainability and Doubling Farmer's Income" organised by Indian Society for Animal Production Management at College of Veterinary and Animal Sciences, Munnuthy, Trissur, Kerela from January 23 -25, 2019.

» **Ms. Rajshree Rath, Dr. Pawan Singh, Dr. M. L. Kamboj, Dr. S. S. Lathwal, Dr. T. K. Mohanty** and **Ms. Himani Tiwari**, Livestock Production & Management Section were awarded the "**Best Research Paper Award"** for their paper, "Assessing Cognitive Performance of Murrah Buffalo Calves in a Visual Discrimination Task" by Commonwealth Veterinary Association during 7th Pan Commonwealth Veterinary Conference entitled "The Role of Veterinarians in Addressing the Global Challenges to the Lives of our Pets, Livestock, Wildlife, Humans, and our Environment" held at National Institute of Animal Nutrition and Physiology, Bengaluru from March 3-7, 2019.

» **Dr. Ganga Sahay Meena, Dr. Ashish Kumar Singh, Dr. Vijay Kumar Gupta, Mr. Dharin Jayswal, Dr. Pankaj T Parmar** and **Dr. Hari Ram Gupta,** Dairy Technology Division received "**2nd Best Research Paper Award"** for the paper entitled "Estimating Cost for Production of Soluble Milk Protein Concentrate 70 (MPC70)" at 47th Dairy Industry Conference organized at Patna, Bihar from February 9 -11, 2019.

» **Ms. Kiran Lata, Mr. Laxamn Naik, Dr. Bimlesh Mann, Dr. Rajan Sharma** Dairy Chemistry Division received **"Best Paper Award"** by Indian Dairy Association in the category of "Dairy Processing" for the year 2017 at 47th Dairy Industry Conference, Patna on February 9, 2019 .

» **Dr. Pawan Singh,** Principal Scientist, Livestock Production & Management Section received **"Best Paper Award"** for the paper entitled "Role of Estrus Specific Molecules on Improvement of Sexual Behavior and Productivity in Murrah Buffalo Bulls" during Asian Buffalo Congress and Indian Society for Buffalo Development Convention, at ICAR-CIRB, Hisar, 2018.

» **Dr. Pawan Singh,** Principal Scientist, Livestock Production & Management Section received **"Best Paper Award"** for the paper entitled "Effect of Micro Climatic Conditions in Different Housing Systems on Performance of Murrah Buffalo Calves" during ISAPM National Conference in January, 2019 held at Trissur (Kerala).

» **Dr. Pawan Singh,** Principal Scientist, Livestock Production & Management Section received **"Best Paper Award"** for the paper entitled "Effect of Mist Cooling and Dairy Fans on Micro Climatic Conditions on Performance of Murrah Buffalo Calves in Summer Season" during International Conference of Society for Science and Nature held at FDDI, GOI Jodhpur (Rajasthan).

» **Mr. B. Singh, Dr. K. Khamrui, Mr. J. Lodh, Mr. A. Debnath,** and **Dr. W. Prasad,** Dairy Technology Division received "**Best Paper Award"** for the paper entitled "Selection of Levels of Ingredients for the Preparation of Milk-Coconut Sweet based on Sensory and Instrumental Colour Attributes" at 47th Dairy Industry Conference, organized by IDA-East zone, Patna during February, 2019.

» **Mr. A. A. Sheikh, Dr. O. K. Hooda** and **Dr. A. K. Dang**, Principal Scientist, Animal Physiology Division got **"Best Paper Award"** for the paper entitled "JAK3 and PI3K Mediates Bovine Interferon-tau Stimulated Gene Expression in the Blood Neutrophils". Published in *Journal of Cellular Physiology* (DOI: 10.1002/jcp.26296) from Society of Animal Physiology of India, 2018.

» **Dr. K. Ponnusamy,** Principal Scientist, Dairy Extension Division received **"Best Article Award of 2017"** for the article on Differential Dairy Development Status in India: A Perception Analysis published in the Indian Journal of Dairy Science given by Indian Dairy Association, New Delhi during 47th Dairy Industry Conference held from February7 -9, 2019 at Patna.

» **Dr. R. B. Kale, Dr. K. Ponnusamy, Dr. A. Mohammad, Dr. S. K. Jha, Dr. B. S. Chandel,** and **Dr. A. K. Chakravarty**, received **"Best Paper Award"** for the article "Differential Dairy Development Status in India: A Perception Analysis" *published in Indian Journal of Dairy Science* 70(3): 371-377 during 47th Dairy Industry Conference held from February 7-9, 2019.

» **Dr. Pawan Singh,** Principal Scientist, Livestock Production & Management Section received **2nd Best Paper Award"** for the paper entitled "Relationship among Testicular, Physical and Semen Quality Parameters of Murrah Buffalo Breeding Bulls" during 47th Dairy Industry Conference (DIC) held from February 7 – 9 , 2019 at Patna.

- **Mr. S. Bathla, Mr. A. Sindhu, Mr. S. K. Dubey, Smaranika, Mr. P. Rawat, Dr. S. Kumar,** and **Dr. A. K. Mohanty,** Animal Biotechnology Centre received **"Best Poster Award"** for their paper. "TMT-based Proteomics Identifies TRPM7 and CH13L1 as Potential Biomarkers for Sub-clinical Mastitis" in "International Conference on Proteomics for Cell Biology and Molecular Medicine" organized by Proteomics Society of India at Pune from December 12 -14, 2018**.**
- **Mr. D. Dua, Mr. G. Tripathi, Dr. P. Palta,** and **Dr. M. K. Singh,** Animal Biotechnology Centre received **"Best Poster Award"** for their paper "Developmental Competence of Ovarian Follicles Affected by Culture Media" at Global Conference on Reproductive Health organized by ISSRF at JNU, New Delhi from February 22 - 24, 2019.
- **Ms. Mrinal** working under the supervision of **Dr. Rajeev Kapila,** Principal Scientist received **"First Prize"** during **"Best Poster Award"** at National Seminar on "Fermented Dairy Foods and Their Health Benefits" organized by Swedish South Asian Network on Fermented Foods in association with NADSI and ICAR-NDRI, Karnal during May 26 -27, 2018.
- **Mr. Jayakumar Sivalingam, Mr. M. R. Vineeth, Mr. T. Surya, Mr. Anshuman K., Mr. K. V. Singh, Mr. S. P. Dixit, Mr. S. K. Niranjan, Mr. M. S. Tantia,** and **Dr. I. D. Gupta,** Animal Genetics & Breeding Division received the first "**Best Poster Award"** for the poster presented at the National symposium on "Sustainable Management of Livestock and Poultry Diversity for enhancing the Farmer's Income" held from February 8 -10, 2018 at RAJUVAS, Bikaner, Rajasthan.
- **Ms. Rana Ekta** and **Dr. A. K. Gupta**, Animal Genetics & Breeding Division and co-workers received "**Best Poster Award"** at National Symposium on "Sustainable Management of Livestock and Poultry Diversity for Enhancing the Farmers' Income" & 15th Annual Convention of Society for Conservation of Domestic Animal Biodiversity (SOCDAB) organized by Rajasthan University of Veterinary and Animal Sciences, Bikaner and Society for Conservation of Domestic animal Biodiversity, NBAGR, Karnal held from February 8 -10, 2018.
- **Ms. Aneet Kour,** Animal Genetics & Breeding Division and co-workers received "**Best Poster Award"** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7-8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.
- **Ms. Kaushalya Devi,** Animal Genetics & Breeding Division and co-workers received "**Best Poster Award"** during 16th National Symposium on Animal Genetic Resources for Food and Social Security (Society for Conservation of Domestic Animal Biodiversity) held from February 7 -8, 2019 at ICAR-National Bureau of Animal Genetic Resources, Karnal.
- **Dr. Nishant Kumar,** Scientist, Livestock Production & Management Section received "**Best Poster Award"** for the paper entitled "Effect of Zinc Supplementation on Performance of Peri-parturient Crossbred Cows during Heat Stress Condition" during Dairy Industry Conference 2019 on "Innovative Approaches for Enhancing Dairy Farmers Income" organized by Indian Dairy Association from February 7 - 9 2019 at Patna.
- **Ms. Shilpa Shree B. G.,** and **Dr. Sumit Arora,** Dairy Chemistry Division received **"Best Poster Award"** for the poster entitled "Impact of Bound Mineral from Whey Protein-mineral Complex on Lipid Oxidative Stability and Bioavailability" druing National Conference on Challenges and Opportunities for the New Generation Dairy Foods in India" held from September 9-10, 2018 at College of Dairy Technology, Sri Venkateswra Veterinary University, Tirupati.
- **Ms. Priya Patel, Dr. Sumit Arora, Ms. Seema Rana** and **Mr. Harisha Bodemala,** Dairy Chemistry Division received "**Best Poster Award"** for the poster entitled "Evaluation of Storage Stability of Astaxanthin in Flavoured Milk" presented at National Seminar-Vision 2030 for Dairy industry and 13th Alumni Convention held from January 4-5, 2019 at AAU, Anand.
- **Ms. Hema J. M., Ms. Richa Singh, Dr. Bimlesh Mann, Dr. Rajesh Bajaj, Dr. Priyanka Rao,** and **Mr. Saurabh Gosewade,** Dairy Chemistry Division received "**Best Poster Award"** for the poster entitled "Comparative Fat Digestibility from Milk of Different Breeds using Simulated GI conditions presented at National Conference on "SLIETCON-2019" held from March 1-2, 2019 at Chandigarh.
- **Ms. Nandita Das, Dr. Rajesh Bajaj, Dr. Bimlesh Mann** and **Dr. Rajan Sharma,** Dairy Chemistry Division received **"Best Poster Award"** for the poster entitled "Chemical Composition and Protein Profiling of Milk from Indigenous Cattle" presented at the 47th DIC at Patna.
- **Mr. Harisha Bodemala, Dr. Sumit Arora, Ms. Seema Rana and Dr. Vivek Sharma,** Dairy Chemistry Division received **"Best Poster Award"** for the poster entitled "Optimization of Spray Drying Conditions for lab Scale Preparation of Milk Protein-Vitamin Complexes" presented in the NDRI Global Alumni Scientific Meet-2019 held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- **Mr. Ranvir, Dr. Kamal Gandhi, Dr. Rajan Sharma** and **Dr. Bimlesh Mann,** Dairy Chemistry Division received **"Best Poster Award"** presented in the NDRI Global Alumni Scientific Meet-2019 held from March 15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.

- **Mr. M. N. Alhussien** and **Dr. A. K. Dang**, Animal Physiology Division got **"J. N. Pandey Memorial Best Poster Award"** on Neutrophil molecules as early predictors of metritis incidence in Dairy cows by Society of Animal Physiology of India, 2018.
- **Dr. Rubina,** Scientist, Livestock Production & Management Section received "**Best Poster Presentation Award"** in 34th Annual Convention of ISSAR and International Symposium held at College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, Gujarat from December 28-30, 2018.
- **Mr. R. V. Rajanikar, Mr. S. Ranvir** and **Dr. P. V. Behare,** Dairy Microbiology Division received "**Best Poster Presentation Award"** for the paper on "Production of Phenyl lactic Acid Enriched Anti-Microbial Formulation from *L. Plantarum* during 47th Dairy Industry Conference, FSQ 9, held from February 7-9, 2019 at Patna.
- **Dr. S. Roy, Dr. S. A. Hussain, Dr. W. G. Prasad, Dr. Y. Khetra,** and **Dr. R. R. B. Singh,** r received **"1st Best Poster Presentation Award"** for the paper entitled "Development of High Protein Ice Cream" presented at 47th Dairy Industry Conference held at Patna, Bihar from February7-9, 2019.
- **Ms. Anjali, M. K.** Dairy Microbiology Division received **"1st Best Poster Presentation Award"** for the paper on "Conducting Polymer Strip Based Sensor for the Detection of Escherichia Coli in Milk" under Food Security, Quality Safety and Regulatory Aspects Category" during 47th Dairy Industry Conference 2019 held on February7-9, 2019 at Patna.
- **Ms. Soniya Ranveer, Ms. Vaishali Dasriya,** and **Dr. Naresh Kumar,** Dairy Microbiology Division got "**First Prize"** for poster presentation on "Development and Validation of Paper Strip Biosensor for Pesticide Residues Detection in Dairy Farm Chain" during NDRI Global Alumani Scientific Meet held from March 15 -17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- **Ms. Anjali M. K., Mr. Raghu H. V.** and **Dr. Naresh Kumar,** Dairy Microbiology Division got "**First Prize"** for poster presentation on "Conducting Polymer Strip based Sensor for the Detection of *Escherichia Coli* in Milk" Under Food Security, Quality Safety And Regulatory Aspects Category" to during 47th Dairy Industry Conference 2019 at Bihar Animal Sciences University, Bihar Veterinary College Campus, Patna.
- **Mr. Prashant Goel, Dr. Naresh Kumar, Ms. Soniya Ranveer, Mr. Pradip Kumar Sharma** and **Mr. Karanpriya,** Dairy Microbiology Division got "**Second Prize"** for poster presented on "Spore based Technology for Rapid Detection of Antibiotic and Pesticide Residues in Milk" during NDRI Global Alumani Scientific meet held from March15-17, 2019 at ICAR-National Dairy Research Institute, Karnal.
- **Dr. Latha Sabikhi, Mr. Gunvantsinh Rathod** and **Mr. Rajender Kumar,** Dairy Technology Division received "**2nd Best Poster Award"** for the poster entitled "Development of Buttermilk Solids-based Omega-3 Oil Encapsulate by Utilizing the Emulsion Stabilization Potential of Buttermilk" at NDRI Global Alumni Scientific Meet-2019.
- **Mr. Bhagvat Kisan, Mr. Sunil Sakhala,** and **Dr. Sangita Ganguly, Dr. Yogesh Khetra and Dr. Latha Sabikhi,** Dairy Technology Division received "**3rd Best Poster Award"** for the poster entitled "Valorization of Mozzarella Cheese Whey into Probiotic Ricotta Cheese" during "NDRI Global Alumni Scientific Meet-2019" held from March 15-17, 2019 at National Dairy Research Institute, Karnal.
- **Ms. Sonia Mor, Dr. Vivek Sharma, Dr. Sumit Arora,** and **Dr. P. S. Minz** received **"3rd Best Poster Award"** for the poster entitled "Potential of Different Colour Parameters to Distinguish Cow Ghee from Buffalo Ghee" by presented in the third National Conference on "Contemporary Food Processing and Preservation Technologies" held from April 12-13, 2018 at School of Bioengineering & Food Technology, Shoolini University, Solan (HP).
- **Mr. V. Batra, Dr. Rakesh Kumar,** and **Dr. T. K. Datta,** Animal Biotechnology Centre received the **"3rd Best Poster Award"** for their paper "Unusual Evolutionary Positioning of Buffalo Class A B Defensins and their Distinct Selective Pressures vis-à-vis other Defensins" at NGASM 2019 organised at NDRI Karnal from March15-17, 2019.
- **Dr. Nitin Tyagi**, Senior Scientist, Animal Nutrition Division received **"3rd Best Poster Presentation Award"** during 11th Biennial Animal Nutrition Association Conference held from November19-21, 2018 at Patna.

Other Awards/Appreciations

- **Dr. A. K. Roy,** Principal Scientist, Animal Physiology Division got a "**Certificate of Appreciation"** for the year 2019 for contributing services as member of the organizing committee during SAPICON-2018 and organizing National Quiz competition as Quiz Master at NDRI, Karnal.
- **Dr. B. S. Meena,** Principal Scientist, Dairy Extension Division received **"Certificate of Appreciation"** as member of Scientific Advisory Board for outstanding contribution to quality of the journal in the year 2018, by International Journal of Livestock Research.
- **Mr. M. A. Mir, Dr. I D Gupta, Dr. Archana Verma, Dr. A. K. Gupta, Dr. A. K. Chakravarty, Dr. A. P. Singh,** and **Mr. M. R. Vineeth,** Animal Genetics & Breeding Division received "**Young Scientist Scholarship (International)"** for attending 11th World Congress on Genetics Applied to Livestock production (WCGALP) held at Auckland in February, 2018.

» **Dr. K. P. Ramesha,** Head, Southern Regional Campus, Bengaluru received **"Malenadu Sadakaru Award"** by Malenadu Mithra Vrunda (Regd), Bengaluru for his contribution to dairy sector held on October 28, 2018 at Bengaluru.

» **Dr. S. Jeyakumar,** Principal Scientist received **"Best Researcher Award"** in the field of Infrared Thermal Imaging and its Application in Veterinary Medicine, under Research Ratna Award of the Year 2019 Jointly Awarded by RULA Awards and United Medical Council in Association with World Research Council on February 26, 2019.

Rajbhasha Purskar

» **Dr. Nishant Kumar,** Scientist, Livestock Production & Management received "**2nd Prize"** in Takniki Hindi Aalekh Pratiyogita organized by Rajbhasha Ekak NDRI, Karnal for paper entitled "Gaabhin Gaay Ki Behtar Dekhbhaal Se Adhik Doodh Utpaadan".

» **Dr. R. K. Meena, Dr. M. Singh, Mr. R. K. Fagodiya, Mr. K. Prajapat,** and **Dr. V. K. Meena,** Forage Research & Management Centre received "**Best Hindi Article Award"** by Rajbhasa unit of NDRI to the article published in Dugdh Ganga 2017-18. "*Dhan Ke Samekit Poshak Tatv Parbhandhan Me Azolla Ka Mahtav".* Dugdh Ganga, 57-59.

» **Dr. Sachin Kumar,** Scientist, Animal Nutrition Division awarded **"Consolation Award"** at Hindi Pakhwada 2018.

» **Dr. A. K. Roy,** Principal Scientist, Animal Physiology Division got **"First Prize"** for the year 2019 from NDRI Karnal for publishing a popular article on "*A-1 Tatha A-2 Doodh Par Vivaad*" in *Vigyan Pragati*- a monthly national magazine.

» **Dr. A. K. Roy,** Principal Scientist, Animal Physiology Division got **"First Prize"** for the year 2019 from NDRI Karnal for publishing a research article on "*Prakash Avadhi Badhane Se Katadiyon Ke Plasma Hormone, Daihik Vriddhi Evam Yauvanavastha Par Prabhav*" in *Krishi Anusandhan Patrika*- A National Journal.

» **Dr. M. Singh,** Head and **Dr. A. K. Roy,** Principal Scientist, Animal Physiology Division got **"Second Prize"** for the year 2019 from NDRI Karnal for publishing a folder on "*Gayon Men Adhik Doodh Hetu Sankramankaleen Prabandhan*" in Hindi.

» **Dr. A. K. Roy,** Principal Scientist, Animal Physiology Division for **"First Prize"** for the year 2019 from NDRI Karnal for making a mobile application on "*Dairy Pashu Palan*" in Hindi for the benefit of farmers.

» **Dr. Asif Mohammad**, Principal Scientist got **"First Prize"** in Hindi Mein Prastuti (Presentation in Hindi) on September 15, 2018 at ERS of ICAR-NDRI, Kalyani.

» **Dr. Champak Bhakat**, Principal Scientist got **"Second Prize"** in Hindi Mein Prastuti (Presentation in Hindi) on September 15, 2018 at ERS of ICAR-NDRI, Kalyani.

» **Dr. A. Mandal,** Principal Scientist and **Dr. A. Chatterjee**, Principal Scientist jointly got **"Third Prize"** in Hindi Mein Prastuti (Presentation in Hindi) on September 15, 2018 at ERS of ICAR-NDRI, Kalyani.

PUBLICATIONS

Animal Genetics & Breeding Division

Sr. No.	Research Papers	NAAS Rating
1	Behera, R., Chakravarty, A. K., Adhikari, S., Kashyap, N., Rai, S., Dash, S., Upadhyaya, A., Singh, A., and Gupta, A. K. (2018) Identification of critical heat stress zone for energy corrected milk yield in Murrah buffaloes using temperature humidity index under subtropical climatic conditions. *Indian J. Anim. Sci.*, 88 (7): 838-41.	6.19
2	Behera, R., Chakravarty, A. K., Kashyap, N., Rai, B., Mandal, S., Singh, A., and Gupta, A. K. (2018) Identification of most suitable temperature humidity index model for daily milk yield of Murrah buffaloes in subtropical climatic condition of India. *Indian J. Anim. Sci.*, 88 (7): 834-37.	6.19
3	Dash, K. S., Gupta, A. K., Kumar, M., Shivhare, Virender, Pushp, R. and Valsalan, J. (2018) Analysis of lifetime performance in Karan Fries Cattle. *Indian J. Anim. Res.*, 52 (5): 761-67.	6.15
4	Dash, K. S., Gupta, A. K., Singh, A., Chakravarty, A. K., Singh, M. and V. (2018) Performance appraisal and genetic parameter estimation of all lactation traits in Karan Fries cattle. *Indian J. Anim. Res.*, 52 (1): 7-12.	6.15
5	Jain, V., Patel, B., Gupta, I. D. and Verma, A. (2018) Exploration of genetic polymorphism in targeted region of Protein Phosphatase 1 Regulatory subunit 11 (PPP1R11) in Murrah bulls. *Indian J. Anim. Res*., 52 (10): 1409-12.	6.15
6	Kour, A., Chakravarty, A. K., Gupta, A. K., and Raina, V. (2018) Identification of genetic marker for CSN3 gene in Karan Fries (Holstein Friesian crossbred) population. *Indian J. Anim. Sci.*, 88 (7): 48-51.	6.19
7	Kumar, K., Bhakat, M., Mohanty, T. K., Lone, S. A., Kumar, R., Sinha, R., Shashank, C. G., Rahim, A., Danish, Z., Paray, A. R., Yadav, H. P. and Gupta, A. K. (2018) Study on semen quality in relation to scrotal surface temperature gradient, testicular covering thickness and scrotal circumference in Murrah bulls. *J. Pharmacognosy and Phytochemistry,* 7(4): 813-17.	5.21
8	Lavakumar, S., Singh, R., Niranjan, S. K., Mishra, S. K., Kumar, P., Vohra, V., Dash, S. K. and Kataria, R. S. (2019) Cytogenetic characterization of Sambalpuri and Manda buffaloes of Odisha. *Indian J. Anim. Sci.,* 89 (1): 53–56.	6.19
9	Magotra, A., Gupta, I. D., Verma A., Alex, R., Vineeth, M. R. and Tavsief, A. (2018) Candidate SNP of cacna2d1gene associated with clinical mastitis and production traits in Sahiwal *(Bostaurusindicus)* and Karan Fries *(Bostaurustaurus × Bostaurusindicus), Anim. Biotechnology*,pp:17.(http://dx.doi.org/10.1080/10495398.2018.1437046).	6.75
10	Mishra, S. K., Dubey, P. K., Dhiman, A., Dubey, S., Verma, D., Kaushik, A. C., Singh, R., Niranjan, S. K., Vohra, V., Mehrara, K. L., and Kataria, R. S. (2019) Sequence-based structural analysis and evaluation of polymorphism in buffalo Nod-like receptor-1 gene. *3 Biotech,*9 (1): 26. https://doi.org/10.1007/s13205-018-1534-2.	7.36
11	Mishra, S. K., Mishra, A. K., Raja, K. N., Vohra, V., Singh, S., Singh, Y., Ahlawat, S. and Kataria, R. S. (2018) Polymorphism analysis at FecB locus in Kajali sheep of India*. Indian J. Anim. Res.,* 52 (3): 474-76.	6.15
12	Mukherjee, A., Mukherjee, S., and Dhakal, R., et al. (2018) High-density genotyping reveals genomic characterization, population structure and genetic diversity of Indian Mithun (*Bosfrontalis*). *Scientific Report*, 8:10316.	10.26
13	Mukherjee, S., Mukherjee, A., Singh, R. J. et al. (2019) Muscle transcriptome signature and gene regulatory network analysis in two divergent lines of a hilly bovine species Mithun (*Bosfrontalis*). *Genomics, DOI*: 10.1016/j.ygeno.2019.02.004.	8.80
14	Pandey, M., Raja, K. N., Yousuf, S. and Gupta, A. K. (2019) Effect of non-genetic factors on first lactation 305 days and lifetime milk yield in Sahiwal cattle*. Indian J. Dairy Sci.,* 72 (1): 89-92.	5.26
15	Parveen, K. Gupta, A. K., Gandhi, R. S., Chakravarty, A. K. and Shabahat, M., (2018) Genetic analysis of trends in production and reproduction traits over years using regression methods in Sahiwal cows. *Indian J. Anim. Sci.*, 88 (3): 84-91.	6.19

Sr. No.	Research Papers	NAAS Rating
16	Parveen, K., Gupta, A. K., Gandhi, R. S., Chakravarty, A. K. and Shabahat, M, (2018) Genetic analysis of trends in production traits of Sahiwal cows over years using BLUP with animal model. *Indian J. Dairy Sci*., 71(4): 396-403.	5.26
17	Parveen, K., Gupta, A. K., Gandhi, R. S., Kalim, O. and Shabahat, M. (2018) Effect of temperature humidity index on milk production performance of Sahiwal cows. *Indian J. Dairy Sci.,* 71 (5): 478-82.	5.26
18	Ranjan, A., Raja, K. N., Sinha, R., Ganguly, I., Gupta, I. D., Bhakat, M. and Mohanty, T. K. (2018) Sequence characterization and SNP identification of TNP1 gene in Indian cattle breeds. *Indian J. Anim. Res*., 52 (12): 1680-83.	6.15
19	Ratwan, P., Chakravarty, A. K., Kumar, M., Gupta, A. K., Lathwal, S. S. and Malhotra, R. (2018) Production performance and estimation of genetic parameters of production traits in Sahiwal cattle. *Indian J. Dairy Sci.*, 71(6): 592-97.	5.26
20	Saha, M., Gupta, A. K., De. S. and Majumder, A. (2018) Microsatellite marker based parentage evaluation in Murrah buffalo. *Indian J. Dairy Sci.,* 71 (3): 273-78.	5.26
21	Singh, A., Bhakat. M., Mondal, S., Mohanty, T. K., Behare, P., Mondal, G., Rahim, A., Yadav, S. K., Gupta, A. K., Gupta, M. D. and Abdullah, M. (2018) Microbial load of frozen thawed Sahiwal semen extended in egg yolk, soya lecithin and liposome based extender. *Indian J. Anim. Res*., 52 (4): 527-29.	6.15
22	Singh, R., Niranjan, S. K., Rajesh, C., Mishra, S. K., Vohra, V., Dash, S. K., Misra, D. and Kataria, R. S. (2018) Cytogenetic characterization of Kalahandi and Paralakhemundi buffaloes of Odisha state confirms their riverine status. *Indian J. Dairy Sci.,* 71(3): 279-83.	5.26
23	Singh, R., Rajesh, C., Mishra, S. K., Gurao, A., Vohra, V., Niranjan, S. K. and Kataria, R. S. (2018) Comparative expression profiling of heat-stress tolerance associated HSP60 and GLUT-1 genes in Indian buffaloes. *Indian J. Dairy Sci.,* 71(2):183-86.	5.26
24	Sulabh, S., Verma, A., Gupta, I. D. and Kumar, B. (2018) Novel SNPs in DGAT1 gene and their association with milk traits in Murrah buffaloes. *Indian J. Dairy Sci.,* 71(2):187-92.	8.80
25	Surya, T., Vineeth, M. R., Sivalingam, J., Tantia, M. S., Dixit, S. P., Niranjan, S. K., and Gupta, I. D. (2018) Genome wide identification and annotation of SNPs in *Bubalus bubalis*. *Genomics. pii:* S0888-7543(18)30441-5. doi: 10.1016/j.ygeno.2018.11.021.	8.80
26	Vohra, V. (2018) Genomic selection and its significance in Indian dairying. *Indian J. Dairy Sci.,*71(6): 539-45.	5.26

Livestock Production & Management Section

Sr. No.	Research Papers	NAAS Rating
1	Choudhary, Sanjay, Yamini, Raheja, N., Yadav, S. K. and Kamboj, M. L. (2018) A Review: Pesticide residue: Cause of many animal health problems. *J. Entomology and Zoology Studies,* 6 (3): 330-33.	5.53
2	Devi, Indu, Singh, Pawan, Dudi, Kuldeep, Lathwal, S. S., Ruhild, Anand P., Singhe, Yajuvendra, Malhotra, R., Baithalu, Rubina K. and Sinha, Ranjana (2019) Vocal cues based decision support system for estrus detection in water buffaloes *(Bubalus bubalis). Computers and Electronics in Agriculture*, 162: 183-88.	8.43
3	Fahim A., Kamboj, M. L., Sirohi, A. S., Bkakat, M., Prasad, S. and Kerketta, S. (2018) Standarization of pulsation rate in crossbred cows milked in automated herringbone milking parlour. *Indian J. Anim. Sci*., 88 (12): 1416-18.	6.28
4	Fahim A., Kamboj, M. L., Sirohi, A. S., Bkakat, M., Prasad, S. and Gupta, R. (2018) Milking machine induced teat reactions in crossbred cows milked in automated herringbone milking parlour. *Indian J. Anim. Sci.,* 88 (12): 1412-15.	6.28
5	Gupta, S. K., Chandra, R., Dey D., Mondal, G. and Shinde, K. P. (2018) Study of chemical composition and mineral content of sun dried azolla pinnata. *J. Pharmacognosy and Phytochemistry,* 7(6): 1214-16.	5.21
6	Hegde, Sujata, Jaisunder, M., Singh, Pawan and Datt, Chander (2018) Macro mineral status in soil, plant and dairy cattle in Andaman group of Islands. *Indian J. Anim. Nutr*., 35 (4): 415-20.	5.02
7	K., Puhle Japheth, Kumaresan, A., Ganaie, Bilal Ahmad, Oberoi, P. S., Lathwal, S. S. and Singh, Pawan (2018) Effect of polyherbal mixture supplementation on incidence of mastitis and milk production in postpartum Murrah buffaloes. *Indian J. Dairy Sci*., 72 (1): 85-88.	5.26
8	Kumar, Amit, Kamboj, M. L., Chandra, Subhash and Bharti, Pranay (2018) Effect of modified housing system on physiological parameters of Murrah buffaloes during autumn and winter seasons. *Indian J. Anim. Res.,* 52 (6): 829-33.	6.20
9	Kumar, Nishant, Ghosh, S. K., Mohanty, T. K., Prasad, J. K. Meena, Sunita and Raheja, Nitin (2018) Effect of season on anti-oxidative enzymatic status and lipid peroxidation of murrah buffalo semen. *Ind. J. Anim. Prod. Mgmt.* 33 (3-4): 48-51.	3.56

Sr. No.	Research Papers	NAAS Rating
10	Kuri, Piyali, Kumar, Parveen, Kumar, Nishant, Aggarwal, Anjali and Singh, Mahendra (2019) Effect of Poly-herbal mixture supplementation during post partum period on reproductive performance of Sahiwal cows. *Indian J. Anim. Nutr.,* 36 (1): 35-39.	5.02
11	Narvariya, D. S., Chandra, Ramesh, Kumar, Nishant, Roy, A. K., Datt, Chander and Mehla, R. K. (2018) Supplementary feeding: Effect on growth and blood metabolites in Sahiwal heifers. *Indian J. Anim. Nutr.,* 35 : 161-65.	5.02
12	Patbandha, T. K., Mohanty, T. K., Tiwari, S., Kumaresan, A., Bhakat, M., Baithalu, R. K. and Sreela L. (2018) Postpartum feeding and resting behaviour of primiparous and pluriparous crossbred cows reared under loose housing. *Indian J. Dairy Sci.,* 71(2): 184-89.	5.26
13	Raheja, Nitin, Choudhary, Sanjay, Grewal, Sonika, Sharma, Neha and Kumar, Nishant (2018). A review on semen extenders and additives used in cattle and buffalo bull semen preservation. *J. Entomology and Zoology Studies,* 6 (3): 239-45.	5.53
14	Raheja, Nitin, Kumar, Nishant, Patel, Brijesh and Lathwal, S. S. (2018) Effect of dietary betaine on reproductive performance of Karan Fries cows during hot humid season. *Int. J. Curr. Microbiol. App. Sci.,* 7 (9): 1451-60.	5.38
15	Shashikumar, N. G., Baithalu, R. K., Bathla, S., Ali, S. A., Rawat, P., Kumaresan, A., Kumar, S., Maharana, B. R., Singh, G., Puneeth Kumar, D. S., Singh, S. K., Lathwal, S. S., Jaiswal, L., Mohanty, T. K. and Mohanty, A. K. (2018) Global proteomic analysis of water buffalo *(Bubalus bubalis)* saliva at different stages of estrous cycle using high throughput mass spectrometry. *Theriogenology,* 110: 52-60.	8.14
16	Singh, P. K., Kamboj, M. L., Chandra, S., Kumar, A. and Kumar, N. (2018) Influence of weaning on growth, health and behavior of (*Bubalus Bubalis*) buffalo calves. *Indian J. Anim Res.,* 53 (5): 680-84.	6.20
17	Tamboli, P., Chandra, R., Singh, M., Chaurasia, A. and Sharma, A. (2018) Milking temperament influence on production performance and plasma hormones in Sahiwal cows. *Int. J. Current Microbiology and Applied Sci.,* 7 (7): 1-7.	5.38
18	Vimlesh, K., Kumaresan, A., Nag, P., Kumar, P., Datta, T. K., Baithalu, R. K. and Mohanty, T. K. (2018) Transcriptional abundance of type-1 endocannabinoid receptor (CB1) and fatty acid amide hydrolase (FAAH) in bull spermatozoa: Relationship with field fertility. *Theriogenology,* 114: 252-57.	8.14
19	Yadav, Satendra Kumar, Singh, Pawan and Singh, Navav (2018) Effect of testicular consistency on semen quality of Murrah buffalo breeding bulls. *Indian J. Dairy Sci*., 72 (1): 93-96.	5.26

Artificial Breeding Research Centre

Sr. No.	Research Papers	NAAS Rating
1	Abdullah, M., Bhakat. M., Mohanty, T. K., Mondal, S., Singh, A. and Kumari, S. (2018) Semen production performance of Sahiwal bulls and the factors affecting it in a organized farm under tropical conditions. *International J. Livestock Res.*, 8 (9): 285-91.	5.36
2	Aslam, M. K. M., Sharma, V. K., Pandey, S., Kumaresan, A., Srinivasan, A., Datta, T. K. Mohanty, T. K. Yadav, S. (2018) Identification of biomarker candidates for fertility in spermatozoa of crossbred bulls through comparative proteomics. *Theriogenology*, 119: 43e51.	8.14
3	Bishist, R., Raina, V. S., Bhakat, M., Mohanty, T. K., Lone, S. A., Paray, A. R. , Rahim A. and Sinha, R. (2018) Effect of varying osmolarity of tris extender on seminal attributes of buffalo bulls during refrigeration. *Int. J. Livestock Res.*, 8 (11): 164-71.	5.36
4	Danish, Ziaullah, Bhakat, Mukesh, Paray, Adil Rasool, Mohanty, T. K., Lone, Shabir Ahmad, Rahim, Abdul, Sinha, Ranjana and Kushwaha, Manish Kumar (2018) Effect of season, parity and stage of lactation on skin surface temperature (°C) of body, teats and udder in lactating Murrah buffaloes. *J. Entomology and Zoology Studies,* 6 (5): 1149-53.	5.53
5	Fahim, A., Kamboj, M. L., Bhakat, M. Mohanty, T. K. and Gupta, R. (2018) Preference of side and standing in relationship with milking characteristics and temperament score of crossbred dairy cows in an 8 × 2 herringbone milking parlour. *Turk J. Vet. Anim. Sci.,* 42 : 49-54.	6.49
6	Golher, D. M., Kumaresan, A., Saraf, K. K., Chhillar, S., Nayak, S. Tripathi, U. K., Bhaskar, C. N., Lathwal, S. S. and Mohanty, T. K. (2018) Influence of season and climatic variables on testicular cytology, semen quality and melatonin concentrations in crossbred bucks reared under subtropical climate. *International J. Biometeorology,* https://doi.org/10.1007/s00484-018-1571-x.	8.58
7	Jalmeria, N. S., Panth, S., Pandita, S, Roy, A. K., Ashutosh, M., Mohanty, T. K., Bhakat, M., Punetha, M. and Gupta, D. (2018) Seasonal variations in hormones and enzymes of seminal plasma and its relationship with semen quality in crossbred cattle bulls. *Biological Rhythm Res.*, 1-11. (DOI: 10.1080/09291016. 2018.1548873).	6.70
8	Kale, R. B., Ponnusamy, K., Sendhil, R., Maiti, Sanjit, Chandel, B. S., Jha, S. K., Mohanty, T. K. and Lal, S. P. (2018) Determinants of inequality in dairy development of India. *Natl. Acad. Sci. Lett*. DOI: 10.1007/s40009-018-0716-0.	6.52

Sr. No.	Research Papers	NAAS Rating
9	Karan, P. Mohanty, T. K., Kumaresan, A., Bhakat, M., Baithalu, R. K., Verma, K., Kumar, S., Gupta, M. D., Saraf, K. K., Gahlot, S. C. (2018) Improvement in sperm functional competence through modified low-dose packaging in French mini straws of bull semen. *Andrologia,* 50 (5): e13003.	7.59
10	Kumar, A., Pandita, S., Laxmi, A. N., Bhakat, M. and Mohanty, T. K. (2018) Effects of prostasomes on functional parameters of fresh and cryopreserved-thawed spermatozoa of crossbred Karan Fries (KF) bulls. *Indian J. Anim. Res.*. DOI: 10.18805/ijar.B-3665.	6.20
11	Kumar, P., Mohanty, T. K., Kumaresan, A., Nag, P., Saraf, K. K., Kumar, V., Lathika, S., Nayak, S. and Bhakat, M. (2018) Incubation of spermatozoa with Anandamide prior to cryopreservation reduces cryocapacitation and improves post-thaw sperm quality in the water buffalo *(Bubalus bubalis). Anim. Reprod. Sci.,* 189: 77-83.	7.65
12	Kumara, V., Kumaresan, A., Nag, P., Kumar, P., Datta, T. K., Baithalu, R. K., Mohanty, T. K. (2018) Transcriptional abundance of type-1 endocannabinoid receptor (CB1) and fatty acid amide hydrolase (FAAH) in bull spermatozoa: Relationship with field fertility. *Theriogenology,* 114 (2018) 252e257.	8.14
13	Kushwaha, M. K. Bhakat, M. Mohanty, T. K. Lone, S. A. Kumar, R. Sinha, R. Shashank, C. G., Rahim, A., Danish, Z., Paray, A. R. Yadav, H. P. and Gupta, A. K. (2018) Study on semen quality in relation to scrotal surface temperature gradient, testicular covering thickness and scrotal circumference in Murrah bulls. *J. Pharmacognosy and Phytochemistry,* 7(4): 813-17.	5.21
14	Mondal, S., Bhakat, M., Singh, A., Mohanty, T.K., Abdullah, M., Yadav, S.K. and Kumar, R. (2019) Effect of cattle-specific estrus molecules on libido and semen production of zebu bulls under tropical climate. *Tropical Anim. Health and Prod.*, (https://doi.org/10.1007/s11250-019-01880-8).	6.98
15	Naha, B. C., Chakravarty, A. K., Mir, M. A., Bhakat, M., Das, Ramendra, Saini, B. L. and Boro, P. (2018) Optimum age at first semen freezing in relation to fertility of Sahiwal breeding bulls. *Indian J. Anim. Res.*. DOI: 10.18805/ijar.B-3486.	6.20
16	Narwade, B. M., Mohanty, T. K., Bhakat, M., Rahim, A., Sinha, R. and Singh, A. K. (2018) Seasonal influence on semen production performance of crossbred buck (Saanen x Beetal) in an organized farm. *Int. J. Livestock Res.*, 8 (8): 196-203.	5.36
17	Paray, A. R., Bhakat, M,, Mohanty, T. K., Behare, P., Lone, S. A, Parry, U. R., Kumar, R., Sinha, R. Yadav, H. P. Rahim, A., Danish, Z., and Shah, N., (2018) Antimicrobial activity of crude aqueous extracts of Moringa oleifera, Azadirachta indica, Carica papaya, Tinospora cordifolia and Curcuma longa against certain bacterial pathogens. *J. Pharmacognosy and Phytochemistry,* 7 (4): 984-94.	5.21
18	Patbandha, T. K., Mohanty, T. K., Tiwari, S., Kumaresan, A., Bhakat, M., Baithalu, R. K. and L., Sreela (2018) Postpartum feeding and resting behaviour of primiparous and pluriparous crossbred cows reared under loose housing. *Indian J. Dairy Sci.*, 71 (2): 198-203.	5.26
19	Prakash, M. A., Prasad, S. Mohanty, T. K. Kumaresan, A., Manimaran, A., Oberoi, P. S., Layek, S. S. and Lathika, S. (2018) Behavioural adaptation of crossbred cows in automatic concentrate feeding station. *Indian J. Anim. Sci.* 88 (3): 82–00.	6.28
20	Saraf, K. K., Singh, R. K., Kumaresan, A., Nayak, S., Chhillar, S. Lathika, S. Datta. T. K. and Mohanty, T. K. (2018) Sperm functional attributes and oviduct explant binding capacity differs between bulls with different fertility ratings in the water buffalo *(Bubalus bubalis). Reproduction, Fertility and Development*. https://doi.org/10.1071/RD17452.	8.11
21	Shashikumar, N. G. Baithalu, R. K. Bathla, S., Ali S. A., Rawat, P., Kumaresan, A., Kumar, S. Maharana, B. R., Singh, G., Puneeth Kumar, D.S., Singh, S. K., Lathwal, S.S ., Jaiswal, L., Mohanty, T. K. Mohanty, A. K. (2018) Global proteomic analysis of water buffalo *(Bubalus bubalis)* saliva at different stages of estrous cycle using high throughput mass spectrometry. *Theriogenology,* 110 : 52-60.	8.14
22	Singh, A., Bhakat, M., Mondal, S., Mohanty, T. K., Behare, P., Mondal, G., Rahim, A., Yadav, S. K., Gupta, A. K., Gupta, M. D. and Abdullah, M. (2018) Microbial load of frozen thawed Sahiwal semen extended in egg yolk, soya lecithin and liposome based extender. *Indian J. Anim. Res.*, 52(4): 527-29.	6.20
23	Tiwari, S., Mohanty, T., Patbandha, T., Kumaresan, A., Bhakat, M., Kumar, N. and Baithalu, R. (2018) Critical thresholds of milk SCC, EC and pH for detection of sub-clinical mastitis in crossbred cows reared under subtropical agroclimatic condition. *Int. J. Livestock Res.,* 8(6): 152-59. doi: 10.5455/ijlr. 20170620120712.	5.36
24	Usha, S. Mohanty, T. K. and Senthilkumar, P. (2018) Effects of physiological status and season on blood biochemical and mineral profile of holstein friesian cross bred cattle. *Int. J. Curr. Microbiol. App. Sci.* 7(12): 1122-32.	5.38
25	Usha, S. Mohanty, T. K. and Senthilkumar, P. (2018) Metabolic indicators for pneumonia and diarrhoea in Holstein Frisian crossbred calves. *Int. J. Curr. Microbiol. App. Sci.,* 7(6): 3296-3304.	5.38
26	Yadav, K. S., Singh, P., Bhakat, M., Mohanty, K. T., Kumar, A., Singh, A., Mondal, S., Upadhyay, V. K. and Tomar, S. (2018) Relationship of age, body condition score and rump fat thickness with semen quality in Murrah buffalo breeding bulls. *Int. J. Livestock Res.*, 8(8): 110-20. doi: 10.5455/ijlr.20180116015543.	5.36

