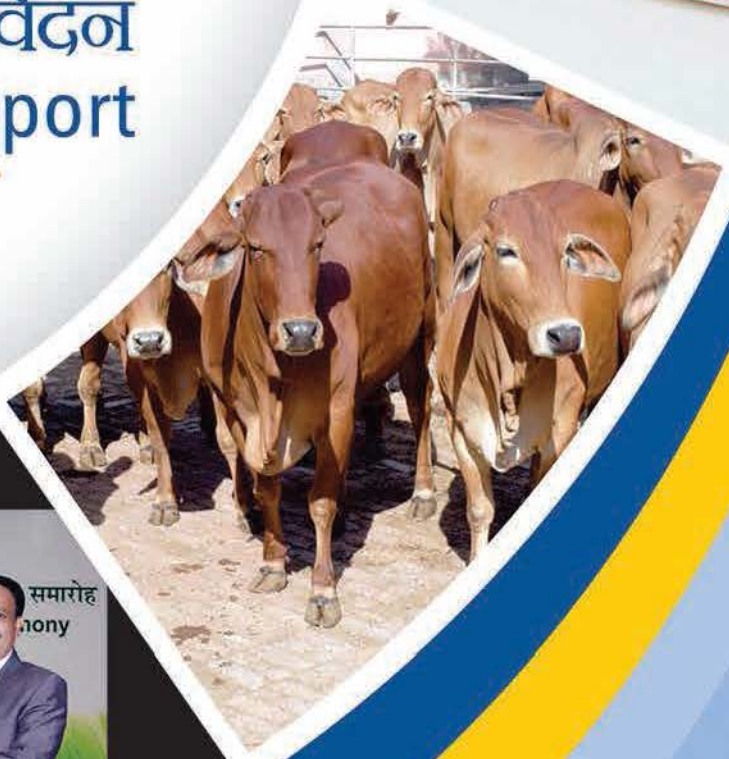
भाकृअनुप
ICAR

वार्षिक प्रतिवेदन
Annual Report
2014-15



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

MILESTONES

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

1936 Renamed "Imperial Dairy Institute".

1955 National Dairy Research Institute came into existence at Karnal, at the former Central Cattle Breeding Farm.
Bangalore facilities became Southern Regional Station of the Institute.

1961 B.Sc. Dairying bifurcated into two branches, namely B.Sc. (Dairy Technology) and B.Sc. (Dairy Husbandry); M.Sc. Dairying courses commenced at Karnal.

1962 Western Regional Station established at Bombay.

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

1966 Institute brought under the aegis of ICAR.

1975 Operational Research Project initiated.

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

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

1983 IDD (DH) started at Bangalore.

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

1987 Embryo Biotechnology Centre established.

1989 The Institute granted "Deemed to be University" status.
M.Sc. in Biotechnology started.

1990 Birth of Pratham, first IVF buffalo calf of the world.

1991 20 bedded Hospital Complex set up and made functional.
National Agricultural Research Project (NARP) funded through World Bank.

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

1996 A two-year National Dairy Diploma (NDD) course introduced at Southern Regional Station of NDRI at Bangalore.
The ICAR award (1993-94) for outstanding KVK conferred on the KVK located at NDRI.

1997 A state-of-the-art Auditorium having seating capacity of 950 and 2 conference rooms and 2 meeting rooms made functional.
A commercial Model Dairy Plant with a capacity of 60,000 lit./ day commissioned for providing practical training to the students of NDRI University and to serve as an interface between Institute and Industry.

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

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

2000 NDRI bagged the Best Annual Report Award second time in succession for the years 1996-97 and 1997-98 in the category of large ICAR Institutes.
A Guest House with two suites named as "Kamdhenu" was constructed at SRS, Bangalore.
Platinum Jubilee of the Institute celebrated on 7th - 8th April 2000 at SRS, Bangalore.
Web-site of NDRI was created and launched by the Hon'ble Union Minister for Agriculture on 23rd December 2000.

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

2002 International Students' Hostel equipped with modern facilities and amenities constructed at NDRI, Karnal.
Feed Quality Control Lab. set up to help keep-strict quality check on feeds being fed to bovine livestock.

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

2004 First IVF goat kid born at NDRI.
ATIC centre at NDRI made functional.

2006 New Animal Biotechnology Centre commissioned.

2007 Creation of Video Conferencing Lab and Mini Auditorium.

2009 World First Cloned Buffalo Calf and second cloned calf "Garima" produced by hand-guided cloning technique at NDRI.
DST supported Technology Business Incubator (TBI) facility made functional.
New Course Curricula for B.Tech in Dairy Technology and Masters and Doctoral Programmes introduced.
Reforms in examination system, grading system and introduction of comprehensive exam. for Ph.D. programme introduced.

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

2011 M.Sc. in Forage Production Introduced at NDRI, Karnal.
National Academy of Dairy Sciences Launched at NDRI, Karnal.
Centre of Excellence in Milk Safety established at NDRI, Karnal
NDRI Recognised as Centre of Advanced Faculty Training (CAFT) in the Disciplines of Dairy Production and Dairy Processing.

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

2013 First female calf named 'Mahima' was born to a cloned buffalo on 25th January 2013.
A male cloned buffalo calf named 'Swarn' was born on 18th March 2013. Donor somatic cell used was isolated from the seminal plasma of an elite bull.

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

2014 NDRI bagged the Sardar Patel Outstanding ICAR Institution Award presented by Hon'ble Prime Minister of India, Sh. Narendra Modi Ji.
A female cloned calf named "Lalima" was born 2nd May, 2014.
NDRI signed a MoU with Riddet Institute, New Zealand to promote research and academic collaborations.
A male cloned calf named "Rajat" was born on 23rd July, 2014.
NDRI produced a clone of endangered wild buffalo of Chhattisgarh named "Deepasha" on 12th December, 2014.
Garima, a cloned buffalo, earlier born at NDRI produced second female calf named "Karishma" on 27th December, 2014.
A new educational approach "Farmers' Farm School" of NDRI was started at village Gorgarh, Karnal.
NDRI got ISO 9001: 2008 certification.
NDRI implemented MIS/FMS to carryout administrative and financial activity of the Institute.

VISION

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

MISSION

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

GOAL

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

MANDATE

- Conducting research in the areas of Dairy Production, Processing and Marketing.
- Demand driven "Human Resource Development" to meet the requirements of Dairy Industry and R&D Institutions.
- Dissemination of innovative dairy production and processing technologies for socio-economic transformations.

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प्राक्कथन

PREFACE

राष्ट्रीय डेरी अनुसंधान संस्थान, वर्ष 2014–15 की वार्षिक प्रतिवेदन आपके समक्ष प्रस्तुत करते हुए मुझे अपार हर्ष का अनुभव हो रहा है। इस प्रतिवेदन में डेरी अनुसंधान, शिक्षण, प्रसार एवं इन कार्यक्रमों को सुदृढ़ करने के लिए संस्थान द्वारा संबंधित कार्यकलापों के क्षेत्र में महत्वपूर्ण उपलब्धियों को समाविष्ट किया गया है। सूचनाओं को इस प्रकार से व्यवस्थित किया गया है कि वे देश के इस प्रतिष्ठित डेरी संस्थान एवं इसकी कार्यप्रणाली का संपूर्ण परिदृश्य प्रस्तुत करता है।

संस्थान के अनुसंधान एवं विकास प्रयासों को हमारे सुनिश्चित एवं सुव्यवस्थित अनुसंधान कार्यक्रमों के द्वारा और अधिक प्रोत्साहन मिला है। इन अनुसंधान कार्यक्रमों में 72 अन्तःसंस्थानीय तथा 54 बाह्य वितीय सहायता प्राप्त अनुसंधान परियोजनाओं पर कार्य चल रहा है। चार अंतरराष्ट्रीय समन्वय अनुसंधान परियोजनाएं जिनमें जननक्षमता से संबंधित जीन निर्धारण पर जर्मन शैक्षिक विनियम सेवाएं (डी.एस.टी.–डी.ए.ए.डी.) परियोजना, डिजाइनर डेरी उत्पादो पर लैक्टिक अम्ल बैक्टीरिया के अनुप्रयोग तथा विकास पर इंडो यू.के. परियोजना, भारतीय बाजार परिस्थितियों के लिए डिजाइन किए गए लचीले प्रतिजैवीय आहारों के विकास पर इंडो–न्यूजीलैंड परियोजना, दूध में रोगजनक जीवाणुओं तथा ऊष्मा प्रतिरोधी अपशिष्टों के प्रबंधन के लिए प्रक्रियाओं के मानकीकरण पर इंडो–साऊथ अफ्रिका–ब्राजील परियोजना चल रही हैं। राष्ट्रीय डेरी अनुसंधान संस्थान

It gives me an immense pleasure to present before you the Annual Report of NDRI for the period 2014-15. The report chronicles the significant achievements of the Institute in the area of Dairy Research, Education, Extension and related activities initiated to strengthen these programmes. The information has been so arranged that it provides a holistic view of this premier dairy Institute of the country and its functioning.

The research and development activities of NDRI got further fillip through its mandate oriented and well-structured research programmes comprising 72 in-house and 54 externally funded research projects, which included four International collaborative research projects including German Academic Exchange Services (DST-DAAD) project on regulation of gene linked to fertility, Indo-UK project on Development and application of lactic acid bacteria on designer dairy products, Indo-New Zealand project on Development of resilient probiotic foods designed for the Indian market conditions and Indo-South Africa Brazil project on validation of procedures for the management of heat resistant spoilage and pathogen i.e. bacteria in milk. NDRI has been successful in getting external funding from almost all leading national funding agencies i.e. Department of Biotechnology (DBT), Department of Science and Technology (DST), National Bank for Agriculture and

को लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेंसियों जैसे जैवप्रौधोगिकी विभाग (डी.बी.टी.) एवं प्रौधोगिकी विभाग (डी.एस.टी.) कृषि एवं ग्रामीण विकास के लिए राष्ट्रीय बैंक (नाबार्ड) राष्ट्रीय डेरी विकास बोर्ड (एन.डी.डी.बी.), राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो (एन.बी.आई.एम.), कृषि पर मूल एवं महत्वपूर्ण अनुसंधान के लिए राष्ट्रीय फंड (एन.एफ.बी.एस.आर.ए.) खाद्य प्रसंस्करण, उद्योग मंत्रालय (एम.एफ.पी.आई.), परमाणु ऊर्जा विभाग, (डी.ए.ई.), भारतीय चिकित्सा अनुसंधान परिषद्, (आई.सी.एम.आर.) तथा पशुपालन एवं डेयरिंग विभाग (डी.ए.एच.डी.) से वितीय सहायता प्राप्त करने में सफल रहा है।

संस्थान ने कई क्लोन उत्पन्न करके क्लोनिंग के क्षेत्र में अपनी विशेषज्ञता स्थापित करने में सफल रहा है। दो मई 2014 को 'लालिमा' नामक क्लोन कटड़ी का जन्म हुआ। प्रशीतित हिम वीर्य से वियोजित सोमेटिक कोशिकाओं का प्रयोग करके 23 जुलाई 2014 को सामान्य प्रसव से 'रजत' नामक क्लोन कटड़े का जन्म हुआ। बारह दिसंबर 2014 को 'दीपाशा' नामक क्लोन कटड़ी का जन्म हुआ। दीपाशा आशा नामक जंगली भैंस का क्लोन था जिसे छत्तीसगढ़ में अपनी सुरक्षा में रखा गया था। गरिमा–2 ने 27 दिसंबर 2014 को सामान्य प्रसव द्वारा 'करिश्मा' नामक क्लोन कटड़ी को जन्म दिया। मूत्र से दैहिक कोशिकाओं को अलग करके पांच फरवरी 2015 को 'अपूर्वा' नामक क्लोन कटड़ी का जन्म हुआ। एनडीआरआई की पशु जैव प्रौधोगिकी के क्षेत्र में कई महत्वपूर्ण उपलब्धियां अपने आप में विश्व रिकार्ड हैं तथा वर्ष 2014 में लिमका बुक में दर्ज की गई हैं। प्रचलित वैज्ञानिक पत्रिका 'सांइटिफिक इंडिया' में वर्ष 2014 की 20 उपलब्धियों में इस संस्थान में चल रहे क्लोनिंग कार्यक्रम को नौवां स्थान दिया गया है।

डेरी प्रसंस्करण के क्षेत्र में कुछ महत्वपूर्ण अनुसंधान उपलिब्धयां हुई जिनमें अल्प सोडियम वाला प्रसस्कृत मोजरैला चीज, इंडियन फार्मस्टिड् आर्टिसनल चीज, एलोविरा प्रोबायोटिक आइस क्रीम, ट्रमिनलिया अर्जुन हैर्ड आधारित क्रियागत दुग्ध पेय तैयार करने की एक प्रक्रिया विकसित की गई। जैव प्रौधोगिकी प्रक्रिया का प्रयोग कर वितरण के दौरान सैल्फ लाइफ तथा स्थिरता बढ़ाने के लिए संशोधित सरंचना वाली लेक्टोबेसिड गैसरी युक्त

Rural Development (NABARD), National Dairy Development Board (NDDB), National Bureau of Agriculturally Important Micro-organisms (NBAIM), National Fund for Basic and Strategic Research on Agriculture (NFBSARA), Ministry of Food Processing Industries (MoFPI), Department of Atomic Energy (DAE), Indian Council of Medical Research (ICMR) and Department of Animal Husbandry and Dairying (DAHD).

The Institute has been continuously successful in establishing its forte in the area of cloning by producing many cloned calves one after the other. A female cloned calf named **'Lalima'** was born on May 2, 2014. A male cloned calf named '**Rajat**', using somatic cells, isolated from the frozen-thawed semen, was born on July 23, 2014 by normal parturition. A female calf named '**Deepasha**' was born on December 12, 2014. Deepasha is a clone of the only wild buffalo named '**Asha**', an endangered species that has been kept in semi-captivity at Chhattisgarh. Garima II, the cloned buffalo, delivered second female calf named '**Karishma**' on December 27, 2014 through normal parturition. A female cloned calf named '**Apurva**' using somatic cells, isolated from urine, was born on February 5, 2015. Many significant achievements of the NDRI in the field of Animal Biotechnology considered as world records were highlighted in the Limca Book of Records, 2014. Cloning work at NDRI was highlighted as 9th, among the top 20 science stories of 2014 by 'Scientific India', a science magazine.

In the area of dairy processing, some of the significant research achievements include development of the technologies for preparation of products like low sodium processed Mozzarella cheese, Indian Farmstead Artisanal Cheese, Aloe Vera probiotic ice cream, *Terminalia* arjuna herb based functional milk beverage. A probiotic *dahi* containing *Lactobacillus gasseri* with improved texture for better shelf life and stability during distribution was prepared using biotechnological approach. Methods for preparing milk protein–mineral and lactose-mineral complexes were developed for the dairy products' fortification purpose. Shelf life

एक प्रतिजैवीय दही तैयार की गई। पुष्टिकरण उद्देश्य के लिए दुग्ध प्रोटिन खनिज एवं लैक्टोक खनिजों के सम्मिश्रण को तैयार करने की विधि विकसित की गई। विभिन्न पैकेजिंग सामग्री सूक्ष्मपोष्टिक तत्वयुक्त पुष्टीकर बाजरा–दूध आधारित न्यूट्रिमिक्स के लिए सैल्फ लाइफ प्रिडिक्शन मॉडल विकसित किए गए। एनडीआरआई पार्लर पर उपभोक्ताओं के लिए शाकाहारी पिजा और बाजरे की लस्सी की शुरूआत की गई है।

दूध में मिलावटी तत्व (न्यूट्रालाइजर, यूरिया, ग्लूकोज, हाईड्रोजन पेराक्साइड एवं माल्टोडैक्ट्रीन) का पता लगाने के लिए पेपर आधारित स्ट्रिप परीक्षण विधि को विकसित किया गया है। ये परीक्षण दूध प्राप्त करने वाली जगह और घर में भी किए जा सकते हैं। घी में वनस्पति तेल/वसा की मिलावट का शीघ्र पता लगाने के लिए एचपीएलसी और टीएलसी आधारित परीक्षण विधियां विकसित की गई। दूध में एनटिबायोटिक की उपस्थिति का पता लगाने के लिए एक नया एंजाइम–स्पोर बेस्ड क्रोमोजैविक परीक्षण विकसित किया गया। दूध में मैलामाइन का पता लगाने के लिए स्वर्ण नैनोकणों का उपयोग करके एक वर्णमिति टेस्ट विकसित किया गया। स्वर्ण नैनोकण दूध में मैलामाइन की उपस्थिति को 0.05 पीपीएम की घनता तक जांचने के लिए सक्षम है।

मशीनीकरण के क्षेत्र में खीर के इन–लाइन उत्पादन हेतु एक विधि का विकास किया गया, पिस्टन दाब प्रौधोगिकी के सिद्धांत आधार पर एक पेड़ा बनाने की प्रणाली का डिजाइन तैयार किया गया। रंग मापन पर आधारित डेरी उत्पादों के रंगों के मुल्यांकन के लिए मशीन विजिन प्रणाली विकसित की गई। चिपचिपे डेरी उत्पादों के लिए भार आधारित मापक एवं भराव प्रणाली का डिजाइन तैयार किया गया। इसके अलावा प्रसंस्करण के क्षेत्र में ऊष्मीय तेल आधारित विधुत दुग्ध ऊष्मायन प्रणाली विकसित की गई।

राष्ट्रीय डेरी अनुसंधान संस्थान को एक मान्य विश्वविद्यालय एवं अनुसंधान के क्षेत्र में एक उत्कृष्ठ केंद्र के रूप में सभी विश्वविद्यालयों, राष्ट्रीय संस्थानों और अनुसंधान संस्थानों में 41वां स्थान प्राप्त है। प्रकाशित रिपोर्ट के अनुसार एनडीआरआई देश का चतुर्थ श्रेष्ठ कृषि विश्वविद्यालय है। संस्थान ने वर्ष 2014–15 से

prediction models for micronutrient fortified barley-milk-based nutrimix were developed with different packaging materials. Vegetarian Pizza and Bajara Lassi were launched at NDRI Parlour for consumers.

To address the growing concern for adulterated milk, paper strip based tests for rapid detection of adulterants (neutralizer, urea, glucose, hydrogen peroxide and maltodextrin) in milk were developed. These tests can be done at milk reception as well as at house-hold level. Rapid HPLC and TLC based protocols were developed for the detection of vegetable oils/ fats adulteration in ghee. A novel Enzyme-Spore Based Chromogenic Assay (ESBA) was developed for the detection of antibiotic residues in milk. A colorimetric test was developed for detection of melamine in milk using Gold nanoparticles. Gold nanoparticles are highly specific for melamine and can detect melamine up to a concentration of 0.05 ppm.

In the area of mechanization, a process was optimized for in-line production of *kheer*. Peda formation system was designed and mechanized on the principle of piston press technology. 'Machine vision system colour desk' was developed for colour measurement of dairy products. Designing of weight based metering and filling system for viscous dairy products and thermic oil based electric milk heating system were a few other innovations made in the area of process engineering..

NDRI as a Deemed University and as a Centre of Excellence in frontier areas of research has been ranked 41st among all Universities, Deemed universities, National Institutions & Research Institutions in the country. Also, NDRI has been ranked as 4th top Agricultural University of India as per the published reports. In addition to National Diploma in Dairy Technology at Southern Regional Station Bangalore, the Institute has also started Diploma in Animal Husbandry and Dairying at Eastern Regional Station, Kalyani from the year 2014-15. A new course entitled 'Advances in Carbohydrate Technology (DT-723) has been introduced for the Ph.D. (Dairy Technology) programme.

दक्षिण क्षेत्रीय केंद्र, बैंगलोर परिसर पर डेरी प्रौधोगिकी में राष्ट्रीय डेरी डिप्लोमा भी प्रारंभ कर दिया है। संस्थान ने पूर्वी क्षेत्रीय केंद्र परिसर कल्याणी में पशुपालन एवं डेयरिंग में डिप्लोमा वर्ष 2014–15 में शुरू कर दिया गया है। इसके अतिरिक्त पीएच.डी. (डेरी प्रौधोगिकी) कार्यक्रम के लिए 'एडवांसिज इन कार्बोहाइड्रेट टेक्नोलोजी' (डी.टी. 723) नामक एक नए पाठ्यक्रम की शुरूआत की गई।

संस्थान का 13वां दीक्षांत समारोह 14 फरवरी 2015 को आयोजित किया गया। इस समारोह में महामहिम प्रो. कप्तान सिंह सोलंकी, राज्यपाल, हरियाणा मुख्य अतिथि रहे। डा. मंगला राय, पूर्व सचिव एंव डीजी आईसीएआर, नई दिल्ली ने अपना दीक्षांत उद्बोधन प्रस्तुत किया। छठा डा. डी सुंदरेसन स्मारक व्याख्यान डा. एन.के. गांगुली, पूर्व महानिदेशक, भारतीय चिकित्सा अनुसंधान परिषद् (आईसीएमआर) नई दिल्ली, द्वारा प्रस्तुत किया गया। डा. के.के. अइया स्मारक व्याख्यान अवार्ड डा. नगेंद्र पी. शाह, प्रो. फूड साइंस एंड डेरी टेक्नोलोजी, यूनिवर्सिटी ऑफ हाँग–काँग को दिया गया। इस वर्ष के लिए डा. हर्ष कुमार भानवाला, चेयरमैन, नाबार्ड, मुम्बई को डा. एन.एन. दस्तूर स्मारक व्याख्यान अवार्ड से नवाजा गया।

राष्ट्रीय डेरी अनुसंधान संस्थान द्वारा अगस्त 2014 में किसान स्कूल की शुरूआत की गई, जिसमें करनाल जिले के गांव गोरगढ़ के 22 किसानों को कृषि के क्षेत्र में अनौपचारिक शिक्षा देने के लिए पंजीकृत किया गया। एनडीआरआई द्वारा 'डेरी शिक्षा किसान के द्वार' अपने पांच वर्ष के अंत में पहुंच चुकी है। जिसके अंतर्गत उत्पादन, प्रसंस्करण एवं प्रबंधन के क्षेत्र के विशेषज्ञ वैज्ञानिकों की टीम महीने के हर दूसरे शनिवार को गांव का दौरा करती है। संस्थान द्वारा सात अक्टूबर 2014 को 'मैसिजिंग पोर्टल सिस्टम की शुरूआत की गई, जिसका उद्देश्य किसानों को समय पर डेरी से संबंधित जानकारियां उपलब्ध कराना है। एनडीआरआई ने तीन दिवसीय राष्ट्रीय डेरी मेले का आयोजन दिनांक 25–27 फरवरी 2015 को किया। जिसमें देशभर से प्रगतिशील किसान, डेरी उद्यमी और कृषक महिलाओं सहित 1400 से ज्यादा आगंतुकों ने हिस्सा लिया। इससे पहले का वर्ष संस्थान के लिए तकनीक हस्तारण में काफी सफल रहा। संस्थान द्वारा विकसित कुल 13 तकनीकों को 20 अलग

Thirteenth Convocation of NDRI was organized on 14th February, 2015. Prof. Kaptan Singh Solanki, Hon'ble Governor of Haryana was the Chief Guest on the occasion. Dr. Mangala Rai, Former Secretary and DG, ICAR, New Delhi delivered the Convocation Address. Sixth Dr. D. Sundaresan Memorial Oration Award was bestowed upon Dr. N. K. Ganguly, Former-Director General, Indian Council of Medical Research (ICMR), New Delhi. Dr. K.K. Iya Memorial Oration Award was given to Dr. Nagendra P. Shah, Professor, Food Science and Dairy Technology, the University of Hong Kong; Dr N. N. Dastur Memorial Oration Award for the year was bestowed upon Dr. Harsh Kumar Bhanwala, Chairman - National Bank for Agriculture and Rural Development (NABARD), Mumbai.

A unique extension initiative, "Farmers' School" was taken up by National Dairy Research Institute, in which 22 farmers of Gorgarh village in Karnal district were enrolled during August, 2014 for imparting non- formal education in all the aspects of agriculture. The Innovative Approach "Dairy Education at Farmers' Door" initiated by NDRI, has reached the end of the 5th year. Under this programme, a team of NDRI scientists including subject matter specialists from production, processing and management disciplines, visits villages on 2nd Saturday of every Month. A messaging portal system for dairy farmers aiming at timely dissemination of dairy information has been launched on 7th October 2014 at NDRI. More than 1200 farmers are getting timely and seasonal message for better decision making in dairy farming in six states. NDRI organized National Dairy Mela on 25th-27th February, 2015. More than 14000 visitors including progressive dairy farmers, dairy entrepreneurs and farm women across the country participated in the Mela. The preceding year has been very successful for NDRI in terms of transfer of technology. A total of 12 technologies developed at the Institute have been transferred to 20 various industries earning Rs. 62.35 lakhs for the Institute.

Besides the research and academics, NDRI also runs Technology Business Incubator. A

अलग उद्योगों को हस्तांरित कर 62.35 लाख की कमाई की गई।

अनुसंधान एवं शिक्षा के साथ साथ एनडीआरआई टेक्नोलोजी बिजनेस इनक्यूबेटर भी चलाता है, इसके अतिरिक्त एक नया बिजनेस प्लानिंग एंड डैवल्पमेंट यूनिट एनएआईपी के अंतर्गत शुरू किया गया है, जिससे युवा व्यवसायियों को दुग्ध उत्पादन एवं दुग्ध पदार्थ से संबंधित प्रशिक्षण दिया जाता है। यह युवा व्यवसायियों को प्रोत्साहित एवं व्यवसाय को आगे बढ़ाने में सुविधा प्रदान करती है। यह यूनिट डेरी व्यवसाय में जागरूकता लाने के लिए जागरूकता शिविर, उद्यमी विकास कार्यक्रम, प्रशिक्षण कार्यक्रम आयोजित करता है। चालू वर्ष के दौरान टीबीआई और बीपीडी के अंतर्गत लगभग 315 उद्यमियों एवं किसानों को डेरी व्यवसाय से संबंधित 12 तरह के प्रशिक्षण दिए गए।

रा.डे.अनु.सं. को डेरी उत्पादन, डेरी प्रसंस्करण और डेरी प्रबंधन के क्षेत्र में अनुसंधान, शिक्षण और प्रशिक्षण के लिए आईएसओ 9001:2008 प्रमाण पत्र प्राप्त हुआ। दुग्ध गुणवता एवं सुरक्षा के लिए रेफरल प्रयोगशाला को पूरी तरह से कार्यशील बनाया गया। यह प्रयोगशाला दुग्ध एवं दुग्ध उत्पादों के लिए मानक विकास तथा मानव संसाधन विकास/अनुसंधान एवं विकास कार्य आयोजित करने के लिए काफी उपयोगी है। संस्थान ने 150 लडकों और 50 लड़कियों की क्षमता वाले नए छात्रावासों का निमार्ण करके नई उपलब्धि हासिल की है। खेल परिसर, बहुउद्देशीय हॉल (काल्कि भवन) और बीस कमरों वाले अतिथि विश्राम ग्रह को कार्यत्मक बनाया गया। पूर्व क्षेत्रीय संस्थान, कल्याणी में शरीर क्रिया विज्ञान, प्रजनन प्रयोगशाला और सूक्ष्म पोषक प्रयोगशाला संस्थापित की गई।

मैं ये बड़े गर्व के साथ कह सकता हूं कि अनुसंधान एवं डेरी के क्षेत्र में मानव संसाधन विकास की गुणवता में संस्थान के सहयोग के लिए आईसीएआर द्वारा सम्मानित किया गया। संस्थान को दिनांक 29 जुलाई 2014 को माननीय प्रधानमंत्री श्री नरेंद्र मोदी जी द्वारा प्रतिष्ठित 'आईसीएआर सरदार पटेल आउटस्टैंडिंग अवार्ड' 2014 से नवाजा गया। फरवरी 2015 में एनडीआरआई ने बारहवें कृषि विज्ञान सम्मेलन की मेजबानी की। जिसमें देश और विदेश

New 'Business Planning and Development (BPD)' Unit has also been established under NAIP to promote entrepreneurship in dairying amongst young professionals and to promote knowledge-based and innovation-driven dairy enterprises. It supports and provides training and facilities required for young budding entrepreneurs. It conducts entrepreneurship awareness camps, entrepreneurship development programmes, training programmes and provides specialized services to existing SMEs and incubation of start-up ventures and mentoring. During the period under report, twelve trainings for around 315 entrepreneurs and farmers were organized under the aegis of TBI and BPD.

During 2014-15, NDRI received ISO 9001:2008 certification for Research, Teaching, Training and Consultancy in the field of Dairy Production, Dairy Processing and Dairy Management. Referral Laboratory for Milk Quality and Safety was also made fully functional. This lab would be of immense use for conducting R&D/HRD development and standards development for milk and milk products. Another landmark has been the creation of a new Boys Hostel and a Girls Hostel having the capacity to lodge 150 boys and 50 girls, respectively. Sports Complex/ Multipurpose Hall (Kalki-Bhawan) and twenty room Guest House have been built up and made functional at NDRI, Karnal. At ERS, Kalyani, Physiology and Reproduction laboratory and Micronutrient laboratory have been created.

I say it with a great sense of pride and honour that the contributions of the Institute in the area of research and quality human resource development in Dairying have been amply rewarded by the ICAR. The Institute received the prestigious "ICAR Sardar Patel Outstanding Institute Award 2014" from Hon'ble Prime Minister of India Shri Narendra Modi on 29th July 2014. In February 2015, NDRI had the rare distinction of hosting (i) 12th Agricultural Science Congress with the participation of over 1700 delegates from India and Abroad, (ii) All India Agricultural University Youth Festival with the participation of 1500 students from

से लगभग 1700 प्रतिनिधियों ने भाग लिया। देशभर के 45 कृषि विश्वविद्यालयों से लगभग 1500 विद्यार्थियों ने अखिल भारतीय कृषि विश्वविद्यालय युवा महोत्सव में भाग लिया एवं संस्थान द्वारा आयोजित इंटर जोनल आइसीएआर स्पोर्टस मीट में 45 आईसीएआर संस्थानों से लगभग 450 खिलाड़ियों ने हिस्सा लिया।

यह सचिव, डेयर एवं महानिदेशक, डा. एस. अय्यप्पन, भारतीय कृषि अनुसंधान परिषद् के मार्गदर्शन एवं अतिरिक्त सचिव, डेयर और सचिव आईसीएआर, सह. महानिदेशकों तथा एस.एम.डी. (पशुविज्ञान) के प्रधान वैज्ञानिकों एवं एनडीआरआई में कार्यरत सभी कर्मचारियों के सहयोग एवं कठिन परिश्रम से संभव हो पाया। यह मेरा सौभाग्य है कि मैं इस कार्य से जुड़े सयुंक्त निदेशकों, प्रभागाध्यक्षों, संकाय, प्रशासनिक/ वित अधिकारियों एवं संस्थान के कर्मिकों एवं छात्रों के योगदान की यहां चर्चा करूं। मुझे आशा ही नहीं पूर्ण विश्वास है कि उनके सहयोग से मैं संस्थान के लक्ष्यों को प्राप्त करने के लिए पूर्ण समर्पण एवं उत्तरदायित्व की भावना से कार्य करूंगा ताकि संस्थान आगामी वर्षों में गौरव एवं सफलताओं की चरम सीमा तक पहुंच सके।

मैं आशा करता हूं कि यह वार्षिक प्रतिवेदन देश के वैज्ञानिक/शैक्षणिक संस्थानों एवं अन्य डेरी विकास संगठनों से जुड़े उद्यमियों के लिए महत्वपूर्ण सूचना का स्त्रोत होगा।

45 agricultural Universities from all over the country and (iii) Inter zonal ICAR Sports Meet with participation of 450 members from 45 ICAR Institutes.

All this could be achieved by the Institute with the continued guidance and encouragement of Secretary DARE & Director General ICAR, Dr S. Ayyappan; Additional Secretary DARE and Secretary ICAR; Deputy Director General (AS), ICAR and also support of Assistant Director Generals and Principal Scientists at SMD (AS); and the dedication, hard work, cooperation and understanding of the esteemed scientists and all other members of the NDRI fraternity. Here I feel privileged to acknowledge and place on record the contributions made by the Joint Directors, Heads of Divisions, Faculty, Administrative and Finance Officers, Staff and students of NDRI in the growth of the Institute. I am sure that with their unrelenting support and efforts, we would be able to march ahead in fulfilling the mandate and objectives of NDRI and bring success and glory to the Institute in the years to come.

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

Srivastava

(A. K. Srivastava)

EXECUTIVE SUMMARY

National Dairy Research Institute is a premier research organization of the nation dedicated for providing Research and Development (R&D) and Human Resource Development (HRD) support towards dairy development programmes in the country. Established in 1923 at Bangalore, the headquarters of the Institute were moved to the present location at Karnal in 1955. It has two regional stations, one at Bangalore and the other at Kalyani for providing region-specific support suited to their agro-climatic conditions. The Institute has the distinction of being a Deemed University for implementing its academic programmes.

ORGANISATIONAL STRUCTURE

In consonance with the administrative pattern of the Deemed University System of the ICAR, the Institute is managed through various policy/ decision making bodies viz. Board of Management, Research Advisory Committee, Academic Council, Executive Council and Extension Council. The Director is the Chief Executive Officer assisted by the Joint Directors for managing research, academic and extension functions. The Institute has three major areas of R and D activities viz. i) Dairy Production, ii) Dairy Processing and iii) Dairy Extension/Management. All the R and D activities are managed through thirteen Research Divisions/ Sections, namely, Dairy Cattle Breeding, Livestock Production and Management, Dairy Cattle Nutrition, Forage Research, Dairy Cattle Physiology, Animal Biochemistry, Animal Biotechnology, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, Dairy Extension and Dairy Economics, Statistics and Management at the main station and its two regional stations. The Institute also has an Agricultural Technology Information Centre (ATIC), Krishi Vigyan Kendra and Dairy Training Centre and Animal Breeding Research Centre. The Institute has infrastructure consisting of central facilities such as Livestock Farm, 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 156 scientists, 232 technicians, 141 administrative and 506 skilled supporting staff.

BUDGET OUTLAY

The financial outlays of the Institute in terms of actual expenditure for Plan and Non-plan for the year 2014-2015 was ₹ 16043.64 lakhs and budget sanctioned for plan and non-plan for the year 2014-2015 was ₹ 16127.00 lakhs. These figures include the financial outlays for the strengthening of Deemed University/KVK and Regional Stations.

RESEARCH

A total number of 72 in-house and 54 external by funded research projects were in operation during the year 2014. In order to strengthen basic and strategic research, funding from extra-mural research projects has touched ₹ 124.00 crores, which is the highest ever in the history of NDRI. Presently, NDRI has four International research collaborative projects including German Academic Exchange Services (DST-DAAD) project on regulation of gene linked to fertility, Indo-UK project on Development and application of lactic acid bacteria on designer dairy products, Indo-Newzealand project on Development of resilient probiotic foods designed for the Indian market conditions and Indo-South Africa Brazil project on validation of procedures for the management of heat resistant spoilage and pathogen bacteria in milk. NDRI has been successful in getting external funding from almost all leading national funding agencies i.e. Department of Biotechnology (DBT), Department of Science and Technology (DST), National Bank for Agriculture and Rural Development (NABARD), National Dairy Development Board (NDDB), National Bureau of Agriculturally Important Micro-organisms (NBAIM), National Fund for Basic and Strategic Research on Agriculture (NFBSARA), Ministry of Food Processing Industries (MoFPI), Department of Atomic Energy (DAE), Indian Council of Medical Research (ICMR) and Department of Animal Husbandry and Dairying (DAHD).

The support from funding agencies has encouraged scientists to work on stem cell, buffalo cloning, transcriptone, embryogenesis, biosensor, nanotechnology, abiotic stress in farm animals, nutraceuticals and functional foods. The funds were also received for strengthening project monitoring and evaluation and computing and digitization of information. The grants from funding agencies has helped students to opt for modern tools and techniques in their dissertation.

RESEARCH

- A male cloned calf named '**Rajat**', was born on July 23, 2014 by normal parturition. Rajat was produced through hand-guided cloning using

somatic cells isolated from the frozen-thawed semen of a highly ranked progeny-tested Murrah buffalo bull (MU-4393) which had died many years back.

- A female calf named '**Deepasha**' was born on December 12, 2014 by normal parturition. Deepasha is a clone of a wild buffalo named '**Asha**', an endangered species that has been kept in semi-captivity at Chhattisgarh.
- A female cloned calf named '**Apurva**' was born on February 5, 2015 through normal parturition. Apurva was produced using somatic cells isolated from urine.
- A female cloned calf named '**Lalima'** was born on May 2, 2014 by normal parturition. Lalima is a clone of an elite Murrah buffalo (MU-5345) of NDRI Livestock Farm.
- Garima II, the cloned buffalo, delivered second female calf named '**Karishma**' on December 27, 2014 through normal parturition.
- Many significant achievements of the NDRI in the field of Animal Biotechnology considered as world records, were highlighted in the Limca Book of Records, 2014.
- Cloning work at NDRI was highlighted as 9th among top 20 science stories of 2014 by 'Scientific India', a science magazine.
- Cloned buffalo embryos were successfully produced using trophoblast cells, urine- and milk-derived somatic cells and lymphocytes as donor cells.
- Cloned blastocysts derived from fibroblasts, milk-derived cells, lymphocytes, trophoblast cells and those produced by *in vitro* fertilization were found to differ in their developmental competence, level of apoptosis, epigenetic status and expression level of many important genes.
- Buffalo trophoblast cell lines were developed from blastocysts produced by *in vitro* fertilization, Hand-guided cloning and parthenogenesis. A feeder-free *in vitro* culture system was developed, which enabled their long-term culture.
- It was demonstrated that staining with brilliant cresyl blue can be effectively used for selection of developmentally competent oocytes for Hand-guided cloning.
- Treatment of buffalo donor cells with epigenetic modifiers was shown to improve the blastocyst rate and quality of cloned embryos.
- Cloned female and male buffalo embryos were found to differ in their developmental competence, epigenetic status, sex-biased transcription patterns in X-linked genes and response to epigenetic modifiers. Aberrant X-linked gene expression occurred frequently in female embryos.
- Lowering the oxygen tension during *in vitro* culture of buffalo embryos from 20 to 5% was found to improve their developmental competence and quality, and reduce the apoptosis level.
- Transgenic cloned buffalo embryos were produced containing pAcGFP-buSCD, a mammary gland specific expression vector, which was found to be able to convert high level of conjugated linoleic acid in mammary gland epithelial cells.
- A novel non-coding RNA (BOA 290U) was identified in buffalo oocyte and its association was established with expressed proteins. It was found to be potentially important for imparting developmental competence to oocytes.
- The chronology of GVBD event was found to be associated with competence of buffalo oocytes. Holding oocytes temporarily at GV stage was found to be useful in enhancing their developmental ability.
- Functional characterization of milk fat globule membrane epidermal growth factor 8 was performed by gene silencing using shRNA. It was observed that MFGE8 was found to be useful for maintenance of cell shape and morphology during lactation in farm animals.
- Various methods were optimized for extraction of proteins from bovine urine. In all, 1600 proteins were identified in bovine urine by LC-MS/MS for the first time.
- Three potential urine protein biomarkers (*bovine allergen, Mannan-binding lectin serine peptidase 2, Alpha-1-microglobulin, Glutaminyl-peptide cyclo-transferase*) were identified for detection of early pregnancy (~ 20 days) in cows. Three proteins namely vitamin-binding protein, apolipoprptein A and complement 3 were up-regulated in bovine serum during pregnancy (16th to 45th day).
- Buffalo recombinant pregnancy-associated glycoprotein PAG1 and PAG2 were expressed in *E. coli*.
- Differential transcript analysis in fetal cotyledon of early pregnant buffalo (~2 months) revealed that prostate-specific antigen is over-expressed during early pregnancy.

- Recombinant Mucus Binding (MUB) protein and S-Layer Protein (SLP) of lactic acid bacteria were expressed in biologically active form. These proteins showed binding with human gut tissue and gut cell lines.
- Sperm Acrosome Associated 3 (SPACA3) protein was shown to have a role in the early development of buffalo embryos.
- Recombinant leucyl aminopeptidase of *Lactobacillus* species was expressed in biologically active form.
- Buffalo hepatocytes were successfully cultured for over a week on several extracellular matrices and feeder fibroblast cells.
- Genetic evaluation of Murrah buffaloes using multi-trait animal model including fertiltiy and production performances was developed.
- Multi-trait repeatability animal model was developed for selection of Murrah buffaloes for higher fertility and milk production.
- The average age for initiating training and age at first collection of semen from the young Murrah bulls significantly reduced to 17.60 and 21.75 months, respectively.
- The age at first use (AAFU) of semen of Murrah breeding bulls was optimized, which could be helpful in early selection of bulls under progeny testing program for improving the conception rate of buffaloes in the herd.
- Best THI model was identified to assess the heat stress in Murrah buffaloes in relation to reproductive performance. THI should be ≤ 75 for better reproduction performance in Murrah buffaloes.
- Age at first freezing of semen was standardized to obtain better conception rate of Sahiwal bulls in the herd.
- A methodology was developed for prediction of lifetime milk production of Tharparkar cows.
- Multi-trait evaluation methodology is being standardized for selection of KF cattle for higher productivity and fertility.
- Annual phenotypic and genetic trends (1992 – 2011) of first lactation production traits & genetic trends of reproduction performance were found in desirable direction in Karan Fries cattle.
- Cytogenetic and molecular cytogenetic techniques were developed for identification of dairy animals with sub-fertility problems in the herd.
- Genetic variants/SNPs of candidate gene (MBL1 gene in Murrah buffaloes) were identified. GC genotyped Murrah Buffaloes were found least susceptible to mastitis. Genetic variants/SNPs of candidate gene (CD 14 gene in Karan Fries cattle) were also identified. AA and CC genotyped KF cattle were found least susceptible to mastitis whereas, AB and CD genotyped animals were found most susceptible to mastitis.
- The Institute got the NCBI GenBank Accession Nos. for six candidate genes related to mastitis.
- In farmer's herd, average conception rate of 52.27% was obtained in Murrah buffaloes and a total of 1860 (955 male and 905 female) calves were born whereas performance data on 183 daughters were recorded for evaluation of bulls under field conditions.
- The expression of HSP 27, 90, and 105 genes in peripheral blood mononuclear cells (*in vitro* and *in vivo*) of Tharparkar and Karan Fries (KF) calves was significantly higher at 44°C than at 25°C. The folds increase in the expression of these genes was significantly higher in KF than Tharparkar indicated that KF calves were less heat tolerant than Tharparkar.
- mRNA expression of HSP 40, 70 and 90, interleukin-6 and interleukin-10 was significantly higher at elevated temperatures (42°C) and their concentrations were much higher in KF than Sahiwal. The significant decrease in HSPs and interleukins concentration by Zn supplementation indicated a possible role of Zn in reducing heat stress.
- A positive correlation between delayed neutrophil apoptosis, persistent staying of neutrophils at the site of infection alongwith formation of NETs act as strategies to fight against the pathogens in the udder during *Staphylococcal* mastitis.
- Evaporative cooling during dry period of buffaloes potentiates immune status around parturition as indicated by differential mRNA gene expression of PRL-R, SOCS 1, SOCS 3 and L-Selectin.
- Female Murrah calves supplemented with yeast culture attained puberty at 20 months and conceived at 24 months of age whereas in non supplemented calves puberty was attained by 28 months of age.
- Plasma Nesfatin 1 and Leptin concentrations were higher and Ghrelin concentration was lower in female buffaloes attaining puberty at 27

months of age than buffaloes attaining puberty at 32 months of age.

- Milk fat globule membrane epidermal growth factor 8 (MFGE8) is essential for maintenance of cell shape and morphology during lactation in farm animals.
- Three potential urine protein biomarkers have been identified for detection of early pregnancy (~ 20 days) in cows. Prostate-specific antigen (PSA) is over expressed during early pregnancy.
- Period of oocyte maturation is affected by heat stress in buffalo. Elevated temperature exposure during this time was found to result in compromised embryo developmental rate.
- The sequence analysis of lactoferrin gene revealed sixteen transitions and five transversions in Malnad Gidda cattle. The lactoferrin content (225.20 ± 31.40) in Malnad Gidda cattle was significantly higher as compared to Deoni, Cross-bred cattle (42.59 to 91.89 mg/L) and Murrah buffaloes (11.75 to 47.13 µg/ml).
- The genetic distance analysis revealed the highest genetic distance between Vechur and Punganur (0.331) and the lowest between Malnad Gidda and Punganur (0.125).
- Genomic DNA was isolated from 150 randomly selected Deoni cattle maintained at Livestock Research Centre , SRS of NDRI to evaluate genetic variability through PCR-RFLP method.
- Semen collection and cryopreservation protocol were standardized for Malnad Gidda and 4400 doses of frozen semen of Malnad Gidda were produced at SRS, NDRI, Bengaluru.
- A detailed morphometric measurements was carried out on 225 Deoni animals maintained at Livestock Research Centre, SRS, Bengaluru and LRIC (KVAFU), Bidar.
- The Malnad Gidda cattle – a unique dwarf cattle of Karnataka was characterized. The breed has the reproductive uniqueness of regular calving (inter calving period of 396± 33 days) under low input regime and gives milk yield ranging between 1 to 6 liters per day. A good number of cows calved more than 15 calves in their life time. *Nagi* – the wonder cow has already produced 20 calves in 25 years.
- Heat shock protein-90 (HSP-90) was found to be decreased significantly on *in vitro* capacitation and cryopreservation of buffalo spermatozoa.
- The actin (a cytoskeleton protein) polymerization and tyrosine phosphorylation of buffalo spermatozoa were increased significantly on *in vitro* capacitation and cryopreservation of buffalo spermatozoa as a coupled process.
- LPS (1µg/ml) treatment to granulose cells induces pro-inflammatory genes via TLR4 signaling while CLA (10 µM) pretreatment to granulosa cells attenuates LPS- induced proinflammatory gene expression by inhibiting translocation of NF-κB to nucleus.
- Current protocol for inducing and synchronizing estrus could serve as a valuable technology to improve reproductive efficiency of post partum Deoni cows.
- A new method of estrus synchronization protocol for cows using kp-10 was developed.
- Bovine specific intranasal spray device for kisspeptin (KiSSpray) was developed.
- Replacement of soybean meal in concentrate mixture with less expensive protein source such as *Cassia tora* (Panwar) was explored.
- Enteric methane emission was found lower ($P<0.05$) in buffaloes fed oat silage compared to those fed oat hay.
- The study revealed that supplementation of rumen protected methionine and lysine in the rations of growing buffalo calves has distinct protein sparing effect.
- Reduction of particle size of paddy straw upto 2.5 cm size improved fibre digestibility and reduced enteric methane emission by 5%.
- Use of indigenous strain of *Butyrivibrio fibrisolvens* as an additive improved CLA content in milk by 2.5 times in lactating goats.
- Bioavailability of trace minerals was found more in calves given mustard oil cake based diets than those given maize germ oil cake or cotton seed cake based diets.
- Supplementation of fresh *Azolla microphylla* @ 1.5 kg/ animal /day significantly improved the growth rate of crossbred heifer without any adverse effect on animal health.
- Electro-chemical properties of indigenous cow and buffalo milk as affected by mastitis were quantified.
- Supplementation of area-specific mineral mixture (KALMIN) @ 2.0 g/day/animal in growing black Bengal goats was found to be beneficial for enhancement of growth and age of puberty.

- Animal feed grad wheat could be used in the ration of growing cross-bred calves by replacing maize grain to formulate economize ration.
- It was observed that green fodder and grain yield of Barley (*Hordeum vulgare* L.) varieties were affected by sowing time and stage of harvesting.
- Yield and quality of forage maize was improved through management of plant density and nutrients in different cultivars.

PROCESSING

- A technology was developed to manufacture low sodium Processed Mozzarella cheese.
- A process was standardized for the manufacture of Indian Farmstead Artisanal Cheese.
- A probiotic *dahi* containing *Lactobacillus gasseri* with improved texture for better shelf life and stability during distribution was prepared using biotechnological approach.
- Shelf life prediction models for micronutrient fortified barley-milk-based nutrimix were developed with different packaging materials.
- The indigenous probiotics strains and their postbiotic preparations stimulated GLP-1 secretion and proglucagon expression from both human and mouse enteroendocrine cells.
- Sugarfree syrups were prepared for use in khoa jalebi.
- Electrophoretic study on alkaline Urea PAGE showed higher degradation of protein in the cheese with prebiotics than control. Degradation of α-casein was more than β- casein during ripening. More peptide formation was observed due to longer period of ripening.
- Lactose hydrolysed whey was utilized in the preparation of buttermilk and *lassi* with acceptable quality. A colorimetric method was standardized to estimate lactose in the presence of its hydrolytic products, glucose and galactose.
- Attempts were made to optimize the production of curd rice. The levels of addition of spices such as coriander leaves, curry leaves, ginger, fenugreek seeds and mustard seeds were optimized.
- Energy and exergy analysis of spray drying of both cow and buffalo milk were carried out . Exergy efficiency of spray drying of cow milk was calculated as 6.68%.
- Orange peel could be used as a cheap natural source of natural antioxidants which could be used in fat rich dairy products like ghee for retarding oxidative deterioration.
- The average hardness value of the paneer samples was found to be 45.5 N. Time of press greatly influenced the hardness of paneer as it increased the hardness value significantly.
- Peptides WP3F5 and CP1F7 purified from whey protein and casein hydrolysates as well as 1 kDa fraction of *L. heveticus* NCDC288 regulated the expression of proglucagon and secretion of GLP-1.
- Twelve strains of Bifidobacteria, isolated from human sources, were duly identified by biochemical and molecular methods. Three strains (NBIF-2, 5, 7) among them were found to be endowed with appreciable *in vitro* probiotic and functional activities.
- Two most prolific trehalose producer strains *Propionibacterium* (PF13, PF18) were isolated and characterized. Significant increase in trehalose production (1.7 fold) was achieved by generation of a mutant (M7). A positive correlation between trehalose content and the stress tolerance of propionibacteria was observed.
- A cost effective technology was developed for the production of trehalose from dairy waste using Propionibacteria.
- Among the 52 isolates bioprospected from dairy and non-dairy sources for riboflavin production and its *operon* characterization, 19 harboured complete *rib* genes and the isolate KTLF1 exhibited maximum vitamin production (2.71 ± 0.05mg/L).
- Spore germination protocol in presence of specific germinant was optimized and expression of enzymes namely esterase, β-glucosidase, α-glucosidase, α-galactosidase and α- amylase was established in aerobic spore forming bacteria.
- Assay protocol having spore germination, pesticide exposure and substrate addition, was optimized with a sensitivity up to 10 ppb of pesticide.
- An "enzyme (s) substrate assay'' was developed for detection of *E. coli* in milk targeting "enzyme-substrate reaction" for specific marker enzyme(s) to release free chromogen with a detection time of 12 ± 0.25 h.
- A miniaturized assay on biochip using EMCCD system was developed for detection of *E. coli*/*E.*

coli O157:H7 in milk based on triggering of spore's germination by marker sugar(s).

- A novel anaerobic fungi named *Oontomyces anksri* gen. nov. sp. Nov. was isolated from the forestomach of an Indian camel (*Camelus dromedarius* L.). The phylogenetic analysis using internal transcribed spacer (ITS) and large-subunit (LSU) regions of rDNA also demonstrated their uniqueness.
- Nine stress tolerant *Kluyveromyces* spp. were isolated, identified and characterized for ethanol production. *Kluyveromyces* 6C17, a thermo-ethanol tolerant strain, produces 10% (v/v) in 20% (w/v) sugar at 42°C. Further, enhancement of galactose utilization by 6C17 strain is being carried out by genetic manipulation.
- Bioactive peptides were produced from soy milk using *L. plantarum* C2. The 10 kDa peptides fraction showed maximum antioxidative (1795 TEAC, µM) and antimicrobial activity (14 mm), and 3 kDa fraction inhibited 80% Angiotensin converting enzyme activity.
- *Lactobacillus* LR28 and LR22 produced 35.25 and 32.34 µg/ml folate, respectively under optimized conditions in skim milk. LR28 culture survived in GIT and showed good antidiarrheal activity in animal model.
- Bioprocess was standardized for Direct Product Probiotic (DPP) *Lactobacillus casei* NCDC 298 Culture by freeze drying.
- Alpha-glucosidase inhibitory milk bioactive peptides were generated by *Lactobacillus* spp. fermentation.
- Casein hydrolysates were evaluated for protection against oxidative stress at different respective concentrations. It showed no cytotoxic effect and was found to provide cytoprotective effect against H_2O_2-induced oxidative stress in Caco-2 cells.
- A method for the production of antioxidant peptide rich hydrolysate was standardized by integrating hydrolysis on membrane reactor.
- Methods were optimized for the preparation of Iron-Modified milk protein and Zinc-Modified milk protein complex.
- Molecular imprinted polymer (MIP) against cephalexin of high selectivity and sensitivity was synthesized by co-polymerization of functional monomer, cross-linker, radical initiator, alongwith target molecule (cephalexin) in a porogenic material.
- Nanoemulsions encapsulating clove oil using milk proteins were prepared and assessed for their antimicrobial activity.
- A rapid and semi-quantitative lateral flow assay based on competitive format using polyclonal antibodies was developed for detection of cephalexin in milk.
- A protocol was standardized for the extraction of DNA from ghee as well as from rendered fats (clarified animal body fats).
- Machine vision system colour desk was developed for colour measurement of dairy products.
- Weight based metering and filling system was designed for viscous dairy products.
- Peda formation system was designed and mechanized on the principle of piston press technology.
- A process was optimized for in-line production of *kheer*.
- Thermic oil based electric milk heating system was developed.
- Significant improvement in Th1/Th2 immune homeostasis, antioxidative status and resistance to pathogenic *E. coli* on consumption of probiotic fermented milk prepared with *Lactobacillus rhamnosus* (MTCC: 5897) and *L. fermentum* (MTCC: 5898) in aging mice was established.
- Major route of transepithelial transport of an osteogenic seven amino acids long peptide and its fragment was studied using Caco-2 cells; the peptide got hydrolyzed by cellular peptidases. The major route of transepithelial transport of the peptide and its breakdown fragment was found to be SOPT2 / PepT1.
- Long-term consumption of *Lactobacillus rhamnosus* S1K3 (MTCC 5957) demonstrated protective abilities against challenge with *Salmonella typhi* in mice, mainly at the mucosal level through activation of the innate as well as adaptive immunity.
- Betacasomorphin-7(BCM-7) was identified as a seven amino acid long peptide, which was produced during digestion of A1 milk but not from A2 milk. Aptamers against BCM-7 were generated, characterized and evaluated for developing method for estimation of BCM-7 in biological fluids.
- Toxicity of Multi Walled Carbon Nanotubes (MWCNTs) was found to be comparatively

higher than Mesoporous Silica Nanoparticles (MSNs), based on *in vivo* studies carried out on mice.

- A process was developed for manufacturing Aloe Vera probiotic ice cream, which could be used as functional food with enhanced immune-modulatory properties.
- A process was developed for preparing Terminalia Arjuna herb based functional milk beverage.
- Vegetarian Pizza and Bajara Lassi were launched at NDRI Parlour for consumers.
- Magnetic imprinted polymers were found to be useful to remove 63-93% of Oxytetracycline, Cephalexin and Cefquinome from water, milk, honey and egg white.
- Transport pathway of seven amino acid long osteogenic peptide appeared to be mediated through receptors in Caco-2 cells.
- Serum glucagon like peptide-1 (GLP-1) level is enhanced on supplementing diet with gum acacia. Gum acacia /inulin in diet helps in reducing epididymal fat.
- A new method for green synstheis of gold nanoparticles was developed.
- Paper strip based tests for rapid detection of adulterants in milk (neutralizer, urea, glucose, hydrogen peroxide and maltodextrin) were developed. These tests can be done at milk reception as well as at house-hold level.
- A colorimetric test was developed for detection of melamine in milk using Gold nanoparticles. Gold nanoparticles are highly specific for melamine and can detect melamine up to a concentration of 0.05 ppm.
- Rapid HPLC and TLC based protocols based on tracer component were developed for the detection of vegetable oils/fats adulteration in ghee.
- Methods for preparing milk protein–mineral and lactose-mineral complexes were developed for the fortification purpose.
- A novel Enzyme-Spore Based Chromogenic Assay (ESBA) was developed for the detection of antibiotic residues in milk.
- A paper strip based protocol to detect organophosphorus group of pesticide with detection limit of 10 ppb was achieved.
- A cost effective food grade medium for *Lactobacillus* spp. using whey was developed.
- A technology was developed for the production of high quality *Misti Dahi* at commercial scale having improved body and texture using well characterized fast acidifying high sugar tolerating lactic culture(s).
- Technologies were developed to manufacture ready-to-use shelf-stable dairy-fruit-cereal based composite smoothie, reduced calorie eggless muffins, starch based frozen dairy custard, Composite dairy-cereal based biscuits with reduced calorie and zero trans-fat, kheer mohan, enzyme-mediated improved texture dahi.
- A double layer emulsion with dairy ingredients as matrix materials was developed for encapsulating potential herb bioactives.
- Quarg type cheese has been developed by replacing milk fat with vegetable oils.
- Dietetic Sandesh was prepared with 30% reduction in calorific value as compared to conventional Sandesh.
- A technology for edible coating was developed for the extension of shelf-life of paneer.
- Intelligent models were developed to predict the moisture sorption characteristics at different temperatures, in selected Indian dairy products.
- Water productivity of milk production in the water scarce areas was higher than the water sufficient areas. Hence, dairy farmers in safe and semi-critical areas should adopt the effective water management practices like DI, SI and irrigation at critical stages.
- A study on quantitative assessment of gains from Indian dairy trade and economic partnership agreement with Asian countries revealed high instability in trade, diversification of trade basket and decreased in market concentration. India has diversified its import and export market from traditional dairy product to value added products. Simulation exercise on tariff reduction suggested that India stands to benefit from export only to Philippines, Vietnam and Myanmar.
- Milk Production Economic Analysis Package namely '**MILKcAP-1.0'** was developed for Standardization of methodology to estimate costs of milk production.
- Two 'resilience scales' were developed to ascertain the answers of two burning issue viz., the reasons for farmers quitting agriculture and committing suicide based on the study in National Calamity affected areas of Bihar.