Animal Biotechnology Centre

Sr. No.	Research Papers	NAAS Rating
1	Agrawal, H., Selokar, N. L., Saini, M., Singh, M. K., Chauhan, M. S., Palta, P., Singla S. K. and Manik, R. S. (2018) M-carboxycinnamic acid bishydroxamide improves developmental competence, reduces apoptosis and alters epigenetic status and gene expression pattern in cloned buffalo (*Bubalus bubalis*) embryos. *Reprod. in Domestic Anim.,* 53 (4): 986-96.	7.42
2	Ali, S. A., Malakar, D., Kaushik, J. K., Mohanty, A. K. and Kumar, S. (2018) Recombinant purified buffalo leukemia inhibitory factor plays an inhibitory role in cell growth. *PLOS One*, 13 (6): e0198523.	8.77
3	Ashok, D., Sood, T. J., Sah, S., Palta, P., Mukesh, M., Chauhan, M. S., Manik, R. S. and Singla, S. K. (2018) Buffalo SCNT embryos exhibit abnormal gene expression of ERK/MAPK pathway and DNA methylation. *Reprod. Domestic Anim.,* 53 (5) : 1247-52.	7.42
4	Dua, D., Nagoorvali, D., Chauhan, M. S., Palta, P., Mathur, P. and Singh, M. K. (2019) Calcium ionophore enhanced developmental competence and apoptotic dynamics of goat parthenogenetic embryos produced *in vitro*. *In Vitro Cellular & Developmental Biology – Animal,* Feb 8. doi: 10.1007/s11626-019-00322-x.	7.45
5	Gautam, D., Vats, A., Verma, M., Rout, P. K., Meena, A. S., Ali, M., Deepika, S. and De, S. (2019) Genetic variation in CSN3 exon 4 region of Indian goats and a new nomenclature of CSN3 variants. *Animal Genetics,* Feb 6. doi: 10.1111/age.12767.	7.84
6	Jena, M. K. and Malakar, D. (2017) Handmade cloning: A handy technique for reproductive cloning. *J. Pharmaceutical Sci. & Res.* 9 (9) : 1564-68.	NA
7	Jena, M. K., Jaswal, S., Kumar, S. and Mohanty, A. K. (2018) Molecular mechanism of mammary gland involution: An update. *Developmental Biology*, 445 (2): 145-55.	9.26
8	Kumar, M., Faraji, M., Sarwalia, P., Kumar, S., Gohain, M., De, S., Kumar, R. and Datta, T. K. (2018) Propensity in low-grade oocytes for delayed germinal vesicle breakdown compromises the developmental ability of sub-optimal grade (*Bubalus bubalis)* oocytes. *Zygote,* 26 (5): 359-65.	7.11
9	Kumar, S., Chera, J.S., Vats, A., De, S. (2019) Nature of selection varies on different domains of IFI16-like PYHIN genes in ruminants. *BMC Evolutionary Biology,* 19 (1) : 26.	9.03
10	Lotfan, M., Ali, S. A., Yadav, M. L., Choudhary, S., Jena, M. K., Kumar, S. and Mohanty, A. K. (2018) Genome-wide gene expression analysis of 45 days pregnant fetal cotyledons vis-a-vis non-pregnant caruncles in buffalo (*Bubalus bubalis*). *Gene,* 654: 127-37.	NA
11	Maharana, J., Debashis, P. and De, S. (2018). Deciphering the ATP-binding mechanism(s) in NLRP-NACHT 3D models using structural bioinformatics approaches. *PLoS ONE*. 13. e0209420.	8.77
12	Panda, M., Kumar, S., Mishra, P., Sahu, M.C., De, S., Datta, T. K. and Kumar, R. (2018) Effect of exogenous progesterone on cumulus characteristics of buffalo oocytes by allowing passage of more number of sperm through cumulus but not essentially fertilization. *Asian Pacific J. Reprod.,* 7 (2): 79-86.	NA
13	Rashmi, Sah S., Shyam, S., Singh, M. K. and Palta, P. (2019) Treatment of buffalo (*Bubalus bubalis*) SCNT embryos with microRNA-21 mimic improves their quality and alters gene expression but does not affect their developmental competence. *Theriogenology*, 126: 8-16.	8.14
14	Saini, M., Selokar, N. L., Palta, P., Chauhan, M. S., Manik, R. S. and Singla, S. K. (2018) An update: Reproductive handmade cloning of water buffalo (*Bubalus bubalis*). *Anim. Reprod. Sci.,* 197: 1-9.	7.65
15	Selokar, N. L., Saini, M., Palta, P., Chauhan, M. S., Manik, R. S. and Singla, S. K. (2018) Cloning of buffalo, a highly valued livestock species of south and southeast Asia: any achievements? *Cellular Reprogramming,* 20 (2): 89-98.	7.43
16	Sharma, A., Lagah, S. V., Nagoorvali, D., Kumar, B. S. B., Singh, M. K., Singla, S. K., Manik, R. S., Palta, P. and Chauhan. M. S. (2018) Supplementation of glial cell line-derived neurotrophic factor, fibroblast growth factor 2, and epidermal growth factor promotes self-renewal of putative buffalo (*Bubalus bubalis*) spermatogonial stem cells by upregulating the expression of miR-20b, miR-21, and miR-106a. *Cellular Reprogramming,* 21 (1): 11-17.	7.43
17	Sharma, A., Shah S. M., Saini, N., Mehta, P., Kumar, B. S. B., Dua, D., Singh, M. K., Singla, S. K., Palta, P., Manik, R. S. and Chauhan, M. S. (2019) Optimization of serum-free culture conditions for propagation of putative buffalo (*Bubalus bubalis*) spermatogonial stem cells. *Cellular Reprogramming*, 21 (1): 1-10.	7.43
18	Singh, S. K., Kumar, S., Mohanty, A. K., Grover, S. and Kaushik, J. K. (2018) Mechanistic insights into the host-microbe interaction and pathogen exclusion mediated by the Mucus-binding protein of *Lactobacillus plantarum*. *Scientific Reports,* 8 (1): 14198.	10.12
19	Singh, S., Choudhary, S., Anand, V., Jaswal, S., Verma, A. K., Kumar, S., Kaushik, J. K. and Mohanty, A. K. (2019) New insights into the catalytic inactivity of mammary gland protein-40, a chitinase-like protein expressed during mammary gland involution. *Molecular Biology Reports.* Feb 13. doi: 10.1007/s11033-019-04679-w.	7.89

Animal Nutrition Division

Sr. No.	Research Papers	NAAS Rating
1	Deen, A. U., Tyagi, N., Yadav, R. D., Kumar, S., Tyagi, A. K., and Singh, S. K. (2018) Feeding balanced ration can improve the productivity and economics of milk production in dairy cattle: a comprehensive field study. *Tropical Anim. Health and Prod.*, 1-8.	6.98
2	Gupta, S., Mohini, Madhu, Malla, B. A., Mondal, G. and Pandita, S. (2018) Effects of monensin feeding on performance, nutrient utilization and enteric methane production in growing buffalo heifers. *Tropical Anim. Health and Prod.*, http://doi.org/10.1007/s11250-018-17665.	6.98
3	Gupta, S., Mohini, Madhu, Thakur, S. S. and Mondal, G. (2018) Dietary supplementation of monensin for methane mitigation in non pregnant dry Murrah buffaloes. *Indian J. Anim. Nutr.,* 35: 298-304.	5.02
4	Gupta, S., Mohini, Madhu, Thakur, S. S. and Mondal, G. (2018) Effect of dietary monensin supplementation on fecal nitrogen excretion and blood metabolites in non pregnant non lactating Murrah buffaloes. *J. Anim. Res.,* 8: 783-88.	5.68
5	Hegde, M. Sujata, Jaisunder, Singh, Pawan and Datt, Chander (2019) Macro mineral status in soil, plant and dairy cattle in andaman group of islands. *Indian J. Anim. Nutr*. 35: 415-20.	5.02
6	Jaglan, N., Kumar, S., Choudhury, P. K., Tyagi, B. and Tyagi, A. K. (2019) Isolation, characterization and CLA production potential of bifidobacterial isolates from ruminal fluid samples of Murrah buffaloes. *Anaerobe*, https://doi.org/10.1016/j.anaerobe. 2019.02.001.	8.74
7	Khare, Anjali, Mani, Veena, Kumar, Sachin and Thorat, Gaurav (2018) Effect of chicory root powder as prebiotic source to growth and nutrient digestibility of murrah buffalo calves. *J. Entomology and Zoology Studies,* 6 (3): 1424-27.	5.53
8	Khare, Anjali, Mani, Veena, Kumar, Sachin and Thorat, Gaurav (2018) Dietary supplementation of chicory root powder as prebiotic source to augment health of Murrah buffalo calves. *Int. J. Curr. Microbiol. App. Sci.,* 7 (7): 2999-3004.	5.38
9	Khare, Anjali, Thorat, Gaurav, Mani, Veena, Kumar, Sachin (2018) Effect of prebiotic supplementation on faecal characteristic on buffalo calves. *The Pharma Innovation J.,* (7): 215-17.	5.03
10	Khare, Anjali, Thorat, Gaurav, Mani, Veena, Kumar, Sachin, Joysowal, Mamata, Aziz, A. and Gupta, Supriya (2018) Prebiotic inulin and fructooligosachride as an alternative growth promoter in animal. *Int. J. Curr. Microbiol. App. Sci.,* 7 (7): 1026-31.	5.38
11	Khare, Anjali, Thorat, Gaurav, Mani, Veena, Kumar, Sachin, Tyagi, A. K. and Yadav, Vandana (2018) Effect of chicory root powder supplementation on faecal microbiology on Murrah buffalo *J. Entomology and Zoology Studies,* 6 (3) : 240-43.	5.53
12	Khare, Anjali, Thorat, Gaurav, Mani, Veena, Joysowal, Mamta, Aziz, A., Gupta, Supriya, and Shukla, Manish (2018) Fluorine Source and their Impact on Animal Body. *Int. J. Advanced Biological Res.*, 8 (3): 404-07.	NA
13	Kumar, R., Pal, R. P., Mani, V., Kewalramani, N., Datt, C., and Singh, D. (2018) Effect of inorganic vanadium supplementation on mineral balances and their circulatory levels in karan fries calves. *Indian J. Anim. Nutr.*, 35(3): 260-65.	5.02
14	Kumar, Rakesh, Kumar, Dinesh, Datt, Chander, Makarana, Govind, Yadav, M. R. and Birbal (2018) Forage yield and nutritional characteristics of cultivated fodders as affected by agronomic interventions: A Review. *Indian J. Anim. Nutr*., 35: 373-85.	5.02
15	Mir, S. H., Mani, V., Pal, R. P., Malik, T. A., and Sharma, H. (2018) Zinc in ruminants: metabolism and homeostasis. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 1-11.	NA
16	Mohini, Madhu, Malla, Bilal Ahmad and Mondal, Goutam (2018) Small ruminant sector in India: Present status, feeding systems and greenhouse gas emissions. *EC Vety. Sci.,* 3.1.	NA
17	Mondal, G., Kakati, B. K., Mehdi, Mohd and Mir, M. S. (2018) Endoparasite infestation in sheep and goat under field condition of Kargil, Ladakh. *North East Vety,* 18: 24-26.	2.61
18	Mor, P., Bals, B., Kumar, S., Tyagi, N., Reen, J. K., Tyagi, B., Choudhury, P. K. and Tyagi, A. K. (2019) Influence of replacing concentrates mixture with AFEX pellets on rumen fermentation, blood profile and acetamide content in the rumen of crossbred (Alpine× Beetle) female goats. *Small Ruminant Res.*, 170: 109-15.	6.97
19	Mor, P., Bals, B., Tyagi, A. K., Teymouri, F., Tyagi, N., Kumar, S., Bringi, V. and Vande Haar, M. (2018) Effect of ammonia fiber expansion on the available energy content of wheat straw fed to lactating cattle and buffalo in India. *J. Dairy Sci.,* 101: 7990-8003.	8.75
20	Nampoothiri, Vinu M., Mohini, Madhu, Malla, Bilal A., Mondal, Goutam, and Pandita, Sujata (2018) Growth performance, and enteric and manure greenhouse gas emissions from Murrah calves fed diets with different forage to concentrate ratios. *Anim Nutr.* 4 (2): 215-21.	NA
21	Nampoothiri, Vinu, Mohini, Madhu, Malla, Bilal Ahmad, Mondal, Goutam and Pandita, Sujata (2018) Effect of diets with different roughage-to-concentrate proportions on manure methane and nitrous oxide fluxes. *Current J. Applied Sci. and Tech.,* 30 (3): 1-9.	5.32
22	Narvariya, D. S., Chandra, Ramesh, Kumar, Nishant, Roy, A. K., Datt, Chander and Mehla, R. K. (2018) Supplementary feeding: Effect on growth and blood metabolites in Sahiwal heifers. *Indian J. Anim. Nutr*., 35: 161-65.	5.02

Sr. No.	Research Papers	NAAS Rating
23	Pal, R. P., Mani, V., Tripathi, D. and Datt, C. (2018) Inorganic vanadium supplementation in crossbred calves: effects on antioxidant status, immune response and haemato-biochemical attributes. *Biological Trace Element Res.*, 186 (1): 154-61.	8.36
24	Pal, R. P., Mani, V., Tripathi, D., Kumar, R., and Kewalramani, N. (2018) Influence of feeding inorganic vanadium on growth performance, endocrine variables and biomarkers of bone health in crossbred calves. *Biological Trace Element Res.*, 182 (2): 248-56.	8.36
25	Tripathi, D., Mani, V., and Pal, R. P. (2018) Effect of vanadium supplementation on production performance, nutrient utilization, plasma mineral concentration and mineral balance in lactating goats. *Biological Trace Element Res.,* 1-7.	8.36
26	Tripathi, D., Mani, V. and Pal, R. P. (2018) Vanadium in biosphere and its role in biological processes. *Biological Trace Element Res.*, 186 (1): 52-67.	8.36
27	Vinceti, M., Chawla, R., Filippini, T., Dutt, C., Cilloni, S., Loomba, R., Bargellini, A., Orsini, N., Dhillon, K. S. and Whelton, P. (2019) *Nutr., Metabolism & Cardiovascular Diseases*. 29: 398-408.	NA

Forage Research & Management Section

Sr. No.	Research Papers	NAAS Rating
1	Ginwal, D. S., Kumar, R., Ram, H., Meena, R. K. And Kumar, U. (2019) Quality characteristics and nutrient yields of maize and legume forages under changing intercropping row ratios. *Indian J. Anim. Sci.,* 89 (3) : 281-86.	6.28
2	Hindoriya, P. S., Meena, R. K., Singh, M., Kumar, R., Ram, H., Meena, V. K. and Kushwaha, M. (2019) Evaluation of kharif forage crops for biomass production and nutritional parameters in Indo-gangetic plains of India. *Indian J. Anim. Nutr.,* 36 (1): 25-29.	5.02
3	Kumar, R., Kumar, D., Datt, C., Makarana, G. and Yadav, M. R. (2018) Forage yield and nutritional characteristics of cultivated fodders as affected by agronomic interventions: A Review. *Indian J. Anim. Nutr.*, 35 (4) : 373-85.	5.02
4	Kumar, S., Sharma, P. K., Yadav, M., Sexena, R., Gupta, K. C., Kumar, R., Garg, N. K. and Yadav, H. L. (2019) Effect of irrigation levels and moisture conserving polymers on growth, productivity and profitability of wheat *(Triticum aestivum). Indian J. Agril. Sci.*, 89 (3): 509-14.	6.23
5	Kushwaha, M., Singh, M., Kumar, R., Tyagi, N., Soni, P. G., Choudhary, S. and Makarana, G., (2018) Yield and quality of multicut fodder sorghum as affected by nutrient levels and biofertilizer application. *Indian J. Anim. Nutr.*, 35 (1): 82-89.	5.02
6	Makarana, G. Yadav, R. K., Kumar, R., Sheoran, P., Soni, P. G., Yadav, T. and Meena, V. K. (2018) Morphological and yield response of pearl millet *(Pennisetum Glaucum L.)* as influenced by different accessions and cutting management under saline irrigation water in North Western Region of India. *Chemical Sci. Review and Letters,* 7 (26) : 616-24.	5.21
7	Makarana, G., Yadav, R. K., Kumar, R., Kumar, A., Soni, P. G., Kar, S. and Rajvaidya, S. K. (2018) Fodder and grain quality of pearl millet *(Pennisetum Glaucum L.)* under cutting management in saline irrigation water. *J. Pharmacognosy and Phytochemistry*, 7 (3) : 1251-57.	5.21
8	Mallikarjun, Ram, H., Kumar, R., Meena, R. K. and Ginwal, D. (2018) Yield and chemical composition of cowpea (Vigna unguiculata) fodder as affected by tillage practices and nitrogen management. *Indian J. Anim. Nutr.,* 35 (3) : 333-38.	5.02
9	Pandey, A. K., Singh, M., Thakur, S. S., Kumar, R., Meena, R. K., Basak, N., Meena, V. K., Kushwaha, M., Tamta, A. and Subrahmanya, D. J. (2018) Yield and chemical composition of fodder guar *(Cyamopsis Tetragonoloba L.)* as affected by harvesting stage and zinc application. *Indian J. Anim. Nutr.*, 35 (2): 186-90.	5.02
10	Ram, H., Singh, R. K., Pal, G., Agarwal, D. K. and Kumar, R. (2018) Effect of tillage practices and genotypes on growth, seed yield and nutrient uptake in wheat *(Triticum aestivum). Indian J. Agril. Sci.*, 88 (11): 117-21.	6.23
11	Tamta, A., Kumar, R., Ram, H., Meena, R. K., Kumar, U., Yadav M. R., Subrahmanya, D. J. and Pandy, A. K. (2019) Nutritional portfolio of maize and cowpea fodder under various intercropping ratio and balanced nitrogen fertilization. *Indian J. Anim. Sci.,* 89 (3) : 280-85.	6.28
12	Tamta, A., Kumar, R., Ram, H., Meena, R. K., Meena, V. K., Yadav, M. R. and Subrahmanya, D. J. (2019) Productivity and profitability of legume-cereal forages under different planting ratio and nitrogen fertilization. *Legume Res. - An Int. J.*, 42 (1): 102-07.	6.23
13	Yadav, N., Yadav, S. S., Yadav, N., Yadav, M. R., Kumar, R., Yadav, L. R., Yadav, L. C. and Sharma, O. P. (2018) Growth and productivity of groundnut *(Arachis Hypogaea L.)* under varying levels and sources of sulphur in semi-arid conditions of Rajasthan. *Legume Res.: An Int. J.*, 41 (2): 293-98.	6.23
14	Yadav, T., Chopra, N. K., Chopra, N. K., Kumar, R. and Soni, P. G., (2018) Assessment of critical period of crop-weed competition in forage cowpea (Vigna unguiculata) and its effect on seed yield and quality. *Indian J. Agronomy*, 63 (1): 124-27.	5.46

Animal Physiology Division

Sr. No.	Research Papers	NAAS Rating
1	Aggarwal, Anjali and Chandra, Gulab (2018) The effect of additional supplementation of vitamin E and zinc on endocrine and metabolic changes in dairy cows during peripartal period. *Veterinarski Arhiv.*, 88 (6): 733-48.	6.29
2	Ajithakumar, H. M., Singh, Mahendra, Punetha, Meeti, Sarangi, Archana, Patel, Brijesh and Rayees, M. D. (2018) Augmentation of productive performance of murrah buffaloes fed with prilled fat and yeast culture in periparturient period. *Int. J. Livestock Res.,* 8 (3): 52-58. http://dx.doi.org/10.5455/ ijlr. 201709140 52050	5.36
3	Alhussien, M. N. and Dang, A. K. (2018). Pathogen-dependent modulation of milk neutrophils competence, plasma inflammatory cytokines and milk quality during intramammary infection of Sahiwal (*Bos indicus*) cows. *Microbial Pathogenesis,* 05/2018; 121., DOI:10.1016/ j.micpath.2018.05.029.	8.33
4	Alhussien, M. N., Kamboj, A., Aljader, M. A., Panda, S. K., Yadav, M. L., Sharma, L., Mohammed, S., Sheikh, A. A., Lotfan, M., Kapila, R., Mohanty, A. K. and Dang, A. K. (2018). Effect of tropical thermal stress on peri-implantation immune responses in cows. *Theriogenology*, 03/2018: 114, DOI:10.1016/ j.theriogenology.2018.03.036.	8.14
5	Alhussien, M. N. and Dang, A. K. (2019) Potential role of neutrophils in maintaining the health and productivity of dairy cows during various physiological and physiopathological conditions: A review. *Immunologic Res.,* Doi: 10.1007/s/2026-019-9064-5.	NA
6	Chandra, Gulab, Aggarwal, Anjali, Kumar, Muneendra (2018) Effect of zinc and vitamin E supplementation on hormones and blood biochemicals in peripartum Sahiwal cows. *J. Trace Elements in Medicine and Biology,* DOI 10.1016/j.jtemb.2018.02.015.	9.76
7	Dar, Mohammad Rayees, Singh, Mahendra, Sharma, Rachana, Thakur, Sunita, Sheikh, Aasif Ahmad and Showkat A. B. (2018) Bovine fertility as regulated by sperm binding proteins: A review. *Asian J. Anim. Vet. Adv.,* 13: 6-13. 114.	NA
8	Das, R., Gupta, I. D., Verma, A., Chaudhari, M. V., Sailo, L. and Singh, S. V. (2018) Identification of SNPs in ATP1A1 gene and their association with heat tolerance in Sahiwal and Karan Fries (*Bos taurus* × *Bos indicus*) cattle under tropical climatic condition. *Indian J. Dairy Sci.,* 71 (4): 409-15.	5.26
9	Goud, T. S., Upadhyay , R. C., Kumar, A., Karri, S., Choudhary, R., Ashraf, S., Singh, S. V., Kumar, O. S. and Kiranmai, C. (2018) Novel extraction of high quality genomic DNA from frozen bovine blood samples by using detergent method. *Open Vety. J.* 8 (4): 415-22.	NA
10	Grewal, Sonika and Aggarwal, Anjali (2018) Physiological response of periparturient Sahiwal and Karan Fries cows during hot humid and winter seasons. *Int. J. Chemical Studies,* 6 (3): 2258-62.	5.31
11	Jalmeria, N. S., Panth, S., Pandita, S., Roy, A. K., Manju, Ashutosh, Mohanty, T. K., Bhakat, M., Punetha, M. and Gupta, D. (2018) Seasonal variations in hormones and enzymes of seminal plasma and its relationship with semen quality in crossbred cattle bulls. *Biol. Rhythm Res.*,https://doi.org/10.1080/ 09291016.2018.1548873.	6.62
12	Jingar, S. C., Singh, Mahendra, Roy, A. K., Lawania, Pankaj, Kumar, Ajesh and Bugaliya, H. L. (2018) Influence of temperature humidity index and dry period on incidence of mastitis in cattle and buffaloes. *International J. Advanced Biological Res*., 8 (1) : 162-64.	4.64
13	Kumar, Amit, Pandita, Sujata, N. Anand Laxmi, Bhakat, Mukesh and Mohanty, T. K. (2018). Effects of prostasomes on functional parameters of fresh and cryopreserved-thawed spermatozoa of crossbred Karan Fries (KF) bulls. *Indian J. Anim. Res.,* DOI: 10.18805/ijar.B-3665.	6.20
14	Kumar, S. and Singh, S. V. (2018) Influence of astaxanthin supplementation on attainment of puberty and lipid peroxidation in Sahiwal and Karan Fries (Holstein ×Tharparkar) heifers during summer season. *Biological Rhythm Res.,* https://doi.org/10.1080/ 09291016.2018.1512298.	6.62
15	Kumar, S. and Singh, S. V. (2019) Inhibition of NF-κB signaling pathway by astaxanthin supplementation for prevention of heat stress-induced inflammatory changes and apoptosis in Karan Fries heifers. *Tropical Anim. Health Production,* doi: 10.1007/s11250-018-01793-y.	6.91
16	Kumar, S., Singh, S. V. and Bhan, S. C. (2019) Effect of dietary supplementation of astaxanthin (potent antioxidant) on growth rate, DMI, FCR and metabolic changes in Karan Fries heifers during heat stress. *J. Agrometeorology,* 21 (1): 80-88.	6.40
17	Kumar, S., Singh, S. V., Pandey, P., Kumar, S. and Tiwari, M. (2018) Advances in stress physiology and bioenergetics of farm animals: An Overview. *Int. J. Current Microbiology and Applied Sci.,* 7 (4): 580-95.	5.38
18	Manjari, P., Hyder, I., Kapoor, S., Senthilnathan, M. and Dang, A. K. (2018) Exploring the concentration-dependant actions of interferon-tau on bovine neutrophils to understand the process of implantation. *J. Cell. Biochem,* DOI:10.1002/jcb.27345.	8.96

Sr. No.	Research Papers	NAAS Rating
19	Nilufar, Haque, Singh, M. and Hossain, S. A. (2018) Improved milk production through PG–PL system by provision of in-house shelter management in lactating Murrah buffaloes during winter season. *J. Anim. Physiol. & Anim. Nutr.,* 102: 166–74.	7.61
20	Nilufar, Haque, Singh, M. and Hossain, S. A. (2018) The influence of a modified micro- environment on stress and milk production through the plasminogen-plasmin system in Murrah buffaloes during hot humid season. *Vet. Arhiv.,* 2 : 201-13.	6.29
21	Pal, Prasanna, Ghosh, Satarupa, Grewal, Sonika, Sahu, Jyotimala and Aggarwal, Anjali (2019) Role of hormones in persistency of lactation: A review. *J. Entomology and Zoology Studies,* 7 (2): 677-83.	5.53
22	Para, Irshad Ahmad, Singh, Mahendra, Punetha, Meeti, Dar, Aashiq Hussain, Naik, Muzaffar Ahmad, Teliamp, Aamir Salam and Gupta, Deepanshu (2018) Milk production and feed efficiencies as affected by dietary yeast (*Saccharomyces cerevisiae*) supplementation during the transition period in Murrah buffaloes, *Biological Rhythm Res.*, DOI:10.1080/ 09291016.2018.1490869.	6.62
23	Patel, B., Kumar, N., Jain, V., Dang, A. K., Sharma, R., Lathwal, S. S. and Singh, S. V. (2017) Effect of zinc supplementation on production performance and udder health of peri-parturient Karan Fries cows during heat stress. *Indian J. Dairy Sci.,* 70 (4): 447-52.	5.26
24	Priyadarshini, Lakshmi and Aggarwal, Anjali (2018) Astaxanthine inhibits cytokines production and inflammatory gene expression by suppressing IkB kinase dependent NF-Kb activation in pre and postpartum Murrah buffaloes during different seasons. *Vety. World*, 11 (6): 782-88.	5.71
25	Priyadarshini, Lakshmi and Aggarwal, Anjali (2018) HSP70s Expression in peripheral blood mononuclear cells in pre and postpartum Murrah buffaloes during summer and winter seasons with astaxanthin supplementation. *J. Anim. Res.,* 8 (4) : 561-70	5.68
26	Punetha, M., Roy, A. K., Ajithakumar, H. M., Para, I. A, Gupta D., Singh, M. and Jaya, Bharati (2018) Immunomodulatory effects of probiotics and prilled fat supplementation on immune genes expression and lymphocyte proliferation of transition stage Karan Fries cows. *Vety. World*, 11 (2): 209-14.	5.71
27	Punetha, M., Roy, A. K., Para, I. A., Gupta, D., Jalmeria, N. S., Pandey, Y. and Singh, M. (2018) Effect of probiotic and prilled fat on lactation performance of crossbred cow during transition period. *J. Expt. Biol. and Agric. Sci.*, 6 (4): 746-750.	5.07
28	Sharma, R., Yadav, P., Dar, M., Parkunan, T., Singh, P., Singh, M., and Ashutosh, M. (2018) Reproductive performance as affected by mastitis in lactating crossbred cows. *Int. J. Livestock Res.*, 8 (2): 92-98. http://dx.doi.org/10.5455/ijlr.20170615103254.	5.36
29	Sheikh, A. A., Hooda, O. K., Kamboj, A., Mohammed, S., Alhussien, M., Reddi, S., Shimray, P. G., Rautela, A., Pandita, S., Kapila, S., De, S. and Dang, A. K. (2018) Interferon tau stimulated gene expression: A proxy to predict embryonic mortality in dairy cows. *Theriogenology*, DOI: 10.1016/j. theriogenology. 2018.07.028.	8.14
30	Sheikh, Aasif Ahmad, Hooda, O. K., Kalyan, Ankita, Kamboj, Aarti, Seid Mohammed, Alhussien, Mohanned, Reddi, Srinu, Panreiphy Shimray, Gachuiwo, Rautela, Ankita, Pandita, Sujata, Kapila, Suman, De, Sachinandan, Dang, A. K. (2018) Interferon-tau stimulated gene expression: A proxy to predict embryonic mortality in dairy cows. *Theriogenology,* 120: 61-67.	8.14
31	Singh, S. V. (2018) Zebu cattle: Unique adaptive traits for their resilience to climate change. *J. Agrometeorology,* 20: 84-90.	6.40
32	Singh, S. V. and Kumar, S. (2018) Circadian rhythm and their significance in relation to physiological functions of animals: A review. *J. Entomology and Zoology Studies,* 6 (4): 1861-66.	5.53
33	Soren, S., Singh, S. V. (2018) Semen quality, lipid peroxidation and expression of mitochondrial gene in ejaculated sperm of Karan Fries (Tharparkar × Holstein Friesian) bulls supplemented with astaxanthin. *Indian J. Anim. Sci.,* 88 (12): 1346-52.	6.19
34	Soren, S., Singh, S. V., Borah, S., Kumar, A. and Dwivedi, D. K. (2018) Global warming: Impact, adaptation and ameliorative measures of semen quality under tropical climatic conditions in crossbred bulls. *J. Anim. Res.,* 8 (5): 1-9.	5.68
35	Tamboli, P., Chandra, R., Singh, M., Chaurasiya, A. and Sharma, B. (2018) Milking temperament influence on production performance and plasma hormones in Sahiwal cows. *Indian J. Current Microbiol. & Applied Sci.*, 7 (7) : 1283-89.	5.38
36	Velagala, C., Sekhar, Naidu and Singh, S. V. (2018) Expression of deiodinase 2 (DIO2) and integrin alpha 9 (ITGA9) genes as indicators' of adaptability and their relationship with physio-biochemical parameters in Tharparkar and Karan Fries heifers during different seasons. *Indian J. Anim. Sci.,* 88 (9): 1030–36.	6.19

Animal Biochemistry Division

Sr. No.	Research Papers	NAAS Rating
1	Bhat, M. I., Kumari, A., Kapila, S. and Kapila, R. (2018) Probiotic lactobacilli mediated changes in global epigenetic signatures of human intestinal epithelial cells during Escherichia coli challenge. *Annals of Microbiology*. https:// doi.org/10.1007/ s13213-019-01451-0.	7.4
2	Dahiya, S., Kumari, S., Rani, P., Onteru, S. K. and Singh, D. (2018) Postpartum uterine infection & ovarian dysfunction. *Indian J. Med. Res.,* doi: 10.4103/ijmr.IJMR_961_18. *Review.*	7.51
3	De, A., Ali, M. A., Chutia, T.**,** Onteru, S. K., Behera, P., Kalita, G., Kumar, S. and Gali, J. M. (2018) Comparative serum proteome analysis reveals potential early pregnancy-specific protein biomarkers in pigs. *Reprod. Fertil. Dev.,* doi: 10.1071/RD18227.	8.11
4	Golla, N., Chopra, A., Boya, S., Kumar, T. V. C., Onteru, S. K. and Singh, D. (2019) High serum free fatty acids and low leptin levels: Plausible metabolic indicators of negative energy balance in early lactating Murrah buffaloes. *J. Cell Physiol*., doi: 10.1002/jcp. 28081.	9.92
5	Goud, T. S., Upadhyay, R. C., Onteru, S. K., Pichili, V. B. R. and Chadipiralla, K. (2019) Identification and sequence characterization of melanocortin 1 receptor gene (MC1R) in *Bosindicus* versus (*Bostaurus* X *Bosindicus*). *Anim. Biotechnol.,* Mar 19:1-12. doi: 10.1080/10495398.2019.1585866.	6.93
6	Kalyan, S., Meena, S., Kapila, S., Sowmya, K. and Kumar, R. (2018) Evaluation of goat milk fat and goat milk casein fraction for anti-hypercholesterolaemic and antioxidative properties in hypercholesterolaemic rats. *Int. Dairy J.*, 84: 23-27.	8.2
7	Kumar, J., Mitra, D., Hussain, A. and Kaul, G. (2019) Exploration of immunomodulatory and protective effect of Withaniasomnifera on trace metal oxide (zinc oxide nanoparticles) induced toxicity in Balb/c mice. *Mol. Biol. Rep.,* 46 (2): 2447–59.	8.87
8	Kumar, N., Reddi, S., Devi, S., Mada, S. B., Kapila, R. and Kapila, S. (2018). Nrf2 dependent anti-aging effect of milk derived bioactive peptide in old fibroblasts. *J. Cellular Biochemistry*, DOI: 10.1002/jcb.28246.	9.0
9	Mada, S. B., Reddi, S., Kumar, N., Vij, R., Yadav, R., Kapila S. and Kapila, R., (2018). Casein-derived antioxidative peptide prevents oxidative stress-induced dysfunction in osteoblast cells. *Pharmanutrition*, 6: 169-79.	7.56
10	Meena, S., Rajput, Y. S., Sharma, R. and Singh, R. (2019) Effect of goat and camel milk vis-a-vis cow milk on cholesterol homeostasis in hypercholesterolemic rats. *Small Ruminant Res.*, 172: 8-12.	6.97
11	Pandey, M., Singh, D. and Onteru, S. K. (2018) Reverse transcription loop-mediated isothermal amplification (RT-LAMP), a light for mammalian transcript analysis in low-input laboratories. *J Cell Biochem.,* 119 (6) : 4334-38.	8.96
12	Pandey. M., Kapila, S., Kapila, R., Trivedi, R. and Karvande, A. (2018) Evaluation of the osteoprotective potential of whey derived-antioxidative (YVEEL) and angiotensin-converting enzyme inhibitory (YLLF) bioactive peptides in ovariectomised rats. *Food and Function,* 9 (9):4791-4801. http://dx.doi.org/10.1039/ C8FO00620B	9.3
13	Reddi, S., Mada, S. B., Kumar, N., Kumar, R., Ahmad, N., Karvande, A., Kapila S., Kapila, R. and Trivedi, R. (2018) Antiosteopenic Effect of Buffalo Milk Casein-Derived Peptide(NAVPITPTL) in Ovariectomized Rats. *Int. J. Peptide Res. and Therapeutics*, https://doi.org/ 10.1007/s10989-018-9763-0	8.2
14	Samtiya, M., Bhat, M. I., Gupta, T., Kapila, S. and Kapila, R. (2018) Safety Assessment of Potential Probiotic Lactobacillus fermentum 6 MTCC-5898 in Murine Model after Repetitive Dose for 28 Days 7 (Sub-Acute Exposure). *Probiotics and Antimicrobial Proteins,* https://doi.org/10.1007/s12602-019-09529-6.	8.35
15	Sanand, S., Kumar, S., Bara, N. and Kaul, G. (2018) Comparative evaluation of half-maximum inhibitory concentration and cytotoxicity of silver nanoparticles and multiwalled carbon nanotubes using buffalo bull spermatozoa as a cell model. *Toxicol Ind. Health*, 34 (9) : 640-52.	8.07
16	Sharma, D., Golla, N., Singh, S., Singh, P. K., Singh, D. and Onteru, S. K. (2019) An efficient method for extracting next-generation sequencing quality RNA from liver tissue of recalcitrant animal species. *J. Cell Physiol*., doi: 10.1002/jcp.28226.	9.92
17	Shukla, A., Dahiya, S**.,** Onteru S. K., and Singh, D. (2018) Differentially expressed miRNA-210 during follicular-luteal transition regulates pre-ovulatory granulosa cell function targeting HRas and EFNA3. *J. Cell Biochem*., 119 (10) : 7934-43.	8.96
18	Sowmya, K., Bhat, M. I., Bajaj, R. K., Kapila, S. and Kapila, R. (2018) Antioxidative and anti-inflammatory potential with trans-epithelial transport of a buffalo casein-derived hexapeptide (YFYPQL). *Food Bioscience,* 28 (2019) 151–163.	8.37
19	Sowmya, K., Bhat, M. I., Bajaj, R. K., Kapila, S. and Kapila, R. (2018) Buffalo milk casein derived decapeptide (YQEPVLGPVR) having bifunctional anti-inflammatory and antioxidative features under cellular milieu. *Int. J. Peptide Res. and Therapeutics.*	7.13

Sr. No.	Research Papers	NAAS Rating
20	Sowmya, K., Mala, D., Bhat, M. I.,Kumar, N., Bajaj, R. K.,, Kapila, S. and Kapila, R. (2018) Bio-accessible milk casein derived tripeptide (LLY) mediates overlapping anti-inflammatory and anti-oxidative effects under cellular (Caco-2) and *in vivo* milieu. *J. Nutritional Biochemistry,* 62: 167-80.	10.42
21	Vedamurthy, G. V., Ahmad, H., Onteru, S. K. and Saxena, V. K. (2019) *In silico* homology modelling andprediction of novel epitopic peptides from P24 protein of Haemonchuscontortus. *Gene,*. doi: 10.1016/j.gene.2019.03.056.	8.50
22	Yadav, R., Dey, D. K., Vij, R., Meena, S., Kapila, R. and Kapila, S. (2018) Evaluation of anti-diabetic attributes of *Lactobacillus rhamnosus* MTCC: 5957, *Lactobacillus rhamnosus* MTCC: 5897 and *Lactobacillus fermentum* MTCC: 5898 in streptozotocin induced diabetic rats. *Microbial Pathogenesis,* 125: 454-62.	8.33
23	Yadav, R., Khan, S. H., Mada, S. B., Meena, S., Kapila, R., and Kapila, S. (2018) Consumption of probiotic *lactobacillus fermentum* MTCC:5898 fermented milk attenuates dyslipidemia, oxidative stress,and inflammation in male rats fed on cholesterol-enriched diet. *Probiotics and Antimicrobial Proteins,* 1-10 https://doi.org/10.1007/s12602-018-9429-4	8.34
24	Yadav, R., Vij, R., Kapila, S., Khan, S. H., Kumar, N., Meena, S. and Kapila, R. (2019) Milk fermented with probiotic strains *Lactobacillus rhamnosus* MTCC: 5957 and *Lactobacillus rhamnosus* MTCC: 5897 ameliorates the diet-induced hypercholesterolemia in rats. *Annals of Microbiology*, 1-12.	7.41

Dairy Chemistry Division

Sr. No.	Research Papers	NAAS Rating
1	Banjare, Indrajeet Singh, Gandhi, Kamal, Sao, Khushbu, Arora, Sumit, Pandey, Vanita (2019) Physicochemical properties and oxidative stability of milk fortified with spray dried whey protein concentrate–iron complex and in vitro bioaccessibility of the added iron. *Food Tech. and Biotechnology,* 57(1): 5945.	7.168
2	Bhatia, Piyush, Sharma, Vivek, Arora, Sumit and Rao, Priyanka Singh (2019) Effect of cholesterol removal on compositional and the physicochemical characteristics of anhydrous cow milk fat (cow ghee). *International J. Food Properties,* 22 (1): 1–8.	7.85
3	Bumbadiya, Mitul, Singh, Richa, Pradhan, Diwas, Mann, Bimlesh and Arora, Sumit (2018) Screening of different novel preservatives for milk preservation by microbial analysis. *Int. J. Chemical Studies,* 5(4): 673-77.	5.31
4	Choudhary, Sonika, Arora, Sumit, Kumari, Anuradha, Narwal, Vikrant, Singh, A. K. (2018) Effect of quality of milk on physico-chemical and textural attributes of buffalo milk concentrate (khoa) during storage. *J. Food Sci. and Tech.,* 56: 1302-15.	7.80
5	Fayaz, S., Sharma, R., Rajput, Y. S., Mann, B. and Lata, K. (2018) Estimation of steviol glycosides in food matrices by high performance liquid chromatography. *J. Food Sci. & Tech.,* doi 10.1007/s13197-018-3270-3.	7.80
6	Gandhi, Kamal, Kumar, Anil and Lal, Darshan (2018) Solvent fractionation technique paired with apparent solidification time (AST) test as a method to detect palm olein and sheep body fat in ghee (clarified milk fat). *Indian J. Dairy Sci.,* 71(3): 246-51.	5.26
7	Gandhi, Kamal, Rana, Seema and Kumar, Harish (2018) Solvent fractionation technique paired with complete liquefaction time (CLT) test to detect bland of palm olein and sheep body fat in ghee. *Int. J. Chemical Studies*, 6 (2): 458-63.	5.31
8	Gowda, Avinash, Sharma, Vivek, Goyal, Ankit, Singh, A. K. and Arora, Sumit (2018) Process optimization and oxidative stability of omega-3 ice cream fortified with flaxseed oil microcapsules. *J. Food Sci. Technol.,* 55 (5): 1705–15.	7.80
9	Gupta, Chitra, Arora, Sumit, Syama, M. A. and Sharma, Apurva (2018) Physicochemical characterization of native and modified sodium caseinate-Vitamin A complexes. *Food Res. Int.,* 106: 964–73.	9.52
10	Hazra, Tanmay, Sharma, Vivek, Sharma, Rekha and Arora, Sumit (2018) PCR based assay for the detection of cow milk adulteration in buffalo milk. *Indian J. Anim. Res.,* 52 (3): 383-87.	6.20
11	Hooda, A., Mann, B., Sharma, R., Bajaj, R., Singh, S. and Ranvir, S. (2018) Effect of ethanol on physico-chemical properties of micellar casein concentrate. *Int. J. Current Microbiology and Applied Sci.,* 7: 1635-44.	5.38
12	Hooda, A., Mann, B., Sharma, R., Bajaj, R., Sen, M., Singh, S. and Ranvir, S. (2018) Characterization of micellar casein concentrate prepared from goat milk. *Int. J. Chemical Studies,* 6: 100-14.	5.31
13	Kandhol, Rakesh, Sharma, Vivek, Arora, Sumit, Rao, Priyanka Singh, Singh, Richa and Gupta, Hariram (2017) Efficiency of physico- chemical constants vis- a- vis reversedphase thin layer chromatography in evaluating the quality of fat in market samples of paneer. *Indian J. Dairy Sci.,* 70 (2): 215- 220.	5.26

Sr. No.	Research Papers	NAAS Rating
14	Mor, Sonia, Sharma, Vivek and Arora, Sumit (2018) Effect of season, heat clarification temperature and ripening of cream on physico-chemical parameters of Ghee. *Int. J. Chemical Studies.* 6 (2): 2894-2900.	5.31
15	Padghan P. V.; Mann, B. and Sharma, R. (2018) In-vivo studies of antioxidant activity of fermented milk (Lassi) by Lactobacillus acidophilus and standard dahi culture. *J. Pharmacognosy and Phytochemistry,* 7 (2): 25-30.	5.21
16	Rao, Priyanka Singh, Nichal, Mayur A., Harisha, Bodemala, Bajaj, Rajesh and Mann, Bimlesh (2018) Comparison of pH stat and O-phthalaldehyde method for degree of hydrolysis measurement of alcalase and flavourzyme digested casein. *Indian J. Dairy Sci.,* 71 (1).	5.26
17	Shilpashree, B. G. and Arora, Sumit (2018) Effect of succinylation on mineral binding ability of whey proteins and its effect on physicochemical characteristics of proteins. *J. Food Measurement and Characterization,* 12: 2324-38.	7.181
18	Shilpashree, B. G., Arora, Sumit, Kapila, Suman and Sharma, Vivek (2018) Physicochemical characterization of mineral (iron/zinc) bound caseinate and their mineral uptake in Caco-2 cells. *Food Chemistry,* 257: 101–11.	10.95
19	Sonu, K. S., Mann, B., Sharma, R., Kumar, R. and Singh, R. (2018) Physico-chemical and antimicrobial properties of d-limonene oil nanoemulsion stabilized by whey protein–maltodextrin conjugates. *J. Food Sci. & Tech.,* https://doi.org/10.1007/s13197-018-3198-7.	7.90
20	Syama, M. A., Arora, Sumit, Gupta, Chitra, Sharma, Apurva and Sharma, Vivek (2019) Enhancement of vitamin D2 stability in fortified milk during light exposure and commercial heat treatments by complexation with milk proteins. *Food Biosci.,* 29 : 17-23.	8.37
21	Yadav, Kanta, Bajaj, Rajesh Kumar, Mandal, Surajit, Saha, Priti and Mann, Bimlesh (2018) Evaluation of total phenol content and antioxidant properties of encapsulated grape seed extract in yoghurt. *Int. J. Dairy Tech.*, 71 (1): 96-104.	7.23

Dairy Technology Division

Sr. No.	Research Papers	NAAS Rating
1	Aggarwal, D., Sabikhi, L., Sathish, K. M. H. and Raju, P. N. (2018) Investigating the effect of resistant starch, polydextrose and biscuit improver on the textural and sensory characteristics of dairy-multigrain composite biscuits uses response surface methodology. *J. Food Meas Charact,* 12: 1167-76.	NA
2	Badola, R., Panjagari, N. R., Singh, R. R. B., Singh, A. K. and Prasad, W. G. (2018) Effect of clove bud and curry leaf essential oils on the anti-oxidative and anti-microbial activity of burfi, a milk-based confection. *J. Food Sci. Technol.,* 55, 4802-10.	7.80
3	Borad, S. G., Singh, A. K., Kapila, S., Behare, P.V., Arora, S., and Sabikhi, L. (2019) Influence of unit operations on immunoglobulins and thermal stability of colostrum fractions. *Int. Dairy J.,* 93: 85-91.	8.21
4	Das, A., Sanyal, M. K., Debnath, A. and Ganguly, S. (2018) Development of spiced and smoked sausage from buffalo milk. *J. Pharmacognosy and Phytochem,* 7: 121-25.	5.21
5	Das, J., Raju, R., Sirohi, S., Chandel, B. S., Raju, P. N. and Meena, B. S. (2018). Consumption pattern of fermented probiotic dairy products in metropolitan Delhi. *Agril. Econ. Res. Rev.,* 31: 191.	NA
6	Ganguly, S., Sabikhi, L. and Singh, A. K. (2019) Effect of whey-pearl millet-barley based probiotic beverage on Shigella-induced pathogenicity in murine model. *J. Funct. Foods,* 54 : 498-505.	9.47
7	Hossain, S., Khetra, Y., Khade, S. and Ganguly, S. (2018) Bioactivity of cheddar cheese during ripening. *Int. J. Chem. Studies*, 6: 1583-87.	5.31
8	Hussain, S. A., Yadav, V., Reddi, S., Patil, G. R., Singh, R. R. B. and Kapila, S. (2019) Thermal processing conditions affect in vitro immunostimulatory activity of Aloe vera juice. *J. Appl. Res. Med. Aromatic Plants*, 12: 73-77.	NA
9	Khetra, Y., Kanawjia, S. K., Puri, R., Kumar, R., and Meena, G. S. (2019) Using taste-induced saltiness enhancement for reducing sodium in Cheddar cheese: Effect on physico-chemical and sensorial attributes. *Int. Dairy J.*, 91: 165-71.	8.21
10	Kumar, C.T.M., Sabikhi, L., Singh, A. K., Raju, P. N., Kumar, R. and Sharma, R. (2019) Effect of incorporation of sodium caseinate, whey protein concentrates and transglutaminase on the properties of depigmented pearl millet based gluten free pasta. *LWT-Food Sci. Technol.,* 103: 19-26.	9.13
11	Kumar, M., Panjagari, N. R., Kanade, P. P., Singh, A. K., Badola, R., Ganguly, S., Behare, P. V., Sharma, R. and Alam, T. (2018) Sodium caseinate-starch-modified montmorillonite based biodegradable film: Laboratory food extruder assisted exfoliation and characterization. *Food Packaging Shelflife,* 15: 17-27.	9.3
12	Lodh, J., Khamrui, K. and Prasad, W. G. (2018) Optimization of heat treatment and curcumin level for the preparation of anti-oxidant rich ghee from fermented buffalo cream by central composite rotatable design. *J. Food Sci. Technol.,* 55: 1832-39.	7.80

Sr. No.	Research Papers	NAAS Rating
13	Meena, G. S., Dewan, A., Upadhyay, N., Barapatre, R., Singh A. K., and Rana, J. S. (2019) Fuzzy analysis of sensorial attributes of gluten free pasta manufactured from brown rice, amaranth, flaxseed flours and whey protein concentrates. *J. Food Sci. Nutr. Res.,* 2: 22-37.	NA
14	Meena, G. S., Singh, A. K., Gupta, V. K., Borad, S. and Parmar P. T. (2018) Effect of change in pH of skim milk and ultrafiltered/diafiltered retentates on milk protein concentrates (MPC70) powder properties, *J. Food Sci. Technol.,* 55: 3526-37.	7.80
15	Meena, G. S., Singh, A. K., Gupta, V. K., Borad, S., Arora, S. and Tomar, S. K. (2019) Alteration in physicochemical, functional, rheological and reconstitution properties of milk protein concentrate powder by ph, homogenization and diafiltration. *J. Food Sci. Technol.,* 56: 1622-30.	7.80
16	Parmar, P., Singh, A. K., Gupta, V. K., Borad, S. and Raju, P.N. (2018) Effect of packaging materials on shelf-life of basundi manufactured using ohmic heating. *Indian J. Dairy Sci.,* 71: 215-22.	5.26
17	Parmar. P., Singh. A. K., Meena, G. S., Borad, S. and Raju, P. N. (2018) Application of ohmic heating for concentration of milk. *J. Food Sci. Technol.,* 55: 4956-63.	7.80
18	Patil, A.T., Meena, G. S., Upadhyay, N., Borad, S., Khetra, Y. and Singh, A. K. (2018) Effect of change in pH, heat treatment and diafiltration on properties of medium protein buffalo milk protein concentrate. *J. Food Sci. Technol.,* 56: 1462-72.	7.80
19	Prasad, W., Khamrui, K., Badola, R., Sandhya, S. and Gupta H. R. (2018) Effect of incorporation of herbal essential oil on anti-oxidative, instrumental color and sensorial attributes of burfi. *Indian J. Dairy Sci.,* 72: 70-75.	5.26
20	Prasad, W., Khamrui, K., Mandal, S. and Badola, R. (2018) Effect of combination of essential oils on physico-chemical and sensorial attributes of burfi in comparison to individual essential oil and BHA. *Int. J. Dairy Technol.,* 71: 810-19.	7.23
21	Rani, R., Sabikhi, L. and Sathish, M. H. K. (2018) Cost estimation of ready-to-serve composite milk-sorghum based breakfast smoothie. *Indian J. Dairy Sci.,* 71: 162-67.	5.26
22	Sandhya, S., Khamrui, K., Prasad, W. G. and Kumar, C. T. M. (2018) Preparation of pomegranate peel extract powder and evaluation of its effect on functional properties and shelf life of curd. *LWT-Food Sci. Technol.,* doi: 10.1016/j.lwt.2018.02.057.	9.13
23	Sharma, H., Mendiratta, S. K., Agarwal, R. K. and Awasthi, M. G. (2018) Optimization of various essential oils and their effect on the microbial and sensory attributes of chicken sausages, *Agric. Res.*, https://doi.org/10.1007/s40003-018-0367-x.	5.90
24	Sharma, H., Mendiratta, S. K., Agarwal, R. K., Talukder, S. and Kumar, S. (2018) Studies on the potential application of blends of essential oils as antioxidant and anti-microbial preservatives in emulsion based chicken sausages. *Brit. Food J.*, 120: 1398-1411.	7.80
25	Sharma, M., Yadav, D. N., Singh, A. K., Vishwakarma, R. K. and Sabikhi, L. (2018) Impact of octenyl succinylated pearl millet (*Pennisetum typhoides*) starch addition as fat replacer on the rheological, textural and sensory characteristics of reduced fat yoghurt. *Int. J. Dairy Technol.*, 71: 723-33.	7.23
26	Soni, A., Gurunathan, K., Mendiratta, S. K., Talukder, S., Jaiswal, R. K. and Sharma, H. (2018) Effect of essential oils incorporated edible film on quality and storage stability of chicken patties at refrigeration temperature (4±1°C). *J. Food Sci. Technol.,* 55: 3538-46.	7.80

Dairy Microbiology Division

Sr. No.	Research Papers	NAAS Rating
1	Ali, S., Kumar, S., Mohanty, A. K. and Behare, P. V. (2018) Draft genome sequence of *Lactobacillus* fermentum NCDC400 isolated from a traditional Indian dairy product. *Genome Announcements,* 6 (2).pii:e01492-17.	NA
2	Anand, S., Garre, M., Saini, P., Beniwal, A. and Grover, C. R. (2018) Synbiotic yogurt supplemented with *Ocimum sanctum* essential oil. *Int. J. Curr. Microbiol. App. Sci.,* 7: 1250-62.	5.38
3	Anand, S., Mandal, S., Singh, K. S., Patil, P., and Tomar, S. K. (2018) Synbiotic combination of *Lactobacillus rhamnosus* NCDC 298 and short chain fructooligosaccharides prevents enterotoxigenic *Escherichia coli* infection. *LWT-Food Sci. and Techol.,* 98 : 329-34.	9.13
4	Bachanti, P., Vij, S., Patil, M. R., Bajad, D. N., Shaikh, A., and Kalyankar, S. D. (2018) Antimicrobial activity of casein fermentate of probiotic *Lactobacillus* spp. *Asian J. Dairy & Food Res.*, 37: 175-81.	4.20
5	Behare, P. V., Gupta, H. R. Jagan Mohan., Rawat, H. and Mandal, S. (2018) Technological evaluation of exopolysaccharides producing lactic cultures for set and stirred fermented milk products. *Indian J. Dairy Sci.,* 70: 491-95.	5.26
6	Goyal, C., Malik, R. K. and Pradhan, D. (2018) Purification and characterization of a broad spectrum bacteriocin produced by a selected *Lactococcus lactis* strain 63 isolated from Indian dairy products. *J. Food Sci. Technol.,* 55: 3683-92.	7.80
7	Kumar, N. Kumari, V. Ram, C., Thakur, K. and Tomar, S. K. (2018) Bio-prospectus of cadmium bioadsorption by lactic acid bacteria to mitigate health and environmental impacts. *Appl. Microbiol. Biotechnol.,* 102 : 1599-1615.	9.34

Sr. No.	Research Papers	NAAS Rating
8	Makwana, M., Grover, C. R. and Kumar, N. (2018) Biocides resistance profiles of biofilm forming bacteria of dairy niche and their control. *Int. J. Curr. Microbiol. App. Sci.,* 2: 1194-2005. https://doi.org/10.20546/ijcmas. 2018.702.147	5.38
9	Mallappa., R. H., Singh, D. K., Rokhana, N., Pradhan, D., Batish, V. K. and Grover, S. (2019) Screening and selection of probiotic *Lactobacillus* strains of Indian gut origin based on assessment of desired probiotic attributes combined with principal component and heatmap analysis. *LWT-Food Sci. and Technol.,* 105: 272-81.	9.13
10	Minj, J. and Vij, S. (2018) Effect of prebiotic inulin on the fermentation and growth kinetics pattern of probiotic yoghurt bacteria. *Int. J. of Curr. Microbiol. App. Sci.,* 6: 1755-68.	5.38
11	Mohan, J., Ali, S. A., Suvartan, R., Kapila, S., Sharma, R., Tomar, S. K. and Yadav, H. (2018) Bioavailability of biotransformed zinc enriched dahi in wistar rats. *Int. J.* Probiotics Prebiotics., 13: 45-54.	NA
12	Panicker, A., Ali S. A., Anand, S., Raju, P. P. N., Kumar, S., Mohanty, A. K. and Behare P. V. (2018) Evaluation of some *in vitro* probiotic properties of *Lactobacillus fermentum* Strains. *J. Food Sci. Technol.,* 55 : 2801-07.	7.26
13	Panwar, R., Kumar, N., Kashyap, V., Ram, C. and Kapila, R. (2018) Aflatoxin M1 Detoxification ability of probiotic lactobacilli of Indian origin in *in vitro* digestion model. Probiotics *Antimicrob.* Proteins, https://doi.org/10.1007/ s12602-018-9414-y	8.36
14	Pradhan, D., Singh, R., Tyagi, A., Rashmi, H. M., Batish, V. K. and Grover, S. (2019) Assessing safety of *Lactobacillus plantarum* MTCC 5690 and *Lactobacillus fermentum* MTCC 5689 using in vitro approaches and an in vivo murine model. *Regul. Toxicol. Pharmacol.,* 101 : 1-11.	NA
15	Pradhan, D., Singh, R., Tyagi, A., Rashmi, H. M., Batish, V. K. and Grover, S. (2018) Assessing the safety and efficacy of *Lactobacillus plantarum* MTCC 5690 and *Lactobacillus fermentum* MTCC 5689 in colitis mouse model. Probiotics *Antimicrob.* Proteins, DOI: 10.1007/s12602-018-9489-5.	8.35
16	Pradhan, D., Goyal, C., Malik, R. and Narsaiah, K. (2018) Efficacy of alginate: Nanoliposome encapsulated pediocin against *L. innocua* in milk system. *Int. J. Chem. Stud.,* 6: 1371-76.	5.31
17	Saini, P., Beniwal, B., Kokkiligadda, A. and Vij, S. (2018) Response and tolerance of yeast to changing environmental stress during ethanol fermentation. Process Biochem**.,** 72 : 1-12.	8.62
18	Saini, P. and Vij, S. (2018) Molecular characterization and identification of bioactive peptides producing Lactobacillus sp. based on 16S rRNA gene sequencing. *Food Biotechnol.,* 32 : 1–14.	6.60
19	Sharma, P., Anand, S., Tomar, S. K. and Goswami, P. (2018) Antibiotic susceptibility of *Lactobacillus* sp. isolated from commercial probiotic products by E-test strip method. *Int. J. Curr. Microbiol. App. Sci*., 7: 3499-3517.	5.38
20	Singh, B. P. and Vij, S. (2018). α-Galactosidase activity and oligosaccharides reduction pattern of indigenous *lactobacilli* during fermentation of soy milk. *Food Biosci.,* 22 : 32-37.	8.37
21	Singh, B. P. and Vij, S. (2018) *In vitro* stability of bioactive peptides derived from fermented soy milk against heat treatment, pH and gastrointestinal enzymes. *LWT-Food Sci. and Technol.,* 91 : 303-07.	9.13
22	Singh, N. A., Kumar, N., Raghu, H. V., Bhand, S., Chandra, S. and Shrama, P. K. (2018) A spore-based miniaturized novel assay for rapid aflatoxin detection in milk. *Environ. Chem. Lett*., DOI: 10.1007/s10311-018-00834-0.	9.13
23	Tehri, N., Kumar, N., Raghu H V. and Vashishth, A. (2018) Biomarkers of bacterial spore germination. *Annals Microbiol.,* 68 : 513-23.	7.41
24	Tehri, N., Kumar, N., Yadav, A., Raghu H.V. and Singh, N. A. (2018) Sugars mediated germination in spores of *Bacillus megaterium*. *Int. J. Microbiology Res.,* 10: 1058-61.	4.77
25	Varsha, S., Mandal, S. and Tomar, S. K. (2018) Antibiotic susceptibility profile of *Pediococcus* spp. from diverse sources. *3 Biotech.,* 489.	7.50

Dairy Enginering Division

Sr. No.	Research Papers	NAAS Rating
1	Barge, R. S., Barnwal, P., Deep, A. and Wale, G. S. (2018) An experimental study on freezing of Kulfi using cryogen. *Indian J. Dairy Sci.,* 71 (4): 353-59.	5.26
2	Barnwal P., Singh K. K., Sharma A., Yadav, D. N. and Saxena S. N. (2018) Grinding performance of cryogenic spice grinding system for coriander. *Int. J. Seed Spices,* 8 (1): 1-6.	3.91
3	Barnwal P., Singh K. K., Sharma A., Yadav, D. N. and Saxena, S. N. (2018) Performance evaluation of cryogenic spice grinding system for fenugreek powder production. *Int. J. Seed Spices,* 8 (2): 6-11.	3.91
4	Deshwal, G. K., Panjagari, N. R., Badola, R., Singh, A. K., Minz, P. S., Ganguly, S., and Alam, T. (2018) Characterization of biopolymer-based UV-activated intelligent oxygen indicator for food-packaging applications. *J. Packaging Tech. and Res.,* 2 (1): 29-43.	NA
5	Minz, P. S., Sawhney, I. K., and Saini, C. S. (2018) Algorithm for automatic calibration of color vision system in foods. *J. Food Measurement and Characterization*, 1-8.	

Sr. No.	Research Papers	NAAS Rating
6	Saxena, S. N., Barnwal, P., Balasubramanian, S., Yadav, D. N., Lal, G., and Singh, K. K. (2018) Cryogenic grinding for better aroma retention and improved quality of Indian spices and herbs: A review. *J. Food Process Engineering,* 41(6): e12826.	7.96
7	Singh G., Singh P. J., Tyagi V. V., Barnwal P., and Pandey A. K. (2019). Exergy and thermo-economic analysis of ghee production plant in dairy industry. *Energy*, 167: 602-18.	10.97
8	Singh G., Singh P. J., Tyagi V. V., Barnwal P., and Pandey A. K. (2019) Exergy and thermoeconomic analysis of cream pasteurisation plant. *J. Thermal Analysis and Calorimetry,* 1-20.	8.21
9	Singh, M., Kumar, B., Minz, P. S., and Singh, G. (2018) Effect of process parameters on colour attributes of rice kheer produced using mechanized system. *Indian J. Dairy Sci.,* 71(4): 330-37.	5.26
10	Wale, G. S., Barnwal, P., Deep, A. and Barge, R. S. (2019) Evaporative performance of single tube and multi tube falling film evaporator prototypes for molten butter: An experimental study. *Indian J. Dairy Sci.,* 72 (1): 59-69.	5.26

Dairy Economics Statistics & Management Division

Sr. No.	Research Papers	NAAS Rating
1	Bijla, S. and Singh,A. (2019) Economic study of Gaushalas in Haryana: Functioning and profitability. *Indian J. Dairy Sci.,* 72: 97-107.	5.26
2	Bijla, S., Khalandar, S., Sharma, P. and Singh, A. (2019) An analysis of constraints faced by Gaushalas in Haryana. *Economic Affairs,* 64: 1-6.	4.82
3	Bhandari, G., Chandra, S., Gupta, M., Katiyar, R., Ravi, Y. and Gorain, B. (2018) Factors stalling agricultural growth-micro-level evidence from Karsanda village of Uttar Pradesh. *Int. J. Pure and Applied Biosci.,* 6: 72-79. doi: http://dx.doi.org/10.18782/2320-7051.7082	4.74
4	Bhandari, G. and Reddy, B. V. C. (2018) Economic analysis of milk production and marketed surplus in migrant and non-migrant member households of hilly district of Pithoragarh, Uttarakhand. *Int. J. Agri. Sci.,* 10: 7549-52.	4.20
5	Horo, Aniketa and Chandel, B. S. (2018) What are the constraints in crossbreeding programme and technology in Jharkhand? *Indian J. Eco. and Develop.*, 14(1): 126-32. DOI: 1.10.5958/2322-0.430.2018.00014.8.	4.82
6	Kharkwal, S. and Malhotra, R. (2018) Cropping pattern and economics of cereals production in diverse seasons of Uttarakhand hills. *J. Plant Develop. Sci.,* 10: 605-10.	4.57
7	Kumari, B. and Malhotra, R. (2019) Socio-economic empowerment of women through women dairy co-operatives: A study of Begusarai district of Bihar. *Indian J. Eco. and Develop.,* 15: 91-97. doi: 10.5958/2322-0430.2019.00010.6.	4.82
8	Kumari, B., Chandel, B. S. and Lal, Priyanka (2018) An econometric analysis of optimality for sustainable paddy production in India. *Agril. Eco. Res. Review,*. 31: 139-45.	5.90
9	Makarabbi, G., Chauhan, A. K. and Kharkwal, S. (2018) Estimation of transaction cost and cost of women dairy self-help groups in Karnataka. *Indian J. Eco. and Develop.,* 14: 724-28. doi : 10.5958/2322-0430.2018.00193.2.	4.82
10	Pallavi, G. L., Singh, A., Chandel, B. S., Shendhil, R. and Lathwal, S. S. (2018) Evaluation of alternate animal identification techniques and livestock insurance products in Bengaluru rural district of Karnataka, Indian J. Eco. *and* Develop., 6:1-9. http://ijed.informaticspublishing.com/ index.php/ijed/article/view/130550/91124	NA
11	Singh, S. K. and Chandel, B. S. (2018) The duo of dairy sector: Spatio-temporal analysis and causality of milk and ghee prices in India. *Indian J. Dairy Sci.,* 71 (5): 517-23.	5.26
12	Roy, A. and Malhotra, R. (2018) Household consumption of dairy products -An analysis of consumer behaviour in Kolkata. *Indian J. Dairy Sci.,* 71: 604-10.	5.26
13	Roy, A., Malhotra, R., Behera, S. and Raghupathi, R. (2018) Determination of factors influencing consumption pattern of milk in Kolkata metropolitan: An application of multinomial logistic regression analysis. *Green Farming,* 9: 1076-80.	4.38
14	Vanishree, M., Sendhil, R., Sirohi, S., Chauhan, A. K., Rashmi, H. M. and Ponnusamy, K. (2018) Role of dairy cooperatives in strengthening value chain of liquid milk and its sustainability in Karnataka: Findings from preliminary study. *Indian J. Eco. and Develop.* 14: 410-15.	4.82
15	Vanishree, M., Sendhil, R., Sirohi, S., Chauhan, A. K., Rashmi, H. M. and Ponnusamy, K. (2018) Value chain analysis of input delivery system for liquid milk in Bengaluru Milk Union of Karnataka. *Indian J. Dairy Sci.,* 71: 502-08.	5.26

Dairy Extension Division

Sr. No.	Research Papers	NAAS Rating
1	Bhuyan, Maneesha, Ponnusamy, K. and Bhattacharyya, Sangeeta (2018) Knowledge level of farm women in scientific dairy farming. *J. Community Mobilization and Sustainable Develop*. 13 (3): 507-12.	NA
2	Bhuyan, Maneesha, Ponnusamy, K. and Singh, Jasbir (2018) A tool to assess women empowerment due to socio-technological interventions in dairying. *Indian J. Dairy Sci.,* 71 (6): 631-36.	5.26
3	Dutta, S., Maiti, S., Garai, S., Bhakat, M. and Mandal, S. (2019) Socio economic scenario of the farming community living in climate sensitive indian sundarbans. *Int. J. Curr. Microbiol. App. Sci.,* 8(2): 3156-64.	5.38
4	Garai, S., Ghosh, M. K., Maiti, S., Dutta, T. K., Bhakat, C., Kadian, K. S. (2019) Development and application of dairy-based sustainable livelihood security index in the districts of West Bengal, India. *J. Rural Studies. DOI* : https://doi.org/10.1016/j.jrurstud.2019.01.017.	8.65
5	Goswami, R. K., Maiti, S., Garai, S., Jha, S. K., Bhakat, M., Chandel, B. S. and Kadian, K. S. (2018) Coping mechanisms adopted by the livestock dependents of drought prone Districts of Bihar, India. *Indian J. Anim. Sci.,* 88 (3): 356-64.	6.19
6	Jose, Elizabeth, Meena, H. R. and Verma, A. P. (2019) Case studies of dairy based farmer producer companies in Kerala. *Int. J. Curr. Microbiol. App. Sci.,* 8(1): 501-505.	5.38
7	Kale, Rajiv Baliram, Ponnusamy, K., Chakravarty, A. K., Sendhil, R. and Mohammad, Asif (2018) Future aspirations and planning of dairy farmers in India: Horizon 2020. *Indian J. Anim. Sci.,* 88 (4) : 493–98.	6.28
8	Kar, Priyajoy and Meena, H. R, (2019) Consumers concern about food safety parameters: A health perspective. *J. Pharmacognosy and Phytochemistry,* 7(5): 2212-14.	5.21
9	Khusboo, Raj, Ponnusamy, K., Kishore, C. N. and Begum, Mehrunnissa (2019) Factors responsible for emergence Public Private Partnership in dairying. *Indian J. Extn. Edu.,* 55(1): 135-38.	5.30
10	Khusboo, Raj, Ponnusamy, K., Kishore, C. N. and Begum, Mehrunnissa (2019) Constraints in execution of Public Private partnership model in dairy farming. *Int. J. Current Microbiology and Applied Sci.,* 8 (3): 1185-90.	5.38
11	Khusboo. Raj, Ponnusamy, K., Kishore, C. N. and Begum, Mehrunnissa (2019) Role performance of extension functionaries in promotion of public private partnership. *J. Entomology and Zoology Studies,* 7 (2): 14-18.	5.53
12	Kumar, B., Sankhala, G. and Sinha, P. K. (2018) Market-led extension approach for livelihood security of dairy farmers through dairying in Bihar. *Indian Res. J. Ext. Edu.,* 18 (4): 81-88.	4.81
13	Kumar, Mukesh, Meena, H. R., Bara, Niva and Jha, B. K. (2018) Livestock owners attitudes toward wildlife conservation: A Review. *Multilogic in Sci.,* 8: 172-174.	5.20
14	Kumar, Mukesh, Meena, H. R., Bara, Niva and Kirti (2018) Capacity building for management of livestock owners- wildlife conflict. *J. Pharmacognosy and Phytochemistry,* 2018; SP1: 2268-2271.	5.21
15	Kumar, Mukesh, Meena, H. R., Seth, Pankaj and Bara, Niva (2018) An index to measure vulnerability of livestock owners livelihood in the vicinity of National Park. *Int. J.Curr. Microbiol. App. Sci.,* 7 (8): 2889-98.	5.38
16	Kumar, V., Gupta, J., and Meena, H. R. (2019) Assessment of awareness about antibiotic resistance and practices followed by veterinarians for judicious prescription of antibiotics: An exploratory study in Eastern Haryana Region of India. *Tropical Anim. Health and Prod.*, 51 (3): 677-87.	6.98
17	Kumar, Vikash, Gupta, Jancy, Kumar, Mukesh, Meena, H. R. (2018) Factors affecting the antibiotic prescribing behaviour of veterinarians in Eastern Haryana Region of India. *Multilogic in Sci.*, 8 (E): 279-81.	5.20
18	Lal, S. P. and Jha, S. K. (2018) Benefit-cost and Constraints analysis of bee-keeping in green revolution province of India. *Bhartiya Krishi Anushandhan Patrika,* 33 (1): 1-5.	3.07
19	Lal, S. P. and Jha, S. K. (2018) Illustrating the way to harmony amid wildlife and agriculture near Shivalik Mountain Range of Northern India: An Empirical Study. *Int. J. Avian & Wildlife Biol.,* 3 (2): 159-64.	NA
20	Malik, Meena (2018) English outside the classroom*, Int. J. English Literature, Language & Skills (IJELLS) 7(1): 155*-58.	NA
21	Maji, Saikat and Meena, B. S. (2018) Organic dairy farming in Uttarakhand: An analysis of prospect from farmers' perspective. *Indian J. Dairy Sci.,* 71 (1): 306-12.	5.26
22	Maji, Saikat and Meena, B. S. (2019) Knowledge of farmers about organic dairy farming practices: A comparative analysis. *Int. J. Livestock Res.,* 9 (3): 129-38.	5.36

Sr. No.	Research Papers	NAAS Rating
23	Nag, A., Jha, S. K., Mohammad, A. and Maiti, S. (2018). Measuring attitude of rural youth towards dairying as an occupation: A likert scale. *Int. J. Curr. Microbiol. App. Sci.,* 6 (12): 3173-3181, DOI: 10.20546/ijcmas. 2017. 612.371.	5.38
24	Nag, A., Jha, S. K., Mohammad, A., Maiti, S., Gupta, J., Gosain, D. K., Datta, K. K. and Mohanty, T. K. (2018) Predictive factors affecting indian rural farm youths' decisions to stay in or leave agriculture sector. *J. Agri. Sci. Tech*., 20: 221-34.	6.81
25	Niketha, L. Sankhala,G. Kumar, S. and Prasad, K. (2018) Constraints faced by the members of women dairy cooperatives in Karnataka, India. *Int. J. Curr. Microbiol. App. Sci.,* 7 (5): 977-85.	5.38
26	Patel, Diksha and Ponnusamy, K. (2018) Prevalence of reproductive problems under different dairy production systems. *Indian J. Extn. Edu.,* 54 (2): 261-65.	5.32
27	Patel, Diksha and Ponnusamy, K. (2019) Development and validation of extension strategies for effective management of reproductive problems of dairy animals. *Indian J. Dairy Sci.,* 72 (2): 212-17.	5.26
28	Ponnusamy, K. and Pachaiyappan, K. (2018) Strengthening extension research in animal husbandry: A review of issues and strategies. *Indian J. Anim. Sci.,* 88 (2): 137-43.	6.28
29	Kale, Rajiv Baliram, Ponnusamy, K., Chakravarty, A. K., Mohammad, Asif and Sendhil, R. (2018) Productive and reproductive performance of cattle and buffaloes reared under farmers' management in differential dairy progressive states in India. *Indian J. Anim. Res.,* 52 (10): 1513-17.	6.20
30	Sachan, R. Sankhala, G. and Singh, P. K. (2018) Correlation analysis of socio-economic variables with adoption of buffalo husbandry practices, *Int. J. Livestock Res.*, 8 (1): 149-57.	5.36
31	Sendhi, R., Sirohi, S. Ponnusamy, K. and Sankhala, G. (2018) Tracking the disparities in Gujarat dairy development-an application of biplot analysis. *Current Sci.,* 114 (10) : 2151-55.	6.88
32	Sharma, N., Meena, H., and Hari, R. (2018) work conflict issues in dairy production and management practices- A gender analysis. *Int. J. Livestock Res.*, 8(7): 160-66.	5.36
33	Shrija, S. Sankhala, G. and Lal, S. P. (2018) Effectiveness of ICT based mobile app in knowledge gain apropos 'environment-friendly dairy farming practices': paired' and Wilcox on signed paired rank test analogy. *J. Community Mobilization and Sustainable Develop.,* 13 (3) : 561-66.	5.30
34	Shrija, S., Sankhala, G. and Lal, S. P. (2018) Exploring the perception of the dairy farmers in relation to different components of the Android mobile App 'ECO-Dairy', *Int. J Agril. Sci.,* 10 (6): 5611-13.	4.20
35	Shrija, S., Sankhala, G. and Lal, S. P. (2018) Profile characteristics and analysis of constraints faced by the dairy farmers of urban and peri-urban areas of Indian national capital region vis-à-vis using mobile android app. *Int. J. Curr. Microbiol. App. Sci.,* 7 (3): 2335-42.	5.38
36	Singh, R. K., Sureja, A. K., Maiti, S., and Tsering, D. (2018) Grazing and rangeland management: Trans-human adaptations by *Brokpa* community in fragile ecosystems of Arunachal Pradesh. *Indian J. Traditional Knowledge*, 17 (3): 550-58.	7.06
37	Verma, A. P., Meena, H. R., Kadian, K. S. and Meena, B. S. (2019) Exploring the perceived feedback of commercial dairy farmers about effectiveness of Android Mobile Apps 'Brucellosis Advisor Apps'. *Int. J. Curr. Microbiol. App. Sci.,* 8(1): 3007-13.	5.38

Southern Campus, Bengaluru

Sr. No.	Research Papers	NAAS Rating
1	Ahirwar, M. K., Kataktalware, M. A., Pushpadass, H. A., Jeyakumar, S., Jash, S., Nazar, S., Devi, L., Kastelic, J. P. And Ramesha, K. P. (2018) Scrotal infrared digital thermography predicts effects of thermal stress on buffalo (*Bubalusbubalis*) semen. *J. Thermal Biology.,* 78: 51-57.	8.09
2	Alex, R., Ramesha K. P., Singh, U., Kumar, S., Alyethodi, R. R., Deb, R., Sharma, S., Sengar, G. S., Kumar, A. and Prakash, B. (2018) Promoter variants of OAS1 gene are associated with reproductive performance and incidence of normal calving in cattle. *Theriogenology,* 108: 255-61.	7.99
3	Alex, R., Ramesha, K. P., Singh, U., Kumar, S., Alyethodi, R. R., Deb, R., Rai, S., Sharma, S., Sengar, G. S., Kumar, A., and Prakash, B. (2018) Association analysis of novel polymorphisms in 2', 5'-oligoadenylate synthetase gene with reproductive traits in indigenous and cross-bred cattle of Indian Origin. *Reprod. Dom Anim.,* 53:442-449. DOI: 10.1111/rda.13129.	7.4
4	Ananth Narayan, M., Deepa, S., Aravindakshan, P., Pagote, C. N. and Jayaraj Rao, K. (2018) Utilisation of kalakand in the preparation of chocolate like product. *J. Pharmacy and Chemistry,* 12 (2): 22-28.	NA
5	Ashwin, K. and Srinivas, Bandla (2019) Optimized oral supplementation of vitamins improve feed intake and rumen microbial protein synthesis in Deoni calves. *Turkish J. Vety. and Anim. Sci.,* 43 : 197-205.	6.49
6	Basak, Sukanta, and Das, D. N. (2018) Productive and reproductive performances of balankya, wannera and waghya strains of Deoni cattle. *Explor. Anim. Med. Res.,* 8 (1): 76-77.	4.27