- NDRI demonstrated the effectiveness of extension delivery through mobile extension unit and showed the yield and income enhancement among dairy farmers of Karnal district under the collaborative project with NABARD.
- Impact assessment of Dairy Production Technologies Transferred by NDRI, revealed that age at first calving and inter-calving period got reduced significantly due to extension interventions in adopted villages.

EDUCATION

- Diploma in Animal Husbandry and Dairying was introduced at Eastern Regional Station, Kalyani.
- A new course entitled 'Advances in Carbohydrate Technology (DT-723) was introduced for the Ph.D. (Dairy Technology) programme.
- Thirteenth Convocation of NDRI was organized on 14th February, 2015. Prof. Kaptan Singh Solanki, Hon'ble Governor of Haryana was the Chief Guest on the occasion. Dr. Mangala Rai, Former Secretary and DG, ICAR, New Delhi delivered the Convocation Address.
- In the year 2014-15, NDRI organized Academic Week prior to Convocation by organizing the series of academic events such as Memorial lectures & presentation of academic achievements and innovations in teaching by different Heads of Divisions followed by deliberations by panelists, selection of students for Best Thesis Awards, etc. "Best Thesis Awards" were also given to Master's and Doctoral students to encourage spirit of competition and motivation for quality research work.
- Dr. K. K. Iya Memorial Oration was given to Dr. Nagendra P. Shah, Professor, Food Science and Dairy Technology, the University of Hong Kong; Dr N. N. Dastur Memorial Oration Award for the year was bestowed upon Dr. Harsh Kumar Bhanwala, Chairman - National Bank for Agriculture and Rural Development (NABARD), Mumbai and Dr. D. Sundaresan Memorial Oration Award was given to Dr. N. K. Ganguly, Former-Director General, Indian Council of Medical Research, New Delhi.
- Four Workshops on Communication and Employment skills were organized on 27th September, 10th October, 11th November and 20th November, 2014.
- Two one-day workshops for the current B.Tech (Dairy Technology) 3rd year students (Class of 2016). The first was on Personality Development and Soft Skills conducted by M/s Success Sutra Educational Institute, Delhi on March 14, 2015, while the second one was on ISO and HACCP conducted by M/s Intertek, Panchkula on March 29, 2015.

EXTENSION

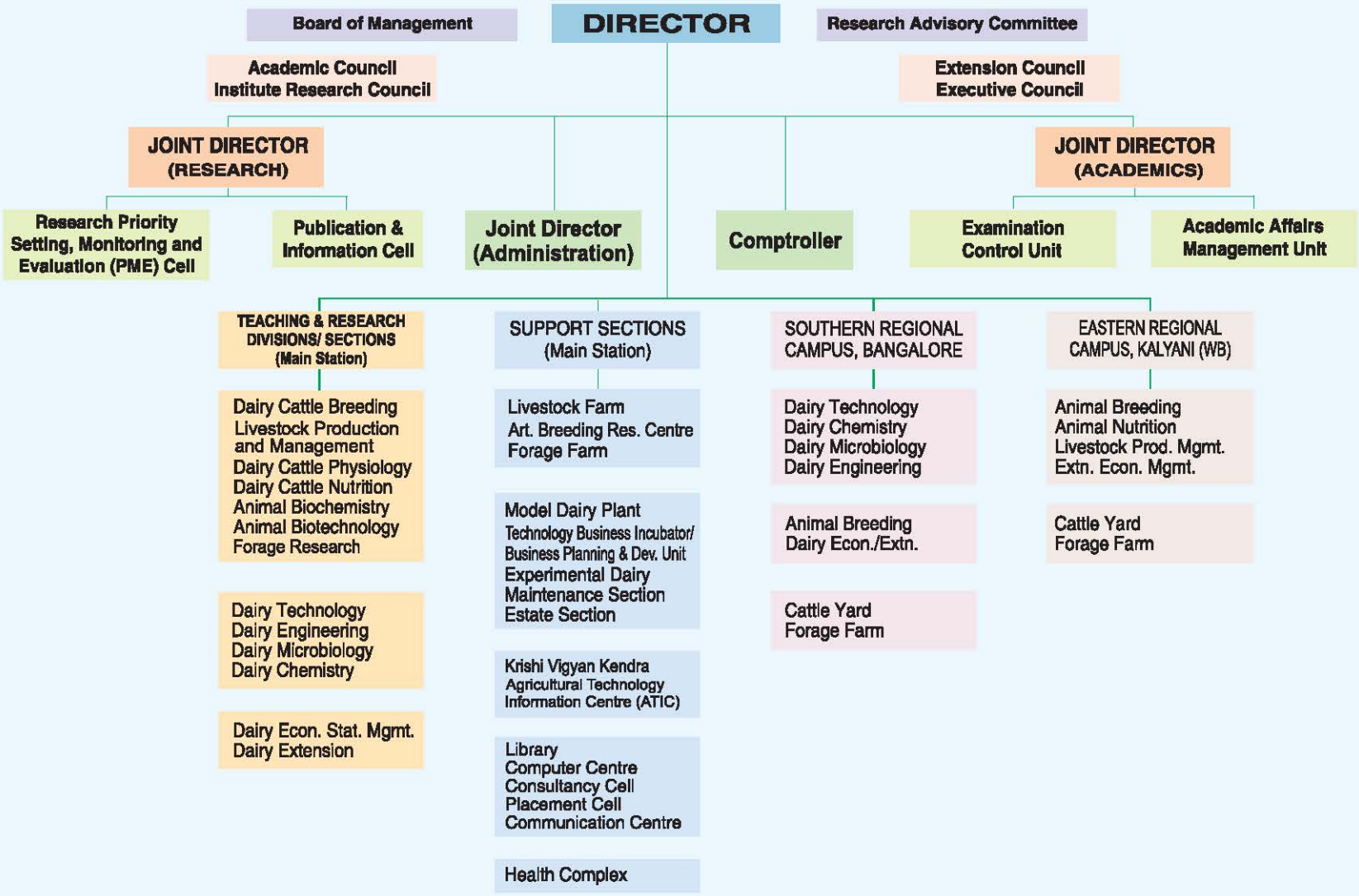
- Forty eight Kisan Sangoshties were organized with the dairy farmers and farm women in the adopted villages for transfer of technologies developed during 2014-15. Farmers were also made aware about the reproductive management practices, mastitis control, disease preventive measures, clean milk production practices, preparation of value added milk products, management of fodder scarcity period and round the year green fodder production.
- Thirty eight on-campus women empowerment training courses and campaigns were organized benefiting 540 farm women. Farm women could generate more income from dairying and maintain healthy atmosphere in their respective families. Seven off-campus women entrepreneurship and capacity building programmes on small scale production of value added dairy products were organized benefiting 144 farm women.
- KVK and DTC of NDRI organized 167 training programmes (both on campus and off campus) on different aspects of dairying and allied fields of agriculture such as crop production, horticulture, bee keeping and fisheries apart from home science for the benefit of 5485 farmers, farm women, rural youth and entrepreneurs.
- ATIC NDRI provided 6454 services to 11339 persons of different states, through video shows, lectures, personal discussions, published literature, toll free phone calls and e-mails. The centre generated revenue of ₹ 113612/- from the sale of books (₹ 4545627) and from the sale of seeds. NDRI and PAU Ludhiana jointly started a seeds sale point at ATIC NDRI for the benefit of farmers.
- NDRI organized 48 Infertility/Veterinary aid Campaigns and Exposure Visits at nearby villages viz., Kulwaheri, Budhakhera, Deepo, Dugro and Dhamanheri. A total number of 1275 animals were treated against the contagious diseases, infertility and for pregnancy diagnosis and general veterinary problems.
- The All India Animal Husbandry Officers' Workshop was organized by the Dairy Extension Division during September 24-25th, 2014. The theme of the workshop was "Opportunities and Challenges in Dairying for Small Farmers".

- NDRI organized National Dairy Mela on 25th-27th February, 2015. More than 14000 visitors including progressive dairy farmers, dairy entrepreneurs and farm women across the country participated in the Mela.
- An action research study was conducted to promote two women based Self Help Group (SHG) working exclusively on dairying activity around Bengaluru distrct. Interventions through need based trainings and supply of strategic inputs had favourable influence on the livelihood of the member farmers.
- A new Educational Approach "Farmers' Farm School" of NDRI was started in village Gorgarh, Karnal. In this school, 20 active farmers were registered as students. Scientists of NDRI are taking classes regularly on every Friday and Saturday.
- Entrepreneurship Development through (BPD) unit of ICAR-NDRI organized seven training programmes from October, 2014 to December, 2014. Fifty five trainees participated in two Entrepreneurship Development through (BPD) on "Commercial Dairy Farming". Fourteen veterinary officers from Tripura state were trained in the area of infertility management in dairy animals in two batches. A group of 20 youths from Assam underwent "Hands on Training on value added dairy products". EDP programme on "Cheese Manufacture" was attended by seven young entrepreneurs from different parts of the country. Under the Business Incubation programme M/s Mishti Farmer Producer Company Ltd., Karnal launched the "Bjaralassi" and other dairy products in Karnal market. The company has a strong network of 250 dairy farmers.

INFRASTRUCTURE

- NDRI received ISO 9001:2008 certification to undertake Research, Teaching, Training and Consultancy in the field of Dairy Production, Dairy Processing and Dairy Management.
- A new Boys Hostel (150 Seater) and Girls Hostel (50 Seater) got constructed and made functional at NDRI, Karnal.
- Sports Complex/Multipurpose Hall (Kalki-Bhawan)/ Twenty room Guest House built up and made functional at NDRI, Karnal.
- Referral Laboratory for Milk Quality and Safety made functional.
- Physiology and Reproduction laboratory was established at ERS, Kalyani.
- Micronutrient laboratory was established at ERS, Kalyani.
- Generator Set 500 KVK got installed for uninterrupted supply of electricity.
- Renovation of Traditional Dairy Products Laboratory of Dairy Technology Division in progress.
- New equipment and instruments like High Shear Homogeniser, Spreadability Rig, Spectrophotometer, Milk Analyser, Khoa making machine and Cream Separators were installed.
- Vehicle Parking in front of Dairy Technology Division got constructed at NDRI, Karnal.
- Sixteen number of Azola Ponds having size of each pond 9' (L)x 3' (B) x 9" (D) with lachcha flooring got constructed for carrying out research work under Livestock Production and Management Section at NDRI, Karnal.
- Old main LT panel got replaced in the office area sub-station building at NDRI, Karnal.
- Complete roofing of central store with pre-coated GI Sheet Roofing & Fibre Ceiling got done at NDRI, Karnal.
- Renovation of five large sheds of Young Calf Pens/Young Bull Pens at Livestock Research Centre NDRI, Karnal.
- Renovation of Dr. D. Sudresan Auditorium, NDRI, Karnal.
- Renovation of rooms in front of Director's Office for converting into Conference Hall at NDRI, Karnal.
- Renovation of four Lecture Halls of Dairy Economics Statistics & Management Division at NDRI, Karnal.
- Renovation of sheds/rooms/floor of Farm Section at NDRI, Karnal.
- Renovation of sheds and providing storage facility in Block No. 7 in farm area of NDRI, Karnal.
- Renovation of three large sheds of calving block at Livestock Research Centre at NDRI, Karnal.
- Renovation of existing Fencing (600 Rft) towards southern side of the Livestock Research Centre at NDRI, Karnal.
- Repair of compound lights around the Auditorium at NDRI, Karnal.
- Renovation of Metalled Road, Cattle Yard, Fodder Section, Training Centre and different labs etc. at ERS, Kalyani.

Organizational Structure of NDRI



1 INTRODUCTION

HISTORICAL PERSPECTIVE

The National Dairy Research Institute is the premier organisation that provides R&D support for dairy development programmes of the nation. Over the years, it has gained prominence as the front ranking research organisation on global basis. The Institute works in close liaison with various National and International developmental agencies. Scientific achievements, development of human resource at multi-tier level and infusion of science in various sectors of the dairy industry have been the hallmarks of the Institute. The Institute catalyses close interaction among scientists, students, farmers and dairy industry for orchestrating dairy development process in a harmonious manner.

The National Dairy Research Institute metamorphosed from erstwhile Imperial Institute for Animal Husbandry & Dairying, which was established at Bangalore in 1923. In 1936, it was expanded and renamed as Imperial Dairy Institute. It was in 1955 that its Headquarters were shifted to Karnal at the location formerly called Central Cattle Breeding Farm. With a view to consolidate the impressive infrastructure already developed at Bangalore, the unit was reorganised to serve as the Southern Regional Station of the Institute. In 1962 and 1964, two regional stations were established in Bombay and Kalyani, respectively, to serve as the Western and Eastern regional stations of the Institute. However, the Western Regional Station (WRS) at Bombay was closed down in 1984. The Southern and the Eastern Regional Stations continue to provide region specific R&D support for dairy development in relation to the agro-climatic conditions that exist in those areas. In 1966, the Institute's management was weaned away from the Ministry of Agriculture and brought under the wings of the Indian Council of Agricultural Research with a view to provide greater operational autonomy in research management functions. In 1989, status of Deemed University was conferred to the Institute for further strengthening the academic programmes for human resource development. The Institute provides high quality education in the field of dairying, which has no parallel in Asia. It is noteworthy that NDRI is not only an important contributor of manpower in dairying required in State Agricultural Universities (SAUs) but also plays an important role in enhancing the teaching capabilities of the faculty from SAUs. This is evidenced by recognition of the Institute by the ICAR, as "Centre for Advanced Faculty Training (CAFT)" in Animal Genetics & Breeding and Dairy Processing disciplines to further strengthen the research and training components.

ORGANISATIONAL SETUP

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

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

The highest policy making body is the Board of Management. The Director NDRI, is the Chairman of this Board. The Research Advisory Committee is responsible for all round progress of research at the Institute and its application. The Academic Council is responsible for all issues relating to the education and training. The Academic Council, in turn, is supported by (i) Standing Committees, (ii) the Post Graduate Faculty, and (iii) the Board of Studies in the respective disciplines. The Extension Council is responsible for guiding extension programmes.

The Executive Council is the main task implementing body on Administrative matters and the powers and the function of this Council shall be those as may be delegated by the BOM.

The research, education and extension activities of the Institute are managed by the Director and the Joint Directors through scientific, technical, administrative and supporting staff. The Director is overall Administrative Head of the Institute and its Regional Stations. The Joint Directors in addition to extending support to the Director in the area of research, academics and administration are responsible to co-ordinate research and educational activities of various Divisions and Regional Stations, respectively. Each of the Regional Stations is administered through the Head located at the station. The scientific and teaching work at the main station is conducted through 12 subject-matter Divisions/Sections.

Board of Management

Chairman	Dr. A. K. Srivastava Director, NDRI
Member	Dr. R. K. Malik Joint Director (Research), NDRI
Member	Joint Director (Academic), NDRI
Members (Head of Divisions/ Principal Scientists nominated By President of ICAR)	Dr. Y. S. Rajput, Head, ABC Division
	Dr. R. C. Upadhyay, Head, DCP Division
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	Dr. P. Khandekar, Principal Scientist, Agriculture Extension, NIANP, Bangalore
	Dr. S. K. Agrawal, Director, Central Institute for Research on Goats, Makhdoom, PO Farrah, Mathura – 281122 (UP)
	Dr. D. K. Sadana, Principal Scientist, Animal Breeding, NBAGR, Karnal
Members Two Members of Governing Body Nominated by the President, ICAR)	Dr. Mruthyunjaya, Ex-National Director, NAIP, ICAR, A-701, Vasundhar Apartments, Plot No. 16, Sector-6, Dwarka, New Delhi
	Dr. Chanda Nimbkar, Director, Animal Husbandry Division, Nimbkar Agricultural Research Institute, P.O. Box No. 23, Phaltan, Maharashtra
Member (VC of Agricultural University Nominated by the President, ICAR)	Dr. R. K. Mittal, Vice Chancellor, RAU, Pusa, Samastipur, Bihar
Member (Nominee of the DG, ICAR)	Dr. K. M. L. Pathak DDG (AS), ICAR
Member (Director IVRI/IARI)	Director, IARI
Member (Jt. Director, Ext. Edu.)	Head, Extension Division
Member (Animal Husbandry Commissioner, Deptt. of Animal Husbandry & Dairying Ministry of Agriculture)	Dr. Suresh S. Honnappagol, Animal Husbandry Commissioner, Dept. of Animal Husbandry Dairying & Fisheries, Ministry of Agriculture, Govt. of India, Krishi Bhawan, New Delhi 110114

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	Sh. Gurumukh Singh, Progressive Farmer, Vill. & P.O. Blair, Tech. Patti, Distt. Tarn-Taran -143303 Panjab
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	Dr. A. M. Thakar, Dean, College of Veterinary Sciences, AAU, ANAND-388001 (Guj)
	Dr. Tasleem Ahmad Ganai Professor, Animal Genetics & Breeding & Registrar, SKUAST-K Shalimar (Kashmir)
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	Dr. T. K. Datta, Head, Eastern Regional Station, NDRI, Kalyani, Distt. Nadia (W.B.)
	Dr. S. K. Kanwajia, Academic Coordinator
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	Dr. A. K. Singh, PS, DT Division
Students Member	Ms. Suman Kumari Joshi, Ph.D. (LPM)
	Ms. Indu Devi, M.Tech (LPM)
Member-Secretary	Joint Director Admn. and Registrar, NDRI Deemed University

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	Agriculture Commissioner, Govt. of India, Ministry of Agriculture, Department of Agriculture & Cooperation, Krishi Bhawan, New Delhi
	Director General, Department of Animal Husbandry & Dairying, Govt. of Haryana, Pashudhan Bhawan, Sector- 2, Panchkula
	Director (Farm Information), Directorate of Extension, Govt. of India, New Delhi
Member Secretary	Dr. K. Ponnusamy, Head, Dairy Extension, NDRI

Sardar Patel Outstanding ICAR Institution Award Bestowed upon NDRI Karnal

Hon'ble Prime Minister of India Sh. Narender Modi Presenting "Sardar Patel Outstanding ICAR Institution Award" to Dr A. K. Srivastava, Director, NDRI at the 86th Foundation Day and ICAR Award ceremony held on 29th July, 2014 at New Delhi

FINANCE

The financial outlays in terms of actual expenditure for Plan and Non-plan for the year 2014-2015 was ₹ 16043.64 lakhs and the sanctioned budget for Plan and Non-plan in 2014-2015 was ₹ 16127.00 lakhs. These figures include the financial outlays for strengthening of Deemed University/KVK and Regional Stations.

Financial Outlays & Expenditure during 2013-14

(₹ in lakhs)

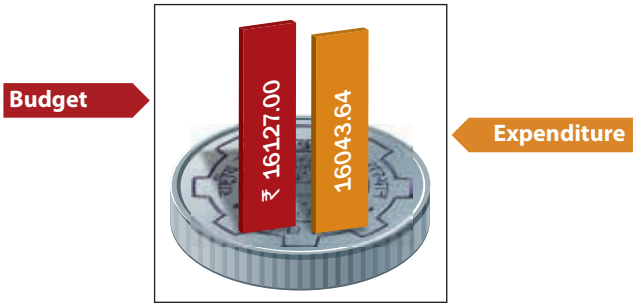
Head	Budget	Expenditure
Non-Plan	14727.00	14645.31
Plan	1400.00	1398.33
Total	**16127.00**	**16043.64**

Revenue Generation

The Revenue Receipts of the Institute and the Regional Stations for the year 2014-2015 were ₹ 1076.20 lakhs.

Sl. No.	Head	Amount (₹ in lakhs)
1.	Sale of Milk/Farm Produce	357.39
2.	Sale of Old Vehicle/Equipment etc.	23.81
3.	Sale of Livestock	25.59
4.	Sale of Publication	3.09
5.	License Fee	55.86
6.	Consultancy	94.02
7.	BPD Training Charges	28.52
8.	KVK Training Charges	43.11
9.	Other Receipts	444.81
	Total	**1076.20**

FINANCIAL OUTLAY



Position of Manpower at NDRI, Karnal and its Regional Stations as on 31.03.2015

Type of Posts	Existing		Vacant	Additional Proposed	Total	
	Approved by D/o Expenditure	In position			Sanctioned + Additional	Existing + Additional
Scientific	194	156	38	20	194+20	157+20
Administrative (Group A&B)	35	31	04	-	-	-
Technical	354	232	122	15	354+15	232+15
Administrative (Group Non-gazatted)	127	*110	20	Nil	127+00	110+00
Supporting	755	506	249	11	755+11	506+11
Total	1465	1035	433	46	1430+46	1005+46

**3 posts of UDCs are excess from the sanctioned strength of the post of UDCs.*

2 RESEARCH ACHIEVEMENTS

DAIRY CATTLE BREEDING

Genetic Improvement of Milch Animals through Identification and Dissemination of Superior Germplasm by Application of Emerging Reproductive and Molecular Technologies

Multi-trait Evaluation of Karan Fries Cattle for Higher Productivity and Fertility

A total number of 55 Karan Fries cows (33.95%) were selected as elite cows for nominated matings with an average 305-day milk yield as 5602 kg and average EPA as 4605 kg which were 14.65% and 13.03% higher than the herd average (4203 kg) and average EPA (4074 kg), respectively. The best 305 day milk yield ranged between 5014 and 8338 kg with an average of 5528 kg.

A total number of 12 KF male calves were reserved on the basis of EPD and dam's best 305 days lactation yield, breed characteristics and physical conformity for the selection of young male calves for future breeding. The dam's best 305 days lactation yield of reserved KF males ranged from 4282-6971 kg. The EPD of selected the male calves ranged between 1.47 and 16.80%.

A total number of 4054 A.I. were performed in Karan Fries and as a result 53.13% conception rate was obtained under field conditions up to December, 2014. A total of 1544 (814 males and 730 females) Karan Fries calves were born in the farmers' herds and test day milk yield data on 259 Karan Fries have been recorded for evaluation of bulls under field conditions.

Phenotypic and genetic trends of production traits viz. FL305DMY (21.85 & 5.15 kg), FLTMY (32.42, 4.32 kg) and FLL (1.08 & 0.62 days) were estimated and found to be positive, significant and in desirable direction. The genetic trends of reproduction traits – AFC (-1.59 days) and FCI (-0.65 days) were negative and in desirable direction but phenotypic trends were positive and non-significant.

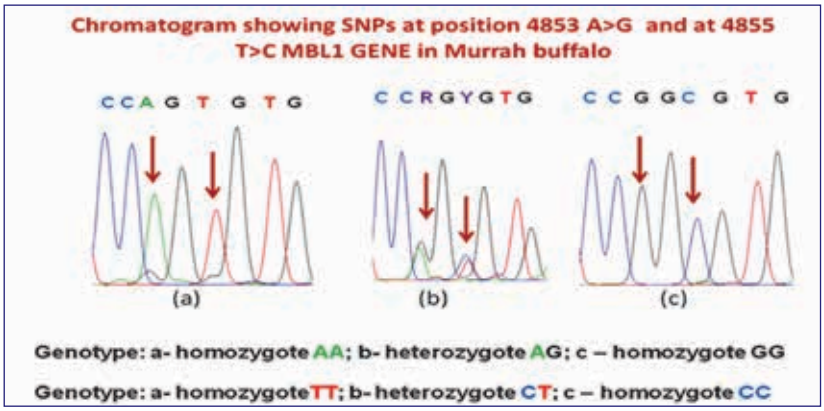
In case of single trait models, the heritability of FL305DMY should be estimated by single trait animal model taking age group as fixed effect instead of AFC as a covariable. It is better than mixed model analysis using LSML. Two-trait animal model combining FL305DMY with either FCI or FSP should be used for precise estimation of heritability with low standard error. For three trait animal model, FL305DMY should be combined with FCI and AFC.

Multiplication and Dissemination of Tharparkar Germplasm

Four out of 14 bulls were under regular semen collection. During the period (January - December, 2014), a total of 11420 doses of frozen semen were produced from Tharparkar bulls. A total of 730 doses of frozen semen were supplied through sale to the farmers and developmental agencies. Data spread over a period of 30 years from 1981 to 2010 comprising of records on 232 female calves born and 536 lactation records on 166 adult Tharparkar cows were analysed to study disposal pattern and lactation specific demographic parameters. The overall replacement rate on female calves born basis was 81.46%, indicating better adaptability of the breed. Expected herd life in first lactation was up to 2.24 lactations and in second lactation, it was 2.19 lactations. After fourth lactation, it showed decreasing trend.

Molecular Characterization and Identification of Polymorphism in Mastitis Related Genes in Sahiwal, Karan Fries Cattle and Murrah Buffaloes

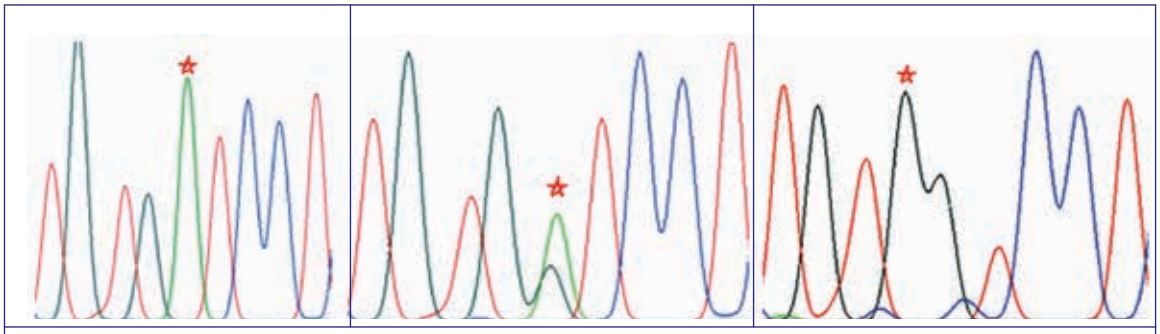
Molecular characterization and identification of polymorphism in MBL1 gene in Murrah buffalo: Mannose binding lectin 1 (MBL1) gene belongs to lectin family, mainly produced in the liver and acts in response to infection by pattern recognition as a



first line of defense. MBL1 gene was characterized and single nucleotide polymorphisms (SNP) were identified to analyze association between genetic variants and the incidence of clinical mastitis in Murrah buffalo.

Genomic DNA from 200 lactating Murrah buffaloes were amplified using five pairs of primers with respective amplicons of 588, 401, 278, 281 and 509 bp. Annealing temperatures ranged from 53°C to 60.5°C. Twenty six nucleotide variations were found in Murrah buffalo when compared to Bos taurus NCBI Reference Sequence (Accession No. AC_000185). 14 SNPs were found in MBL1 gene when compared with consensus sequence of Murrah buffalo. Out of which, 8 were in promoter region, 2 in intron-3 and 4 in exon-5 coding region resulting in 2 synonymous and 2 non synonymous type of change at A4853G and C4855T (Serine150 Glycine). SNP 2689G>C resulted in three genotypes: CC, CG and GG with respective frequencies of 0.238, 0.469 and 0.293, which showed a significant ($p<0.05$) association with clinical mastitis in Murrah buffaloes. Animals with genotype CG were least susceptible to mastitis.

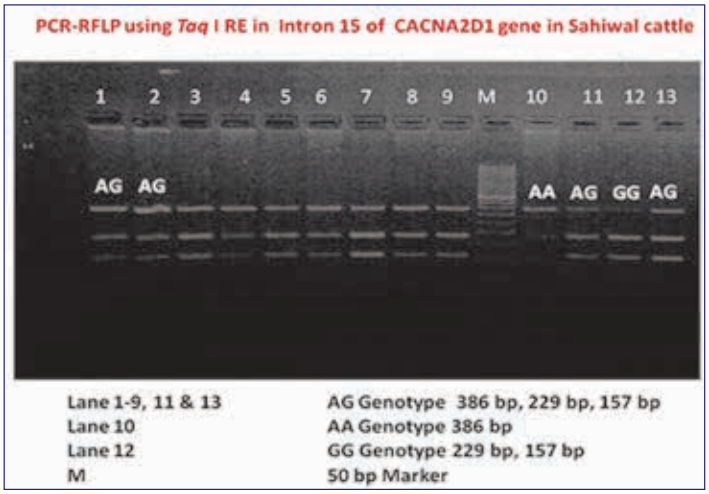
Molecular characterization and identification of polymorphism in MBL2 gene in Murrah buffalo: In MBL2 gene, a total number of 39 nucleotide changes were found in reference (NCBI Accession No. AC_000183.1) sequence. Murrah animals exhibited 4 SNPs, two of which resulted in amino acid substitution: 1262G>A in Gly40Asp and 4387C>T in Thr166Met. Allelic association analysis showed that A allele of 1262G>A, A allele of 3382A>T, C allele of 4387C>T and C allele of 4511C>T were significantly associated with clinical mastitis ($P<0.01$). Haplotype association analysis showed that out of total 7 haplotypes generated, Hap1 (AACC), Hap2 (AACT), Hap3 (AATT) and Hap4 (ATTT) had significant association with higher risk while Hap7 (GTTT) with lower risk of clinical mastitis in Murrah buffaloes ($P< 0.01$).



homozygote AA *heterozygote AG* *homozygote GG*

Chromatogram showing SNP at position G>A 1262 of MBL2 gene in Murrah buffalo

Identification of polymorphism in CACNA2D1 gene in Sahiwal and Karan Fries cattle: PCR-RFLP analysis of 386 bp segment of intron 15 of CACNA2D1 gene in mastitis affected and non affected animals (Control) in Sahiwal and Karan Fries animals was carried out using reported primer and *Taq* I restriction enzyme. Three genotypes AA, AG and GG found in Sahiwal and Karan Fries cattle differ significantly regarding mastitis incidence. AA and AG genotyped animals were found to be more susceptible to clinical mastitis. Similarly PCR-RFLP analysis of 269 bp segment of Exon 24 of CACNA2D1 gene in mastitis affected and non affected animals (Control) in Karan Fries animals was done by *Hpa* II restriction enzyme. Three genotypes AA, AG and GG in Sahiwal and Karan Fries differ significantly regarding mastitis incidence. AA and AG genotyped animals were found susceptible to mastitis. Two G>A nucleotide changes at 67 and 97 position, and an insertion of A at 54 position was detected in Karan Fries cattle.



AICRP Indigenous Breed Programme (Sahiwal Cattle)

Germplasm was supplied to the data recording units i.e., GLF Hisar, Bhiwani Gaushala, GBPUA&T, Pantnagar, GADVASU, Ludhiana for testing of bulls. During the period (January-December, 2014), frozen semen doses produced from bulls of Set I & Set II were 23840 and a total of 5061 doses were supplied through sale to the farmers and various developmental agencies.

Network Project on Buffalo Improvement (Institute Unit)

The breeding programme in the Murrah herd was followed for test mating of 14th and 15th set of bulls. Fifteenth set had 15 bulls of which eight bulls test mating continued up to March, 2015. The dams' best lactation 305 day or less milk yield of eight test bulls had ranged from 2828 in first lactation to 3605 kg. Two proven bulls were used for elite mating at the centre.

Herd performance and evaluation: The herd strength increased during the reporting period. Average age at first service and age at first calving of buffaloes were 27.91 and 40.39 month. Average age for initiating training and age at first collection of the young Murrah bulls has significantly reduced to 17.60 and 22.75 months. The average service period of buffaloes has been estimated as 134.71 days. The overall female conception rate in the herd was 41.30 %. The female calf (0-3 month) mortality was marginally higher (11.42 %) than the target. The wet and herd average were increased to 8.05 Kg and 5.10 Kg, respectively. The average milk fat, SNF and total solids were estimated as 8.30 %, 9.65 %, and 17.95 %, respectively. The information on 305 days milk yield of daughters were collected, compiled and supplied to Nodal institute for genetic evaluation of XI th set of Murrah bulls using Contemporary Comparison Method.

The comparison of estimated breeding values (EBVs) of Murrah bulls through different sire evaluation methods, viz. contemporary comparison (CC), least-squares (LS), simple regressed least-squares (SRLS) and best linear unbiased prediction (BLUP) for FLMTDMY revealed that BLUP method is more efficient, accurate and stable with lowest genetic variation. The average predicted CR based on first A.I was found highest (39.95%) at <3.5 years and lowest (34.87%) at >4.5 years of age at first A.I/use. Similarly, average predicted overall CR was found highest (41.05%) at <3.5 years and lowest (39.42%) at >4.5 years of age at first A.I/use of Murrah bulls. Under progeny testing program, Murrah bulls should be used at young age, i.e. prior to 3.5 years, which is expected to result in 5.08% better CR based on first AI and 1.63% better overall CR in comparison to Murrah bulls used after 4.5 years of age.

The best temperature humidity index model (THI model) was identified among seven different THI models for analyzing the effect of heat stress on pregnancy rate of 581 Murrah buffaloes in a subtropical climate. A negative association was found between THI and pregnancy rate. THI model [THI = [0.4 × (Tdb + Twb)] × 1.8 + 32 + 15] indicated the maximum decline (-0.761 %) in pregnancy rate with per unit increased in THI value and therefore, it was identified as the best THI model for studying the effect of heat stress on pregnancy rate of Murrah buffaloes in a subtropical climate.

Selection of young Murrah bull: A total of twelve elite Murrah male calves were reserved during the period (2014-15) on the basis of Expected Predicted Difference and dam's best 305d or less lactation milk yield, breed characteristics and physical conformity for the selection of young male calves for future breeding. The dam's best 305 days lactation milk yield of reserved males ranged from 2740 kg in first lactation to 4088 kg. The EPD and superiority of reserved Murrah male calves ranged from 58 to 243 kg and 2.71 to 11.36%, respectively. The center proposed seven Murrah bulls out of which four breeding bulls were selected for test mating under XVth Set. The dam's best 305 days milk yield of selected bulls ranged from 2828 in first lactation to 4341 kg.

Bulls for elite mating at the institute herd: The breeding programme in the herd was followed for nominated mating using semen of three Proven Murrah Bulls. About 40 Murrah buffaloes were identified as elite animals. The average lactation milk yield of elite Murrah buffaloes was increased to 3173.22 kg which was 48.89% higher than the herd average. The best lactational milk yield of elite Murrah buffaloes ranged between 2737 kg in first lactation to 4341 kg. Eighty six daughters and eighty four male calves were born in the herd of which 11 and 9 were elite female and male calves, respectively.

Germplasm production and dissemination: The NDRI centre produced 19,878 doses of frozen semen during the period. The centre supplied 7000 doses of frozen semen to other centers. In addition, 5824 doses of semen were supplied to NDRI Field Unit, 4060 doses of semen were

supplied for different research purpose and 11,966 doses of frozen semen to farmers and other dairy development organizations during the period.

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

Network Project on Buffalo Improvement (Field Unit)

A total of 3941 AI were performed in Murrah Buffaloes under field conditions during 2014-15 and as a result 52.27 % conception rate was obtained. Across the villages, the highest conception rate was observed in Rindal (55.65%) and lowest was observed in the village Kheri-Mansingh (46.85%). A total of 1860 (955 male and 905 female) Murrah buffalo calves were born in the farmers' herds and performance data on 183 daughters recorded for evaluation of bulls under field conditions. Sixteen breeding bulls belonging to the 14th and 15th set were used for AI during the year.

Cytogenetical screening of pre-pubertal cattle, buffaloes and goats for early detection of reproductive disorders: Breedable females were examined to assess prevalence of reproductive problems and cytogenetic screening in Sahiwal, Karan Fries and Murrah breeds of cattle and buffalo, respectively. Incidence of reproductive problems in cows and heifers was recorded over a period of five years (2009-2013). The incidence of reproductive anomalies was found minimum in Sahiwal heifers and cows as compared to Karan Fries cattle and Murrah buffaloes. A total of 180 available breedable females (reproductively normal and abnormal), were cytogenetically screened. FISH was performed on chronic cases with reproductive disorders and cytogenetically abnormal animals. Conventional cytogenetic screening revealed numerical anomalies viz., autosomal mosaicism and Turner's syndrome. Two types of cell lines 60, XX (83.5% cells) One KF heifer and 61, XX+16A (16.5%) were observed in one KF heifer. Three cell lines 49, XX- 11A (16.7% cells), 50, XX (76.7% cells) and 51, XX+11A (6.6% cells) were observed in one Murrah female. Another Murrah animal showed XO condition with chromosomal configuration 49, XO in 100% metaphase plates. Structural anomaly such as autosomal translocation was also recorded in 100% of metaphase plates in one Sahiwal animal. Frequency of gaps and breaks were significantly ($P<0.01$) different between abnormal and normal (control) animals. Percent incidence of fragile sites was found at a much higher level in reproductively abnormal animals as compared to normal breedable females. Occurrence of structural and numerical anomalies in animals was found to be related with various reproductive problems such as anoestrus, irregular heat cycle, abortions and repeat breeding. It is concluded that there is a need to identify the incidence of these reproductive problems through cytogenetic screening along with molecular cytogenetics in routine for augmenting reproduction and hence the economic status of the farm. The breeding animals encounter various reproductive problems, which cause a major loss to farms and farmers. It was inferred that karyotyping of all the young calves, breedable animals would facilitate an early detection of reproductive anomalies in cattle and buffaloes.

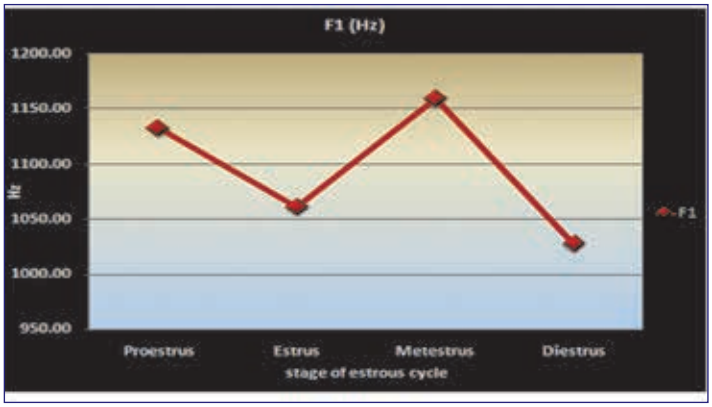
LIVESTOCK PRODUCTION AND MANAGEMENT

Development of State-of-the-art Dairy Production Systems Using Better Housing and Fertility Management Practices, Climate Change and its Impact on Livestock Production

Identification of individual dairy animals by vocal signatures: Murrah buffaloes could be differentiated from one another with an overall average accuracy of (94.50%, k= .937, 100% training data) and (74.21%, k = 0.7037, 67:33 training data). The values of acoustic features like; formants, number of pulse, number of period, degree of voice breaks and mean noise to harmonic ratio differed significantly for all the adult individuals of buffalo. Hence these acoustic features might be the best one to be utilized in individual identification through vocalization pattern recognition technique.

Identification of different physiological conditions of animals using acoustic features: Acoustic features of voice are very useful to differentiate the various stages of estrous cycle in dairy animals. Among all the acoustic features, call duration, total energy, mean pitch, mean intensity and formants (especially F1) are important voice which unfold

the variation in voice signals of different phases of estrous cycle. Reproductive hormones (E_2, P_4 and LH) showed positive and negative correlation with different acoustic features of voice, which helped in selecting the best acoustic features of voice to be utilized for estrus detection in dairy animals.



Formants F1 (Hz) trend of voice signals during different stages of estrous cycle in Murrah buffaloes

Effect of feed energy levels on puberty, sexual maturity and semen quality in buffalo bulls: Effect of feeding different energy levels on age at puberty, sexual maturity and semen quality was studied in Murrah buffalo bulls. For the study, eighteen male calves at an average age of ~ 6 month and body weight of 90 kg were taken from the institute herd. Three groups were formed with six animals in each group. One group was kept as control and fed as per NRC(2001)/ICAR recommendations of feeding of buffalo males. Second and third group were also fed as per the control plus 10% and 20 % extra energy, respectively. The extra energy in the feed of higher energy groups was supplied through molasses. Daily feed intake was recorded of all the bulls throughout the study. Monthly body weight, measurement of scrotal circumference and blood sample collection for the estimation of testosterone of all the bulls were performed. Sexual behaviour in terms of number of mounts made by each bull during training of semen collection and then reaction during semen collection were recorded. Weekly semen collection and semen freezing were performed as per the routine standard procedure for buffalo semen freezing. Semen quality of each ejaculate was evaluated by assessing the ejaculate volume (ml), sperm concentration (m/ml), viability (%), acrosome integrity (%) and abnormality (%) of fresh semen; and per cent sperm motility, viability and acrosome integrity of frozen semen sample of every bull.

Results obtained in this study revealed that bulls started mounting at an average age of 15.4, 14.2 and 14.2 months with the body weight 260, 261 and 276 kg and scrotal circumference 20.3, 20.1 and 20.6 cm in control, 10% HE and 20% HE groups, respectively. The bulls acquired mating ability (detachment of penis from the sheath) at average age of 18.8, 17.6 and 19.2 months in control, 10% and 20% energy groups, respectively. The age at which the bulls donated semen first time (age at first ejaculation) in AV was 20.4, 18.4 and 19.3 months with body weight 350, 356 and 364 kg and scrotal circumference 23.6, 24.0 and 25 cm in control, 10% and 20%HE groups, respectively. Bulls across the groups attained sexual maturity in terms of the ejaculate volume (~2 ml) and sperm concentration (>500 m/ml) ~ 19-21 months of age and sperm motility (~60%) and freezability (~50% sperm motility) at ~22 months of age. Though the ejaculate volume among the groups was higher in the bulls with 20% HE energy than the 10%HE and control but sperm concentration per ml was found to be higher in 10% HE than the control and 20% HE. Sperm abnormality was found to be higher in the 20%HE group than the 10%HE and control. It can be concluded from this study that bulls which were provided with 10% HE started mounting, attained mating ability, donated semen and attained sexual maturity earlier than the bulls of 20% HE and control. Interesting information that emanated from the study was that the semen from Murrah buffalo bulls can be obtained as early as at 18-19 months of age.

Performance and behaviour of dairy animals under a model loose housing system: An existing loose cattle shed meant for housing 20 cows/ buffaloes was modified by increasing the height of the shed from present 10 ft to 15 ft and by increasing the width of the covered area inside the shed from the present 10 ft to 20 ft. A sand bed 6 inches thick was provided both inside covered area and in the open area. The existing elevated manger was replaced with fence-line feeding system. The shed including the open area was made mosquito and fly proof by installing a mosquito net. As a heat stress amelioration measure, timer controlled water foggers were installed with heavy duty pressure blowers for added air circulation.

The performance and behaviour of the crossbred cows housed under the existing shed and the modified shed was evaluated by conducting 2 experiments. One experiment was conducted from January to May and the other from July to December on 16 freshly calved crossbred cows. The 8 cows belonging to one group were housed under the modified cow shed and the other group of 8 cows were housed under the existing shed.

The microclimate, comfort, animal performance and behavioural parameters were studied as per the objectives of the study. The feeding and other management practices were similar in the two groups of cows. The data generated on various parameters of the study were analyzed using suitable statistical techniques and the salient findings obtained are presented here as under:

- The maximum temperature was significantly lower during hot-humid and autumn seasons inside modified shed as compared to the existing shed. During winters and during hot-dry summer months, the maximum temperature was statistically similar inside the existing shed and inside the modified shed. The maximum temperature was brought down by about 6.5°C both during hot-dry and hot-humid seasons inside the modified shed as compared to the open area by these housing modifications which added to the thermal comfort of the animals.

- In hot-dry summer and hot-humid summer seasons the mean THI values were significantly lower in modified shed than that in the existing shed. The mean THI values during winter and autumn months did not vary significantly between the two types of sheds and were lower than 72. However, these values were lower than that in the open area. During hot-dry season, the THI value in the modified shed was close to the threshold value of 72, indicating that the increase in the height and width of the roof and the installation of foggers with pressure fanning was effective in improving the microclimate inside the modified shed to the desired extent.

- The mean cow comfort indices were significantly lower in hot-dry, hot-humid summers as well as during autumn season in cows housed under modified shed as compared to the cows housed under the existing shed. The sand use indices varied from 72.5 during hot-dry summer season to 78.5 during autumn season whereas the sand yard standing indices varied from 5.75 in hot-humid summer to 9.5 during autumn season.

- The mean rectal temperature (RT) and respiration rate (RR) were significantly lower during all seasons in cows housed under the modified shed as compared to the cows housed under the existing shed indicating improved thermal comfort of the cows housed under the modified shed. The mean skin temperature was significantly lower during winter months and significantly increased during autumn months in cows housed under the modified shed.

- The mean plasma cortisol concentrations did not vary significantly during all seasons in cows housed under two types of sheds. However, these values were relatively lower in the cows housed in the modified shed during all seasons.

- The mean daily dry matter intake (DMI) was significantly higher during hot-dry, hot-humid summers and autumn season in cows housed under the modified shed. However, it did not differ significantly between the two groups of cows during winter months.

- The mean daily milk yield was significantly higher in cows housed under modified shed during all 4 seasons.

- The mean daily resting time was significantly higher and mean daily standing time was significantly lower during hot-dry, hot-humid summer months and during autumn months in cows housed under modified shed as compared to the cows housed under the existing shed. The mean daily eating time was significantly higher during hot-humid summer months and during autumn months in cows housed under the modified shed. The increase in resting time, eating time and rumination time and decrease in standing time in cows housed under the modified shed during hot-dry, hot-humid summer and autumn months indicated that the cows were more comfortable as the duration of these behaviours were close to their natural behaviour patterns.

It is concluded from this study that **t**he crossbred cows housed inside modified shed were more comfortable and had improved physiological reactions and behavioural patterns during the hot-dry, hot humid summer and autumn seasons as compared to the cows housed in existing shed. The crossbred cows housed inside modified shed had improved feed intake and productive performance during all seasons as compared to the cows housed in existing shed

Development of management practices for the provision of effective milk let-down stimulus in weaned cows and buffaloes: During the previous year (2013-14) 18 late pregnant Murrah buffaloes were selected and divided into 3 groups and were subjected to 3 treatments. In treatment I (control) the calves were weaned from their dams immediately after birth and were trained manually to drink colostrum as well as milk from a pail. Milk let-down stimulus to the buffaloes was provided by the provision of concentrate mixture and teat

massage before milking. In Treatment II, the calves were allowed natural suckling for milk let-down stimulus at the start of milking and at the end of milking, the calves were again allowed to suckle the required amount of colostrum as well as milk and in treatment III, the calf borne were replaced with a synthetic dummy calf for maternal bonding and the dummy calf was used for provision of milk let-down stimulus at every milking. The data were analysed using suitable statistical techniques during this year (2014-15) and the salient findings obtained are presented as under:

Use of dummy calf for milk let-down

Natural calf suckling for milk let-down

- The overall mean daily colostrum yield, mean daily milk yield and mean milk flow rate were significantly higher in calf suckled and dummy used buffaloes in comparison to weaned buffaloes. The overall mean milk let down time, mean milking time and milking temperament scores were significantly lower in calf suckled and dummy used buffaloes than that in weaned buffaloes. The overall mean SSC in milk and mean CMT scores values were significantly lower in calf suckled and dummy used buffaloes as compared to weaned buffaloes

- The mean blood plasma cortisol concentrations before milking on the day of calving, on 5th, 7th, and 15th day after calving were significantly lower in case of calf suckled and dummy used buffaloes as compared to weaned buffaloes. The mean blood plasma cortisol concentrations on the day of calving, on 5th, 7th, and 15th day after calving after milking were also significantly lower in case of calf suckled and dummy used buffaloes as compared to weaned buffaloes. The mean blood plasma cortisol concentrations in case of dummy used buffaloes on the day of calving, on 5th, 7th, and 15th day after calving were significantly higher after milking as compared to before milking

- Mean daily colostrums intake on the first and second day after calving was significantly higher in case of dam suckled buffalo calves than in case of weaned calves. Mean daily milk intake time and mean daily body weight gain were significantly higher in dam suckled calves as compared to weaned calves. Mean blood serum concentrations of IgG, IgM and IgA on the day of calving, on 2nd, 7th, 28th, 42nd and 56th days after birth were significantly higher in dam suckled calves than in weaned calves. Mean time spent on different abnormal behaviours was significantly higher in case of weaned calves than in case of suckled calves.

It is concluded from this study that the reproductive performance of naturally suckled buffaloes was marginally adversely affected in comparison to weaned buffaloes. The growth performance, the immune status, health and behaviour of naturally suckled buffalo calves was better as compared to weaned calves.

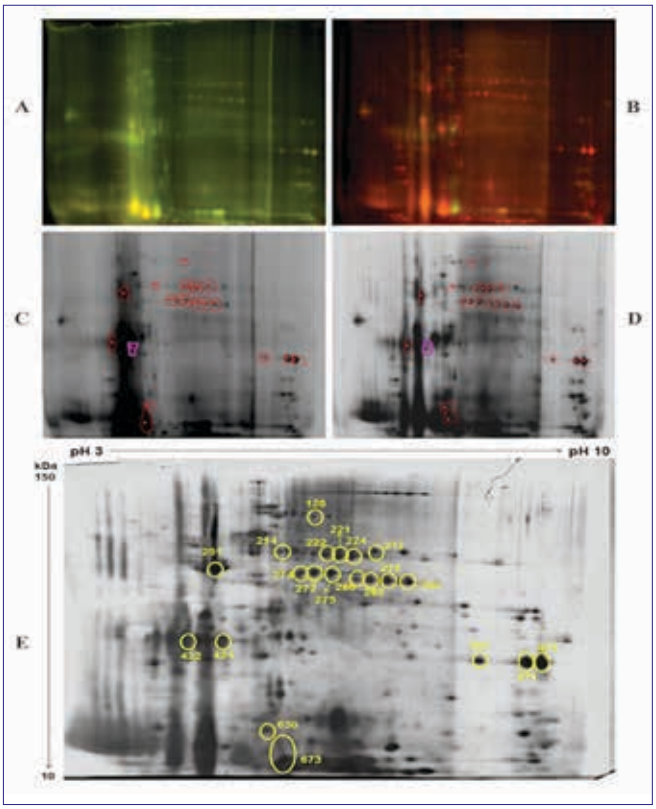
Development of national code of practices for the management of dairy animals in India: This project was undertaken in collaborative mode on consultancy basis with World Society for the Protection of Animals (WSPA) now renamed as World Animal Protection. The project was aimed at generating a comprehensive code of practices for the management of animals in organized commercial dairies in India providing a direction to dairy owners for effective management of animals contributing to sustainability of dairy business.

Under this project a draft code of management practices of dairy animals with respect to breeding, feeding, housing and healthcare management and record keeping was developed. A stakeholder meeting to elicit their views for incorporation in the Dairy Standards was held on 23.8.2014 in which about 35 persons including dairy experts, the Chairman, Animal Welfare Board of India, Government officers, NGO representatives and progressive farmers participated.

The final document "National Standards of Management of Dairy Animals in India" was launched/ released by the Honáble Director, NDRI Karnal and Mr. Mike Baker, Chief Executive Officer, World Animal Protection at a special launch function held at Anand Agricultural University, Anand on 10.10. 2014. The standard dairy animal management practices have been passed on to SAUs, Animal Science Institutes, State Animal Husbandry, Department and Veterinary Council of India for recommending them to the farmers.

Infertility in crossbred bulls: Search for spermatogenic cell markers for early prediction of fertility: The

primary aim was to investigate the proteomic markers in spermatozoa which can predict the fertility status of crossbred bulls. Based on the conception rate, high-fertile and low-fertile bulls were selected, and frozen-thawed spermatozoa from six ejaculates per bull were pooled to analyse the proteome of spermatozoa.



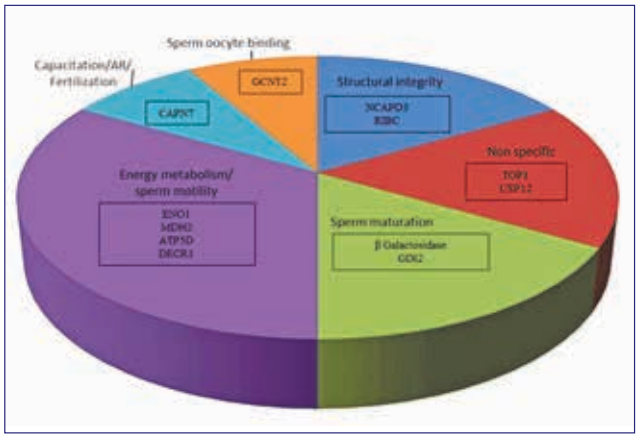
Analysis of sperm proteome by DIGE. [A] Low fertile labeled with Cy3 and high fertile with Cy5. [B] Dye swapped to avoid bias. [C&D] Differentially expressed spots, analysed by DeCyder software. [E] Silver stained preparative gel used for spots identification, differentially expressed protein spots are shown in circles with spot numbers.

To investigate the differentially expressed proteins, DIGE analyses was performed using purified proteins from spermatozoa of high and low fertile bulls. Proteins extracted from high- and low-fertile spermatozoa were labelled using CyDye. Gels were scanned in Image Quant and results were analysed with DeCyder software. The representative DIGE gels showing the overlay of Cy3 and Cy5 images are shown in ***Figure A & B*** and those analysed with DeCyder software and differentially expressed protein spots demarcated in ***Figure C & D***.

An average of 700±15 protein spots were detected in the internal standard gel images. Only matched spots detected on all the internal standard images were considered for DIGE analysis. It was observed that 21 protein spots were differentially expressed between the groups (***Figure 1E***), among which 17 spots were over expressed in high-fertile group and 4 were over expressed in low-fertile group. All the differentially expressed protein spots were identified by MALDI-TOF/MS analysis and found that 12 different proteins were over expressed in high-fertile and 3 proteins were over expressed in low-fertile spermatozoa. After identifying the differentially expressed proteins and their functional classification, some potential proteins were selected from the list for validating as putative fertility markers. Four proteins were selected which were most suitable candidates viz. ENO1, MDH2, ATP5D and PDC-109. To confirm the identity of selected proteins and to find out the correlation between their expression levels with fertility in crossbred bulls, western blot analysis was performed with frozen-semen samples from 18 crossbred bulls with known fertility. Among ENO1, MDH2, ATP5D and PDC-109, the first three proteins were over expressed in high-fertile group and the last one was over expressed in low-fertile group. The relative expression of ENO1 and PDC-109 was found to be significantly correlated with the conception rate in crossbred bulls. It was concluded that ENO1 and PDC-109 may serve as potential panel of markers for determination of fertility of crossbred bulls.

Decrease in sperm energy supply and premature capacitation may be the probable reasons for decreased fertility in crossbred bulls

The GO annotation of differentially expressed proteins in spermatozoa of high and low fertile bulls revealed that with respect to biological process, most of the differentially expressed proteins were involved in cellular process (9) and metabolic process (9). Based on molecular function, many of them were involved in catalytic (9) and biding (8) activities. As per cellular component classification (Supplemental figure 2C), majority of



Sperm specific functional classification of proteins under expressed in spermatozoa of low fertile crossbred bulls compared to high fertile bulls

the differentially expressed proteins were found to be originated from cell (9), organelle (6) and membrane (4). To understand the major functional pathways down regulated in crossbred bulls leading to poor fertility, the proteins under expressed in the spermatozoa of low-fertile crossbred bulls were manually classified based on various sperm specific functions. Majority of the proteins under expressed in low-fertile crossbred bulls were involved in sperm energy metabolism (4), followed by sperm structural integrity (2), sperm maturation (2), sperm oocyte binding (1), and capacitation/acrosome reaction (Figure).

Comparative proteomic analysis of taurine, indicine and crossbred bull spermatozoa for identification of proteins related to sub-fertility in crossbred bulls: Infertility is not a major problem in purebred exotic or purebred indigenous breeds. However, when we cross them infertility is a serious problem in the male offspring. Comparing the sperm proteins in the purebred and crossbred will help us to identify some proteins that might be related to sub-fertility in crossbred bulls. Holstein Friesian (HF; Taurine breed; Bos taurus), Tharparkar (TP; Indicine breed; Bos indicus) and Karan Fries crossbred (KF; HF X TP; 50 to 75% HF inheritance) bulls were utilized for identification of proteins that might be related to infertility in crossbred bulls. The proteomic profiles of spermatozoa from these breeds were compared by two dimensional difference gel electrophoresis and differentially expressed proteins were identified through mass spectrometry.