Sr. No.	Research Papers	NAAS Rating
7	Basak, Sukanta, Das, D. N. and Mundhe, U. T. (2018) Genetic and non- genetic factors affecting productive and reproductive traits in Deoni cattle. *Indian J. Anim. Res.,* DOI: 10.18805/ijar.B-3574.	6.20
8	Debnath, Partha Pratim and Ghosh, Bikash Chandra (2018) Role of lactose, glucose and citrate in the flavor enhancement of enzyme modified ghee. *Int. J. Chemical Studies,* 6 (5): 3269-74.	5.31
9	Divya, P., Ramesha, K. P., Kumari, Ragini, Singh, Arun Pratap, Das, D. N., Basavaraju, M. and Mundhe, U. T. (2018) Single Nucleotide Polymorphism in KiSS1 gene and its association with semen quality in *Bos Taurus* and Bos indicus bulls. *Indian J. Anim. Res.,* 52 (8):1124-28.	6.15
10	Gupta, A. K., Kumar, Sanjay, Pal, Yash, Bhardwaj, Anuradha, Chauhan, Mamta, Kumar, Birendra, Prince and Vijh, R. K. (2018) Genetic diversity and structure analysis of donkey population clusters in different indian agro-climatic regions. *J. Biodiversity & Endangered Species*, DOI: 10.4172/2332-2543.S2225.	NA
11	Jamuna, G., Sharma, A. K., Manimaran, A. and Sankar, P. (2018) Hepatoprotective effects of Allium sativum and Withania somnifera on ochratoxin: A-induced toxicity in rats. *J. Pharmacognosy and Photochemistry,* 7(3): 2675-80.	5.21
12	Karthikeyan, S., Arunmozhi Devi, M, C., Narmatha, N., and Uma (2018) Perception of dairy farmers regarding effectiveness of artificial insemination services of different dairy service delivery systems. *Indian J. Anim. Health,* 57(1): 27-34.	4.08
13	Karthikeyan, S., Arunmozhi Devi, M, C., Narmatha, N., and Uma, V. (2018). Perceived effectiveness of dairy service delivery systems in Namakkal District of Tamil Nadu, India, *Int. J. Current Microbiology and Applied Sci.,* 7(5): 337-47.	5.38
14	Karthikeyan, S., Arunmozhi Devi, M. C., Narmatha, N. , Uma, V., and Thirunavukkarasu, D. (2018) Perceived effectiveness of training and advisory services of different dairy service delivery systems in Namakkal District of Tamil Nadu. *Int. J. Sci., Environment and Tech.*, 7(2): 618-23.	3.98
15	Karthikeyan, S., Arunmozhi Devi, M.C., Narmatha, N., Uma, V., and Thirunavukkarasu, D. (2018). Perceived effectiveness of animal health services offered by different service providers in Namakkal District of Tamil Nadu. *Indian J. Dairy Sci.*, 71(4): 430-34.	5.26
16	Karthikeyan, S., Arunmozhi Devi, M.C., Narmatha, N., Uma, V., and Thirunavukkarasu, D. (2018) Profile of the dairy farmers and the constraints faced by them in utilizing different dairy service delivery systems. *Int. J. Agri. Sci.,* 10 (16): 7000-02.	4.82
17	Kumar, Rohit, Kataktalware, M. A., Senani, S., Letha, Devi G, Sivaram, M., Jeyakumar, S. and Ramesha, K. P. (2019) Risk factors associated with incidence of hoof disorders in cross bred dairy cattle under field conditions. *Int. J. Curr. Microbiol. App. Sci.,* 8(4): 2284-92.	5.38
18	Kumar, S., Subash, S., Jangir, R., Devi, M.C.A., Jeyakumar, S., Dixit P. K. and Ramesha K. P. (2018) Scientific rationality, perceived effectiveness and adoption of traditional knowledge practices associated with Sahiwal cattle breed of Rajasthan. *Indian J. Anim. Sci.,* 88 (4): 96-100.	6.28
19	Kumar, Sunil, Subash, S., Baindha, Ashok and Jangir, Rameti (2018) An inventory of ethno-veterinary medicine (EVM) for treatment of indigenous cattle in Western Rajasthan, India. *J. Community Mobilization and Sustainable Develop.,* 13(3) : 403-09.	5.30
20	Kumar, Vimlesh, Kumaresan, Arumugam, Nag, Pradeep, Kumar, Puneeth, Datta, Tirtha Kumar, Baithalu, Rubina Kumari and Mohanty, Tushar Kumar (2018) Transcriptional abundance of type-1 endocannabinoid receptor (CB1) and fatty acid amide hydrolase (FAAH) in bull spermatozoa: Relationship with field fertility. *Theriogenology,* 114: 252-57.	7.99
21	Kumaresan, A., Anders Johannisson, Patrice Humblot and Ann-Sofi Bergqvist (2019) Effect of bovine oviductal fluid on motility, tyrosine phosphorylation, and acrosome reaction in cryopreserved bull spermatozoa. *Theriogenology,* 124 : 48-56.	7.99
22	Kumari, Ragini, Ramesha, K. P., Kumar, D. P., Sinha B., Basavaraju M. and Rao A. (2018) Association of Aquaporin 7 gene variants with semen quality in Murrah buffaloes. *Vet. Arhiv.,* 88 : 749-61.	6.29
23	Kumari, Ragini, Ramesha, K. P., Kumar, Rakesh, Divya, P., Sinha, Beena and Gonge, D. S. (2018) Genetic polymorphism of Aquaporin 7 gene and its association with semen quality in Surti bulls. *Buffalo Bulletin*, 37(2): 191-98.	6.1
24	Lokesh Babu, D. S., Jeyakumar, S., Vasanta, Patil Jitendra, Sathiyabarathi, M., Manimaran, A., Kumaresan, A., Pushpadass, Heartwin A., Sivaram, M., Ramesha, K. P., Kataktalware, Mukund A. and Siddaramanna (2018) Monitoring foot surface temperature using infrared thermal imaging for assessment of hoof health status in cattle: A review. *J. Thermal Biology*, 78:10–21.	8.16
25	Lokesha, E. and Srinivas, Bandla (2018) Evaluation of additive effect of feed additives in crossbred cows under *in vitro* and *in vivo* conditions. *Indian J. Anim. Res.,* (On line publshed B-3578; 15-11-2018).	3.90
26	Manimaran, A., Kumaresan, A., Sarkar, S. N., Boya, S., Sreela, L., Mooventhan, P. and Wankhade, P. R. (2019) Differential expression of bovine major acute phase proteins, cytokines and metabolic indicator genes in clinical endometritis cows. *Indian J. Anim. Sci.,* 89 (4): 402-06.	6.28

Sr. No.	Research Papers	NAAS Rating
27	Mol, P., Kannegundla, U., Dey, G., Gopalakrishnan, L., Dammalli, M., Kumar, M., Patil, A., Basavaraju, M., Rao, A., Ramesha, K. P. and Prasad, T. S. K. (2018) Bovine milk comparative proteome analysis from early, mid and late lactation in the cattle breed, Malnad Gidda *(Bos indicus). OMICS A J. Integrative Biology*, 22 (3): 223-35.	8.72
28	Muhammad Aslam, M. K., Kumaresan, A., Yadav, Savita, Mohanty, T. K., Datta, T. K. (2019) Comparative proteomic analysis of high- and low-fertile buffalo bull spermatozoa for identification of fertility associated proteins. *Reproduction in Domestic Anim.,* https://doi.org/10.1111/rda.13426.	7.40
29	Muhammad Aslam, M. K., Sharma, Vinay K., Pandey, Shashank, Kumaresan, A., Srinivasan, A, Datta, T. K., Mohanty, T. K., Yadav, Savita (2018) Identification of biomarker candidates for fertility in spermatozoa of crossbred bulls through comparative proteomics. *Theriogenology,* 119 : 43-51.	7.99
30	Mundhe, U. T., Das, D. N., Jadhav, P. V. and Singh, Arun Pratap (2018) Review on study of toll like receptor 2 gene and its polymorphic relationship with mastitis in cattle. *Int. J. Livestock Res.,* (8) 5: 19-30.	5.36
31	Mundhe, Das, D. N. and Saravanan, R. (2018) Effect of non-genetic factors on milk yield and U.T. milk quality traits in Jersey crossbred cattle. *Int. J. Current Microbiology and Applied Sci.,* 7 (8) 1733-44.	5.38
32	Mundhe, U., Gandhi, R., Das, D. N., Dongre, V. and Singh, A. (2018) Sire evaluation based on first lactation 305 day milk yield and monthly part lactation records in Sahiwal cattle. *Int. J. Livestock Res.,* 8 (9): 228-33.	5.36
33	Murari, Gohler Durgesh, Kumaresan, A., Saraf, Kaustubh Kishor, Chillar, Shivani, Nayak, Samiksha, Tripathi, Utkarsh K., Bhaskar, Chavan Nitin, Lathwal, S. S. and Mohanty, T. K. (2018) Influence of season and climatic variables on testicular cytology, semen quality and melatonin concentrations in crossbred bucks reared under subtropical climate. *Int. J. of Biometeorology,* DOI: 10.1007/s00484-018-1571-x.	8.20
34	Prakash, Mani Arul, Prasad, Shiv, Mohanty, T. K., Kumaresan, A., Manimaran, A., Oberoi, Parvender Singh, Layek, Siddhartha Shankar and Lathika, Sreela (2018) Behavioural adaptation of crossbred cows in automatic concentrate feeding station. *Indian J. Anim. Sci.,* 88 (3): 339-43.	6.28
35	Rafiq, Syed and Ghosh, Bikash (2018) Effect of non-dairy ingredients on the quality characteristics of processed cheese during storage. *J. Adv. Dairy Res.* 6 (2): 208.	NA
36	Rathod, Akash J. and Srinvias, Bandla (2018) Fermentation rate of agro-industrial co-products with dual rate constant. *Applied Biological Res.,* 20 (3): 317-23.	5.07
37	Reen, J. K., Ramesha, K. P., Deginal, R, Ahirwar, M. K., Kannegundla, U., Chandra, S., Palat, D., Das D. N., Kataktalware, M. A., Jeyakumar, S. and Isloor, S. K. (2018) Luteinizing hormone beta gene polymorphism and its effect on semen quality traits and luteinizing hormone concentrations in Murrah buffalo bulls. *Australian J Anim Sci.,* 31(8): 1119-26.	7.24
38	Reen, J. K., Ramesha, K. P., Preeti, Revanasiddu, S. D. and Rohit K. (2018) Molecular characterization of luteinizing hormone receptor (LHR) gene in Murrah bulls. *J. Entomology and Zoology Studies,* 6 (3): 246-50.	5.53
39	Saraf, Kaustubh Kishor, Singh, Raushan Kumar, Kumaresan, Arumugam, Nayak, Samiksha, Chhillar, Shivani, Lathika, Sreela, Datta, Tirtha Kumar and Mohanty, Tushar Kumar (2019) Sperm functional attributes and oviduct explants binding capacity differs between bulls with different fertility ratings in the water buffalo (*Bubalus bubalis*). Eproduction. *Fertility and Develop.,* 31 (2) : 395-403.	8.66
40	Sathiyabarathi, M., Jeyakumar, S., Manimaran, A., Heartwin A. Pushpadass, Sivaram, M., Ramesha, K. P., Das, D. N. and Kataktalware. M. A. (2018) Infrared thermal imaging of udder skin surface temperature variations to monitor udder health status in *Bos indicus* (Deoni) cows. *Infrared Physics & Technology,* 88: 239-44.	NA
41	Sathiyabarathi, M., Jeyakumar, S., Manimaran, A., Heartwin, A. Pushpadass, Kumaresan, A., Lathwal, S. S., Sivaram, M., Das, D. N., Ramesha, K. P. and Jayaprakash, G. (2018) Infrared thermography to monitor body and udder skin surface temperature differences in relation to subclinical and clinical mastitis condition in Karan Fries crossbred cows. *Indian J. Anim. Sci.* 88 (6): 694-99.	6.28
42	Sharma, Monika, Yadav, D. N., Singh, A. K., Vishwakarma, R. K., Sabikhi, L. (2018) Impact of octenyl succinylated pearl millet (Pennisetum typhoides) starch addition as fat replacer on the rheological, textural and sensory characteristics of reduced□fat yoghurt. *Int. J. Dairy Tech.,* 71(3): 723-33.	7.23
43	Singh, Ajay and Srinivas, Bandla (2018) Affect of variable protein and energy diet on purine derivatives excretion and quantitative microbial protein production in crossbred and indigenous calves. *Int. J. Current Microbiology and Applied Sci.,* 7(11): 2257-66.	5.38
44	Singh, Ajay and Srinivas, Bandla (2018) Residual feed intake and growth rate of crossbred and Deoni calves on diets with variable protein and energy. *Livestock Int. J.*, 6 (4): 66-70.	3.90

Sr. No.	Research Papers	NAAS Rating
45	Srinivas, B., Jayakumar, S. and Ramesha, K. P. (2018) Feed resources and nutritional status of Malnad Gidda cows in the native tract of western Ghats of Karnataka: A case study. *Range Management and Agroforestry,* 39 (1): 103-08.	6.64
46	Wankhade, P. R., Manimaran, A., Kumaresan, A., Jeyakumar, S., Ramesha, K. P., Sejian, V., Rajendran, D. Bagath, M. and Sivaram, M. (2018) Metabolism and immune status during transition period influences the lactation performance in Zebu *(Bos indicus)* cows. *Indian J. Anim. Sci.,* 88 (9): 1064-69.	6.28
47	Wankhade, P. R., Manimaran, A., Kumaresan, A., Jeyakumar, S., Ramesha, K. P., Sejian, V., Rajendran, D. and Varghese, M. R. (2017) Metabolic and immunological changes in transition dairy cows: A review. *Vet. World,* 10 (11): 1367-77.	5.71
48	Zade, Sandip and Ghosh, Bikash C. (2018) Effect of coagulants, stage of cream addition and inulin incorporation on the quality characteristics of mascarpone cheese. *Indian J. Dairy Sci.,* 71(4): 368-73.	5.26

Eastern Campus, Kalyani

Sr. No.	Research Papers	NAAS Rating
1	Akourki, A., Mondal, M., Karunakaran, M., Pal P. (2018) Effect of soybean lecithin extender on Post-thaw semen quality of Bengal buck. *Indian J. Anim. Hlth*. 57 (2): 153-164.	4.08
2	Behera, R., Chakravarty, A. K., Kashyap, N., Bharti, Rai, S., Mandal, A., Singh, A. and Gupta, A. K. (2018) Identification of most suitable temperature humidity index model for daily milk yield of Murrah buffaloes in subtropical climatic condition of India. *Indian J. Anim. Sci.* 88 (7): 74-77.	6.19
3	Behera, R., Chakravarty, A. K., Sahu, A., Kashyap, N., Rai, S., and Mandal, A. (2018) Identification of best temperature humidity index model for assessing impact of heat stress on milk constituent traits in Murrah buffaloes under subtropical climatic conditions of Northern India *Indian J. Anim. Res.,* 52 (1):13-19.	6.15
4	Behera, R., Chakravarty, A. K., Sahu, A., Kashyap, N., Rai, S., Dash, S., Upadhyaya, A., Singh, A. and Gupta, A. K. (2018) Identification of critical heat stress zone for energy corrected milk yield in Murrah buffaloes using temperature humidity index under subtropical climatic conditions. *Indian J. Anim. Sci.,* 88 (7): 78-81.	6.19
5	Behera, R., Sahu, A., Mandal A., Rai, S., Karunakaran, M. and Dutta T.K. (2018). A1 versus A2 Milk-Impact on human health. *Int. J. Livestock Res.,* 8 (4): 1-7.	5.36
6	Bhakat, C., Mohammad, Asif, Mandal, D. K., Chatterjee, A., Mandal, A. and Rai, S. (2018) Some factors influencing intra mammary infection and udder health in Jersey cross bred cows. *Int. J. Basic and Applied Biology,* 5: 37-40.	NA
7	Chakurkar, E. B. Nayakvadi, S., Naik, P. K., Mandal, A. and Karunakaran, M. (2018) Testicular development and seminal attributes of agondagoanpig. *Indian J. Anim. Reprod.,* 39 (2): 19-21.	NA
8	Choudhary, S., Santra, A., Sarkar, S. and Das S. K. (2018) *In vitro* digestibility and fermentation kinetics of some north eastern Himalayan tree leaves using cattle rumen fluid as inoculums. *Indian J. Anim. Sci.,* 88 (9):1085-89.	6.19
9	Dutta, T. K., Satapathy, Debasish, Mandal, D. K. and Chatterjee, A. (2019) Sources and impact of arsenic on livestock in India and its amelioration through dietary strategy. *Indian J. Dairy Sci.,* 72: 1-11.	5.26
10	Ghosh, M. K., Mondal, M., Verma, R. K. and Muwel, N. (2018) use of area specific mineral mixture to ameliorate region specific reproductive problems in ruminants. *Res. & Reviews: J. Dairy Sci. and Tech.,* 5 (1): 1-4.	NA
11	Kale, R. B., Ponnusamy, K., Chakravarty, A. K., Mohammad, A. and Sendhil, R. (2018) Productive and reproductive performance of cattle and buffaloes reared under farmers' management in differential dairy progressive states in India. *Indian J. Anim. Res.,* 52 (10): 1513-17.	6.15
12	Kale, R. B., Ponnusamy, K., Chakravarty, A. K., Sendhil, R. and Mohammad, A. (2018) Future aspirations and planning of dairy farmers in India: Horizon 2020. *Indian J. Anim. Sci.,* 88 (4): 493-98.	6.19
13	Karmakar, P. K., Sarkar, M., Raha, C. and Mandal, Ajoy (2018) Genetic parameters for direct and maternal effects on birth weight of Garole sheep. *Indian J. Small Ruminants*, 24 (2): 225-29.	NA
14	Karmakar, P., Behera, R. and Mandal, Ajoy (2018) Growth performance and effect of non-genetic factors affecting growth traits in Garole sheep. *Indian J. Anim. Sci.,* 88 (3): 377-78.	6.19
15	Karunakaran, M., Konyak, P., Mandal, A., Mondal, M., Bhakat, C., Mandal, D. K. (2018) chemically well-defined extender for preservation of black bengal buck semen. *Res.earch & Reviews: J. Dairy Sci. and Tech.,* 6 (2): 7-10.	NA
16	Karunakaran, M., Mandal, A., Mondal, M., Bhakat, C., Garai, S. (2018) Semen preservation and artificial insemination in Bengal Goat at field level. *Res. & Reviews: J. Vety. Sci. and Tech.,* 4 (2): 25-28.	NA

Sr. No.	Research Papers	NAAS Rating
17	Karunakaran, M., Gajare V. C., Mandal, A., Mondal, M., Das, S. K., Ghosh, M. K., Rai, S. and Behera, R. (2019) Electrophoretic profile of seminal proteins and their correlation with in vitro sperm characters in Black Bengal buck semen. *Vet. World,* 12 (5): 621-28.	5.71
18	Karunakaran, M., Konyak, P., Mandal, A., Mondal, M., Bhakat, C., Rai, S., Ghosh, M. K. and Behera, R. (2018) Effect of trehalose- an impermeant cryoprotectant on cryopreservation of Black Bengal buck semen. *Indian J. Anim. Res.,* 53 (1): 37-40. DOI: https://doi.org/ 10.18805/ijar.B-3470.	6.15
19	Konyak, P., Mandal, A., Mondal, M., Bhakat, C., Das, S. K., Rai, S., Ghosh, M. K. and Karunakaran, M. (2018) Preservation of black Bengal buck semen in soybean lecithin based chemically defined extender. *Indian J. Anim. Res.,* 52 (8): 1151-54.	6.15
20	Kumar, A., Mandal, A., Gupta, A. K., Karunakaran, M., Das, S. K. and Dutta, T. K. (2018) Genetic analysis of fertility traits in Jersey crossbred cows. *Indian J. Anim. Res.,* 52 (8): 1108-13.	6.15
21	Kumar, Ajit, Mandal, D. K., Mandal, A., Bhakat, C., Chatterjee, A. and Rai, S. (2019) Effects of milking temperament on milk yield, udder health and milk composition in crossbred jersey cows. *Int. J. Livestock Res.,* 9 (1): 187-94.	5.36
22	Kumar, R., Chandra, P., Konyak, P., Karunakaran, M., Santra, A. and Das, S. K. (2018) *In vitro* development of caprine embryo in different culture media using cryopreserved Black Bengal buck semen. *Int. J. Biotech. and Allied Fields,* 6 (1): 1-9.	NA
23	Kumar, S., Alex, R., Gaur, G. K., Mukherjee, S. S., Mandal, D. K., Singh, U., Tyagi, S., Kumar, A., Das, A. K., Deb, R., Kumar, M., Sirohi, A. S., Chand, N., Pasad, R., Bhasin, V., Prakash, B. and Kashyap, S. (2018) Evolution of Frieswal cattle: A crossbred dairy animal of India. *Indian J. Anim. Sci.,* 88 (3): 265-75.	6.19
24	Mandal, A., Singh, L. A., Talokar, A. J., Koloi, S., Mandal, D. K. and Karunakaran, M. (2018) Genetic and non-genetic factors affecting lactation persistency in Jersey crossbred cows. *Indian J. Dairy Sci.,* 71(4): 435-38.	5.26
25	Mandal, D. K., Sahu, Dharma, Mandal, A., Chatterjee, A., Bhakat, C., Rai, Saroj, Mohammad, A., Ghosh, M. K. and Dutta T. K. (2018) Efficacy of Paddy straw as roof heat insulator in cow shed: Its impact on productive performance and economic consideration. *J. Energy Res. and Environment Tech.,* 5 (2): 22-26.	NA
26	Mandal, A., Behera, R., Rai, S., Karunakaran, M., Dutta, T. K. (2018) Performance evaluation of Barbari Goats in semi-arid Region of India: *A Review, Research & Reviews: J. Dairy Sci. and Tech.*, 5 (2): 25-29.	NA
27	Mandal, A., Behera, R., Bhusan, S. and Rout, P. K. (2018) Factors affecting growth traits of Jakhrana goats in semi-arid region of India. *Indian J. Small Ruminants*, 24(1): 22-26.	NA
28	Mandal, A., Behera, R., Ratwan, P., Bhakat, C. and Santra, A. (2018) Genetic parameters for direct and maternal effects on birth weight of crossbred calves. *Indian J. Anim. Sci.*, 88 (3): 373-76.	6.19
29	Mandal, A., Verma, G., Koloi, S., Pathak, K., Bhakat, C. and Mandal, D. K. (2018) Genetic studies on monthly test day milk yield of Jersey crossbred cattle. *Indian J. Anim. Sci.,* 88 (7): 863-67.	6.19
30	Mandal, Ajoy, Das, S. K., Karunakaran, M., Bhakat C. and Dutta, T. K. (2018). Application of genomic selection in livestock improvement. *Research and Reviews: J. Dairy Sci. and Tech.,* 2 (3): 1-6.	NA
31	Mandal, D. K., Karunakaran, M., Dutta, T. K. and Mandal, A. (2018) Factors affecting the persistency of milk production in Jersey crossbred cattle. *J. Dairy Vety. and Anim. Res.*, 7 (6): 268-71.	NA
32	Mandal, D. K., Sahu, Dharma, Mandal, A., Chatterjee, A., Bhakat, C., Rai, Saroj, Karunakaran, M. and Dutta, T. K. (2018) Alteration of micro-environment of animal shed through roof insulation by paddy straw - its seasonal efficacy and physiological impacts on Jersey crossbred cows. *Indian J. Dairy Sci.,* 71 (5): 483-90.	5.26
33	Medhi, D., Chakravarty, P., Deori, S. and Santra, A. (2018) Nutritional status and compensatory growth in yak calves maintained on different plane of nutrition. *Indian J. Anim. Sci.,* 88 (4): 506-08.	6.19
34	Medhi, D., Santra, A., Paul, V. and Deb, S. M. (2018) Effect of plane of nutrition on blood biochemical parameters and attainment of sexual maturity in growing yaks. *Indian J. Anim. Sci.,* 88 (4): 470-73.	6.19
35	Mohammad, A and Chatterjee, A (2018) Decoding resilience status of dairy farmers against extreme weather events: A demographic perspective. *J. Anim. Res.,* 8 (5): 885-90.	5.68
36	Mohammad, A., Chatterjee, A., Bhakat, C., Rai, S. and Dutta, T. K. (2018) Analytical study on resilience to adverse weather events among tribal and non tribal livestock farmers: A livelihood security perspective. *Int. J. Basic and Applied Biology,* 5 (2): 50-53.	NA
37	Mohammad, A., Chatterjee, A., Bhakat, C. and Dutta, S. (2018) Determining the dimensions affecting resilience status of livestock farmer against extreme weather events by developing one resilience scale. *Int. J. Current Microbiology and Applied Sci.*, 7: 3247-53.	NA
38	Mondal, M., Baruah, K. K., Ghosh, M. K., Karunakaran, M, and Dutta, T. K. (2018) Kisspeptin modulates reproduction in ruminants. *Research & Reviews: J. Vety. Sci. and Tech.,* 5 (1): 7-12.	NA

Sr. No.	Research Papers	NAAS Rating
39	Mondal, M., Karunakaran, M. and Baruah, K. K. (2018) Designing mithun specific probes towards development of microarray for Mithun *(Bos frontalis). Research & Reviews: J. Vety. Sci. and Tech.,* 4 (3): 1-7	NA
40	Mondal, M. and Ghosh, M. K. (2018) Application of nutrigenomics for enhancement of body growth in ruminants. *Research & Reviews: J. Vety. Sci. and Tech.,* 5 (1): 1-6.	NA
41	Mondal, M. and Baruah, K. K. (2018) Development of a rapid microtiterplate based colorimetric method for estimation of non-esterified fatty acids in bovine plasma. *Research & Reviews: J. Vety. Sci. and Tech.,* 4 (3): 29-34.	NA
42	Mondal, M., Baruah, K. K., Karunakaran, M., Ghosh, M. K. and Dutta, T. K. (2018) Development of a new kisspeptin based method of ovulation synchronization for crossbred dairy heifers. *Research & Reviews: J. Dairy Sci. and Tech.,* 4 (3): 12-16.	NA
43	Mondal, M., Karunakaran, M., Ghosh, M. K. and Dutta, T. K. (2018) Development of an endocrine profiles based mathematical model for the estrous cycle in indian crossbred cows. *Research & Reviews: J. Vety. Sci. and Tech.,* 4 (3): 35-38.	NA
44	Mondal, M., Singh, R. K., Baruah, K. K., Kumar, A. and Singh, V. (2018) Mithun: A promising milch animal of the northeastern hill region of India. *Research & Reviews: J. Dairy Sci. and Tech.,* 4 (3): 17-21.	NA
45	Nag, A., Jha. S. K., Mohammad, A., Maiti. S., Gupta, J., Gosain, D. K., Datta, K. K. and Mohanty, T. K. (2018) Predictive factors affecting indian rural farm youths' decisions to stay in or leave agriculture sector. *J. Agri. Sci. Tech.,* 20: 221-34.	6.89
46	Pathak, K., Koloi, S., Ghosh, M. K., Karunakaran, M. and Mandal, A. (2018) Genetic analysis of calf survivability in crossbred cattle. *Indian J. Dairy Sci.*, 71 (6): 598-603.	5.26
47	Paul, A., Bhakat, C., Mandal, D. K., Mandal, A., Mohammad, A., Chatterjee, A. and Rai, S. (2018) Influence of udder hygiene management on milk characteristics in jersey cross-bred cows at lower gangetic region. *Int. J. Current Microbiology and Applied Sci.,* 7(8): 1264-72.	NA
48	Perveen, S., Das, P. K., Ghosh, P. R., Banerjee, D., Mukherjee, J., Naskar, S. and Mondal, M. (2018) Alterations in haemato-biochemical profile and blood metabolites during different periods of prepubertal growth in black Bengal goat (Capra hircus): Effect of sex and season. *Biological Rhythm Res.*, DOI: 10.1080/09291016. 2018.1478687.	6.70
49	Prasad, S., Prakash, C., Rohit, K., Karunakaran M., Santra, A. and Das, S. K. (2018) Development of cattle embryo through *in vitro* technique using epidermal growth factor as a media supplement. *Int. J. Bio-resource and Stress Management,* 9 (6): 691-94.	4.65
50	Rai, S., Tyagi, S., Kumar, M., Karunakaran, M, Mondal, M., Mandal, A. and Behera, R. (2018) Understanding motility dynamics of crossbred bull spermatozoa when analyzed by Computer Assisted Semen Analyzer (CASA). *Indian J. Anim. Res.,* 52 (4): 530-32.	6.15
51	Rai, S., Karunakaran, M., Tyagi, S., Kumar, M. and Behera, R. (2018) Motility dynamics of crossbred bull spermatozoa at different concentrations when analysed by computer assisted semen analyser. *Int. J. Livestock Res.,* 8 (2): 116-20.	5.36
52	Rai, S., Sahu, J., Ghosh, M. K., Chatterjee, A., Behera, R., Mandal, D. K. and Bhakat, C. (2018) Optimizing the performance of Jersey crossbred calves by modifying raising practice at NDRI, ERS Cattle Yard. *Int. J. Basic and Applied Biology,* 5 (2): 48-49.	NA
53	Rai, S., Tyagi, S., Mandal, D. K., Kumar, M., Karunakaran, M., Mandal, A and Behera, R. (2018) Correlation of HOST to some conventional sperm quality parameters evaluated in frozen thawed semen of Frieswal bulls, *Indian J. Anim. Sci.,* 88 (3): 311-13.	6.19
54	Rai, S., Tyagi, S., Mandal, D. K., Kumar, Mahesh, Karunakaran, M., Mandal, A., and Behera, R. (2018) Correlation of HOST to some conventional sperm quality parameters evaluated in Frozen thawed semen of Frieswal bulls. *Indian J. Anim. Sci.,* 88 (3): 311-13.	6.19
55	Ratwan, P., Mandal, A., Kumar, M., Karunakaran, M., Dutta, T. K. (2018) Carbon footprints of dairy animals: Causes and its mitigation. *Research & Reviews: J. Dairy Sci. and Tech.,* 4 (3): 6-11.	NA
56	Ratwan, P., Kumar, M., Chakravarty, A. K. and Mandal, A. (2019) Estimation of direct and maternal (co)variance components for lactation traits in Jersey crossbred cattle at an organized farm. *Indian J. Anim. Sci.*, 89 (2): 193-99.	6.19
57	Ratwan, P., Kumar, M., Kumar, A., Chakravarty, A. K. and Mandal, A. (2018) Impact of additive direct and maternal heritability on production efficiency traits in Jersey crossbred cattle. *Indian J. Anim. Sci.*, 88 (7): 848-52.	6.19
58	Sahu, Dharma, Mandal, D. K., Bhakat, Champak, Chatterjee, Anupam, Mandal, Ajoy and Mandal, Mohan (2018) Effects of roof ceiling and flooring on microclimate of shed and physiological indices of crossbred jersey cows. *Int. J. Livestock Res.,* 8 (4): 272-80.	5.36
59	Sahu, J., Rai, S., Behera, R., Mandal, D. K., Ghosh, M. and Mondal, M. (2019) Effect of feeding synbiotic on growth and health performance of Jersey crossbred calves. *Int. J. Livestock Res.*, 9 (2): 274-81.	5.36

Sr. No.	Research Papers	NAAS Rating
60	Taku, T., Santra, A., Barik, S., Mandal, D. K. and Das, S. K. (2019) Assessment of fodder quality and methane production potential of north-eastern Himalayan forest tree leaves. *Indian J. Anim. Sci.,* 89 (1): 90-96.	6.19
61	Talokar, A. J., Mandal, A., Singh, L. A., Behera, R., Karunakaran, M., Ghosh, M. K. and Bhakat, C. (2018) Genetic analysis of non-return and conception rate of Jersey crossbred cattle. *Indian J. Anim. Sci.,* 88 (4): 431-33.	6.19
62	Wadkar, S. K., Mohammad, A., Garde, Y. A. and Argade, S. D. (2018) Farmers attitude and knowledge in accessing aAQUA e-Agriservice in Maharashtra: A critical analysis. *J. Global Communication*. 11(2): 145-51.	4.50

Review Articles

Sr. No.	Research Papers	NAAS Rating	Impact Factor
1	Dutta, T. K., Satapathy, D., Mandal, D. K. and Chatterjee, A. (2019) Sources and impact of arsenic on livestock in India and its amelioration through dietary strategy. *Indian J. Dairy Sci.,* 72 (1): 1-11.	5.26	NA
2	Kashyap, V., Grover, C. R., De, S., Panwar, R. and Verma, S. (2018) Enteric methane emissions and abatement approaches: A Review. *Int. J. Livestock Res.,* 8 (11) :1-21 DOI 10.5455/ijlr.20180208090406	5.36	NA
3	Koloi, S., Pathak, K. Karunakaran, M. and Mandal, A. (2018) Lactation persistency and its genetic evaluation in cattle- A review. *Research and Reviews: J. Dairy Sci. and Tech.*, 7 (3): 1-8.	NA	NA
4	Kumar, N., Kumari, V., Ram, C., Thakur, K. and Tomar, S. K. (2018) Bio-prospectus of cadmium bioadsorption by lactic acid bacteria to mitigate health and environmental impacts. *Applied Microbiol. Biotechnol.,* 102: 1599-1615.	9.34	3.34
5	Paray, A. R., Bhakat, M., Khanday, Z. B, Parry, U. R., Lone, S. A., Yadav, H. P. and Danish, Z. (2018) Antimicrobial activity of Indian medicinal plants, Azadirachta indica, Carica papaya, Curcuma longa, *Moringa oleifera* and *Tinospora cordifolia*: A review. *The Pharma Innovation*, 7 (10): 523-31.	NA	NA
6	Paray, A. R., Bhakat, M., Lone, S. A., Mohanty,T. K., Sinha, R., Rahman, J. Ur, Khanday, Z. B. and Danish, Z. (2018) Role of preputial washing in reducing microbial load and improving bovine semen quality. *Asian Pacific J. Reprod.,* 7 (3): 97-102.	NA	NA
7	Sabikhi, L. and Kumar, C. T. M. (2018) Application of inorganic metal oxide nanoparticles in dairy products: Opportunities and challenges. *Indian J. Dairy Sci.,* 71: 1-6.	5.26	NA
8	Yadav, Prasad, Sahu, H. P., Lone, S. K., Shah, S. A., Singh, N., Verma, A., Baithalu, U. K., R. K. and Mohanty, T. K. (2018) Advances in sperm sexing in bovines. *J. Exp. Zool.* India 21 (1): 1-9.	NA	NA

Popular Articles/Technical Papers

Aggarwal, Anjali, Choudhary, Renuka, Priyadarshini, Lakshmi and Grewal, Sonika (2018)Infrared thermography technology and its application in livestock. *Dairy Planner,* 15 (11): 5-6.

Bhakar, Ankur and Ram, Hardev (2019) Hybrid napier grass a boon to forage production. *Indian Farming*, 69 (2): 35-38.

Choudhary, Sanjay, Yamini, Raheja, Nitin and Kamboj, M. L.(2018) Present status and proposed breeding strategies for goat production in India. *Indian Dairyman*, July, 2018: 99-102

Choudhary, Sanjay and Kamboj, M. L. (2018) Method of handling dairy cattle for worker safety, improved animal performance and welfare. *Indian Dairyman*, September, 2018: 68-73.

Gandhi, Kamal, Kumar, Anil, Rana, Seema, Singh, Indrajeet (2018) Melamine: A Chemical adulterant in milk and milk products. *Beverage & Food World*, 45 (7) : 36-38.

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TRAINING AND CAPACITY BUILDING

According to the Government of India National Training Policy in 2012 based on the tenet of 'competency-based training for all, Human Resource Management (HRM) unit has been established at NDRI for effective coordination and implementation of training programmes. The training plan of NDRI addresses the gap between the existing and the required competencies and provides opportunities to the employees to develop their competencies.

A. Deputations Abroad

» **Dr. Yogesh Khetra**, Scientist (Sr. Scale), Dairy Technology Division attended Cheese Symposium 2018 at Rennes, France during April 4-6, 2018. He was granted International Travel Support by Department of Science and Technology for attending this symposium.

» **Dr. P. Narender Raju**, Scientist (Sr. Scale), Dairy Technology Division visited Yezin Agricultural University, Yezin, Nay Pyi Taw, Myanmar as a visiting faculty member to deliver a course to M.Tech. and Ph.D. (Food Engineering & Technology) students at Indo-Myanmar: Advanced Centre for Agricultural Research and Education (ACARE), sponsored by Ministry of External Affairs, Govt. of India from June 27 to July 21, 2018.

Dr. P. Narender Raju at YAUYNPT, Myanmar as a visiting faculty member

» **Dr. Naresh Kumar**, Principal Scientist, Dairy Microbiology Division was deputed to attend ICAR-ILRI collaborative workshop at Nairobi Kenya from June 30 to July 8, 2018. Dr. Naresh Kumar presented scientific development on spore based technologies for rapid detection of antibiotic and pesticide residue in milk during the workshop.

» **Dr. Smita Sirohi,** Head, Dairy Economics Statistics and Management Division was deputed to attend "30th International Conference of Agricultural Economics" at Vancouver, Canada during the period from July 28 to August 2, 2018.

» **Dr. R. R. B. Singh,** Director NDRI, Karnal, **Dr. Latha Sabikhi**, Head and **Dr. Yogesh Khetra**, Scientist, Dairy Technology attended Indo Danish Collaborative Workshop on "Dairy, Food Ingredients and Water" at University of Copenhagen, Denmark from September 6-7, 2018.

Director ICAR-NDRI with scientists at University of Copenhagen, Denmark

» **Dr. Vivek Sharma**, Principal Scientist, Dairy Chemistry Division was deputed to attend two months international training programme under Institutional Development Plan (IDP) at Food Chemistry and Technology, Blichers Alle Foulum, Aahrus University, Denmark during March 25 to May 23, 2019.

B. Trainings (Category-wise)

Scientists

Name of Employee	Name of Training Programme Attended	Duration	Organizing Institute
Dr. Rajesh Kumar, PS Dr. A. K. Dixit, PS Dr. Sanjit Maiti, Sci.	Training on "Impact Evaluation of Agriculture Technologies"	April 2-6, 2018	Srinagar
Dr. Rajan Sharma, PS	Awareness Programme on "ISO/IFC 17025 2017"	May 5-6, 2018	Chandigarh
Dr. Rajan Sharma, PS Dr. Richa Singh, Sci.	Laboratory Course on "Change in ISO/IEC 17025"	May 7, 2018	Chandigarh
Dr. Shaik Abdul Hussain, Sci.	Training Programme on "Intellectual Property Rights for Agri-Startups"	May 8 -11, 2018	MANAGE, Hyderabad
Dr. Shilpa Vij, PS	Management Development Programme on "Leadership Development (a Pre-RMP programme)"	June 4-15, 2018	NAARM, Hyderabad
Dr. Chitranayak, Sr. Sci.	Short Course on "Introduction to Transducers / Sensors for Industrial Automation" at ATI-EPI (Advanced Training Institute for Electronics and Process Instrumentation)	June 11-15, 2018	Dehradun
Dr. Mamata, PS	Winter School Training Programme on "Current Concepts and Frontier Technologies for Conservation and Improvement of Indigenous Dairy Bovine Genetic Resources"	July 19 to August 8, 2018	SRS of ICAR-NDRI, Bengaluru
Er. Ankit Deep, Sci.	Training Programme on "Employability Entreprenship and Life Skills"	July 23-27, 2018	Dehradun
Dr. Sachin Kumar, Sci.	Training Programme on "Analysis of Next Generation Sequencing (NGS) Data Commencing"	July 31 to August 13, 2018	Hyderabad
Dr. M. L. Kamboj, PS	Workshop on "Integrating Dairy Animal Welfare in Abbott Nutrition's Dairy Supply Chain"	August 10, 2018	Mumbai
Dr. Kamal Gandhi, Sci.	A Training in the Laboratory on "Quality Management and Internal Audit Training for Standarzation"	August 27-30, 2018	Noida
Dr. A. Chatterjee, PS Dr. Subrata Kumar Das, PS Dr. Champak Bhakat, PS ERS, Kalyani	A Training Programme on "Stress Management at NAARM"	September 4-7, 2018	NAARM, Hyderabad
Dr. Hardev Ram, Sci.	ATraining in Winter School on "Advances in Salinity & Sodicity Management under Agro–Climatic Regions for Enhancing Formers Income".	September 4-24, 2018	CSSRI, Karnal.

Name of Employee	Name of Training Programme Attended	Duration	Organizing Institute
Dr. A. Kumaresan, PS	Training Programme on "Quality Control Aspects of Frozen Semen Technology"	October 23 to November 3, 2018,	CFSPTI, Hesaraghatta
Dr. Kamal Gandhi, Sci.	Training Programme on "Measurement Uncertainly"	November 19-20, 2018	NITS, Mumbai.
Ms. Gunjan Bhandari, Sci.	A Training Programme on "Impact Assessment of Agricultural Research & Technologies at NAARM"	December 4-7, 2018	Hyderabad
Dr. Sanjeev Kumar, Sci.	CAFT Training Programme on "Advance in Experimental Designs & Analysis" at ICAR-IASRI	December 6-26, 2018	New Delhi
Dr. Meena Malik, Professor Dr. P. Barnwal, PS	MDP on "Leadership Development (a pre-RMP Programme)" at ICAR-NAARM	December 18-29, 2018	Hyderabad
Dr. Richa Singh, Sci.	Training Programme on "Laboratory Quality Management System and Internal Audit"	January 8-11, 2019	Noida
Dr. Sanjit Maiti, Sci.	A Training Programme on "Geospatial Analysis using QGIS &R" at NAARM	February1- 6, 2019	Hyderabad
Dr. Ashwani Kumar Roy Sr. Sci.	A Training Programme on "Improving e Government in Agriculture" at MANAGE	February 4- 8, 2019	Hyderabad
Dr. A. K. Sharma, PS	A Training Programme on "Big Data Management & Comprehensive Analysis"	February 11 -15, 2019	Mohali

Technical Staff

Name of Employee	Name of Training Programme attended	Duration	Organizing Institute
Sh. Vinod Kumar, TO	A Training Programme on "Hospitality Management"	April 20-25, 2018	NAARM Hyderabad
Sh. Pavan Kumar, TO Sh. Soyrav Singh, STA	Short Course on "Introduction to Transducers / Sensors for Industrial Automation" at ATI-EPI (Advanced Training Institute for Electronics and Process Instrumentation)	June 11-15, 2018	Dehradun
Sh. Tara Chand, ACTO Sh. Rajinder Kumar, STA Sh. Atul Gupta, STA	Training Programme on "Personality and Personal Skills"	June 19-21, 2018	NBAGR, Karnal
Parveen Kumar, TO	Training Course on "CNC Programming & Machining"	July 1-31, 2018	ITI, Karnal
Sh. Umed Singh, STA	Training Programme on "Automobile Maintenance Road Safety and Behavioral Skills"	July 13-23, 2018	CIAE, Bhopal
Er. J. K. Dabas, ACTO	Training Programme on "Emerging Technologies for Sustainable and Intelligent HVAC&R"	July 27- 28, 2018	Kolkatta
Sh. Varinder Singh, STA Sh. Dharamvir Pal, STA Sh. Dharam Pal, STA Sh. Raj Pal, Tech	Training Programme on "Motivation Positive Thinking and Communication Skills for Technical Staff"	August 1-7, 2018	CIAE, Bhopal
Sh. Narendra Singh, TO Sh. Lakshman, STA	Training Programme on "Elsevier Empowering Agriculture Research in India"	August 24, 2018	Hisar
Sh. Dharam Pal, STA	Training Programme on "Farm Management"	September 14-20, 2018	ICAR IFST, Modipuram
Sh. Sandeep Deswal, STO	Training Camp for "NCC Cadets"	September 30 to October 9, 2018	Geeta Institute of Management & Technology, Kurukshetra
Sh. Pavan Kumar, TO	11th National Convention & Seminar on "Dairy Process Engineering From Farm to Table"	October 21-22, 2018	Indore
Sh. Narender Kumar, TO Sh. Deen Dayal Kumar, STA	Training Programm on "Khoa for Library Staff of ICAR"	February 21-26, 2019	NAARM, Hyderabad
Sh. Ramesh Kumar, STA	Training Programme on "Automobile Maintenance Road Safety & Behavioral Skill"	February 19-25, 2019	CIAE, Bhopal
Dr. Om Vir Singh, CTO	Seminar on "Dairy Business and Challenges"	February 19-25, 2019	Bhopal

Administrative Staff

Name of employee	Name of training programme attended	Duration	Organizing Institute
Sh. Rajesh, Assistant	Training Programme on "OPS" at ISTM	June 11 to July 6, 2018	New Delhi
Sh. Ram Dhari, Assistant, Ms. Krishna Azad, Assistant Ms. Swati Yadav, Assistant Sh. Dharmendra Singh, Assistant Ms. Sushma Rani, UDC	Training Programme on "Personality and Personal Skill Development"	June 19-21, 2018	NBAGR, Karnal
Annu, Assistant Renu Bala, Assistant	Training Programme on "OPS" at ISTM	August 6-31, 2018	New Delhi

C. Participation in Conferences/ Seminars/Workshops within India

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. F. Magdaline Eljeeva Emerald, PS	Seminar on "Building Better Science" held at Agilent Technologies, Bengaluru.	April 5, 2018
Dr. Sangita Ganguly, Sci.	National Seminar on "Emerging Role for Probiotics in Cognition, Autoimmunity and Metabolic Disorders" held at Guntur.	April 13, 2018
Dr. Naresh Kumar, PS	National Technology Day at University Institute of Engineering and Technology, KUK.	May 14, 2018
Dr. S. Subash, PS	National Dialogue on "AI and ToT Applications in Agriculture" held at NAARM, Hyderabad.	June 1-2, 2018
Dr. A. K. Dixit, PS	State Working Committee on "Doubling Farmers' Income" held at CCS-HAU, Hisar.	June 12, 2018
Dr. B. Srinivas, PS Dr. Mukund A. Kataktalware, PS Dr. A. Kumaresan, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. B.C. Ghosh, PS Dr. K. Jayaraj Rao, PS Dr. M.H. Sathish Kumar, PS Dr. Monika Sharma, PS Mr. H.C. Devaraja, PS Dr. M.C.A. Devi , PS Dr. S. Subash, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. B. Srinivas, PS	National Seminar on "Promotion of Dairy Entrepreneurship and Skill Development for Doubling Farmer's Income" held at ICAR-NDRI, Bengaluru.	July 1, 2018
Dr. S. Subash, PS	International Conference on "Medicinal Plants and Herbal Drug Discovery" held at Hotel Capitol, Bengaluru.	July 18-20, 2018
Dr. Bikash C. Ghosh. PS	Seminar on "Food Additives: A Global Perspective on Safety and Evaluation and Use", held at FSSAI, New Delhi.	July 19-20, 2018
Dr. Latha Sabikhi, Head Dr. Yogesh Khetra, Sci. Mr. Gunvantsinh Rathod, Sci. Dr. P. N. Raju, Sci.	Workshop/ N-Reach Programme on Different Aspects of Soft Skills and Personality Development by M/s Nestle India.	July 26-27, 2018
Dr. Latha Sabikhi, Head	Dairy Seminar on "VISION 2030 – Dairy Farming Best Way Out to Increase Farmers Income" held at PAU, Ludhiana.	July 29, 2018
Dr. M. L. Kamboj, PS	Workshop on "Integrating Dairy Animal Welfare in Abbott Nutrition's Dairy Supply Chain" held at Mumbai.	August 10, 2018
Dr. M. K. Ghosh, PS Dr. C. Bhakat, PS Dr. D. K. Mandal,PS Dr. A. Chatterjee, PS Dr. A. Mandal, PS Dr. M. Karunakaran, PS Dr. M. Mondal, Sr. Sci. Dr. Asif Mohammad, Sci. Dr. Saroj Rai, Sci. Dr. Rajlaxmi Behera, Sci.	International Conference on "Agricultural and Allied Sciences: The Productivity Food Security and Ecology" held at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia.	August 13-14, 2018

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. A. K. Singh, PS Dr. F. Magdaline Eljeeva Emerald, PS	International Conference on "Recent Advances in Food Processing Technology", held at Indian Institute of Food Processing Technology Thanjavur (Tamil Nadu).	August 17-19 , 2018
Dr. K. P. Ramesha, Head	Brain Storming Session on "Panchaavya Ayurved" at Nagpur.	August 18-19, 2018
Dr. K. Ponnusamy, PS	Regional Conference on "Motivating and Attracting Youth in Agriculture (Maya)" held at New Delhi.	August 30-31, 2018
Dr. Suneel Kumar Onteru, Sr. Sci.	Hands on Training on "Aquaculture Genomics and Bioinformatics" held at Chennai.	August 27 to September 1, 2018
Dr. F. Magdaline Eljeeva Emerald, PS	International Exhibition on "Dairy Products, Processing & Packaging Machinery and Allied Industries" held at Media Today Group, Bangalore International Exhibition Centre (BIEC), Bengaluru.	August 31 to September 2, 2018
Dr. Dheer Singh, Head	Training cum Workshop on "Managing Technology Value Chains" held at Hyderabad.	September 3-9, 2018
Dr. A. K. Tyagi, Head	"60th National Symposium of CLFMA" held at Goa.	September 7-8, 2018
Dr. Sumit Arora, PS Dr. Vivek Sharma, PS Dr. A. P. Ruhil, PS Dr. Rakesh Kumar, PS Dr. Shilpa Vij, PS Dr. P. Heartwin Amaladhas, PS Dr. Mukesh Bhakat, Sr. Sci. Dr. Manoj Kumar Singh, Sci. Dr. Narender Raju P, Sci. Dr. Nishant Kumar, Sci. Dr. Pradip Vishnu Behra, Sci. Dr. Rubina Kumari Bathalu, Sci. Dr. Sachin Kumar, Sci.	National Conference on "Challenges and Opportunities for the New Generation Dairy Foods in India" held at College of Dairy Technology, Sri Venkateswara Vety. University (SVVU), Tirupati (AP).	September 9-10, 2018
Dr. Dheer Singh, Head	3rd International Conference on "Nutraceutical and Chronic Diseases" held at Cancer Research Institute, Himalayan Institute of Medical Sciences, Swami Rama Himalayan University, Dehradun.	September 14-16, 2018
Dr. Rajan Sharma, PS	Workshop on "Entrepreneurship Opportunities in Dairy Industry" held at University Auditorium, Paneer Campus Nitte, Mangalore.	September 21, 2018
Dr. K. Ponnusamy, PS	International Symposium on "Animal and Disaster" held at Chennai.	September 26-27, 2018
Dr. Asit Das, PS	12th Annual Convention & National Conference on "Wildlife Health Management" held at Pantnagar, Uttarakhand.	September 29-30, 2018
Dr. Latha Sabikhi, Head Dr. Shaik Abdul Hussain, Sci. Dr. Heena Sharma, Sci. Dr. Yogesh Khetra, Sci. Dr. G. S. Meena, Sci. Mr. Gunvantsingh Rathod, Sci. Dr. Sangita Ganguly, Sci.	Agriculture Conclave held at Indira Gandhi Prathishthan, Lucknow.	October 5-8, 2018
Dr. Manoj Kumar Singh, Sci. (SS)	India International Science Festive-2018 held at Lucknow.	October 5-10, 2018
Dr. S. K. Jha, PS	Workshop on "Designing Curricula for Master's and Doctoral Degree Programmes in the Discipline of Veterinary Extension Education" held at ICAR – IVRI, Izatnagar, Bareilly (U.P.).	October 8, 2018
Dr. A. K. Tyagi, Head	National Workshop on "Recasying of Syllabi as a Subject Matter Expert" held at Veterinary College, Guwahati.	October 9-10 , 2018
Dr. Naresh Kumar, PS Dr. Raghu H V., Sci.	International Symposium on "Microbiological Food Safety Sampling and Testing in Food Safety Management" held at Hotel RedisonBlu Plaza, NH-8 Mahipalpur, New Delhi.	October 9-10 , 2018
Dr. Latha Sabikhi, Head Dr. Shilpa Vij, PS Dr. G. S. Meena, Sr. Sci. Dr. Shaik Abdul Hussain, Sci. Dr. Heena Sharma, Sci. Dr, Yogesh Khetra, Sci. Mr. Gunvantsingh Rathod, Sci. Dr. Sangita Ganguly, Sci.	Second Workshop under "Broad Subject Matter Area (BSMA) in Dairy Science & Technology for Deliberations on Revising PG Syllabus" held at Anand Agri. University, Anand.	October 11-12, 2018

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. K. P. Ramesha, Head Dr. B. Srinivas, PS Dr. Mukund A. Kataktalware, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. P. Heartwin Amaladhas, PS Dr. Menon Rekha Ravindra, PS Mrs. F. Magdaline Eljeeva Emerald, PS Dr. M. C. A. Devi, PS Dr. S. Subash, PS	National Consultation on "Agristart-ups for Smart Farming" held at ICAR-NIANP, Bengaluru.	October 11-12, 2018
Dr. P. Barnwal, PS Dr. G. S. Meena, Sr. Sci. Dr. Chitranayak, Sr. Sci. Er. Ankit Deep, Sci.	11th National Convention and Seminar on "Dairy Process Engineering" held at Indore Madhya Pradesh.	October 21-22, 2018
Dr. T. K. Datta, Head Dr. Madhu Mohini, PS Dr. Ajoy Mondal, PS Dr. Ashok Santra, PS Dr. M. Karunakaran, PS Dr. Sohanvir Singh, PS Dr. Manoj Kumar Singh, Sci. (SS) Dr. Heena Sharma, Sci. Dr. Sachin Kumar, Sci., Dr. Satish Kumar, Sr, Sci. Dr. Vedamurty G. V., Sci.	Asian Regional Conference on "Goats (ARCG-2018)" held at Amity University, Jaipur.	October 22-26, 2018
Dr. Bikash C. Ghosh, PS Dr. A. K. Dixit, PS	19th World Food Congress (IUFoST, 2018) held at CIDCO Exhibition Centre, Mumbai.	October 23- 27, 2018
Dr. Magan Singh, Sr. Sci. Dr. Rajesh Kumar Meena, Sci.	21st Biennial National Symposium on "Doubling Farmers" Income through Agronomic Interventions under Changing Scenario" held at MPUAT, Udaipur, Rajasthan.	October 24-26, 2018
Dr. M. L. Kamboj, PS	Conference on "India for Animals, 2018" held at Hyderabad.	October 26-28, 2018
Dr. Pawan Singh, PS	26th Annual Congress of "Society of Andrology India" held at MIET Meerut.	October 26-28, 2018
Dr. K. P. Ramesha, Head	International Conference on "Neuroscience & 36th Annual Meeting of Indian Academy of Neurosciences" held at Banaras Hindu University, Varanasi.	October 29-30, 2018
Dr. Sangita Ganguly, Sci.	National Conference on "Advances in Biopolymers" held at University of Kashmir, Srinagar.	October 30-31, 2018
Dr. Nishant Kumar, Sci. Dr. Pradip Behra, Sci. Dr. Shaik Abdul Hussain, Sci. Sh. Writdhama G. Prasad, Sci.	International Conference on "Rural Livelihood Improvement by Enhancing Farmers Income through Sustainable Innovative Agri. and Allied Enterprises" held at Patna.	October 30 to November 1, 2018
Dr. M. Sivaram, PS	Workshop on "Sample Size Estimation for Health Sciences Research" held at National Institute of Mental Health and Allied Sciences (NIMHANS), Bengaluru.	October 31, 2018
Dr. M. Sivaram, PS	36th Annual Conference of "Indian Society for Medical Statistics" held at NIMHANS, Bengaluru.	November 1-3, 2018
Dr. A. K. Mohanty, PS Dr. Suman Kapila, PS	3rd Convention of "Veterinary Biochemists and Biotechnologists" held at Lala Lajpat Rai University, Hisar.	November 2-3, 2018
Dr. Chander Dutt, PS	A National Symposium on "Bridging Biochemical Interventions and Environment for Health" held at LUVAS, Hisar.	November 2-3, 2018
Dr. Yogesh Khetra, Sci.	Second Meeting under Broad Subject Matter Area (BSMA) on "Dairy Science and Technology" held at SVVU, Tirupati.	November 12-13 , 2018
Dr. K. S. Kadian, Head Dr. Champak Bhakat, PS Dr. B. S. Meena, PS Dr. H. R. Meena, Sr. Sci.	9th National Extension Education Congress on "Climate Smart Agri Technologies" held at CAPHET, Ranipool, Sikkim.	November 15-17, 2018

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. A. K. Tyagi, Head Dr. Madhu Mohini, PS Dr. Veena Mani, PS Dr. Raman Malik, PS Dr. Asit Dass, PS Dr. G. Mondal, PS Dr. Mohan Mondal, Sr. Sci. Dr. Nitin Tyagi, Sr. Sci. Dr. Mohan Mondal, Sr. Sci. Dr. Nitin Tyagi, Sr. Sci. Dr. Sachin Kumar, Sci.	11th Biennial Conference of Animal Nutrition Association on "Reorienting Animal Nutrition Research in the Perspective of Farmers Welfare" held at Bihar Animal Sciences University, Patna.	November 19-21, 2018
Dr. M. K. Ghosh, PS Dr. S. K. Das, PS Dr. C. Bhakat, PS Dr. D. K. Mandal, PS Dr. A. Chatterjee, PS	International Symposium & 8th Conference of Indian Meat Science Association on "Technological Innovations in Muscle Food Processing for Nutritional Security, Quality and Safety" held at West Bengal University of Animal and Fishery Sciences, Kolkata, West Bengal.	November 22-24, 2018
Dr. K. Ponnusamy, PS	National Conference on "Revisiting Agricultural Research and Monitoring System for Developing Innovations": To Meet the Newer Challenges held at CIWA, Bhubaneswar. Odisha.	November 24-25, 2018
Dr. K. P. Ramesha, Head Dr. Mamta, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. Jeyaraj Rao, PS	National Conference on "Ecosystem Conservation and Sustainable Development (ECOCASD-2018)" held at AET Intuitions, Bengaluru.	November 27-29, 2018
Dr. Sadeesh E. M., Sci.	Annual Conference of the Society for Mitochondrial Research and Medicine (SMRM) on Targeting Mitochandria for Health & Disease held at CSIR-Central Drug Research Institute, Lucknow.	November 28-30, 2018
Dr. Sohanvir Singh, PS	Annual Review Meeting on "Gramin Krishi Mausam Sewa" held at RARS, Tirupati.	December 3-5, 2018
Dr. M. L. Kamboj, PS	Workshop on "Animal Behaviour and Welfare" International Society for Applied Ethology (ISAE) held at Delhi.	December 8, 2018
Dr. Sujeet K. Jha, PS Dr. Sanjit Maiti, Sci. Dr. Sanchita Garai, Sci.	National Seminar on "Integrated Farming System for Enhancing Farmers' Income and Nutritional Security" held at WBUAFS, Kolkatta (WB).	December 5-7, 2018
Dr. A. Manimaran, PS Dr. A. Kumaresan, PS	18th Annual Conference of "Indian Society of Veterinary Pharmacology and Toxicology (ISVPT)" and National Symposium on "One Health: Veterinary Pharmacology and Toxicology Approaches" held at College of Veterinary Science & AH, (AAU), Anand (Gujarat).	December 5-7, 2018
Dr. Sunita Grover, Head	ILSI-India Conference on "Role of Probiotics in Promoting Healthy Microbiome for Health and Immunity" held at Hotel Le Meridien, New Delhi.	December 6, 2018
Dr. Naresh Kumar, PS	India Food Safety Summit and Awards 2018 held at Delhi.	December 6, 2018
Sh. Diwas Pradhan, Sci.	59th Annual Conference of "Association of Microbiology of India & International Symposium" held at Hyderabad.	December 9-12, 2018
Dr. K. P. Ramesha, Head Dr. K. Jayaraj Rao, PS	Incubator Manager Training Programme held at Dayanand Sagar University Campus, Bengaluru..	December 10-11, 2018
Dr. A. K. Mohanty, PS Dr. Sudarshan Kumar, Sci.	10th Annual Meeting of Protomics Society India and International Conference on "Protomics for Cell and Molecular Biology" held at NCCS, Pune.	December 12-14, 2018
Dr. I. K. Sawhney, Emeritus Scientist Dr. P. Heartwin Amaladhas, PS Dr. F. Magdaline Eljeeva Emerald, PS Dr. M. H. Sathish Kumar, PS Mr. Devaraja HC, Sr. Sci. Dr. Manoj Kumar C.T, Sci.	8th International Food Convention IFCON 2018 "Holistic Approaches for Start-ups, Human Resource Training for Agriculture and Food Industry Gemmation (HASHTAG)" held at CSIR-CFTRI, Mysore.	December 12-15, 2018
Dr. A. Manimaran, PS	International Conference on "The Role of Toxicology in Public Health" held at Central Inter-Disciplinary Research Facility, Sri Balaji Vidyapeeth (Deemed University), Puducherry.	December 13-14, 2018
Dr. Vikas Vohra, PS	72nd ISAS Conference at ICAR-CIAE, Nabibagh, Bhopal (MP).	December 13-14, 2018
Dr. K.P. Ramesha, Head Dr. S. Jeyakumar, PS	National Symposium of "Forage and Livestock Based Technological Innovations for Doubling Farmers Income" held at UAS-Dahrwad, Karnataka.	December 13-14, 2018

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Dr. J. K. Kaushik, PS	25th Annual Convention of "Indian Society of Veterinary Immunology & Biotechnology" held at Mithan, Nagaland.	December 13-15, 2018
Dr. Gautam Kaul, PS	An International Conference "FSLE-India Kerala Conference, 2018" held at Kerala.	December 14-15, 2018
Dr. Anupama Mukherjee, PS	1st National Genetics Congress on "Genetics for Sustainable Food "held at New Delhi.	December 14-16, 2018
Dr. K. P. Ramesha, Head	National Workshop on "Indigenous Cow Management and Value Added Products" held at Karaikudi, Tamil Nadu.	December 17-18, 2018
Dr. Sohanvir Singh, PS Dr. Suneel Kumar Onteru, Sr. Sci.	National Conference on "Propelling Transition Toward Sustainable Food Production through Rekindling Physiological Strategies for Addressing Contemporary Challenges" held at ICAR-IVRI, Izatnagar.	December 22-23, 2018
Dr. Rakesh Kumar, PS	National Seminar on. "Dairy Vyavsaya and Chunotia" held at Jiwaji University, Gawalior.	December 22-24, 2018
Dr. K. Ponnusamy, PS	High Level Symposium on "Emerging Food Systems in South Asia: Policy Challenges and Opportunities" held at NASC, New Delhi.	December 24, 2018
Dr. T.K. Mohanty, PS Dr. S. Jeyakumar, PS Dr. A. Kumaresan, PS Dr. Mukund A. Kataktalware, PS Dr. A. K. Mohanty, PS Dr. Nishant Kumar, Sci. Dr. Rubina Kumari Baithalu, Sci.	30th Annual Convention of the Indian Society for Study of Animal Reproduction and International Symposium on "Productivity Enhancement through Augmenting Reproductive Rural Economy" held at Anand, Gujarat.	December 28-30, 2018
Dr. M. L. Kamboj, PS Dr. Pawan Singh, PS Dr. S. S. Lathwal, PS Dr. Mukesh Bhakat, PS	National Conference on "Innovation in Animal Production for Sustainability and Doubling Farmer's Income" held at College of Vety. & Animal Sciences, Munnuthy, Trissur, Kerela.	January 23-25, 2019
Dr. K. P. Ramesha, Head	National Training on "Accreditation Evaluation and Surveillance Procedures" held at APEDA, New Delhi.	January 30-31, 2019
Dr. T. K. Dutta, Head Dr. M. K. Ghosh, PS Dr. A. Mandal, PS	19th Indian Veterinary Conference and National Symposium on "Innovative Progress in Animal Health and Production for Safe and Secured Food Under one Health Perspective" held at Belgachia, Kolkata.	February 1-2, 2019
Dr. A. Chatterjee, PS Dr. A. Mohammad, Sci.	National Seminar on "Sustainable Resource Management for Enhancing Farm Income, Nutritional Security and Livelihood Improvement" held at Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Birbhum, W.B., India.	February 1-3, 2019
Dr. F. Magdaline Eljeeva Emerald, PS	Short Course on "Applied Rheology" held at Anton Paar India, Raman Research Institute, Bengaluru.	February 6, 2019
Dr. S. K. Jha, PS	National Conference on "Women Empowerment through Agro-Entrepreneurships for Livelihood Security", held at SKUAS&T, Kashmir.	February 7-8, 2019
Dr. Latha Sabikhi, Head Dr. T. K. Mohanty, PS Dr. S. S. Lathwal, PS Dr. Nishant Kumar, Sci. Dr. Shaik Abdul Hussain, Sci. Dr. G. S. Meena, Sci. Dr. W. Prasad, , Sci.	47th Dairy Industry Conference, IDA (East Zone), in association with Bihar State Chapter of IDA, Patna.	February 7- 9, 2019
Dr. K. Ponnusamy, PS	ICAR-CSSRI Golden Jubilee International Salinity Conference 2019 on "Resilient Agriculture in Saline Environment under Changing Climate: Challenges and Opportunities" held at CSSRI, Karnal.	February 7- 9, 2019
Dr. K. P. Ramesha, Head Dr. K. S. Kadian, Head Dr. T. K. Dutta, Head Dr. B. S. Meena, PS Dr. B. C. Ghosh, PS	47th Dairy Industry Conference on "Innovative Approach for enhancing Dairy Farmers' Income" held at Patna organized by Indian Dairy Association (EZ), Kolkata.	February 7- 9, 2019
Dr. A. K. Sharma, PS	Training Programme on "Big Data Management & Comprehensive Analysis" (sponsored by Department of Science & Technology, Govt. of India), C-DAC, Mohali.	February 11-15, 2019

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Mr. Devaraja HC, Sr. Sci.	Workshop on "Probiotics – Ambassadors of Human Health" held at Dairy Science College, KVAFSU Hebbal, Bengaluru.	February 14-15, 2019
Dr. K. P. Ramesha, Head Dr. B. Srinivas, PS Dr. Mukund A. Kataktalware, PS Dr. P. K. Dixit, PS Dr. M. Sivaram, PS Dr. Mamta, PS Dr. A. Kumaresan, PS	Symposium on "Group Dynamics of Smallholder Farmers" Organised by NABARD in collaboration with SRS:ICAR-NDRI, ICAR-ATARI and ICAR-NIANP, Bengaluru.	February 16, 2018
Dr. A. Kumaresan, PS Dr. Gopal Sankhala, PS Dr. Sanjit Maiti, Sci.	"14th Agricultural Science Congress" organised by NAAS, IARI, New Delhi.	February 20-23, 2019
Dr. S. Jeyakumar, PS	International Conference on "Role of Veterinary Science in Farmers Livelihood" organized by Kalnadi Ariviyallyakkam, TANUVAS, Chennai. Organised by Madras Veterinary College, Chennai.	February 22-23, 2019
Dr. T. K. Dutta, Head Dr. M. K. Ghosh, PS Dr. C. Bhakat, PS Dr. A. Mandal, PS Dr. A. Chatterjee, PS Dr. M. Mondal, Sr. Sci. Dr. Asif Mohammad, Sci. Dr. Saroj Rai, Sci. Dr. Rajlaxmi Behera, Sci.	National Seminar on "Industry Oriented Research in Dairy Processing: An Update and Future Strategies" held at BCKVV, Mohanpur, West Bengal.	February 22-23, 2019
Dr. Nishant Kumar, Sci.	Global Conference on "Reproductive Health with Focus on Occupational, Environmental and Life Style Factors & 29th Annual Meeting of the Indian Society for the Study of Reproduction and Fertility (ISSRF)" held at Jawaharlal Nehru University, New Delhi.	February 22-24, 2019
Dr. Madhu Mohini, PS	2nd International Conference on "Innovations in Chemical, Biological & Environmental Sciences" held at Arya P.G. College, Panipat.	February 27-28, 2019
Dr. M. L. Kamboj, PS Dr. Pawan Singh, PS Dr. A. Manimaran, PS	7th Pan Commonwealth Veterinary Conference on "The Role of Veterinarians in Addressing the Global Challenges to the Lives of Our Pets, Livestock, Wildlife, Humans, and our Environment" held at National Institute of Animal Nutrition and Physiology, Bengaluru.	March 3-7, 2019
Dr. Sangita Ganguly, Sci.	National Symposium on "Probiotics and Functional Foods on Health Management" held at Department of Food Engineering and Technology, Tezpur University, Tezpur.	March 4-5, 2019
Mr. Devaraja HC, Sr. Sci.	Workshop organized by Bengaluru District Co-Operative Milk Producers Societies, Bidadi, Ramanagara.	March 9, 2019
Dr. M. C. A. Devi, PS Dr. S. Subash, PS	Training Programme on "Empowerment and Entrepreneurial Development in Agriculture" held at UAS, Bengaluru.	March 11-15, 2019
Dr. F. Magdaline Eljeeva Emerald, PS Dr. Monika Sharma, PS	International Conference on "Emerging Scenario in Agribusiness" held at Indian Institute of Plantation Management, Bengaluru.	March 21-22, 2019
Ms. Gunjan Bhandari, Sci.	National Seminar on "Prospects of Making Haryana a Total Organic State" held at Department of Economics, Kurukshetra University, Kurukshetra.	March 28, 2019
Dr. Monika Sharma, PS	National Conference on "Emerging Trends in Food Technology & Advance Chemistry" held at Jain Deemed to be University (SET), JGI Global Campus, Kanakapura, Bengaluru.	March 29, 2019

MAJOR EVENTS

Conferences/Seminars/Symposia/Workshops/Training programmes Organised

The Institute hosted quite a good number of Seminars, Workshops and Short Courses with the participation of delegates from India and abroad. Some of the important ones are listed as under:

Sl. No.	Title of Workshop/Conference/Seminar/Training organised	Duration
1	An International Training Programme on "Management of Dairy Cooperatives"	April 10 - 24, 2018
2	A Workshop on "Working in Laboratory: Do's and Don'ts"	April 28, 2018
3	Extension Programme for Extension Reforms' (SSEPERS) under Agricultural Technology Management Agency (ATMA) scheme	May 1, 2018
4	A Training Programme on "Ice Cream and Frozen Desserts"	May 7-12, 2018
5	A National Conference on "Fermented Dairy Foods and their Health Benefits"	May 26- 27, 2018
6	A Training Programme on "Microbiological Quality and Safety Evaluation of Dairy Products"	May 28 to June 3, 2018
7	A Training Programme on "Artificial Insemination and Veterinary First Aid"	June 5 to July 6, 2018
8	Summer Training Programme on "Food Technology"	June 15 - July 14, 2018
9	An Orientation Programme on "Dairying and Animal Husbandry"	June 18, 2018
10	A Training Programme on "Milk Processing and Value Addition"	June 21 – 30, 2018
11	Training Programme on "Microbiological Quality and Safety Analysis of Dairy Products"	June 22– July 2, 2018
12	Web telecast of Prime Minister's Sawand arranged with the members of Self Help Groups	July12, 2018
13	Workshop/ N-Reach Program for students on "Different Aspects of Soft Skills and Personality Development	July 12 - 13 & July 26 - 27, 2018
14	A Training Programme on "Petroleum Conservation"	July13, 2018
15	An International Training Programme on "Ultrasonography and Reproductive Disorder Management in Dairy Animals" at Southern Campus of ICAR-NDRI, Bengaluru	July 16 – 20, 2018
16	A Winter School at Southern Campus of ICAR-NDRI	July19, 2018
17	A Winter School on "Nutritional Strategies to Enhance Livestock Productivity and Farm Economy"	September 5 - 25, 2018
18	A Seminar on "Entrepreneurship in Dairy and Food Industry: Concept to Commercialization "	September 14 to 15, 2018
19	Swachhta Hi Sewa Campaign	September 15, 2018
20	ISO-9001:2015 Auditor Training for the Employees of NDRI, Karnal	October 3 -5 2018
21	Institute-Industry Meet, 2018 at ICAR-NDRI, SRS, Bengaluru	October 6,2018
22	An Orientation Programme for Fresher Students	October 8, 2018
23	A Discourse on "Disaster Management"	October 12, 2018
24	A Workshop for the Fresher Students on "Life is Awesome"	October 12 - 13, 2018
25	A Brainstorming Session on "Breeding Strategies for Sustainable Cattle Production"	November 2-3, 2018
26	Training Programmes on "Scientific Goat Farming"	November 13-17, 2018
27	26th Annual Conference of Agricultural Economics Research Association at NDRI, Karnal	November 15-17, 2018
28	A "Farmers Scientist Interface"	November 16, 2018

Sl. No.	Title of Workshop/Conference/Seminar/Training organised	Duration
29	Training Programme on "Scientific Dairy Farming"	November 27 to December 6, 2018
30	A National Symposium on Augmentation of Animal Productivity under Changing Socio-Economic Scenario & 27th Annual Conference of Society of Animal Physiologist of India	November 27-28, 2018
31	Training on Cloning and Embryo Production	December 1–15, 2018
32	CAFT National Training Programme in Dairy Processing on "Nano-technological and Biochemical Techniques for Assessing the Quality and Safety of Milk and Milk Products"	December 1–21, 2018
33	A Training Programme on " Developing Winning Research Proposals"	December 13-16, 2018
34	Swachhta Pakhwara	December 16-31, 2018
35	Refresher Programme on "Management of Modern Dairies for Established Agripreneurs under Agri-clinic and Agri-business Centre"	December 26-29, 2018
36	Kisan Mela	December 28, 2018
37	CAFT Training Programme in Dairy Processing on "Rapid Bio-sensors and Micro-techniques for Monitoring Contaminants and Adulterants in Dairy Foods"	January 4 - 24, 2019
38	An International Training Programme on "Modern Dairy Technology, Management and Cooperatives"	February 5– 19, 2019
39	Training-cum-Workshop on "Enhancement of Competency and Work Efficiency in Organization	February 13-15 , 2019
40	An International Training Programme on "Milk and Milk Products Processing"	March 4- 18 , 2019
41	NDRI Global Alumni Scientific Meet (NGASM)	March 15-17, 2019
42	Leadership-cum-Scientific Meet	March 17, 2019
43	17th Convocation of NDRI Deemed University	March 23, 2019

Specific Day(s) Celebrated (April 2018-March 2019)

1	Elie Metchnikoff Day Celebrated	May 15, 2018
2	World Milk Day	June 1, 2018
3	World Yoga Day Celebrated	June 21, 2018
4	World Breast Feeding Day Celebrated	August 7, 2018
5	Soil Health Day Celebrated	December 5, 2018
6	Kisan Divas Celebrated	December 23, 2018
7	International Women's Day Celebrated	March 8, 2019

DISTINGUISHED VISITORS

04.04.2018	A delegation from Morocco.
18.04.2018	OIE-Performance of Veterinary Service (PVS) Mission Team

OIE Performance of Veterinary Service (PVS) Mission Team visiting Livestock Farm

26.04.2018	Sh. Santanu Mitra, Additional Development Commissioner, O/o DC (MSME), Nirman Bhavan, New Delhi
21.05.2018	Chairman, Uttar Pradesh Go Seva Aayog
16.06.2018	Seventeen member delegation from Nepal
23.06.2018	Dr. Neena Malhotra, Joint Secretary, Ministry of External Affairs (East & Southern Africa Division), New Delhi

Dr. R. R. B. Singh, Director NDRI interacting with Dr. Neena Malhotra, Joint Secretary, Ministry of External Affairs (East & Southern Africa Division)

29.06.2018 High Commissioners of Rwanda and Uganda

High Commissioners of Rwanda and Uganda visiting Livestock Farm

25.7.2018 Dr. Santosh Kumar Singh, Agricultural Specialist of U.S. Embassy, New Delhi

27.7.2018 Mr. Suresh Narayanan, Chairman and Managing Director, Nestle India

Mr. Suresh Narayanan, Chairman and Managing Director, Nestle India Manager visiting Model Dairy Plant

28. 7. 2018 Director (Finance), ICAR, New Delhi

9.10.2018 Shri Parshottam Rupala, Minister of State for Agriculture & Farmers' Welfare and Panchayati Raj, Government of India

13.11.2018 Twenty one member delegation from 2018 Class of Resource & Agricultural Leadership (REAL), Montana State University, USA

15.12.2018 His Excellency Parasivum Pillay Vyapoory, President of Mauritius

9.01. 2019 Four member delegation from Brazil

11.01. 2019 Mr. Vinith Shivram Poduval, Senior Vice President, Food Safety & Quality, Schreiber Foods, Washington, USA

22.03. 2019 Dr. Venkatesh, Director General of Health Services, Govt. of India

PERSONNEL

INSTITUTE STAFF
(As on March 31, 2019)

Director's Cell

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

Joint Director (Research) Cell

Latha Sabikhi, PhD	Joint Director (Research)
Ranjana, BA	Private Secretary

Research Priortisation, Monitoring and Evaluation Unit

Meena Malik, M Phil, PhD	Professor (English)
Braj Kishor, MA, B Lib Sci	Asst. Chief Technical Officer
Sunil Sharma, MSc	Technical Officer

Joint Director (Academics) Cell

R. R. B. Singh, PhD	Joint Director (Academics)
Parvesh Lata, BA	Private Secretary

Academic Affairs Management Unit

S. K. Tomar, PhD	Academic Coordinator
A. P. Ruhil, PhD	Controller of Examinations
Bhagwan Das, BA	Asst. Admn. Officer

Administrative Wing

Susanta Saha, MSc, MBA	Joint Director (Admn.) & Registrar
Vivek Purwar, M Tech	Sr. AO
Ram Niwas, BA	Admn. Officer
Ritu Dalal, B Tech	Admn. Officer
A. K. Mishra	Admn. Officer
Rajbir, BA	Asst. Admn. Officer (DDO)
S. S. Meena, BA	Asst. Admn. Officer (Purchase)
Braham Prakash, BA	Asst. Admn. Officer
Dharam Singh Meena, BA	Asst. Admn. Officer (Stores)
Subhash Chand, BA	Asst. Admn. Officer
Ajit Singh, BA	Asst. Admn. Officer (E- IV)

Mukesh Dua, BA	Asst. Admn. Officer (II & V)
Ram Pal	Asst. Admn. Officer (III)
Anita Rani, BA	Private Secretary

Finance Wing

D. D. Verma, M Com, PGDFM	Comptroller
R. K. Singh	Sr. Fin. & Account Officer
Kunal Kalra, B Com, PGDM	Finance & Accounts Officer
Vishal Acharya, MA	Asst. Fin. & Account Officer

Animal Genetics & Breeding Division

S. M. Deb, PhD	Head
Archana Verma, PhD	Principal Scientist
I. D. Gupta, PhD	Principal Scientist
Anupama Mukherjee, PhD	Principal Scientist
Vikas Vohra, PhD	Principal Scientist
Om Vir Singh, PhD	Chief Technical Officer
Y. K. Panwar, MA	Sr. Technical Officer

Livestock Production & Management Section

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

Animal Nutrition Division

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

Animal Physiology Division

Mahendra Singh, PhD	Head
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
Avnish Kumar, BCom	Personal Assistant