There were 17 differentially expressed protein spots in the 2D-DIGE gel of HF vs. KF samples. Among this, nine spots were over expressed in HF and eight spots were over expressed ($p<0.05$) in the spermatozoa of crossbred bulls. The differential expression ranged from 1.2 to 5.9 fold between the groups. Among the total 17 spots, 16 protein spots were identified using MALDI-TOF/MS. The protein adenylate kinase isoenzyme-1 was found to be highly over expressed (5.9 fold) in KF bulls compared to HF bulls, whereas 60S ribosomal protein L5 was highly abundant in HF bulls (3.7 fold). The proteomic comparison of Tharparkar and crossbred spermatozoa showed eight differentially expressed protein spots, among which four spots were over expressed ($p<0.05$) in both the groups. The fold change of differential expression ranged from 2 to 2.9 between the groups. Ataxia telangiectasia and Rad3 related protein isoform was highly abundant in KF bulls (2.9 fold) and beta defensin-3 was highly over expressed in TP bulls (2.8 fold). After comparing the proteomic profile of crossbred spermatozoa against both Indicine and Taurine parents, a three way comparison of samples was performed, i.e. HF vs. TP vs. KF using the HF vs. KF and TP vs. KF gels. It was found that 17 protein spots were differentially expressed ($p<0.05$) between the three breeds and the fold difference in expression ranged between 2.3 to 14.6. On identification of the differentially expressed proteins, spot numbers 175 and187 matched to same protein, sperm inner acrosomal membrane protein IAM38 whereas spots 249 and 245 were Izumo sperm-egg fusion protein 4 isoform X1 and 233 and 198 were Interferon regulatory factor 4. Overall, 14 proteins were found to be differentially expressed ($p<0.05$) among the three breeds.

Identification of putative fertility markers in seminal plasma of crossbred bulls through differential proteomics: Identification of some potential biomarkers to determine the latent fertility of bulls accurately has long been the interest of researchers. In this study, the proteomic profile of seminal plasma from bulls with varying fertility to identify fertility associated proteins was compared. The proteomic profile of high and low fertile bulls were compared using the technique 2D-DIGE and the differentially expressed proteins were identified using MALDI-TOF/MS. Out of 19 proteins identified to be differentially expressed ($P<0.05$) between high and low fertile bulls, 9 were over expressed in seminal plasma of high fertile bulls and 9 were over expressed in seminal plasma of low fertile bulls. The differential expression ranged from 1.5 to 5.5 fold between the two groups and Protection of telomeres 1 protein (POT1) was very highly expressed in high fertile group and Prostaglandin E2 receptor EP3 (PTGER3) was over expressed in low fertile group. It is inferred that expression of certain proteins in the seminal plasma varied with bull fertility and concurrent comparisons of expression of these proteins and other fertility assays may help in determining bull fertility.

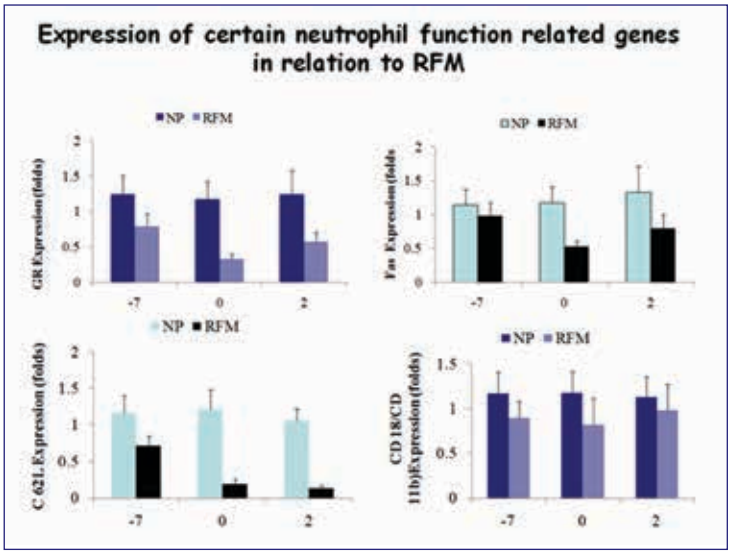
Relationship of blood and seminal plasma testosterone concentrations with semen quality in crossbred bulls: The present investigation was conducted to study the association of testosterone concentrations with semen quality in crossbred bulls (n=8) span. Based on the prior record on ejaculate rejection rate, the bulls were classified into good (n=4) and poor (n=4). A total number of 16 ejaculates were collected from each bull at weekly intervals to study the semen quality parameters. Blood and seminal plasma sample (n=6 per bull) were collected at 15 days interval. Testosterone concentrations were estimated using Bovine ELISA Kit in serum and seminal plasma samples. There

was no significant difference between good and poor bulls in the ejaculate volume. However, the mass activity differed significantly between good and poor bulls (3.19 ± 0.03 Vs. 1.57 ± 0.13). Similarly, the individual motility, viability, membrane integrity and sperm concentration differed significantly (P<0.05) between good and poor bulls. The percentage of spermatozoa with protamine deficiency was significantly (P<0.001) higher in the ejaculates of poor bulls compared to good bulls. The mean ± SE testosterone concentration in blood serum and seminal plasma of good bulls was 4.26 ± 1.38 and 2.13 ± 1.04 ng/ml, respectively while the corresponding values in poor bulls were 7.06 ± 1.50 and 5.71 ± 1.78 ng/ml, respectively. Blood testosterone concentration had significant negative correlation with viability of spermatozoa in good bulls. There was no significant relationship between testosterone concentration and any of the other semen parameters studied.

Management practices to improve semen productivity by mitigating low libido problem in Sahiwal bulls: Analysis of twenty five years data revealed that one of the major reasons of culling of Sahiwal bulls was poor libido (23.12%). To overcome from the problems oestrous specific mucus was applied, which was effective to bring back 6 out of eight poor libido bulls in semen production (75%). In another management intervention through routine exercise, application of halter and same bull handler helped in better sexual expression and reduction of average age of first semen donation of the young bulls (21.3 months).

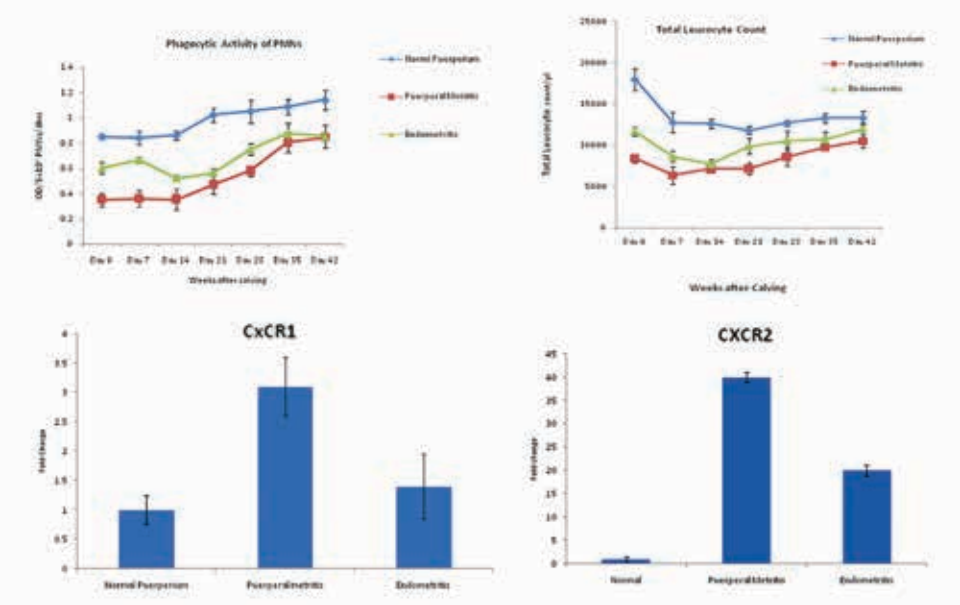
Indicators of retention of fetal membranes and evaluation of preventive/therapeutic regimes for maintaining postpartum fertility in dairy bovine: Peripheral blood concentrations of pro-inflammatory cytokines are altered in cows developing retention of fetal membranes. Retention of fetal membranes (RFM) adversely affects the production and reproduction potential of the affected cows leading to huge economic loss. Since expulsion of fetal membranes is an inflammatory process, the present study compared the concentrations of certain pro-inflammatory cytokines [Interleukin-1β (IL-1), Interleukin-6 (IL-6), Interleukin -8 (IL-8) and Tumor necrosis factor- α (TNF-α)] between the cows that developed RFM (n=10) and the cows that expelled fetal membranes normally (n=10) to find out if they could serve as a predictive tool for RFM. Blood samples were collected from the cows from 30 days before expected parturition through day -21, day -14, day -7, day -5, day -3, day -1, on the day of parturition (day 0), day 1 postpartum and the pro-inflammatory cytokines were estimated in blood plasma using ELISA method. It was inferred from the sudy that the concentrations of pro-inflammatory cytokines were low in the cows developing RFM compared to those expelled fetal membranes normally. This is alteration in cortisol concentrations and expression of certain genes associated with neutrophil functions in cows developing retention of fetal membranes.

The peripheral concentrations of cortisol and expression of glucocorticoid receptor (GR), Fas, CD 62L, CD 18/11b, Caspase 3 and Bcl2 in neutrophils in relation to fetal membranes (RFM) in dairy cows was investigated. Blood samples were collected from 12 crossbred cows (6 normal cows and 6 RFM cows) on 7 ± 2 day pre-partum, on the day of calving and day 2 postpartum. Blood plasma was separated for estimation of cortisol (Using ELISA method) and neutrophils were isolated for gene expression analysis. The cortisol concentrations were significantly (P<0.05) higher on the day of calving and on day 2 postpartum in RFM cows compared to normal cows. On the day of calving, the proportion of immature neutrophils was significantly (P<0.05) higher while the proportion of mature neutrophils was significantly (P<0.05) lower in RFM cows compared to normal cows. The relative gene expression of GR and CD 62L was significantly lower (P<0.05) on the day of calving and on day 2 postpartum in RFM cows in compared to NP cows. It was observed that cortisol concentrations were negatively related to expression of genes related to neutrophil functions, and high cortisol concentrations and altered neutrophil functions were associated with RFM in dairy cows.



Modulation of postpartum reproductive performance through supplementation of long or short chain fatty acids during transition period: Thirty-six cross-bred cows were used to study the effect of long-chain (flaxseed) or short-chain (butyric acid) fatty acid supplementation on metabolic status, ovarian function and reproduction performance during transition period. Control cows received a routine feed of transition diet, while the cows in two treatment groups were supplemented with either 750-g crushed flaxseed or 250 g butyric acid per cow per day. Ovarian activity was monitored by transrectal ultrasonography on 10th, 20th and 30th day post-partum. Results indicated that cows in flaxseed group were in positive energy balance as indicated by lower NEFA and Beta hydroxy Butyrate and higher glucose concentrations. Uterine involution was completed well within 30 days post-partum in all the cows in flaxseed fed group compared to 76.9% in butyric acid supplemented and 61.5% in control groups. The size of dominant follicle and corpus luteum was significantly higher ($p < 0.05$) for flaxseed group compared to control group, which in turn resulted in higher concentrations of plasma progesterone. Cows fed on diets supplemented with flaxseed exhibited post-partum heat earlier and bred sooner ($p < 0.05$) than control cows. It has been noticed that supplementation of flaxseed and butyric acid enhanced involution of uterus, early resumption of cyclicity and thereby early breeding. However, in view of the encouraging results obtained for flaxseed supplemented group, its organic nature and easier availability at farmer's gate, it may be concluded that flaxseed can be safely included in transition diet to modulate reproductive performance of dairy cattle.

Modulation of uterine immunity to prevent postpartum uterine infections in dairy cows: To assess the neutrophils function, total leucocyte count, phagocytic activity of neutrophils were studied during postpartum period i.e. from day of parturition to 42 days after parturition and expression of IL-8 receptors i.e. CXCR1 and CXCR2 were studied on neutrophils on day of parturition using qRT-PCR. A total number of 20 Sahiwal cows were included in the experiment out of which nine animals did not suffer from postpartum uterine diseases and undergo normal involution, whereas six animals suffered from puerperal metritis and five animals suffered from endometritis. Cows that developed puerperal metritis within 10 days of parturition and endometritis 21 days onwards had lower ($P<0.05$) TLC, phagocytic activity during initial period of postpartum i.e. day of parturition to day 21 postpartum in comparison to cows those had undergone normal puerperium. IL-8 receptors i.e. CXCR1 and CXCR2 m-RNA expression on neutrophils surface on the day of parturition was 3 fold and 20-40 fold lower ($P<0.05$) in cows that later on developed puerperal metritis and endometritis in comparison to cows that have undergone normal puerperium. Since a clear cut difference in neutrophils functions during early postpartum period in cows that did and didn't develop uterine infections later on was observed, hence, modulating the uterine functions during peripartum period might help in reducing the occurrence of postpartum uterine infections.



Expression of CXCR1 and CXCR2 on neutrophils surface on the day of parturition in cows

Genetic Improvement of Milch Animals through Identification and Dissemination of Superior Germplasm by Application of Emerging Reproductive and Molecular Technologie

A Cloned Buffalo Bull Produced from Frozen Thawed Semen

A male cloned calf named '**Rajat**' produced through 'Hand-guided Cloning' was born on July 23, 2014 by normal parturition. Its weight at the time of birth was 32.0 kg. The calf is a clone of a highly-ranked progeny-tested Murrah buffalo bull (MU-4393), which had died many years back. The donor cell was isolated from the frozen-thawed semen of this bull born on December 10, 1995. This bull had ranked 'first' in 5th set of All India Progeny-testing Program and had 22.29% superiority. This technology could be useful in multiplying the best bulls and meet their demand in the country.

Rajat

Production of Wild Buffalo (*Bubalus arnee*) Calf through Inter-species Cloning

A cloned wild buffalo female calf named '**Deepasha**' was born on December 12, 2014 by normal parturition. Its weight at the time of birth was 32 kg. Deepasha is a clone of a wild buffalo named '**Asha**', the only wild-buffalo in Chhattisgarh in semi-captivity. An *in-situ* breeding programme to save wild buffaloes from becoming extinct is going on for the past five years at Udanti. Chhattisgarh's state animal, known locally as 'Ban Bhainsa', is similar to Bhainsa in appearance but is a different species. Wild buffalo is in the Red List of International Union for Conservation of Nature (IUCN). It is also a Schedule I animal under the Wildlife Protection Act 1972.

Deepasha

A Cloned Calf Produced from Somatic Cell isolated from Urine

A female cloned calf named **'Apurva'** was born on February 5, 2015. The calf was born by normal parturition, and its weight at the time of birth was around 37 kg. The calf is clone of an elite Murrah buffalo (MU-5345) of NDRI Livestock Farm. Earlier **'Lalima'** was produced from the same buffalo. In this case the donor cell was isolated from urine of the donor animal. This is the first report in the world across the species in which cloned embryos have been produced using somatic cells isolated from urine.

Apurva

A Cloned Calf Produced from an Adult Murrah Buffalo

A female cloned calf named '**Lalima',** produced through 'Hand-guided Cloning, was born on May 2, 2014 by normal parturition and its birth weight was 36 kg. It is a clone of an elite Murrah buffalo (MU-5345) of NDRI Livestock Farm. The donor cell was taken from the ear tissue of MU-5345, which produced 2713 kg milk in standard lactation period of 305 days and 3494 kg in total lactation period of 471 days, during her 3rd lactation.

Lalima

Birth of 'Karishma', another Calf from Garima-II, A Cloned Buffalo

Garima II, a cloned buffalo produced using embryonic stem cell as donor cell, which was born on August 22, 2010, delivered the second calf, a female named '**Karishma**', on December 27, 2014 through normal parturition with a birth weight of 35 kg. Garima-II was inseminated with frozen-thawed semen of a progeny-tested bull No. 5258 of NDRI's Livestock Farm on February 27, 2014, which resulted in conception. Later, a female buffalo calf '**Mahima**', which was the first ever calf from a cloned buffalo, was born to 'Garima-II'.

Karishma

Development of Buffalo Trophoblast Cell Lines for Cloning

Trophectoderm (TE) cells were isolated from IVF-derived hatched blastocysts or Hand-made cloning (HMC)-derived cloned blastocysts and were established on fetal fibroblast feeder layer or MaxGel ECM coated dishes under feeder-free conditions. TE-IVF and TE-HMC cell lines could survive for 41 (>450 days) and 36 passages (>390 days), respectively. TE cells at passage >5 were characterized by examination of expression of TE-specific markers. It was concluded that i) just as from IVF blastocysts, TE cell lines can be derived from SCNT and parthenogenetically produced blastocysts, ii) although TE cells derived from SCNT embryos have capability to grow in culture similar to that of cells from IVF embryos, significant differences exist in the gene expression levels between the two types of embryos and between the TE cells derived from them, which may have a role in the placental abnormalities associated with SCNT pregnancies, iii) a feeder-free *in vitro* culture system was developed, which enabled long-term culture of TE cells derived from both IVF and SCNT buffalo embryos, iv) TE cells can be used as donor cells for the production of blastocysts by HMC. However, their developmental competence and quality is lower than of blastocysts produced from fetal or adult fibroblasts, v) the epigenetic status and expression of many important genes is different in blastocysts produced using TE cells and those produced using fetal or adult fibroblasts or those produced by IVF, vi) BCB+ oocytes had developmental competence and quality higher than that of BCB- oocytes and comparable to that of IVF blastocysts suggesting that BCB staining can be effectively used for selection of developmentally competent oocytes for HMC.

Transgenesis

For production of transgenic buffaloes expressing recombinant human insulin protein in milk, human pro-insulin cDNA was cloned from its genomic DNA and mutated by overlap extension PCR to introduce furin consensus cleavage sequences (Arg-X-Lys-Arg). For mammary gland-specific human insulin expression, buffalo beta lactoglobulin promoter (3.9 kb) and 3'UTR (1.5 kb) were cloned into pAcGFP-N1 vector and named pAcISUBC. Expression vector was transferred into a BuMECs and human insulin (hINS) expression was detected by RT-PCR, Immunocytochemistry, Western Blotting and ELISA. Buffalo female fetal fibroblast cells (BFF) at passage 5 was transfected using GFP tag human insulin plasmid

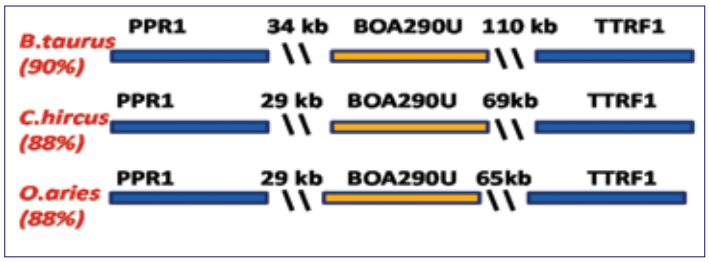
(pAcISUBC) by nucleofection and cultured with G418 for 3 weeks to obtain positive transgene cell clones. Transgene integration into BFF genome was confirmed by southern blotting. Transgene integrated cells were used as a nuclear donor to construct embryos by Hand-made cloning technique. Reconstructed embryos derived from transgenic cells could successfully develop into blastocysts at day 8 of culture; about 64 % of them were found GFP-positive.

In another study aimed at generating lactoferrin-expressing transgenic buffaloes, expression vectors of hLF were constructed under different caprine mammary gland specific promoters viz. α-casein, β-casein and α-lactoglobulin. cDNA of hLF gene (2259bp) was cloned downstream using promoter regions of i) β-casein (6500bp and 3500bp), ii) α-casein (5270bp and 2970bp) iii) BLG (2700bp and 2100bp). These different promoters were assayed by luciferase assay system to identify the most active promoter. The translation initiation codons of 5′ flanking regulatory fragments were mutated from ATG to AAG. Further, hLFcDNA and modified promoter fragments were combined through restriction digestion and ligation and cloned into pAcGFP1-1 vector. The developed vectors were accordingly renamed as pBCL1/2, pACL1/2 and pBLG1/2, for expressing hLF under beta-casein, alpha-casein and BLG promoter regions, respectively. These developed vectors were subsequently transfected into goat mammary epithelial cells. The transfected cells were further selected using G418 selection method and positive clones were generated.

Genomics

Unique Non-coding RNAs Identified in Buffalo Oocytes

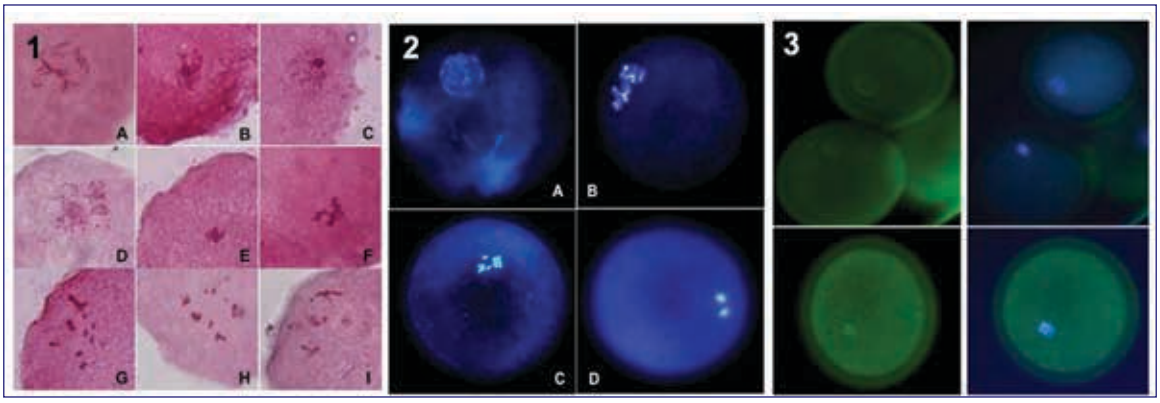
Construction of a buffalo oocyte specific subtracted cDNA library has raised fresh challenges of defining the importance of unknown preferentially oocyte expressed transcripts. From this library four ESTs were selected and their full length sequence was generated using 5′ and 3′ RACE. Bioinformatic analysis of these sequences revealed their weak coding potential and possibility of non-coding RNAs. Predicting their possible protein functional domains on pfam, smart and supfam databases presented no apparent similarity and concluded these as non-coding sequences. One of the sequence (BOA290U) having four transcript variants revealed protein binding characteristics and was interestingly found to be intergenic at specific positions across different species. Further, the differential expression pattern of this RNA in oocytes of differential development ability, classified based on Brilliant Cresyl Blue (BCB) staining, showed consistent increased expression from 0 to 24 Hrs in BCB+ oocytes relative to BCBoocytes. Other three sequences viz. BOB182U, BOD176U and BOE283N also revealed wide expression variations in high and low competent oocytes. Together, it hints at the possibility of non-coding RNA mediated transcriptional control in oocytes which could be crucial for determining their development competence.



Similarity of the unique long non-coding RNA identified in buffalo oocytes and its location at intergenic region across the species

Synchronizing the Buffalo Oocytes for Germinal Vesicle Break Down (GVBD)

GVBD marks the first significant event towards successful completion of meiosis in oocytes. The immature buffalo oocytes was subjected to a two-step culture system, first in the presence of a GVBD inhibitor like Roscovitine and Cilostamide followed by maturing them in GVBD inhibition free medium. Nuclear maturation was assessed after 24 hrs by Aceto-orcein and Hoechst staining. Results showed that Roscovitine at a concentration of 100 µM alone or in combination with Cilostamide 30 µM could hold majority of the oocytes under meiotic arrest at 24 hrs of culture. Holding oocytes for meiotic arrest for 24 hrs did not affect their developmental ability. For *in vitro* maturation (IVM) of the oocytes post meiotic arrest withdrawal; activators of PI3K/ Akt pathway were added in IVM medium with the idea that an over expressed Akt will help meiotically inhibited oocytes to undergo GVBD while favoring cell survival by preventing apoptosis. Supplementing IVM medium with SC-79 (synthetic compound), an Akt activator, resulted in improved development rate of oocytes as compared to control (not GVBD inhibited). Further, it was observed that a reduced GV retention time of 6 hrs (instead of 24 hrs) followed by IVM in SC-79 supplemented medium at the rate of 10 µg/ ml resulted in substantial improvement of the cleavage and blastocyst rates.



Three alternate methods of characterizing the GVBD event in oocytes. 1. Aseto-orcein staining 2. Hoechst staining and 3. Anti Lamin-DAPI staining. Method 3 was found to be a highly authentic and reproducible one

Innate Immunity in Indian Cattle (*Bos indicus*) and Buffalo (*Bubalus bubalis*)

Buffalo RIG1 and MDA5 genes were investigated to understand the mechanism of receptor-induced antiviral response. Sequence analysis revealed that RIG1 and MDA5 maintain a domain arrangement that is common in mammals. Critical binding site residues of the receptors are evolutionary conserved among mammals. Molecular dynamics simulations suggested that RIG1 and MDA5 follow a similar, if not identical, dsRNA binding pattern that has been previously reported in human. Moreover, binding free energy calculation revealed that MDA5 had a greater affinity towards dsRNA compared to RIG1. Constitutive expressions of RLR genes were ubiquitous in different tissues without being specific to immune organs. Poly I:C stimulation induced elevated expressions of IFN- b and IFN-stimulated genes (ISGs) through interferon regulatory factors (IRFs) mediated pathway in buffalo fetal fibroblast cells.

Expression of Heat Shock Factors (HSFs) in Buffalo (*Bubalus bubalis*)

The heat shock factors (HSFs) are recognized as master regulator of heat shock responses in mammalian species. The four major heat shock factor genes viz. HSF-1, 2, 4, and 5 were studied in Buffalo. The buffalo HSF genes showed domain architecture similar to other mammalian species. The transcript level of HSF-1 gene was found up-regulated in months of high and low ambient temperatures. In contrast, the expression of HSF-4 and 5 genes were found down-regulated in months of high ambient temperature. This suggests that the intricate balance of different HSFs is adjusted to minimize the effect of seasonal changes in environmental conditions.

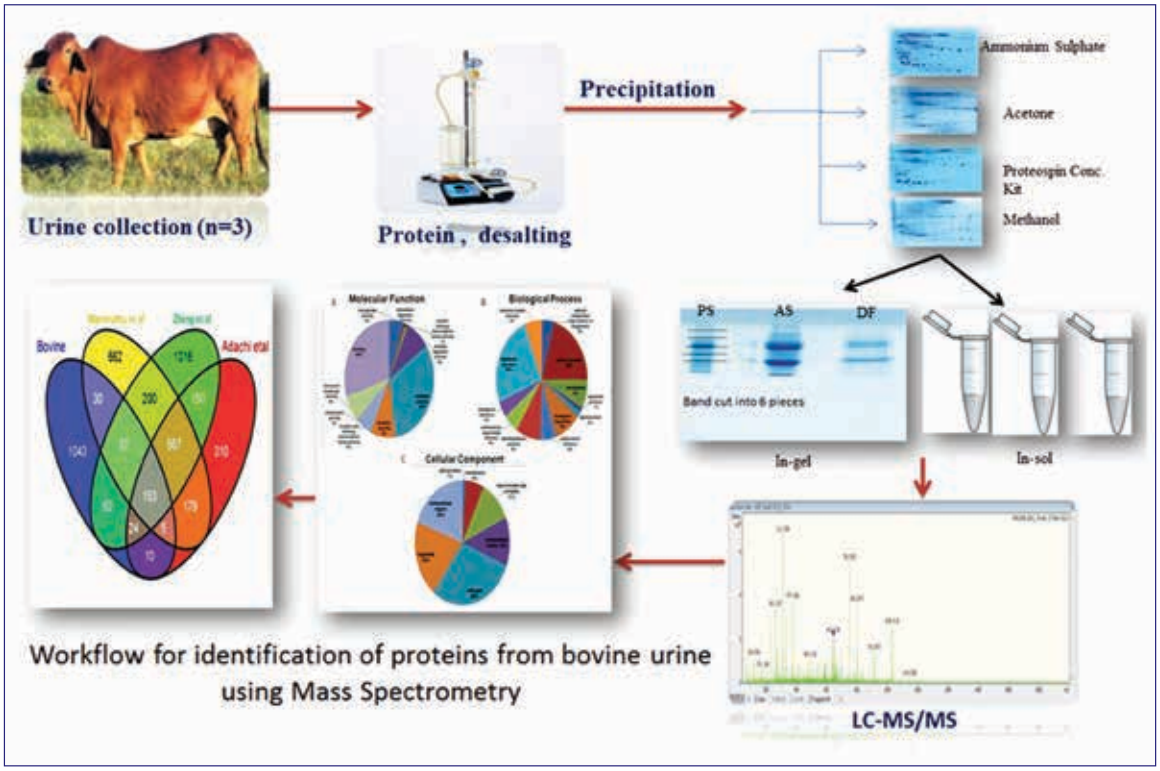
Functional Characterization of Milk Fat Globule Membrane Epidermal Growth Factor 8 (MFGE-8) in Buffalo Mammary Epithelial Cells

- Milk fat globule epithelial growth factor8 (MFG-E8) was functionally characterized in buffalo mammary epithelial cells. For this, the RNA was isolated from the buffalo mammary epithelial cells (BuMECs) followed by preparation of MFGE-8 cDNA and its cloning into pJET vector and sequenced. Buffalo MFG-E8 constituted 1293 nucleic acids representing 431 amino acids. To study the function of MFGE-8 genes, shRNA of MFGE8 was cloned into pKLO.1-Puromammalian expression vector which was transfected into BuMECs. MFGE-8 was knocked down to the extent of 64%. Due to the knockdown of MFGE-8 gene changes were observed in cell viability and cell proliferation in BuMECs. Majority of the BuMECs lost their cell shape and aggregated into undefined masses. It was concluded that MFGE-8 is essential for maintenance of cell shape and morphology during lactation in farm animals.

Profiling of Cow Urinary Proteins Using Various Extraction Methods Reveals more than 1550 Proteins

Urine can be used in diagnosis of different diseases including cancer and other patho-physiological conditions. Three methods i.e., ammonium sulphate precipitation, ProteoSpin column and diafiltration were used for extraction of proteins from urine for identification of urinary proteome. The tryptic peptides generated after In-gel and In-solution method were identified using LC/MS/MS (ESI-qTOF), which resulted in identification of 1582 proteins. In-gel trypsin digestion method

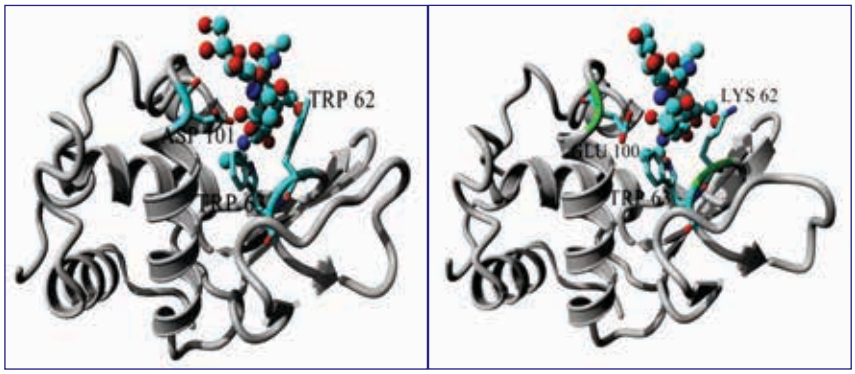
revealed more protein (1191) in comparison to in-solution digestion method (541). Maximum proteins were identified in ammonium sulphate precipitation method (938) followed by ProteoSpin (606) and diafiltration (444) methods, respectively. The profile of the identified proteins was compared with human urinary proteome of which 311 bovine urinary proteins matched with human. An exclusive list of 38 bovine urinary proteins with high protein scores were listed which are absent in human urine. All identified proteins were analyzed according to Gene Ontology which were classified according to cellular component, biological processes and molecular functions. This study reports for the first time an exclusive evidence of more than 1550 proteins in urine of healthy cow donors.



Workflow for identification of proteins from bovine urine using Mass Spectrometry

Recombinant Sperm Acrosome Associated 3 (SPACA3) Protein of Buffalo Arrested Early Development of Buffalo Embryos

Presence of SPACA3 protein was demonstrated in the buffalo sperm proteome. SPACA3 gene was cloned and expressed. Recombinant buffalo SLLP1 was found to inhibit sperm-oocyte interaction and development of growing embryos. Fertilization was inhibited by 43%, while morula and blastocyst formation was inhibited by >80% in comparison to controls. Chicken egg white lysozyme did not show any additional effect at these stages except the minor decrease in fertilization that was commensurate, with decrease in the rate of morula and blastocyst formation. The mammalian oocytes present various glycan moieties including N-acetylglucosamine (NAG), which might serve as ligand for interaction with SLLP1 present on sperm and facilitate sperm-oocyte



Structural Models of Buffalo SLLP1 with Tri-NAG (left side)

Model on right side shows X-ray structure of chicken egg white lysozyme bound with Tri-NAG (PDB ID: 1LZB). The secondary structures of models are shown in gray and Tri-NAG molecule is shown in ball and stick style shown in elemental colours. The amino acid residues shown and labelled are those involved in direct substrate binding in the two complexes.

binding. The binding of buffalo SLLP1 with chitin, which is a polymer of NAG, was also observed. The *in silico* analysis indicated the interaction of tri-NAG with buffalo SLLP1. These results suggested recruitment and evolution of SLLP1 in testis for highly specialized function like sperm-oocyte interaction. Additionally, the results suggested that SLLP1 at high concentration might also interfere with the subsequent cleavage process after first cleavage.

In vitro Culture of Functionally Active Buffalo Hepatocytes

A simple method was developed for isolation and short-term culture of functionally active buffalo hepatocytes. Buffalo hepatocytes were isolated from caudate lobes by using manual enzymatic perfusion with 50 ml sterile syringe and mechanical disruption of liver tissue. Hepatocytes yield was $(5.3 \pm 0.66)\times10^7$ cells per gram of liver tissue with a viability of 82.3 ± 3.5%. Freshly isolated hepatocytes were spherical in shape with well contrasted border. After 24h of seeding onto fibroblast feeder layer and different extracellular matrices like dry collagen, matrigel and sandwich collagen coated plates, hepatocytes formed confluent monolayer with frequent clusters and exhibited typical cuboidal and polygonal shape with restored cellular polarity. Cells expressed hepatocyte-specific marker proteins like albumin, hepatocyte nuclear factor 4α, glucose-6-phosphatase, tyrosine amino transferase, cytochromes, cytokeratin and α antitrypsin. Hepatocytes could be immunostained with anti-cytokeratins, anti-albumin and anti-α antitrypsin antibodies. Abundant lipid droplets were detected in the cytosol of hepatocytes using oil red stain. In the *in vitro* culture system, hepatocytes could be grown for five days and maintained for up to ten days on buffalo skin fibroblast feeder layer.

Recombinant Mucus Binding Protein (Mub) and S-layer Protein (Slp) of Lactic Acid Bacteria Showed Binding with Human Gut Tissue and Gut Cell Lines

Recombinant mucus-binding protein (Mub) and S-layer protein (Slp) were expressed in *E. coli*. The recombinant proteins were allowed to bind with human intestinal tissue and cell lines. Binding sites were localized by antisera against the recombinant fusion protein. The intestinal cells projecting inside the lumen were completely stained with recombinant proteins. The expressed and purified adhesion protein Mub was observed to have good adhesion to purified Mucin type-III, crude rat intestinal mucus, human intestinal tissue sections and human intestinal carcinoma cell lines (HT-29 and Caco-2). These results suggested that recombinant surface proteins of lactobacilli could bind with gut tissue/cell line and might possibly compete with pathogen leading to their faster clearance from the gastrointestinal tract.

DAIRY CATTLE PHYSIOLOGY

Development of State-of-art Dairy Production System

National Initiative on Climate Resilient Agriculture (NICRA)

Expression of HSP 27, 90 and 105 Genes in Peripheral Blood Mononuclear Cells during Thermal Stress in Tharparkar and Karan Fries Calves

Results of *in vivo* and *in vitro* study showed significantly (P<0.05) higher expression of HSP 27, HSP 90 and HSP 105 genes in both the breeds at 44°C. During *in vivo* study the expression of HSP 27, HSP 90 and HSP 105 increased by10.84, 8.02 and 3.94 folds, respectively in Tharparkar, whereas, the respective values in Karan Fries increased by 10.82, 14.42 and 39.09 fold at temperature 44°C compared to 25°C. *In vitro* study indicated an increase in HSP 27 expression by 2.39 and 5.11 fold; HSP 105 by 1.45 and 8.70 fold at 44° C than at 38°C in Tharparkar and Karan Fries, respectively. The expression of different HSPs was significantly higher (P< 0.05) in Karan Fries than Tharparkar. The study indicated that Karan Fries calves were less heat tolerant than Tharparkar calves.

The physiological responses (RR, HR, RT, ST) increased significantly at 44°C in both the breeds and the values differed significantly (P<0.01) from the values recorded at 10°C and 25°C. The increase in RR, RT, HR, and ST was higher in Karan Fries than Tharparkar. The haematological responses were significantly higher at 44°C in Karan Fries than Tharparkar.

RBCs, haemoglobin and haematocrit increased significantly (P< 0.05) in both Tharparkar and Karan Fries at 44°C. No significant differences were observed in cortisol, GH, prolactin and thyroid hormones at 10°C and 25°C but their levels were significantly different at 44°C than 10°C and 25°C. T_4 decreased significantly (P<0.01) in both breeds at 44°C compared to10°C and 25°C. The alterations in physiological, haematological and hormonal responses were significantly different between the two breeds, thus indicating that Karan Fries are more sensitive than Tharparkar to heat stress.

Dynamics of HSPs and Interleukins in Peripheral Blood Mononuclear Cells Subjected to Heat Stress and Zn Treatment in Karan Fries and Sahiwal Cows during Transition Period

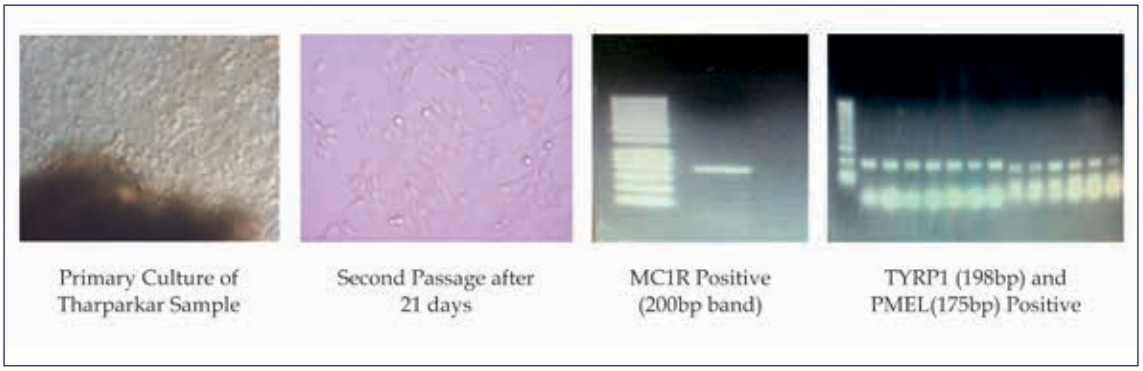
The mRNA expression of HSP 40, 70 and 90 was significantly (P<0.05) higher in heat exposed Karan Fries and Sahiwal cows compared to their respective control groups. The fold increase of mRNA 40, 70 and 90 at 42°C with respect to the reference values (37°C) were 8-10, 7.5-15.6 and 5-10, respectively. The expression of HSPs was significantly higher (P<0.05) in KF than Sahiwal cattle irrespective of exposure temperature and transition period. The expression of mRNA HSP 90 α was highest on the day of calving in both the breeds at all the exposure temperatures. The highest concentration of HSP 70 (14.95 ± 0.83 ng/ml) was recorded in KF on the day of calving at 42°C. Supplementation of Zn reduced HSPs expressions 2-3 times in both breeds exposed at 42°C. Interleukin-6 (IL-6) concentrations were significantly higher in KF (218.57 ± 1.57 pg/ml) than Sahiwal (198.43 ± 13.68 pg/ml). Zn treatment significantly decreased the concentrations of Interleukins. The significant decrease in HSPs expressions and interleukins concentration by Zn supplementation indicated a possible role of Zn in reducing heat stress.

Studies on Physiological vis-a-vis Genetic Adaptation to Thermal Stress in Cattle

This study was conducted in Tharparkar and Karan Fries heifers with different hair coat and skin colour. The physiological responses were significantly (P<0.01) higher in Karan Fries than Tharparkar heifers during summer. Blood pCO_2 was significantly (P<0.05) lower during summer than winter in both breeds. The plasma cortisol was significantly (P<0.01) higher during summer than winter in both the breeds but the increase in cortisol was significantly (P<0.05) much higher in Karan Fries than Tharparkar heifers. T_3 and T_4 were significantly (P<0.01) higher during winter than summer in both the breeds. Tyrosinase (essential enzyme for skin pigmentation) was significantly (P<0.01) higher during winter than summer in both the breeds. MC1R and PMEL (genes responsible for skin pigmentation) were highly (P<0.01) expressed during winter than summer in both breeds. The expression of these genes showed negative correlation (P<0.01) with heat stress. The variations in recorded observations and higher expression of genes indicated that the higher pigmentation in Tharparkar compared to Karan Fries cattle is a thermo adaptability character in indigenous cattle.

Isolation and Characterization of Melanocytes

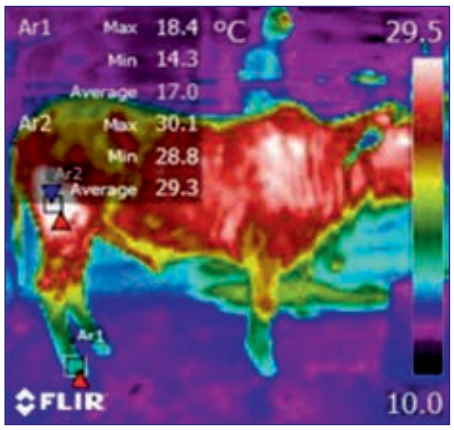
Melanocytes isolated from tissue samples of Tharparkar cattle were found to be DOPA positive indicating the presence of tyrosinase enzyme. Microscopic studies revealed the formation of melanin in melanocytes. Molecular Characterization of these cells also indicated that the cells were positive for coat color related genes MC1R, TYRP1, PMEL.



Primary Culture of Tharparkar Sample | Second Passage after 21 days | MC1R Positive (200bp band) | TYRP1 (198bp) and PMEL(175bp) Positive

Thermal Profiling of Sahiwal Cattle during Winter Season

Thermal image analysis of Sahiwal cow at different anatomical sites revealed that body surface temperature and blood flow varied with change in ambient temperature, humidity and UV index. Ear and lower extremity of legs showed the lowest temperature during winter season. The results of the study will help to develop the relationship between body surface temperature, skin blood flow, skin characteristics with changes in climatic variables.



Studies on Blood flow in Zebu and Crossbred Cattle

The skin blood flow in Sahiwal, Tharparkar and Karan Fries cattle at different body sites was measured using Peri Med during summer and winter season. The skin blood flow was significantly higher in Sahiwal and Tharparkar than Karan-Fries cattle during summer as well as winter seasons. Blood flow differed significantly at dorsal, abdominal and middle ear in zebu and crossbred cattle indicating better thermo-adaptability of indigenous than crossbred cattle particularly during summer.

Effect of Thermal (Summer and Winter) Stress on Milk Plasminogen-plasmin and Hormones in Lactating Murrah Buffaloes

Mist and fan cooling during hot dry and hot humid conditions significantly ($p<0.05$) reduced physiological responses, milk plasmin, cortisol, norepinephrine levels and increased milk yield in both the seasons suggesting a beneficial effect of this practice. Milk plasminogen, β-casein and plasma glucose levels also increased concomitant to increase in milk yield. During winter paddy straw bedding reduced ($p<0.05$) physiological responses, milk plasmin, cortisol levels and increased milk plasminogen and β-casein. Plasma GH levels varied between 1.82 to 2.3 ng/µl in lactating Murrah buffaloes yielding > 10 kg of milk/day. Plasma prolactin and ghrelin level showed diurnal variation during the 12 hours of sampling. Epinephrine administration @1 µg/ kg body weight/day in lactating buffaloes significantly reduced milk yield ($P<0.05$), but no effect was observed in milk composition, plasminogen, β-casein and calcium concentration indicating that elevated catecholamine in blood had no effect on milk synthesis but were inhibitory to milk secretion.

Molecular Basis for Modulation of Immune-Competence of Neutrophilic Function *In Vivo* and *In Vitro* of High Producing Cows and Buffaloes

Both blood and milk polymorphonuclear neutrophils (PMNs) were isolated to evaluate the neutrophil dynamics in relation to mastitis. The results indicated significantly ($p<0.05$) higher somatic cell count (SCC), phagocytic activity (PA) in milk of clinic mastitis (CM) cows compared to sub-clinic mastitis (SCM) and control cows. Significantly lower ($p<0.05$) apoptosis was observed in PMNs isolated from both blood and milk of CM group compared to control and SCM group. The milk neutrophils of CM group of cows formed neutrophil extra-cellular traps (NETs) as evidenced from the scanning electron microscopy (SEM) images. Surface expression of CD 44 revealed a significantly ($p<0.05$) lower expression in milk neutrophils of CM group compared to SCM and control group of cows. The study indicated a positive correlation between delayed neutrophil apoptosis, persistent staying of neutrophils at the site of infection alongwith formation of NETs as the strategies to fight against the pathogens in the udder during *Staphylococcal* mastitis.

Augmentation of Growth in Murrah Buffaloes with Fermented Yeast Culture Supplementation

Female Murrah buffaloes supplemented with fermented yeast culture @ 24g /animal /day from seventeen months of age attained puberty by 20 months, conceived by 24 months, whereas non supplemented group attained puberty by 28 months of age. Males supplemented with the yeast culture attained puberty by 24 months whereas non- supplemented group by 27 months of age. Plasma Nesfatin 1 and leptin concentrations were higher whereas Ghrelin was lower in female buffaloes heifers attaining puberty at the age of 27 months compared with buffaloes attaining puberty at the age of 32 months. The results indicated

that the attainment of puberty in buffaloes was associated with plasma concentration of IGF1, Nesfatin, Leptin, higher daily gain and improved feed conversion efficiency.

Augmenting Productivity with Prilled Fat Supplementation in Lactating Cows

Lactating KF cows yielding 12-16 kg milk were supplemented with prilled fat @75g/day for 90 days in early lactation resulted in increased milk yield, milk fat, milk triglycerides, milk lactose, SNF, cholesterol and protein; decreased in plasma NEFA ($P<0.05$); no change in plasma leptin, ghrelin, insulin and T_3. No detrimental effect was also observed on DMI, digestibility of nutrients (OM, ADF, NDF, CP, NFE), plasma VLDL, BHBA and cholesterol, however, HDL concentration decreased ($P<0.05$). In another experiment animals supplemented with prilled fat 35 days pre-partum to 95 days post-partum resulted in increased milk yield, milk fat, body weight, BCS, plasma T_4, leptin and reproductive efficiency but no effect was observed on T_3 and Insulin concentration.

Effect of Photoperiod on the Growth and Puberty of Buffalo Heifers

The growth studies in the buffalo heifers revealed that the plasma leptin concentration increased concomitant to the rise in the body weights of the animals maintained at the Temperature Humidity Index (THI) of 62.76 to 76.96 during long day photoperiods. Plasma triglyceride levels fluctuated during different fortnights.

DAIRY CATTLE NUTRITION

Raising Productivity of Dairy Animals through Improved Feeding Strategies, Efficient Nutrient Utilization and Use of Non Conventional Feed Resources

Early lactation performance and metabolic profile in Murrah buffaloes fed diet supplemented with prilled fat

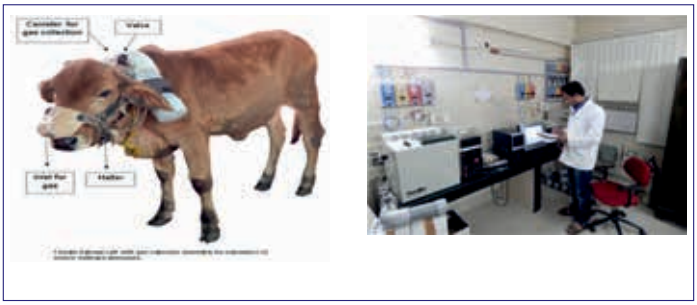
Fifteen early lactating Murrah buffaloes were divided into three groups of five animals each on the basis of MPPA, parity and body weight. Five buffaloes in group T_1 had average milk yield of 5 kg/d and buffaloes in the other two groups (T_2 and T_3) had average milk yield of 9-10 kg/d. The animals were fed with a balanced ration as per Kearl (1982) recommendations. The third group (T_3) was supplemented with prilled fat @ 75g /d/ animal in addition to the basal ration from 6th day of postpartum to 45th day of postpartum and 150 g/d/animal till the experimental period of 120 days. Milk fat content was higher in group T_3. Lactose, SNF and total solids yields were increased by supplementing prilled fat in the diet. Prilled fat supplementation had no significant effect on blood glucose, NEFA, BHBA, triglycerides and cholesterol. However, HDL- cholesterol was higher ($P<0.01$) in T_3. Low NEFA concentrations in group T_3 suggested less mobilisation of fat. The overall mean leptin levels were 1.33 ± 0.16, 1.36 ± 0.11 and 1.48 ± 0.33 for T_1, T_2 and T_3, respectively. The mean insulin and IGF_1 levels were similar in different groups. The duration for commencement of cyclicity was reduced by 5 days in T_3 group as compared to T_2 and the conception rate was increased from 40% (T_2) to 60% in (T_3) fat supplemented group. Supplementation of prilled fat in the diet of early lactating Murrah buffaloes was cost effective and net income per animal/day was higher than that of non-supplemented animals.

Feed intake, nutrient assimilation and enteric methane emissions in female Sahiwal calves of varying residual feed intake

The present investigation was undertaken to study residual feed intake, nutrient utilization, enteric methane emissions and blood biochemical parameters in 18 Sahiwal calves fed total mixed rations, consisting of wheat straw, berseem and concentrate mixture to meet their requirements. Residual feed intake (RFI) values were calculated for individual calves and they were designated as low (n=9; RFI= -0.14 kg/d) and high (n=9; RFI= +0.14 kg/d) RFI groups. Low RFI animals consumed less ($P<0.05$) dietary DM compared to high RFI animals (2.56 vs 3.02 kg/100 kg B.wt.) while gaining similar body weights (0.48 and 0.47 kg/d) indicating higher efficiency of feed utilisation in the former group. Low RFI group showed better feed conversion ratio (FCR) compared to high RFI group (5.52 and 6.64 kg DM consumed/kg gain). FCR value was 20.29% lower in low RFI group.

Enteric methane production was lower in low RFI animals compared to high RFI animals when expressed as g/kg DM intake (13.69 vs. 14.89) or g/kg DDM intake (21.87 vs. 23.70). RFI was positively related with methane production. The values of blood glucose (56.71 and 59.14 mg/dl);

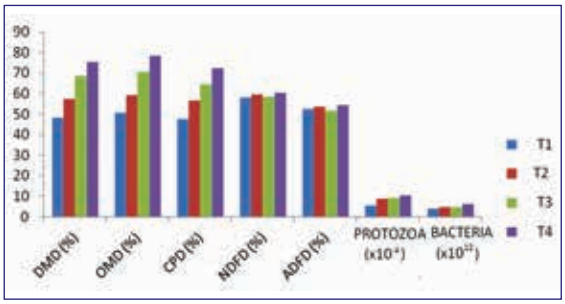
total plasma protein (7.32 and 7.54 g/dl) and growth hormone (2.37 and 2.29 ng/ml) were similar in both groups. Low RFI group possessed higher ($P<0.05$) values for creatinine (1.52 vs. 1.26 mg/dl) and IGF_1 (140.4 vs 122.4.98 ng/ml). On the contrary, the levels of aspartate aminotransferase (118.74 vs. 97.51 IU/L) and BUN (22.03 vs. 18.14 mg/dl) were higher in high RFI group compared to low RFI group of female Sahiwal calves. Thus, high efficient animals could be selected based on RFI.



Analysis of methane and SF_6 gas using Gas chromatography

Effect of increasing levels of metabolizable protein and energy on bacteria, protozoa, and nutrient digestibility *in vitro*

A study was conducted to assess the impact of different levels of metabolizable protein (MP) and metabolizable energy (ME) on total bacterial and protozoa count, digestibility of DM, OM, CP, NDF and ADF *in vitro*. Grains (maize, sorghum), oilcakes (groundnut cake (GNC), cottonseed cake (CSC), mustard oilcake (MOC), cereal straws (wheat and paddy), non legume fodders ((maize, sorghum and oat) legume fodders (berseem, lucerne and cowpea) and grasses (seteria, hybrid napier, para grass, barmuda grass and guinea grass) were evaluated. CP content ranged from 9.34 to 11.37% (dry matter basis) in grains, 28 to 40.25% in oil cakes, 9.62 to 13.12% in non legumes, 16.12 to 18.3% in legumes, 7.91 to 10.12% in grasses and 3.5 to 4.37% in straws. MP content ranged from 6.03 to 7.16% in grains, 17.16 to 25.68% in oil cakes, 6.95 to 7.64% in non legumes, 11.09 to 13.51% in legumes, 5.94 to 7.9% in grasses and 0.67 to 0.72% in straw. In the next phase, four diets T_1, T_2, T_3, T_4 (concentrate: maize fodder: wheat straw in the ratio of 20: 30: 50, 20: 40: 40, 40: 40: 20, 30: 50: 20) were formulated with different levels of MP (5.33%, 5.71%, 7.26%, 8.06%) and ME (7.25, 7.54, 8.1, 8.23 MJ/kg), respectively and incubated with rumen liquor. The bacterial and protozoal number increased (4.03 to $6.26x10^{12}$/ml SRL, 5.46 to $10.33x10^4$/ml SRL, respectively) with increasing MP and ME levels in the diets (Fig 1). Similarly, digestibility of DM, OM, CP, NDF and ADF were also increased from 65 to 75%, 66.66% to 78.80%, 60.25% to 65.52%, 57.98% to 60.64%, 51.56 to 54.64%, respectively with the increase in MP and ME levels in the diet.



Effect of various levels of MP and ME on digestibility of nutrients and microbial population

Bioaccessibility of trace minerals from oilseed cakes and straw

An *in vitro* study was conducted to assess the bioaccessibility of copper (Cu), molybdenum (Mo) and zinc (Zn) from selected mustard cake (MC), cotton seed cake (CSC), maize germ oil cake (MGOC) and wheat straw (WS) by three stage *in vitro* solubility techniques. The bioaccessibility of Cu was significantly higher in MC (70.99 ± 0.39%), followed by MGOC (68.66 ± 0.12%) and CSC (65.33 ± 0.19%) and the lowest value was observed for WS (55.00 ± 0.28%). Bioaccessibility of Mo was significantly higher in all three oilseed cakes (83.33 ± 0.84 to 85.00 ± 0.23%) in comparison to WS (78.22 ± 1.30%) but no significant difference was observed among selected oilseed cakes. Bioaccessibility of Zn was higher in MC (45.00 ± 1.15%), followed by MGOC (42.00 ± 0.57%) and CSC (38.03 ± 0.67) and the lowest value was observed for WS (26.00 ± 1.15%).

Quantitative prediction of nutritive value index of indigenous forages based on their chemical constituents: Nutritive value index is a function of both relative feed intake and the digestibility of feed. Thus, it considers both digestibility and palatability, indicating its ability to predict animal performance more accurately. Fifteen Sahiwal female calves were divided into 3 groups. The animals in group-1 were fed 500 g wheat straw +*ad lib.* oat hay, 750g wheat straw + *ad lib.* oat hay and *ad lib.* oat hay in groups 1, 2 and 3, respectively, to predict nutritive value index of indigenous forages from their chemical constituents. The highest nutritive value index was observed in group 3 (55) compared to group 1 (48) and 2 (49). Methane production was similar in all the groups. The following regression equation was developed to predict the nutritive value of forages:

$$Y= -2.68 + 0.66*CP + 10.03*DMI + 0.94*TDN -1.36*ADICP \quad (R^2=0.66)$$

Where, CP = Crude protein, DMI = Dry matter intake, TDN = Total Digestible nutrients, ADICP = Acid detergent insoluble crude protein

Quantitative prediction of protein utilization based on feed composition and determination of metabolic faecal nitrogen in buffaloes:

Buffalo calves were fed diets given graded levels of protein (5, 7.5, 10, 12.5 and 15% CP of total DMI). ADG was significantly lower in group 1(5% CP) in comparison to other groups. Dry matter digestibility increased with increasing protein levels in diet. Methane production decreased significantly with an increase in protein levels and its lowest (54.4g/day) and highest (84.07g/day) values were found in groups fed 5 and 12.5% CP, respectively. The following two equations were developed when faecal nitrogen out go was regressed on total nitrogen intake and nitrogen balance separately: Y= 0.334 + 0.029X and Y= 0.349 + 0.057X (R^2=0.415). Thus, MFN excretion from buffaloes accounted for 0.33-0.35 g/100g DMI. Another multiple regression equation was developed which predicts CP digestibility with higher accuracy in comparison to three stage *in vitro* technique. Equation was formulated by regressing truly digestible CP calculated from NRC (2001) equation and CNCPS protein fractions as Td CP (%CP)=8930.784-88.2163*P_A -24.730*P_{B1}-24.877*P_{B2} -24.711P_{B3} -24.852*P_C (R^2= 0.869), where, Td CP= Truly digestible crude protein, P_A= Non protein nitrogen, P_{B1} = soluble CP, P_{B2} = Neutral detergent in soluble CP but soluble in acid detergent (NDIP), P_{B3} =NDIP-ADIP and P_c = Acid detergent insoluble CP (ADIP)

Metabolizable protein and energy requirements for buffalo calves fed on low methane producing rations

The study was aimed at formulating rations with lower methane production value and to find out the energy (ME) and protein (CP or MP) requirements of male Murrah buffalo calves with low methane rations. Among grains, the methane emission (g/kg DM) was the highest from pearl millet (41.35) and lowest from sorghum red (30.57), whereas among agro-industrial byproducts it was higher in wheat bran, gram churi and maize gluten meal compared to rice bran. In oil cakes, cotton seed cake was the lowest (18.85) and soybean meal was highest (45.43 g/kg DM) in methane emissions. Among fodders, methane production was the highest from maize fodder (31.04 g/kg DM). The rations formulated using low methane producing ingredients were effective in reducing methane emissions by 14.93% in buffaloes. The ME, TDN, CP, MP and DCP requirement for maintenance were 133.1 kcal, 36.97g, 6.446 g, 3.949 g and 3.835 g per kg $BW^{0.75}$, respectively. The ME, TDN, CP, MP and DCP requirement for growth were 6.11 kcal, 1.7g, 0.463 g, 0.316 g and 0.395 g per g kg $BW^{0.75}$, respectively.