Animal Biotechnology Centre

Dr. P. Palta, PhD	Principal Scientist and In-Charge
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. Satish Kumar, PhD	Principal Scientist
Dr. Rakesh Kumar, PhD	Principal Scientist
Dr. M. K. Singh, PhD	Scientist
Dr. S. Kumar, PhD	Scientist

Animal Biochemistry Division

Dheer Singh, PhD	Head
Gautam Kaul, PhD	Principal Scientist
Rajeev Kapila, PhD	Principal Scientist
Suman Kapila PhD	Principal Scientist
Sunil Kumar Onteru, PhD	Sr. Scientist
Ms. Suneeta Meena, MSc	Scientist
Sadeesh E. M., PhD	Scientist
Vedamurthy G. V., PhD	Scientist
Ravi Kant, PhD	Asst. Chief Technical Officer

Dairy Technology Division

Latha Sabikhi, PhD	Head
S. K. Kanawjia, PhD	Emeritus Scientist
A. K. Singh, PhD	Principal Scientist
Kaushik Khamrui, PhD	Principal Scientist
Narender Raju Panjagari, PhD	Scientist (Sr. Scale)
Ganga Sahay Meena, PhD	Scientist
Yogesh Khetra, PhD	Scientist
Shaik Abdul Hussain, PhD	Scientist
Gunvantsinh Rathod, M Tech	Scientist
Neelam Upadhayay, PhD	Scientist
Wridhama Prasad, M Tech	Scientist
Sanket G. Borad, M Tech	Scientist (till December, 2018)
Sangita Ganguly, PhD	Scientist
Heena Sharma, PhD	Scientist
Manoj Kumar, CT, MTech	Scientist
Gaurav Kr. Deshwal, M. Tech.	Scientist
Prem Kumari, B.A.	Private Secretary

Experimental Dairy

Hari Ram Gupta, PhD	Chief Technical Officer (In-Charge)
Lehri Singh, MSc	Chief Technical Officer
Sanjeev Kumar, MA	Asst. Chief Technical Officer
Gurpartap Singh, M Tech	Technical Officer
Jagdish, BA	Technical Officer

Dairy Chemistry Division

Bimlesh Mann, PhD	Head
Raman Seth, PhD	Principal Scientist
Sumit Arora, PhD	Principal Scientist
Vivek Sharma, PhD	Principal Scientist
Rajan Sharma, PhD	Principal Scientist
Rajesh Bajaj, PhD	Principal Scientist
Richa Singh, PhD	Scientist
Priyanka Singh Rao, MSc	Scientist
Kamal Gandhi, PhD	Scientist
Shakuntla Rani, BA	Private Secretary

Dairy Microbiology Division

Sunita Grover, PhD	Head
R.K. Malik, PhD	Emeritus Scientist
S. K. Tomar, PhD	Principal Scientist
Naresh Kumar, PhD	Principal Scientist
Shilpa Vij, PhD	Principal Scientist
Chand Ram, PhD	Principal Scientist
P. V. Behare, PhD	Scientist (SS)
Raghu H.V., MSc	Scientist (SS)
Rashmi H. M., MTech	Scientist (SS)
Diwas Pradhan, M Tech	Scientist
Mr. Saurabh Kadyan, M.Tech	Scientist
Seema RanI, BA, BEd	Personal Assistant

Dairy Engineering Division

A. K. Singh, PhD	Head
P. Barnwal, PhD	Principal Scientist
Chitranayak, PhD	Sr. Scientist
P. S. Minz, M Tech	Scientist (Senior Scale)
Amita Vairat, M Tech	Scientist
Ankit Deep, M Tech	Scientist
Kushbu Kumari, M Tech	Scientist
Om Prakash, Dip (Agri. Engg.)	Chief Technical Officer
S. K. Chaudhary, AMIE	Chief Technical Officer
J. K. Dabas, PhD	Asst. Chief Technical Officer
Sunil Kumar, M Tech	Asst. Chief Technical Officer
Sh. Parveen Kumar, Dip (Machinist)	Technical Officer
Ms. Manju Bala, Dip Arch	Technical Officer
Varinder Hans, BA	Technical Officer

Dairy Economics, Statistics and Management Division

B. S. Chandel, PhD	Head
A. K. Chauhan, PhD	Principal Scientist
Ravinder Malhotra, PhD	Principal Scientist
Ajmer Singh, PhD	Principal Scientist
A. P Ruhil, PhD	Principal Scientist
A. K. Sharma, PhD	Principal Scientist
Anil Kumar Dixit, PhD	Principal Scientist
Udita Chaudhary, MSc	Scientist
Gunjan Bhandari, MSc	Scientist
Tara Chand, BSc	Asst. Chief Technical Officer
Sunita Chaudhary, BA	Private Secretary

Dairy Extension Division

K. S. Kadian, PhD	Head
S. K. Jha, PhD	Principal Scientist
Gopal Sankhala, PhD	Principal Scientist
K. Ponnusamy, PhD	Principal Scientist
B. S. Meena, PhD	Principal Scientist
H. R. Meena, PhD	Principal Scientist
Ritu Chakravarty, PhD	Sr. Scientist
Sanchit Maiti, PhD	Scientist
Sanchita Garai, PhD	Scientist
Meenu Rani, MA, PGDCA	Private Secretary

Forage Research and Management Centre

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

Agricultural Technology Information Centre (ATIC)

Arun Kumar Misra, PhD	Principal Scientist & In-Charge
Jitendra Rana, PhD	Asst. Chief Technical Officer

Krishi Vigyan Kendra/Trainers' Training Centre

Surender Gupta, PhD	Chief Technical Officer & In-Charge
Rajeshwar Dayal, BSc	Asst. Chief Technical Officer
Mohar Singh, MSc	Asst. Chief Technical Officer
Kulvir Singh, MSc	Asst. Chief Technical Officer
Deepa Kumari, BSc, MA	Technical Officer
Balraj	Technical Officer

Forage Production Section

Ashutosh, PhD	Sr. Scientist & In-Charge
Satish Kumar, PhD (Horti.)	Chief Technical Officer

Anil Kumar Dagar, MSc	Asst. Chief Technical Officer
Ravi Rawat, MSc (Entomology)	Sr. Technical Officer
Mahender Pal	Technical Officer
Dharm Pal	Technical Officer

Livestock Research Centre

S. S. Lathwal PhD	Principal Scientist & In-Charge
Nishant Kumar, MVSc	Scientist
Rubina Kumari Bithalu, MVSc	Scientist
Pramod Kumar, MSc	Asst. Chief Technical Officer
Amarpal Singh, PhD	Sr. Technical Officer
Ashwani Kumar, MSc	Sr. Technical Officer
Rajbir	Technical Officer
Samar Singh	Technical Officer

Animal Health Complex

Parveen Kumar, MVSc	Chief Technical Officer
S. Raju, MVSc	Chief Technical Officer
J. K. Pundir, BVSc	Asst, Chief Technical Officer
Sahdev Singh, MSc	Asst. Chief Technical Officer

Artificial Breeding Research Centre

T. K. Mohanty, PhD	Principal Scientist & In-Charge
Mukesh Bhakat, PhD	Sr. Scientist
Subhash Chand, BVSc	Sr. Technical Officer

Library Services

S.M. Deb, PhD	Head
B. P. Singh, MA, PGDCA, M Lib, I Sc	Asst. Chief Technical Officer
Narendra Singh, MCA, M Lib I Sc	Technical Officer

Computer Centre

A. K. Sharma, PhD	Principal Scientist & In-Charge
A. P. Ruhil, PhD	Principal Scientist
Naresh Kumar Dahiya, M Tech	Asst. Chief Technical Officer
Des Raj Dip. CSP	Technical Officer

Communication Centre

Gopal Sankhala, PhD	In-Charge
Dharambir, BA	Technical Officer

Vehicle Maintenance Section

Sanjeev Kumar, B Tech, M Sc (CS)	Technical Officer

Official Language Unit

Susanta Saha, MSc, MBA	In-Charge
Rakesh Kumar, MA	Assistant Director (OL)
Kanchan Choudhary, MA	Asst. Chief Technical Officer

Security Section

Ashutosh, PhD	In-Charge
Deepak Chopra, BA	Security Officer
Rajvir Singh, MA, PGDCA	Security Supervisor

Maintenance Section

R. K. Bansal, BE (Civil)	In-Charge
S. K. Saini, B Tech (Mechnical)	Sr. Technical Officer
Khem Chand, ITI (Electrical)	Technical Officer
Balbir Singh, ITI (Electrical)	Technical Officer
Arun Kumar, ITI (Electrical)	Technical Officer
Ishwar Singh Nagar	Technical Officer

Health Complex

Dheer Singh, PhD	In-Charge
Manoj Kumar, MBBS	S. M. O.
Richa Walia, Diploma Nursing	Technical Officer
Saroj Kathuria, Diploma Nursing	Technical Officer
K. S. Khanna	Technical Officer
Sarroj Bala, D Pharma	Technical Officer
Anuradha, Diploma Nursing	Technical Officer

Hospitality Cell

J. K. Dabas, PhD	In-Charge (Asst. Chief Technical Officer)
Vinod Kumar	Technical Officer (Liaison Officer)

Sports Section

A. K. Singh, PhD	In-Charge
G. S. Meena, PhD	Coordinator
Sandeep Deswal	Sports Instructor

Estate Section

Sushil Kumar Kamboj, MSc	In-Charge (Chief Technical Officer)
P. M. Meena, MSc	Asst. Chief Technical Officer

Southern Regional Station, Bengaluru

K. P. Ramesha, PhD	Head
B. Surendra Nath, PhD	Principal Scientist
Bikash Chandra Ghosh, PhD	Principal Scientist
P. K. Dixit, PhD	Principal Scientist
Bandla Srinivas, PhD	Principal Scientist
K. Jayaraj Rao, PhD	Principal Scientist
D. N. Das, PhD	Principal Scientist
M. C. Arunmozhi Devi, PhD	Principal Scientist
A. Kumaresan, PhD	Principal Scientist
S. Jeyakumar, PhD	Principal Scientist
P. Heartwin Amala Dhas, PhD	Principal Scientist

M. Sivaram, PhD	Principal Scientist
Menon Rekha Ravindra, PhD	Principal Scientist
Mukund .A. Kataktalware, PhD	Sr. Scientist
F. Magdaline Eljeeva Emerald PhD	Sr. Scientist
Mamta, PhD	Sr. Scientist
S. Varalakshmi, PhD	Scientist
S. Subash, PhD	Scientist
A. Manimaran, PhD	Scientist
Monika Sharma, PhD	Scientist
H. C. Devaraju, M Tech	Scientist
Sathish Kumar. M. H., PhD	Scientist
Lakshman Naik.N., PhD	Scientist
P. Muruganantham, M Lib Sci	Chief Technical Officer
V. R. V. Surendranath Naik, MD	Chief Medical Officer
B. K. Rajashekaraiah, BSc (Agri.)	Asst. Chief Technical Officer
Veeraju, BE (Civil)	Asst. Chief Technical Officer
P. G. Satish, BVSc	Asst. Chief Technical Officer
Siddaramanna, PhD	Sr. Technical Officer
R. Keshavamurthy, BSc (Agri.)	Sr. Technical Officer
Gurunath Gouda Patil, BSc (Agri.)	Sr. Technical Officer
K. Ningaraju, MVSc	Sr. Technical Officer
Meganathan, Dip. (Elec. Engg.)	Sr. Technical Officer
K. P. Lakshminarayanappa, DME (Mech.)	Sr. Technical Officer
Janakshi, MCA	Sr. Technical Officer
M. S. Nagarajaiah, Dip. (Civil Engg.)	Sr. Technical Officer
Vimala, BSc	Technical Officer
K. Ramakrishna Prasad, MSc	Technical Officer

Eastern Regional Station, Kalyani

T. K. Datta, PhD	Head
M. K. Ghosh, PhD	Principal Scientist
S. K. Das, PhD	Principal Scientist
A. Santra, PhD	Principal Scientist
C. Bhakat, PhD	Principal Scientist
A. Mandal, PhD	Principal Scientist
D. Mandal, PhD	Principal Scientist
A. Chatterjee, PhD	Principal Scientist
M. Karunakaran, PhD	Principal Scientist
M. Mondal, PhD	Sr. Scientist
Asif Mohammad, PhD	Scientist
Saroj Rai, PhD	Scientist
Rajalakshmi Behra, MVSc	Scientist
Alokesh Goswami, MSc	Chief Technical Officer
Amitava Ghosh, MVSc	Chief Technical Officer
Somnath Dutta, MVSc	Chief Technical Officer
Prabir Saha, MSc	Chief Technical Officer
Sukhdev Singh, BA	Asst. Admn. Officer

PERSONALIA

Joining/Appointments

» Sh. Rajinder Kumar joined as Chief Admn. Officer at ICAR-NDRI, Karnal after being relieved from ICAR, New Delhi w.e.f. 25.4.2018.

» Dr. Mamata Chauhan, Sr. Scientist (Animal Biochemistry) discipline joined at Southern Campus of ICAR-NDRI Bengaluru after being relieved from ICAR-NRC on Equines, Hisar w.e.f. 28.6.2018.

» Dr. Vikas Vohra, Principal Scientist (AG&B) discipline joined at ICAR-NDRI, Karnal after being relieved from ICAR-NBAGR, Karnal w.e.f. 30.6. 2018.

» Dr. Asit Das, Principal Scientist (Animal Nutrition) discipline joined at ICAR-NDRI, Karnal after his transfer from ICAR-IVRI, Izatnagar w.e.f. 17.7.2018.

» Sh. Saurabh Kadyan, Scientist (Dairy Microbiology) joined at ICAR-NDRI, Karnal after relieving from ICAR-NAARM, Hyderabad w.e.f. 1.10.2018.

» Sh. Gaurav Kr Deshwal (Dairy Technology) joined at ICAR-NDRI, Karnal after being relieved from ICAR-NAARM, Hyderabad w.e.f. 3.10.2018.

» Sh. Rajneesh Kumar Singh, Sr. F&AO joined at ICAR-NDRI, Karnal after being relieved from ICAR-IISWC, Dehradun (Uttrakhand) w.e.f. 11.2.2019.

» Sh. Vivek Purwar, Sr. AO joined at ICAR-NDRI, Karnal after being relieved from ICAR-NBPGR, New Delhi w.e.f. 11.3.2019.

Promotions

» Dr. Monika Sharma, Scientist (Food Technology) promoted to the next higher RGP Rs. 7000/- w.e.f. 18.9.2015.

» Ms, Udita Chaudhary, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) revised Level-11 w.e.f. 5-11-2016 vide O/o No. 6-35/2017/DPCS/E-I(S)/404-13 dated 19.3.2019.

» Dr. Rashmi H. M., Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) revised Level-11 w.e.f. 15.9.2016.

» Dr. Rubina Kumari Baithala, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 1.1.2017.

» Dr. Shaik Abdul Hussain, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 1.1.2017.

» Dr. Saroj Rai, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 7000) w.e.f. 15.9.2017.

» Dr. Nishant Kumar, Scientist promoted to the next higher RGP (Rs. 15600-39100+RGP Rs. 8000) w.e.f. 20.7.2017.

» Smt. Sunita Chauhary, Private Secretary awarded Financial Upgradation under MACP w.e.f. 30.04.2019.

Retirements/Relieving/Transfers

» Dr. Neelam Kewalramani, Principal Scientist, Animal Nutrition Division retired from Council's service w.e.f. 30.4.2018.

» Dr. B. V. Balasubramanyam, Principal Scientist (Dairy Technology), Southern Campus of ICAR-NDRI Bengaluru retired from Council's service w.e.f. 30.4.2018.

» Sh. S. C. Sharma, Sr. Fin. & Accounts Officer retired from Council's service w.e.f. 31.7.2018.

» Sh. H. R. Arya, Senior Admn. Officer retired from Council's service w.e.f. 30.9.2018.

» Dr. Jancy Gupta, Prinicipal Scientist, Dairy Extension Division retired from Council's service w.e.f. 30.11.2018.

» Shri. K. L. Sampath, Assistant Chief Technical Officer, retired from Council's service w.e.f. 31.12.2018

» Dr. Smita Sirohi, Head, Dairy Economics Statistics & Management Division appointed as Advisor (Agricultural & Marine Products) at Embassy of India, Brussels & relieved from ICAR-NDRI, Karnal w.e.f. 9.1.2019.

» Dr. Sanket G. Borad, Scientist (Dairy Technology discipline) resigned from the post of Scientist & relieved from ICAR-NDRI, Karnal w.e.f. 1.1.2019.

» Dr. Ashok Kumar Gupta, Principal Scientist, Animal Genetics & Breeding Division retired from Council's service w.e.f. 28.2.2019.

» Sh. Rajinder Kumar, Chief Admn. Officer transferred from ICAR-NDRI, Karnal to join at ICAR H.Q w.e.f. 14.3.2019.

Additional Responsibility

» Dr. Latha Sabikhi, Head, Dairy Technology Division entrusted with the additional responsibility of Acting Joint Director (Research) w.e.f. 11.3.2019 for a period of six months vide O/o No.1-44/2016/E-I(S)/Vol-III/297-305 dt. 11.3.2019.

» Dr. S. M. Deb, Principal Scientist entrusted with the additional responsibility of Acting Head, Animal Genetics & Breeding Division w.e.f. 1.3.2019 for the period of six months vide O/o No.F.6-48/15/HOD/E-I(S)/Vol.III-221-27 dt. 28.2.2019.

MAIN CAMPUS, NDRI, KARNAL

RESEARCH DIVISIONS

Animal Genetics & Breeding Division

Animal Genetics & Breeding Division has been actively involved in conducting research in the areas of animal genetics and breeding including cytogenetics and molecular genetics. The thrust areas of research of the Division are development of genomic selection strategies for dairy cattle and buffaloes for improving performance traits, genetic improvement of indigenous and crossbred cattle and Murrah buffaloes by progeny testing of breeding males, faster multiplication of indigenous cattle, development of sustainable breeding plans, part and complete characterization of genes and their association with production/reproduction traits, disease resistance, screening of young breeding males for genetic disorders and assessment of reproductive efficiency of cattle and buffaloes.

Another important mandate of the Division is the academic activity for development of human resources in the field of animal genetics and breeding.

The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at the Division during eighth plan continued its activities on conducting the national training to scientists / teachers from Research Institutes, State Agricultural/Veterinary Universities and Livestock Development Organizations in advanced areas of Animal Genetics and Breeding. A total of 34 National Training Programs have so far been organized under the aegis of CAFT (AG&B) in the division.

The Division also fulfills the mandate of extension in the area of Animal Genetics & Breeding through training programs in KVK, TBI and Dairy Extension division, consultancy services to farmers and various dairy stakeholders, supply of superior germplasm in the form of frozen semen and surplus breeding males to farmers, livestock developmental agencies, state governments and other stakeholders involved in dairy development in the country.

The organizational structure for research consists of Animal Breeding Lab., Biometrical Genetics Lab., Buffalo Breeding Lab., Molecular Genetics Lab., DNA Bank for cattle and buffaloes and Livestock Record Cell. Besides this, breeding herds of cattle (Karan Fries, Karan Swiss, Sahiwal, Tharparkar and Gir) and Murrah buffaloes is also an integral part of the research component of Animal Genetics and Breeding Division.

Livestock Production & Management Section

The Livestock Production and Management (LPM) Section came into being in June, 2009 after it was disassociated from the Dairy Cattle Breeding Division. Earlier, a separate faculty of LPM was working along with the Dairy Cattle Breeding Division and post graduate and doctorate degrees were being awarded since 1976. The Section is working in the front line areas of all applied aspects of dairy animal production and has been successful in evolving many transferable technologies and development of packages of practice on the routine care and management of dairy animals. Beside research, the faculty of LPM has been engaged in teaching both at UG and PG levels.

The Livestock Production Management (LPM) Section is shouldering the responsibility of various important activities of the Institute. LPM faculty is working as four pillars of Livestock Production Management i.e. breeding, feeding, housing and healthcare. This is contributing very meticulously in Livestock Research Centre and Artificial Breeding Research Centre to cater to the research needs of most of the disciplines of ICAR-NDRI. This faculty is also entrusted with the responsibility of HRD development in the area of scientific dairy farming, commercial dairy farming, infertility management of dairy animals and frozen semen production and quality control.

Animal Biotechnology Centre

Biotechnology was initiated at NDRI, Karnal during mid eighties under a UNDP 'Centre of Excellence on Biotechnology' programme. The urgent need for application of recent biotechnological advances in reproduction and production

of superior females of dairy breeds of ruminants for improving animal productivity in our country formed the basis for the establishment of a state-of-the-art Embryo Biotechnology Centre (EBC) with financial support from the Department of Biotechnology. Biotechnology was further strengthened by establishment of Livestock Genome Lab and Molecular Biology Unit. Animal Biotechnology Centre was reorganized in June 1999 by consolidating all the infrastructure facilities created under various programmes on biotechnology. Besides research on areas relevant to biotechnology in dairy production and processing, the Centre also offers M.Sc./M.V.Sc./M.Tech and Ph.D. (Animal Biotechnology) programmes.

The objectives of the proposed Division are 1) To undertake biotechnology oriented basic and applied research programmes for improving animal productivity and for developing innovative dairy processes for producing superior quality, safe and wholesome dairy products, 2) To train manpower in application of Biotechnology in Dairy Production and Dairy Processing and 3) To organize Masters and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

A state-of-the-art biotechnology research facility, which offers a working space of more than 20,000 sq. ft., was created in 2007 to consolidate the biotechnology research at NDRI. It has specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research, Structural Biology etc.

Animal Nutrition Division

Animal Nutrition Division undertakes basic and applied research in field of post-graduate programmes of education and participates in the process of extension education through various training programmes and field level technology development and refinement in the discipline of animal nutrition and forage production. The research laboratories are equipped with modern analytical instruments for chemical and physical analysis. The Division has developed excellent laboratory facilities, which are central facilities for research and education, not only for the Institute but also for various sister organizations seeking such support from time to time. The central facilities include central fine instrumentation laboratory, laboratory for anaerobic rumen microbial work, laboratory for environment related studies including methanogenesis, quality control laboratory, feed processing unit and nutritional biotechnology laboratory. Some of the sophisticated instruments available include atomic absorption spectrophotometer, gas-liquid chromatography, HPLC system, ^{15}N-Analyzer, methane analysis equipment using SF_6 technique, spectrophotometer, PCR machine etc. Research on precision nutrition is being undertaken since the past few years. Besides research, Animal Nutrition Division also offers the M.Sc./M.V.Sc. and Ph.D. in Animal Nutrition.

Forage Research and Management Centre

Agronomy Section (Forage Research and Management Centre) was established as a sister section of the forage production section since July 2013 to strengthen the research, teaching and extension activities related to round the year forage production and quality improvement of forages through agronomic manipulations. The mandate of the section includes developing the agro-techniques for enhancing the fodder productivity and quality through efficient management of resources and disseminating the knowledge about new agro-techniques for forage crop production and management to the dairy farmers/extension functionaries. At present, the section offers Master's and Doctoral programmes in Forage Agronomy. The section has about 10 acres of land for conducting research experiments and facilities for quality analysis of forages.

Animal Physiology Division

Animal Physiology used to function as a section of the erstwhile Dairy Husbandry Division and subsequently as Dairy Cattle Nutrition and Physiology Division till the end of the 6th Five Year Plan. The discipline of Animal Physiology received the status of an independent division in 1984. The division made a humble beginning with limited resources at its disposal. It was a challenging task to develop infrastructural facilities in the division during those days with limited budgetary provisions. The division not only succeeded in establishing the state-of-the-art research facilities, but also earned fame in publishing the best quality research papers at the Institute. The scientists and the students have earned exemplary recognitions while working at this division and abroad during training and postdoctoral programs. The division has always taken a lead in organizing various brain storming sessions, conferences, symposia and training programs for the benefit of scientific and technical community engaged in research. Being one of the important production disciplines, Animal Physiology has always come forward to solve the problems of dairy farmers. It has one of the biggest and prestigious projects on NICRA running successfully at the Institute. The alumni of the division have achieved higher positions in research and management in the Institute and in ICAR/SAUs. The division has developed certain useful technologies like induction of lactation, rBST to augment milk production, milk SCC for udder health and CMP and application of mist and fan to alleviate summer stress, which have been adopted several progressive farmers of the area.

Animal Biochemistry Division

Research endeavours of the Division are presently directed towards development of probiotic and prebiotic foods, dairy nutraceuticals and their mechanism of action, validation of health benefit claims of Indian dairy products, nutrigenomics, characterization of buffalo fertility genes, sperm functions and cryopreservation of semen, spermatogonial stem cells research and bioinformatics in dairy processing and production.

The Division has instrument rooms with modern equipments viz. Alpha- and Beta-counters, Ultra-centrifuge, High speed centrifuges, Micro-centrifuges, UV-visible spectrophotometers, Spectrofluorometer, PCR, Real Time PCR, ELISA Plate readers, High Pressure Liquid Chromatography, Gas Liquid Chromatography, Inverted and fluorescent microscopes, Ice flaking machines, Freeze dryer, Gel documentation (Imaging) systems, ultra filtration unit, Ultra-low temperature freezers and Carbon dioxide incubators. The Division has a cold room for carrying out research at low temperature. Cell culture facilities are also available in the Division.

The salient research achievements of the Division are: development of different types of probiotic dahi and validation of their health-benefits in reducing serum cholesterol levels, protection against gastrointestinal cancer and management of diabetes in animal models, validation of nutraceutical attributes of dairy ghee in coronary heart diseases, gastro-intestinal and mammary cancer and improvement of immune system, and elucidation of its molecular mechanism, bioavailability of vitamins and minerals from dairy products, levels of conjugated linoleic acid in milk products, characterization of 8 amino acid transport systems in mammary gland and their induction at the onset of lactation, antiatherogenic properties of milk and its mechanism, hormonal profile of reproductive phases of buffalo, biochemical changes in sperm maturation, capacitation, acrosome reaction and semen freezing, signal transduction mechanism of sperm function, expression and hormonal regulation of fertility related ovarian genes in buffalo, SSCP analysis of CYP19 aromatase gene in anestrus buffaloes and transduction pathways (PI3K and MAPK) in cattle granulosa cells during steroidogenesis and apoptosis.

Dairy Chemistry Division

The mandate of Division is to conduct fundamental and applied research for understanding chemistry of milk and milk products, to impart educational programmes for undergraduate and postgraduate courses and to provide R&D support towards chemical-quality control related problems of the dairy industry.

The Division has contributed significant knowledge on the chemistry of milk and milk products. The salient achievements are: evaluation of physico-chemical properties of buffalo milk and alteration in its calcium and casein levels 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, revealing chemistry of ghee and ghee residue flavour, antioxidant properties of ghee residue, chemical makeup and structural integrity of milk fat globule membrane, influence of various processing parameters on the major minerals and trace elements and their partitioning, rapid and simple methods for the determination of SNF in milk, formulation of quality standards of milk and milk products now prescribed by the Central Committee of Food Standards under 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, structure and bacteriostatic role of lactoferrin, characterization and crystallization of buffalo lactoperoxidase, functional properties of WPC, effect of processing treatments on vitamins, calcium fortified milk, 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 and buffer exchange and concentration. Different analytical methods developed for testing of milk & milk products: strip based tests developed for the detection of added urea, neutralizers, hydrogen peroxide, glucose, maltodextrin in milk, new colour based method developed for rapid detection of detergents in milk, method developed for vegetable oil detection in ghee using RP-HPTLC and nano-encapsulation of bioactive components for their application in functional foods. A method was standardized for assessment of proteolysis in UHT milk using Attenuated Total Reflectance-Fourier Transform Infrared (ATR–FTIR) spectroscopy. An RP-HPLC method was standardized for separation and quantification of all milk protein fractions and genetic variants in one run with high resolution. A preservative formulation was prepared as an alternative to formalin for preservation of milk and milk products samples kept for chemical analysis. Panchgavya formulation with potent antifungal activity has been standardized with respect to ratio of individual ingredients, temperature and days of fermentation.

The Division has state-of-the-art air conditioned seminar room, lecture room equipped with interactive board, LCD projectors, visualiser, podium etc., quality control lab, undergraduate and postgraduate labs, instrument room (equipped with HPLC, GLC, Mastersizer, ultrafiltration, electrophoresis, Imaging system, refrigerated water bath, dual beam digital spectrophotometer, water purification system, BOD incubator, sonicator etc.), research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ nutraceuticals and quality assurance), chemical section of National Referral Centre for Milk Quality and Safety (equipped with FTIR, HPLC, GC-MS, AAS, PCR, Real-time PCR, particle size analyser, electrophoresis, Elisa Reader, Western Blot, digital refractometer, protein analyzer, lyophilizer, fume hoods, conductivity & O_2 meter etc.).

Dairy Microbiology Division

Dairy Microbiology Division is currently engaged in research, teaching, consultancy, training and technology transfer in specialized field of Dairy Microbiology. Research work of the Division covers the areas related to starter cultures and fermented milk products, direct vat starters (DVS), indigenous probiotics and their functional efficacy, culturomics, metagenomic and metabolomics of milk and fermented dairy products, prebiotics and synbiotics, functional fermented foods, bioactive peptides, microbial metabolites and biopreservatives, biosensors, quality assurance and food safety. The Division has played a leading role in establishing National Collection of Dairy Cultures (NCDC) with current repository of 955 microbial cultures and National Referral Centre for milk quality and safety. The Division has recently transferred technologies on two indigenous strains of probiotics, Misti Dahi/doi, EPS producing culture for preparation of low-fat dahi, rapid kits for antibiotic residues, *Listeria monocytogenes* and *Enterococci* to potential stake holders in our country for their industrial application. The faculty is also involved in imparting teaching and guidance for both under-graduate and post-graduate programmes. The Division offers M. Tech and Ph.D. programmes both in Dairy Microbiology and Food Safety and Quality Assurance. Besides, the Division is also contributing in teaching Microbiology courses for B. Tech (Dairy Technology) students. The Division also 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 Technology Division

The Dairy Technology Division, one of the earliest Divisions of NDRI, Karnal, is involved in teaching, research, training and consultancy activities. The educational programmes include the flagship programme of B. Tech. (Dairy Technology), Masters and Ph.D. (Dairy Technology) and Masters (Food Science & Nutrition/Food Technology). The research efforts of the divisional faculty are channelled through sponsored as well as in-house projects including dissertations of post graduate students. The projects focus on basic and applied studies to refine processing and packaging technologies for traditional, composite, western and dried dairy products. The Division has developed strong expertise in the area of membrane processing, biotechnological applications, composite dairy and food products and their packaging. It has successfully organised 37 National Training Programmes under the ICAR-sponsored Centre for Advanced Faculty Training in Dairy Processing (earlier, Centre for Advanced Studies in Dairy Technology) since 1994, for teaching faculty of State Agricultural Universities and other institutions. The Division of Dairy Technology has received a number of awards in recognition of the outstanding scientific contributions made by the scientists, students and staff, such as Fellow of the Indian Dairy Association, Best Employee Award from ICAR, Best Teacher Awards, Rafi Ahmed Kidwai Awards, Jawaharlal Nehru Award, DAAD Fellowships, Humboldt Fellowships and several others, including Best Research Paper awards. Most recently, the Institutional Development Plan under the National Agricultural Higher Education Project for the incentivisation of undergraduate programmes was granted to ICAR-NDRI, under which several activities for the improvement of faculty and students are in progress in the Division. An integrated dairy management program has been proposed in collaboration with Institute of Rural Management, Anand for the B. Tech. (Dairy Technology) students getting admission in the academic session 2019-20. The Dairy Technology Division, over the years has contributed significantly to the human resource needs and technological repertoire of the Indian Dairy Industry.

Dairy Engineering Division

Dairy Engineering (DE) Division, established as one of the major research divisions, has been contributing to teaching, research, training and industrial consultancy since the inception of the Institute. The Division has research laboratory facilities to cater to the needs of specific areas and programmes such as process engineering, process equipment design, thermal, electronics and instrumentation. In addition to this, there are post-graduate teaching laboratories, Research & Development workshop and equipment testing hall to support both research and teaching activities. During the past three decades, the Division has achieved breakthroughs in developing a number of process equipment for manufacturing indigenous milk products. Many of these equipment have been patented and efforts are being made to transfer them to the equipment manufacturers. The Division has tie-ups with equipment manufacturers and users for their collaboration in development or in adoption of the research efforts. The Division has developed equipment for the manufacture of khoa, burfi, basundi, ghee etc on industrial scale. Recent research achievements include development of weight based filling system for kheer, machine vision system for colour measurement of dairy products, turbo assisted scraped surface heat exchanger (SSHE) etc. Current research areas focus on development of weight based filling system for rabri and equipment for mechanized production of kheer and rabri. The Division also conducts specialized training to graduate engineers during summer.

Dairy Economics, Statistics & 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 formulating projects 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 Division

Dairy Extension Division was established at NDRI, Karnal in May, 1961 to undertake extension activities, besides teaching and research in Extension Education. Research endeavours 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. In addition, the Division organises the main extension programmes of the Institute, such as Dairy Mela and demonstrations, field days, etc. 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. The interface not only helps the dairy organizations to find solutions for today's problems, but also to realizes the vision for the future. The Division also organizes technology transfer campaigns, infertility and veterinary aid campaigns, Kisan Sanghoshthies and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, help in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers. Extension Education Programme "Dairy Education at Farmers' Door" was initiated in 2009, to strengthen the effective dissemination of dairy production and processing technologies among farming community. Another Extension Approach "Farmers Farm School" in village was initiated in 2014, for updating farmers knowledge in the field of dairy farming, in particular and agriculture, in general.

SUPPORT SECTIONS

Livestock Research Centre

The total milk production of the herd during the current year was 1039384.8 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 10.9 and 11.4 kg per head per day, respectively. The milking average of Sahiwal cows and Murrah buffaloes was 6.3 and 7.4 kg per animal per day, respectively. One Sahiwal Cow (SW-2233) produced best milk yield of 23.5 kg in peak lactation. Best yield in Murrah buffalo (MU-7358) was 18.0 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 35.0 kg (KF-7763) and 20.5 kg (KS-4447), respectively.

Bovine Strength of Cattle and Buffaloes as on 31.03.2019

Age group	Cattle						Buffaloes	Total Bovines
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total	Murrah	
Calves upto 6 months								
Male	13	11	10	02	24	60	37	97
Female	34	09	13	-	32	88	29	117
Heifers	115	56	32	08	120	331	146	477
Cows	195	68	81	10	167	521	222	743
Male (young stock)	12	11	08	06	77	114	84	198
Bullocks	-	-	-	-	06	06	-	06
Teaser Bulls	-	-	-	-	-	-	02	02
Total	**369**	**155**	**144**	**26**	**426**	**1120**	**520**	**1640**

Flock Strength of Goats as on 31.03.2019

Age Group	Alpine x Beetal	Sannen x Beetal	Total
Female			
Kids upto 6 months	26	03	29
6-12 months	13	02	15
Yearling	41	16	57
Goats	53	15	68
Male			
Kids upto 6 months	25	14	39
6-12 months	06	01	07
Bucks	41	16	57
Total	205	67	272

Milk Production at NDRI, Karnal during 2018-19

Total Milk production (kg) : **1039384.8 kg**

Average Number of Animals in Milk per day : Cattle : 237

Buffaloes : 112

Goats : 42

Sale of Livestock (2018-19)

Mode of Disposal	Cattle	Buffaloes	Goats	Total
Public Auction	419500.00 (60)	548000.00 (18)	102000.00 (12)	1069500.00 (90)
On Book Value	-	56735.00 (03)	150900.00 (26)	207635.00 (29)
Grand Total	**419500.00 (60)**	**604735.00 (21)**	**252900.00 (38)**	**1277135.00 (119)**

* Auction of animals was conducted on 18th, 19th & 20th September, 2018

* Figures in parentheses indicate the total number of animals sold.

Performance of Dairy Animals (01.04.2018 to 31.03.2019)

Particulars	Genetic Groups									
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total	Murrah	Alpine X Beetal	Saneen X Beetal	Total
Average number of animals in milk per day	84	21	26	06	100	237	112	32	10	42
Average number of dry animals per day	89	42	47	05	56	239	102	10	02	42
Milking average (kg) per day	6.3	4.4	3.5	10.9	11.4	8.1	7.4	1.5	1.7	1.5
Overall average (kg) per day	3.1	1.5	1.3	0.6	7.3	4.0	3.9	1.1	1.4	1.2
Best yield (kg) in a day	23.5	13.5	17.5	20.5	35.0	-	18.0	4.6	4.2	-
Animal Number	2233	1384	16	4447	7763	-	7358	296	247	-

Month-wise Milking Average (kg) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal (2018-19)

Months	Cows										Buffaloes		Goats			
	Sahiwal		Tharparkar		GIR		Karan swiss		Karan Fries		Murrah		Alpine x Beetal		Sannen x Beetal	
	No of animals in milk/ day	Milk yield (kg)/ animal/ day	No of Animals in milk/ day	Milk yield (kg)/ animal/ day	No of Animals in milk/ day	Milk yield (kg)/ animal/ day	No of animals in milk/ day	Milk yield (kg)/ animal/ day	No of Animals in milk/ day	Milk yield (kg)/ animal/ day	No of Animals in milk/ day	Milk yield (kg)/ animal /day	No of animals in milk/ day	Milk yield (kg) / animal/ day	No of animals in milk/ day	Milk yield (kg)/ animal/ day
Apr, 18	83	6.2	23	5.9	30	4.8	06	12.6	101	12.1	117	8.3	28	1.8	10	2.2
May, 18	85	6.6	24	4.9	30	4.1	07	10.7	104	11.4	124	7.8	39	1.6	12	1.9
June, 18	78	7.8	22	4.1	26	4.5	07	9.0	102	10.4	120	7.5	39	1.5	11	1.8
July, 18	89	6.7	23	4.5	25	3.6	06	9.7	89	10.4	112	7.0	36	1.0	11	1.2
Aug, 18	85	6.7	25	3.7	26	2.9	06	9.8	92	9.1	107	6.5	28	08	10	09
Sep, 18	84	6.4	21	4.7	22	3.1	06	10.1	88	10.4	101	6.8	17	1.0	07	09
Oct, 18	87	6.1	22	4.0	24	3.0	06	10.7	96	10.9	98	7.2	11	1.2	05	1.2
Nov, 18	86	6.3	19	4.9	24	2.5	06	9.2	98	11.3	99	7.2	19	1.5	07	1.4
Dec, 18	81	6.4	18	5.2	21	3.5	06	10.1	97	12.3	111	7.6	35	1.5	11	1.7
Jan, 19	87	5.4	20	3.8	26	3.2	07	10.0	101	13.2	116	7.8	42	1.5	13	1.7
Feb, 19	83	5.6	17	2.9	30	3.4	06	11.8	108	12.7	120	7.4	45	1.7	14	1.7
Mar, 19	82	5.5	13	4.8	31	3.2	07	10.5	115	13.0	122	7.2	46	1.7	14	1.9
Average	**84**	**6.3**	**21**	**4.4**	**26**	**3.5**	**06**	**10.9**	**100**	**11.4**	**112**	**7.4**	**32**	**1.5**	**10**	**1.7**

Fodder and Concentrate (2018-19)

Months	Type of Fodder (q)				Concentrate (kg)
	Green	Dry/Hay	Silage	G. Total	
April, 18	13408.50	304.50	-	13713.00	94467.00
May, 18	10895.50	716.50	-	11612.00	112441.00
June, 18	15500.00	289.00	-	15789.00	116020.00
July, 18	20952.90	113.50	-	21066.40	111000.00
August, 18	17246.00	52.50	-	17298.50	125865.00
September, 18	15809.75	127.50	-	15937.25	107813.00
October, 18	14587.00	1416.00	-	16003.00	114200.00
November, 18	9453.00	5864.50	-	15317.50	114700.00
December, 18	10798.00	5064.50	-	15862.50	115250.00
January, 19	14466.00	730.50	1399.00	16595.50	120931.00
February, 19	16086.50	466.00	2042.50	18595.00	113119.00
March, 19	20172.00	179.50	2045.00	22396.50	115200.00
Total	**179375.15**	**15324.50**	**5486.50**	**200186.15**	**1361006.00**

Total Milk Production and Milk Supplied to Experimental Dairy (2018-2019)

Month	Total Milk Production	Total Disposal Milk	Total Milk Send to Expt. Dairy	Total Milk Received by Expt. Dairy
April, 18	99055.5	14454.7	83860.5	83585.0
May, 18	96885.6	11260.8	85139.2	85030.0
June, 18	87758.7	9676.8	77785.2	77763.0
July, 18	81381.4	9454.9	71579.7	71675.0
August, 18	73348.5	10233.4	62958.4	63030.0
September, 18	72427.2	10116.0	61909.6	61970.0
October, 18	79434.2	11442.1	67555.1	67605.0
November, 18	79088.2	11324.8	67319.1	67205.0
December, 18	89441.3	13196.1	75642.8	75720.0
January, 19	94951.3	16672.7	77975.5	79165.0
February, 19	86456.6	14607.9	70973.2	70840.0
March, 19	99156.3	14413.7	84141.0	84185.0
Total	**1039384.8**	**146853.9**	**886839.3**	**887773.0**

Fat and SNF Percentage of Cattle and Buffaloes (2018-2019)

First Lactation	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of observations	244	34	43	1	470	479
Average Fat %	4.29	4.27	4.36	5.50	4.31	7.67
Range	2.90-5.80	3.30-5.60	3.30-5.60	5.50	2.90-5.80	5.70-10.10
No. of observations	244	34	43	1	470	479
Average SNF%	8.80	8.83	8.76	9.10	8.79	9.85
Range	8.10-9.20	8.50-9.20	8.40-9.10	9.10	8.20-9.20	9.00-10.30
All Lactations	**Cows**					**Buffaloes Murrah**
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of Observations	925	207	283	63	1128	1271
Average Fat %	4.34	4.28	4.30	4.33	4.34	7.67
Range	2.90-5.80	3.20-5.60	3.00-5.70	2.90-5.50	2.90-5.90	5.30-10.40
No. of Observations	925	207	283	63	1128	1271
Average SNF%	8.80	8.79	8.79	8.77	8.79	9.85
Range	8.10-9.20	8.50-9.20	8.30-9.20	8.30-9.20	8.20-9.20	8.80-10.50

Protein and Lactose Percentage of Cattle and Buffaloes (2018-2019)

First Lactation	Cows					Buffaloes Murrah
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of observations	244	34	43	1	470	479
Average Protein %	3.28	3.32	3.29	3.30	3.30	3.72
Range	2.90-3.60	3.00-3.70	2.90-3.50	3.30	2.90-3.80	3.10-4.30
No. of observations	244	34	43	1	470	479
Average Lactose%	4.47	4.48	4.47	4.50	4.47	5.15
Range	3.90-4.47	4.00-4.80	3.90-4.47	4.50	3.70-5.10	4.30-5.90
All Lactations	**Cows**					**Buffaloes Murrah**
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	
No. of observations	925	207	283	63	1128	1271
Average Protein %	3.29	3.28	3.29	3.26	3.30	3.70
Range	2.50-3.90	2.90-3.80	2.90-3.90	2.90-3.60	2.90-3.80	3.10-4.40
No. of observations	925	207	283	63	1128	1271
Average Lactose%	4.46	4.45	4.47	4.43	4.47	5.13
Range	3.70-5.20	4.00-5.20	3.90-4.90	3.90-4.90	3.70-5.10	4.00-5.90

Production and Reproduction Performance of Cattle and Buffaloes (2018-19)*

Traits	Sahiwal	Tharparkar	Karan Fires	Murrah
First Lactation				
Age at 1st calving (months)	44.23 (38)	40.21 (10)	36.88 (24)	44.39 (35)
Total milk yield (kg)	1721 (38)	1392 (6)	4423 (18)	2594.09 (48)
305 or less days milk yield (kg)	1652 (38)	1340 (6)	3530 (18)	2471.75 (48)
Lactation length (days)	259 (38)	304 (6)	373 (18)	340.69 (48)
Service period (days)	122 (21)	196 (6)	182 (13)	118 (22)
Dry period (days)	120 (21)	171 (6)	70 (12)	103.08 (23)
Calving interval (days)	368 (21)	475 (6)	455 (12)	417.08 (23)
All Lactations				
Total milk yield (kg)	1810 (117)	1422 (19)	4085 (40)	2390.23 (123)
305 or less days milk yield (kg)	1754 (117)	1406 (19)	3623 (40)	2318.78 (123)
Lactation length (days)	267 (107)	261 (19)	350 (40)	307.39 (123)
Service period (days)	122 (48)	140 (14)	150 (26)	118.93 (54)
Dry period (days)	130 (48)	158 (14)	76 (24)	115.62 (55)
Calving interval (days)	404 (48)	427 (14)	428 (24)	415.62 (55)
Best Lactation 305 days				
Milk yield (kg)	4424 (Animal no. 2122)	2095.5 (Animal no. 1384)	5755.5 (Animal no. 7261)	3991 (Animal no. 6626)

*Figures in parenthesis indicate the number of animals

Artificial Breeding Research Center

The Artificial Breeding Research Centre (ABRC) with 144 breeding bulls (Sahiwal-49, Tharparkar-19, Karan Fries - 29, Karan Swiss - 02, Murrah - 36, Gir - 9), is engaged in progeny testing programme for Sahiwal and Murrah bulls. This centre is engaged in advanced research on bull management, breeding soundness evaluation standards for the indigenous bull, semen cryobiology, sperm sexing; early bull fertility assessment and dissemination of quality germplasm to the farmers and developmental agencies. The Artificial Insemination Laboratory under ABRC is also developing strategies for fertility improvement in dairy cows and buffaloes through reproduction management and oestrous synchronization.

Research, Extension and Education Achievements

The scientists working in the centre are actively involved in various institute research projects, inter-institute research projects and externally funded projects to achieve the research objectives.

Four Murrah breeding bulls were selected under Network Project on Buffalo Improvement for the 18th set of progeny testing programme.

Reproduction Management

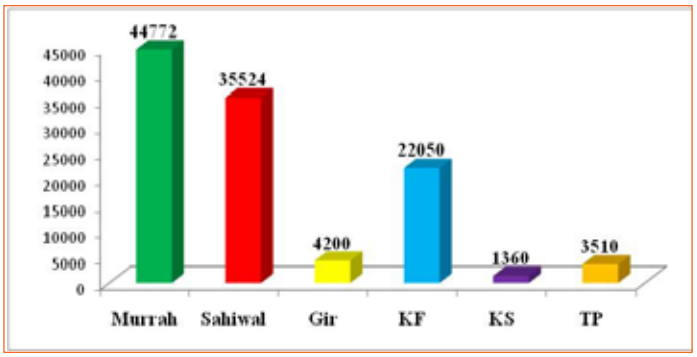
Reproductive Status of NDRI Herd during 2018 (January to December)

Particulars	Breeds					
	SW	TP	KS	GIR	KF	MU
Cow / Buffalo						
No. of observations	82	33	5	31	57	108
Service period (days)	130.20	122.9	318.4	170.45	158.36	145.91
No. of service/conception	1.62	1.63	1.4	1.9	1.70	1.65
Heifer						
No. of observations	55	17	2	16	39	61
Av. age at maturity (Month)	26.29	27.70	27.5	31.0	26.56	30.96
Av. age at conception (Month)	29.21	28.52	27.5	31.81	29.25	34.3
No. of service/conception	1.74	1.58	1.0	1.42	1.82	1.72
Conception Rate (%)						
Conception rate 1st service	42.04	42.25	54.54	46.77	33.55	46.15
Conception rate 3rd service	82.95	66.19	63.63	85.48	71.05	83.25
Over all conception rate	42.21	34.39	26.92	41.66	36.54	44.34

SW-Sahiwal, TP-Tharparkar, KS-Karan Swiss, KF-Karan Fries, MU- Murrah

Production of Superior Germplasm

The centre is involved in production and conservation of superior male germplasm of cattle and buffaloes. During 2017-18 a total of 1,11,416 doses of frozen semen were produced.



Breed wise production of superior germplasm (2018-19)

Dissemination of Superior Germplasm

The centre is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes. ABRC disseminated 78728 ml doses of liquid semen of Sahiwal, KF and Murrah bulls to local farmers and also disseminated / supplied 79997 doses of frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers and various Dairy development organizations / Institutes / Gaushalas of 12 states viz., Haryana, Punjab, Uttarakhand, Delhi, U.P, Rajasthan, Bihar, Himachal Pradesh, Bihar, J&K and Maharashtra.

Month-wise Dissemination of Semen Doses (2018– 2019)

Month	Liquid semen doses (ml) to Farmers	Frozen semen doses to Farmers / Institutes / Dairy Development Agencies
April, 18	5830	5394
May, 18	6715	5117
June, 18	5850	3820
July, 18	6115	22432
August, 18	7220	3546
September, 18	7560	7942
October, 18	7490	6535
November, 18	6568	5619
December, 18	6725	5310
January, 19	6505	7328
February, 19	5620	2544
March, 19	6530	4410
Total	**78728**	**79997**

Extension Activities

- ABRC provided exposure visits to all the participants who came for the Entrepreneurship Development Program on Commercial Dairy Farming under SINED-TBI during this period.
- ABRC arranged exposure visits to farmers and trainees of KVK and students of In Farm Training.
- Training was organised on "Breeding Soundness Examination (BSE) of Bull and Andrological Examination" for VO and QCO of Semen Stations from January 7-9, 2019 and "Laboratory Techniques" for Incharge/General Manager of Frozen Semen Stations from February 25 to March 3, 2019.
- The centre distributed 5 surplus breeding bulls (Karan Fries - one, Murrah - three and Gir- one) to government agencies/farmers.
- Rendered services or straw testing of empty frozen straws for different animal husbandry departments.
- Provided advisory services to the farmers in use of A.I., different breeding activities and other aspects of dairy bull management.
- ABRC supported research activity of the students of Animal Biochemistry, Animal Biotechnology, Livestock Production management, Animal Physiology and Animal Genetics and Breeding Division to carry out research on various aspects on sperm biology.

Other Extension Activities

- A 35 days certificate course on "Artificial Insemination and Veterinary First Aid" was organised for 10 AI technicians working in Motihari district at Eastern Campus, Kalyani from June 5 to July 6, 2018.
- A fodder nursery was established on different varies of hybrid Napier nursery in the KVK for demonstration and supply of saplings to the farmers.
- An animal health camp was organized with collaboration of ATMA on May 5 2018. Dr. Deo Barman was an expert in treating animals with the supply of medicines from the NDRI-Piprakothi Centre.
- Pashudhan Arogya Mela was organised at Motihari December 23 -25, 2018. Several farmers participated in Mela.
- A total number of 300 farmers visited the centre and took advice on animal treatment and management.
- A team of scientists participated in State Agricultural Fair at Zila School Maidan, Motihari, East Champaran, Bihar from April13 to 15, 2018

Semen Distributed among Farmers from the Centre (January 2018 to December 2019)

Year 2018 (Period)	Supply of Semen for AI
January, 18	150
February, 18	22
March, 18	255
April, 18	542
May, 18	280
June, 18	313
July, 18	128
August, 18	325
September, 18	288
October, 18	280
November, 18	75
December, 18	142
Total	**2800**

Forage Production Section

The foremost responsibility of Forage Production Section is to produce adequate quantity of good quality green fodder to meet the nutritional requirements of the Institute herd. After meeting the day to day requirement of fodder, some area is utilized for production of fodder seed and other grain crops to meet the requirements for transfer of technology programmes of Institute and partial fulfilment of the grain component of feed.

Allocation of the Farm Land to Different Units

Sr. No.	Unit	Area (Acres)
1.	Forage Production Section &RFS (Seed)	805.69
2.	Farm Building, Road Drains, Channel & Silo Pit.	106.21
3.	Area under Eucaleptus trees (Farm)	5.01
	Land under Forage Production Section	**916.91**
	Land under Campus, Buildings and other Institute Activities	
1.	Narmda Hostel, Kalki Bhawan, Plantation area and Dairy Mela Ground	42.75
2.	Institute campus and Building	324.53
3.	Dairy Demonstration & other schemes, KVK	33.39
4.	Artificial Breeding Research Complex, Block-5	10.00
5.	Model Dairy Plant	20.50
	Total	**431.17**
	Grand Total (Land with NDRI, Karnal as on May, 2017)	**1348.08**
	Land handed over to other Agencies	
	Indian Railway	0.49
	33 KVA H.S.E.B., Karnal (Station)	0.49
	NBAGR (ICAR)	74.99
	DWR	47.97
	Total	**123.94**
	Overall Land	**1472.02**

Fodder/Feed Production and Supply

A total of 193992.90 quintal green and 15620 quintal dry good quality fodder was produced from high yielding varieties of fodder crops of maize, sorghum, Napier grass, sugargraze and cowpea during kharif season and berseem, oats, Chinese cabbage and winter maize in rabi season. Similarly, seed/grain crops of oats were also grown. A total of 198198.65 quintal of fodder including 177574.65 quintal green fodder, 5493.50 quintal silage, 3013.50 quintal straw and 12117.00 quintal dry fodder was supplied to cattle yard.

Production and Productivity of Forage Crops (Green Fodder & Dry Fodder) during 2018-19

S. No.	Crop	Area(ha)	Average Yield (q/ha)	Production in (q)
1.	Berseem + Oats + Mustard	22.53	919.92	20726.00
2.	Berseem + Oats + Rye + Mustard	48.30	762.39	36823.25
3.	Oats + Rye + Mustard	10.04	537.15	5393.00
4.	Oats + Mustard	19.35	283.67	5489.00
5	Rye Grass	0.40	1352.32	547.50
6.	Lucern	0.40	520.00	210.50
7.	Oats	17.40	403.06	7089.50
8.	Maize + Oats	14.41	254.32	3535.00
9.	Mustard	9.39	241.96	2272.00
10.	Maize	113.22	292.83	33154.45
11.	Maize + Jowar	7.02	215.60	1513.50
12.	Maize + Cowpea	34.05	269.03	9160.75
13.	Nutrifeed	21.92	459.62	10075.00
14.	Sugargraze + Jowar	2.83	566.96	1604.50
15.	Jowar (SC)	63.88	2970.00	10750.00
16.	Sugargraze	60.20	171.86	10346.25
17.	Napier Grass	5.46	312.36	1705.50
18.	Napier + Cowpea	5.26	303.42	1596.00
	Total	**456.06**	-	161991.70
19.	Jowar dry	-	-	9021.50

Production and Productivity of Grain Crops and Straw (2018-19)

S. No.	Crop	Area(ha)	Average Yield (q/ha)	Production (q)
1.	Oats	56.69	28.43	1612.15
2.	Mustard	0.61	2.46	1.50
3.	Oats Straw	56.69	26.97	1529.00

Fodder Supply to Cattle Yard/Animal Nutrition (2018-19) (FPS & RFS)

Month	Green (q)	Silage (q)	Dry Straw (q)	Dry Fodder (q)	Total (q)
April, 18	13025.50		304.50		13330.00
May, 18	10895.50		692.50		11588.00
June, 18	15609.50		289.00		15898.50
July, 18	21321.90		93.50		21415.40
August, 18	17246.00		32.50		17278.50
September, 18	15938.75		107.50		16046.25
October, 18	14886.00		13.50	1382.50	16282.00
November, 18	9463.00		33.00	5806.50	15302.50
December, 18	10373.00		78.50	4928.00	15379.50
January, 19	13902.50	1406.00	723.50		16032.00
February, 19	15412.50	2042.50	466.00		17921.00
March, 19	19500.50	2045.00	179.50		21725.00
Total	**177574.65**	**5493.50**	**3013.50**	**12117.00**	**198198.65**

Forage Conservation

A total of 1529.00 q of dry fodder such as oats straw in the form of by- product of these crops was produced. To fulfil the nutritional requirements of the herd during lean period and to provide required dry matter during winter months, when DM content in the lush green forages is very low, silage and oats straw were supplied.

Calculated Cost of Fodder Supplied to Livestock Research Centre/ Animal Nutrition from Forage Production Section (2018-19)

Sl. No.	Crop Name	Quantity (q)	Rate (Rs./q)	Amount (Rs.)
1.	Green	177574.65	150/-	26636197.50
2.	Silage	5493.50	300/-	1648050.00
3.	Dry Fodder	12117.00	100/-	1211700.00
4.	Straw	3013.50	400/-	1205400.00
	Total	198198.65	-	30701347.50

Revolving Fund Scheme on Seed Production

Unavailability of good quality seeds/ grains of improved varieties of fodder crops is the biggest constraint in increasing the production of fodder grains crops. Thus, a Revolving Fund Scheme on Seed Production of Fodder Crops was initiated at NDRI, Karnal in 80 hectare area to produce the seeds grains of improved varieties of fodder crops for cultivation at Institute farm, Institute regional stations, sale to farmers and other agencies. During the year under the report, 2540.79 quintal seeds of improved varieties of fodder crops, 109.25 quintal grains, 32001.20 quintal green fodder, 3104.50 quintal dry fodder, 2186.25 quintal bhusa and 7938.50 quintal silage were produced. Total calculated cost of seed, grain, green fodder, dry fodder, silage and bhusa is Rs. 14881786.00 under Revolving Fund Scheme on Seed Production during the report as given below:

Production of Seed under RFS Seed Production (2018-19)

Kind of Seed	Quantity of Seed (q)	Rate (Rs/q)	Calculated Cost (Rs.)
Oats kent	683.40	3500/-	2391900.00
Mustard Chinese Cabbage	30.20	6000/-	181200.00
Oats Kent BR Seed	70.00	7250/-	507500.00
Wheat Seed	1757.19	2168.75/-	3810906.00
Total	**2540.79**		**6891506.00**

Production of Grain under RFS Seed Production (2018-19)

Kind of Grain	Quantity of Grain (q)	Rate (Rs/q)	Calculated Cost (Rs.)
Wheat	32.70	1200/-	39240.00
Oats	76.55	1200/-	91860.00
Total	**109.25**	**-**	**131100.00**

Production of Green Fodder, Dry Fodder (Bhusa) amd Silage under RFS, Seed Production and Supplied to LRC through Forage Production Section (2018-19)

Kind of Fodder	Quantity (q.)	Rate (Rs./q.)	Calculated Cost (Rs.)	Remarks
Green Fodder	32001.20	150/-	4800180.00	Supplied to LRC
Dry Fodder	3104.50	100/-	310450.00	Supplied to LRC
Bhusa	2186.25	400/-	874500.00	Sold / LRC
Silage	7938.50	300/-	2381550.00	Supplied to LRC
Grand Total	**-**	**-**	**8366680.00**	

Revenue Generation by Sale /Supply of Seed/Grains/Bhusa under RFS (Seed Production)

Kind	Supplied in q	Sold Qty. in q	Total Qty. supply/Sold in q	Rate per q	Amount (Rs.)
Mustard Seed C. Cabage	1.131	66.00	67.131	6000/-	402786.00
Oats Seed	-	1414.65	1414.65	3500/-	4951275.00
Wheat Seed	-	1757.19	1757.19	2168.75	3810906.00
Oats BR Seed	-	48.77	48.77	7250/-	353583.00
Wheat Grain	32.70	-	32.70	1200/-	39240.00
Oats grain	76.55	-	76.55	1200/-	91860.00
Bhusa	-	1000	1000	400/-	400000.00
Grand Total	**110.381**	**4286.61**	**4396.991**	**-**	**10049650.00**

Maintenance Section

Since 1979, Maintenance Section has been providing the services related to mechanical, electrical, civil, refrigeration and air conditioning etc., new works addition/alterations required in the labs/Institute, maintenance of the sub-station, overhead lines, street lights, service connections maintenance of electric supply to the office area as well as residential area of the Institute, generator power supply to office and residential area including International Girls and Boys hostels, Guest house and Scientist home in case of power failure, liaison works with UHBVN, CPWD, Haryana State Pollution Control Board and Local Authorities, maintenance of the water supply and sewage disposal system in the Institute, planning and inspection of new buildings in the Institute, operation and maintenance of ETP and other miscellaneous works of the Institute.

Human Health Complex

Human Health Complex (HHC) was established in 1991. It caters to the health needs of the employees of NDRI as well as to other sister ICAR Institutes in Karnal i.e. IARI, NBAGR and IIWBR, in addition to the students and retired ICAR employees.

The Complex has a diagnostic clinical lab, well equipped with fully automated Haematonalyser. HHC is also equipped with 160 MAS X-RAY machine. The HHC has well qualified nursing staff, lab technicians and pharmacist to assist doctors in providing the desired medical facilities. The HHC also organizes various health awareness programmes. It had organized the following free health check-up camps for screening the patients and health talks in public interest.

1. Eye camp on 4/4/2018 by Cygnus Hospital
2. BMI camp on 19/4/2018 by Amritdhara Hospital
3. Ortho camp on 2/5/2018 by IVY Hospital
4. Ortho camp on 30/8/2018 by IVY Hospital
5. ENT camp on 3/12/2018 by PARK Hospital
6. Ortho camp on 8/3/2019 by VIRK Hospital
7. EYE camp on 14/3/2019 by Sarswati Nethralya Hospital
8. ENT and DENTAL camp on 10/4/2019 by Mahabir Dal Hospital
9. EYE Camp on 3/7/2018
10. ENT camp on 29/9/2018
11. Ortho camp on 12/10/2018

Experimental Dairy Plant

Experimental Dairy Plant has been functional at this Institute since 1961 with the objective of providing necessary infrastructure facilities to the scientists for scaling up of new products/processes developed in the laboratories on the pilot scale as well providing training facilities to the students to impart knowledge on 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.

Products Manufactured in Experimental Dairy during 2018-19

Sr. No.	Product	Quantity
1	SMP (R)	16,885.0 kg
2	Pasteurized Butter (200 g)	1,912 packets
3	Ghee	14,718.0 kg
4	Paneer	37,347.5 kg
5	Burfi	4,998.5 kg
6	Kalakand	31,293.5 kg
7	Lassi (200 ml)	1,49,382 packets
8	Ice-cream (100 ml)	68,390 cups
9	Flavoured Dairy Drink (200 ml)	3,38,239 packets
10	Processed Cheese Slices (200 g)	1,192 packets
11	Gulab Jamun Mix	3,487.0 kg
12	Pizza Cheese (200 g)	2,805 packets
13	Cheddar Cheese	337.0 kg
14	WheyPro* (200 ml)	6,298 glasses
15	Wheypro*Choco* (200 ml)	5840 glasses

These products were sold through the Milk Parlour located at the Institute's main entrance gate. Experimental Dairy provides practical, teaching, research and training facilities to students and scientists of the NDRI Deemed University. It also provides training facility to outside students of various universities/colleges. Sixty six students from several intuitions were provided training during the financial year 2018-19. 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. Experimental Dairy developed two new products WheyPro* andWheyPro*Choco* and and launched them at Milk Parlour.

Computer Centre

Computer Centre is a central facility to provide computational support to the scientists and administration and impart training to students/scholars. The Computer Centre offers two Computer Science courses to under-graduate students and one course to post graduate students including PhD scholars. There is a well established Computer Laboratory for students' teaching, which is equipped with state-of-the-art 64-bit i5 computer systems together with multi-function laser printers. These computer systems are equipped with different software, i.e., operating systems such as Unix/Linux, MS-Windows and statistical/scientific computing systems like SAS 9.3 with JMP, MATLAB, WEKA, etc. Also, compilers for various programming languages are available, which include FORTRAN 90, C, C++, RStudio, Python, Visual Studio, etc. Institute has a well established Local Area Network (LAN) system connecting all the research divisions and sections through optical fibre/UTP cabling to cover the main buildings and through ADSL switches for a few distantly located buildings, thereby providing connectivity to all the scientists, technical/administrative staff and students.

Besides this, the Centre offered internship programmes on advanced topics in Applied Artificial Intelligence (encompassing Soft Computing and Machine Learning areas) using open source R Programming language, to externally sponsored students through consultancy scheme. Academic linkages were established for possible research collaborations with Centre for Development of Advanced Computing (Mohali), Department of Statistics & Operational Research and University Institute of Engineering & Technology, Kurukshetra University (Kurukshetra) and NIFTEM, Sonepat.

ASRB Online Examinations for ARS (Prelim) and NET were conducted successfully by the Online Exam Centre, ICAR-NDRI Karnal.

Agriculture Knowledge Management Unit:The agriculture Knowledge Management Unit (AKMU) is fully functional with the Internet and e-mail connectivity through National Knowledge Network (NKN) node with 1 Gbps bandwidth provided by the National Informatics Centre (NIC), Govt. of India. The AKMU has been strengthened by installing three new servers. 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, web content filtering, etc. It also undertakes the implementation of ICAR programs like ERP (MIS/ FMS), Personnel Management Information System (PERMISNet-II), Half Yearly Progress Monitoring System (HYPM), etc. Statistical Cell is also functioning under Computer Centre, which disseminates university related information to various state and national-level government agencies like UGC, MHRD-AISHE etc.

Management Information Service: Computer Centre continued to prepare various MIS reports relating to milk production, supply of feeds and fodders, herd performance, animal management system, etc., for decision support to the farm managers/heads of divisions using in-house developed software. The processing of pension bills and GPF transactions pertaining to the staff as well as generation of various reports was also carried out by the Centre.

Website: The ICAR-NDRI website (http://www.ndri.res.in) disseminates the latest information to its various stakeholders and end users about Research, Teaching, Office Circulars, Forthcoming Workshops/Conferences/ Winter Schools announcements, Institute Publications (Annual Reports/Newsletters), RTI related information, Telephone Directory, University Information (B. Tech., M.Sc. and Ph.D. Rules, Admission Notice), etc. Some new web pages on Students Empowerment Unit and a portal on 'Sophisticated Analytical Instruments Facility' were constructed and integrated with the institute website.

Telephone Exchange: The EPABX section smartly managed the communication infrastructure in the Institute and extended efficient service of the broadband connection available in the institute through cost-effective PRI system. New Telephone Directory 2019 was compiled and published. Also, up-to-date Telephone Directory is available on institute website.

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 94,427 volumes, which include books, standards and annual reports, bound journals and theses. In addition, 419 eBooks of different foreign and Indian publishers were purchased recently for perpetual access at NDRI Campus. Library has an excellent computer section having fifty workstations for students and staff of the Institute. Students use these to get current information in the advanced research areas and for communication.

The Library provides Internet, Email, Documentation, Reference, Current Awareness Services, CD-ROM Literature scanning through CD-ROM of CAB Abstract, Food Science Technology Abstract, AGRIS, Derwent Biotechnology Abstract, Indian Standards and ISO Standards on food products including milk and dairy products on CD-ROM. The Library also provides Photocopying, Document Scanning, Printing and Computerised Issue-Return and reservation facilities.

The Library, NDRI is an active partner CeRA (Consortium for e-Resources in Agriculture) and provides single point search for consortia subscribers. Library subscribed open access journals to its users under institute's IP addresses. Instant Document Delivery Services were provided to users of ICAR sister Institutes, State Agricultural Universities and other participating Institutions on their request.

Document Delivery Request Send Report 2018		
Name of Institute/University	Total Requests Received	Total Requests Fulfilled
Total document delivery request received and delivered to ICAR Institutes/ State Agricultural Universities	77	55

The Library is also an active partner of Agricat (a sub-portal under WorldCat). Presently **52,180** catalogue records of Library, NDRI available on Agricat/ WorldCat. Users from participating institutions worldwide may access catalogue records of National Dairy Research Institute though URL: http://www.worldcat.org or www.agricat.worldcat.org.

Library digitized 3287 records of Institute outputs, which includes valuable books, institutional publications, M.Sc. and Ph.D. Dissertations, reports, conference proceedings, reprints etc. available on Krishi Kosh, the Institutional Repository of Indian National Agricultural Research System. In addition, complete online library catalogue is also available on URL: library.ndri.res.in by using Koha-Library Management System.

Library subscribed anti-plagiarism software iThenticate, which has repository of over 50 million research articles. Itis one of the largest repositories of database and has exclusive access to Crossref database of more than 80% of the bio-medical publishing houses including Elsevier, Nature, Willey-Blackwell, Taylor & Francis, Springer, Oxford University Press etc. Additionally, iThenticate uses 110 million online and offline articles from aggregators, content providers e.g. PubMed, MedLine, ABC CLIO, SAGE Reference, ProQuest, gale etc.

Communication Centre

Communication Centre has audio visual/video and photo laboratories for providing the services to the staff and students of the Institute. This centre covers all the events organized by the Institute. This centre organized 25 exhibitions at different sister Institutes of ICAR and other research and development organizations across the country. The audio visual lab handled Sound and Projection Systems in Dr. D. Sundaresan auditorium, Pinaki hall, University committee room and conference halls of the Institute. Besides this, audio visual lab also provided Sound and Projection Systems in play ground for students and staff activities.

The facilities of audio video editing, recording of audio video clippings on DVD and VCD dubbing and mixing were extended to students, staff and scientists for their research projects. Video coverage of events of the Institute consisting of various national Seminars, Workshops, Conferences, Cultural programmes, Cattle shows, Kisan sangosthies, Exhibitions and other functions of the Institute was carried out and video films were edited.

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 of milk per day and is presently running in full capacity. Model Dairy Plant is presently certified under the Food Safety Management System ISO 22000:2005.

Special Features

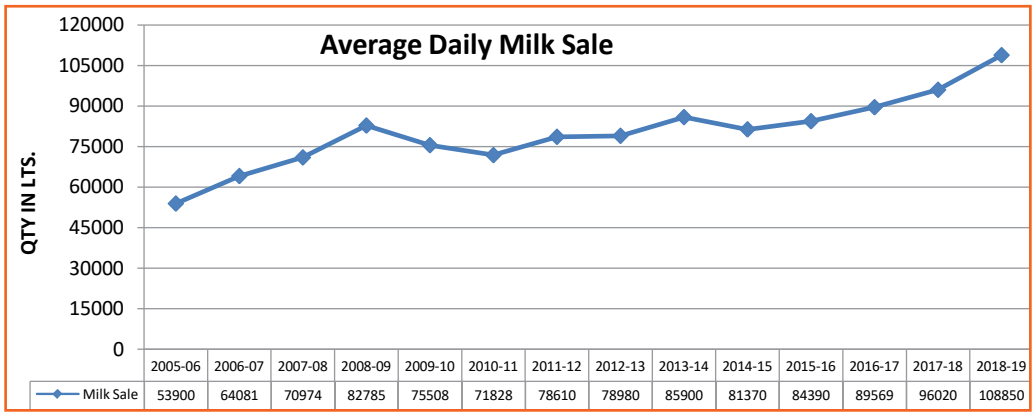
» Model Dairy Plant (MDP), an autonomous unit of ICAR, is independently managed by a committee, whose Chairman is the Director of NDRI.

» Model Dairy Plant provides six months in-plant training to the students of B. Tech. (DT) of 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 and confidence in managing the modern commercial Dairy Plant and handling real life problems in production management.

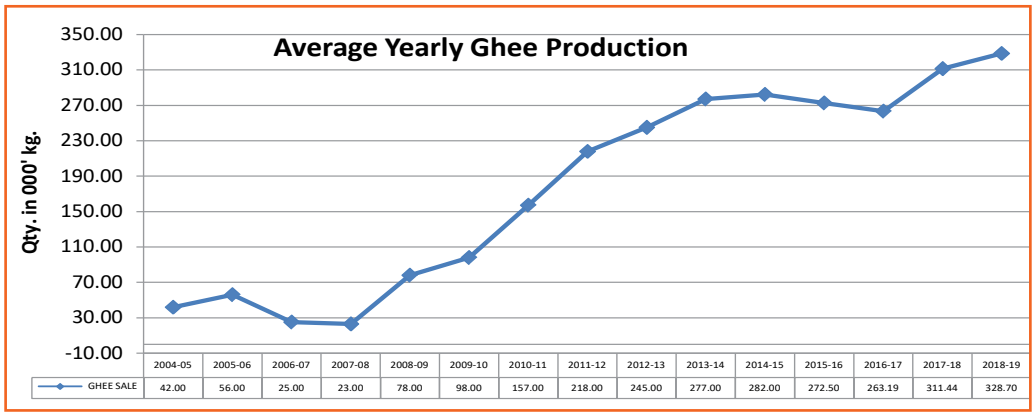
» It also provides infrastructure facilities to the scientists of NDRI for scaling up R & D concepts from laboratory scale to industrial scale under commercial environment.

Liquid Milk Processing / Packaging: MDP is currently engaged in processing and packaging of milk for Mother Dairy in different variants (Full Cream, Toned, Double Toned, Skim Milk and Cow Milk). MDP is presently processing/ packing 1,10,000 litres per day of polypack milk in all the varieties for Mother Dairy, Delhi. The plant is running in three shifts and the supplies from MDP are dispatched in the evening and morning to Delhi market and nearby cities thereby utilizing the plant to more than its full capacity.



	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Milk Sale	53900	64081	70974	82785	75508	71828	78610	78980	85900	81370	84390	89569	96020	108850

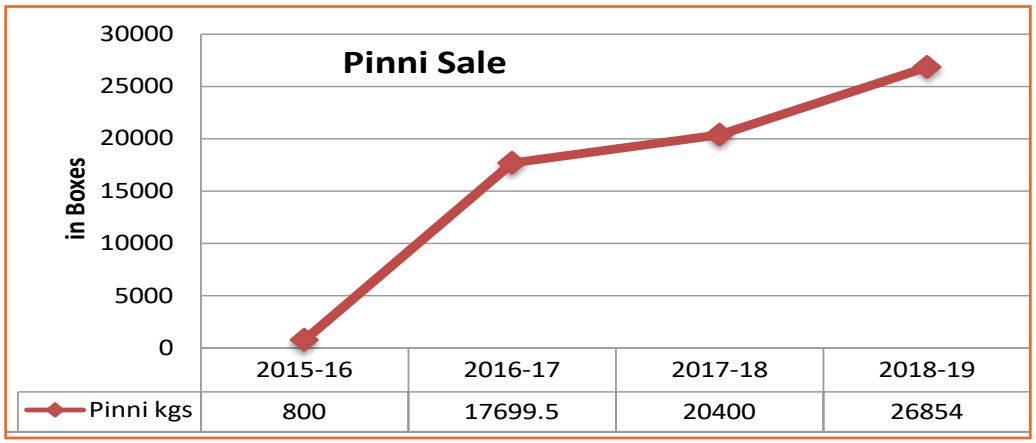
Ghee Manufacturing: MDP manufactures cow ghee from cow butter purchased from different State Federations. The production is taken as per demand. The average production/sale of ghee is 25-30 metric tons per month. All the ghee manufactured at MDP is being sold through the MDP Sale Counter.



	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
GHEE SALE	42.00	56.00	25.00	23.00	78.00	98.00	157.00	218.00	245.00	277.00	282.00	272.50	263.19	311.44	328.70

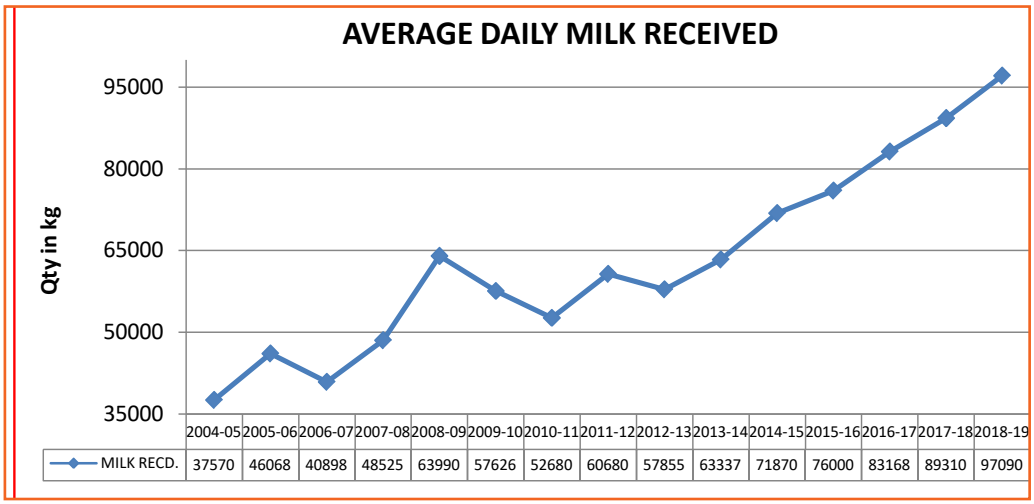
Cheese and Paneer: MDP is also engaged in training students in manufacturing of cttage cheese, processed cheese and paneer on trial basis. The section is operated occasionally for the purpose of taking trials and making the students familiar with the manufacturing details.

*Pinni***:** Pinni, developed by the students of batch 2010-14, was launched at the 13th Convocation of NDRI Deemed University on 14th February 2015. Total sale of pinni was 26.8 metric tons in the year 2018-19



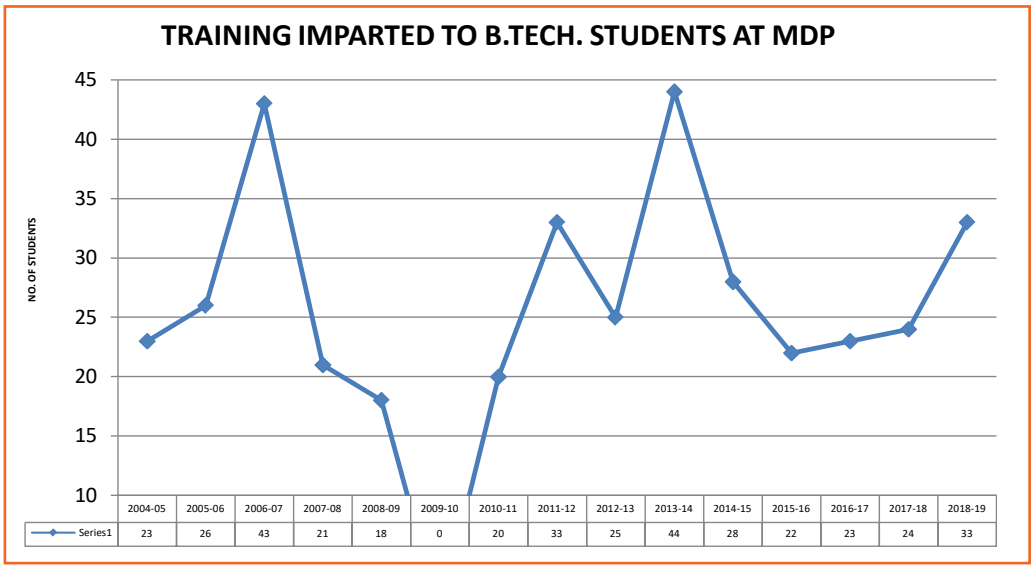
	2015-16	2016-17	2017-18	2018-19
Pinni kgs	800	17699.5	20400	26854

Procurement of Milk: MDP does not have its own infrastructure for milk procurement and receives milk on behalf of Mother Dairy from the new generation cooperatives of Punjab and Rajasthan. The average milk procurement



per day is approximately 1 lakh liters to 1.25 lakh liters, which is sufficient to meet day to day demand of different milk variants being packed at MDP.

Student Training: Model Dairy Plant provides In-plant training to the 4th year B.Tech. (Dairy Technology) students of NDRI Deemed University. The students are provided with In-plant Training Manual comprising of unit wise operation covering all the sections of the Dairy Plant. Since its inception in 1996, Model Dairy Plant has provided training to twenty three batches of B.Tech. (Dairy Technology) students. The student trainees are provided Rs.1500/- per month as stipend. So far, 585 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 In-plant 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 2018-19

- Average milk dispatch per day was 108850 liters.
- Ghee sale was approximately 328.70 metric tonnes this year.
- Pinni Sale was 26.8 metric tonnes.
- High Speed Milk packing machine installed.
- ETP online data monitoring system started.

REGIONAL CAMPUSES

SOUTHERN CAMPUS, BENGALURU

The National Dairy Research Institute was started at Bengaluru in 1923 as Imperial Institute of Animal Husbandry and Dairying. It was the first institution that started dairy education programmes to meet the manpower requirements of the dairy industry. Upon shifting the Institute Headquarters to Karnal in 1955, the establishment at Bengaluru continued as the Southern Regional Station of NDRI. The station has been catering to the research, training and extension needs of the dairy farmers and dairy industry of the southern region.