To investigate the effect of supplementing rumen protected methionine (RPM) and lysine (RPL) on pre parturient and post parturient performance in crossbred calves

Twenty seven crossbred cows with most probable production ability of around 4000 L milk were selected and divided into three groups (9 each) on the basis of Most Probable Production Ability (MPPA) and lactation number. Animals in group T_1 (control group) were fed chopped wheat straw, chaffed green maize fodder and compounded concentrate mixture as per requirements (NRC, 2001), animals in group T_2 (treatment group) were fed the same ration as to control group plus 5 g RPM (1.98 g/h/d net deliverable RPM) and 20 g/ h/d RPL(4.42 g/h/d net deliverable RPL), whereas the animals in groupT_3 were fed the same ration as to the control group plus 54g/h/d RPC product (10 g/h/d deliverable RPC) from 40 days before the expected date of parturition.

During 120 days postpartum period, milk yield (15.89, 17.69, 19.28 kg/d), 4% FCM (16.21, 18.24 and 20.14 kg/d) and ECM yield (16.20, 18.11 and 20.10 kg/d) were higher (P<0.01) in both the treatment groups (T_2 and T_3) than T_1 and was the highest in group T_2. Similar trend was observed for fat content whereas milk protein and SNF were higher (P<0.01) in T_3 than that in T_1 and T_2. Total solids were higher (P<0.01) in T_2 and T_3 than that of T_1. Furthermore, milk choline concentration (mg/dl) was higher (P<0.01) in group T_3 (133.97) than that of T_1 (87.69) and T_2 (88.63), but MUN (18.57, 18.44, 17.72 mg/100 ml) was similar among all groups. Mono unsaturated fatty acids and unsaturated fatty acids were higher (P<0.05) in group T_3 than that of T_1 and T_2. Commencement of cyclicity was apparently lower for animals in T_2 group; the values being 62.44, 64.11 and 65.13 days for T_3, T_2 and T_1groups respectively. Similar trend was recorded for number of artificial inseminations per conception which was lower in group T_3 (2.29) than T_1 (2.60) and T_2 (2.67). Number of days open after calving were lower (P<0.05) in group T_3 than T_2 and T_1. Overall conception rate was similar in all the three groups.

Effect of Cr supplementation on immune cell function, productivity, nutrient metabolism and bioavailability of essential minerals

Two separate experiments were conducted on buffalo calves during summer and winter months

for studying the effect of different levels (0, 0.5, 1.0, and 1.5 ppm) of inorganic Cr . In each experiment, 24 buffalo calves were randomly assigned to four treatments (n=6) and fed for 120 days. A metabolic trial for a period of 7 days was conducted after 3 months of dietary treatments. The results from both the experiments revealed that varying ambient temperature had no effect on weight gain, feed consumption and physiological variables (respiration rate, pulse rate, rectal temperature) in different treatment groups. Therefore, these effects were not moderated by Cr ($CrCl_3$) supplementation. However, a significant increase ($P<0.05$) in plasma total Ig, lymphocyte proliferation and neutrophil phagocytic activity among Cr supplemented groups showed that Cr had immunity enhancing effect in both the seasons. During summer months, decline in blood glucose, insulin, cortisol and HSP_{70} concentrations was observed whereas only insulin and cortisol levels decreased during winter season in 1.0 and 1.5 ppm Cr supplemented groups. Supplementation of Cr at 1.5 ppm to buffalo calves resulted in the lowering of glucose and insulin levels at 10.25 and 6.25%, respectively as compared to the non-supplemented group during summer. Compared to the control group, the basal concentration of FRAP value was highest ($P<0.05$) in 1.5 ppm Cr supplemented group in both the seasons. NEFA and thyroid hormones level were found similar. It was concluded that Cr as $CrCl_3$ in the diet of summer and winter exposed buffalo calves showed beneficial effects on biochemical, immunological and endocrine parameters.

Refinement in the inventory of methane emissions from dairy animals

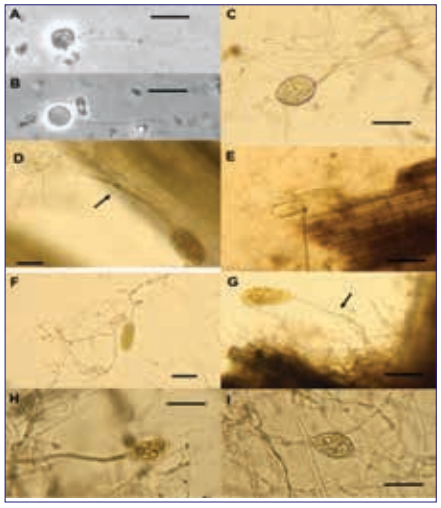
Total methane produced in the year 2003 was 10.12 Tg, which increased by 3.76% and was 10.50 Tg in 2007 and 10.8 Tg in 2010 with projected population. Contribution of Uttar Pradesh was maximum in 2003 with 16.34%, which had a decreasing trend by 1.71% in 2007. Andhra Pradesh, Madhya Pradesh and Rajasthan contributed about 8.3 to 8.8% which showed an increasing trend in 2007 while contribution of Maharashtra, Gujarat and Bihar was 7.8 to 5.16. Bihar and Gujarat showed an increase of 11 to 15% while Maharashtra showed a decrease of 8.26%. Contribution of Punjab was only 4.36%, which also showed a decrease of 15%. Among NEH states Assam, Arunachal Pradesh and Meghalaya and UTs except Chandigarh showed an increase while there was a decrease in other NEH states. Among other states, Kerala, Orissa Tamilnadu, West Bengal and Goa have shown a reduction which continued in 2010 (about 5-10%). There was overall increase by 3.7% in 2007 and 2.86% in 2010.

CLA producing potential of Butyrivibrio sp. and its subsequent utilization as a probiotic for animals:

A total of 105 anaerobic cultures were isolated from rumen liquor of buffaloes from different parts of India. Molecular characterization with universal 16S rRNA, genus and species specific primers revealed that the isolated rumen bacteria were *Butyrivibrio fibrisolvens, B. hungtaei, B. proteoclasticus, Pseudobutyrivibrio sp., Bacillus dendrites, Bacillus pumilus, Paenibacillus sp.* and *Provedencia vermicola.* The CLA production potential of all the isolated bacteria showed that bacterial isolate *Butyrivibrio fibrisolvens* 4a had the highest CLA production ability (140.77µg/ml) when incubated at 200 µg/ml linoleic acid for 1 h. Addition of different dietary oils and fatty acids to the media containing *Butyrivibrio fibrisolvens* 4a resulted in increased activity of *B. fibrisolvens* thereby facilitating higher CLA production. Therefore, *Butyrivibrio fibrisolvens* 4a was selected for *in vivo* animal trial in order to ascertain its utilization as feed additive in growing goats. There was a significant decrease in SFA and an increase in MUFA and PUFA content, which seemed to play a positive role in increasing this CLA accumulation in muscles.

Raising Productivity of Dairy Animals through Improved Feeding Strategies, Efficient Nutrient Utilization and Use of Non -Conventional Feed Resources

Veterinary Type Culture – Rumen Microbes: Phylogenetic analysis using both the internal



(Figure - Morphology of zoospores of a new anaerobic fungi (A, B) are uniflagellate, with the flagellum ca. 3-4 times the length of the spore body. Thalli are monocentric with sporangia normally being formed terminally (E-I) but occasionally intercalary (D). The shape of the sporangium was variable, ranging from ovoid (C) to elongate (F) and the sporgangiophore usually (G-I) 2-3 times the length of the sporangium. A constriction is often visible at the base of the sporangiophore (arrowed, G, I). Scale bar indicates 10 µm (A, B) or 50 µm (C-I)).

transcribed spacer (ITS) and large-subunit (LSU) regions of the rRNA locus demonstrated that anaerobic fungi isolated from the forestomach of an Indian camel *(Camelus dromedarius L.)* were identical to and formed a distinct clade within, the anaerobic fungi of phylum Neocallimastigomycota. Morphological examination showed that both isolates formed monocentric thalli with filamentous rhizoids and uniflagellate zoospores, broadly similar to members of the genus *Piromyces*. Since the genetic analyses demonstrated this fungus was only distantly related to *Piromyces* sp. and closer to the polycentric *Anaeromyces* clade, it was assigned to a new genus and species. Interrogation of the GenBank database identified several closely related ITS sequences, which were all environmental sequences obtained from camels, raising the possibility that this fungus may be specific to camelids

FORAGE RESEARCH MANAGEMENT

Effect of sowing time and stage of harvesting on green fodder and grain yield of barley (*Hordeum vulgare* L.)

The field study was conducted in split-split plot design with four treatment of date of sowing (21st October, 31st October, 10th November and 20th November) in main plots, three varieties (RD-2552, RD-2035 and RD-2715) in sub plots and three stage of harvesting (45DAS, 55DAS and 65DAS) in sub-sub plots with three replications in total 108 numbers of plots. Third date of sowing (10th Nov.) was significantly superior among all dates of sowing and produced maximum number of grains per spike. Highest green fodder and dry matter yield was obtained from variety RD 2715 sown on 10 Nov. and harvested at 65 DAS. The yield significantly differed across dates of sowing, varieties and stage of harvesting. No significant difference was found in protein content among varieties. Harvesting of crop at 45 days showed the highest grain yield, straw yield, test weight, leaf: stem ratio, crude protein, ether extract and organic matter percentage. Sowing between 21st October to 10th November is ideal time for dual purpose barley for production of higher fodder, grain and straw. On the basis of the performance of RD 2552 in terms of higher green fodder as well as grain production and benefit : cost ratio, it is advisable to grow this as dual purpose barley variety.

Improvement in yield and quality of forage maize through management of plant density and nutrients in different cultivars

Plant population, plant height and number of leaves/plant increased with increase in seed rate. Green and dry fodder yield, leaf: stem ratio, leaf length and width decreased with increase in seed rate, however, differences were not significant. The decrease in stem girth was significant with successive increase in seed rate from 60 to 90 kg/ha. Yield improved significantly with successive increase in fertility levels up to 125% of RDF. Interaction effect between plant density and fertility levels was found significant. Higher seed rate did not show response to applied fertilizer at more than 75% RDF level. These results suggested that for obtaining good quality fodder with better yield, 60 kg/ha seed rate should be used alongwith 125% RDF. Fodder maize variety J-1006 was superior over to African tall in terms of yield. Application of zinc either as basal or foliar spray improved growth and yield.

ANIMAL BIOCHEMISTRY

Anti-Obesity Potential of Dietary Fibres

Dietary fibers are advocated to ameliorate the complications associated with obesity. The influence of dietary incorporation of a comparatively less studied soluble fiber like gum acacia taking the obesity prone mice model C57BL/6J fed high fat high calorie diet was investigated and compared with the effects of a well known fiber (inulin). Body weight of C57BL/6J mice fed high fat diet was higher in comparison to control group animals. Dietary incorporation of soluble fiber (gum acacia/inulin, 7% w/w) in High Fat Diet (HFD) exhibited antiobesity effects. The epididymal fat accumulation after 18 weeks in animals fed gum acacia/ inulin was significantly less as compared to HFD fed group. No significant difference could be observed in liver, kidney & spleen weights among different treatment groups. Blood glucose level was significantly increased as a consequence of HFD feeding. The dietary incorporation of gum acacia as well as inulin could resist the effect to a significant level. Both types of fibers were equally effective in normalizing the serum lipid profile. Inulin feeding seemed to be more effective than gum acacia with reference to LDL-C levels. Serum glucagon like peptide-1 (GLP-1) level was found to be significantly

higher in mice fed HFD supplemented with gum acacia fiber in comparison to animals fed HFD only. Adiponectin (responsible for regulating energy homeostasis) expression in E. fat appeared to decrease due to HFD feeding. The expression level was significantly increased in fibre fed groups. The significant increase in leptin expression (adiposity signal) was correlated with increased epididymal fat mass accumulation on HFD feeding. A resistance to the leptin expression could be observed on feeding gum acacia/inulin. The cpt1 (regulator of fatty acid beta oxidation) and pgc1ß (linked with induction of genes involved in beta oxidation) in liver were found to be down-regulated while expression of SREBP-1c (a key regulator of lipogenesis) in liver and GPR43 & PPARγ in adipose tissue was increased significantly in animals fed HFD. The dietary incorporation of fibers was observed to resist the effect of HFD feeding, which can be surmised as an effect resulting in increased energy expenditure. However, positive effects of inulin were relatively more pronounced. Ingestion of fibers upregulated the expression of proglucagon in colon which is well correlated with the significant increase in serum GLP-1.

Probiotic Fermented Milk Confers Healthy Aging

Supplementation of probiotic fermented milk (PFM) containing *Lactobacillus rhamnosus* (MTCC 5897) and *Lactobacillus fermentum* (MTCC 5898) increased neutrophil respiratory burst response, phagocytic activity and migratory velocity without any significant changes in the directionality of neutrophil migration. Both probiotics showed a remarkable increase in Th1 response (IFN-γ) with a concurrent decrease in Th2 response (IL-4 and IL-10) in splenocytes. Probiotics supplementation decreased circulatory inflammatory molecules in plasma which otherwise increased in control groups due to aging. The downstream effects of Th1 response were also evident in humoral antibody production wherein an increase in IgG2a and a decrease in IgE and IgG1/IgG2a ratio were observed. There was no change in IgA levels or IgA+ cells in intestine. Antioxidant enzymes (superoxide dismutase, catalase, glutathione peroxidase) in PFM-fed groups also recorded increased activities which were more pronounced in the liver than in RBCs. In pathogen challenge study, PFM fed groups recorded a remarkable decrease in the translocation of pathogenic *E.coli* in peritoneal fluid, intestine, spleen and liver and a considerable increase in pathogen-specific antibodies (IgA and IgG1) was also observed. The inflammatory status in plasma registered increased presence of inflammatory molecules (IFN-γ, TNF-α and MCP-1) in PFM fed groups as compared to control animals of aged group. In conclusion, PFM supplementation alleviated immunosenescence-associated Th1/Th2 imbalance, improved antioxidant capacity, and enhanced resistance of aged mice to *E. coli* infection thereby signifying its potential in augmenting healthy aging.

Induction of Oral Tolerance and Alleviation of Allergy by Probiotic Fermented Milk

Fermented milk prepared with *L. rhamnosus* (MTCC 5897) was used to study its impact on the induction of oral tolerance and alleviating allergic responses after its supplementation in the diet of mother mice and their offspring against ovalbumin (OVA) induced allergy in newborn mice. Intervention of probiotic fermented milk (PFM) during suckling-weaning transition showed remarkable reduction in physical symptoms of allergy (ear swelling response and water percentage in feces) with improved gut immune system (higher goblet and IgA+ cells, sIgA levels and TLR-2 expression) and the suppression of inflammatory markers (MCP-I and COX-2 expression) in newborns. Restoration of Th1/Th2 homeostasis by shifting cytokines (IL-4, IFN-γ and TGF-β) profile with decreased OVA specific antibodies (IgE, IgG, IgG1) as well the ratios of IgE/IgG2a and IgG1/IgG2a in serum further confirmed the results. In conclusion, probiotic supplementation either in the diet of mothers alone during suckling period or subsequently in the diet of their offspring and also during post weaning period showed beneficial effects in alleviation of allergic sensitization in newborn mice, which had otherwise Th2 biased immune response at the time of birth and predisposes offspring to allergic disorders.

Bioavailability and Transepithelial Transport of Milk Derived Bioactive Peptide

The bioavailability and transepithelial transport of an antioxidative and ACE inhibitory peptide, VLPVPQK derived from casein hydrolysates was investigated along with elaborately studied opioid peptide β-casomorphin (BCM 5) by transwell assay using a human intestinal cell (Caco-2) monolayer. The peptides in the apical and basal chamber of transwell were detected with RP-HPLC. The apical to basal transport mechanism was studied using bradykinnin as control as it shows resistance to cellular peptidases. VLPVPQK and BCM 5 were hydrolysed by cellular peptidases while Bradykinnin was found intact. The bioavailability for VLPVPQK (1.0%) was found to be relatively much higher than BCM 5 (0.03%) and Bradykinnin (0.1%). Interestingly the effect of inhibitors on the

transport of VLPVPQK suggested involvement of a novel mechanism SOPT 2 while BCM 5, its hydrolytic product and Bradykinnin were observed to be transported mainly via the intracellular transcytosis pathway.

Osteoanabolic Effect of Bioactive Peptides Derived from Buffalo Casein

Four casein derived peptides namely 1, 2, 3 & 4 of below 1 kDa were selected from previously analyzed LC-MS/MS data of pepsin-trypsin hydrolysates of buffalo casein for studying the osteoblastogenic potential using rat calvarial cells. The progressive development of the osteoblast was characterized by three phases: proliferation, differentiation and matrix mineralization. Osteoblast proliferation was studied by MTT assay and osteoblast differentiation was characterized by ALP activity and mineral deposition was checked by alizarin red staining. The peptides 2, 3 and 4 induced osteoblast proliferation significantly compared to the control at 30, 30 & 60 ng/ml, respectively. Also, the four peptides significantly induced alkaline phosphatase activity and mineral deposition in comparison to control. However, peptide 2 showed more ALP activity and mineral deposition among all the peptides studied. Thus, these peptides posses osteoanabolic effect and hence, could be exploited in functional foods preparation for the management of osteoporosis.

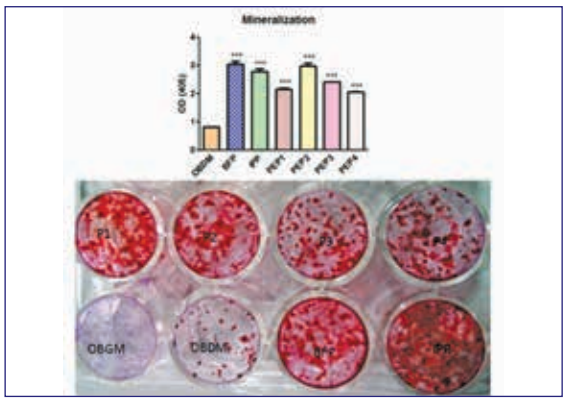


Fig: Plate showing the mineralization nodules of osteoblasts as analyzed by alizarin red staining OBGM: Osteoblast growth medium, OBDM: Osteoblast differentiation medium, BFP: Bone forming peptide, IPP: Isoleucine-Proline-Proline, P1: peptide 1, P2: peptide 2, P3: peptide 3, P4: peptide 4.

Hypocholesterolemic and Hypoglycemic Effect of Milk

Hypocholesterolemic and hypoglycemic potential of milk from different species was evaluated using experimental rats. Hypercholesterolemic and hyperglycemic conditions in experimental rats were created by feeding cholesterol enriched diet and intraperitoneal injection of streptozotocin, respectively. Administration of goat, camel, cow and buffalo milk (3% fat) along with cholesterol enriched diet (CED) for three months significantly decreased plasma TC by 41.8-56.3%, TGs by 30.3-50.7% and LDL-C by 50.8-65.3% and increased HDL-C by 35.0-69.7%. Milk feeding decreased atherogenic index, cholesterol deposition in aorta and cholesterol level in liver. Cholesterol level in liver was in the following order: (Goat, Camel) < Cow < Buffalo. Feeding of milk also increased the cholesterol excretion in feces. Feeding of goat/camel milk caused more cholesterol excretion in feces than cow/buffalo milk. HMG-CoA reductase activity was decreased with CED feeding and further decrease was observed with goat and cow milk. Milk reduced the oxidative stress by enhancing the activities of catalase, GPx and SOD (liver and RBCs) and decreasing the level of TBARS and PCs (liver and plasma). Antioxidative potential of milk was in the order: Goat > Camel > Cow > Buffalo. Similar trend was also observed in therapeutic study but the effectiveness of milk in cholesterol lowering was less as compared to prophylactic study.

Administration of goat and camel milk to diabetic group for one month significantly decreased body weight. In contrast to goat, cow, buffalo and camel milk increased insulin level, decreased blood glucose and HbA_{1c}. Also, feeding of camel milk decreased plasma TC, TGs, VLDL-C, LDL-C, atherogenic index, FFAs in blood, liver cholesterol and liver TGs and increased plasma HDL-C significantly. Expression of gluconeogenesis enzymes genes (*g6pase* and *pepck*) in liver was significantly lower in camel milk group. Furthermore, camel milk reduced oxidative stress by increasing the activity of catalase, GPx and SOD (pancreas, kidney, liver and RBCs) and decreasing the level of TBARS and PCs (pancreas, kidney, liver and plasma). Antidiabetic effect was observed only in case of camel milk.

Development of High Affinity DNA Aptamers against Betacasomorphin-7

Betacasomorphin-7(BCM-7) is a seven amino acid long peptide and is produced during digestion of A1 milk but not from A2 milk. It has been speculated that consumption of A1 milk may cause non-communicable disorders such as DM-1, IHD, autism and schizophrenia. In this study, aptamers against BCM-7 were generated, characterized and evaluated for developing a method for the estimation of BCM-7 in biological fluids. Aptamers for BCM-7 were selected from 10^{13} random pool of

ssDNA sequences which have 18 nt long constant regions at each of 5′ and 3′ ends and 36 nt long random sequences between the constant regions. The aptamers were selected through the process referred as Systematic Evolution of Ligands by Exponential Enrichment (SELEX). The aptamer pools obtained after SELEX were amplified and inserted into pGEM T cloning vector. The recombinant vector was transformed in *E.coli* (DH5α). A total of 41 white colonies were selected. Plasmid from individual colony was isolated and sequenced. Examination of sequences of aptamers revealed 15 different aptamer sequences. This indicated the enrichment of selected aptamers. The generated aptamers against BCM-7 exhibited K_d values in the range from 7 nM to 156 nM. There was no consensus sequence amongst 15 aptamers. However, there were five secondary structural motifs (using Mfold software) which were common to more than one aptamer. Accordingly, aptamers were grouped into five different groups. These motifs might be involved in recognition of BCM-7 by aptamers. Aptamer coated gold nanoparticles were used for checking the presence of BCM-7 in solution. These particle exhibited color change in the presence of BCM-7. The effectiveness of seven aptamers was in order of seqU4 > seq3 > seq1 > seq7 > seqU5 > seqU2 > seq10. The color change in the presence of BCM-7 proved that aptamers recognized BCM-7. Aptamer linked immobilized assay (ALISA) was also used for comparative evaluation of aptamers for their cross-recognition of BCM-5, BCM-7, BCM9-A1 and BCM-9A2. Some aptamers were better selective over others. The selectivity of aptamers was in the order of seq6 > seq3 > seqU4 > seq4 > seq1 > seq10. Aptamers seq7, seqU5 and seqU2 lack selectivity. ALISA was also used for developing an assay protocol for measuring BCM-7 in pure solution and BCM-7 spiked urine, blood, β-casein digest. The method required binding of biotinylated aptamers to streptavidin coated plate and the competition of binding of BCM-7-peroxidae with BCM-7. The decrease in absorbance in the presence of BCM-7 proved that ALISA can be used for the estimation of BCM-7.

Imprinted Polymers against Antibiotics and the Extraction of Antibiotics from Food Matrix

Molecular imprinted polymers (MMIP) were prepared over the surface of iron magnetite. Efforts were made to prepare polymers having capability to recognize oxytetracycline (OTC), Cephalexin, Cefquinome. The polymers were prepared from methacrylic acid using free radical reaction. Since polymerization was achieved over iron magnetite, the prepared magnetic imprinted polymer have the capability to get it easily separated in magnetic field after binding with antibiotics. These polymers were characterized by FTIR, SEM and DLS. MMIP against OTC, Cephalexin and Cefquinome were successfully applied for their recovery from water, milk, honey and egg. MMIP against OTC showed the recovery in range of 70-80%, from water (80%), milk (70%), honey (75.6%) and egg (75%). MMIP against Cephalexin showed recovery in range of 60-88% from methanol, milk, honey and egg. MMIP against Cefquinome showed recovery in a range of 74-93% from water, milk, honey and egg.

Tyrosine Phosphorylation Status of Heat Shock Proteins in Buffalo Spermatozoa

Freshly collected murrah buffalo semen of more than +3.0 mass activity was cryopreserved in egg yolk (EY) and soya milk (SM) extenders. These spermatozoa were *in vitro* capacitated using heparin (10µg) by standard protocols. The heat shock proteins viz. HSP-60, HSP-70 and HSP-90 were detected in fresh *in vitro* capacitated and cryopreserved spermatozoa by Western blot analysis using specific monoclonal antibodies followed by chemiluminiscence detection. The expression levels were compared using densitometric analysis taking fresh spermatozoa as control and taken as 100%. HSP-60 expression was increased in *in vitro* capacitated spermatozoa while HSP-70 showed a little decrease in cryopreserved spermatozoa in comparison to fresh. Protein tyrosine phosphorylation (PTP) status of heat shock proteins was assessed using 2D Gel Electrophoresis. Two isoforms of HSP-60 were obtained on *in vitro* capacitation and cryopreservation compared to only one isoform in fresh spermatozoa.

LPS Induced Expression of Pro-Inflammatory Genes and their Attenuation By Dietary Conjugated Linoleic Acid

LPS induced immune response in buffalo granulosa cells, and the possibility of CLA to attenuate LPS induced proinflammatory gene expression in buffalo granulosa cells *in vitro* was studied. The results showed that LPS (1µg/ml) increased the proinflammatory gene expression within 2-3h after treatment, and these levels were close to normal after 6 h. The treatment of TLR4 inhibitor prevented the LPS induced pro-inflammatory gene expression. Similarly, treatment with CLA (10 µM) along with LPS didn't show any effect on LPS induced pro-inflammatory gene expression. However, granulosa cells pre-exposed to CLA for 24 h reduced the LPS induced pro-inflammatory gene expression.

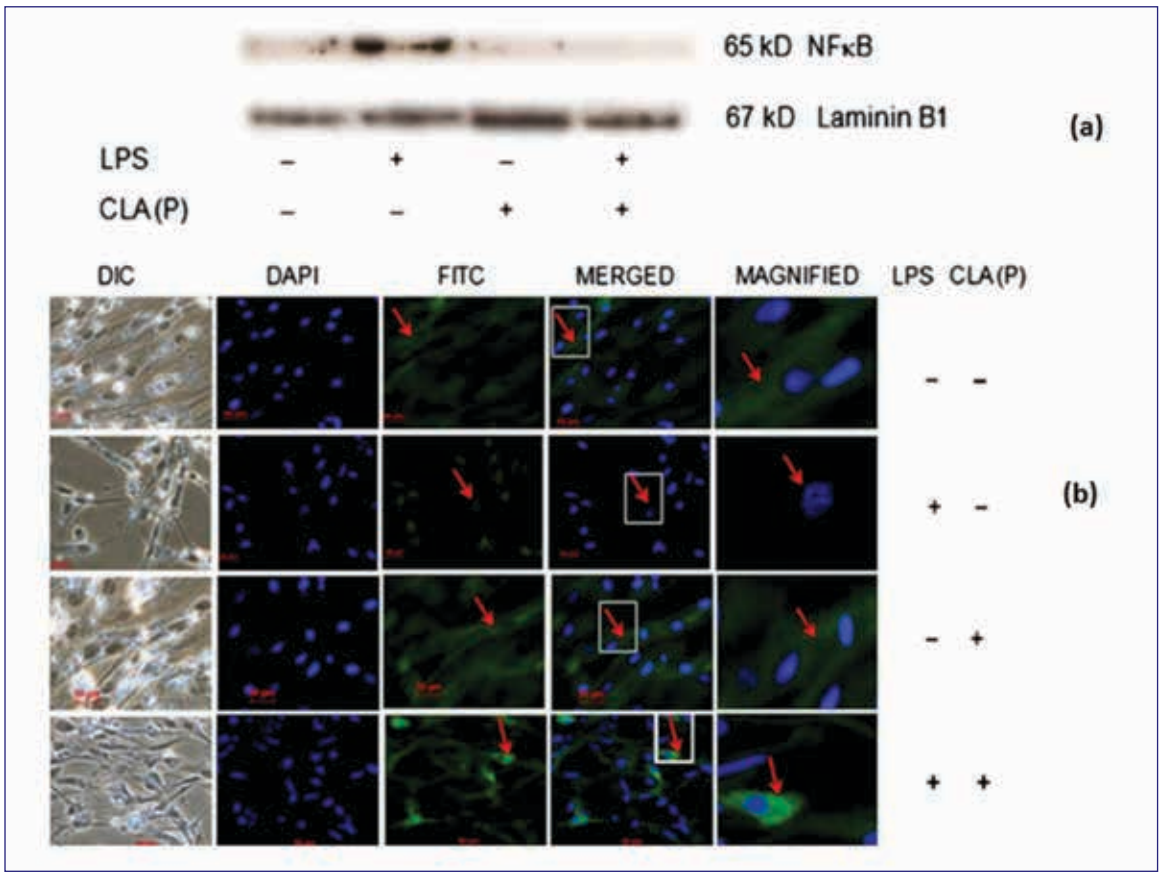


Figure : Effect of CLA pre-treatment on LPS-induced NF-κB activation and immunolocalization: Western blot (a) showed that there was more nuclear NF-κB in nuclear protein isolated from cells treated with LPS, while there was an absence of NF-κB in the protein isolated from cells pre-treated with CLA followed by LPS treatment. Similarly, immuno-staining (b) showed that CLA pretreatment prevented the NF-κB translocation to nucleus, while in LPS treatment (second row from top), there was an intense nuclear NF-κB levels required for pro-inflammatory cytokines expression. Arrows indicate the localization of NF-κB localization in either cytoplasm or nucleus. Boxed regions are magnified further for more clarity. Scale bar, 50 µm. (above figure)

The present findings raised the possibility of using dietary CLA/PUFA in preventing LPS induced granulosa cells dysfunction underlying infertility.

Metagenomic Aanalysis of Microbes in Uterine Swab using Universal 16sRNA Gene

The purpose of this activity was to identify and compare the uterine bacterial composition between normal and endometritic postpartum buffaloes using 16S rDNA cloning, which was a type of culture-independent method. A total of 151 cloned plasmids for 16S rDNA from both normal and endometritic uterine samples were sequenced. Cloning library of 16S rDNA revealed a clear cut difference between bacterial populations of normal and endometritic postpartum buffaloes. Cloned sequences were assigned to five major groups and one uncultured group. The five major groups include- Bacteroidetes, Firmicutes, Fusobacteria, Proteobacteria, and Tenericutes. Major cloned sequences from normal status endometrium were affiliated to phylum Proteobacteria, and most of the sequences showed high degree of similarity with bacteria *Haemophilus felis*. The most prevalent bacteria found in endometritic samples were *Psychrobacter* sp. PRwf-1, *Psychrobacter pulmonis* etc.

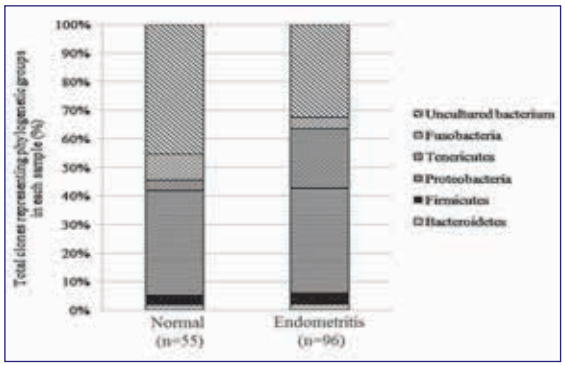


Fig. Stacked bars showing the bacterial group-level compositions of the uteri of normal and endometritic postpartum buffaloes

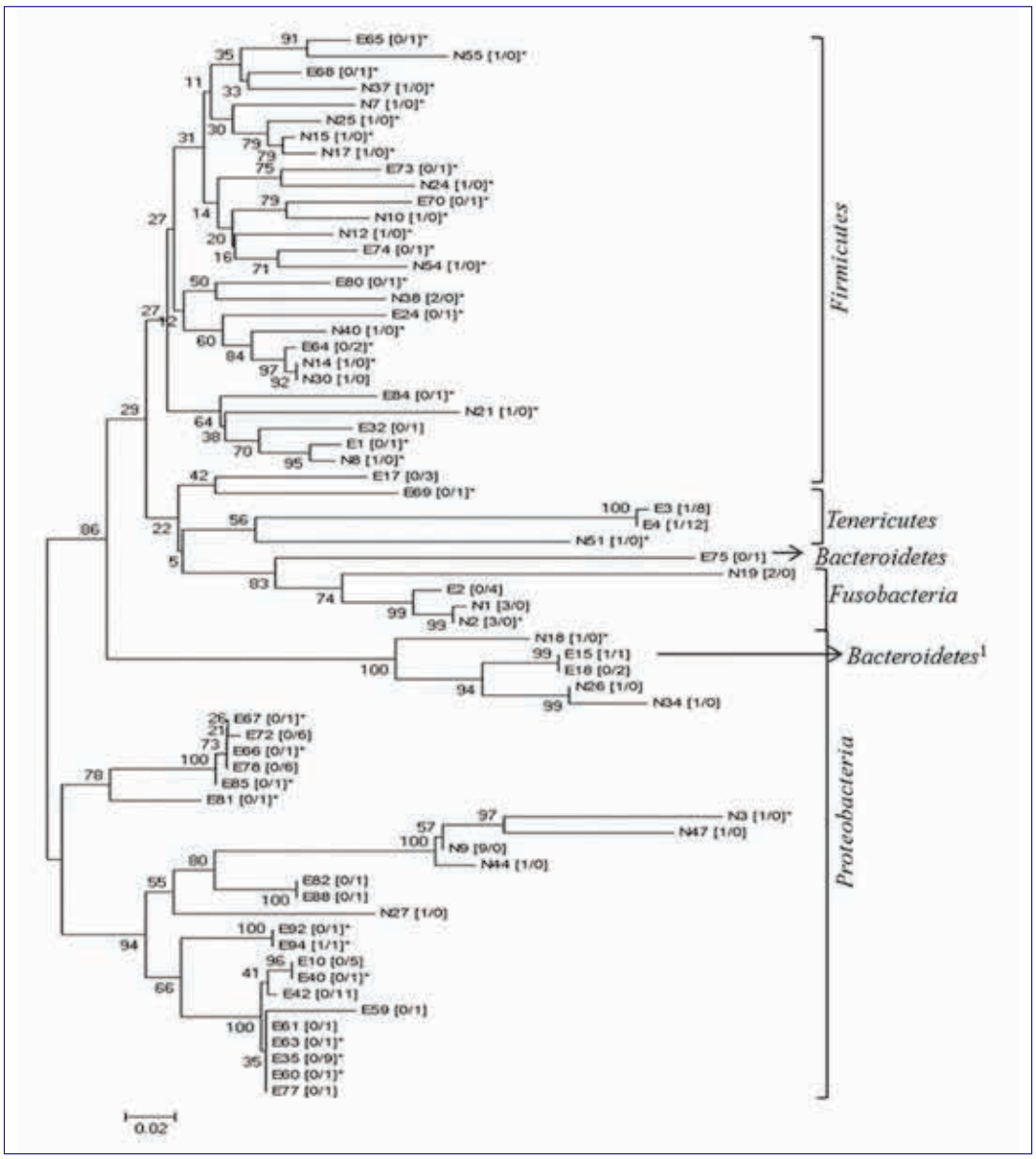


Figure: Phylogenetic tree of the bacterial groups identified from clone libraries from uteri of normal (n=3) and endometritic (n=3) postpartum buffaloes showing their affiliations.

Profiling of salivary fern patterns during the estrous cycle of a buffalo population sample

Salivary fern patterns were determined during different stages of estrus cycles in buffaloes. Saliva showed different crystallization patterns at different days of estrous cycle in buffaloes. An average estrous cycle based on the salivary fern patterns is 21.7 days in a buffalo population sample. Around 75% cases showed dominant ovarian follicle by ultrasonography in the presence of typical salivary fern patterns. Endometritis related anovulation reduced the intensity of the salivary fern patterns at estrus.

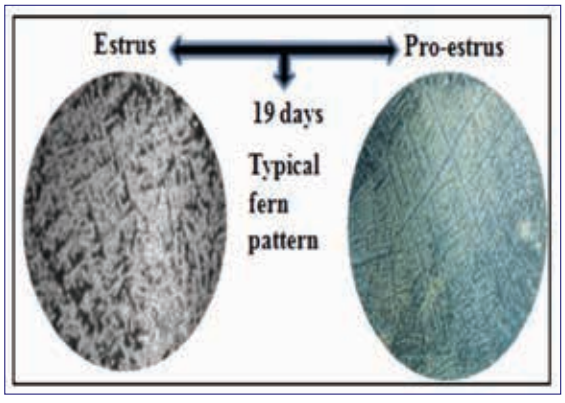


Figure. Typical salivary fern patterns at the estrus stage of buffalo estrous cycle

Biosafety of Nanomaterials

A study was designed to clarify the toxic nature of nanoparticles with respect to class, size, shape, and route of nanoparticles and nanotubes. Two nanomaterials, Mesoporous Silica Nanoparticles (MSNs) and Multi Walled Carbon Nanotubes (MWCNTs) were compared for toxicity using cell lines and albino mice as a test animal model. The results showed that MWCNTs even at much smaller doses than MSNs displayed similar toxicity levels. Based on observations, it may be concluded that toxicity of MWCNTs is higher than MSNs. No significant difference was found in the organ weight coefficient of different organs like liver, kidney and spleen after exposure to increasing doses of both MSNs and MWCNTs when compared to control. Conclusively, it can be stated that hepatic toxicity as measured by increase in serum biomarkers occurs probably due to aggregating capacity of MWCNTs.

Biosensing of *Bacillus Cereus* and its Toxins

The principle of cytotoxicity based biosensor using buffalo spermatozoa using the activity of mitochondria has already been established. In Buffalo, permatozoa based biosensor buffalo spermatozoa acts as a bioreceptor which interacts with cereulide (analyte). This interaction leads to the inhibition of dehydrogenases of mitochondria. 3-(4,5-dimethylthiazol-2-yl)-2,5 diphenyl tetrazolium bromide (MTT) dye is cleaved by active mitochondria in absence of cereulide. In presence of cereulide, formation of formazan crystal is inhibited. The insoluble colored dark purple formazan crystals formed were used as the colorimetric indicator for toxicity. These formation and non-formation of formazan crystals were then measured by multi-well plate reader. The identification of formazan crystals at the mid piece of spermatozoa was observed by Phase contrast microscopy and Differential Interference Contrast microscopy. The feasibility of this biosensor is demonstrated by toxicant dependent color changes using buffalo spermatozoa as a model system. Fresh ejaculated spermatozoa were used for the detection of cereulide in milk powder.

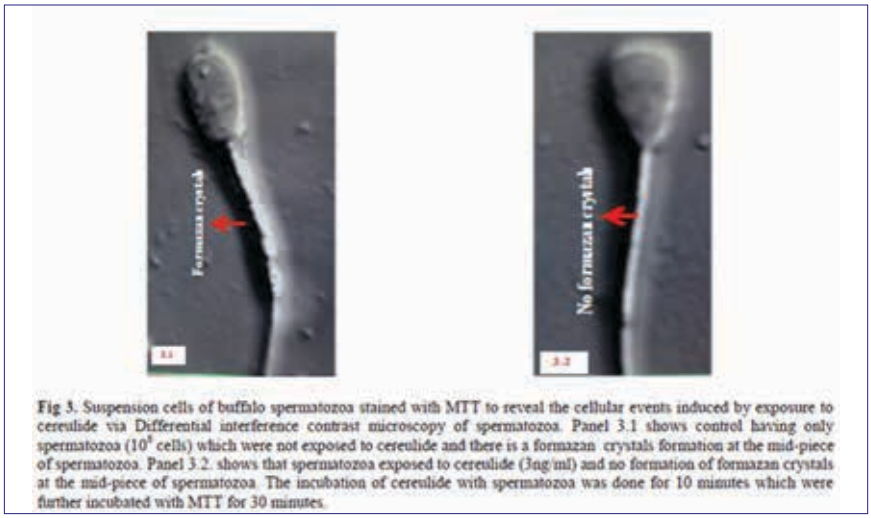


Fig 3. Suspension cells of buffalo spermatozoa stained with MTT to reveal the cellular events induced by exposure to cereulide via Differential interference contrast microscopy of spermatozoa. Panel 3.1 shows control having only spermatozoa (10^8 cells) which were not exposed to cereulide and there is a formazan crystals formation at the mid-piece of spermatozoa. Panel 3.2. shows that spermatozoa exposed to cereulide (3ng/ml) and no formation of formazan crystals at the mid-piece of spermatozoa. The incubation of cereulide with spermatozoa was done for 10 minutes which were further incubated with MTT for 30 minutes.

DAIRY CHEMISTRY

Research on Nutraceuticals from Milk, Functional Foods with Prebiotics, Probiotics, Micronutrients and Other Bioactive Compounds for Improved Human Health

Preapration and characterization of clove oil nanoemulsions having antimicrobial activity: Clove oil was encapsulated in the form of nanoemulsions oil in water (O/W) by using an ultrasonicator and high speed homogenizer. The clove oil was taken as the inner oil phase (O) (1-10% w/v) and the outer aqueous phase (W) was prepared by mixing different emulsifiers such as Whey Protein Concentrate (WPC-70), sodium caseinate, Tween-80, lecithin, maltodextrin, pectin alone and in combination. The most stable formulation of clove oil nanoemulsion was prepared using whey protein concentrate and maltodextrin as emulsifiers with a particle size of 199.2 ± 2.28 nm and zeta potential of -36.5 ±

0.48mV. The prepared nanoemulsions were stable to different food processing conditions like various thermal treatment (pasteurization, forewarming, boiling, sterilization), ionic strengths (0.1-1M) and pH range(3.0-7.0). The antimicrobial activity of the prepared nanoemulsions were measured against *E. coli, Bacillus subtilis, Candida lipolytica, Aspergillusflavus, Salmonella typhiimurium*, *Listeria monocytogens*, *E. coli O157:H7*, and *Shigella*. The mechanism of action of nanoemulsions droplets on bacterial surface was assured by scanning electron microscopy. These nanoemulsions system can be used as an effective delivery system for poorly soluble antimicrobial to preserve high moisture foods.

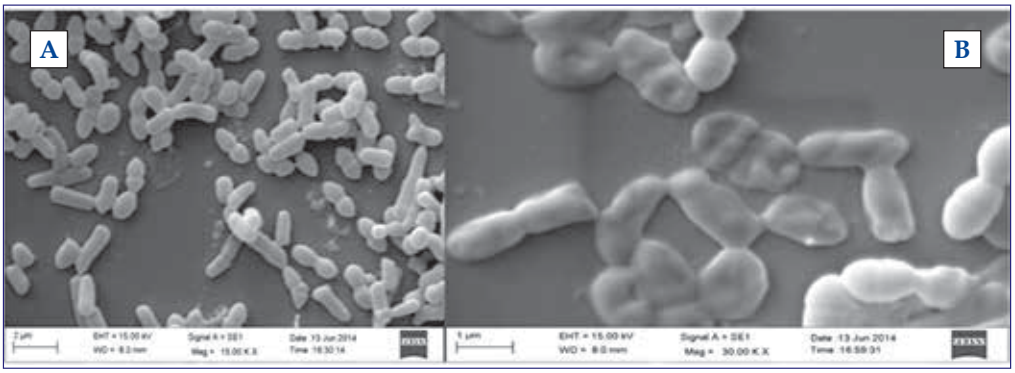
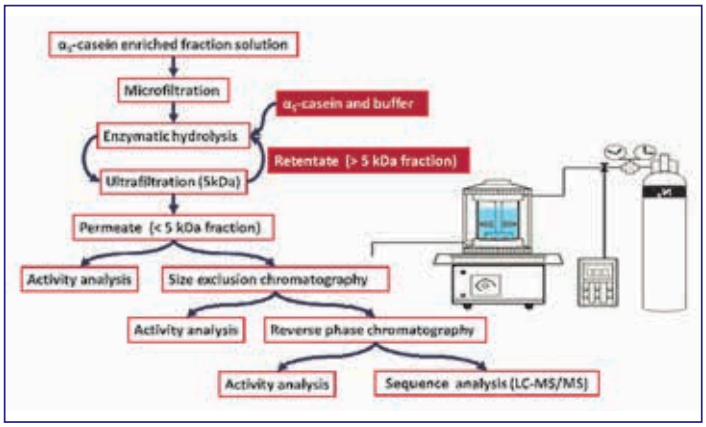


Figure: Scanning electron micrograph of mechanism of action of nanoemulsion on *E. coli* A) *E. coli* culture B) *E. coli* culture treated with emulsion

Optimization of conditions for generation of antioxidant peptides from buffalo casein: Hydrolysis of buffalo sodium caseinate was done using protease-I and protease – II at 0.2 –8.0 U/mg protein and 0.8 U - 1.7 U/mg protein, respectively, alone or in combination, for the period of 2-8h at optimum pH and incubation temperature. Optimization of protease-I and protease – II concentration with their hydrolysis period was assessed for measurement of degree of hydrolysis and antioxidant activity following central composite rotatable design (CCRD) and response surface methodology (RSM). The optimized hydrolysis conditions for buffalo casein included protease-I at 3U/mg protein for 4.5h and protease-II at 2.5 U/ mg protein for 6h, while maintaining the pH using pH stat autotitrator. Under the optimized conditions, the maximum DH showed antioxidant activity corresponding to 2051.67 µM trolox /mg protein in the permeate fraction whereas the same for total buffalo casein hydrolysate resulted 1915.02 µM trolox /mg protein. Casein hydrolysates were evaluated for protection against oxidative stress at different respective concentrations. It did not show cytotoxic effect but provided cytoprotective effect against H_2O_2-induced oxidative stress in Caco-2 cells.

Development of integrated enzymatic membrane based reactor for production of bioactive peptides from buffalo α_s-casein: A method for the production of antioxidant peptide rich hydrolysate was standardized by integrating hydrolysis on membrane reactor. Buffalo α_s-casein enriched fraction was hydrolysed under optimized conditions in a batch reactor by coupling the enzymatic hydrolysis with membrane separation for simultaneous production and separation of peptides. After completion of first hydrolysis, hydrolysates were ultra-filtered through the membrane reactor. The retentive part of hydrolysates was reconstituted (0.5 % protein) by feeding fresh solution of substrate. The hydrolysis was continued for next hydrolysis cycle under similar conditions with continuous stirring without further dosage of enzyme. Hydrolysate obtained in permeate fractions resulted in more than 60% recovery in retentate. Resultant hydrolysate showed strong antioxidant activity having TEAC value of 3.38 ± 0.06 µmol TE/mg along with potent ACE inhibitory activity (IC_{50} = 0.36 mg/mL) and iron-(II) chelation capacity (328.19 ± 1.42 µM Fe^{2+}/mg). The hydrolysates were characterized by



size exclusion chromatography and evaluated for antioxidant and ACE inhibitory activity.

Mineral bound milk based ingredients: preparation, characterization and application: Iron concentration upto 3.6, 3.0 and 2.4mM and zinc concentration upto 2.4, 1.6 and 2.0mM were optimized for sodium caseinate (NaCN), whey protein concentrate (WPC) and Milk protein concentrate (MPC), respectively. Iron concentration upto 7.4, 5.6 and 7.0mM and zinc concentration upto 7.6, 5.0 and 7.0mM were optimized for Succinylated sodium caseinate (S. NaCN), Succinylated whey protein (S. WP) and Succinylated milk protein (S. MP), respectively. Best milk protein– mineral (both native and succinylated protein) complex was selected on the basis of three major criteria: a) it (final protein – mineral complex) should carry sufficient amount of mineral b) it should maintain maximum amount of initial added protein in the form of total yield and c) it should possess better solubility under physiological conditions (pH 7.0). WPC-mineral (iron/zinc) complexes were selected among the different native protein-mineral complexes (fig a) and S. NaCN – mineral (iron/zinc) complexes were selected among different succinylated protein – mineral complex (fig b).

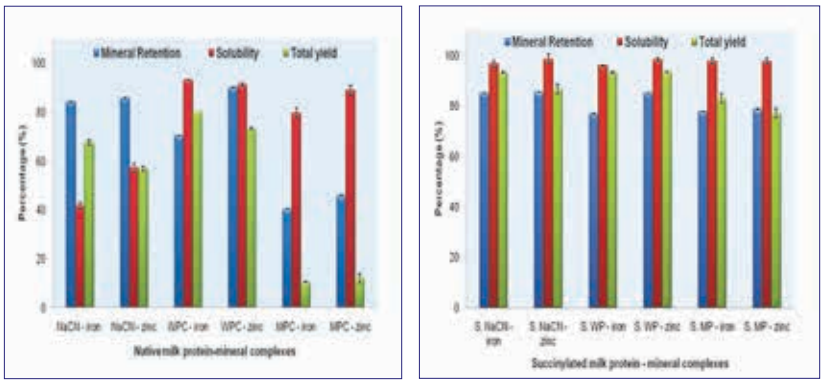


Fig: Mineral retention, solubility and yield (on weight basis) of selected complexes of different mineral bound milk proteins: (a) native protein – mineral complexes (b) succinylated protein – mineral complexes

Clean Milk Production with a Focus on Emerging Health Concerns and Development of New Generation Tools for Ensuring Quality Control through Application of Newer Chemical and Biotechnological Concepts

Synthesis and application of cephalexin imprinted polymer for solid phase extraction in milk: Molecular imprinted polymer (MIP) against cephalexin was synthesized by co-polymerization of functional monomer, cross-linker, radical initiator, alongwith target molecule (cephalexin) in a porogenic material. Binding of cephalexin towards prepared MIP was studied in different solvents (water, methanol, 1 M NaCl, acetone and acetonitrile) and best binding was observed in methanol. Partition coefficient and selectivity of prepared imprint and non-imprint was also studied. Cross reactivity in terms of binding efficiency was also assessed with other antibiotics. Chromatographic study of MIP was carried out by packing prepared imprint into glass column. MIP was used as matrix in solid phase extraction (SPE) for recovery of cephalexin from spiked milk samples for further estimation by high performance liquid chromatography. No interference was observed from milk components after elution of cephalexin from MIP, indicating selectivity and affinity of MIP.

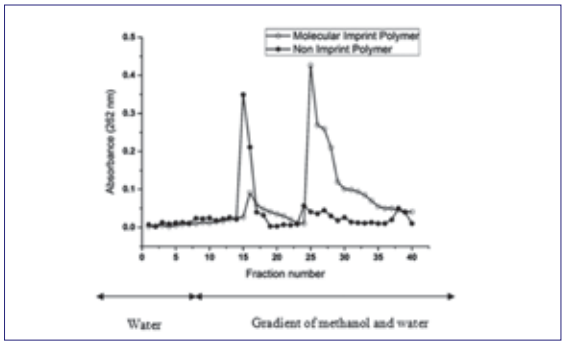


Figure : Binding and elution profile of cephalexin imprinted polymer in glass column

Lateral flow assay based rapid detection of cephalexin in milk: A rapid and semi-quantitative lateral flow assay was developed for detection of cephalexin in milk. The assay is based on competitive format using polyclonal antibodies. Antibodies were raised in rabbit after immunization with cephalexin-keyhole limpet hemocyanin. The specificity of affinity purified antibodies was ascertained by direct enzyme-linked immunosorbent assay. Laboratory prepared gold nanoparticles

were characterized and coupled with anti-cephalexin antibodies, which competed for free cephalexin in the sample and cephalexin-bovine serum albumin conjugate on the test line of lateral flow strip. The control line of lateral flow strip consisted of species specific (secondary) antibody. The assay was validated with spiked milk samples. The lower detection limit of the cephalexin was 30 ppb in milk which is lower than Codex prescribed maximum residue limit (MRL). The storage stability of the prepared strip was also established and strips were stable for 6 months at room temperature.

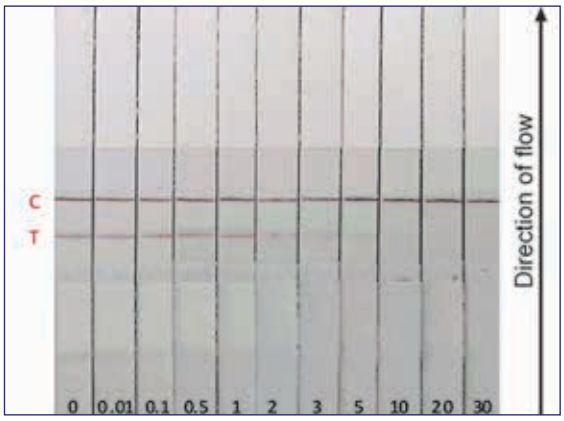
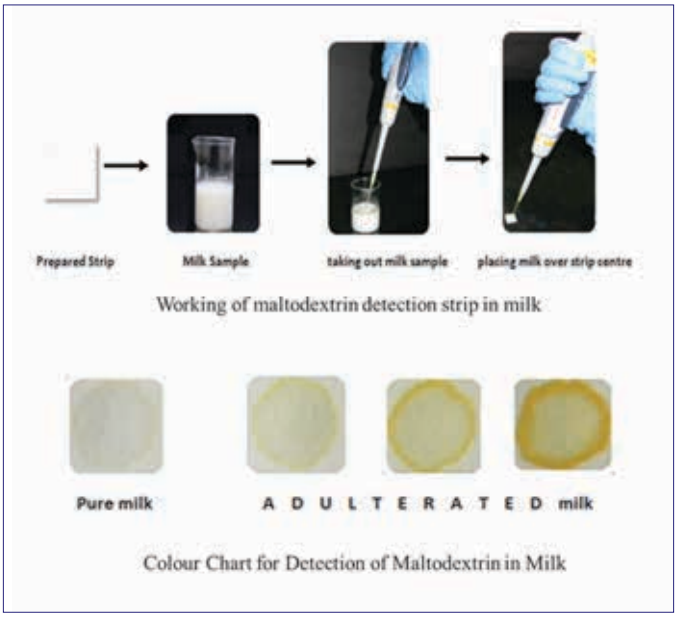
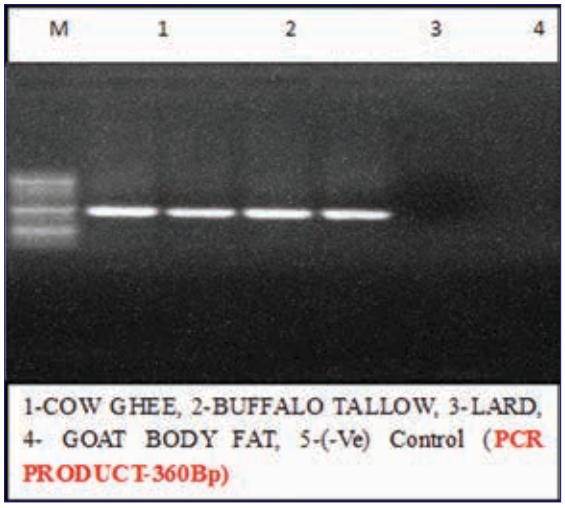


Figure: Detection of cephalexin using lateral flow strips in borate buffer at various concentrations (ppb)

Development of strip based tests for detection of maltodextrin in milk: A rapid paper based strip test was developed for the detection of maltodextrin in milk. The prepared strip is white in colour. The test involves putting a drop of milk on the strip followed by visualization of change in colour of the strip. The colour changes to yellow after about 3 minute in case milk is adulterated with maltodextrin. The intensity of yellow colour produced in the strip is proportional to the amount of maltodextrin present in milk sample. The test can detect presence of 0.05% level of maltodextrin in milk and is more sensitive than the existing methods. The test can be used at milk reception centres and also at house hold.



Development of chromatographic and PCR based methodology to ascertain the quality of milk fat and its validation under field conditions A protocol was standardized for the extraction of DNA from ghee as well as from rendered fats (clarified animal body fats) by using different DNA extraction kits namely Machel Nagery Tissue Kit and Pro-2 Qigen food kit. Results obtained showed that the yield of DNA was low in all the samples. The low 260/280 ratio clearly indicated that the DNA isolated was not the intact DNA and might have under gone degradation as a result of heat treatment given during clarification of butter. However, on amplification using universal primer, faint bands were observed on agarose gel confirming the feasibility of DNA extraction from milk fat and rendered fats.



PCR amplification for fat samples using UNI-1 primer

Information generated would be useful in developing a method of DNA extraction from heat clarified fats.

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

Sodium caseinate based conjugates were prepared through conjugation of sodium caseinate with three polysachardies viz., maltodextrin (NM), pectin (NP) and gum arabic (NG) in the protein:polysacharide ratio of 1:1, 1:2 and 2:1, respectively. The physico-chemical and emulsification properties of these conjugates were evaluated. Conjugates of sodium caseinate and pectin in the ratio of 1:2 (NP12) exhibited best emulsifying activity (46.72%) and emulsion stability (7 days). Colour values were also determined using Hunter colour scale. Maximum 'L-value' (80.82) and minimum 'a-value' (2.98) were recorded for NP21, indicating better whitening characteristics of the conjugates. Solubilities of the sodium caseinate-maltodextrin conjugates were measured over different pH values, where NM12 showed better solubility compared to sodium caseinate at isoelectric pH. Whey protein based conjugates were prepared through conjugation of whey protein concentrate (WPC-80) with three polysaccharides viz., maltodextrin (WPMD), high methoxyl pectin (WPHMP) and gum arabic (WPGA) in the protein:polysaccharide ratio of 1:1, 1:2 and 2:1, respectively. The physico-chemical and emulsification properties of these conjugates were evaluated. Conjugates of WPC-80 and HM pectin in the ratio of 1:2 (WPHMP12) exhibited best emulsifying activity (84.16%) and emulsion stability (15 days). Maximum colour intensity was observed for WPGA21 conjugate indicating maximum colour. WPHMP12 showed better solubility (>75%) at entire pH range (pH 3 to 7).

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

Four *S. thermophilus* strains viz. NCDC 74, NCDC 343, NCDC 344 and NCDC 428 procured from NCDC were screened for their compatibility with potential probiotic culture *Lactobacillus paracasei* ssp. *paracasei*. All the *S. thermophilus* cultures showed good compatibility with the probiotic bacteria L. *paracasei*. Inhibitory action was not found among the probiotic bacteria and *S. thermophilus* strains. 16S rDNA partial sequencing of five potential probiotic *Lactobacillus* bacteria isolates viz. (named as D, F, G, L and 3) having good growth characteristics in the presence of *Aloe vera* juice was also carried out.

Optimization of *Kheer Mohan* Process

A technology was developed for the production and storage of cow milk *Kheer Mohan*. This developed technology resulted in 50 % reduction in cooking time as well as 5 (30 days) and 10 (60 days) times enhancement in its shelf life at refrigerated and ambient temperature, respectively.

Process Development of Low-sodium Cheese

Low sodium processed cheese was developed wherein sodium was reduced to a level of 70%. The product was evaluated for changes during storage and non-significant differences were observed between control and low sodium processed Mozzarella cheese. The product had an excellent meltability and stretchability.

Effect of Packaging Materials and Modified Atmosphere Packaging on the Shelf-life of Selected Composite Dairy Foods

The moisture sorption isotherms and shelf-life of selected composite dairy foods as affected by various packaging materials and modified atmosphere packaging were studied. The multivariate analysis techniques viz. cluster analysis and principal component analysis (PCA) revealed that peroxide value and sensory staleness were affecting the stability of complementary food during storage while sensory flavor and overall acceptability were affecting the storage stability of snacks. The shelf life of snacks, biscuits and complementary foods was found to be the best when packaged in metalized linear low-density polyethylene (MLLDPE), polypropylene (PP) and foil laminate (ALP), respectively. Based on the overall acceptability, the highest predicted shelf life of protein-rich milk-millet extruded snacks packaged and stored MLLDPE at 30, 37 and 45°C was found to be 133, 123 and 106 days, respectively. Complementary food was found to be shelf stable for only 42 days when stored at 45°C irrespective of the packaging materials. However, it was predicted to have a shelf life of 84, 87 and 92 days at 30 °C, when packed in nylon pouch, PET jar and laminate pouch, respectively. The model developed for predicting shelf life of the complementary packaged in laminate pouch at 45 °C, was found to be t = -4.441 + 0.097 PV_c + 0.963 ST_c. Modified atmosphere packaging (nitrogen flushing) of complementary food revealed that peroxide value, the critical quality attribute, was significantly reduced (P<0.001). The study revealed that modified atmosphere packaging (MAP) resulted in enhanced shelf life of milk-millet complementary food (from 45 days to 90 days). However, no major change in the shelf life of milk protein-rich extruded snacks could be found due to nitrogen flushing.

Effect of Transglutaminase-modulated Texturization on the Survival of Probiotic *Lactobacillus Gasseri* in *Dahi*

The objective of the project was to optimize the technological parameters for *dahi* making using *Lactobacillus gasseri* as well as to assess the survival of *L. gasseri* in texturized *dahi*. Four probiotic strains of *L. gasseri* with proven and pronounced anti-oxidative and anti-hypocholesterolemic properties were selected for the study. A co-culture technique using 14 *dahi* starters alongwith the four *L. gasseri* strains was attempted for making probiotic *dahi* and the best combination was selected for co-culturing for making *dahi*. Addition of microbial transglutaminase (mTG) at predetermined rates and time affected the survival of probiotic bacteria positively (approx 100 times increment), thereby substantiating the initial hypothesis. Thus a probiotic *dahi* was developed with sufficient probiotic count of *Lactobacillus gasseri* (10^6-10^7) with ice-cream-like scooping ability and a shelf-life of more than 21 days with 11.33% TS and 1.81% fat. The cost of developed product was approximately ₹ 61.22 per litre (₹ 6.12/100 g) when packaged in polystyrene cups.

Application of Cheese Making Principles to Indian Farmstead Artisanal Cheese

The study was conducted for optimizing the process for farmstead artisanal cheese making under Indian conditions and to study its ripening changes during storage. Standard cheese making protocol was modified to suit farmstead conditions. The process modification included varying the cooking temperature and brining time by the application of Response Surface Methodology. The optimised product contained 45.85% moisture, 54.16% TS, 29.58% fat, 22.34% protein, 2.83% ash, 1.05% salt, 0.04% lactose, 54.44% FDM, respectively. The product was ripened for 60 days to evaluate ripening changes. The product had good flavour and texture and remained acceptable up to two months. The study revealed that a good quality product could be made by applying the standard cheese making techniques to the Indian rural farmsteads. Farmstead artisanal cheese manufacturing will provide an avenue for product diversification, while simultaneously enhancing farm level incomes.

Shelf-life Prediction of Micronutrient Fortified Barley-Milk-Based Nutrimix

The present investigation was planned to study the effect of different packaging and storage conditions on the quality of barley-milk-based *nutrimix* was studied. It was packaged in either aluminium foil laminate pouch, nylon pouch or PET jar and stored at 30, 37 and 45°C. The equilibrium moisture content was found to be in the range of 1.63 to 46.58 g/100g (db) at 28-45 °C and 0.1-0.9 a_w. The adsorption isotherms were found to be similar to type-II curve. It was observed that BET model could aptly describe the sorption behavior in a_w range of 0.10-0.45, while GAB, Ferro-Fontan and Peleg models in the entire a_w range. Cluster analysis and principal component analysis (PCA) revealed that peroxide value, sensory staleness and lightness were affecting the stability of *nutrimix* during storage. The chemical reaction kinetics of both peroxide value (PV) and staleness followed zero order (n=0). The apparent activation energy (E_a) of PV of *nutrimix* packed in PET jar, nylon and laminate pouches were found to be 49.18, 42.74 and 38.19 KJ/mole, respectively. *Nutrimix* was found to be shelf stable for only 42 days when stored at 45°C irrespective of packaging materials. The model developed for predicting shelf life of the *nutrimix* packaged in laminate pouch at 45 °C, was found to be $t = -4.441 + 0.097\,PV_c + 0.963\,ST_c$.

Storage Stability of Thermally Processed Milk Added with Vitamin A and Iron

Combination of salt and Vitamin A acetate were fortified to buffalo toned milk and processed to thermal treatments (HTST pasteurization and Batch sterilization). During storage of thermally processed (pasteurized and batch sterilized) Ferrous gluconate (FG) and Vitamin A Acetate (VAA) fortified milk, various quality parameters namely pH, acidity, FFA, HMF, furosine, HCT, TBA, L*, a*, b*, WI, iron, Vitamin A, viscosity, proteolysis, microbiological and sensory attributes were studied. Samples fortified with FG15+VAA2500 showed non-significant changes compared to control sample; while FG20+VAA2500 and FG25+VAA2500 showed significant changes during storage at 4, 37 and 45°C in terms of physico-chemical and sensory attributes. The predicted shelf life of control and iron-Vitamin A fortified sterilized milk stored in glass bottles was found to be 250 and 210 days at 4°C; 182 & 160 days at 37°C and 120 &110 days at 45°C, respectively. However, the level of added VAA decreased rapidly after 30 days storage in sterilized milks samples stored at 37°C and 45°C to the initial levels.

Technology of Cheese-dip

Cheese dip was prepared utilizing different ingredients viz., Cheddar cheese, protein blend consisting of sodium caseinate and whey protein concentrate, milk fat and with the aid of processing agents like stabilizer and emulsifier. The level

of addition of each suitable ingredient and the selection of stabilizer and emulsifier was conducted on the basis of sensory attributes of the product. After selecting the level of addition of each ingredient, optimum level of addition from the selected range for each ingredient was achieved by Central Composite Rotatable Design of Response Surface Methodology for evaluation of individual and interactive effects of different factors on the responses (sensory, textural and rheological attributes). Type of spice and its level to enhance the sensory characteristics of the optimized product was selected on the basis of sensory scores. Four spices viz., oregano, cumin, black pepper and ginger were tried in the product to find out the most suitable spice and its level in the cheese dip.

Technology of a Breakfast Smoothie from Dairy and Plant Sources

Three variants of breakfast smoothie were formulated, based on sorghum, finger millet or chickpea flour alongwith a fruit (mango), vegetable (carrot), honey and milk sources so as to provide adequate amount of minerals, vitamins and dietary fiber. All the variants contained pre-standardized quantities of milk, mango pulp, carrot juice and honey. Germinated sorghum finger millet chickpea flour, sugar and pectin levels were optimized for the product formulation using Response Surface Methodology (RSM). The smoothie variants contained appreciable amounts of calcium, iron, and vitamin A, while the antinutrient phytic acid was reduced owing to processing treatments. Storage studies indicated that the smoothies remained acceptable for 75-90 days at 4°C and 60-90 days at 30°C. The cost of production ranged from ₹14.84 to ₹15.27 per 200 ml. The consumer studies involving 110 consumers indicated appreciable acceptability of the samples.

Composite Dairy-cereal Based Biscuits with Enhanced Functional Properties

Technology was optimized to formulate composite, reduced calorie, zero trans fat biscuits from a dairy-cereal base using whole multigrain flour, artificial sweeteners and fat replacers alongwith functional ingredients as fiber. Animal bioassays involving feeding trials revealed that the formulated product increased the HDL cholesterol with concomitant reduction in the LDL cholesterol, improved the regeneration of destroyed beta cells and enhanced the insulin sensitivity in diabetes-induced rats. The formulated product remained acceptable in terms of physical and sensory characteristics when packed in metalised LDPE pouches for 180 days at 35°C

Development of Barley-milk Based Fermented Probiotic Drink

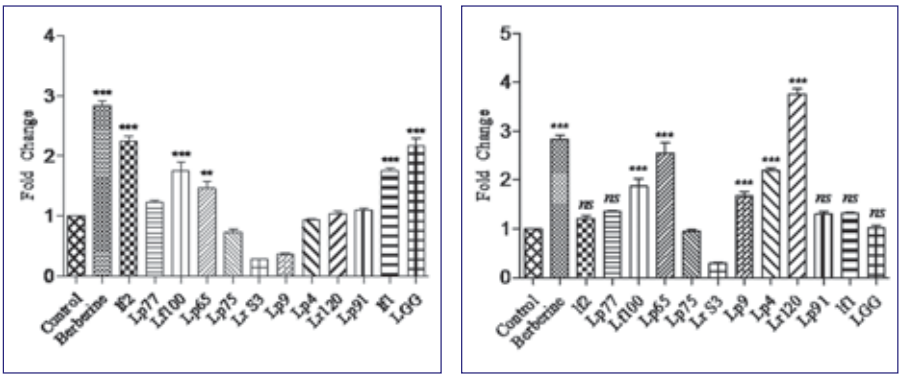
L. plantarum 344 co-cultured with *S. thermophilus* 20 was selected for the development of barley-milk composite based probiotic fermented drink. The optimized drink rated 7.8 (in between like very much and like moderately) for overall acceptability on 9 point hedonic scale and contained 8.59 log cfu/ml of probiotic strain, and 0.14 g/100 g β-glucan. Barley flour concentration was the most critical variable, which significantly ($\rho<0.01$) affected the overall acceptability, probiotic count and β-glucan content of probiotic drink. When analysed for antioxidant potential, the optimized probiotic drink exhibited 0.40 and 0.79 mg/ml trolox equivalent ABTS and DPPH radical scavenging activity, respectively. Antimicrobial activity of the supernatant obtained from optimized product was high against tested pathogens. The optimized drink remained best acceptable up to a period of 9 days when packed in PET bottles and stored at 5 ± 1°C. However, product packed in LDPE pouches, when compared with the PET bottles had significantly ($\rho<0.01$) higher non-LAB count and yeast and mould count. Cost of production per 200 ml product in PET bottle was estimated to be around ₹12.09.

Development of Cream Cheese Fortified with Inulin and Phytosterol

Cream cheese was made by both cold and hot pack method following traditional procedure for preparing cream cheese. Depending on sensory evaluation cold pack method was selected for further work. Among three starter culture, the NCDC -275 was selected as it resulted in better flavour in addition to higher rate of pH reduction as compared to other culture. To get suitable body and texture, the stabilizer was selected for cream cheese on the basis of its effect on sensory quality, textural attributes as well as rheological properties.

Research on Nutraceuticals from Milk, Functional Foods with Prebiotics, Micronutrients and Other Bioactive Compounds for Improved Human Health

Screening of probiotics and prebiotics for the expression of Glucagon like peptide-1 (GLP-1), a satiety inducing hormone, as prophylactics against Diabetes Mellitus – 2: A total number of twelve *Lactobacillus* strains which included eleven indigenous isolates and one reference strain were evaluated for their ability to enhance the expression of pro-glucagon and pro-GIP as well as the secretion of GLP-1 in STC cells using both live and their heat killed preparations. Live forms of Lf2, Lf1 and LrS3 were able to induce the expression of pro-glucagon gene at a significant level whereas Lf2, Lf100, Lf1 and Lp65 stimulated pro-GIP gene expression. Heat killed preparations of probiotics were comparatively more effective in stimulating the secretion of GLP-1. Heat killed form of Lr120 was able to stimulate the highest secretion of GLP-1 followed by Lf2 and LrS3. Heat killed forms of Lp91 and LrS3 elicited both GLP-1 secretion and expression but not GIP expression. However, live forms of both Lf1 and Lf2 induced both the secretion and expression at significant level. Besides, STC-1 cells when challenged with protein hydrolysates (whey protein and casein) as well as supernatant of fermented milk to determine their effect on the expression of pro-glucagon, pro-GIP and CCK and the secretion of GLP-1 were found to significantly alter the expression and secretion of gut hormones. The FTIR spectrum of 1kDa fractions indicated the presence of carbonyl function group (C=O) (1654cm^{-1}) and ether linkage (1215 cm^{-1}). Skeletal vibrational band of thioether was also recorded at 669 cm^{-1}, suggesting the presence of peptide moiety having some thioether group.



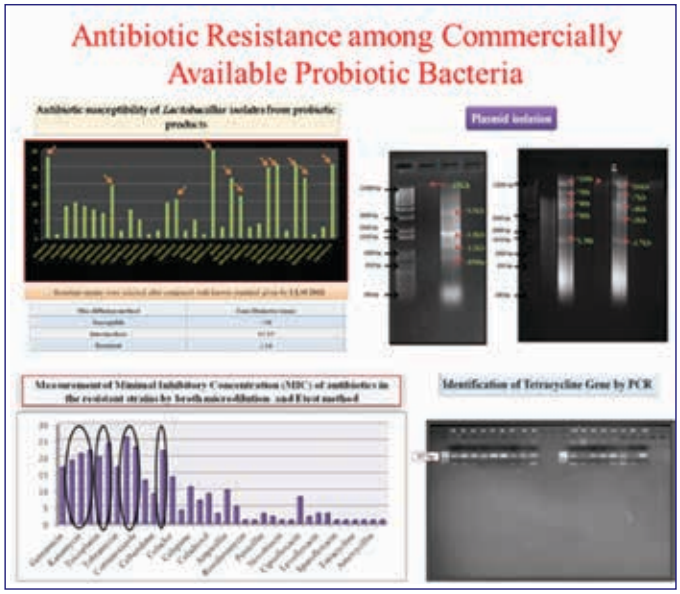
Live probiotic lactobacilli *Heat killed probiotic lactobacilli*

Expression of pro-GIP in mouse enteroendocrine cells induced with heat killed preparations of probiotic lactobacilli

Healthy foods: Production of stable and active probiotics: The cell biomass of a potential probiotic strain of *L. casei* NCDC 298 was produced under batch fermentation in MRS broth and whey based medium at pH 6.0 (inoculation rate 6.0-7.0 log cfu/ ml). The early stationary phase culture (9.0-10.0 log cfu/ ml) was obtained after 10 h at 37°C. The cell biomass was concentrated from the culture media by centrifugation (10000 rpm for 10 min at 4°C) and preserved as frozen concentrate and freeze dried powder forms. Viable counts were in the range of 11 -12 log cfu/g of freeze dried powder which were stable during storage at -20°C till 75 days. On the other hand, viable counts were in the range of 10 -11 log cfu/ ml in frozen concentrate and were stable during storage at -20°C till 60 days. Preserved *L. casei* NCDC 298 biomass was incorporated in fermented milk beverages @ 8 log cfu/ml of final product. The viable counts were also found stable during storage under refrigeration conditions till 7 days. The study indicated that the concentrate *Lactobacillus* culture can be used for value addition to the fermented and non-fermented dairy products.

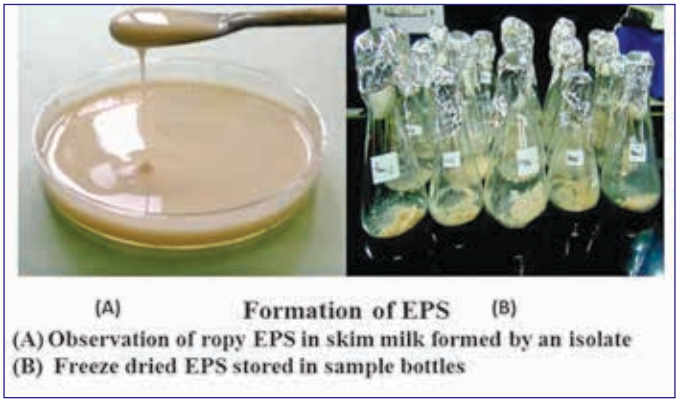
Status of antibiotic resistance among commercially available probiotic bacteria: As many as 42 commercial probiotic preparations (pharmaceutical preparations and dairy products) were procured from the market. Out of these, 17 products contained *Bacillus coagulans* as probiotic organism and hence were not considered for this study. Further, no probiotic organism could be isolated from 6 products and 2 had *Lactobacillus strains* whose identity didn't match to the ones *Lactobacillus* claimed on their labels. Thirty cultures were isolated from 19 probiotic products and characterized by microscopic, biochemical and molecular methods as *L. reuteri, L. acidophilus, L. rhamnosus, L. fermentum, L. plantarum* and *L. casei*. Antibiotic susceptibility profile of isolates was studied against 48 medically important antibiotics. A total of 29 strains were found to be resistant to antibiotics, some of which were resistant to multiple drugs and only one strain was found to be sensitive to all of the antibiotics. Isolated strains were found to be resistant against a number of antibiotics such as Penicillin, Methicillin, Tetracycline, Ampicillin, Gentamicin, Ofloxacin, Vancomycin, Nalidixic acid, Amikacin, Norfloxacin, Co-Trimoxazole, Teicoplanin, Cefadroxil and Norfloxacin etc. All the isolates had MIC higher

than the value prescribed by CLSI against a number of antibiotics. The results indicated the presence of multiple drug resistance in most of the isolates.



Development of resilient probiotic foods designed for the indian market conditions: Twelve isolates of Bifidobacteria of native origins were evaluated for probiotic and functional attributes by *in vitro* methods. Three native strains of *Bifidobacterium* spp. were characterized as potential probiotics by *in vitro* techniques. Six potential strains of indigenous *Lactobacillus* cultures (*Lactobacillus rhamnosus* RSI-3, *L. fermentum* RS-2, *L. casei* NCDC 298, *L. reuteri* LR 6, *L. gasseri* Lg70, and *L. gasseri* 2Sc) selected on the basis of their previously studied probiotics attributes for further use were revalidated for their *in vitro* probiotic attributes.

Diversity of exopolysaccharides produced by lactic acid bacteria: Fifty different strains of EPS producing lactic acid bacteria including *Streptococcus* and *Lactobacillus* genera were isolated from different



(A) Formation of EPS (B)

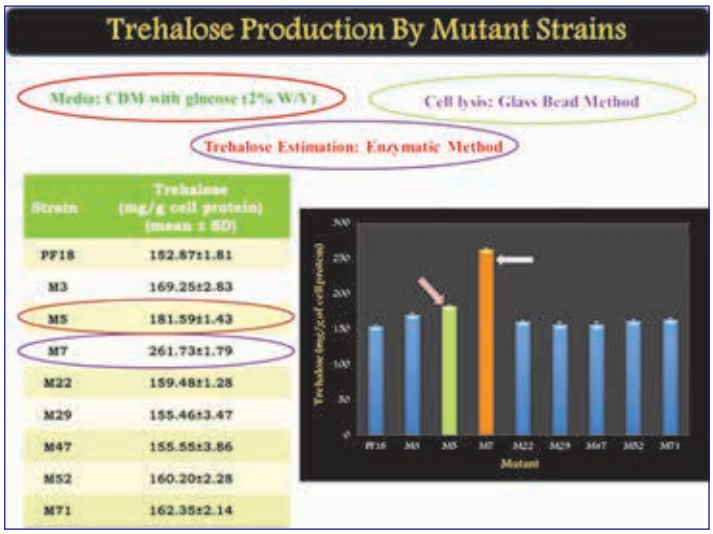
(A) Observation of ropy EPS in skim milk formed by an isolate
(B) Freeze dried EPS stored in sample bottles

villages and towns of Karnal district and identified upto a species level. The EPS produced by these isolates was extracted using ethanol precipitation followed by freeze drying for further use. Amongst the Lactobacilli isolates, *L. rhamnosus* (Ndri1) had shown the highest level of EPS at 215.21 mg/L followed by 213.11 mg/L by *L. rhamnosus* (Bha5) and 209.49 mg/L by *L. rhamnosus* (Kar1) whereas amongst Streptococci, EPS at a level of 196.54 mg/L was produced by *S. thermophilus* (MC1) followed 195.78 mg/L by *S. thermophilus* (MM1) and 194.14 mg/L by *S. thermophilus* (AM1). The lowest level of EPS was produced by *L. acidophilus* (Dam6) at a level of 96.12 mg/L and 94.59 mg/L by *S. thermophilus* (Nsp9).

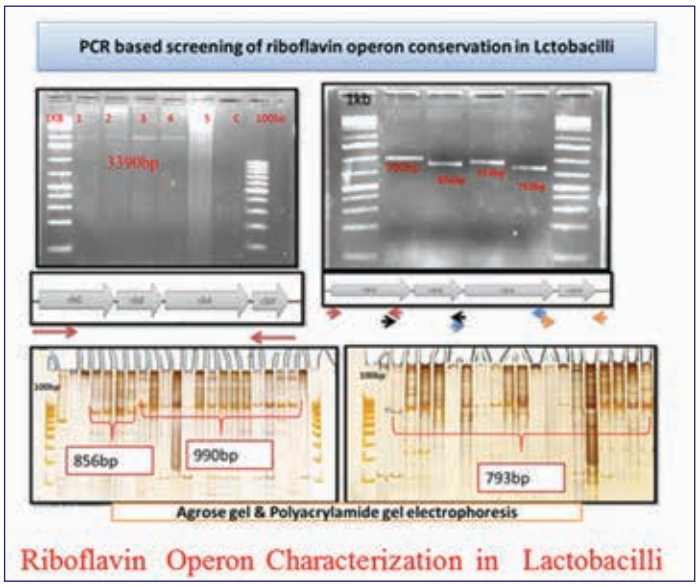
Veterinary type culture collection, (Dairy Microbes): A total of 30 lactic cultures were isolated from dairy and non-dairy samples, identified by biochemical and molecular methods and deposited in VTCC repository. These cultures belonged to three genera *Lactobacillus*, *Streptococcus* and *Lactococcus* which included *L. plantarum* (13), *L. brevis* (2), *S. thermophilus* (5), *L. rhamnosus* (3), *L. curvatus* (1), *L. paracasei* (1), *L. fermentum* (1), *L. acidophilus* (1), *L. delbrueckii* subsp. *bulgaricus* (1), *L. delbrueckii* subsp. *lactis* (1) and *L. lactis* (1). All 30 cultures were tested for titratable acidity, pH, curdling time and proteolytic activity. All cultures produced titratable acidity and pH in the range of 0.45-2.25 % (lactic acid) and 3.9-5.9, respectively. Curdling time varied from strain to strain and mainly affected by the origin of source. Cultures isolated from curd samples (VTCC 340 - 347) exhibited lesser curdling time 6-8 h than those isolated from non-dairy samples (30-56 h). Based on the proteolytic activity, five cultures were found to be highly proteolytic (VTCC 343, 347, 402, 406, 407), seven moderately proteolytic (VTCC 342, 345, 346, 400, 401, 405, 410) and seven weakly proteolytic (VTCC 340, 341, 344, 403, 404, 408, 409). Based on flavour producing ability, *L. plantarum* VTCC 408 showed highest flavour production (based on colour intensity). Among the EPS producing *S. thermophilus* cultures, highly ropy cultures can be used to manufacture stirred fermented milk products while less ropy and capsular strains can be used to prepare set products. Shelf-life storage study of Dahi with protective cultures at 7°C extended its shelf-life upto 30 days.

Trehalose production by dairy propionibacteria and its relationship with stress resistance: Forty isolates, from a total of presumptively screened 44 were identified as *Propionibacterium freudenreichii.* On screening by enzymatic method in chemically defined medium (CDM), 38 isolates were found to be trehalose$^+$. Among them, 13 isolates were low (6.6-50 mg/g cell protein), 17 moderate (50-100

mg/g cell protein) and 8 high trehalose producers (100-200 mg/g cell protein). PF18 (153.30 ± 3.12 mg/g cell protein) and PF13 (135.45 ± 3.84 mg/g cell protein) were found to be the highest trehalose producing isolates. Two different methods (enzymatic and HPLC method) of trehalose estimation showed a comparable efficiency and accuracy for trehalose estimation from propionibacteria. Optimization of trehalose production in CDM by RSM culminated into 1.33 and 1.4 fold increase in the trehalose yields for PF18 and PF13, respectively. Two mutants of PF18 i.e. M7 and M5 generated by ethyl methane sulfonate (EMS) exhibited similar growth rates as parent strain but 1.7 and 1.2 fold improved trehalose productivity, respectively. Three different strains of propionibacteria i.e. trehalose overproducing mutant M7, high trehalose producing parent PF18 and non trehalose producer PF4 were used for the evaluation of role of trehalose in resistance of *Propionibacterium* strains towards different set of stress conditions viz. osmotic, acid, heating, cold and oxidative conditions. The results of this study presented a positive correlation between trehalose content and the stress tolerance of propionibacteria except under oxidative stress. Cultivation of mutant M7 under optimized conditions resulted in trehalose yield of 295.71 ± 5.00 mg/g of biomass within 54h, which represents a 40% increase over the yield obtained under unoptimized conditions, thus, presenting a novel food grade strategy for the conversion of whey lactose into the commercially important nutraceutical trehalose.



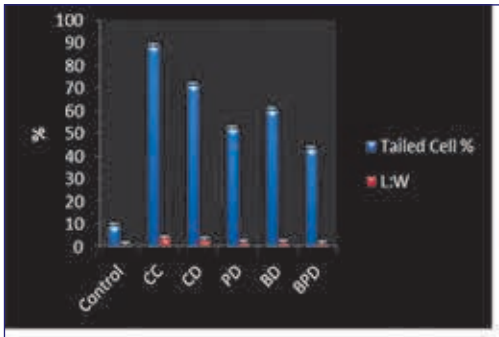
Riboflavin operon characterization in Lactobacilli: Among the 52 isolates bioprospected from dairy and non-dairy sources, 19 were found harbouring complete *rib* structural genes. The isolates harbouring both complete as well as incomplete operon were compared phenotypically for riboflavin production by chemical, fluorescence and microbiological based assays and the microbiological assay method was found to be the most sensitive among these methods. Among the 30 isolates tested for riboflavin production ability, 10 were found to be riboflavin producers. No difference was found in the size of 4 *rib* genes among the different isolates as confirmed by Polyacrylamide gel electrophoresis profile. Among them, KTLF1 and KTP13 were found to be the prolific riboflavin producers. The *rib* genes amplified in KTLF1 were cloned and sequenced. The riboflavin producing isolates were able to survive in a medium devoid of riboflavin as well as they have supported the growth of riboflavin auxotroph *L. casei* MTCC1408. Among the screened isolates on agar diffusion assay, the maximum increase in the growth of auxotroph was observed in the presence of KTLF1, KTLF3 and KTP13. Expression pattern of *rib* genes was studied in selected isolates viz., LF1, LF2, LF3, LF4, LF5M and MTCC8711. The range of relative fold in mRNA expression in *rib1* gene is 0 to 3.5 0 to 2.0 in *rib2* gene, 0 to 6.0 in *rib3* and 0 to 7 fold in *rib4* in MRS and RAM over control culture. The riboflavin producers were further screened for *in vitro* probiotic properties, safety aspects as well as technological properties.



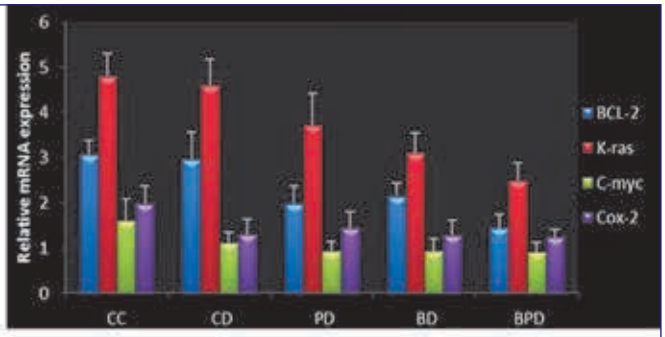
Antioxidative and immunomodulatory effects of conjugated linolenic acid producing *Lactobacillus* spp.: Conjugated linolenic acid (CLnA) producing lactobacilli were isolated from different sources like human, dairy based and non-dairy based products. Out of 191, only 78 isolates were able to tolerate and grow at 0.5 mg/mL Linolenic Acid (LNA) in medium. Out of these, only 44 produced CLnA (ranging from 15 to 58 µg/mL) in MRS broth.

Amongst these, 28 isolates were further screened in skim milk and varying levels of CLnA (i.e. 15 to 62 µg/mL) were obtained. Ten highest CLnA producing isolates were further confirmed for c9, t11, c15 and t9, t11, c15 isomers by GC in both MRS and skim milk and all the isolates produced the desired isomers with higher amount in skim milk than MRS. Maximum amount of c9, t11, c15 was produced by SIF56 (62.36 µg/mL) and SIF1 (55.97 µg/mL) followed by LDD38, SIF50 and SIF40. PCR identification of these isolates confirmed seven as *L. plantarum*, two as *L. fermentum* and one as *L. gasseri*. Of these, *L. plantarum* SIF40 showed potential probiotic attributes and after optimization of various parameters, it was revealed that maximum CLnA (45.54 µg/mL) production was at 0.5 mg/mL at pH 6.0 after 48 h of fermentation in skim milk. Overall, *L. plantarum* SIF40 was selected for anti-oxidative and immunomodulation studies *in vivo*. Its progressive supplementation (alone and/ or with LNA) to the albino mice for 30 days, induced with oxidative stress, significantly brought the important enzymes (i.e. catalase, glutathione peroxidase, superoxide dismutase and TBARs) levels to the normal in liver, kidney and RBCs. In immuno-compromised albino mice, the level of IgA were increased at 5th day in CLnA fed group, while IgG level at 8th day in SIF40 and CLnA fed group.

Anti-carcinogenic potential of blueberry fortified probiotic *Dahi* against colon cancer: Out of 29 *Lactobacillus* strains, probiotic *L. rhamnosus* CRD11 was chosen for the preparation of blueberry fortified probiotic *dahi* (BPD) on the basis of its best anticarcinogenic activity and compatibility with blueberry. The best combination of 8% blueberry pulp, 1.5% inoculum level and 9 h incubation time as recommended by RSM was used to develop blueberry fortified probiotic *dahi*. The anti-carcinogenic potential of probiotic *dahi* (PD) and blueberry fortified probiotic *dahi* (BPD) was evaluated in terms of histological, antioxidant, faecal and molecular parameters. Colon cancer was induced in male wistar rats by subcutaneous injection of 20 mg DMH/kg body weight weekly up to 15 weeks. The probiotic *dahi* alone and in combination with blueberry was effective to prevent the progression of colon carcinogenesis >90% in wistar rats. The tumor incidence, multiplicity and volume were lower in both BPD and PD fed groups as well as the decreased progression of preneoplastic biomarker such as aberrant crypt foci (ACF) and mucin depleted foci (MDF). The PCNA labeling index a marker for the progression of carcinogenesis in GI tract was increased progressively in the DMH challenged rats as compared to other treatment groups. Both probiotics and blueberry exhibited synergistic effect in preventing a rise in PCNA and p53 labeling index. The BPD fed group had higher antioxidant and detoxification activity as compared to DMH group. Expression of all the genes was higher in DMH control group as compared to BPD and PD groups. These groups also showed a minimum genotoxic stress as compared to DMH control group. Higher incidences of carcinoma tumors was observed in DMH control group with no carcinoma in PD and BPD fed groups. Inhibition of colon cancer was more in BPD fed group as compared to only PD fed group wistar rats.



Effect of dahi variants on DNA genotoxicity in wistar rats as observed by silver stain comet assay on DMH induced rats.



Influence of dahi variants on gene expression (BCl-2, K-ras, C-myc and Cox-2)

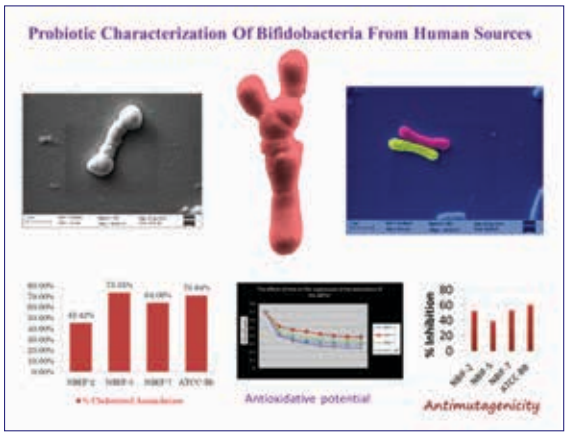
Mechanistic study of a potential indigenous probiotic *Lactobacillus* strain and its fermented milk formulations in enhancing intestinal barrier function in mouse model: A total of 35 indigenous strains of probiotic lactobacilli were subjected to a preliminary screening based on their antimicrobial activity against *Salmonella* Typhi Ty2 and *Salmonella* Typhimurium LT2. Lp77 exhibited highest autoaggregation (45.87 ± 7.61%) followed by Lp4 and Lp9 whereas, six *Lactobacillus* strains namely Lp77, LrhS3, Lp4, MTCC 5690 and Lr120 exhibited a relatively higher coaggregation rates

with *S. typhimurium* LT2. In bacterial interference assay using HT-29 cells, Lr120 and Lp9 displayed the greatest exclusion efficacy of 59.07 ± 7.01 and 59.16 ± 1.17% against *S. typhi* Ty2, respectively. Pre-treatment with probiotic *Lactobacillus* strains resulted into enormous difference in the induction of intestinal barrier function genes in *S. typhi* Ty2 challenged HT-29 cell monolayer. MTCC 5690 evoked significant up regulation of occludin, claudin-1, ZO-1 and TLR2 in HT-29 cells in both control and pretreatment conditions. However, contrary to this, a significant down regulation of TLR4 gene (0.055 ± 0.002 fold) was recorded under the same conditions. MTCC 5690 was finally selected for the preparation of fermented dairy products in combating *S. typhimurium* LT2 infection in mice model. Measurement of *in vivo* intestinal permeability and histological analysis of ileum revealed that probiotic fermented products effectively maintained the health and integrity of intestinal epithelium. The expression data revealed that the changes caused by MTCC 5690 in intestinal barrier function were established by the modulation of key regulatory receptors TLR2 and TLR4. These effects were further validated by immunohistochemistry of ileum, which demonstrated the continuous and intense staining pattern and regular organization of IBF proteins in probiotic fermented products. The study indicated that consumption of indigenous probiotic *L. plantarum* MTCC 5690 in the form of fermented dairy foods could increase the functioning of intestinal barrier in normal health as well as in enteric infection conditions.

Milk protein hydrolysates as prospective agonist for the expression of gut hormones by mouse enteroendocrine STC-1 cells: Milk protein hydrolysates were prepared by enzymatic hydrolysis of casein and whey proteins with pepsin and pancreatin as well as by the fermentation of reconstituted skim milk with *L. helveticus* strains. The STC-1 cells were challenged with protein hydrolysates (whey protein and casein) as well as the supernatant of fermented milks to determine their effect on the expression of proglucagon, pro-GIP and CCK and secretion of GLP-1. It was observed that these hydrolysates possessed an ability to alter the expression and secretion of gut hormones. Further attempts were also made to purify and characterize the bioactive peptides present in the protein hydrolysates by ultrafiltration (10, 3 and 1 kDa) and reversed phase chromatography (RPC). During the purification by RPC, two active peptides *viz*, WP3 F5 and CP1 F7 from whey protein and casein, respectively were obtained. WP3 F5 up-regulated the expression of proglucagon, proGIP and CCK by 1.37, 1.37 and 1.29 folds, respectively. Similarly, CP1 F7 up-regulated the expression of proglucagon, proGIP and CCK by 5.2, 2.5 and 0.78 folds, respectively. These two peptides also increased the secretion of GLP-1 by 1.2 and 2.5 fold, respectively. However, the 1 kDa fraction of *L. helveticus* NCDC 288 fermented milk supernatant showed the maximum expression of proglucagon, pro-GIP and CCK by 3.9, 1.5 and 4.5 folds, respectively and the secretion of GLP-1 by 3.1 fold.

Probiotic characterization of Bifidobacteria from human sources: A total of 40 probable isolates were obtained from different sources (Milk, Infant and Adult faeces). Out of which only 12 were found to be positive for fructose-6-phosphate phosphoketolase (F6PPK). These isolates were further characterized using genus specific PCR with primer pair P0 and Lm3, which gave positive amplification band of 1.4kb. 16S rRNA sequencing of selected isolates identified these isolates as *B. animalis* (8), *B. breve* (3) and *B. pseudocatenalum* (1). These isolates were further subjected to a subtractive system of *in-vitro* analyses based on the guidelines for evaluation of probiotics. Three bifidobacteria strains out of 12 were finally selected on the basis of their discernible probiotic attributes (resistance to bile and low pH, inhibition of intestinal pathogens, and attachment to intestinal cells) for safety evaluation (antibiotic resistance, haemolytic activity and mucin degradation). The absence of hemolytic activity and mucin degradation were found invariably among all the strains. The study was further extended to evaluate the isolates for their potential antioxidative, antimutagenic and hypocholesterolemic properties.

Differential proteome analysis of putative probiotic *Lactobacillus fermentum* strains: The study was carried out to identify key proteins which may be used to screen novel probiotic strains. As



many as 185 common and 8 new spots were obtained in control and treated samples (1.2% bile salt) of BIF-19. Bile stress changed the protein profile of *L. fermentum* BIF-19 in which some pathways were activated and others were suppressed. The proteins involved in the regulation of homeostasis, ABC transporter, carbohydrates and lipid metabolism were highly activated while those involved in the reproductive functions were down-regulated during the bile stress. Nucleotide synthesis and cell division were suppressed under the bile stress in order to balance the internal environment of the organism.

Probiotic attributes of β-galactosidase (β-Gal) positive dairy yeasts: The present investigation was carried out for screening of β-Gal activity in probiotic dairy yeasts (*Kluyveromyces*). Isolates (n=112) of yeasts were obtained from different sources and from different dairy products (i.e. dahi, raw milk, lassi, butter milk, cream, etc.). Amongst them, 45 isolates were β-Gal positive and were found to be *Kluyveromyces* spp. when subjected to PCR based identification. The isolates with higher β-Gal activity (n=10) were further tested for probiotic attributes. Isolates screened at different pH (i.e. 1.5, 2.5, 3.5 and 6.5) were tolerant to low pH and also exhibited tolerance to bile salts (0.5, 1.0 and 2.0%). The isolates possessed resistance to gentamycin, penicillin, vancomycin etc., but failed to reveal antimicrobial activity against *Salmonella typhi*, *Listeria monocytogenes, Staphylococcus aureus, Bacillus cereus* and *Escherichia coli*. None of the isolates (n=10) produced gelatinase and DNase.

Direct Vat Set (DVS) *Misti Dahi* Culture: *Misti dahi,* one of the most popular indigenous fermented milk product in India, is still prepared using undefined mixed strain starters and by traditional methods. Since concentrated freeze dried starter cultures are not available, there is a need for the development of cost-effective viable process for the production of concentrated *Misti dahi* culture. The present study was taken up to produce concentrated freeze dried starter culture using cost effective whey based medium (WBM). Growth performance of *Misti dahi* culture was comparable in whey based medium (K=1.06) and M17 (K=1.14) broth. Increase in growth rate was observed in fermenter scale study (K=1.23) and it was further increased upon controlling pH at 6.5 (K=1.43). Culture biomass was produced at fermenter level for preservation. Culture biomass produced was harvested by centrifugation, re-suspended in freeze-drying medium and subjected for freeze drying. Viable counts of freeze dried DVS cultures were 11-12 log cfu/g. Dry culture was packed in cryo-vials and vacuum sealed glass ampoules. Packed cultures were stored at -20 ± 1°C and analyzed for viable counts and suitability in the preparation of *Misti dahi*. Viable counts of DVS *Misti dahi* cultures remained in the range of 11-12 log cfu/g till 60 days and no significant differences in viability of culture in cryo-vials and in vacuum sealed glass ampoules were observed. Curd setting time of DVS culture was 8.5 h which remained same during storage, whereas for fresh culture, it was 6.5 h. Textural, physiochemical, microbiological and sensory qualities of *Misti dahi* prepared using DVS and fresh culture were comparable for 30 days storage.

Production of colostrum whey derived antimicrobial bioactive peptides by proteolytic *L. helveticus* 288 and *L. rhamnosus* C6: Colostrum whey was prepared by acid hydrolysis and whey protein fractions of 10, 5 and 3 kDa were prepared by ultrafiltration. Antimicrobial activity of colostrum whey concentrated (10 fold) and protein fractions was evaluated against five pathogens namely *B. cereus*, *E. coli*, *L. monocytogenes*, *S. typhi* and *S. aureus*. Concentrated colostrum showed antimicrobial activity against *B. cereus* and *E. coli* only. Colostrum whey was fermented by proteolytic *L. rhamnosus* C2 and *L. helveticus* 288 and peptide fractions (3, 5, 10 kDa) of fermentate were tested for antimicrobial activity. Fermented colostrum whey (concentrated) showed maximum antimicrobial activity against all the pathogens. Ten kDa fractions of the fermentates showed activity but 3 and 5 kDa fractions did not show antimicrobial activity. Colostrum whey showed maximum antimicrobial peptide production at 37°C incubation temperature, with 2% inoculum at 4 pH. Colostrum whey fermentate, its concentrate and 10 kDa peptides were stable even at 3.0 pH, temperature of 63°C/30 min, and pepsin and trypsin treatments.

Fermented whey and soy beverages with curcumin supplementation: Soy milk was prepared by adding whey in place of water and supplemented with curcumin. *L. acidophilus* NCDC195 (LA195) and *S. thermophilus* NCDC323 (YC323) were used for the fermentation of whey and soy. After 24 h of incubation at 37°C, their acidity and total counts were 1.38, 1.41 and 9.09, 9.39 log cfu/ml, respectively. LA195 and YC323 showed antimicrobial activity against *E. coli, B. cereus, S. aureus, L. monocytogenes, Sh. dysentriae, and S. typhi*. Zone of inhibition ranged between 16 to 23 mm. Maximum antioxidant activity was obtained by LA195+YC323 (989.70 TEAC (µM)) with curcumin. On the basis of maximum antimicrobial activity and antioxidant activity, LA195+YC323 were selected for the preparation of whey and soymilk based fermented drink at 2% of inoculum level at 37°C for 20 hrs. Acidity, pH and log count (cfu/ml) were 1.58% lactic acid, 3.98 and 8.42. Soy beverage with 12% sugar solution had more acceptability in terms of colour and flavour on the basis of 9 point Hedonic scale. Product was stable for 14 days at 4°C and no coliform and yeast and molds were present.

Value Addition of Traditional Milk Products through Application of New Processes, Biotechnological Interventions, Packaging and Mechanized Manufacturing System

Preservation potential of bioactive components of essential oils in dairy foods: The selected natural bioactive components i.e. transcinnamaldehyde (TC), citral (C) and eugenol (E) were evaluated for their synergies, sub-inhibitory concentrations (SIC) and effect of food matrices on their antimicrobial efficacy against *Listeria monocytogenes* ATCC 15313, *Escherichia coli* O157:H7 and *Saccharomyces cerevisiae* NCDC42 in food model media, skim milk and flavoured milk. Eugenol exhibited higher killing effect in sterilized milk against *L. monocytogenes* ATCC 15313 as compared to *E. coli* O157:H7. The growth of pathogens in the presence of SIC concentrations of bioactive components reduced their adhesion ability and made them more susceptible to gastrointestinal environment *i.e.* bile salts and low pH. Sub inhibitory concentrations of bioactive components adversely affected nutrient utilization pattern. The bioactive components showed immense potential as natural preservatives to enhance food safety and shelf life of dairy foods.

Whey to Biofuel: Bioethanol production by stress tolerant and metabolically engineered yeast from whey: Out of 213 thermotolerant yeasts isolates, about 15% were able to tolerate 20% of initial sugar concentration. Among the nine thermotolerant *Kluyveromyces* spp. identified by 18S rRNA sequencing, all of them showed tolerance to 7.5% ethanol concentration. The yeast strains C17, C18 were able to produce up to 8 -10 % ethanol in 20% sugar concentration in broth as well as from galactose alone. *K. marxianus* MTCC1389 was hyper β-galactosidase producer with maximal amount of β-galactosidase activity (3398 miller unit) followed by 6C17 and 6C18. The maximal enzyme production by MTCC1389 was observed at 37°C, pH 5.0 and 30 h incubation. *Klyuveromyces* strain 6C17 and 6C18 showed diauxic growth in glucose and galactose, and glucose and lactose. Out of seven cultures of *Kluyveromyces marxianus* (MTCC1389, 1388, 188, 4059, 4136, 242, and 4139), MTCC 1389 tolerated sugar (lactose) upto 20%, produced ethanol upto 7.5% and showed growth upto 42°C. β-galactosidase activity was also found to be the highest (3398 Miller units) in MTCC 1389. This strain also adapted to high lactose (20%) and produced ethanol (8%v/v), residual lactose (3%w/v) and glycerol (6.3g/L) in whey. *K. marxianus* MTCC 1389 was also used for the production of β-galactosidase and the activity of the enzyme was found to be 5244 Miller Unit. Among the two strains of *Saccharomyces cerevisiae* (Industrial strain and *Saccharomyces cerevisiae* MTCC 170), the industrial strain showed good tolerance to temperature, sugar and ethanol.

Bioprotective cultures for enhanced safety of dairy products: In the present study, 230 lactic acid bacterial cultures were isolated from raw milk, kimchi, dosa batter, dahi and lassi. Out of these, six cultures showing good antimicrobial activity were further used as bioprotective cultures. These six cultures were identified by species specific 16s-rRNA PCR assay and were found to be one strain each of *Lactobacillus rhamnosus* and *Lb. paracasei* and four strains of *Lb. plantarum*. The cultures possessed antifungal activity against *Saccharomyces cerevisiae* MTCC170, *Saccharomyces cerevisiae* MTCC172, *Aspergillus* spp. and *Penicillum* spp. and also exhibited good antibacterial activity against several Gram-positive and Gram- negative bacteria. *In situ* bioprotective capacity of these cultures was evaluated in dahi. Dahi prepared with bioprotective cultures as co-cultures showed shelf life of at least one month at 7°C. These cultures are bioprotective in nature when used as co-culture with dahi cultures as they could extend the shelf life of the product to more than 30 days.

Clean Milk Production with A Focus on Emerging Health Concerns and Development of New Generation Tools for Ensuring Quality Control Through Application of Newer Chemical and Biotechnological Concepts

Monitoring of drug and environment pollutants: A total of 50 commercial feed, 51 raw and 26 pasteurised milk samples were collected from different places and analysed for the presence of Aflatoxin B1, M1 and antibiotic residues.

Estimation of Aflatoxin B1 in feed : Overall incidence of Aflatoxin B1 in feed sample was observed at different levels i.e. 8 % samples were found positive below 5 ppb, 2 % in the range of 5-10 ppb, 6.0 % in between 10-15 ppb, 6.0% between 15-20 ppb, 6.0 % between 20-25 ppb, 22 % between 25-30ppb, 48 % (24 Nos.) between 30-35 ppb and 8.0% samples were found contaminated in the range of 35-40 ppb level of aflatoxin B1.

Estimation of aflatoxin M1 in raw and pasteurized milk samples : In raw milk, 12 out of 51 samples (23.53%) were found positive at 0.5 ppb and 14 samples (27.45%) were found positive at 0.25 ppb level of aflatoxin M1, while rest of the samples were found negative for the presence of Aflatoxin M1. In pasteurized milk, 8 out of 26 samples were found positive at or above MRL i.e.0.5 ppb.

Estimation of antibiotic residues in raw and pasteurised milk : Overall, 11 milk samples (3 Raw + 8 Pasteurized) were found positive for antibiotic residues.

Development and evaluation of spore based biosensors for monitoring of pesticide residues in milk: Spore germination protocol in the presence of specific germinant was optimized and expression of five enzymes namely esterase, β-glucosidase, α-glucosidase, α-galactosidase and α- amylase was established successfully in *Bacillus megaterium* 2949 during spore germination. "Three steps" assay protocol which involved spore germination; pesticide exposure; and substrate addition was developed in tube and similar protocol with reproducibility was also achieved on paper strip (whatman filter paper no. 602 H). Pesticide sensitivity upto1.0 and 10 ppb with paraoxon-ethyl could be achieved using developed assay employing two different substrates namely indoxyl acetate and 4-nitrophenyl-butyrate, respectively. Sensitivity of 10 ppb which comply the MRL established limits set by EU i.e 20 ppb was also verified on 96 well plate assay. Solvent evaporation step was introduced in the developed protocol to avoid their interference in enzyme pesticide inhibition

Development of enzyme-spore sensor for monitoring antibiotic residues in milk: Different strains of *Bacillus stearothermophilus* (69, 206, 326, 327 328, 330, 331, 332, 333 NCDC and 2235 NCIM) were screened for marker enzyme (s) i.e. α-D-glucosidase, α-D-galactosidase, β-D-glucosidase, β-D-galactosidase, α-D-mannosidase, β-D-xylosidase, β-D-glucuronidase, esculinase and acetyl esterase activity. *B. stearothermophilus* 69 was selected for assay developments since this strain exhibited significantly higher. AK among five different media exhibited better spore germination wherein color change was observed in 3.0 hrs. This medium was further modified and re-optimized by removal/addition of different components and spore germination time was improved. Then ESBA was developed by optimizing spore concentration (100 ± 10µL), volume of germination medium (200 ± 10µL), chromogen concentration (100 ± 10µL), quantity of milk (100 ± 10µL) and time/temperature combination of spore heating (100 ± 1°C/15 ± 1 min.). The developed assay was evaluated for limit of detection (LOD) of different antibiotics like gentamycin, neomycin, streptomycin, kanamycin, penicillin, amoxicillin, ampicillin, cefazolin, cefalexin, oxacillin, tetracycline, sulphadimidine, erythromycin and chloramphenicol when spiked in milk at ≥ MRL level set by codex could be detected. Enzyme spore based assay was also checked for the inhibitory effects of detergents like sodium hydroxide and sodium hypochlorite and 0.8% and 100 ppm levels were found non inhibitory, the QAC was interfering at 10 ppm level, formalin (0.02%) and hydrogen peroxide (0.05%) showed inhibition at low concentrations. Aflatoxin M1 and Pesticides presence in milk were found insensitive to working of enzyme spore based assay developed in current study. The assay was evaluated with 200 samples of raw and pasteurized milk procured from different sources. Performance of assay was found similar with charm II assay and ROSA test and showed excellent performance under field conditions.

Value Addition to Traditional Milk Products through Application of New Processes, Biotechnological Interventions, Packaging and Mechanized Manufacturing System

Machine vision system for quality evaluation of dairy products based on colour measurement: Machine Vision System (MVS) Color Desk system was designed and developed. System was calibrated using 24 colour Macbeth chart. Calibration equations were developed in MS-Excel and various models were evaluated. A method was developed to apply the calibration models for the correction of color values. Digital images were taken in standard lighting conditions (4 lamps, color temperature of 6500 K). Various image resolution were tried (0.3, 2, 8 and 16 mp) and the system validation was completed by 21 shade test chart. For image processing and analysis, Scilab 5.4 software was used. The system was successfully evaluated for colour measurement of plain *burfi*. The developed system can be used for improving quality control and providing a highly useful color measuring tool for the food industry.

Development of weight based metering and filling system for viscous dairy products: Engineering parameters of rice *kheer*, a viscous dairy product, were determined at various levels of total solids (25.5% to 45.1%). Bulk density ranged between 1027.3 to 1062.9 kg/m^3. The textural parameters such as firmness, work of adhesion, work of shear and stickiness ranged between 0.2909 to 0.449N, -007 to -0.117mJ, 1.040 to 2.003mJ and -0.020 to -0.034N, respectively. Hardness of cooked rice grain decreased from 11.068 to 4.180N with an increase in total solids. The rheological parameters of rice *kheer* serum were determined for different total solids (25.5% - 45.1%) at different temperatures (25 - 45^{o}C). Apparent viscosity was found to increase with increasing total solids but decreased with increasing temperature. Yield stress ranged from 0.4226 – 0.6709 Pa. On the basis of engineering parameters of rice *kheer*, a metering and filling system was designed and it is under fabrication in Research and Development Workshop of Dairy Engineering Division.

Modelling the Moisture Sorption Isotherms in Selected Dairy Products Using Soft Computing Techniques

Intelligent models based upon three soft computing approaches, *i.e.*, connectionist, Adaptive Neuro-Fuzzy Inference System (ANFIS) and Neuro-Genetic-Algorithm (NGA) models were developed to predict the sorption isotherms (adsorption and/or desorption) at different temperatures between 10 to 45°C depending on a product, over a water activity range of 0.11–0.97 for dry dairy products, *viz.*, dried acid casein, fortified Nutrimix (weaning food), skim milk powder, whey protein concentrate, Gulabjamun mix; and for a high moisture dairy product, Peda. The prediction potential of these intelligent models was compared *vis-à-vis* the performance of conventional empirical models, *i.e.*, Brunauer, Emmett and Teller (BET), Caurie, Halsey, Oswin, modified Mizrahi and Guggenheim- Anderson-de Boer (GAB) models that were also developed in this study. In general, the ANFIS hybrid model exhibited the overall best performance while the GAB model was found to be the best among the conventional models. Accordingly, product-wise comparative analysis of these two models' prediction accuracy in terms of Root Mean Square percent error (%RMS) is as follows: Casein powder – ANFIS models 0.09-0.2 (adsorption) and 0.15-0.33 (desorption), GAB models 1.93-5.78 (adsorption) and 1.4-4.95 (desorption); Nutrimix powder – ANFIS models 0.09-0.34 (adsorption) and 0.23-0.35 (desorption), GAB models 5.48 - 10.60 (adsorption) and 5.54 - 9.54 (desorption); Skim milk powder – ANFIS models 0.07-0.15 (adsorption) and 0.14-0.19 (desorption), GAB models 4.92-6.25 (adsorption) and 4.79-6.24 (desorption); Whey protein concentrate powder – ANFIS models 0.13-0.19 and 0.15-0.21 (desorption), GAB models 5.04-5.78 (adsorption) and 5.99-6.68 (desorption); Gulabjamun mix – ANFIS models 0.65-0.95 (adsorption), GAB models 7.24-12.63 (adsorption); and Peda – ANFIS models 0.20-0.40 (adsorption) and 0.44-0.54 (desorption), GAB models 4.87-6.28 (adsorption) and 6.18-6.79 (desorption).

Hence, soft computing paradigm (especially hybrid ANFIS model) is potentially intelligent modelling tool for dairy and food industry to determine various parameters for design and optimisation of drying equipment, design of packages, predictions of quality, stability and shelf-life, and calculating moisture changes that may occur during storage of these (or similar) Indian dairy/food products.

Costs and Returns in Milk Production: Developing Standardized Methodology and Estimates for Various Production Systems

The cost estimates of agri-based enterprises in agrarian economy of India are vital for improving the resource use efficiency of the farm inputs and ensuring remunerative prices to the farmers. A uniform standardised methodology for estimation of cost of milk production was developed and the economics of milk production was worked out in three types of production environments in the country, *i.e.*, dynamic, transient and under-developed. Characterisation of production environments were done on the basis of four parameters related to dairy, *viz.*, milk yield, cropped area under fodder, milk production density and infrastructure status. In each production environment, three belts, geographically distinct from each other were selected to give a fair geographic representation.