The Campus is endowed with necessary infrastructure in terms of qualified staff, farmland, dairy herd, laboratories, library, staff dispensary, hostel facilities etc. The Campus has a land area of about 46 hectares. About 16 hectares of land is utilized for the cultivation of various forage crops for meeting the feeding requirement of the dairy herd.

The Campus has good laboratory and infrastructural facilities for carrying out research work on animal genetics and breeding, dairy animal production and reproduction, screening of microbes, chemical and microbiological analyses of dairy products, testing of dairy equipment, manufacturing of various dairy products, etc. The research, training and transfer of technology programmes at the campus are carried out through different sections. To cater to the needs of the students, the library is stocked with books, journals, theses and reprints. Hostel and guest house facilities also exist at the campus for students and visitors.

Education

The course work for Ph.D (Dairy Engineering), M.Tech (Dairy Engineering), M.Tech (Dairy Technology), and Diploma (Dairy Technology) are being conducted at the campus. The students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Animal Nutrition, Livestock Production & Management, Agricultural Economics and Agricultural Extension Education are being guided for their Doctoral and Masters' dissertation work.

Short term Training Programmes are being imparted in Dairy Processing, Quality Assurance, Dairy Production and Extension for the students, dairy farmers/ entrepreneurs and personnel from Co-operative Federations and Private Organisations. Besides, In-plant training and In-lab training are provided to the UG and PG students of other Colleges/Universities. PG students of other Universities are also guided to carry out their Project Work.

Major Events

» ICAR sponsored Winter school on "Current Concepts and Frontier Technologies for Conservation and Improvement of Indigenous Dairy Bovine Genetic Resources" was successfully organized from July19, 2018 to August 8, 2018 for 17 participants from different parts of the country.

» The 96th Foundation Day of ICAR-NDRI and National Seminar on "Promotion of Dairy Entrepreneurship and Skill Development for Doubling Farmers Income" was organized on July 1, 2018. Commemorating the Foundation Day of ICAR-NDRI, the Foundation Stone was laid for Livestock Research Centre (LRC) building by Dr. T. Mohapatra, Secretary DARE and Director General, ICAR, New Delhi in presence of Dr A. K. Srivastava, Chairman,

ASRB; Dr. J. K. Jena, DDG (FS&AS), Dr. Mrutyunjaya, Former Director NAIP, ICAR; Dr. Ashok Kumar, ADG (AH), ICAR; Dr R. R. B. Singh, Director, NDRI and other dignitaries.

» The Alumni Association of Southern Regional Station of ICAR-National Dairy Research Institute organized one day National Symposium on "Sustainable Livestock Development under Climate Change Scenario" on November 28, 2018, in association with AET Institutions, Doddakannelli, Bengaluru at SRS of ICAR-NDRI, Bengaluru as part of National Conference on "Ecosystem Conservation and Sustainable Development" held during November 27 - 29, 2018. The Symposium was inaugurated by the Chief Guest, Dr. S.A. Patil, Former Director of ICAR-IARI, former Vice Chancellor of UAS-D. The function was well attended by more than 80 participants.

» SRS of ICAR-NDRI organised a Symposium on February 16, 2019 as a part of the on-going NABARD Project on 'Group Dynamics of Small holder Farmers (2016-19). The Symposium was attended by 77 delegates including researchers, academicians, personnel from KVK, farmers and research scholars. Dr S. Rajendra Prasad, Vice-Chancellor, UAS, Bangalore was the Chief Guest. Dr S. Ayyappan, NABARD Chair Professor welcomed the participants and gave a brief account of the project highlighting the objectives and the work carried during period.

» Southern Regional Campus of ICAR-NDRI, Bengaluru in association with ICAR-IARI, New Delhi organized one day Regional Stakeholders' Workshop on "Alternate Agricultural Production Pathways in Changing Climates for Southern Region" on March 8, 2019 at SRS of ICAR-NDRI, Bengaluru**.** The workshop was attended by 35 participants representing State development departments of Southern India.

» An Institute – Industry meet was organized on October 6, 2018 to explore collaboration opportunities with dairy industry as well as to transfer technologies developed at NDRI, Bengaluru. Various technologies developed at NDRI Karnal and Bengaluru were presented to industry representatives during the meet and a few industry personnel were also given opportunity to present their views and perspectives on what NDRI is expected to do for the Indian dairy industry. In all 54 persons representing 30 industries participated in the Meet.

» A flagship training programme was organised on "Commercial Dairy Production" for progressive dairy farmers and dairy entrepreneurs during February11-16, 2019. A total of 12 participants from different parts of the country participated.

» Southern Campus of ICAR-NDRI, Bengaluru organized an International Training Programme on "Ultrasonography and Reproductive Disorder Management in Dairy Animals" from July 16– 20, 2018 for five Veterinary Officials of Nepal. The training programme was sponsored by the Department of Livestock and Nepal Agri**c**ultural Research Council, Nepal.

Extension Activities

» Advisory services were rendered on scientific feeding of dairy cows, cattle feed formulations, indigenous cattle farming, hydroponic fodder cultivation, processing of milk for dairy products, improved varieties of green fodder, stress management in dairy cows to eighty nine persons during personal visits, through mail and phone queries.

» A total of 1741 visitors visited the institute in 62 batches, comprising of 1032 farmers, farmwomen and farm youth from Southern States, 641 students from various academic institutes, 55 officials from Agricultural / Animal Husbandry Organisations and 13 general visitors. An exposure cum orientation training programme was organised for 375 farmer trainees from 14 districts of Tamilnadu and two districts of Kerala under ATMA Scheme. The farmer-trainees were oriented about the ongoing activities of the Institute, scientific dairy farming

and clean milk production. Farmers visited fodder demonstration unit and livestock research unit as a part of exposure programme. They were briefed about ongoing research and extension activities of the Institute.

» Exposure cum Training programme was organised for 269 farmer trainees in 10 batches comprising farmers, farmwomen and farm youth under 'Support to State Extension Programmes for Extension Reforms' (SSEPERS) under Agricultural Technology Management Agency (ATMA) scheme. The farmer trainees were made aware of technical know-how of scientific dairy farming aspects in breeding, feeding and healthcare aspects by lecture presentations in local language, visit to Livestock Research Centre and Experimental Dairy Plant with special emphasis on clean milk production. A demonstration session of machine milking and recommended package of practices on clean milk production was organised for the benefit of farmer-trainees.

» The extension team visited Dairy farm households in identified villages (adopted as well as under MGMG progrmme) and had interaction with farm families to analyze specific problems to be addressed in dairying and dairy cattle management. Extension team along with multi-disciplinary team, visited farm households at farmers' door and necessary technical advice was rendered on various aspects of scientific dairy farming, green fodder production, clean milk production and dairy animal management aspects to the farmers and farm women at their doorsteps. As a part of outreach programme for field extension officers, guest lectures were presented to Veterinary officers of Chikkaballapura District on "Role of veterinarian in sustainable livelihood improvement, food security and safety" on April 26, 2018 for 60 veterinarians from KMF & Department of Animal Husbandry and Veterinary Sciences and on "Approaches and Recent advances in Ruminant Nutrition" for 20 veterinarians from Department of Animal Husbandry and Veterinary Sciences of Government of Karnataka (All Districts) on October 3, 2018.

Sexed Semen Technology: A Success Story under Cooperative Dairy Production System in Karnataka

The Institute evaluated the fertility of commercially available sexed semen in Holstein Friesian cattle maintained by dairy co-operative farmers of Bangalore Milk Union Limited, Karnataka Milk Federation, Ramnagara district, Karnataka through mass synchronization and timed AI protocol. After an initial field survey and selection, a total of 121 HF crossbred/graded heifers and first lactation post-partum cows belonging to 111 farmers of 45 villages were selected and subjected for oestrus synchronization programme using CIDR + OvSynch protocol. Out of 121 cattle subjected for AI, 40 became pregnant with a synchronized pregnancy rate of 33%. Out of 38 cattle, 37 cattle delivered female calves and one cow delivered a male calf with 97.36% birth of females. The pregnancy rate was higher in heifers (36.73%) than lactation cows (30.55%). Calves born through AI of sexed semen did not differ physically in any respect from those produced through conventional semen, and none of the heifer/cow showed any dystocia. These results indicate that better selection, nutritional status and the current protocol for synchronizing estrus could serve as an effective approach for successful implementation of sexed semen technology under field conditions.

EASTERN REGIONAL STATION, KALYANI

» The main objective of establishing the Eastern Regional Campus of ICAR-NDRI, Kalyani is to identify the major constraints of dairy production in eastern and north eastern India and to offer solutions through research and extension activities to these problems. 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 conditions of dairy farmers of this region.

» The Eastern Regional Station was established at the Central Dairy in Calcutta in 1964 and was shifted during 1966 to Kalyani, Nadia district about 50 km north of Calcutta and was located in the Administrative Building of Kalyani University. The Regional Animal Nutrition Research Centre of the I.C.A.R. till then located at Haringhata,

West Bengal, was merged with the ERS of NDRI with effect from June 1, 1968. In 1978 the Government of West Bengal granted 100 acres of land at Kalyani where cattle sheds, forage unit, staff quarters etc. were gradually built up. The Station built its own laboratory building and the entire station started functioning within the same campus from May, 1987.

» The research at Eastern Campus is being conducted in the area of Animal Nutrition (1964 till date), Dairy Chemistry and Bacteriology (1972-1976), Animal Breeding (1977-till date), Soil Science (1977-1985), Dairy Economics and Dairy Extension (1977-till date), Forage Production and Livestock Production and Management (1986-till date), Animal Biotechnology Section started functioning during 2005. The Animal Physiology and Reproduction Laboratory were also established in 2013-14. Goat Farm was established in 2014-15 in a small scale for research, education and training purposes. Krishi Vigyan Kendra-II, Nadia District of West Bengal was sanctioned in 2016-17 for establishment in the Campus of ERS-NDRI, Kalyani.

» The Eastern Campus has infrastructure facilities like Research Laboratories, Cattle Herd, Fodder Farm, Library, Computer Section, Academic Cell, Hostels and Guest House, Estate Section *etc*.

» The Library contains 1818 books, 4078 volumes of bound journals and other periodicals in the field of Dairying. Besides, Annual Reports of different Institutes and proceedings of various workshops and seminars are also available for reference. Presently, Indian Journals are subscribed for students and Scientists.

» The computer centre facilitates the maintenance of database and analysis of research data. The Institute has Internet connectivity through NKN, which are useful for searching literature and references. The cell is facilitating the practicals of DAHD students.

» M.Sc. / M.V. Sc. and Ph. D. students of different disciplenes like Animal Nutrition, Livestock Production & Management, Animal Physiology, Animal Biotechnology, Animal Genetics & Breeding and Dairy Extension are alloted to pusue their disseration/ research work at Eastern Regional station, Kalyani. 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.

» Two training programmes on Artificial Insemination and Veterinary First Aid were organized in the institute for 30 participants during March 27 to April 27 2018 and June 5 to July 6, 2018, respectively.

» Two training programmes on 'Scientific Dairy Farming' were organised for 39 trainees from different parts of West Bengal. Trainees were exposed to recent developments in scientific dairy production technologies in theoretical and practical sessions. One training programme on 'Scientific Goat Farming' was also organized for 38 farmers from West Bengal during November 13 – 17, 2018.

Extension Activities under Tribal Areas of West Bengal

» The tribal livestock farmers were provided several extension interventions. Interventions like organising scientists-farmers interaction sessions, fodder demonstration, animal health cum vaccination camps in tribal villages, on and off-campus training programmes etc. were conducted under TSP project. Enhancement of knowledge of the tribal farmers and changing attitude of tribal populace towards modernization of livestock farming was achieved through interactions and method demonstrations. Twelve scientists- farmers' interaction sessions were also organized under the project. The emphasis was given on scientific animals rearing practices. Several inputs like veterinary medicines, mineral mixture, livestock etc. were distributed among farmers. Apart from that fodder seeds and planting materials of maize, cowpea, sorghum, rice-bean, H. Napier, Guinea grass etc. were also distributed. Two on-campus training programmes on 'Scientific dairy farming' and one training

programme on 'Scientific goat farming' were organized for tribal unemployed youth. A total number of 420 goats, 23 piglets, 4575 chicks and 500 ducklings were distributed among the tribal farmers for improving their livelihood through livestock farming.

Extension activities in North Eastern Hill Region

» Team from Eastern Campus of ICAR-NDRI visited six North-eastern states and distributed several inputs and organized scientists-farmers interaction sessions with the farmers. Teams visited Tripura, Meghalaya, Mizoram, Arunachal Pradesh, Nagaland and Sikkim and organized veterinary health camps, demonstration and scientists-farmers interaction sessions. During camps, veterinary medicines and fodder seeds were distributed to the farmers. Lots of in depth discussions and interactions were carried out on various topics viz. health management, clean milk production, reproductive performances, various livestock production system and their constraints, solutions etc. during the interaction sessions. Several inputs like livestock, mineral mixture, poultry feed, pig feed, veterinary medicines etc. were distributed among the farmers.

» A total number of 15 major visiting teams comprising of 834 visitors visited the institute. The visitors came through several institutes /organizations like FACC of Bidhan Chandra Krishi Viswavidyalaya, Jawahar Navodaya Vidyalaya, ICAR-IVRI, ICAR-CIFRI, Serampore College, Aelis, Barrackpore, Hooghly District Central Co-Operative Bank, Odisha state government officials/farmers and several farmers groups from different parts of West Bengal also visited the campus.

Livestock Farm

Annual Performance of Herd Maintained at Eastern Campus (2018-19)

Particulars	Jersey Cross
Herd strength as on 31-12-2017	198.00
Total milk production (kg)	204727.50
Av. no. of cows' in milk/day	72.00
Av. no. of cows' dry/day	20.00
Wet average (kg)/day	7.86
Herd average (kg)/day	6.17
Age at first calving (month)	31.00
No. of animals inseminated	152.00
No. of animals pregnant	62.00
Conception rate (%)	41.00
Service period (days)	108.00
Inter calving period (days)	426.00
Mortality (%)	8.60

Milk Production Performance of Herd at Eastern Campus (2018-2019)

Months (2018)	Milk Production (kg)	Wet Average (kg)	Herd Average (kg)	Average FAT %	Average SNF %
January, 2018	16565.00	7.61	6.41	5.64	9.33
February, 2018	15958.00	8.30	6.90	5.45	9.22
March, 2018	18426.00	8.72	7.10	4.86	9.05
April, 2018	18851.50	9.03	7.25	4.85	9.01
May, 2018	19112.00	8.70	7.00	4.94	9.05
June, 2018	18716.00	8.40	6.70	5.11	9.10
July, 2018	17445.00	7.70	6.00	5.03	9.01
August, 2018	15942.00	7.13	5.35	4.93	8.80
September, 2018	16243.00	7.34	5.50	5.09	8.99
October, 2018	17871.50	7.40	5.74	4.93	8.74
November, 2018	15423.00	7.00	5.10	5.32	9.16
December, 2018	14192.50	7.00	5.00	5.53	9.32
Total Milk	**204727.50**				
Overall Average	**17060.625**	**7.86**	**6.17**	**5.14**	**9.07**

Forage Farm

Forage Farm section is engaged in cultivation of quality fodder crops in about 27-30 hectares area and manages harvesting and supply of fodder crops either chaffed or unchaffed to the Cattle Yard. Besides cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machineries including tractors, chaff cutter etc. There is a small vermi-compost unit used for training and demonstration purpose. There is an agri-meteorological observatory where regular observations are taken for various meteorological parameters like relative humidity, maximum and minimum air temperature, soil temperature at different depth, wind speed and direction, rainfall etc. There are more than 1000 plants of teak, shesham, mango, coconut *etc*. growing around the Institute premises. Mango and guava based agro-forestry is developed in the ERS campus. Besides, there is a fodder herbarium for training and demonstration purpose. The Forage Section has necessary facility for covering the theoretical and practical part of training on fodder crop production.

Production of Different Fodder Crops at ERS Fodder Farm during (2018-19)

Sl. No.	Type of fodder	Quantity (q)
1	Maize/Maize + Cowpea	2456.80
2	Sorghum/Sorghum +Cowpea/Sorghum + Rice Bean	6604.15
3	Oats / Oats + Mustard	3169.15
4	Berseem/Berseem + Mustard	3287.80
5	Sole Cowpea/Sole Rice Bean	235.25
6	Hybrid Napier Grass/Guinea Grass/Para Grass	73.00
7	Coix	16.00
8	Bajra/Bajra + Cowpea	2229.70
	Total	**18071.85**

BUDGET AND EXPENDITURE

The financial outlays in terms of actual expenditure for Grants for the year 2018-2019 was ₹ 21728.35 lakhs and the sanctioned budget for Grants in 2018-2019 was ₹ 21770.11 lakhs. These figures include the financial outlays for Regional Stations.

Financial Outlays & Expenditure during 2018-19

NDRI (including Eastern Campus, Kalyani)

(₹ in lakhs)

Sr. No.	Head	Grants	
		Budget	Expenditure
1.	Grant in Aid : Capital	535.58	528.52
2.	Grant in Aid : Salaries	7073.50	7070.28
3.	Grant in Aid : General	11697.92	11677.75
	Total	**19307.00**	**19276.55**

Southern Campus, Bangalore

(₹ in lakhs)

Sr. No.	Head	Grants	
		Budget	Expenditure
1.	Grant in Aid : Capital	109.04	107.72
2.	Grant in Aid : Salaries	1420.10	1410.78
3.	Grant in Aid : General	933.97	933.30
	Total	**2463.11**	**2451.80**

Revenue Generation

The Revenue receipts of the Institute and the Regional Campuses for the year 2018-2019 were ₹ 969.93 lakhs.

Sr. No.	Head	Amount (Rs. in lakhs)
1.	Sale of Milk/Farms Produce	319.30
2.	Sale of Old Vehicle/Equipment etc.	9.47
3.	Sale of Livestock	18.60
4.	Income from Royalty/Sale of Publication/Advertisement	0.24
5.	License Fee	95.76
6.	Interest Earned on Loans and Advances	22.77
7.	Leave Salary and Pension Contribution	11.58
8.	Receipts from Schemes	53.05
9.	Analytical and Testing Fee	28.43
10.	Pre-shipment Fee	45.19
11.	Application Fee from Candidates	0.03
12.	Diploma Charges	0.00
13.	Receipt from Services Rendered	1.09
14.	Interest Earned on Short Term Deposits	89.75
15.	Interest Generated from Internal Resource	74.75
16.	Miscellaneous Receipts	199.92
	Total	**969.93**

Position of Manpower at NDRI, Karnal and its Regional Stations as on 31.03.2019

Type of Posts	Existing		
	Approved by D/o Expenditure	In position	Vacant
Scientific	195	155	40
Administrative (Group A&B)	36	29	07
Technical	337	163	174
Administrative (Group Non-gazetted)	129	101	28
Supporting	761	367	394
Total	**1480**	**870**	**610**

राजभाषा कार्यकलाप

भारत सरकार की राजभाषा नीति के अनुसरण में राजभाषा हिंदी के प्रचार, प्रसार एवं कार्यान्वयन हेतु संस्थान में वर्ष 1979 में राजभाषा एकक की स्थापना की गई। संस्थान में राजभाषा नीति, नियमों एवं व्यवस्थाओं के नियमानुसार अनुपालन एवं कार्यान्वयन के लिए संस्थान के राजभाषा एकक में वर्ष 1988, 1989 एवं 2011 में क्रमशः हिन्दी अनुवादक, सहायक निदेशक एवं उप निदेशक के पद सृजित किए गए। राजभाषा एकक द्वारा संस्थान के अधिकारियों, वैज्ञानिकों, प्रशासनिक कर्मचारी, तकनीकी कर्मचारी आदि को राजभाषा हिंदी में कार्य करने के लिए प्रोत्साहित करते हुए हर संभव सहयोग भी प्रदान किया जा रहा है। संस्थान के राजभाषा एकक द्वारा निम्नलिखित विवरणानुसार विभिन्न गतिविधियों का आयोजन किया गया।

» संस्थान में गठित संस्थान राजभाषा कार्यान्वयन समिति की वर्ष में चार तिमाही बैठकें प्रत्येक आयोजित की गई। इन बैठकों में राजभाषा कार्यान्वयन के क्षेत्र में संस्थान की प्रगति का आकलन किया जाता है एवं भावी कार्यक्रमों हेतु कार्ययोजना तैयार कर उन्हें कार्यान्वित किया जाता है। रिपोर्टाधीन अवधि में 27.6.2018, 9.10.2018, 12.12.2018 एवं 29.03.2019 को तिमाही बैठकों का आयोजन किया गया।

» राजभाषा नियम 1976 के नियम–11 का अनुपालन करते हुये संस्थान द्वारा सभी प्रकार के मानक फार्मों एवं स्टेशनरी सामान आदि को द्विभाषी रूप में प्रयोग करना सुनिश्चित किया जा रहा है।

» राजभाषा के प्रगामी प्रयोग को सतत् बढ़ाने एवं कर्मचारियों की सरकारी काम–काज में राजभाषा के प्रयोग में होने वाली झिझक को दूर करने के लिए प्रत्येक तिमाही में कम से कम एक हिंदी कार्यशाला का आयोजन किया जा रहा है।

» संस्थान में दिनांक 14.9.2018 से 03.10.2018 तक हिन्दी उल्लास मास का आयोजन किया गया। दिनांक 14 सितंबर 2018 को हिन्दी दिवस समारोह एवं दिनांक 10.10.2018 को राजभाषा पुरस्कार वितरण समारोह का आयोजन किया गया। इस अवधि में संस्थान में कुल 10 प्रतियोगिताएं, दिनांक 14.9.2018 को संस्थान के उत्कृष्ट प्रभाग/अनुभाग को राजभाषा शील्ड हेतु प्रतियोगिता, दिनांक 17.9.2018 को विद्यार्थियों के लिए हिन्दी अनुभव लेखन प्रतियोगिता, दिनांक 22.09.2018 को हिन्दी गीत–गायन प्रतियोगिता, दिनांक 25.09.2018 को हिन्दी टिप्पण एवं आलेखन प्रतियोगिता, दिनांक 26.09.2018 को हिन्दी निबंध प्रतियोगिता, दिनांक 27.09.2018 हिन्दी शोधपत्र/पोस्टर प्रदर्शन प्रतियोगिता, दिनांक 01.09.2018 से 30.09.2018 अवधि के दौरान हिन्दी ईमेल प्रतियोगिता, दिनांक 19.9.2018 को खुला प्रश्न मंच प्रतियोगिता, दिनांक 10.10.2018 को राजभाषा प्रश्नोत्तरी प्रतियोगिता, पूरे उल्लास मास के दौरान हिन्दी हस्ताक्षर अभियान का आयोजन किया गया। राजभाषा पुरस्कार वितरण समारोह में विभिन्न राजभाषा प्रतियोगिताओं के 157 विजेताओं को प्रशस्ति प्रमाणपत्रों से सम्मानित किया गया।

» वर्ष 2017–18 की ''वैज्ञानिक तथा तकनीकी वार्षिक मूल हिन्दी टिप्पण एवं आलेखन प्रतियोगिता में प्राप्त हुई 07 प्रविष्टियों में से नियमानुसार 16 सुपात्र कर्मचारियों को को नकद पुरस्कार एवं प्रमाण पत्रों से पुरस्कृत किया गया।

» हर वर्ष की भॉति संस्थान की वार्षिक गृह पत्रिका ''दुग्ध गंगा'', तिमाही न्यूज लैटर ''डेरी समाचार'' तथा नराकास करनाल के अध्यक्षीय कार्यालय के रूप में समिति की वार्षिक गृह पत्रिका ''कर्णोदय'' को पूर्णतः हिन्दी में प्रकाशित किया जा रहा है।

» संस्थान के वैज्ञानिकों से प्राप्त वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, वार्षिक प्रतिवेदन, प्रशासनिक पत्र, परिपत्र, ज्ञापन, विभिन्न समारोहों की प्रेस विज्ञप्ति, गणमान्य अतिथियों, मंत्रियों आदि के संबोधन, व्याख्यान एवं अन्य सामग्री का अनुवाद कार्य संस्थान के राजभाषा एकक द्वारा किया जा रहा है।

» 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।

» राजभाषा एकक द्वारा वैज्ञानिक तथा तकनीकी शब्दावली आयोग द्वारा प्रकाशित ''बृहत प्रशासनिक शब्दावली'' की प्रतियाँ संस्थान के कर्मचारियों को उपलब्ध कराई गई हैं। संस्थान में अंग्रेजी/टाइपिस्टों/आशुलिपिकों को हिन्दी

टाइपिंग सीखने हेतु निरन्तर प्रोत्साहित किया जा रहा है तथा डेस्क प्रशिक्षण के द्वारा कंप्यूटर पर हिंदी टाइपिंग सिखाई जा रही है।

» संस्थान के निदेशक, नगरस्तरीय नगर राजभाषा कार्यान्वयन समिति, करनाल के पदेन अध्यक्ष भी हैं। अध्यक्ष नराकास एवं निदेशक, भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की अध्यक्षता में समिति की दो बैठकें, प्रथम बैठक दिनांक 12.6.2018 को एवं दूसरी बैठक दिनांक 30.11.2018 को संपन्न हुई हैं। नराकास की छमाही बैठकों में करनाल में स्थित 53 केन्द्र सरकार के कार्यालयों, उपक्रमों, निगमों, अनुसंधान संस्थानों, विश्वविद्यालयों, लिमिटेडों तथा राष्ट्रीयकृत बैंकों आदि के प्रशासनिक अध्यक्षों, वरिष्ठ अधिकारियों, राजभाषा अधिकारियों एवं प्रतिनिधि अधिकारियों द्वारा प्रतिभागिता की जाती है। इन बैठकों में भारत सरकार, राजभाषा विभाग के प्रतिनिधि अधिकारी भी शामिल होते हैं। समिति द्वारा समिति के रूटीन प्रकार के कार्यों के अलावा अध्यक्ष नराकास एवं संस्थान के निदेशक महोदय के मार्गदर्शन में संस्थान के राजभाषा एकक के प्रभारी मय नराकास समन्वयक एवं सचिव नराकास द्वारा समिति के सदस्य कार्यालयों को राजभाषा के प्रचार, प्रसार एवं कार्यान्वयन हेतु समय समय पर मार्गदर्शन एवं सहयोग भी प्रदान किया जा रहा है। समिति द्वारा छमाही बैठकों में सदस्य कार्यालयों के प्रधानों एवं प्रतिनिधियों की सहमति से निर्णित अनुसार विभिन्न राजभाषा गतिविधियों का आयोजन किया गया। नराकास के तत्वावधान में दिनांक 19.4.2018 को वाक्य अनुवाद (अंग्रेजी–हिन्दी) एवं हिन्दीतर कर्मचारियों के लिए निबंध प्रतियोगिता, दिनांक 08.08.2018 को राजभाषा अधिकारियों के लिए चर्चा सत्र व संगोष्ठी, दिनांक 26.11.2018 को हिन्दी निबंध प्रतियोगिता, दिनांक 27.12.2018 को हिन्दी कार्यशाला (विषय : राजभाषा का प्रबंधन व हिन्दी में ईमेल कैसे बनाएं आदि) दिनांक 28.12.2018 को संयुक्त नगरस्तरीय अंतर बैंक संगोष्ठी (विषय ''मार्केटिंग और ग्राहक सेवा का भाषायी संदर्भ''), दिनांक 23.01.2019 को नगरस्तरीय बैंकिंग शब्दावली प्रतियोगिता का आयोजन किया गया।

डॉ. आर.आर.बी. सिंह, निदेशक रा0के0अनु0सं0, करनाल राजभाषा हिन्दी उल्लास मास के अवसर पर कर्मचारियों को संबोधित करते हुए

नराकास करनाल की छमाही बैठक का दृश्य

SWACHCHH BHARAT ABHIYAN: CLEAN & GREEN NDRI

Swachchh Bharat Abhiyan is a mission led by the government of India to make India a clean India. To realize Gandhiji's dream of a Clean India, NDRI is supporting this drive of the Government of India by organizing cleanliness campaigns, talks on cleanliness, awareness camps, etc. in the Institute campus and in the adopted villages. The Institute focuses on spreading awareness about better sanitation and hygiene practices and disseminating information about the importance of cleanliness, through various programmes. The residents of the Institute's campus and the villagers were also educated to make the campaign effective and successful. All the scientists, students and staff of the Institute made a massive sanitation drive not only in campus but also in nearby villages of the Institute during April 2018 - March 2019. Further, in order to inculcate the value of maintaining health and hygiene at household- level, especially among the residents of the campus of the Institute, several environment friendly dustbins were kept at many locations inside the premises of the Institute.

Staff of NDRI taking pledge during Swaxchchh Bharat Abhiyan

Awareness Campaigns

A team of extension scientists also organized awareness campaigns in the adopted villages of the Institute. The team sensitized the villagers about the importance of cleanliness and to keep the villages neat and clean. Emphasis was given for wider adoption of the bio-waste management towards processing of bio-wastes into clean and environment-friendly bio-fuels and organic manures. Further, when scientists, technical officers, staff and students of the Institute visited the nearby villages for programmes like Dairy Education at Farmers' Doors, Farmers' Farm School and Mera Gaaon Mera Gaurav, they educated the villagers about significance of Swachchh Bharat Abhiyan, thereby inculcating a sense of cleanliness among them. Similarly, the farmers coming to attend the training programmes, organized by Krishi Vigyan Kendra and Women Empowerment Lab of the Institute were

Women Farmers taking pledge during Swachchh Bharat Abhiyan campaign

also made aware about significance of maintaining health and hygiene at the household levels and the vicinity of their respective localities. The farmers were advised to follow the practices associated with clean milk production.

Swachchhta Pakhwada

NDRI celebrated Swachchhta Pakhwada under "*Swachchh Bharat Abhiyaan*" programme of the Institute during December 16 to 31, 2018 at NDRI, Karnal. All the scientists, technical officers, administrative, financial, supporting staff and students of the Institute participated in this cleanliness drive and cleaned up NDRI premises and nearby places of the Institute. After cleaning the allotted area, participants collected the garbage and disposed it at the dumping ground. In addition to this, NDRI organized a cleaning campaign on massive scale in the campus and adopted villages of NDRI. The employees and students of NDRI took the task of cleaning every nook and corner of the Institute. Residents of NDRI were sensitized for the making their surroundings clean. The employees of NDRI launched several campaigns jointly with villagers to implement the National Sanitation Campaign (Swachh Bharat Abhiyan) in the district.

Swachchh Bharat Abhiyan in progress

Swachhata Pakhwada was also organized at Southern Regional Campus, Bengaluru. A rally was organized by carrying Swachhtha Pakhwada Banner through residential quarters within the campus and through Adugodi area adjoining the campus boundary wall. The employees and students of the Campus visited farms and households in the nearby villages and briefed the farmers and farmwomen about the importance of cleanliness and sanitation drive to maintain good health of family members and dairy cattle. The team interacted with school-going children and sensitized them about their role in maintaining cleanliness of their home, farm and village environment. The staff performed cleaning activity along with the dairy farmers at the Dairy Co-operative society (DCS) premises by cleaning the drains and surrounding area, inside and outside premises.

A debate on "Effectiveness of Swachha Bharat Abahyan on Improving Cleanliness in the Country" was organized for the Post Graduate and Ph. D. students of the Southern Campus. An expert talk on "Waste Segregation and its Disposal" was also delivered by Smt. Andal Jagannathan on December 23, 2018 at Southern Campus, Bengaluru. Staff and students took out swachhata parade in the local areas, slums, main roads etc., and aired 'swachhata slogans' on December 24, 2018. Participants cleaned the public places while some members aired the slogans. The participants made a door-to-door campaign for spreading awareness on importance of the programme and also highlighted the need for segregation of waste before disposal. The participants distributed waste segregation pamphlets (printed in Kannada and English) and informed the shop owners to display the same for spreading the awareness of waste segregation. As a part of swacchta pakhwada, housekeeping staff of the Institute was taken on a visit to waste segregation, paper recycling, waste water treatment and recycling units of Christ University, Bengaluru to create awareness and educate them on waste management and disposal practices on 29th December, 2018.

Smt. Andal Jagannathan delivering lecture on waste segregation and its disposal

MERA GAON MERA GAURAV (MGMG)

The scheme was initiated at the Institute- level (as per the directive of the Council) in August- September, 2015. At present, a total number of 29 groups comprising of 4 scientists each from different disciplines of the Institute have been involved in carrying out the programme (MGMG) in 50 villages in the vicinity of the Institute. The major objective of this innovative initiative is to promote the direct interface of scientists with the farmers to hasten the lab-to-land process, while providing the farmers with the required information, knowledge and advisory services on a regular basis via adoption of villages. Subsequently, based on the feedback given by the villagers, including those engaged in the field of dairying coupled with their involvement in the process of selection of the concerned interventions, some dairy-centric intervention(s) were finalized in a participatory approach for the purpose of implementation in the adopted villages under the scheme of MGMG.

In view of this, an effective strategy was developed to make this programme more meaningful, especially from the perspective of stakeholders involved at the grassroots. Accordingly, a plan was chalked out, wherein identification of the dairy-centric intervention(s) was done. Further, the groups were formed and from March 2018 onwards, the outreach of MGMG was focused on selected villages in a 'Cluster Approach'.

During the year 2018-19, various teams of the Institute visited villages and carried out activities such as interface meetings, *sangoshthies*, demonstrations, trainings and literature support. Awareness was creation on different topics such as health and hygiene, balanced feeding of dairy animals, importance of education, preparation of milk products and value addition, winter management techniques for crops and animals, scientific dairy farming practices etc. Under this programme, the following activities were carried out by the Institute.

Sl. No.	Name of Activity	No. of Activities Conducted	No. of Farmers Benefitted
1.	Visits to villages by teams	36	1320
2.	Interface meeting/ Goshthies/ Trainings	37	1165
3.	Demonstrations conducted	16	405
4.	Literature support provided	26	525
5.	Awareness created	46	1210
6.	Facilitation for new varieties, seeds, technology and feeding of mineral mixture to enhance milk production etc.	17	235
	Total	**178**	**4860**

Scientists of NDRI interacting with farmers in a village

Eastern Regional Campus of ICAR-NDRI implemented the **'Mera Gaon Mera Gaurav'** programme in fifteen selected villages. All the scientists are actively involved in implementation of this programme. During the period under report, a total of 26 visits were organized in villages to update the knowledge of dairy farmers about scientific dairy farming and solve the problems of the farmers at their doorstep and 214 farmers were directly benefitted. During visits, 693 animals were treated. Several inputs like veterinary medicines, mineral mixture, fodder seeds, extension literatures etc. were distributed among farmers and they were also sensitized about the maintenance of cleanliness in their households.

Southern Regional Campus, Bengaluru also identified villages under MGMG programme and extension team interacted with farm families to analyze specific problems to be addressed in dairying and dairy cattle management. Extension team along with multi-disciplinary team, visited farm households at farmers' door and necessary technical advice was rendered on various aspects of scientific dairy farming, green fodder production, clean milk production and dairy animal management aspects to the farmers and farm women at their doorsteps. As a part of outreach programme for field extension officers, guest lectures were arranged for veterinary officers of Chikkaballapura District on "Role of veterinarians in sustainable livelihood improvement, food security and safety" on April 26, 2018. A total number of 60 veterinarians from Karnataka Milk Federation and Department of Animal Husbandry and Veterinary Sciences participated in this programme. Another lecture was arranged on "Approaches and recent advances in ruminant nutrition" for 20 veterinarians from Department of Animal Husbandry and Veterinary Sciences of Government of Karnataka on October 3, 2018.

Veterinary services being rendered at a village

ACHIEVEMENTS AT A GLANCE

Research Projects

Externally Funded	:	78
In-house	:	78
Contract Research	:	05

Publications

Research Papers/ Review Articles	:	455
Research Papers> 7 NAAS Rating	:	121

IPR & Technology Transfer

Patent Filed	:	4
Patent Granted	:	4
New Technologies Developed	:	12
Technologies Commercialized	:	12

Human Resource Development

B. Tech.	:	25
M.Tech./M.Sc./M.V.Sc.	:	144
Ph.D.	:	80
Dip. in (DT)	:	10
Dip. in (AH&D)	:	02

Institutional Development Plan

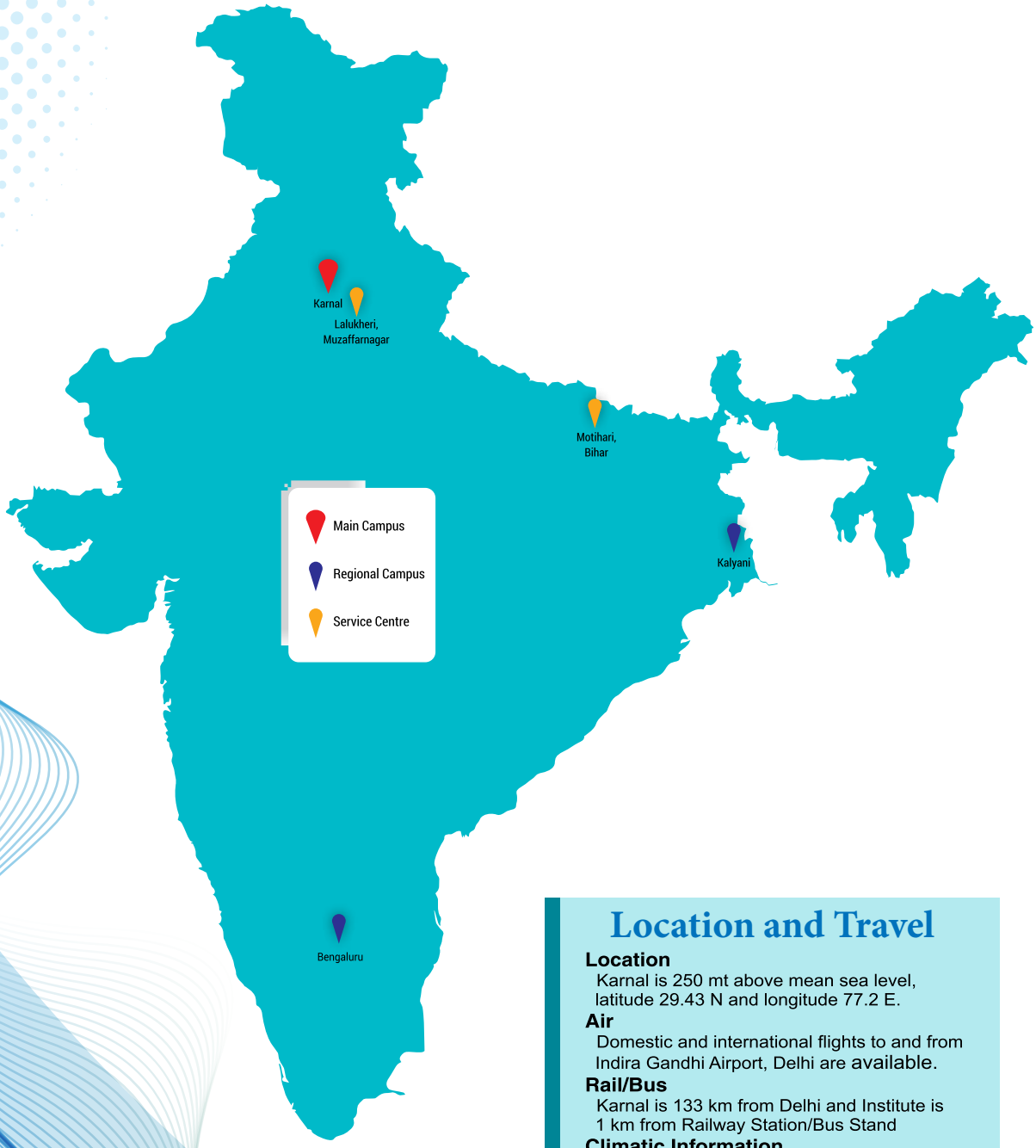
B.Tech students Deputed Abroad for Internship	:	31
Faculty Deputed Abroad for Advanced Training	:	15

Capacity Building

Entrepreneurs Develop. Prog.	:	14
Students Trained	:	150

Services to Farmers

Kisan Sangosthies	:	17
Trainings	:	283
Veterinary Camps	:	36
Advisory Services Provided	:	3722
Kisan Mela on Crop Residue Management	:	1
Livestock and Agriculture Mela	:	1



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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