A software: Milk Production Economic Analysis Package (MILKEcAP: 1.0) was developed to facilitate database management of the survey data and to provide ready estimation of cost and returns from milk production from local cow, crossbreed and buffalo, based on the standardised methodology.

The results of cost and returns (2012-13 prices) showed that the gross cost of maintenance of the crossbred cows is the highest in Western Maharashtra (₹ 206/animal/day) followed by Northern Plains (₹190/animal/day). The maintenance cost of local cows was in general lower, particularly so in the underdeveloped production environment (up to ₹ 85/day) as it is a low input system. The cost of milk production from local cows showed wide regional variations, ranging from ₹ 22.3/*l* in Uttrakhand to ₹ 46.6 in Western Maharashtra. The productivity of local cows is low (1.2-3.6 *l*/day), except in Malwa region, where average milk yield was 5.2*l*/day. In the underdeveloped production environment, the animals are heavily dependent on common property resources for their subsistence; and hence, the out-of-pocket expenses for the farmers are low. In the hill region of Uttrakhand, the sale price of milk is able to cover all the costs and leave a surplus. The transient production environment also has substantial size of indigenous milch cattle stock, but the maintenance of milch animals for milk production is not economically viable in the region except for the Malwa region of M.P. where productivity is reasonably good. The economic viability of crossbred cows is much better than that of local cows. The farmers are at least able to cover their operating costs in all the parts of the study area. The cost of buffalo milk production is highest in Gujarat (₹ 39.7/*l*), but the farmers are able to earn positive net economic margin on account of the remunerative prices offered by the cooperative network. In the buffalo dominant areas of northern India, the cost of buffalo milk production is lower than in Gujarat, but farmers are not able to get good price of their product. The region has a preference of high fat based milk of buffaloes, but the vendors and middlemen who collect most of the milk produced, corner a substantial share of consumers rupee giving low farm-gate prices of milk to the farmers.

Sustainability of Smallholder Dairy Production System in Under-developed Production Environments

In the Uttrakhand state, based on the data of 300 milk producing households from 30 villages of two districts, *viz.*, Nainital and Almora, farm household typologies were constructed by using two multivariate statistical techniques, *viz.*, Principal Component Analysis (PCA) and Cluster Analysis (CA). Four homogenous groups (clusters) were: C_1 (28.42%) - small landholding, buffalo stock, adoption of technology low; C_2 (40.75%) - buffalo stock, technology adoption; C_3 (22.60%) - low intensity of market participation; and C_4 (8.22%) - crossbred cattle, market participation high, and technology adoption. Among the smallholder farmers also, there was substantial heterogeneity in sustainability status across farms, ranging from average of 0.19 on C_3 to 0.86 on C_4 with an overall average of 0.49. On a 0-1 point scale, the economic sustainability scores were above 0.8 for all clusters except C_3 indicating encouraging economic status of dairy farming. This was also reflected in the positive net economic margin from all three types of dairy animal. The increased market orientation improved the economic sustainability of the dairy farmers. The social and ecological dimensions are weak links in the hill region. The improvement in the same can be brought about through policy focus on infrastructure development, technology dissemination and eco-friendly utilisation of dung.

In the tribal belt of Chhattisgarh, also characterised as underdeveloped dairy production environment,

the economic dimension of sustainability is very weak. Low productivity and low sale price of milk (₹ 26-27 for cow milk and ₹ 29 for buffalo milk) are major factors for poor economics of milk production. Also, the ecological sustainability scores in the region are very poor (0.38) on account of poor livestock support services and ensuing unscientific breeding practices. In order to make dairy farming sustainable in the region, breed improvement thus, needs to be the priority area for research and development policy.

Quantitative Assessment of Gains from Indian Dairy Trade and Economic Partnership Agreement with ASEAN Countries

From a heavily import dependent country in dairy during 1980s, India has evolved as net exporter of dairy products during the last three decades. In order to promote trade, several policy measures have been undertaken, including signing of multilateral regional trade agreements such as AIFTA. This study analysed the gains from higher exports to dairy entrepreneurs in the form of improvement in Price-Cost Margin (PCM), Total Factor Productivity (TFP) and Technical Efficiency (TE), varietal gains to the consumers of dairy products through imports and assesses the potential trade gains from this regional agreement. The study was based on secondary data from various sources on several variables, the major being dairy trade statistics for the last three decades (1980-81 to 2009-10) and data on principal characteristics of Indian dairy industry (1980-81 to 2008-09) from Annual Survey of Industries. Trends indicated high instability in trade, diversification of trade basket and decrease in market concentration. India has diversified its imports and export basket from traditional dairy products like concentrated and sweetened milk & cream, and fat based products to value added dairy products like cheese & curds, whey based products, yogurt & other acidified dairy products. Sources of dairy imports were diversifying from European countries to Oceania and Asian countries. New export markets have emerged in the African countries. The performance of dairy industry in terms of PCM, TFP and TE has improved over the years but the extent of improvement varied widely among states and over time with changing policy horizon especially during the liberalisation phase. Export intensity had significantly positive influence in improving the performance of dairy industry, suggesting that dairy entrepreneurs gain from enhancing exports. Increase in varietal imports had effect on price index of dairy commodities and gains from variety were 4% of the change (TE1993-TE2010) in gross value of output from dairy sector. Simulation exercise on tariff reduction under AIFTA suggested that India stands to benefit from exports only to Philippines, Vietnam and Myanmar, while the threat of increased imports in India is not alarming. In light of the empirical evidence of gains to domestic producers and consumers from trade in dairy products, the study concludes that policy and research emphasis should be on development of efficient milk value chain to boost trade. Drawing from the lessons of limited export potential created under AIFTA, the study contends that *ex-ante* analysis of any such trade agreement can be instrumental to provide policy support for the benefit of dairy sector.

Water Footprints of Crop and Milk Production in Rain-Fed and Irrigated Regions

Two district level studies, one, in state of Andhra Pradesh and the other, in Punjab were conducted to assess the consumptive water use in production of major crops and milk and implications were drawn for the sustainable water use in the states. The estimates were generated on basis of area, production and value of output. In Andhra Pradesh, the water footprints in monetary terms were highest for Paddy (283 m^3/'000 ₹), followed by Red Gram (245m^3/'000 ₹) and Sorghum (152 m^3/'000 ₹). The estimates of water footprint of milch animals showed that consumptive water use of crossbred animal (10.56 m^3 per day) is five times greater than local cow (2.01 m^3 per day) and nearly double than buffalo (6.73 m^3 per day), primarily due to their higher feed requirement. In terms of milk output, at the state level, the water footprints are higher for buffaloes than cows. Taking weighted average of consumptive water use per unit of value of milk production of all three types of animals, the weights being the total production of milk from each animal type in the district, the average water footprint works out to be 0.06 m^3/₹ that is, 60 litres of water is consumed to produce a rupee worth of milk output in Andhra Pradesh. The estimates of groundwater requirement based on the water footprint of crop and milk production showed that six districts of Andhra Pradesh namely Medak, Karimnagar, West Godavari, Chittoor, Nizamabad and Ranga Reddy as hotspots, that is the gap between requirement and availability of groundwater is very sharp. These hotspot-districts and three vulnerable districts of Nalgonda, Warangal and Mahabubnagar are in need of utmost policy attention in context of sustainable use of ground water resources.

In Punjab, the Gross Economic Efficiency (GEE) of paddy was substantially higher in Ludhiana (₹10.09 /m^3), as compared to other districts. In case of wheat, gross economic water use efficiency was highest for Gurdaspur (₹22.25 /m^3) and lowest for Jalandhar (₹14.92 /m^3). Water productivity (WP) of milk production, both in physical and monetary terms, varied widely across districts because of difference in buffalo and crossbred milk prices and composition of dairy herd. In Zone-I, WP of milk production was much higher for buffalo (₹61.50 /m^3) than for local cow (₹44.04 /m^3). In Zone-II, the GEE of milk production was highest in Jalandhar (₹45.32 /m^3), while in Zone-III, it was highest in Faridkot (₹63.02 /m^3). Among all category of milch animal GEE of buffalo was highest whereas it was lower in case of local cows due to the spatial variation in prices and feeding pattern followed by the farmers. Ferozpur, Sangrur and Bathinda, respectively, were the worst performing districts in terms of gross economic efficiency of water use for paddy-wheat-milk production in Punjab. Water use efficient farm plans in these districts showed that reducing paddy, wheat area and increasing fodder crops area to support larger stock of milch crossbreds and buffaloes, can increase the gross value of output and also result in water saving.

Infrastructural Disparities in Rural India for Livestock Sector

Infrastructural development in the country for livestock sector includes Veterinary Institutions/ Hospitals, Veterinary Aid Centres, Veterinary Dispensary, Artificial Insemination (AI) Centres, Semen Production Centre, Cattle Breed Farms, Frozen Semen Production Centres and Milk Processing Units, etc. The country has the largest AI network in the world, but considering the size of livestock population, the existing supporting infrastructural facilities like Semen Production Centres (37), Frozen Semen Production Centres (143), Liquid Nitrogen Plants (130) and Cattle Breeding Farm (414) were far less in number to ensure adequate and timely availability of quality semen at the AI centres. Regarding the accessibility of the veterinary services, about 75% of farmers all over India access veterinary services within the village to 5 km radius, remaining 25% of farmers were still covering more distance for accessing veterinary services. Most of the north east states like Meghalaya, Arunachal Pradesh and Nagaland were having poor accessibility. Major reasons for poor accessibility were poor quality of services provided by the institution and non-availability of veterinary doctors in the hospitals. The accessibility of information regarding animal husbandry was 4.19% across the country. 23.2% of the farmers of Kerala were accessing information, while accessibility of Uttarakhand farmers to information regarding animal husbandry was poor. Aggregate infrastructure index was computed to assess overall infrastructure availability. Value of the index was found higher for Kerala, Punjab, Lakshadweep, Karnataka and Tamil Nadu but lower for three states namely Jharkhand, Bihar and Odisha. The study identified critical issues in the development of livestock sector infrastructure, namely, 1) adequate investment to remove regional imbalances, 2) effective governance mechanism, 3) increase private sector participation in rural infrastructure, and 4) Improve quality of services.

Economics of Milk Production and Marketed Surplus in Chittorgarh District of Rajasthan

This study was taken up with the objectives to work out cost of milk production and returns from different species of milch animals, estimation of resource use efficiency, analysis of marketed surplus of milk and its disposal pattern. The study revealed that the overall per day cost of maintenance was ₹ 129.79, ₹ 71.87, ₹ 103.76 for milch crossbred cow, local cow and buffalo respectively. Per litre cost of milk was estimated to be ₹ 26.71, ₹ 37.05, ₹ 28.58, respectively, for crossbred cow, local cow and buffalo. Per litre net return was found to be ₹ 5.29, ₹ -5.05 and ₹ 7.42, respectively, from crossbred cow, local cow and buffalo. The resource use efficiency of concentrate for crossbred cow was found positive and significant indicating under utilisation of this input. In case of local cow, the resource use efficiency of labour was found negative and significant indicating over utilisation of this input. In case of buffalo, the resource use efficiency of concentrate and labour were found positive and significant indicating under utilisation of these inputs. Marketed surplus was 79.48, 83.45, and 89.67% for small, medium and large household farmers, respectively. Out of total quantity of milk marketed per day, 66.23% of milk was disposed to cooperative dairy; remaining amount of milk surplus was disposed off to different categories: Halwai (19.31%), milk vendor (7.02%), local consumer (3.99%) and private dairy (3.45%). Thus, there is a scope for increase in milk yield of crossbred cow and buffaloes by using the labour and concentrate inputs judiciously.

Economics of Milk Production and Optimisation of Herd Size of Commercial Dairy Farms in Jaipur District (Rajasthan)

Dairying in India has traditionally been a small holders' enterprise. As the demand for milk and milk products is increasing rapidly, milk producers have been adopting dairy farming as a commercial enterprise to tap the market opportunities. This study was taken up with the specific objectives to work out cost of milk production and returns from different species of milch animals, to find out input-output relationship and resource use efficiency and finally to find out optimum herd size of commercial dairy farms. Primary data were collected from a sample of 100 commercial dairy farms drawn from six tehsils of Jaipur district. The commercial farms were classified into small, medium and large categories based on herd size.

The average herd sizes on small, medium and large commercial farms were 25.95, 39.49 and 73.44 milch animals, respectively. Overall average daily milk yield for milch crossbred cow, buffalo and local cow were 7.81, 6.74 and 4.84 litres, respectively. Overall gross maintenance cost for milch local cow was worked out to be ₹ 127.08 per day. Net return per litre per local milch cow was found to be positive for medium and large categories. It was highest for large category (₹ 5.20) and negative for small category (₹- 1.55). Overall per day gross maintenance cost for milch crossbred cow was worked out to be ₹ 191.81 per day, which varied from ₹ 197.58 for large category to ₹185.86 for small category. Net returns per litre of milk were found to be positive for all the categories. It was highest for large category (₹ 8.95) and lowest for small category (₹ 4.31). Overall gross maintenance cost for milch buffalo was worked out to be ₹ 205.43 per day, which varied from ₹ 200.54 for small category to ₹ 207.31 for large category. Net returns per litre per milch buffalo were found to be positive for all the categories. It was highest for large category (₹ 5.64) and lowest for small category (₹ 3.45).

In case of small category of herd size, it was observed that dry fodder, green fodder, labour and miscellaneous expenses were optimally utilized. In case of medium category, it was observed that dry fodder, green fodder and miscellaneous expenses were efficiently utilised. In case of large category of herd size, dry fodder, concentrate and miscellaneous expenditure were efficiently utilised.

Under existing situation, the herd composition of small category of farms was 1.47, 6.86 and 11.37 for local, cross bred and buffaloes, respectively. The integer values of local, cross bred and buffaloes under optimum conditions were 3, 6 and 11, respectively. In case of medium farms, the absolute numbers of animals under optimum plan were found to be nil in local cows, 8 crossbred animals and 19 buffaloes. On large category of farms, optimum plan eliminated for all local cows suggesting that farmers should maintain only crossbred cows and buffaloes at the rate of 39 crossbred and 10 buffaloes for maximization of returns.

DAIRY EXTENSION

Livelihood Perspective of Integrated Farming Systems in Nadia District of West Bengal

A 'Livelihood Security Index' (LSI) was developed to measure the livelihood security level of the farmers in Nadia district of West Bengal. The systems which included horticulture and fishery had higher livelihood security whereas Crop+Dairy, Crop+Dairy+Poultry, Crop+Dairy+Goatery system had lower livelihood security. Bioresource flow models of different combinations indicated that the farming system which included horticulture, fishery enterprises alongwith crops and dairy gave better economic return. Farmers' feedback on Integrated Farming System (IFS) revealed that regular supply of food from farm and low cost of production were the major benefits while higher cost of labour and lower availability of labour were the major limitations in pursuing IFS.

Impact of Jan Utthan Programme on Employment and Income Generation Through Livestock Among Bhil of Maharashtra

The study revealed that *Jan Utthan Programme* had generated more employment (in man-days per year) for the beneficiaries group. Around 72.00 per cent of the beneficiaries were employed for 259 man days per year, whereas only 52.50 per cent of non-beneficiaries were under this group. Predominant constraints as perceived by the beneficiaries with respect to livestock-rearing were non-availability of improved breed, non-availability of green fodder round the year, poor access to veterinary services, poor knowledge of livestock rearing practices, and

low price for livestock-products in the market. Delay in getting benefits of the scheme was ranked 1st by the respondent in terms of availing the intended benefits of the scheme.

Knowledge and Adoption of Machine Milking Practices by Dairy Farmers of Community Milking Centres in Mandya District of Karnataka

Majority of the respondents had medium level of knowledge (48.34%) and adoption (40.584%) of machine milking practices. With respect to individual machine milking practices, majority had adequate knowledge regarding special cares for udder health and clean milk production, which are necessary for using milking machine. Education, family income, experience in Community Milking Centre (CMC), mass media exposure, organizational participation, extension contact and training undergone have positive and significant relationship with knowledge level and adoption of dairy farmers. The study exposes some of the flaws of milking machine that could help scientists to develop better management practices and to make milking machine more farmers friendly.

Drought Coping Strategies among Dairy Farmers in Bundelkhand Region of Uttar Pradesh

Majority of the respondents were feeding stored crop residues for maintaining desired production and productivity of the animals during drought whereas, few farmers were feeding purchased feeding materials and they were storing wheat straw and other crop residues (gram/lentil/mustard/linseed, etc.). It was also observed that very few farmers were growing fodder during drought, and altering sowing time. Other managemental practices were avoidance of long distance grazing and in reduction in herd size. The community based coping strategies were filling the community ponds for arranging drinking water to the animals during scarce water availability and use of pipe for conveyance to save water from evaporation as well as leaching losses.

Contribution of Livestock Production Systems towards the Sustainable Livelihood of the Tribes of Jharkhand

Livestock Production Systems (LPS) comprising of Cattle+ Goat+ Pig (C+G+P) contributed the most towards the sustainable livelihood of the respondents (Sustainable Livelihood index value-28.02), closely followed by Cattle+ Buffalo +Goat (25.53) and Cattle+ Goat (24.61). Compared to other sustainable livelihood components, human capital had minimum Sustainable Livelihood index value in all production systems. The major constraints faced by the respondents in cattle and buffalo production was decreasing common grazing land; in pig production, 'high vulnerability of piglets to diseases and deaths; in goat production, 'high mortality during monsoon, and in poultry production 'high level of vulnerability due to diseases. Thus, the livelihoods promotion among tribal people needs a paradigm shift focusing on sustainable LPS to keep pace with food security and future challenges in the area.

Gender Perspective of Integrated Farming System in Hilly and Plain Region of Tripura

Male farmers in the region were found to take almost all decision in both the regions, while the share of female in decision making was negligible. The male farmers had more resource access in plain (86.70%) and hill region (67.43%) and control over the resources in plain (81.71%) and hill (53.71%), respectively. The respondents in plain experienced constraints like pest and disease infestation, poor storage facility whereas in hill poor storage facilities and transportation facility were severe in crop farming. In livestock farming inadequate veterinary services, higher incidence of disease, inadequate training and poor transportation facilities were major constraints in plain and both hill region.

Bovine Preference of Dairy Farmers in South-Bihar Alluvial Plain Zone

Secondary data analysis of bovine population in Bihar indicated that there was increase in number as well as quantity of milk production from the same. A study with 160 farmers indicated that economic factors, followed by climatic, marketing, animal traits, and governmental factors were found to influence bovine preference in the study area. Among different performance traits there was high level of awareness for average daily milk yield, peak yield, lactation length, dry period, and age at the first calving.

Livelihood Security and Resilience Among Farmers Affected by National Calamity in Bihar

Assessment of farmers' resilience in relation to their profession indicated that 33.75% were in need; 23.75% were fragile, 17.50% were vulnerable, 13.12% were coping and 11.88% were resilient.

From the overall analysis, it was found that only a small percentage of farmers had high livelihood security. Resilience scale result indicated that majority of respondents were pessimistic towards their profession and optimistic towards their life. Hence the resilience building programme should be extended in the study area especially in relation to profession.

Impact Assessment and Sustainability of the E-Agriservice for Dairy Farmers of Maharashtra

About 47.50% of users had high level of knowledge about IDFPs, while one third (33.33%) of non-users had medium level of knowledge. Both the categories of farmers possessed better knowledge about the breeding practices, as compared to the feeding-fodder and health care practices. The knowledge of users and non-users was significantly different. The aAQUA e-Agriservice was technologically and socially highly sustainable while, medium in economically, institutionally and politically, it was moderately sustainable. Delayed response to the queries and dependency on the young generation for accessing internet were perceived as the major constraints in the study area. It may be concluded that the aAQUA e-Agriservice had positive impact in improving users' knowledge level and project had medium level of sustainability.

Dairying amongst Pastoral Communities of Jammu and Kashmir

The respondents of the study belonged to ten clans which include Suddan, Geggi, Gujrana, Chauhan, Pathan, Khatana, Bhadana, Kasana, Chechi and Baggad. The respondents migrate from the plains to highland pastures in *Baisakh* month and from the highland pastures to plains in *Aashad* month. More than fifty percent of the respondents reared 14-17 animals and 15.00 percent reared more than 17 cattle and buffaloes. About fifty percent of the total milk produced was sold, while 36.83% was processed and 14.82% was consumed at home by the respondents. Sale of animals (38.80%) and dairy (35.33%) were the major contributors in the total annual income. Application of common salt on teats to cure mastitis was the most commonly used ITK in the study area. The overall knowledge level was about 55.10%.

Awareness about different dairy development programmes was directly and significantly correlated with education, social participation, herd size and milk production and negatively and significantly with the age of the respondents.

Perception and Coping Strategies for Climate Variability by Dairy Farmers in Western Dry Region of India

Large proportion of the dairy farmers strongly felt the changes in environmental temperature (74.16%) and in the pattern of cold and heat waves (61.66%). Majority (87.50%) of the dairy farmers suggested that organizing awareness campaign about climatic problems may help them to manage their animals for better productivity. It is suggested to use appropriate communication methods to create awareness about dealing the climate change among extension functionaries, farmer groups, input dealers, radio and television.

A Comprehensive Study on Integrated Farming Systems for Sustainable Rural Livelihood Security in Backward Districts of Maharashtra

The existing integrated farming systems in the study area indicated that Crop + Goatary + Horticulture and Crop + Dairy + Goatary + Horticulture were the dominant farming systems. More than one- third of the respondents had perceived high level of reduction in vulnerability in conventional farming through integrated farming systems. The needs of services as perceived by the farmers were information on what, when and how to produce, efficient milk procurement system, the assured market for the timber, marketing of live goats on body weight basis, market for horticultural crops, timely vaccination services and the need for timely credit supply at lower interest rate with minimum collateral security.

Dairy Extension Education and Services at Farmers' Door through Mobile Extension Unit: An Action Research

An innovative model of Extension Education and veterinary services at farmers' door was developed using Mobile Extension Unit with funding support from NABARD. The programme facilitated prompt delivery of Veterinary services, wide Artificial Insemination (AI) coverage and Dairy Education in 12 villages of Karnal district. The programme led to reduction of inter-calving period, service period and increase in milk production. Improvement in adoption of improved dairy farming practices resulted in incremental income to dairy farmers. The 10 youth who were trained for 3 months in AI, PD and veterinary first aid in the project are working in villages and earning on an average Rs. 20,000 -

30,000 in a month. Overall, the project successfully helped in reaching the unreached through Mobile Extension Unit for quick delivery of veterinary services and information.

Impact of Dairy Production Technologies Transferred by NDRI among Dairy Farmers in Karnal District

Interventions by NDRI scientists in the adopted villages motivated the farmers to allocate more area under fodder (19.00%) and in vegetables (6.00%). The incidence of the morbidity (last 5 years) in the adopted villages for the parasitic diseases (17.98%), repeat breeding (6.20%), mastitis (5.17%) and anoestrus (2.27%) were less as compared to that in the non-adopted villages. Significant reduction in age at first calving and inter-calving period and higher milk productivity was noticed in the adopted villages as compared to non-adopted villages.

The vast majority of the respondents suggested that NDRI facilities should be continued in adopted villages and extended to adjoining villages, farmers expressed their requirement of training on preparation of concentrate at home. The persons trained at NDRI for carrying out artificial insemination and first aid of the dairy animals are self-employed and are able to earn their livelihood within or outside their villages. Since, a significant adoption gap exists in adopted and non-adopted villages, field extension interventions need to be given impetus for dairy development

Effectiveness of Mobile Advisory Services in Dairy Farming

The effectiveness of mobile advisory services in dairy farming is being assessed in 6 states namely, Haryana, Punjab, Rajasthan, Uttar Pradesh, Uttarakhand and Gujarat. A web enabled NDRI Messaging service portal was developed with data base facilities. The portal was launched on 7th October 2014 and every week 2 SMS are being sent to the 1200 respondents in 6 states. Encouraging feedback from the SMS recipients are being received.

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

Animal husbandry practices were found to be very conventional in nature in the study area. It was observed that maximum disaster damage occurred on encroached area near road and river side. Agriculture land was damaged badly due to high flow of water from top to bottom. Small ruminants and ponies died in large numbers as they were on the top hill during floods flash. For the sensitization of farmers and other agencies about livestock farming in disaster prone area, 10 extension folders were prepared for awareness creation about disaster management in Hindi. Awareness creation about disaster management, plantation of perennial fodder grasses (*Nandi*, Napier grass and Bhimal tree), deworming for livestock, mineral mixture, animal health camps (with local Vety. hospital), goat and sheep for resource poor family, capacity building of youth through exposure training (on farm and off farm), mobile advisory services for the respondents were the important interventions inputs introduced in the study area where majority of the population were Bhotia, Buksa, Jaunsari, Tharu and Raji tribes community.

SOUTHERN REGIONAL STATION, BANGALORE

Evaluation and Improvement of Indigenous Cattle of Malnad Region of Karnataka

Genetic variance of lactoferin gene and its assocoiation with lactoferin and SCC: PCR-SSCP analysis revealed that exons 2, 3, 6, 8, 9, 12, 15 and 17 were polymorphic. The sequence analysis of lactoferrin gene revealed sixteen transitions and five transversions in Malnad Gidda cattle. The lactoferrin content in Malnad Gidda cattle (225.20 ± 31.40) was significantly higher as compared to Deoni, Cross-bred cattle (ranged 42.59 to 91.89 mg/L) and Murrah buffaloes (ranged 11.75 to

47.13 µg/ml). The observed association between the genetic variants with SCC and lactoferrin content indicated the possibility of using these genetic variants in lactoferrin gene as prognostic markers for selection for high lactoferrin content, low somatic cell score and mastitis resistant cows.

Characterization of GnRHR gene in ***Bos taurus*** and ***Bos indicus*** cattle: PCR-SSCP analysis of the entire coding region of GnRHR in two hundred fifty *Bos taurus* (Holstein Friesian, Jersey) and *Bos indicus* (Malnad Gidda, Deoni) bulls using five set of primers indicated high degree of genetic variation.

Molecular characterization of KISS1 gene in cattle and buffaloes: KISS1 gene encodes a family of neuropeptides called kisspeptins and have the ability to regulate gonadotrophin-releasing hormone. PCR-SSCP analysis revealed a total of 9 distinct patterns in exon 1 across the studied population with 3 patterns in Holstein Friesian cattle. Sequence analysis revealed 8 single nucleotide polymorphisms (SNPs) with 4 transitions, 3 transversions and 1 indel. The phylogenetic tree constructed based on neighbour joining method using exonic region of the bovine KISS1 gene revealed the clustering of different species in a single node.

Assessment of genetic diversity among dwarf cattle breeds of Southern India: Assessment of the genetic diversity among dwarf breeds using 12 sets of microsatellite markers showed a mean number of alleles of 7.818 ± 1.66 across breeds and in different breeds, it ranged from 7.273 in Malnad Gidda to 3.546 in Vechur. The genetic distance analysis revealed highest genetic distance between Vechur and Punganur (0.331) and lowest between Malnad Gidda and Punganur (0.125).

Transcriptome profiling and RNA-Seq analysis: Sequencing of mature RNA enriched from the blood sample of one selected Malnad Gidda bull resulted in generation of 55 million paired-end reads of 100bp length on the Illumina HiSeq 2500 sequencing platform. Mapping of processed 55 million raw read pairs against the *B. taurus* UMD3.1 genome and annotation information from Ensembl resulted in identification of 9,484 unique protein-coding genes with FPKM (Fragments Per Kilobase of exon mapped per Million fragments Mapped) ≥1. The observed percentage of mapped RNA-Seq reads from our study against *B. taurus* and *B. indicus* genomes is only 71 and 41, respectively. These observations clearly underscore the limited usability of available *Bos indicus* - genome information.

Polymorphism in aquaporin 7 (AQP7) gene in *Bos indicus* and *Bos taurus* bulls: Analysis of exons 2, 4, and 6 of (AQP7) gene revealed 3, 2 and 4 unique SSCP band patterns, respectively in all the breeds under study. All other exons showed monomorphism.

Investigation on QTL and non-genetic factors regulating post-partum productive and reproductive performances in Deoni cattle: It was observed that the first postpartum estrus occurs early in heifers as compared to multiparous cows, thereby resulting into increase in calving interval. The study was initiated to understand the role of QTL, endocrine status, feeding and other managemental conditions of the herd on maternal instinct expressed by suckling in Deoni animals and post-partum production and reproduction performances. Daily recordings of data from lactating Deoni animals on suckling, post suckling milk let down, daily milk yield revealed that mean suckling time was 1.04 ± 0.14 (1.0-2.0) minutes. While, mean milking time was 4.21 ± 1.26 (2.0-8.0) minutes and daily milk yield recorded was 3.29 ± 1.07 (1.0-8.0) kg/day.

Characterization of entire coding region of β-Casein gene in Indian buffaloes: PCR-SSCP analysis and sequencing of entire coding region of β-casein gene in Murrah and Surti buffaloes (*Bubalus bubalis*) were carried out using 104 bull's samples collected from organized frozen semen stations of Karnataka State in India. Sequence analysis showed 11 SNPs in the exonic region and 22 SNPs in partial intronic region. In Exon 7 Surti buffalo exhibited three SSCP band patterns (A, B, C) with the frequency of 0.76, 0.20 and 0.04, while Murrah buffaloes exhibited two SSCP band pattern (A, B) with the frequency of 0.21 and 0.79.

Molecular characterization and expression of ISG 15 gene during early pregnancy in Deoni cattle: Genomic DNA was isolated from 150 randomly selected Deoni cattle maintained at LRC, SRS of NDRI to evaluate genetic variability through PCR-RFLP method. PCR-RFLP analysis showed polymorphism in FGF2 intron and ISG 15 gene with one and six nucleotide changes, respectively. ISG15 gene with restriction enzyme BspMI showed three genotypes viz. AA, AB and BB with genotypic frequencies of 41.7, 44.7 and 13.6%, respectively. Expression profiling of ISG 15 mRNA was carried out with comparative method of qRT PCR with SYBR green as fluorescent dye. A significantly high expression of ISG 15 mRNA was found on day 16 ($P<0.05$) and day18 ($P<0.01$) of pregnancy in heifers whereas in multiparous cows difference

in ISG15 level was higher than nonpreganant cows but it was not significant. The results of the current study concluded that up regulated expression of ISG 15 gene in dairy heifers during early pregnancy indicated the presence of a viable embryo in the uterus. Hence, ISG mRNA15 level could be used as a marker for early pregnancy diagnosis in nulliparous heifers as early as day 18 of the pregnancy.

Factors affecting semen quality and freezability in Deoni and Malnad Gidda cattle: Six Deoni and seven Malnad Gidda male calves were selected on the basis of dam's milk yield. All the bull calves were screened for genetic diseases, chromosomal aberrations and sexually transmitting diseases and subjected to training modules viz., to mount on a dummy animal, to donate semen in an AV and dismount. Except two Deoni and one Malnad Gidda bull calves, all animals were successfully trained. In Malnad Gidda bulls (72 ejaculates), average ejaculate volume, mass activity, and progressive motility 3.05 ml (range 1-5 ml) and 2.61 (range 1-5), 52.71 % (range 10-90 %), respectively. Semen samples with required concentration (> 500 x 10^6/ml) and initial progressive motility (>70 %) were subjected to freezing and about 4400 AI doses were frozen. In Deoni bulls (14 ejaculates), average ejaculate volume, mass activity, and progressive motility was 4.6 ml (range 2-7 ml) and 3.07 (range 2-4), 59.71 % (range 10-80 %), respectively.

National Initiative on Climate Resilient Agriculture (NICRA) - Deoni: The detailed morphometric measurements were carried out on 225 Deoni animals maintained at Livestock Research Centre, SRS, Bengaluru and LRIC (KVAFU), Bidar. A study was conducted to evaluate the physiological and haematological responses of six Deoni cows maintained under semi-intensive management (SIM) during summer season. The micro-climate variables, physiological and haematological parameters were recorded at weekly interval in the morning (7:00 AM) and afternoon (2:00 PM) using standard methods. The diurnal variations were observed for all the physiological parameters *viz*., skin temperature (°C), rectal temperature (°C) respiration rate (/min) and pulse rate (/min). The ST showed significantly higher (P<0.05) values in the afternoon (36.82 ± 0.24) as compared to morning (33.76 ± 0.17), whereas RR showed significantly higher (P<0.05) values in the afternoon as compared to morning (25.70 ± 0.12 vs. 25.22 ± 0.12). The haemoglobin (g/dL) and Lymphocytes (%) levels were significantly higher (P<0.05) in the afternoon. Temperature Humidity Index (THI) showed significant positive correlation (P<0.05) with ST (0.64) in the afternoon, whereas T_{max} showed significant positive correlation (P<0.05) with Mean Corpuscular Hemoglobin (pg) (0.81) in the morning.

Reproductive performance of Deoni cattle under organized farm management: Studies on reproductive performance of Deoni cattle (n=332) in all the parities spread over a period of 16 years (1996-2012) were used for present study. Among the various non-genetic parameters studied, parity and period had significant influence over calving interval, calving to first service, and service period and there was no significant influence was observed on breeding interval and gestation length. Season had significant influence over calving to first service i.e. between March and June (summer). Farm management showed significant influence on calving interval i.e. it was significantly lower at NDRI-SRS farm than other two farms. Period of birth showed significant influence on AFS and AFC.

Induction of oestrus on fertility response in pre-pubertal heifers and post partum cows using CO-Synch with CIDR and FTAI protocol: A study was conducted on 10 post partum Deoni cows maintained under loose housing system at Cattle Yard, SRS. They were selected to evaluate the CO-Synch and CIDR protocol for induction of estrum and subsequent fertility. A total of 10 cows were tied individually for stall feeding alongwith nutritional supplementation as per the standard feeding and management. On day 0, each cow was administered GnRH (Receptol®) injection i/m @ 2.5 ml/cow and was inserted with CIDR (EAZIBREED CIDR® 1380). On day 7 PGF_2a *(Cloprostenol-Vetmate®)* injection was administered i/m @ 2 ml/cow followed by CIDR removal on day 8. Fixed time AI (FTAI) was performed at 48 and 72 hours after PGF_2a *injection, with GnRH injection i/m @ 2.5 ml/cow at 72 hours. Pregnancy was confirmed in inseminated heifers on day 30 post insemination using progesterone based assay kit (HeatAid®)* and ultrasonography. CIDR retention rate and estrus expression rate was 100 per cent. Out of 10 cows 6 were found pregnant with a synchronized pregnancy rate of 60 per cent. The result suggested that the current protocol for inducing and synchronizing estrus could serve as a valuable technology to improve reproductive efficiency of post partum Deoni cows.

Development of *khoa-jalebi* using non-conventional sweeteners: The formulated sugar free syrups (two sugar free syrups) were used as soaking syrups in the preparation of khoa jalebi. It was observed that the xylitol - mannitol base syrup was not suitable because mannitol appeared as

white specks on the jalebi on cooling. On the other hand, using levulose and sucralose mixture syrup, good quality khoa jalebi could be produced. Based on the sensory quality parameters, the following soaking syrups were recommended: 1) Sorbitol, 60 gm + Maltodextrine, 15 g + Sucralose (550 ppm) + water, 25 g 2) Xylitol, 50 g + Maltodextrine, 25 g + Sucralose (100 ppm) + water, 25 g 3) Levulose mixture (60%) and 4) Sucralose mixture (60%). Significant difference was observed in the values of hardness and consistency of khoa jalebi prepared from all sugarfree sweeteners syrups. It was found that shelf life of control and sorbitol syrup containing khoa jalebi was 12 days and that of levulose and sucralose mixture jalebi was 9 days at 37°C,

Incorporation of inulin and resistant starch in Cheddar cheese to enhance functional attributes: Two per cent prebiotic was added into the 50 lit of milk before pasteurization for each trial. The milk was pasteurized and subsequently Cheddar cheese was manufactured. Alternatively, 2% Inulin and Resistant Starch were added separately into the each batch of 5 kg milled cheddar curd at the time of salting. Control cheese was made without the addition of inulin and resistant starch. All cheese blocks were pressed, surface dried, parafined and kept in the cold room for ripening. Periodical sensory and physico-chemical analysis were carried out. There was no significant increase in the yield of the green cheese due to the addition of prebiotic in the milk or dry blended into the curd during salting. Incorporation of prebiotics into milk before pasteurization resulted in 1-2% low moisture retention as compared to the cheeses made with the prebiotics added at the time of salting. The increase of free fatty acids during the ripening was highest in inulin added cheese whereas it was lowest in control during ripening. More peptides formation was observed due to longer period of ripening of the prebiotic added cheese.

Development of dry mix for khoa jalebi preparation: Khoa jalebi is a traditional khoa-based sweet delicacy with a characteristic pleasant aroma. An attempt was made for the development of a dry mix (DM) for the preparation of khoa jalebi (KJ) batter. During present investigation, two different formulations were used for KJ-DM development: (1) Skim milk powder (SMP) based and (2) Khoa powder (KP) based formulations. During storage, the mix packed in LDPE and Metalized polyester pouches, became slightly darker as indicated by reflectance values. TBA value of the mix also increased slightly which is suggestive of progressing oxidation in the mix; this however was within the acceptable limit. Gain in moisture content of KJ-DM was found more in case of LDPE pouch compared to metalized polyester pouch. The shelf life of the KJ-DM was observed to be more than 90 days at 30°C in both types of packaging materials.

Utilization of lactose hydrolysed whey in the preparation of probiotic fermented beverages: Attempts were made to utilise the paneer whey in preparation of lassi and butter milk. The paneer whey was concentrated to 12% TS and the lactose was hydrolysed by using lactase enzyme. Addition of 1% lactase enzyme and incubation at 45°C for 60 minutes resulted in about 55% lactose hydrolysis. The concentrated and lactose hydrolysed whey (CLHW) was used in the preparation of lassi and buttermilk. The CLHW was used in three different forms for the production of lassi. It was observed that incorporation of CLHW in milk @ 10% by volume and fermentation, and use of fermented CLHW up to 10% in dahi for lassi production resulted in the product which was comparable to control. A colorimetric method was standardized to estimate lactose in the presence of its hydrolytic products, glucose and galactose.

Isolation and identification of bacteriophages from dairy products and environment and evaluation of starter cultures for the phage resistance: The samples from paneer dip water, refrigerated water from chiller cheese whey, and paneer whey were collected from the experimental dairy of the station and tested for the presence of bacteriophages. The samples from chiller tank from Dairy Production Unit were also screened for the presence of bacteriophages. The results indicated the possible presence of phages in their lactic cultures.

Post-Processing intervention to improve quality and shelf-life of curd rice: Curd rice is an important part an Indian menu particularly that of a south Indian. Attempts were made to optimize the production of curd rice. The Sona Massoori variety of raw rice was selected for the production of cooked rice for use in preparation of curd rice. Pressure cooking of rice resulted in cooked rice with soft grain which is desirable for curd rice preparation. Use of 3.5 parts of water for every part of raw rice and pressure cooking yielded good quality cooked rice. It was observed that mixing of cooked rice and milk in 1:1 ratio and fermenting results in production of most acceptable quality curd rice. Use of 1.5% salt was found optimum.

The levels of addition of spices such as coriander leaves, curry leaves, ginger, fenugreek seeds and mustard seeds were optimized.

Analysis of energy and exergetic performance of spray drying system for milk-malted millet food: Energy and exergy analysis of spray drying of both cow and buffalo milk were carried out in the study. Both milks were concentrated in an evaporator (Make: BÜCHI, Rotavapor R-3) to 22 % total solids content. The drying of concentrated milk was accomplished in the lab spray drier. The dryer was equipped with a twin-fluid internal mixing nozzle (1mm dia.). The hot air temperature was monitored and recorded prior to flow into the drying chamber using a thermocouple. The air pressure was set at 1.5 bar. The temperature and relative humidity of ambient air were recorded. The concentrated milk was fed into the drying chamber. The drying air temperature of 200°C was used and the volumetric flow rate of feed was adjusted to 4 mL/min. The aspirator rate of the spray dryer was fixed at 45Nm^3/min. The powder collected was weighed and approximately 2 g was dried in an oven at 102°C for 5 h for determination of moisture content. Exergy efficiency of spray drying of cow milk was calculated as 6.68%. Trials in buffalo milk are in progress. The physical and thermal properties of buffalo milk powder are being determined for calculating the energy and exergy efficiencies.

Extension of shelf-life of ghee using extracts of fruit and vegetable by-products: Fruit and vegetable by-products viz. orange peel, pomegranate peel, tomato waste and grape seed were identified as potential natural sources of antioxidants for extension of shelf-life of ghee. Antioxidants activities of ghee incorporated with natural antioxidants extracted from orange peel powder were evaluated at different storage temperatures and compared with antioxidants activities of ghee incorporated with synthetic antioxidant, i.e, butylated hydroxyanisole (BHA) and control. Reduced rate of development of peroxide value (PV) and thiobarbituric acid (TBA) was observed in ghee incorporated with orange peel powder extract as compared to ghee incorporated with BHA and control. Orange peel could be used as a cheap natural source of natural antioxidants which can be used in fat rich dairy products like ghee for retarding oxidative deterioration. Evaluation of antioxidant properties of pomegranate peel and optimization of extraction process for extraction of antioxidants from pomegranate peel are being carried out.

Modeling the antioxidant potential of the orange peel extract in Ghee: Butylated hydroxyl anisole (BHA) is the commonly used 'synthetic antioxidant' in ghee. Use of synthetic antioxidants has been restricted due to their suspected health issues. In recent years, use of natural source like tulsi, shatavari, coriander extracts etc in ghee for their antioxidant activities have been demonstrated. These commodities are costly and not easily available in all the seasons. Therefore, the present work was investigated for evaluation of antioxidant activities and modelling the antioxidant potential of orange peel extract in ghee. The optimized extraction parameters for orange peel powder extract were: 1 g orange peel powder; 10 ml ethanol; 30 °C temperature; 6 h time. The total phenol content (TPC) and radical scavenging activity (RSA) of the extract were 98.17 mg of caffeic acid equivalent (CAE)/g and 93.27 % inhibition at the optimized extraction process. The regression models describing the effect of extraction parameters on TPC and RSA of orange peel extract were found to be linear model and quadratic model, respectively. The colour and flavour scores of ghee incorporated with orange peel powder extract (OPPE) @ 0.5 to 1% were comparable with the sensory scores of the control. Modeling results revealed that most of the treatments followed first order and fractional conversion first order kinetic models for describing the antioxidant activities.

Design and development of microprocessor based automated instrumentation system for pneumatic paneer hoop cum-press unit: Average value of porosity of paneer was found to be 20.29 % and the bulk density 1.0926 g/cc. A reduction on porosity value was observed as the pressure applied on the paneer hoop was raised while the bulk density was increased to about 1.32 g/cc. Effect of pressure and time of pressing on porosity of paneer was also observed and the results of the porosity show that, highest value of porosity (24.07%) was observed in P_3T_2 combination (i.e. 13kg pressure and 30 minutes pressing), whereas the lowest value of porosity (12.76%) was observed in P_2T_2 (i.e. 10 kg pressure was applied for 30 min. duration). In textural profile analysis, it was found that the cohesiveness and gumminess were increasing with the increase in pressure. From the observations, it could be concluded that there was no significant change in cohesiveness with the changes of applied pressure and time of press.

Dairy Entrepreneurship Development of Rural Women: An Action Research: The study was conducted to promote two women based Self Help

Group (SHG) working exclusively on dairying activity. Based on the preliminary survey and contacts established with local NGOs two women SHGs on dairying were formed in Suradenapura village and Hannumanahalli village in association with local NGOs viz, Peoples Trust and Samastha Micro Finance respectively. Suradenapura village based SHG is comprised of ten women members who are economically very poor and most of them are from the weaker section with poor educational background. This group was exclusively formed and dairying activity was promoted as most of them are landless and sustaining their livelihood only through working as an agricultural laborers and petty shop keepers. Through our sustained institute interventions, this SHG has secured a group loan from Kalpatharu Grameena Bank and through this money, each member of this group have bought HF crossbred animals and continuing the dairying activity generating savings. In case of Hannumanahalli village, SHG comprised twenty women members, most of them are from modest economic background and possess small agricultural land. Primarily, they are sustaining their livelihood through sericulture activity and also crop husbandry like paddy, ragi and coconut trees. Majority of the members are literate. The group members were motivated to take up the dairying activity and with a loan from micro finance plus their own money, they bought HF crossbred animals and presently continuing dairying activity and repaying the loans through selling the milk to KMF.

Geo-spatial databank and data mining for strategic planning and development of dairying in Karnataka state: An integrated database on various aspects of dairy sector at the regional and state level of the country is very frequently sought for making management decisions, developing criteria and indicators for the sustainability assessment of dairy sector, making policy decisions and to evaluate various dairy developmental programmes. While the factors affecting dairy sector have lot of spatial variability, there is no geo-referenced database available for dairy sector. In this regard, the district level geospatial database and data mining for the dairy sector of Karanataka State has been envisaged. As part of the data sourcing process, the Department of Animal Husbandry and Veterinary Services and Karnataka Milk Federation were visited and latest data pertaining to the livestock census, milk production, prices of milk and milk products have been collected. Efforts are being made to undertake district level analysis of factors affecting milk production.

Detection of PCR-SSCP Markers of the Bovine Lactoferrin Gene and its Association with Somatic Cell Count and Lactoferrin Content in Milk

Entire coding region of bovine lactoferrin gene was characterized by PCR-SSCP and direct sequencing methods in Deoni cattle and Murrah buffaloes. The association between genetic variants of lactoferrin gene with milk lactoferrin content and Somatic Cell Count (SCC) was investigated in Deoni (*Bos indicus*) cows and Murrah buffaloes *(Bubalus bubalis)*. The PCR-SSCP analysis revealed a high degree of genetic variation in Deoni and Murrah buffaloes with a total of 20 and 11 different variants, respectively. Comparison of the nucleotide sequences of lactoferrin gene of the Deoni cows with taurine cattle revealed a total of 39 point mutations, 25 of which were found to be in the coding region. In Murrah buffaloes comparison of nucleotide sequences with taurine reference sequence (Accession number ENSBTAG00000001292) revealed a total of 23 point mutations 16, respectively. The sequence results revealed high degree of genetic variation in exonic region in both Deoni cattle and Murrah buffaloes.

Molecular Characterization of Interleukin-8 Gene and its Association with Milk Production and Udder Health Traits in Deoni Cattle

The study was conducted in the state of Maharashtra and Karnataka. Chi-square test revealed the population was not in H-W equilibrium with respect to genotypes of IL-8 gene expression was significantly higher in the milk of SCM group which the same was down regulated in healthy group of Deoni cattle. Clustal W2 alignment analysis showed one single nucleotide at 2738 position (C to A) change in the Exon 3 region of IL-8 gene in Deoni cattle. Expression study of IL-8 gene was carried out in milk of (n=16) Deoni cattle using real time PCR technique. Fold change of IL-8 gene was significantly (0.70 ± 0.028) higher in milk of SCM group and lower (0.13 ± 0.03) expression obtained in healthy group in milk of Deoni cattle.

Effect of Cation and Anion Minerals on *In Vitro* Fermentation Kinetics, *In Vivo* Microbial Protien and Milk Produciton in Deoni Cows

The study was undertaken to evaluate the best salt source of cation (Ca^{2+}, Na^{+}, K^{+}, Mg^{2+}, Mn^{2+}, Co^{+}, Cu^{2+}, Fe^{2+} and Zn^{2+}) and anions (P, I^{-}, Se, Mo) mineral elements based on *in vitro* fermentation kinetics and effect of best salt sources of cations (CMS) or anions (AMS) or both together (CAMS) mineral supplements (MS) on *in vivo* microbial protein (MBP) production in rumen and milk production in

cows. Cations only showed significant influence on extent, rate constant and half time of fermentation but not anions. No impact on the intake, digestibility of basal diet, milk yield and composition however, MBP production was 33, 17 and 46% higher in CMS, AMS and CAMS compared to control which was without MS. Somatic cell count in milk, RBC, haematocrit, RBC distribution width, platelet count and platelet width were improved with CAMS but not with CMS or AMS. The study concluded that the effect of cations and anions in the MS was collectively exhaustive on MBP, immunity and blood profile of cows.

Incorporation of Concentrated Whey in the Production of Multigrain Bread

An attempt was made to utilize paneer whey to optimize the conditions of production of multigrain bread. Multigrain bread is one of the fastest rising items of consumption throughout the world as changing lifestyles make people to look for multiple nutrients from a single food item. Whey concentrated to 15, 20 and 25% total solids were incorporated into multigrain bread dough containing 5% each oat, maize, sorghum and flaxseed flour to supplement with 80% wheat flour and the dough prepared was proofed and subjected to baking temperatures of 160, 185 and 210°C. The effects of TS level of concentrated whey and baking temperature on the sensory, textural and physico-chemical (reflectance) aspects of the bread were studied. The results revealed that whey concentrated up to 15% TS can be used to replace the dough water without adversely affecting the sensory properties and baking temperature of 185°C, provided the bread with best overall acceptability scores. Improvers permitted by the FSSAI- namely $CaCO_3$, $Ca_3(PO_4)_2$ and ammonium persulphate were also used in the whey incorporated bread at their maximum permissible limits to improve the overall characteristics of the experimental sample. After extensive sensory studies, it was decided to use $Ca_3(PO_4)_2$ as the preferred improver at a level of 1500 ppm. The optimized multigrain bread made by incorporation of 15% concentrated whey contained 73.87% TS, 12.25% fat, 11.24% protein, 1.84% ash and 8.43% lactose. The physico-chemical characteristics of the experimental sample differed slightly from those of the control sample. The shelf life studies indicated that the experimental sample had better microbial keeping quality than the control samples at both 30°C and 5°C but sensory scores showed unacceptability at 4 days and 12 days at 30°C and 5°C, respectively for both the samples.

Enrichment of *Lassi* by Incorporation of Peptides from Whey Protein Concentrate

Lassi is a refreshing beverage, which is widely consumed throughout our country by people of all age groups. The study was initiated to increase functionality of *Lassi* by incorporation of hydrolyzed whey proteins. Investigations were conducted to release lower molecular weight peptides from whey protein concentrate by enzymatic digestion and its incorporation into *Lassi* to develop functional foods. The optimum degree of hydrolysis of 7% in 10% whey protein was achieved in 30 minutes using enzyme to substrate ratio of 1: 25. Cream and lactic acid were added to the hydrolyzate to equalize fat content and pH similar to those of *dahi*. The above protein hydrolyzate could be incorporated at 40 % v/v level without causing significant changes to the sensory attributes of *Lassi*. Sugar content of 15% was found to be optimum for the enriched *Lassi*. Angiotensin-I-Converting Enzyme inhibition activity was measured *in vitro*. Enriched *Lassi* was found to have 79.67 % ACE inhibitory activity as opposed to 42.17 % activity in control sample. The shelf life studies indicated that the non-thermized enriched *Lassi* samples could be stored for 9 days while thermized enriched *Lassi* samples had a shelf life of 14 days at refrigerated temperature.

Utilisation of Lactose Hydrolysed Whey in the Preparation of Lassi

Attempts were made to utilise the whey solids in the concentrated form and partially hydrolysing its lactose in preparation of *lassi*. The *paneer* whey was concentrated to 12% TS and its lactose was hydrolysed by using lactase enzyme. Addition of 1% enzyme and incubation at 45°C for 60 minutes resulted in 55.75% lactose hydrolysis. When the milk was replaced by the concentrated and lactose hydrolysed whey (CLHW) and *dahi* was prepared for *lassi* preparation, it was observed that *dahi* prepared from milk replaced up to 10% by the CLHW can be used for lassi preparation. The sensory evaluation of the *lassi* samples showed that the CLHW incorporated samples can be stored up to 10 days at refrigerated conditions with marginal reduction in the sensory scores.

Development of Technology for Mulayari (Bamboo Seed) Payasam

Payasam is a popular Indian traditional product consumed by people across the country, though under different names. Several varieties of *payasam* are being prepared, their basic method of manufacture remaining the same, but differences

and variations exist in their ingredients. The various ingredients levels were studied and optimized. It was noted that for complete cooking of bamboo seeds, they need to be pressure cooked in presence of water @ 300 ml water per 100 g seeds for 20 min at 15 psi steam pressure. Soaking of the seeds for 6 hours at ambient temperature before cooking helped in reducing the cooking time to 10 min at 15 psi. The optimized levels of ingredients for bamboo seeds *payasam* preparation included: Quantity of bamboo seeds and water: 100 g and 300 ml; jaggery: 250 g per kg *payasam*; fresh coconut extract: 100 g or 125 g per kg *payasam*; toned milk: 125 g per kg *payasam*. The standardized method of preparation involved cleaning and washing of bamboo seeds, soaking 100 g seeds in excess of water for 6 h at ambient temperature, draining the water, addition of 300 ml of fresh water and pressure cooking at 15 psi for 10 min. The cooked grains were then mixed with 125 g of fresh coconut extract and 125 g toned milk. The jaggery syrup (250 g of jaggery was dissolved in equal amount of water and heated to liquid syrup) was then added and the entire mixture was heated and desiccated to a final weight of about 1 kg. The bamboo seeds *payasam* thus prepared had a composition of TS-38.75%, fat – 7.8%, protein – 4.96%, lactose – 0.56%, sucrose – 20.25%, ash – 0.84% and other carbohydrates – 4.34%. The *payasam* was packaged in LDPE and Metalised polyester pouches and stored at 30°C and 5°C for shelf life evaluation. Based on the sensory evaluation results, it was observed that the shelf life of the *payasam* was only 1-2 days at 30°C and more than 15 days at 5°C. This technology for the manufacture of bamboo seeds based *payasam* was developed for commercial applications.

Utilization of Lactose Hydrolysed Paneer Whey in the Preparation of Buttermilk

In the present study, a process was optimized to hydrolyse lactose in paneer whey and utilize the same for the preparation of buttermilk, a popular fermented beverage. Estimation of lactose using a specific colour development reaction between lactose and methylamine was adopted to calculate the degree of hydrolysis of lactose. Concentrated lactose hydrolysed paneer whey (CLHPW) with 12% TS was utilized in the preparation of buttermilk by its incorporation either before fermentation of milk to dahi or by addition to dahi as diluent. For buttermilk, a total solids level of 6.6% including 0.6% salt was considered optimum. Dahi with acceptable quality could be obtained by lending milk with CLHPW in a ratio of 2:1. Dahi, thus, made was diluted with fermented or non-fermented lactose hydrolysed paneer whey (4% TS) to prepare buttermilk. The buttermilk samples packed in LDPE pouches kept well for 10 days under refrigerated storage. This study showed that concentrated lactose hydrolysed whey could be used for the preparation of buttermilk by replacing the milk solids with whey solids up to 67%.

Determination of Physical and Engineering Properties of Toukir and its Application in the Preparation of Gulabjamun

Curcuma angustifolia Roxb. (*Zingiberaceae*) starch is an important ingredient in the preparation of khoa-jalebi. In this study, various physical (bulk, tapped and colour) and thermal (specific heat, thermal conductivity, thermal resistivity and thermal diffusivity) properties were analysed at moisture contents of 3, 6, 9 and 12%. The microstructural properties of toukir were determined using scanning electron microscopy. The bulk and tapped densities decreased from 630 to 530 kg/m^3 and from 930 to 750 kg/m^3 with increase in moisture content. Colour of toukir, measured using Minolta spectrophotometer in terms of L*, a* and b* values, were 95.74, 0.01 and 3.30, respectively. Significant changes in thermal properties with moisture content were observed. Scanning electron microscopic analysis of toukir showed the granules were polyhedral in shape, and were similar in structure to that of corn starch.

Process Optimization for Production of Functional Yoghurt by Incorporating Flax Seed Extracts

Omega-3–fatty acids have emerged as the most beneficial ingredient in the functional food ingredient area, and the flax seeds are the best source of omega-3–fatty acids as a plant source. The study revealed that use of toned milk with incorporation of flax seed oil upto 2% with 8% sugar resulted in production of most acceptable yoghurt. For production of stirred fruit yoghurt, the study revealed that use of 20% (sugar and fruit combination) in yoghurt with 2% flax seed oil and 1% flax seed flour was more acceptable and comparable to control. The fatty acid analysis profile revealed that alpha linolenic acid (ALA) content increased from 0.45% of ALA in control sample to 22.80% of ALA in the final product, contributing to nearly 50% of the RDI of ALA. The iron content in the final product was 0.211mg/100 gm of the product. Microbiology and sensory scores revealed that fruit yoghurt could be stored upto 15 days at refrigerated temperature which was comparable to control yoghurt.

Analysis of Milk Supply Chain in Kolar in Karnataka State

The study was carried out in Kolar, which happens to be a progressive dairy district in Karnataka. The study made use of both the primary and the secondary data. The cost of milk production per liter of milk, for crossbred cow and buffalo was computed at ₹ 18.78 and ₹ 28.77, respectively. Share of feed cost in the total cost varied from around 65.80% (Buff) to 69.60 % (CB). The share of labour cost ranged between 21.70% (Buff) to 15.73% (CB). The net return was negative (₹ -2.77/lit) for the Buffalo, while crossbred cows it was positive (₹ 5.21/ lit) net returns. The cost of manufacturing of Toned milk was worked out to be ₹ 24.00 per liter, with maximum on raw milk cost (84.71 %). The manufacturing cost of Goodlife was found as ₹ 35.45/ liter, with maximum on raw milk cost (67.48 %). The cost of manufacturing of Nandini curd was found as ₹ 30.97/ liter, with maximum on raw milk cost (69.65 %). The manufacturing cost of Nandini peda was worked out to be ₹ 222.45/ kg, with maximum on raw milk cost (52.70 %).The three suggested indicators of efficiency; all three are measured at producer level. Good score of 3.2 was obtained at production cost in producer level. Processing unit got good efficiency in processing of products. Profit got good score of 4.2. Similarly all the stages like collection centre, processing and retail marketing of dairy value chain got the very good score of 4.0 which shows its very good efficiency in whole value chain regarding profit. Return on investment got high score (4.5) at the level of supermarket.

An Economic Study of Milk Production Under Different Levels of Groundwater Exploitation in Southern Karnataka

The study was carried out in Mysore and Chamarajanagar Districts of Karnataka State to analyse cost of milk production, water use efficiency and estimate the technical efficiency in milk production under different levels of groundwater exploitation. In case of crossbreds, irrespective of level of groundwater exploitation around 70% of the milk production cost was composed of feed cost and it was slightly higher in over exploited (72%) area. Milk production cost of crossbreds was highest in over exploited (₹ 19.38/l) areas followed by critical (₹ 18.46/l), semi-critical (₹ 17.66/l) and safe (₹ 16.68/l) areas and hence dairy farmers realized highest net returns in safe (₹ 5.82/l) and semi-critical (₹ 4.84/l) areas than the critical (₹ 4.04/l) and over exploited (₹ 3.12/l) areas. In milk production from buffaloes, the share of total feed and fodder cost varied from 63 to 75% and highest share of feed and fodder cost was reported in semi-critical (75%) and lowest was in safe (63.91%) area. The cost of milk production was highest in over exploited (₹ 26.34/l) and critical (₹ 25.62/l) areas than in the safe (₹ 2 2.19/l) and semi-critical (₹ 23.06/l) areas and this resulted in marginal positive net returns of ₹ 2.31/l in safe and ₹ 1.44/l in semi-critical areas and losses in critical (₹ 1.12/l) and overexploited (₹ 1.84/l) areas. The analysis of determinants of WTP by Tobit model revealed that irrespective of level of groundwater exploitation level of education of the farmer and area under irrigation had the positive significant impact on WTP. The study demonstrated that farmers are incurring considerable cost to explore and utilize the groundwater in dairying. Water productivity in the water scarce areas was higher than the water sufficient areas. Hence, dairy farmers in safe and semi-critical areas should adopt the effective water management practices like DI, SI and irrigation at critical stages.

Consultancy Project

Screening of males for genetic diseases and karyotypic abnormalities: It is absolutely necessary to screen all animals for genetic diseases, especially bulls used in the artificial insemination programmes, to minimize the risk of spreading of genetic diseases to next generation. Therefore, 51 males belonging to *Bos faurus* (Holstein Friesian, Jersey), *Bos indicus* (Deoni, Amrithmahal, Khillar, Hallikar) and buffaloes (Surti and Murrah) were screened either under semen collection or intended for semen collection from 2 semen stations in Karnataka for four genetic diseases viz. BLAD, Dumps, Citrullinemia and Factor X1 deficiency and for karyotypic abnormalities using molecular genetic tools. **A revenue of Rs 5.60 Lakhs was generated as consultancy charges towards screening for genetic diseases and cytogenetic abnormalities.**

EASTERN REGIONAL STATION, KALYANI

Dietary Manipulation of Rumen Fermentation Using Tree Leaves of North-Eastern India

In north-eastern states of India, tree leaves generally used as a livestock feed. However, these tree leaves were not nutritionally evaluated as a animal feed. Animals refuse to eat certain tree leaves due to its higher content of condensed tannin and lignin. Nineteen tree leaves e.g., mulberry (*Morus indica*), agar (*Aquilaria agallocha*), gamahar (*Gmelina arborea*), akashmoni (*A auriculiformis*), Horboroi (*Phyllanthus acidus*), glyricidia (*Glyricidia maculata*), politamother (*Erythrina variegate*), bajna (*Zanthoxylum limonella*), kumira (*Careya arborea*), dumur (*Ficus hispida*), sonal (*Cassia fistula*), shet simul (*Ceiba pentendra*), kamela (*Mallotus philippensis*), karoi (*Albizia procera*), asok (*Saraca asoca*), barun (*Crataeva nurvala*), bahera (*Terminalia bellirica*), nageshwar (*Mesua ferrea*) and sisu (*Dalbergia sisso*) were collected from Tripura and their nutrient compositions was estimated. Futher, nutritional evaluation of the collected tree leaves was done by *in vitro* gas production technique using cattle rumen liquor. Organic Matter (OM) and CP content of these tree leaves varied from 90.1 to 97.9 and 9.5 to 14.7 % whereas NDF and cellulose content varied from 36.5 to 65.2 and 13.6 to 29.1 % on DM basis, respectively. EE content of these tree leaves varied from 2.7 to 6.9% on DM basis. It was concluded from the preliminary *in vitro* studies that glyricidia (*Glyricidia maculate)* was the best tree leaves among the collected/tested tree leaves for feeding to the livestock in Tripura and Kamela (*Mallotus philippensis*) may be used as a rumen manipulator to reduce ruminal methane production.

Cryopreservation of Immature Cattle Oocytes and Foetal Skin Fibroblast Cells

Cattle ovaries were collected from local slaughterhouse and transported to the laboratory within 3-4 h. in a thermo flask containing normal saline supplemented with penicillin (50 IU/ml) and streptomycin (50 µg/ml) maintaining 30° to 32 °C. Surrounding tissues were trimmed by using sterilized surgical scissors and washed thoroughly with prewarmed normal saline. Cumulus oocyte complexes (COCs) were collected in aspiration medium (HEPES modified TCM 199 + DPBS + 0.3 % BSA + 50 µg/ml Gentamycin) using sterile 19 gauge hypodermic needle from visible surface follicles 3-5 mm in diameter. COCs were washed thoroughly with prewarmed washing media and a group of 10-15 oocytes suspended in equilibration media (pre-cooled) for 1-2 min. followed by cryopreservation/ vitrification media. After that COCs were loaded in the 0.25 ml straw and sealed the open end with hot forceps and were plunged into liquid nitrogen directly for future use.

The study was undertaken to cryopreserve foetal skin fibroblast cells. Cattle foetus was obtained from abattoir and skin samples were collected and cut into small pieces and further processed. The results show that cattle fetal skin fibroblast cells can be cryopreserved by a simple and rapid technique in a solution of 10% DMSO in culture media for future use.

Preservation of Black Bengal Buck Semen

An attempt was made to preserve Black Bengal buck semen in liquid and frozen conditions. Semen ejaculates (n= 72) were collected from five numbers of Black Bengal bucks by artificial vagina. Fresh ejaculates were characterized with volume of 0.75 ± 0.25 ml, sperm cell concentration 522 ± 35.30 millions/ml, mass activity 3.8 ± 0.2, progressive forward motility 85.40 ± 8.20 %, functional membrane integrity 62.36 ± 3.46% and normal count 92.0 ± 1.90%. Semen samples were preserved in Tris egg yolk citrate buffer at refrigeration temperature. Buck semen samples preserved in refrigeration condition up to four days of storage were used for AI. A total of 50 AI were carried out by AI workers with a non return rate of 66% (33 out of 50). Attempts were made to preserve buck semen in frozen condition using Tris egg yolk citrate buffer with different concentrations of the cryoprotectants-glycerol. 5 and 6% of glycerol (v/v) has given satisfactory results with 34.5% post thaw motility, 36 ± 3.4 % acrosome abnormality and 36 ± 2.6% functional membrane integrity.

Fig. Kids born through artificial insemination

Motility and acrosomal abnormality in preserved buck semen during storage at refrigeration temperature

Storage period	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	168 hr
Motility (%)	61.5^{a}	52.1^{b}	43.7^{c}	36.2^{d}	28.8^{d}	19.7^{e}	13.2^{e}
Acrosomal abnormality	12.1^{a}	15.2^{ab}	17.1^{b}	20.0^{b}	22.5^{bc}	22.5^{bc}	24.9^{c}

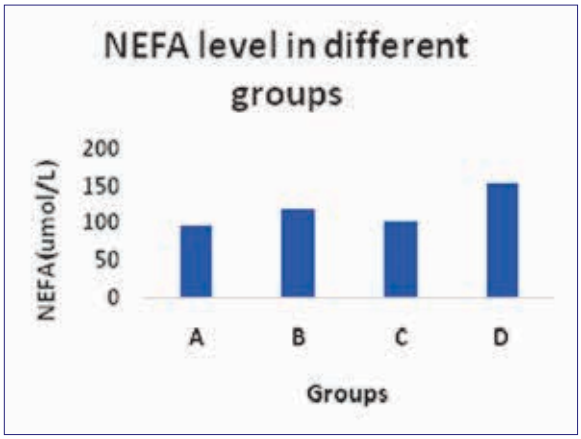
Means with different superscripts in a row differ significantly (P<0.01)

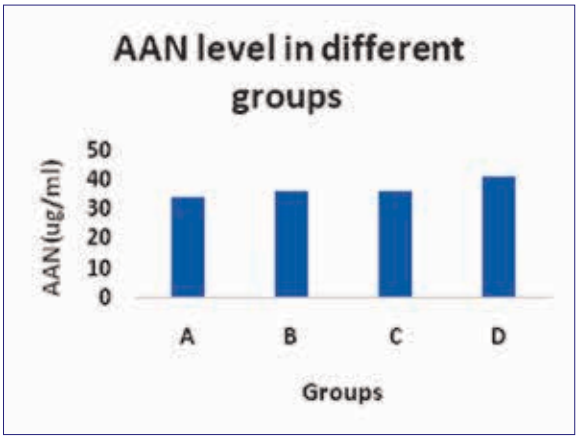
Development of Genetic Model for Improving the Selection Efficiency of Crossbred Cattle at ERS NDRI, Kalyani

Data on 1116 records which comprises of first to thirteen lactations of 319 Jersey crossbred animals extended over 30 years (1986-2015) were used to study the effect of different environmental factors on production and reproduction traits. Data on the entire duration was divided into 6 periods comprising 5 years each where differences would be sizeable enough to be detected. The year was delineated into 3 seasons based on prevalent climatic conditions viz. winter (Nov. to Feb.), summer (March to June) and rainy (July-October) seasons. The data was distributed in nine genetic groups, having different levels of Jersey inheritance in animals. The production traits considered for this study were 305-days milk yield (MY305D), total milk yield (TMY), peak yield (PY), milk yield per day of calving interval (MY/CI) and lactation length (LL) and the reproductive traits included age at first calving (AFC), service per conception (NS/C) and calving interval (CI) of animals. Different environmental factors like period and season of calving/birth, lactation number and genetic group of animals significantly affected the most of the production and reproduction traits of animals. The genetic group, lactation number and period of calving of animals had significant (P<0.05) effects on all the production traits under study. Regarding the reproduction performance of herd, the average AFC and CI of animals in the herd were 1090.87 ± 14.31 and 457.01 ± 11.26 days, respectively with the NS/C of 1.82 ± 0.04. The age of first calving of animals was significantly (P<0.05) influenced by genetic group, period and season of birth of animals. However, the calving interval of animals varied significantly among different parities and cows calved in different periods. The lactation number and genetic group of animals significantly (P<0.01) affected the number of service per conception of animals in this study.

Effects of Area-Specific Mineral Mixture Supplementation on Productive and Reproductive Performance in Black Bengal Goats

Mineral supplementation was found to enhance productive and reproductive performances of ruminant species, particularly to those who are deficient in particular types of minerals. Addition of deficient mineral (s) in diet could economize feeding than supplementing all essential minerals emanating the concept of 'Area-specific mineral mixture (ASMM)'. Therefore, the present study was undertaken to observe the effect of ASMM on growth performance, body condition score (BCS), puberty, blood metabolites (Glucose, NEFA and AAN) and enzymes (SGOT and SGPT) in growing black bengal goats. For the purpose, goats (n=24) were divided equally in to four groups viz. Group I, II, III and IV supplemented with ASMM @ 0, 1, 2 and 3 g/day/animal, respectively. It may be concluded from the study that area specific mineral mixture @ 2.0g/day/animal in growing Black Bengal goats may be of great use for enhancement of growth and age at puberty.





Comparative Nutritional Evaluation and Utilization of Some Newer Feed Resources in Dairy Cattle Ration

Comparative evaluation of chemical and *in vitro* parameters of Azolla microphylla: Chemical and *in vitro* parameters of *Azolla microphylla* were evaluated in comparison to some common protein sources of cattle. It was observed that Azolla contained more protein, ether extract and total ash than Berseem and Cow pea but lower values were obtained than Mustard cake. Azolla was found to have lower crude fibre, NDF and amylase NDF than Berseem and Cow pea while, ADF content of Azolla was slightly higher than Cow pea (29.66 ± 0.48) but lower than Berseem (37.18 ± 0.57). Cellulose and hemicellulose values of *Azolla microphylla* was 16.02 ± 1.2 and 12.3 ± 0.87 which were found to be lower than Berseem and Cowpea but higher than mustard oil cake. The protein fractions revealed more of rumen undegradable protein (fraction B3) in Azolla. The C fraction (ADIP) was although higher in Azolla but it is comparable with cowpea fodder. Gas produced up to 24 h as per cent of total gas production were similar in case of Azolla, Berseem and Cowpea. *In vitro* true DM digestibility (IVTDMD) of *Azolla microphylla* was almost similar to Berseem and cow pea and the in vitro crude protein digestibility (IVCPD) was more than cow pea. There was significant decrease in *in vitro* total gas production with the increase in level of inclusion of Azolla replacing Berseem at 24, 48, 72 and 96 h of incubation.

Effect of Supplementing Fresh Azolla Microphylla on Growth Performance of Jersey Crossbred Female Calves

The effect of fresh *Azolla microphylla* supplementation in crossbred female calves was studied in a Growth trial of 112 days. Twelve cross bred growing female calves were distributed into two groups (T_0 and T_1). The animals in (T_0) group were fed with paddy straw (around 50 %) and concentrate mixture (around 50 %). In the (T_1) group fresh *Azolla microphylla* was supplemented @1.5 kg/ animal (equivalent to 90 g DM basis) replacing equivalent weight of concentrate mixture on DM basis. There was no significant difference in total dry matter intake, CP intake and TDN intake between the two groups. **S**upplementation of fresh *Azolla microphylla* could sustain and enhance the growth performance of cross bred growing female calves especially under straw based feeding system where/when green fodder availability is scanty.

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

In lower gangetic region, sub clinical mastitis in Jersey crossbred cows, a big and silent problem causes higher economic losses to the farmers. A study was conducted to compare the incidence of sub clinical mastitis (SCM) in two management system: manual and mechanized milking in ERS-NDRI farm. A total of 12 crossbred (JerseyX Red Sindhi) cows in mid-lactation and parities of 2 to 4 were selected from the herd. Animals were divided into two comparable groups. The first group was milked by using hand (full hand method) whereas second group was milked by milking machine (DeLaval combine milking floor mounted machine - 2TR model). The somatic cell counts (SCC), Fat, and SNF, pH and modified California mastitis test (MCMT) were determined in morning and evening milk samples. Diagnosis of sub clinical mastitis was based on SCC, MCMT and pH. The data were analysed by using paired sample T-test. The logarithms of SCC number were used for trying to normalize data distribution. It was concluded that the incidence of sub clinical mastitis was reduced in machine milking practices with higher milk quantity without affecting milk quality in Jersey crossbred cows in lower gangetic region.

Development of KiSSpray (Bovine Specific Intranasal Spray Devices for Kisspeptin)

Kisspeptin, a potent secretagogue of GnRH, has recently emerged as a master player in animal reproduction. Kisspeptin-10 (kp-10) is only 10-amino acids long. It may, therefore, easily cross the blood brain barrier and act on the GnRH neurons located in the central nervous system (CNS). A cheaper intranasal spray device was designed specifically for cattle. The developed KiSSpray device has an efficiency to pump 20µg kp-10/spray.

Kisspeptin-10 @ 50µg per animal were administered intranasally in five heifers, using the spray device was developed to find out whether intranasal spray induces blood LH peaks. The results revealed that LH peak was induced at 2.25h after kisspeptin-10 (kp-10) spray and the peak was sustained till 6-h post kp-10 administration. Kisspeptin-10 intranasal spray may, therefore, be used as a potent stimulator of GnRH in bovine.

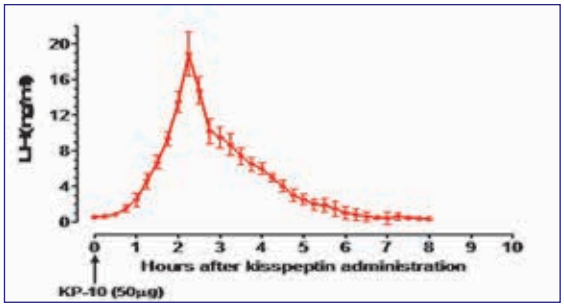


Figure: Changes in the plasma LH profile (mean ± SEM) in crossbred heifers (n=05) after intranasal administration of 50µg of KP-10. Blood samples were collected at 15 min intervals post-KP10 administration for 8 h period.

Standardization of Optimum Dosage of KP-10 for Crossbred Heifers/Cows: Peripheral vis-à-vis Intranasal Administration

Peripheral administration of kp-10: Different doses of kp-10 viz., 0 (no kp-10, only equal volume of normal saline), 50, 100 and 200µg kp-10 per animal were administered i.v. in animals selected randomly. Blood samples were collected at 15-min intervals beginning with 1h prior to and 8h post kp-10 administration. Blood LH was estimated in all samples using bovine specific LH enzyme immunoassay.

Intranasal administration of kp-10: Different doses of kp-10 viz., 0, 50 and 100µg kp-10 per animal were administered through intranasal route using KiSSpray in animals selected randomly. Blood samples were collected at 15-min intervals beginning with 1h prior to and 8h post kp-10 administration. Blood LH was estimated in all samples using bovine specific LH enzyme immunoassay.

Response of different doses of kp-10 administered either i.v. or intranasal route in terms of Area Under LH response Curve (AUC) have been detailed in Table 1. Pretreatment AUC for different dosages of kp-10 were similar (P>0.05) when kp-10 was administered either peripheral or intranasal route. Post-treatment AUC for 50, 100 and 200µg KP-10 doses when administered intravenously was significantly higher (P<0.001) than respective pre-treatment AUC values (Table 1).

As that of peripheral route (i.v.), the values of post-treatment LH AUC for 50 µg and 100 µg KP-10 dosage administered through intranasal route were higher (P<0.01) than 0 µg dosage, but the values were similar (P>0.05) between 50 and 100 µg dosages. Hence, 50 µg dosage of KP-10 per animal intranasal is found to be optimum to elicit the response of KP-10 in terms of LH release. Interestingly, 50 µg KP-10 when administered through intranasal route exhibited more response in terms of blood LH release than those observed even with 200 µg KP-10 through peripheral route (Table).

Table: Mean area under LH response curve (AUC; ng/ml.min) for different dosages of KP-10 administered either intravenous or intranasal during pre and post-treatment period in heifers

Dosage (per heifer)	KP-10 administered through i.v. route		KP-10 administered through intranasal route	
	Pre-treatment AUC	Post-treatment AUC	Pre-treatment AUC	Post-treatment AUC
0µg KP-10	0.45 ± 0.005a	0.53 ± 0.007a	0.35 ± 0.01a	0.45 ± 0.009a
50µg KP-10	0.46 ± 0.006 a	34.7 ± 3.69b	0.42 ± 0.009 a	88.23 ± 7.45d
100µg KP-10	0.44 ± 0.010 a	52.3 ± 7.12c	0.47 ± 0.011 a	93.47 ± 8.37e
200µg KP-10	0.47 ± 0.011 a	63.9 ± 6.97c	0.43 ± 0.010 a	---

[a,b,c,d,e] Means without a common superscript differ (P<0.05).

Induction of Estrus in Anestrus Heifers using OvSynch Protocol/New Method of Estrus Synchronization Protocol using Kisspeptin-10

Twelve numbers of crossbred anestrus heifers were selected from the ICAR-NDRI, ERS farm. To characterize the endocrine profiles in these heifers, blood sample (3ml) from each animal were collected daily by jugular venipuncture for 24 days. Plasma samples obtained from the collected blood after centrifugation at 3000rpm at 4°C were used to estimate different reproductive hormones viz., estradiol-17β, progesterone and LH. All hormones were found to be at basal level. No definite trend for any of the hormone estimated was recorded.

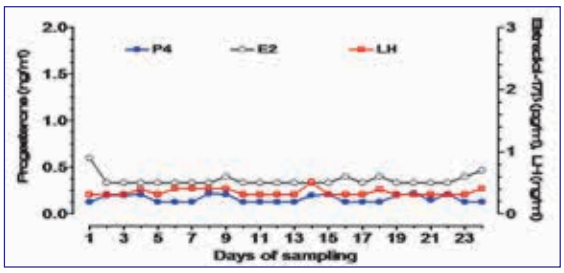


Figure: Hormonal profiles (mean ± S EM) in crossbred anestrus heifers

Sixteen numbers of anestrus heifers were treated for induction of estrus following Ovsynch protocol (day 0: GnRH, day 7: PGF2α, day 9: GnRH). Five animals responded to the treatment. These five animals were inseminated on day 10 of the Ovsynch protocol, of which only three were found to be pregnant. Thirteen non-responsive/non-pregnant heifers were subjected to new method of estrus synchronization protocol using Kisspeptin-10. Except one heifer (2082), all animals responded to the treatment i.e. exhibited estrus. Blood samples were collected from all these animals at regular interval for estimating hormones. Hormones i.e. blood LH and progesterone was estimated in seven animals only. Results have been presented in the figures 3 and 4. The progesterone concentration was at the lowest level (P<0.001) on the day of estrus (day 0). The concentration increased gradually thereafter to reach the peak level on day 13 of the cycle. The level decreased gradually to the lowest level again on the day of estrus in the next cycle. The mean (±SEM) plasma LH concentrations differed significantly (P<0.001) on different days of the estrous cycle.

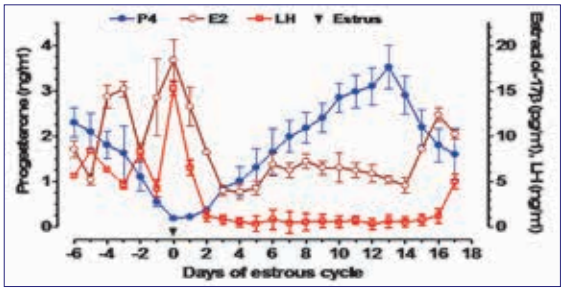


Figure: Hormonal profiles in anestrus heifers turned cyclic post-kisspeptin-10 treatment throughout the estrous cycle

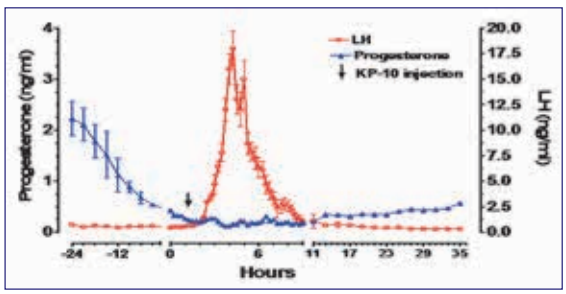


Figure: Mean (±SEM) plasma concentrations of LH and progesterone in crossbred heifers treated with new method of estrus synchronization using KP-10

Upliftment of Socio-Economic Condition of Tribal People Through Integrated Livestock Farming in North Eastern Hill Region/Eastern Part of India *(TSP Project)*

The work under TSP was focused to treat the animals from different diseases, immunization against different diseases in cattle, goat, poultry, deworming against different enteric parasites of the animals in the tribal dominated areas of Sundarbans, South 24 Paraganas, Ayodhya hill areas of Purulia, Duars region of Jalpaiguri. Feed resource development was also focused in these areas to increase the production potential of the animals. Under this project one 42 days trainng programme was conducted on "Artificial Insemination & Veterinary First aid". Six particpants were tribal farmers from three different districts. Under this training programme six (6) exposure visits were conducted to different farm like State livestock farm, Govt. of W.B, Kalyani, Nadia (2 times), Haringhata farm, Mohanpur, Nadia (2 times), Frozen semen station, Haringhata Farm, ERS,IVRI, Kolkata. Under this project, Seven (7) different Animal health and vaccination camp were organized in different tribal dominated villages; total 3921 animal six different types were treated. On 8th August 2014, one veterinary camp was organized in Adibasipara, Bijoynagar, Sundarbans, 24 Paraganas (S). On 9th September, 2014 one veterinary camp was organized in Ayodhya hills of Purulia district. On 17th November 2014, one veterinary camp was organized in Totapara, Alipurduar. On 5th December 2014, one veterinary camp was organized in Uttar Ballaguri, Madarihat, Birpara, Jalpaiguri. On 6th December 2014, one veterinary camp was organized in Bali 2, Adibasapara, Bijoynagar, Sundarbans 24 Paraganas (S). On 4th February 2015, one veterinary camp was organized in Chatni village, Ayodhya hill Purulia. Fodder demonstration including distribution of rooted slips of different varies of quality grass was also carried out. Area specific mineral mixture was also distributed to the tribal farmers for feeding to their animals.

A CD containing a compendium of lectures being released during National Seminar

3 TRANSFER OF TECHNOLOGY

DAIRY EXTENSION

Field/Farm Technician (FFT) Laboratory

The Field/Farm Technician (FFT) Laboratory of Dairy Extension Division provides a base for extension work in the adopted villages around Karnal and keeps the records of all extension activities of the Division. Newly adopted villages are: Dungro, Deepo and Dhamnheri.

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

Activities Conducted in Adopted Villages during (2014-2015)

Sr. No	Activities Conducted	Nos. of Cases
1.	A.I. in Cows	518
2.	Conception Rate (%)	38.10
3.	A.I. in Buffaloes	286
4.	Conception Rate (%)	30.80
5.	Nos. of Cross-breed Calves Born	98
6.	Nos. of Buffalo Calves Born	125
7.	General Treatment	315

Infertility and Veterinary aid Campaigns

A total of 48 camps were organized in Kulwaheri, Budhakhera, Deepo, Dugro & Dhamanheri villages. During the Campaigns 1275 cases were treated for reproductive disorders and various veterinary ailments. Ectoparasitic control campaign and deworming programmes for control of endoparasites were conducted. Special attention was given to improve the productive and reproductive cause of animals by diagnosis and proper treatment.

Kissan Sanghosthi

Forty eight Kisan Sangosthies were organized at village level to update the knowledge of dairy farmers and to provide the spot solutions to their problems.

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

Dairy Education at Farmers' Door (DEFD)

A new Extension Education Programme "Dairy Education at Farmers' Door" initiated by NDRI continued in the year 2014-15 for strengthening the effective dissemination of dairy production and processing technologies among farming community. A team of NDRI scientists including subject matter specialists from production, processing and management group visited various villages on every 2nd Saturday. Scientists also obtained the feedback from the participating farmers. At the outset, arrangement for discussion with a group of farmers was made at the local common entrance of the villages and discussed on farmers' problems related to scientific dairy farming, crop husbandry practices and also to gave veterinary advice to the farmers.

All India Animal Husbandry Officers' Workshop-2014

The All India Animal Husbandry Officers' Workshop was organized by the Dairy Extension Division during September 24-25th, 2014. The theme of the workshop was "Opportunities and Challenges in Dairying for Small Farmers".

Plenary session were categorized into four sub thematic areas: Livestock production technologies for sustaining small farmers, Newer Milk processing technologies for small farmers, Innovative strategies for promoting entrepreneurship among small farmers and Emerging Problems and Issues of Dairying under Field Conditions. A total number of 47 participants from 11 different states of the country participated.

A Training of Livestock Assistants and Field Coordinators

A training was organized for 36 livestock assistants and field coordinators of Centre for micro finance, Malviya Nagar, Jaipur on "Scientific Dairy Farming" during 3-5 December, 2014. This training was designed in such a way that technological information would be transferred alongwith the extension techniques so that it will be an active learning on the part of the participants who in turn can motivate the livestock farmers for increasing

farm productivity. The status of the animal husbandry and various issues influencing the livestock sector were fully covered in the training so that it would be more convenient for livestock assistants and field coordinators to work with the various clientele groups in the rural areas.

Model Training Course on Good Dairy Farming Practices: A Way Forward for Organic Farming

An 8 days Model Training Course on "Good dairy farming practices: a way forward for organic farming" sponsored by the Directorate of Extension, Department of Agril. & Coopn., Ministry of Agriculture, Govt. of India and organized by Dairy Extension Division, National Dairy Research Institute, Karnal from 29th October to 5th November 2014. This Model Training Course was aimed to facilitate orientation of Animal Husbandry, veterinary and Dairying offices on current scenario of livestock and familiarize them with various components of good dairy farming. A total number of 25 participants representing 14 states of the country participated.

Progressive Dairy Farmers Meet-2014

Progressive Dairy Farmers Meet-2014 was organised on 7th October, 2014 in which 200 progressive dairy farmers from various districts of Haryana as well as other states, personnel from NGOs and officials from related government departments actively participated. The meet was inaugurated by Dr. R. S. Paroda, Chairman, Haryana Kisan Ayog.

During an open discussion, various issues of dairy sector were raised by the farmers which were discussed at length and different queries as well doubts of the farmers were answered by the experts.

Training on Heat Detection in Dairy Animals

A training programme on "Heat Detection in Dairy Animals" was organized by the Dairy Extension Division during 1.5.2014 to 3.5.2014. Thirty farmers who belonged to villages namely Kulwehri, Subri and Kunjpura participated in this training programme.

Dairy Samachar

Quarterly Dairy Samachar were compiled, edited and published by Division Dairy Extension, NDRI, Karnal. Dairy Samachar was sent/distributed to the farmers, as a regular practice to dairy owners and other dairy entrepreneurs in different states throughout the country. Dairy Samachar made the farmers well aware of newly developed dairy technologies of the institute.

Forage Museum: To maintain the green fodder availability round the year, a forage museum 2 acre (87120 square feet) was established at NDRI in which following four fodder production modules were developed.

Perennial Grass: Presently 16 varieties of perennial grasses (napier-7, Guinea-3, Nandi grass-1Anjan-3, paragrass-1, Bahia grass-1) were planted at forage museum.

Seasonal fodder crops: In Rabi season, three varieties of Berseem, two varieties of oats and one variety of Turnip were cultivated at forage museum site.

Silvi-pastrol : A total of 10 species of fodder have to be planted in coming kharif season.

Horti-pastrol : A total of 100 lemon plants have to be planted in coming kharif season.

Farm School

A new educational approach "Farmers' Farm School" of NDRI was started in village Gorgarh, Karnal. In this school, 20 active farmers were registered as students. Scientists of NDRI were taking classes regularly on every Friday and Saturday. In this period basics of animal husbandry along with wheat cultivation were covered and at the end of the month, quiz was also organized.

Advisory Services

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

Technologies Assessed and Transferred

- Location specific mineral mixture supplementation
- By pass fat for higher milk producing animals
- Balance feeding technologies
- Ration preparation at home
- Scientific calf rearing practices
- Information system on clean milk production
- Scientific udder health management practices
- Value added dairy based food products
- Preventive measure of mastitis control
- Round the year green fodder production technology

KRISHI VIGYAN KENDRA (KVK)

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

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

At KVK, need based training courses are designed for different types of clientele. After training, follow up extension programme is undertaken. While designing the courses, the entire concept of farming system is taken into consideration to make the enterprises economically viable for the farmers. For making training programmes more effective, the KVK has developed close linkages with different Government, Non-Government and voluntary agencies and line Departments.

Training Programmes Organized by KVK (April, 2014 to March, 2015)

Title of the course	Duration (days)	No. of Courses	No. of Beneficiaries	Mandays Trained
On Campus				
Dairy Production				
At KVK	5	11	894	4470
Sponsored	4-6	42	1260	6019
Dairy Processing	5	6	111	555
Crop Production				
At KVK	3-4	4	115	401
Sponsored	4-5	2	67	293
Vermiculture	3	3	61	183
Bee-keeping				
At KVK	4	3	98	392
Sponsored	5	1	14	70
Fish Farming	4	2	70	280
Home Science	2-12	9	215	935
Azolla cultivation	2	1	36	72
Total (A)		**84**	**2889**	**13673**
Short Integrated Training Programmes (B)	1-2	55	1834	**2041**
Total (A+B)		**139**	**4723**	**15714**
Off Campus				
Dairy Production	1	6	311	311
Dairy Processing	1	4	68	68
Crop Production	1	15	291	291
Vermiculture	1	3	45	45
Home Science	1	2	47	47
Total (C)		**30**	**762**	**762**
Grand Total (A) + (B) +(C)		**167**	**5485**	**16476**

Front Line Demonstrations (2014-15)

Front Line Demonstration (FLD) is a National Programme to promote and popularize the production of the oilseed and pulse crops apart from latest varieties in fodder and cereal crops in this region. One of the prime mandates of KVK is to conduct FLD in various crops to generate production data and feedback information and to study the factors, which enhance the optimum yield, and also to prove the production potential of newly developed crop production technology. The following FLD programmes were conducted during 2014-2015.

S. No	Crop		Varierty	Total No. of Demo.	Area (ha.)	Av. yield
1.	OILSEEDS	Mustard	Pusa Vijay	11	4.45	18.55
			RH-749	5	2.0	18.69
			Pusa Agrani	4	1.61	19.70
2.	PULSES	Gram	BG-1103	12	2.42	15.56
			HC-1	6	1.21	16.54
		Summer Moong	MH-421	15	6.0	5.68
3.	CEREALS	Wheat	HD-2967	5	2.0	55.20
			HD-2894	5	2.0	52.61
4.	FODDER	Oats	HJ-8	15	6.0	517.0
		Sorghum (Jowar)	Redchari	18	6.0	689.0
		Maize	African Tall	3	0.8	501.0
			J-1006	10	4.0	457.0
		Bajra	FBC-16	17	6.0	454.0
		Berseem	BL-42	11	2.53	1311.0
			HB-1	12	2.53	1204.0
			Mescavi	3	0.40	1117.0

Extension Activities of KVK

The KVK has four stockman centres in the adopted villages, namely: Taprana, Phusgarh and Jundla Gate, Karnal to take care of animal health and artificial insemination in the operational area. The animal health management activities and field extension activities were carried out through these stockman centres. Subject-matter specialists of KVK organized 6 camps of one day duration in these KVK adopted villages also to create awareness among farmers about animal infertility problems and dairy management aspects. A total number of 6356 cases were attended, out of which 202 cases were for general treatment, 161 of infertility treatment, 360 for dehorning, 2066 for pregnancy diagnosis and 3567 A.Is. in dairy animals. Through Artificial Insemination 1782 calves were born.

- KVK focused its efforts in increasing the Moong cultivation area in the district. Moong varieties SML-668 and MH-421 were promoted and the farmers having different categories of land holding were encouraged to grow summer Moong for getting pulse as well as to increase the soil fertility.
- Conservation agriculture technologies like zero tillage, direct seeded rice and bed planting in cultivation of wheat and paddy cultivation were demonstrated to various groups of farmers and farm women not only from Karnal district but also from other states. It was also promoted in different villages.
- KVK played an important role in organizing National Dairy Mela that was held on 25th-27th February, 2015. More than 14000 visitors including progressive dairy farmers, dairy entrepreneurs and farm women across the country participated in the Mela.
- KVK staff advised the farmers, farm women and rural youth in person who visited KVK and through telephone and e-mails regarding their queries.
- KVK staff frequently visited various villages in Karnal and nearby districts and issued advisories to farmers regarding growing paddy crop under deficit monsoon condition during Kharif 2014.
- KVK organized the exhibitions depicting its activities and achievements on 25th -27th February, 2015 during National Dairy Mela organized by NDRI, Karnal, on 28th March 2015 in village Dabarki Kalan district Karnal and on 30th October 2014 on the occasion of Kisan Mela in DWR Karnal.

Revenue Generated

Total revenue generated at KVK through various activities during **April 2014 to March, 2015** was **₹ 43,11,602/-** as given in the following Table.

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 information from NDRI, relevant information available from other research institutions/stations of ICAR and state institutions located at Karnal are utilized by this centre for the end users visiting this centre. Large number of entrepreneurs, practicing farmers and extension workers visits this centre. Besides end users, large number of students are availing the facilities of ATIC for the orientation programme and to have latest information related to dairying and allied fields.

Mandate of ATIC

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

Dissemination of Technological Information

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

- Personal interaction with visiting farmers.
- Display of Models etc; organizing / participating in Melas and Exhibitions.
- Audio/Video shows
- Visits to Dairy farm
- Information through toll free telephone number (1800-180-1199)
- Providing Publications.
- Providing material inputs like improved seed varieties , Vermi compost etc.
- Through Email

Services Rendered in Agricultural Technology and Technology Products from April 2014 to March, 2015

Sr. No.	Detail of Services	No. of Services*	No. of Persons
1.	Dairy/Agriculture related information through Video show and Lecture	112	4857
2.	Personal Discussion with Subject-Matter-Specialist on Dairy Farming	80	140
3.	Information through Dairy/Agriculture Literature	137	135
4.	Information on Agriculture (Seed/Fertilizer/Compost etc)	2535	2591
5.	Information through telephone (Toll-free) on Agriculture & Dairying etc.	3485	3485
6.	Information through e-mail on Agriculture & Dairying etc.	101	101
7	Progressive Farmers Meet	04	30
Total		**6454**	**11339**

* Additional service through email has been initiated and 08 persons have been provided reports, literatures etc.

Total Sale

Sr. No.	Item	Amount (₹)
1.	Books	113612.00
2.	Agriculture Inputs*	4545627.00
	Total	**4659239.00**

*Seed Varieties sold:

Oats (Kent), Jowar (SX-17), Maize 1006, Barseem BLL-10, Mustard Grain Barley Grain Wheat-2967, PB 621, 550, 658, Paddy: PR-114, 123

4 DAIRY EDUCATION

EDUCATION AND TRAINING

National Dairy Research Institute is the premier Institution of International repute in Human Resource Development for the growing dairy industry in India. NDRI which has been conferred deemed to be university status vide Govt. of India, Ministry of Human Resource Development, Department of Education, and Notification No. F. 9-15/85-U.3 dated 28.3.1989, is well equipped and staffed to meet emerging needs of the 21st century of the dairy industry. The University offers academic programmes both at under-graduate and post-graduate levels in the field of Dairy Science and Technology. The following courses were offered by NDRI Deemed University during the academic session 2014-15. The courses have been so designed as to provide broad base as well as specialized training on different aspects of dairying.

B.Tech. (Dairy Technology)

This 4 Year degree 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 Master's degree programme in the following disciplines: i) Dairy Microbiology; ii) Dairy Chemistry; iii) Dairy Technology; iv) Dairy Engineering; v) Animal Biochemistry; vi) Animal Biotechnology; vii) Animal Genetics and Breeding; viii) Livestock Production and Management; ix) Animal Nutrition; x) Animal Physiology; xi) Dairy Economics; xii) Dairy Extension Education, xiii) Agronomy (Forage Production), Food Quality and Safety Assurance and M.V.Sc. in Animal Reproduction, Gynaecology and Obstetrics

Diploma in Dairy Technology and Animal Husbandry

The Diploma programme offers intensive training in dairy processing and quality control of milk and dairy products, engineering aspects of dairy processing equipments and dairy business. The Institute has also started Diploma in Animal Husbandry at ERS of NDRI, Kalyani.

Scholarship and Fellowships

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

Institute Scholarships

Master's degree	₹ 7560/- P.M. for two years plus ₹ 6000/- per annum as contingency.
Ph.D.	₹ 10,500/- P.M. for three years and ₹ 10,000/- per annum as contingency.
Ph.D. (In-service)	₹ 1000/- P.M. for three years and ₹ 10000/- per annum as contingency.

ICAR Junior Research Fellowship

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

ICAR Senior Research Fellowship

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

National Talent Scholarship

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

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

Career Guidance, Training and Placement Cell

The placement Cell provides career guidance, training and placement services for the passing out students in various disciplines of the Deemed University. B.Tech. (Dairy Technology) and Master in Dairying students were provided employment in reputed organizations through campus interviews. Passed out students of NDRI are getting employment in Dairy/ Food Industry (Govt./Cooperative/Multinationals). Salary ranges from ₹ 20,000 to 60,000/- per month. In addition to employment a number of students also opt for higher studies in India and abroad. The major functions of the Cell are as follows:

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

Counselling for Admissions

Counselling for admission to UG and PG programme was held by the Education Division of ICAR on 15.6.2014 and 29th, June, 2nd & 4th July, 2014, respectively at NASC Complex, New Delhi.

Entrance Examination

An all India Competitive entrance examination for admission to Ph.D. programme for the session 2014-15 was conducted by NDRI on 12.5.2014 at three centers i.e. Karnal, Bangalore and Kalyani.

Admissions

Admission for the academic session 2014-15 for Diploma in Dairy Technology, Diploma in Animal; Husbandry & Dairying, B.Tech. (Dairy Technology), M.Sc./M.V.Sc./M.Tech. and Ph.D. programmes were made and the admission process was closed on 4.9.2014.

A total number of 23 students joined Diploma in Dairy Technology, 20 students joined Diploma in Animal Husbandry & Dairying, 27 students joined B.Tech. (Dairy Technology), 152 students joined Masters' programme including three foreign national, 107 students including three foreign nationals joined the Ph.D. Programme.

Degrees Awarded during the 13th Convocation

B.Tech. (Dairy Technology)	43
Master in Dairying	110
Ph.D.	67

Meetings

- 77th , 78th and 79th meeting of the Standing Committee on Course Curricula and Academic Affairs was hold on 17.6.2014, 29.10.2014 and 17.1.2015
- 54th, 55th, 56th and 57th rd meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 17.6.2014, 19.6.2014, 16.8.2014 and 23.1.2015.
- 50th meeting of Standing Committee on Scholarship, Financial and Academic Progress was held on 17.6.2014
- 37th meeting of Academic Council was held on 21.06.2014.
- 38th meeting of Academic Council was held on 12.02. 2015.

Thirteenth Convocation of NDRI Deemed University

Thirteenth Convocation of NDRI Deemed University was held on 14th February, 2015. Prof. Kaptan Singh Solanki, Hon'ble Governor of Haryana presided over the Function and Dr. Mangala Rai, Former Secretary, DARE & Director General, Indian Council of Agricultural Research delivered the Convocation Address. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI Deemed University presented the Convocation Report. A total of 221 students (including 74 girls) were conferred different degrees i.e. B.Tech. (Dairy Technology) - 43, Master's - 110 and Doctoral - 67.

A galaxy of eminent guests including Dr. Gurbachan Singh, Dr. K. M. L. Pathak, Dr. Arvind Kumar and Dr. B. K. Joshi, Dr. G. R. Patil and others graced the occasion.

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

Students awarded Medals in B.Tech. (DT)

Name of the Student	Type of Medal
Ms. Ankita Kataria	Gold
Ms. Nitika Sangwan	Silver
Ms. Bhanu Gambhir	Bronze

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

Name of the student	Discipline	Type of Medal
Arun Pratap Singh	Animal Genetics & Breeding	Gold
Deshmukh Pavan Vijayrao	Dairying Engineering	Silver
Mohsin Ayoub Mir	Agricultural Extension Education	Bronze

Students awarded Medals in Ph.D.

Name of the student	Discipline	Type of Medal
Siddhartha Shankar Layek	Livestock Production & Management	Gold
Ms. Pragya Bhaduria	Livestock Production & Management	Silver
Argade Shivaji Dadabhau	Agricultural Extension Education	Bronze

Merit Certificate to 20% of the total pass out students in B. Tech.(DT) Programme based on performance in course work were awarded to the following students: Ms. Ankita Kataria, Ms. Nitika Sangwan, Ms. Bhanu Gambhir, Ms. Priyanka, Ms. Sakshi Mittal, Sanju Narwal, Ms. Rita Devi and Ms. Meenakshi.

Merit certificates to toppers of each discipline in Master's and Ph.D. degree programme for performance in course work as per the eligibility criteria were awarded to the following students:.

Master's Students

Name of the student	Name of the discipline
Chaudhari Dipak Dilip	Dairy Microbiology
Brajesh Kumar	Dairy Chemistry
Chaudhary Madhabhai Bhikhabhai	Dairy Technology (SRS)
Deshmukh Pavan Vijayrao	Dairy Engineering (SRS)
Ms. Rishika Vij	Animal Biochemistry
Ms. Shikha Pachauri	Animal Biotechnology
Arun Pratap Singh	Animal Genetics & Breeding
Rahul Kumar Joshi	Livestock Production & Management
Ms. Sonam Dixit	Animal Nutrition
Ms. Indu B.	Animal Physiology
Ms. Rapolu Harika Devi	Agricultural Economics
Sudhanand Prasad Lal	Agricultural Extn. Edu.
Pooja Gupta Soni	Agronomy(Forage Production)

Doctoral Students

Name of the student	Name of the discipline
Ms. Poonam	Dairy Microbiology
Ms. Vidhu Yadav	Dairy Technology
Ms. Neelam Upadhyay	Dairy Chemistry
Rohit Sharma	Animal Biochemistry
Ms. Sulochana Sen	Animal Genetics & Breeding
Siddhartha Shankar Layek	Livestock Production & Management
Ms. Sonali Prusty	Animal Nutrition
Dilip Kumar Swain	Animal Physiology
Argade Shivaji Dadabhau	Agricultural Extn. Edu.
Ms. Shalini	Animal Biotechnology

Best Thesis Awards

Best Thesis Awards for Master's theses (one each in Production, Processing and Management Groups) carrying a citation, a certificate and ₹ 5000 were awarded. Two theses in each programme were recommended by committees in each discipline. The students presented their theses before the Award Committee. The award committees evaluated the theses and gave their recommendations for the Best Thesis Awards in their respective groups as given below:

Best Master's Thesis Awards

Group	Name of the student	Name of the Guide	Discipline
Production	Ms. Samreen Fatima	Dr. D. Malakar	Animal Biotechnology
Processing	Mr. Brajesh Kumar	Dr. Rajan Sharma	Dairy Chemistry
Management	Ms. Rapola Harika Devi	Dr. Smita Sirohi	Dairy Economics

Gold Medals for best thesis research work in Ph.D. Programme of Production, Processing and Management Group were awarded. The award carries Gold Medal, Citation and Certificate. Two theses in each programme were recommended by committees in each discipline. The students presented their thesis before the Award Committee. The award committees evaluated the thesis and gave their recommendations for the Best Thesis Awards in their respective groups as given below:

Group	Name of the student	Name of the Guide	Discipline
Production	Mr. Selokar Naresh Lalaji	Dr. S.K. Singla	Animal Biotechnology
Processing	Ms. Kiran Kumari	Dr. S.K. Tomar	Dairy Microbiology
Management	Dr. Argade Shivaji Dadabhau	Dr. Gopal Sankhala	Dairy Extension

Dr. D. Sundaresan Memorial Oration Award-2015

Dr. D. Sundaresan Memorial Oration Award-2015 was bestowed on Padam Bhushan Prof. N. K. Ganguly, former Director General, ICMR, New Delhi. Prof. Ganguly delivered the lecture on 11th February, 2015 in Dr. N. N. Dastur Auditorium of NDRI on the topic "Probiotics & Vaccine". The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. N. N. Dastur Memorial Oration Award-2015

Dr. N. N. Dastur Memorial Oration Award-2015 was bestowed on Dr. Harsh Kumar Bhanwala, Chairman, National Bank for Agriculture and Rural Development (NABARD), Mumbai. Dr. Bhanwala delivered the oration on 9th February, 2015 in the Dr. N. N. Dastur Auditorium of NDRI on the topic "Leveraging Animal Wealth For Small Farmers' Prosperity". The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Dr. K. K. Iya Memorial Oration Award-2015

Dr. K. K. Iya Oration Award-2015 was bestowed on Dr. Nagendra P. Shah, Professor, Food Science and Dairy Technology, The Univrsity of Hongkong. Dr. Shah delivered the lecture on 10th February, 2015 in Dr. N. N. Dastur Auditorium on the topic "Improving Health Functionalities by Reducing Fat and Salt Contents in Cheeses and Using Probiotics". The award carries an amount of ₹ 20,000, a citation, shawl and a certificate

Best Division Award for Academic Achievements and Innovations in Teaching

The Different Head of Divisions presented the innovations and significant achievements during 2013-14 in education/research and consultancy during Academic Celebrations in the Dr. D. Sundaresan Auditorium on 1st February, 2015 before the Committee. On the recommendation, the "Best Divisional Award" was presented to Animal Biochemistry and Animal Biotechnology Centre jointly.

Best Teacher Award for Excellence in Teaching

Best Teacher Awards at Under-graduate teaching and Post-graduate levels at NDRI, Karnal to recognize and promote teaching excellence and motivate the faculty to adopt high standards for content preparation, delivery of lectures, motivation of students and overall development of students were conferred upon at:

UG level

Er. P.S. Minz, Scientist, Dairy Engineering Division

PG Level

Dr. Sumit Arora, Principal Scientist, Dairy Chemistry Division

Memorandum of Understanding Signed

NDRI signed Memorandum of Understanding with the following Universities for collaboration in areas of mutual interest:

5 HONOURS / AWARDS

- **Dr. Sumit Arora,** Principal Scientist, Dairy Chemistry Division received "**Best Teacher Award"** (Post-graduate teaching) for the year 2014-15 during the 13th Convocation of NDRI Deemed University 14th February, 2015 at NDRI, Karnal.

- **Dr. R. Malhotra,** Principal Scientist, Dairy Economics Statistics and Management Division received **"Best Teacher Award"** (Under-graduate teaching) for the year 2013-14 during the 13th Convocation of NDRI Deemed University, Karnal held on 14th February, 2015.

- **Dr. Y. S. Rajput**, **Dr. Rajan Sharma** and **Mr. Amit Baruni** were jointly awarded **"NRDC Meritorious Invention Award"** for the innovation/invention **"Test for detection of detergent in milk"** by National Research Development Corporation (An Enterprise of DSIR, Ministry of Science and Technology, Govt. of India) New Delhi on 25th February, 2015.

- **Dr. K. P. Ramesha** was conferred with **"Sir J. C. Bose Memorial Award – 2014"** by Indian Science Monitor, (Regd.), Chennai, in the 12th Annual Sir J. C. Bose Memorial Function on 18th January, 2015 held at Bharatiya Vidya Bhavan, Bengaluru.

- **Ms. Rishika Vij,** M.V.Sc student working with **Dr. Suman Kapila,** Principal Scientist (Major Advisor), Animal Biochemistry Division received "**Young Scientist Award"** in the 12th Agricultural Science Congress held from 3rd-6th February, 2015 at NDRI under the auspices of National Academy of Agricultural Sciences (NAAS) for paper entitled "**Bioavailability and transepithelial transport of milk derived bioactive peptide".**

- **Mr. Rohit Sharma,** Ph.D. student working with **Dr. Rajeev Kapila,** Principal Scientist (Major Advisor), Animal Biochemistry Division, was awarded "**Young Investigator Award"** for oral presentation entitled "**Administration of milk fermented with probiotic *Lactobacillus fermentum* and *L. rhamnosus* alleviates immunosenescence, improves antioxidant capacity and resists pathogenic *E.coli* infection in aging mice**" during 2nd Annual Conference of Probiotic Association of India and International Symposium on "Probiotics and Microbiome : Gut and Beyond" on 3rd - 4th November, 2014 at India Habitat Centre, New Delhi.

- **Ms. Rashmi, H. M.,** Scientist, Dairy Microbiology Division received "**Young Investigator Award"** (Cash prize and a citation) for her paper entitled **"Exploring probiotics and postbiotics for their potential to stimulate GLP-1 secretion from enteroendocrine cells**" by **Mallapa, R.H., Panwar, H., Singh, R., Batish, V. K.** and **Grover, S.** (2014) at 2nd Annual Conference of PAi and International Symposium on "Probiotics and Microbiome : Gut and Beyond", New Delhi on 3rd - 4th November, 2014. The award carried a cash prize of Rs. 10,000 and a citation.

Ms. Rashmi, H. M., Scientist, Dairy Microbiology Division receiving Young Investigator Award from Dr. A. K. Srivastava, Director & Vice-Chancellor, NDRI, Karnal

- **Mr. Vamshi Saliganti, Dr. Rajeev Kapila, Ms. Srinu Redii** and **Dr. Suman Kapila** were awarded **"Best Poster Award"** in the category of Nutrition and Health for the poster entitled **"Impact of feeding probiotic *Lactobacillus rhamnosus* (MTCC 5897) fermented milk on development of newborn's Immune System"** organized on the occasion of XII Agricultural Science congress-2015 at ICAR-NDRI Karnal during 3rd -6th February, 2015.

- **Ms. M. Uttrani, Dr. S. V. Singh, Mr. S. Kumar, Dr. R. C. Upadhyay, Dr. O. K. Hooda,** and **Mr. Beenam** received **"Young Scientist Award"** for the research paper entitled **"Seasonal variation in expression of skin color genes in indigenous and cross bred cattle and their correlation with physiological responses"** during 12th Indian Science Congress held from 3rd – 6th February, 2015 at NDRI, Karnal.

- **Ms. Rishika Vij** received **"Young Scientist Award"** for paper entitled **"Bioavailability**

and transepithelial transport of milk derived bioactive peptide" during the 12th Agricultural Science Congress held from 3rd – 6th February, 2015 at NDRI under auspices of National Academy of Agricultural Sciences (NAAS).

- **Dr. A. Kumaresan,** Senior Scientist (Animal Reproduction) received "**Dr. S. K. Sirohi Memorial Award"** for outstanding contribution in research.

- **Dr. Avtar Singh** received **"Haryana Gaurav Samman Award"** on Pratima Raksha Samman Samiti, Karnal commemorating the Death Anniversary of great patriot Pandit Din Dyal Upadhyay on 11th February, 2015.

- **Dr. Mahendra Singh** received "**J. N. Pandey Memorial Best Poster Presentation Award"** for the year 2013 at XXIII Annual Conference of Society of Animal Physiologists of India (SAPI) conference held at CIRB, Hisar, 27th – 28th November, 2014.

- **Dr. Dheer Singh** was conferred with **"Chellappa Oration Award 2014"** by Indian Society of Veterinary Pharmacology & Toxicology for outstanding contribution in Animal & Veterinary Sciences during 14th Annual Conference of Indian Society of Veterinary Pharmacology & Toxicology (ISVPT) held at AAU, Khanapara, Guwahati from 2nd -4th December, 2014.

- **Ms. P. Sailaja, Mr. K. N. Jayaveera,** and **Dr. K. Jayaraj Rao** were awarded **"K. U. Patel Memorial Award"** for paper **"Optimization of ingredients mix for production of selected paneer products"**. published in *Indian Food Packer,* January-February 2013 by All India Food Processors' Association, New Delhi.

- **Mr. R. Prajapati, Mr. P. S. Minz** and **Mr. P. Lanjewar** were awarded **"Budding Researcher Award – 1st"** for the oral paper entitled **"In- line Standardization technique: An Alternative concept for milk standardization" in National Seminar on Engineering Interventions for Global Competitiveness of Indian Dairy Industry"** held on 8th-9th September, 2014 at ICAR-NDRI, Karnal.

- **Mr. Naresh Selokar** received "**NDRI Best Ph.D. Thesis Award"** (Production group) for his Ph.D. thesis entitled **"Epigenetic reprogramming of donor cells using a valproic acid and RNAi approach for the production of cloned buffalo (*Bubalus bubalis*) embryos"** during 13th Convocation of NDRI Deemed University on 14th February, 2015.

- **Ms. Kiran Kumari** was awarded **"NDRI Best Ph.D. Thesis Award"** (Processing group) for his Ph.D. thesis entitled **"Riboflavin operon characterization in *Lactobacilli"*** during 13th Convocation of NDRI Deemed University on 14th February, 2015.

Dr Kiran Kumari, PhD, DM, receving Best PhD Thesis Award from Dr. A. K. Srivastava, Drector & V.C., NDRI, Karnal

- **Ms. Ropalu Harika Devi** received "**NDRI Best M.Sc. Thesis Award"** (Management group) during 13th Convocation of NDRI Deemed University, Karnal held on 14th February, 2015.

- **Mr. Brajesh Kumar** received **"NDRI Best M. Tech. Thesis Award"** (Processing group) during 13th Convocation of the NDRI Deemed University held on 14th February, 2015. He completed his dissertation under the guidance of **Dr. Rajan Sharma**, Principal Scientist, Dairy Chemistry Division, NDRI, Karnal.

- **Ms. Samreen Fatima** received "**NDRI Best M.Sc. Thesis Award"** (Production group) for her M.Sc. thesis entitled **"Generation of primordial germ cell-like cells from surface epithelial stem cells of ovary in goat"** during 13th Convocation of NDRI Deemed University on 14th February, 2015.

- Students of Dairy Technology Division won **"First Prize"** in the 11th National Dairy Products Judging Contest and 7th Dairy and Food Quiz Contest held at SMC College of Dairy Science, Anand Agricultural

University, Anand, Gujarat during 6th – 7th October, 2014.

- Students of the Dairy Technology Division won **"First Prize Food Quiz Competition"** in the National Seminar-cum-Fest 'Androit-2014' at the College of Food Processing Technology & Bio-energy, AAU, Anand in October 2014.

First Prize in the Food Quiz Competition at AAU, Anand

- **Mr. S. Kumar, Dr. H. V. Raghu, Dr. N. Kumar, Dr. N. A. Singh and Dr. R. K. Malik** were awarded "**Best Paper Award"** published in the "Dairy Processing Area" in the Indian Journal of Dairy Science for the calendar year 2013 for the paper entitled **"Spore based chromogenic assay for detection of β-lactam antibiotic in milk"** during **43rd Dairy Industry Conference** on held on 21st February, 2015 in the Science City, Kolkata. The award carried a cash prize of Rs. 5,000 and a citation.

- **Ms. Namita Rokana**, Ph.D. student, Dairy Microbiology Division was given "**Best Poster Award"** for poster entitled **"Modulation of intestinal barrier function to alleviate *Salmonella* infection in mice by oral administration of fermented milks produced with *Lactobacillus plantarum* Lp91"** by **Rokana, N., Singh, R., Mallapa, R.H., Batish, V. K. and Grover, S.** (2014) at 2nd Annual Conference of PAi and International Symposium on "Probiotics and Microbiome : Gut and Beyond", New Delhi on 3rd - 4th November, 2014.

- **Dr. Archana Verma, Dr. Bharat Kumar, Dr. I. D. Gupta** and **Dr. Indrasen Chauhan** received "**Best Oral Presentation Award"** for the research paper **"Forebrain embryonic zinc finger-like gene polymorphism affects mastitis incidence in Murrah buffaloes"** presented during International Conference on 'Challenges and Opportunities in Animal Health at the Face of Globalization and Climate Change' at DUVASU, Mathura from 31st October – 1st November, 2014.

- **Dr. Ashwani Arya, Dr. Archana Verma, Dr. I. D. Gupta, Dr. Dhaman Kumar, Dr. Shahid A. Shergojry, Dr. Avtar Singh, Dr. Arun Pratap Singh** and **Dr. Mohsin Ayoub Mir** received "**Best Paper Award"** for the research paper **"Identification of SNPs in HSPB1 gene and their association with thermotolerance in Murrah buffaloes"** during International Conference on 'Challenges and Opportunities in Animal Health at the Face of Globalization and Climate Change' at DUVASU, Mathura from 31st October – 1st November, 2014.

- **Dr. S. K. Shelke, Dr. S. S. Thakur** and **Dr. S. M. Shette** were presented **"Outstanding Research Paper Award (2011-13)"** for their paper entitled **"Production and reproduction performance of Murrah buffaloes *(Bubalis bubalis)* supplemented with rumen protected fat and protein"** published in December, 2012 issue of *Indian Journal of Animal Nutrition* at Global Animal Nutrition Conference 2014 organised by ANSI and NIANP, Bangalore.

- **Mr. P. K. Naik, Mr. R. B. Dhuri, Mr. M. Karunakaran, Mr. B. K. Swain, Mr. N. P. Singh** were awarded for the **"Best Article"** published in Indian Dairyman entitled **"Hydroponics technology for green fodder production".** The award was presented in the 43rd Dairy Industry Conference held during 19th - 21st February, 2015 at Kolkata.

- **Mr. Brajesh Kumar, Mr. Bhavesh Panchal, Mr. Rahul Thakur, Mr. Prerna Narula, Dr. Rajan Sharma, Dr. Y. S. Rajput** and **Dr. (Mrs.)**

Bimlesh Mann received **"First Prize for the Poster Presentation"** on topic **"Strip based tests for rapid detection of adulteration in milk"** in the 7th National Seminar on "Dairy Sector: the key player for nutritional security in India" jointly organized by ICAR- National Dairy Research Institute and NDRI Graduates Association on 19th - 20th September, 2014.

- **Mr. Brajesh Kumar, Mr. Bhavesh Panchal, Mr. Rahul Thakur, Mr. Prerna Narula, Dr. Rajan Sharma, Dr. Y. S. Rajput** and **Dr. (Mrs.) Bimlesh Mann** received **"First Prize for the Hindi Poster Presentation"** on topic **"Paper strip ke madhayam se dugdh mai milavat ki sheegrah janch ke tarike"** in Rajbhasha Maas celebration on 15th September, 2014.

- **Mr. Vamshi Saliganti**, Ph.D. student working with **Dr. Rajeev Kapila**, Principal Scientist (Major Advisor), Animal Biochemistry Division was awarded "**Best Poster Award**" entitled "***L. rhamnosus* (MTCC 5897) fermented milk administration to mothers and offspring during suckling weaning transition alleviates ovalbumin induced allergy in newborns**" during 2nd Annual Conference of Probiotic Association of India and International Symposium on "Probiotics and Microbiome : Gut and Beyond" on 3rd - 4th November, 2014 at India Habitat Centre, New Delhi.

- **Ms. Manpreet Kaur,** Ph.D. working with **Dr. A. K. Puniya,** Principal Scientist (Major Advisor), Dairy Microbiology Division received "**Best Poster Award**" during "5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014)" organized by "International Institute of Food and Nutrition Sciences (IIFANS)" from 15th -16th October, 2014 at Jawaharlal Nehru University, New Delhi.

- **Ms. Aishwarya Panicker, Mr. Pradip Behare, Dr. A. K. Mohanty,** Dairy Microbiology Division received **"Best Poster Award"** for their poster entitled "**Differential Proteome analysis of putative probiotic *Lactobacillus Fermentum* BIF 19 strain"** during 2nd Annual Conference of PAi and International Symposium on "Probiotics and Microbiome : Gut and Beyond" at India Habitat Centre, New Delhi from 3rd-4th November, 2014.

- **Dr. L. Naik, Dr. R. Sharma, Dr. Y. S. Rajput, Dr. Bimlesh Mann** and **Dr. K. Lata** (2015) received "**Best Poster Award"** for the poster titled "Design of lateral flow assay for detection of oxytetracycline in milk" in the XII Agricultural Science Congress-2015 organized by National Academy of Agricultural Sciences (NAAS) and NDRI at NDRI, Karnal during 3rd -6th February, 2015

- **Mr. Vamshi Saliganti,** pursuing Ph.D. under **Dr. Rajeev Kapila**, Principal Scientist, Animal Biochemistry Division was awarded with **"Third Prize"** during the poster display and presentation for the **"Young Investigator Award"** at the symposium, "Probiotics - from bench to community" organized by Yakult India Microbiota and Probiotic Science Foundation on 7th – 8th March, 2015 at New Delhi.

- **Mr. Ansuman Kumar, Mr. Ajoy Mandal, Mr. M. Karunakaran, Ms. Poonam Ratwan** and **Dr. T. K. Dutta** were awarded the **"First Prize"** for the **"Best Poster Presentation"** on the topic **"Estimates of genetic parameters of days open in crossbred cattle"** in the 43rd Dairy Industry Conference held during 19th - 21st February, 2015 at Kolkata.

- **Mr. M. Karunakaran** and **Mr. T. G. Devanathan** were awarded the **"Second Prize"** for the "**Best Poster Presentation"** on the topic **"Effect of heparin binding protein on lipid peroxidation status of bovine sperm cells"** in the 43rd Dairy Industry Conference held during 19th - 21st February, 2015 at Kolkata.

- **Dr. A. K. Chakravarty, Dr. J. Valsalan, Dr. C. S. Patil** and **Dr. A. K. Gupta** got "**First Best Paper Award"** in 43rd Dairy Industry Conference held in Kolkata during 19th – 21st February, 2015 for the best research article **"Genetic evaluation of Murrah buffaloes for life time performances"** published in the "Dairy Production Area" in the *Indian Journal of Dairy Science*, 2013.

- **Dr. J. Valsalan, Dr. A. K. Chakravarty, Dr. C. S. Patil, Dr. Vijay Kumar** and **Dr. Atul Mahajan** received **"Best Poster Presentation Award"** for the research paper **"Genetic evaluation of fertility in high producing Murrah buffaloes"** in National symposium on "Harmonizing phenomics and genomics for sustainable management of Livestock for upliftment of rural masses" held at NBAGR, Karnal.

- **Mr. N. Saini, Mr. S. M. Shah, Mr. S. Ashraf, Mr. R. Kaushik, Dr. M. K. Singh, Dr. P. Palta, Dr. S. K. Singla, Dr. R. S. Manik** and **Dr. M. S. Chauhan** received "**Best Poster Award"** (Animal Production Category) for the paper **"Construction of expression vector of human lactoferrin under different caprine mammary gland specific promoters"** during 12th Indian Science Congress held from 3rd – 6th February, 2015 at NDRI Karnal.

- **Mr. K. Rameshbabu, Mr. R. Kaushik, Mr. K. P. Singh, Mr. S. K. Mohapatra, Mr. A. Sandhu, Dr. M. K. Singh, Dr. P. Palta, Dr. S. K. Singla, Dr. R. S. Manik** and **Dr. M. S. Chauhan** received "**Best Poster Award"** (Animal Reproduction Category) for the paper **"Evaluation of in vitro expression of mammary gland- specific expression vector encoding buffalo (*Bubalus bubalis*) Stearoyl-CoA desaturase for development of transgenic embryos"** during 12th Indian Science Congress held from 3rd – 6th February, 2015 at NDRI Karnal.

- **Mr. B. Brahma, Mr. M. C. Patra, Ms. S. Karri, Mr. M. Chopra, Mr. P. Mishra, Mr. B. C. De, Mr. S. Kumar, Mr. S. Mahanty, Mr. K. Thakur, Mr. K. M. Poluri, Dr. T. K. Datta** and **Dr. De, S.** received "**Best Poster Award"** (Animal Health Category) for paper **"Bactericidal activity of cathelicidin against challenging pathogens: Indian buffaloes are genetically privileged"** during 12th Indian Science Congress held from 3rd – 6th February, 2015 at NDRI Karnal.

- **Ms. Sonia Saini, Dr. A. K. Singh, Mr. P. Srinivasulu, Mr. R. Devi, Ms. Renuka, Mr. A. Kumar, Mr. Y. Kumar, Mr. L. Sharma, Mr. T. Sridhar, Dr. S. V. Singh and Dr. R. C. Upadhyay** received **"First Prize"** for the poster presentation to research paper entitled **"Changes in the transcriptome by heat stress and relationship to acquisition of thermotolerance in zebu cattle"** by during the International Symposium on "New Dimensions in Agro-meterology for Sustainable Agriculture (NASA- 2014)" held at GBUA&T, Pantnagar from 16th -18th October, 2014.

- **Ms. S. Meena, Dr. Y. S. Rajput, Mr. A. K. Pandey, Dr. R. Sharma** and **Mr. R. Singh** were awarded "**Best Poster Award"** for their paper **"Comparative hypocholesterolemic effect of milk from different species"** during XII Agriculture Science Congress 2015 at NDRI Karnal.

- **Dr. L. Naik, Dr. L, Mr. R. Sharma, Dr. Y. S. Rajput, Dr. B. Mann, and Ms. K. Lata** were awarded **"Best Poster Award"** for their poster **"Design of lateral flow assay for detection of oxytetracycline in milk"** during XII Agriculture Science Congress 2015 at NDRI Karnal.

- **Mr. Raja Shekar Kurva, Mr. Surender Jangra, Mr. Raj Kumar Sharma, Ms. Jayasimha Chagalamarri** and **Mr. Gaurav Bhakri** received **"Best Poster Award"** (Dairy Process and Product Development Category) for the poster entitled **"**Éxploring **anti-obesity potential of soluble fiber: influence of gum acacia and inulin in high fat-high sucrose diet fed C57 BL/6 mice"** during XII Agricultural Science Congress held on 3rd – 6th February, 2015 at NDRI, Karnal.

- **Dr. Suneel Kumar Onteru** and **Dr. Dheer Singh** received "**Best Poster Award"** (Animal Reproduction Category) for the poster entitled **"Salivary Fern Patterns, an alternative for buffalo estrus detection"** at XII Agricultural Science Congress-2015 on "Sustainable Livelihood Security of Smallholder Farmers", conducted by NAAS, ICAR during 3rd – 6th February, 2015 at NDRI, Karnal.

- **Mr. Harish Kumar, Mr. Naveen Kumar and Dr. Raman Seth** received **"First Prize"** for Poster Presentation on "**Preparation of whey powder and IgG enriched whey colostrum powder from goat colostrums**" during International Conference on Updating Food Technology: A Challenge towards Public Health Nutrition (ICUFT-2014)" held on 7th - 8th May, 2014 at Jawaharlal Nehru University, New Delhi.

- **Ms. M. Kaur, Ms. A. Garsa, Ms. M. Puniya, Dr. A. K. Puniya** received **"Best Poster Award 2014"** during 5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014), 15th -16th October organized by International Institute of Food and Nutritional Sciences, and held at Jawaharlal Nehru University, New Delhi.

- **Mr. M. Samaddar, Mr. C. Ram** and **Mr. M. Sen** received "**Best Poster Award (1st Prize)"** on **"Plant derived antimicrobials: An alternative against antibiotic resistant Salmonella spp. of dairy foods"** during 43rd

Dairy Industry Conference, organized by Indian Dairy Association, Calcutta from 19th – 20th February, 2105.

- **Ms. Akanksha Wadehra, Dr. A. K. Singh, Dr. R. R. B. Singh and Dr. Sumit Arora** received "**First Prize**" for the poster presentation entitled **"Optimization of Process Parameters for Thermally Processed Shelf Stable-starch based milk desserts"** during the 5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014) held on 15th -16th October, 2014, at JNU New Convention Centre, New Delhi.

- **Ms. Aishwarya Panicker** received **"Best Poster Award"** for poster presentation at 2nd Annual Conference of PAi and International Symposium **on "Probiotics and Microbiome : Gut and Beyond"** held at New Delhi on 3rd - 4th November, 2014.

- **Ms. Alia Khan, Mr. N. Kumar, Mr. S. Arora, Mr. Raghu H. V.** and **Mr. S. Shaikh** received **"Best Poster Award"** during 7th National seminar organized by NGA and ICAR-NDRI on 20th September, 2014 at NDRI, Karnal.

- **Ms. Varsha Garg, Dr. Surajit Mandal** and **Ms. Poonam Sharma** received **"First Prize"** for paper entitled **"Evaluation of antibiotic resistance patterns of Pediococcus spp. "National Conference in Food Technology: Emerging Trends (NCFT-2015)"** during 24th - 25th March, 2015, Chaudhary Devi Lal University, Sirsa.

- **Dr. Rajawardana, Dr. P. N. Raju, Ms. Rashmi, H. M and Dr. Sangita Ganguly** received **"Best Poster Award"** for the research poster entitled **"Development of oats and honey-based synbiotic functional dairy beverage"** at 2nd PAi Conference and International Symposium on "Probiotics and Microbiome: Gut and Beyond" held at India Habitat Centre, New Delhi during 3rd -4th November, 2014.

- **Dr. P. N. Raju, Dr. N. Tyagi, Dr. P. Malhotra, and Er. P. S. Minz** received **"Best Oral Paper Award"** for the presentation entitled **"Development of low-calorie deep-fat fried paneer using edible coatings"** at 9th National Convention of Indian Dairy Engineers Association (IDEA) and National Seminar on Engineering Interventions for Global Competitiveness of Indian Dairy Industry held during 8th -9th September, 2014 at NDRI, Karnal.

- **Dr. Kunal Kumar Ahuja, Dr. Ashish Kumar Singh, Ms. Kiran Bala and Dr. Sudhir Kumar Tomar** received **"Best Poster Award"** (Process and Product Development Category) for the poster entitled **"Process optimization for the manufacture of barley-milk based fermented probiotic drink"** organized on the occasion of XII Agricultural Science Congress-2015 at ICAR-National Dairy Research Institute, Karnal from 3rd -6th February, 2015.

- **Dr. M. Manjunatha, Mr. A. Asha, Dr. Menon Rekha Ravindra, Dr. B. Surendranath, Dr. J. Rao, Dr. P. Heartwin, Dr. E. Magdaline** and **Mr. Chitranayak** received "**First Prize**" for oral presentation on **"Effect of extraction parameters on total phenol content and radical scavenging activity of orange peel powder extract"** in the International Conference on Advances in Food Technology & Health Sciences (ICAFTHS-2014) conducted by the International Institute of Food & Nutrition (IIFANS), New Delhi.

- **Dr. S. Subash, Dr. Satish Kulkarni, Dr. P. K Dixit** and **Dr. M. C. A. Devi** received **"Best Poster Presentation Award"** under Agricultural Extension category for the Poster presentation on **"Development of a framework for 'Certified Livestock Advisor"** by during XII Agricultural Science Congress on "Sustainable Livelihood Security of Smallholder Farmers" held during 3rd - 6th February, 2015 at NDRI, Karnal.

- **Mr. I. K. Panchal, Dr. Sawhney** and **Dr. A. K. Sharma** received **"Best Poster Award-1st Prize"** for the poster paper entitled **"Effect of seasons on electrochemical parameters of healthy vis-a-vis Mastistis Milk in Sawhiwal Cows"** in National Seminar on Engineering Interventions for Global Competitiveness of Indian Dairy Industry held on 8th -9th September, 2014 at ICAR-NDRI, Karnal.

- **Dr. P. Barnwal** and **Mr. Christopher Kavimani** received **"Best Oral Paper Award - 3rd Prize"** for the paper entitled **"Kheer and its engineering properties"** in National Seminar on Engineering Interventions for Global Competitiveness of Indian Dairy Industry held on 8th -9th September, 2014 at ICAR-NDRI, Karnal.

- **Mr. P. Lanjewar, Mr. P. S. Minz, Mr. P. Jotarkar, Mr. R. Prajapati** and **Mr. A. S. Warrier** received **"Best Poster Award-1st Prize"** for the poster paper entitled **"New generation cream separators"** in National Seminar on Engineering Interventions for Global Competitiveness of Indian Dairy Industry held on 8th -9th September, 2014 at ICAR-NDRI, Karnal.

- **Dr. Y. S. Rajput, Head, Animal Biochemistry, Dr. M. S. Chauhan, Principal Scientist, Animal Biotechnology Centre** and **Dr. A. Kumaresan,** Sr. Scientist (AGRO) elected as NAAS Fellows in the year 2015.

- **Mrs. Nimisha Tehri,** Ph.D. student, Dairy Microbiology Division received **"Second Best Poster Award"** for the poster entitled **"Expression of marker enzymes during spore's germination for novel application in assay development"** at 12th Agriculture Science Congress (ASC), Karnal on 3rd - 6th February, 2015 under the area of Food safety and quality management.

- **Dr. K. P. Ramesha** received the "**Indian Dairy Association Fellowship Award 2014-15"** on 19th February, 2015 at Kolkata during the 43rd Dairy Industry Conference from Dr. A. K. Srivastava, Director cum Vice Chancellor, NDRI, Karnal, Haryana for exemplary role and contributions to Indian Dairy Association and to the Indian dairy industry.

- **Dr. K. P. Ramesha** was honoured for his life time achievements during 12th Chikamagalur District Kannada Sahithya Sammelana at Chikamagalur on 28th February 2015 .

- **Animal Biotechnology Centre** and **Animal Biochemistry Division** were adjudged as "**Best Divisions"** for the year 2013-14 during 13th Convocation of NDRI Deemed University on 14th February, 2015.

- **Dr. M. Bhakat, Dr. A. K. Chakravarty, Dr. A. K. Gupta, Dr. P. Singh, Dr. T. K. Mohanty** and **Dr. A. P. Singh** received "**Second Best Bulletin Award"** (2013 - 2014). "*Gaaye evam bhains ki nasal sudhaar mein karyarat kritrim prajanan anusandhan Kendra"* during Rajbhasha Mass Celebration on 15th September, 2014 at NDRI, Karnal.

- **Dr. A. P. Singh, Dr. A. K. Chakravarty, Dr. M. Bhakat, Dr. Subhas Chand, Dr. J. K. Pundir, Dr. J. S. Rana, Dr. A. K. Gupta** and **Dr. P. Singh** received **"Second Best Folder Award"** (2013 - 2014). *"Kritrim prajanan karte samay dhyaan rakhne yogya batein" folder lekhan mein dwitiya puruskar* during Rajbhasha Mass Celebration on 15th September, 2014 at NDRI, Karnal.

- **Dr. R. C. Upadhyay, Dr. S. V. Singh, Dr. O. K. Hooda, Ms. Beenam Baliyan** and **Mr. Yogendra Kumar** received "**First Prize"** for the folder entitled "**Dudharu gayon evam bheson ke prabhandhan evan khanpan dwara thanella rog se bachav"** during Rajbhasha Mass Celebration on 15th September, 2014 for the year 2012-2013.

- **Dr. S. V. Singh, Dr. R. C. Upadhyay, Mr. Yogendra Kumar** and **Mr. Beenam Baliyan** received **"First Prize"** for the article entitled "**Pashu utpadan par viprit tapkram ka prabhav evam bachav ke upay"** during Rajbhasha Mass Celebration on 15th September, 2014.

- **Dr. Anjali Aggarwal and Dr. R. C. Upadhyay** received **"First Prize"** for bulletin entitled **"Grishm ritu mein dudharu gayon mein suksham poshak tatvon ki aavshayakta"** during Rajbhasha Mass Celebration on 15th September, 2014.

- **Dr. S. V. Singh, Mr. Suresh Kumar, Ms. Beenam Baliyan, Mr. Anil Kumar** and **Dr. R. C. Upadhyay** received **"Second Prize"** for the folder entitled "**Gayon ke pratirodhak shamta mein sudhar hetu suksham poshak tatvon ki bhumika"** during Rajbhasha Mass Celebration on 15th September, 2014 for the year 2013-2014.

- **Dr. S. V. Singh, Dr. R. C. Upadhyay, Dr. O. K. Hooda, Mr. Yogendra Kumar, Mr. Beenam Baliyan and Dr. A. K. Singh** received **"Consolation Prize"** for the folder entitled **"Sardi ke mausham me navjaat bachde – bachdeo ka palan poshan, parbandhan evam bacheao"** during Rajbhasha Mass Celebration on 15th September, 2014 for the year 2012-2013.

- **Ms. Renuka, L. Sharma, Dr. A. K. Singh, Mr. A. Kumar, Mr. Y. Kumar, Mr. P. Srinivasulu, Mr. R. Devi, Mr. T. Sridhar, Mr. S. Saini, Dr. S. V. Singh, Dr. T. K. Datta** and **Dr. R. C. Upadhyay** received **"Second Best Oral Presentation Award"** for the research paper entitled **"Infrared thermal imaging for assessment of thermal comfort in zebu cattle (Bos indicus)"** during the International

Symposium on "New Dimensions in Agro-meterology for Sustainable Agriculture (NASA- 2014)" held at GBUA&T, Pantnagar from 16th -18th October, 2014.

- **Dr. A. K. Roy** received **"First Prize"** for the best article published in *Kheti*, March-2014 during Rajbhasha Mass Celebration on 15th September, 2014 at NDRI, Karnal.
- **Dr. A. K. Roy** received **"Second Prize"** for the article published in *Dugdh Ganga*-2013 during Rajbhasha Mass Celebration on 15th September, 2014 at NDRI, Karnal.
- **Dr. A. K. Roy** received **"Third Prize"** for the poster during Rajbhasha Mass Celebration on 15th September, 2014 at NDRI, Karnal.
- **Rohit Sharma,** Ph.D. Student working with **Dr. Rajeev Kapila** (Major Advisor) received "**Certificate of Appreciation"** for academic year 2013-14 in recognition of his outstanding research work in the field of Dairy Processing during 13th NDRI convocation.
- **Ms. Rishika Vij,** M.V.Sc. Student working with **Dr. Suman Kapila** (Major Advisor) received **Certificate of Appreciation** for academic year 2013-14 in recognition of her outstanding research work in the field of Dairy Processing during 13th NDRI convocation.
- **Ms. Sneha Aggarwal,** M.Sc. Student working with **Dr. Y. S Rajput** (Major Advisor) received **"Certificate of Appreciation"** for academic year 2013-14 in recognition of her outstanding research work in the field of Dairy Processing during 13th NDRI convocation.
- **Ms. Vamshi Saliganti, Dr. Rajeev Kapila,** and **Dr. Suman Kapila** received **"Third Prize"** for paper entitled **"Consumption of probiotic Lactobacillus rhamnosus (MTCC 5897) fermented milk plays a key role on newborn's immune system development during suckling-weaning transition"** during the poster display and presentation for the young Investigator at the symposium, Probiotics from bench to community" organized by Yakult India Microbiota and Probiotic Science Foundation on 7th - 8th March, 2015 New Delhi.
- **Dr. Rajan Sharma, Dr. Sumit Arora, Dr. Latha Sabikhi, Dr. Naresh Kumar, Dr. A. K. Puniya, Dr. S. V. Singh, Dr. A. Kumaresan** and **Dr. K. P. Ramesha (**SRS) were awarded Fellowship of the National Academy of Dairy Science by National Academy of Dairy Science, Karnal on 26th May, 2014.
- **Dr. A. K. Puniya** was awarded Fellowship of ANSI – 2014 by Animal Society of Nutrition India in recognition of his significant contributions in animal science with special reference to ruminant nutrition.
- **Dr. A. K. Puniya** was nominated as Advisory Committee Member during International Conference on Biotechnology and Bioengineering (ICBB-2014), organized by Microbiology Society, India and BITS (Dubai Campus), Dubai, UAE.
- **Dr. A. K. Puniya** was awarded the **"Certificate of Appreciation"** by 'The Annual Bio-medical Research Conference for Minority Students', 12th –15th November, 2014 held in San Antonio, Texas, USA, in recognition of his outstanding contribution in reviewing undergraduate, post baccalaureate and graduate student abstracts.
- **Ms. Poonam Sharma** received **"Consolation Prize in Poster Presentation"** during 5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014) on 15th -16th October, 2014 at Jawaharlal Nehru University, New Delhi
- **Ms. Suman, Mr. C. Ram, Ms. G. Manju,** and **Mr. M. Samaddar,** were awarded **"Third Best Oral Presentation Prize"** for the paper entitled **"Hypocholesterolemic and antagonistic activity of indigenous *Lactobacillus* species isolated from camel milk"** during 4th International Conference on "Updating Food Technology: A challenge towards Public Health Nutrition". Organized by International Institute of Food and Nutritional Sciences (IIFANS), New Delhi, ICMR, DST and DBT sponsored from 7th - 8th May, 2014.
- **Ms. Suman, Mr. V. Kumar, Mr. N. Kumar,** and **Mr. C. Ram** were awarded **"Consolation Prize"** for paper entitled "**Evaluation of *Lactobacillus plantarum* strains for hypocholesterolemic, antioxidative and antimicrobial attributes"** during 5th International Conference on "Advances in Food Technology and Health Sciences" (Food Engineering and Biotechnology. Organized by International Institute of Food and

Nutritional Sciences (IIFANS), New Delhi, ICMR, DST and DBT sponsored form 15th - 16th October 2014 at JNU New, Delhi.

- **Mr. Santosh Anand, Mr. Prasad Patil, Dr. Surajit Mandal** and **Dr. S. K. Tomar** received **"Third Prize in Oral Presentation"** on "**Effect of synbiotic combination on LT and ST toxin gene expression in enterotoxigenic Escherichia coli"** during 5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014) on 15th - 16th October 2014 at JNU New, Delhi.

- **Mr. Prasad Patil** and **Dr. Surajit Mandal** received "**Third Best Poster Prize"** for paper entitled **"Preparation of Alpha-Glucosidase and DPP-IV Inhibitory Milk Bioactive Peptides by using Lactobacillus spp. for Management of Type-2 Diabetes"** during 5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014) on 15th - 16th October 2014 at JNU New, Delhi.

- **Ms. Varsha Garg, Dr. Surajit Mandal, Mr. Santosh Anand, Mr. Prasad Patil and Ms. Poonam Sharma** were awarded **"Consolation Prize"** on **"Antibiotic Resistance Profile of *Pediococcus Spp.* from Dairy and Non-dairy sources"** during 5th International Conference on Advances in Food Technology and Health Sciences (ICFTHS-2014) on 15th - 16th October 2014 at JNU New, Delhi.

- **Dr. Rakesh Kumar, Dr. Magan Singh, Dr. Ashutosh, Dr. H. R. Meena and Dr. C. Datt** were given **"Second Best Hindi Book Award"** for the book, "*Chara utpadan awam pasupalan vikas takniki gatividhian*" during Rajbhasha Mass Celebration on 15th September, 2014 NDRI for the year 2013-14.

- **Dr. Rakesh Kumar, Mr. Birbal, Dr. Magan Singh, and Mr. Uttam Kumar** were given "**Third Best Hindi Paper Award"** for the paper, "*Phaslon ke liya poshak tatva parbhandhan*" during Rajbhasha Mass Celebration on 15th September, 2014 NDRI for the year 2013-14.

- **Dr. Magan Singh, Dr. Rakesh Kumar, Dr. A. S. Harika** and **Mr. Uttam Kumar** were given "**Consolation Award"** for the paper, "*Varsh bhar hare chare se pasu utpadan mein vridhi layen*" during Rajbhasha Mass Celebration on 15th September, 2014 at NDRI, Karnal.

- **Mr. Devaraja, H. C., Mr. M. Kumar, Dr. Suman Kapila, Dr. K. Khamrui and Mr. Sathish Kumar, M. H.** received "**Third Prize"** for the poster presentation entitled **"Studies on hypocholesterolemic effect of butter fortified with phytosterols and conjugated linoleic acid"** during 7th National seminar on Dairy sector: The key player for nutritional security in India, held on 19th - 20th September., 2014 at NDRI, Karnal.

- **Dr. Subrata Hati, Dr. K. Khamrui, and Dr. S. Mondal** received **"Second Best Paper Award"** for the poster entitled **"Biofunctional whey-based beverages"** in 43rd Dairy Industries Conference held in Kolkata, during 19th -21st January, 2015.

- **Ms. Ritika Puri, and Dr. K. Khamrui** received **"Third Best Paper Award"** for **"Application of quantitative descriptive analysis (qda), principal component analysis (pca) and response surface methodology (RSM) for standardized process of *cham-cham* making"** in 43rd Dairy Industries Conference held in Kolkata, during 19th -21st January, 2015.

- **Dairy Extension Division** received **"Second Prize"** in the National Dairy Mela 2015 exhibition stall organised by National Dairy Research Institute, Karnal during 25th – 27th February 2015.

- **Ms. Parvinder Sharma, Dr. K. Ponnusamy** and **Mr. Rajiv Kale** won "**Second Best Poster Award"** for the article entitled **"Women empowerment through value addition in dairying"** during the celebration of Rajabhasa Mass Samaroh-2014 held on 15th September, 2015 at NDRI, Karnal.

- **Dr. S. Varalakshmi** was awarded "**VLIR-UOS Fellowship"** to attend International training program on food safety, quality assurance systems and risk analysis at the University of Ghent, Belgium from 24th September, 2014 to 20th December, 2014.

- **Mr. Chitranayak, Dr. M. Manjunatha** and **Dr. Menon Rekha Ravindra** received **"Consolation Hindi Prize"** for the paper **"Dairy vigyan me mool hindi lekhan"** published at Dugdh Ganga- "Dugdh Evam Dugdh Utpado Me Milwat Ki Jaanch Hetu Viksit Taknik", Vol.4, 2013-2014, Page: 104-109

- **Dr. Mahin Sharif** received "**Certificate of Appreciation"** from Director & Vice-Chancellor of ICAR-NDRI, in recognition of the outstanding Ph.D. research work on "**An economic study of milk production under different levels of groundwater exploitation in Southern Karnataka"** under the guidance of **Dr. P. K. Dixit**.

- **Dr. Mohan Mandal** was nominated as Task Force member, Animal Biotechnology-I of the Department of Biotechnology, Govt. of India from 2014 to 2017.

- **Dr. Chander Datt, Dr. Vijay Kumar Sharma, Dr. Nitin Tyagi, Dr. S. S. Kundu,** and **Dr. S. S. Lathwal** received **"Second Prize"** for Bulletin in Hindi **"Romanthi Pashuon Mein Upapachay Vikar: Roktham Avum Upchar"** during *Rajbhasha Maas* in September, 2014 at NDRI, Karnal, NDRI Publication No. 100.

- **Dr. Chander Datt, Dr. S. S. Kundu, Dr. Veena Mani, Dr. Nitin Tyagi, Dr. V. K. Sharma and Ms. Nita Sharma** received "**Third Prize"** for the folder in Hindi **"Dairy pashuon ke aahar mein khanij mishran milayen: utpadakta badhayen"** during Rajbhasha Maas in September, 2014 at NDRI, Karnal, NDRI Publication No. 125.

- **Mr. P. Talukdar, Dr. A. K. Medhi, Mr. R Bhuyan** and **Dr. G. Mondal** received **"Second Prize"** for poster presentation on the topic **"Effect of various levels of protein on performance in Hampshire crossbred pigs"** during Global Animal Nutrition Conference-2014 held at Bengaluru from 20th – 22nd April, 2014.

- **Mr. R. Prajapati, Mr. P. S. Minz** and **Mr. P. Lanjewar** received **"Best Poster Award-2nd Prize"** for the poster paper entitled **"In-line sensors in processing industry for measurement of parameter and properties"** in National Seminar on Engineering Interventions for Global Competitiveness of Indian Dairy Industry held on 8th -9th September, 2014 at ICAR-NDRI, Karnal.

- **Mr. Christopher Kavimani** and **Dr. P. Barnwal** received **"Consolation Prize"** for the poster paper presentation on **"Kheer ke kuchha abhiyantrikee gun (some engineering properties of kheer)"**, in Hindi Pakhwada Samaroha celebrations, ICAR-NDRI, Karnal on 30th September, 2014

- Exhibition Stalls of **Dairy Cattle Breeding** and **Animal Breeding Research Centre** bagged **"Third Position"** in National Dairy Mela (25th -27th February, 2015).

- Bureau of Indian Standards (BIS), Govt. of India - has given the responsibility to Animal Breeding Research Centre, NDRI, Karnal for developing the Indian Standards for Instruments related to Artificial Insemination for Livestock.

- **Dr. Nishant Kumar** received **First Prize** by Rajbhasha Vibhaag, NDRI, Karnal for his Hindi book entitled "**Dairy farming ke mul sidhhant ewam wyawhaarik gyaan**" during Rajbhasha Maas on 15th September, 2014 at NDRI, Karnal.

- **Dr. Nishant Kumar** received **"Third Prize"** by Rajbhasha Vibhaag, NDRI, Karnal for his Hindi folder entitled **"Pashuon Ki prajanan samasyaaon ki rokthaam ke liye pashupaalakon ko aawashyak sujhaaw"** during Rajbhasha Maas on 15th September, 2014 at NDRI, Karnal.

- **Dr. Nishant Kumar** received **"Consolation Prize"** by Rajbhasha Vibhaag, NDRI, Karnal for his Hindi paper entitled **"Prajanak saando ki dekhbhaal ewam prabandhan"** during Rajbhasha Maas on 15th September, 2014 at NDRI, Karnal.

Prof. Kaptan Singh Solanki, Hon'ble Governor, Haryana conferring Doctor of Science 'Honoris Causa' to Dr. Mangala Rai, Former-DG, ICAR during 13th Convocation of NDRI Deemed University

6 RESEARCH FUNDING AND COLLABORATIONS

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

SL. No.	Title of the Project	Name of PI	Funding Aency	Duration
1.	Network project on buffalo Improvement-Field Unit (CIRB Hisar-125001)	Avtar Singh	Network	2007-2017
2.	Network project on buffalo Improvement-Institute herd (CIRB Hisar-125001)	A. K. Chakravarty	Network	2007-2017
3.	Evaluation and improvement of indigenous cattle of Malnad region of Karnataka-DAH&VS	K. P. Ramesha	Bangalore Govt. of Karnataka	2011-2014
4.	Genetic diversity and haplotyping of innate immune genes in Indian cattle and buffalo	S. De	DBT	2012-2015
5.	Network programme on veterinary type culture (VTC)-Rumen Microbes.	A. K. Punia	ICAR	2010-2017
6.	Micro-encapsulation of Bacteriocins for their controlled release.	R. K. Malik	NFBSFARA	2011-14
7.	Monitoring of drug residues and other environmental pollutants-outreach project of ICAR	N. K. Goel	ICAR Fund	2009-2015
8.	Scheme on Dairy Microbes under Network Mode	R. K. Malik	Network	2010-15
9.	Indigenous breed program (Sahiwal Cattle)	A. K. Gupta	ICAR	2010-2017
10.	Deciphering the mechanism of aberrant maternal recognition of pregnancy events in sheep and buffalo under heat and nutritional stress.	T. K. Datta	NFBSFARA	2010-15
11.	National initiative on climate resilient Agriculture	R. C. Upadhyay	CRIDA (ICAR)	2010-17
12.	Cost and returns in milk production: Developing standardized methodology and estimates for various production system.	Smita Sirohi	DAHD	2012-14
13.	Screening probiotics and prebiotics for expression of glucagon like peptide-1(GLP)-1), a satiety inducing hormone, as prophylactics against diabetes mellitus-2.	Sunita Grover	ICMR	2012-15
14.	Anti-Mullerian hormone profile, its characterization and expression for using as diagnostic marker for fertility assessment in farm aninals.	Avijit Haldar NER Tripura/ S. De	DBT	2012-15
15.	Early detection of pregnancy in cow and buffalo by pregnancy associated proteins (PAPs)	A. K. Mohanty	NFBSFARA	2012-15
16.	Establishment of facilities for research and training in stem cell technology in pigs.	M. S. Chauhan	DBT	2012-16
17.	Status of antibiotic resistence among commercially available probiotic bacteria.	S. K. Tomar	ICMR	2012-15
18.	Diversity study of CLA producing indigenous butyrivibrio spp its subsequent utilization as a probiotic for animals and genes expression pattern of enzymes involved in biohydrogation of fatty acids.	A. K. Tyagi	DBT	2011-2014
19.	Infertility in crossbred bulls:Search for spermatogenic cell markers for early prediction on fertility.	A. Kumaresan	NFBSFARA	2012-16
20.	Development of transgenic goat for production of human lactogerrin.	M. S. Chauhan	NFBSFARA	2012-16
21.	Digestive enzymes (a-glucosidase and a-amylase) probiotics lactic acid bacteria for controlling postprandial hyperglycemia	A. K. Punia	DBT	2012-15
22.	Diversity of exopolysaccharides produced by lactic acid bacteria	Pradip Behare	DST	2013-16
23.	Countering Gastrointestinal Tract pathogens by Adhesion-Promoting Probiotic Surface Proteins.	J. K. Kaushik	NFBSFARA	2012-2015

24.	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	ICAR	2012-17
25.	Imprinted polymers for sensing and removal of selected antibiotic and pesticide residue	Y. S. Rajput	NFBSFARA	2013 - 2015
26.	Characterization of colostrum Bio-active components from different spices (Camel, Sheep and Goat) and their application in the formulation of Novel Dairy Products	Raman Seth	MFPI	2012-2014
27.	Bioacoustics tool: A novel non-invasive approach for efficient monitoring of health and productivity in dairy animals	S. S. Lathwal	DBT	2013-2016
28.	Luteinizing hormone based sensor for estrus detection in buffaloes	Dheer Singh	NFBSFARA	2013- 2016
29.	Enhancing development competence of oocttes for better in vitro fertilizing ability.	T. K. Dutta	NFBSFARA	2013-2016
30.	Estimation of hormonal profile, metabolites and milk composition during lactation in bovines and validation of bovine growth hornone RIA kit.	Mahendra Singh CCPI	BRNS (DAE)	2013-15
31.	Development of Strip based Detection Tests for selected Adulterants and Contaminants in Milk.	Rajan Sharma	SERB (MOFPI)	2013-14
32.	Development of parthenogenetic goat from embryonic stem cells.	M. K. Singh	NFBSFARA	2013-2017
33.	Healthy Foods: Production of stable and Active Probiotics.	Surajit Mandal	MFPI	2013-2015
34.	Production of buffalo casein hydrolysates enriched with antioxidative and immunomodulatory peptides and their application for the development of functional beverage.	Rajesh Kumar	MFPI	2013-2015
35.	Mineral bound with based ingredients: Preparation, characterization and application.	Sumit Arora	MOFPI	2013-15
36.	Development of resilient probiotic foods designed for the Indian Market conditions.	R. K. Malik	DST (Indo Newzealand)	2013-15
37.	Whey to Biofuel: Bioethanol Production by stress tolerant and metabolically engineered yeast from whey.	Shilpa Viz	NFBSFARA	2013-14
38.	Recombinant expression of lactobacilli aminopeptidases for the production of bioactive peptides.	J. K. Kaushik	DBT	2013-2016
39.	Preparedness of livestock rearers among the tribal in Disaster Prone Areas of Uttarakhand.	H. R. Meena	ICSSR	2014-2016
40.	Development of chromatographic and PCR based methodology to ascertain the Quality of milk fat and its validation under field conditions.	Vivek Sharma	SERB	2013-2014
41.	Preparation and characterization of nanoemulsions of curcumin for their use in functional foods.	Bimlesh Mann	DST	2014-15
42.	Onset of Puberty and Induction of Estrus: Role of Kisspeptin (Kiss1) in bovine species (Mithun and Cattle).	Mohan Mandal PI of Cooperating Institute.	DBT	2014-2017
43.	Development and application of lactic acid bacteria as designer products.	S. K. Tomer (DM)	BBSRC Funded joint India-UK collaboration project.	2014-2017
44.	Niche Area of Excellence (NAE) Scheme entitled "Development and evaluation of spore based biosensors for monitoring of pesticides residues in milk".	N. K. Goel	ICAR Funded	2014 -2018

45.	Microbial diversity of industrial waste polluted sites of Punjab: Biogeochemical interactions for recycling of metals and degradation of pollutants.	A. K. Puniya	DBT	2014-2017
46.	Intellectual property management and transfer/ commercialization of Agriculture Technology Scheme.	Y. S. Rajput	ICAR	2014-2015
47.	Manipulation of partitioning of nutrients and energy balance to augment milk production and reproductive performance in dairy animals-	Mahendra Singh	BRNS	2014-2017
48.	Microbial diversity of Bio-Films in Dairy Niche.	R. K. Malik	AMAAS	2014-2017
49.	Comparative metagenome of human gut of North and North-eastern region of India"	PI of Collaboration Instt. Sunita Grover	DBT	2014-2017
50.	Development of Aptamer Based Detection System for Aflatoxin M1 in Milk.	Rajan Sharma	DBT	2014-17
51.	Controlled release dispensers for delivery of semiochemicals.	Gautam Kaul	DBT	2014-17
52.	Application of Endocrine Biotechniques for Induction of Mother-neonate Bonding in Mithun (Bos frontalis).	Mohan Mandal (ERS)	DBT	2013-14
53.	Study of mechanism of probiotic action in persistent diarrhea in children caused by enteroaggregative E. coli-using a mouse model.	Sunita Grover	ICMR	2014-2016
54.	"Incentivizing Research in Agriculture" Project-V Semen sexing in cattle.	S. K. Mohanty & S. K. Singla	ICAR	2014-17
55.	Development of mammalian cell based biosensor prototypes for toxins in commercial milk.	Suneel Kumar Onteru	DBT	2014-18

NDRI, Karnal Signs Memorandum of Understanding with Riddet Institute, New Zealand to promote research and academic collaborations

From back left: Distinguished Professor Harjinder Singh, Distinguished Professor Paul Moughan, Massey International Relations Director Michael O'Shaughnessy

Bottom row: Professor AK Srivastava, Director and Vice-Chancellor of the National Dairy Research Institute, Massey University Vice-Chancellor Steve Maharey.

7 EMPOWERMENT OF WOMEN AND MAINSTREAMING OF GENDER ISSUES

Dairy Extension Division

Thirty Eight women empowerment trainings and campaigns were organized with the objective to create awareness in the field of dairying and home science and also impart skill in these areas so that farm women could generate more income from dairying and maintain healthy atmosphere in their respective family. By these programme, 600 farm women were trained.

Name of the Programme	On-campus / Village	Total Courses Conducted	No. of Participant
Entrepreneurship development on small scale production of tomato paste	On-campus	1	14
Capacity building of farm-women in scientific dairy farming	Subri, Shahpur, Bazidpur, Kulwehri	7	111
Capacity building of farm-women in fruit and vegetables preservation	Subri, Bazidpur, Kulwehri	5	68
Awareness campaign of farm-women in hygiene and health	Dungro, Subri Kulwahri, Bazidpur	6	103
Capacity building of farm-women in value added milk products	Subri, Kulwahri Dungro	7	104
Women empowerment of farm-women through SHG	Dungro, Dhamanhari, Deepo	8	88
Importance of mineral mixture for dairy animals	Deepo	1	14
Balanced diet for pregnant and lactating mothers	Deepo, Shahpur Deepo	3	38
Total		**38**	**540**

Dr. (Ms) Amrita Patel, Ex-chairperson, NDDB Anand receiving the 1st Dr. Verghese Kurien Memorial Oration Award

Krishi Vigyan Kendra (KVK)

- An off campus training programme on fruits and vegetables preservation was organized for 32 women in village Kailash of Karnal district.
- Training programme of Five days duration was conducted for 50 women from various districts of Haryana state in food processing at KVK Karnal.
- A training programme was organized on household food security through kitchen and nutrition gardening for 15 farm women at village Pal Nagar of district Karnal.
- A special twelve days training was organized for 19 women of Karnal district on embroidery at KVK.
- Three on campus training programmes were organized for 67 women on processing of fruits and vegetables at KVK NDRI Karnal to apprise them on preparation methods of sauses, jams, pickles etc.
- Two training programmes of three days duration was organized on milk products making for 31 women at KVK Karnal.
- Subject matter experts of the Institute delivered five lectures to nearly 250 farm women of SHGs, Anganwari workers, Asha workers and Mahila Sakshar Samooh of different districts of Haryana for their capacity building.
- Two training programmes of five days duration were organized on scientific dairy farming for 16 farm women from state of Himachal Pradesh sponsored by Block Development Office, Thiyong, Shimla and 40 women from Gujarat sponsored by Project Director, ATMA, Kutch at KVK, NDRI Karnal.

NDRI survey team at a remote village in Rajasthan

- KVK provided trainings to 170 women on scientific dairy farming, fish farming, bee keeping and entrepreneurship development in milk processing at KVK. The beneficiaries belonged to various states of the country.

Southern Regional Station, Bangalore

Dairy Entrepreneurship Development of Rural Women: An Action Research: The study was conducted to promote two women based Self Help Group (SHG) working exclusively on dairying activity. Based on the preliminary survey and contacts established with local NGOs two women SHGs on dairying were formed in Suradenapura village and Hannumanahalli village in association with local NGOs viz, Peoples Trust and Samastha Micro Finance, respectively. Suradenapura village based SHG comprised of ten economically very poor women members belonging to the weaker section with poor educational background. This group was exclusively formed and dairying activity was promoted as most of them are landless and sustaining their livelihood only through working as an agricultural laborers and petty shop keepers. Through our sustained institute interventions, this SHG has secured a group loan from Kalpatharu Grameena Bank and through this money, each member of this group bought HF crossbred animals and continuing the dairying activity generating savings. In case of Hannumanahalli village, SHG comprised twenty women members from modest economic background and having small agricultural land. Primarily, they were sustaining their livelihood through sericulture activity and also crop husbandry like paddy, ragi and coconut trees. Majority of the members were literate. The group members were motivated to take up the dairying activity and with a loan from micro finance plus their own money, they bought HF crossbred animals and presently continuing dairying activity and repaying the loans through selling the milk to KMF. The institute's interventions included in terms of counselling the members, orientation training, providing the technical know- how, on-campus and on-field demonstrations for do-how skill, exposure visit, distributions of necessary inputs/literatures etc. The SHG members were also encouraged to cultivate fodder through distribution of Maize, Sorghum, Cowpea and Agathi fodder seed kits.

8 PUBLICATIONS

INSTITUTE PUBLICATIONS

Aggarwal, Anjali (2015) *Impact of Heat Stress in Transition Cows*. NDRI Publication No. 129/2015.

Aggarwal, Anjali and Tyagi, Amrish (2015) *Khees, Navjat Bachdon Ke Liye Amrit*. NDRI Publication No. 127/2015.

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Hon'ble Union Minister for Agriculture, Shri Radha Mohan Ji Releasing ISO Certification Granted to NDRI Karnal

9 CONSULTANCY, PATENTS AND COMMERCIALISATION OF TECHNOLOGIES

INDUSTRIAL CONSULTANCY SERVICES

In year 2014-15, the Consultancy Services of NDRI helped many prospective dairy entrepreneurs by providing project reports, which enabled them to secure loans/financial assistance from different organizations. Revenue generated from consultancy services was utilized for strengthening the Institute's infrastructure and R&D work and also part of the money was shared among the scientists rendering such service as an incentive. Consultancy services also provided a via media for two-way communication between scientists and industry. Feedback from industry through such interactions helped the scientists to focus and fine-tune their research efforts to fulfill the real needs of dairy industry.

Institute Technology Management Committee (ITMC)

ITMC is the governing body at the Institute level for all obligatory decision related to grant and enforcement of patents as per national laws and for technologies commercialization developed at NDRI. ITMC is chaired by Director, NDRI. ITMC discusses and decides cohort diversity of issues in meeting such as eligibility of invention for commercialization/ patenting, pricing of the technology and commercialization of technology. During the year 2014-2015, six meetings were held on 17th April 2014, 7th July, 2014, 1st August 2014, 19th October, 2014, 27th November, 2014 and 11th February, 2015. During the year 2014-15, a total of 13 technologies developed at the Institute were transferred to 20 various industries earning ` 57.10 lakhs + Service Tax (12.36%) for the Institute.

Following Technologies were Commercialized during 2014-2015

S. No	Title of Technology	Date	Organization which purchased technology	License Fee (INR)* (₹ in lakhs)
1.	New Colour Based Test for Rapid Detection of Detergent in Milk	03.01.2015	Havmor Ice-cream Ltd., Ahmedabad, Gujrat	6.00
2.	Strip Based Test for Detection of Neutralizers in Milk	26.12.2014	Mother Dairy Fruit & Vegetable Private Limited	1.00
3.	Strip Based Test for Detection of Added Urea in Milk	26.12.2014	Mother Dairy Fruit & Vegetable Private Limited	1.00
4.	Strip Based Test for Detection of Hydrogen Peroxide in Milk	26.12.2014	Mother Dairy Fruit & Vegetable Private Limited	1.00
5.	Strip Based Test for Detection of Glucose in Milk	26.12.2014	Mother Dairy Fruit & Vegetable Private Limited	1.00
6.	Strip Based Test for Detection of Maltodextrin in Milk	26.12.2014	Mother Dairy Fruit & Vegetable Private Limited	1.50
7.	Strip Based Test for Detection of Neutralizers in Milk	11.12.2014	Rajasthan electronics and Instruments Limited	1.00
8.	Strip Based Test for Detection of Added Urea in Milk	11.12.2014	Rajasthan electronics and Instruments Limited	1.00
9.	Strip Based Test for Detection of Hydrogen Peroxide in Milk	11.12.2014	Rajasthan electronics and Instruments Limited	1.00
10.	Strip Based Test for Detection of Glucose in Milk	11.12.2014	Rajasthan electronics and Instruments Limited	1.00
11.	Strip Based Test for Detection of Maltodextrin in Milk	11.12.2014	Rajasthan electronics and Instruments Limited	1.50
12.	A PCR Based Method for differentiating A1 and A2 milk.	01.12.2014	A2 Milk Research Corporation Raipur, Chhattisgarh	4.00
13.	A PCR Based Method for Differentiating Cow and Buffalo Milk.	01.12.2014	A2MilkResearch Corporation Raipur, Chhattisgarh	6.00
14.	Sugar Tolerating Lactic Culture Por preparation of Misti Doi	01.11.2014	Namaste India Foods Pvt. Ltd., Kanpur, U.P.	1.60
15.	An Indigenous Probiotic Strain of Lactobacillus Fermentum	30.09.2014	Sarvotham Care Ltd., Secunderbad	10.00
16.	An Indigenous Probiotic Strain of Lactobacillus Plantarum	30.09.2014	Sarvotham Care Ltd., Secunderbad	10.00
17.	High Protein Iron Fortified Bajra Biscuits	01.08.2014	Sarvotham Care Ltd., Secunderbad	0.75
18.	High Protein Iron Fortified Bajra Biscuits	01.08.2014	Mrs. Santosh Yadav 68, Nyaypuri, Karnal	0.75
19.	Bajra Lassi	01.08.2014	Misthi Farmer Producers Co. Ltd., VPO-Nagla Roran Karnal	1.00
20.	New colour Based Test for Rapid Detection of Detergent in Milk	19.03.2014	Rajasthan Co-operative Dairy Federation Ltd., Jaipur, Rajasthan.	6.00
	Total			57.10

*12.36% tax has also been paid by the purchaser of the technology.

NDRI- Industry Meet

NDRI-Industry meet was organized on 1st December, 2014 wherein technologies available at NDRI were presented to participants from Industries with a focus on commercial transfer. Commercial and technological aspects of Forty nine technologies were presented by inventors to allow one-to-one interaction and facilitation of technology transfer. Representatives from Keshav Milk Products, Rookan Dairy, ITC ltd, Mother Dairy, Karnal Milk Foods Ltd, Kamdhenu Feeds Ltd, Modern Dairy Pvt Ltd, A2 Milk Research Corporation and Suman Dairy participated in NDRI-Industry meet.

Patents Granted (2014-15)

1. A Novel Process of Sporulation, Activation and Germination in Thermophilic Bacteria for Rapid Detection of Antibiotic Residues in Milk. **(Patent Grant No. 264145). Inventors: Naresh Kumar, Girdhari Ramdas Patil, Sharmila Sawant, Ravinder Kumar Malik.**

2. A noninvasive DNA isolation methodology in Dairy Animals. **(Patent Grant No. 258646). Inventors: Sachinandan De, Ashutosh Sharma, Paras Yadav, Tirtha Kumar Datta, Surender Lal Goswami.**

3. A Process for Commercial Manufacture of Kradi. **(Patent Grant No. 260553). Inventors: Girdhari Ramdas Patil, Hilal Ahmad Punoo, R. R. B. Singh.**

4. A Kit for detection of detergent in milk. **(Patent Grant No. 264661). Inventors: Y. S. Rajput, Sumandeep, Rajan Sharma.**

Patents Filed (2014-15)

1. A strip for detection of maltodextrin in milk and process for the same. (Rajan Sharma, Y. S. Rajput, Bimlesh Mann, Prerna Narula, Rahul Thakur & Brajesh Kumar) (2097/DEL/2014).

2. Microencapsulated flaxseed oil powder and a method of preparation thereof. (Vivek Sharma, Ankit Goyel, Sumit Arora & Darshan Lal (2030/DEL/2014).

3. Marker enzymes and spore germination based assay for detection of E. coli in milk and milk products (Naresh Kumar, Ramakant Lawaniya, Avinash, bhawana Arora, Raghu H.V, Mandeep Balhara, Saurabh Kadyan & Vinay Kumar Singh) (2214/DEL/2014).

4. Development of enzyme-spore based assay (s) for monitoring antibiotic residues in milk. (Naresh Kumar, Alia khan, Shivani Arora, Falguni Patra, Meenakshi Dhaiya, Raghu H.V, Mandeep balhara, Pradeep Kumar Sharma & Suleman Shiekh) (2213/DEL/2014).

5. Development of a Bubalus bubalis (Indian Water Buffalo) mammary epithelial cell line. (Tapas Mukhopadhyay, Nilambra Dogra, Ashok Kumar, Ashok K. Mohanty, Jai K. Kaushik, Ajay K. Dang) (2806/DEL/2014).

6. Application of a mammary gland specific glycoprotein as a biomarker for detection of sub-clinical mastitis. (Ashok K. Mohanty, Surender Singh, Jai K. Kaushik, Ajay K. Dang, Tushar K. Mohanty) (2807/DEL/2014).

7. Composition for Modulating Fertility. (J. K. Kaushik, Pradeep M. A. and Shalini) (3703/DEL/2014).

8. Mangifera indica flower panicles' extract stablized gold nanoparticles and method for making the same. (Varij Nayan, Suneel Kumar Onteru, and Dheer Singh) (807/DEL/2015).

9. A strip based test for detection of detergent in milk (Y.S. Rajput, Gulab Singh and Rajan Sharma) (750/DEL/2015).

10. High fiber reduced calori biscuits from dairy-multigrain composite (Latha Sabikhi, Dipesh Aggarwal and Ashish Kumar Singh) (758/DEL/2015).

11. A PCR based method for detection of a field strain of Ureaplasma diversum (Dheer Singh, Onnureddy Kaipa, Suneel Kumar Onteru, Sriram Kannan (806/DEL/2015).

12. Antimicrobial nanoemulsion of clove oil stabilized with milk protein and a process thereof. (Bimlesh Mann, Minaxi, Rajesh Kumar and Rajan Sharma) (913/DEL/2015).

13. Patent application was filed by P.S. Hegde, K.P. Ramesha and K.M. Nagaraja for "Novel process of converting raw jack fruit as livestock feed with long shelf life". 2014. Application No. 3688/CHE/2014 CBR No.13841.

Transfer of Technology

Exchange of MoU for the technology of "Rapid strip based tests for detection of adulteration of milk" with officials of Rajasthan Electronics and Instruments Limited (REIL), Jaipur on 11th December, 2014 during the ICAR Governing meeting at New Delhi.

Exchange of MoU for the technologies of "Rapid strip based tests for detection of adulteration of milk" with officials of Mother Dairy on 26th December, 2014.

Exchange of MoU for the technology of "A new test for detection of detergent in milk" with officials of Havmor Icecream Ltd. Ahmadabad on 13th January, 2015.

Two technologies on indigenous probiotic strains of Lactobacillus fermentum and Lactobacillus plantarum were transferred to Sarvotham Care Ltd., Secunderabad through MoU exchange at ICAR, Krishi bhawan on 30th September, 2014 for a total cost of ₹ 20 lakhs.

"Sugar tolerating lactic culture for preparation of *Misti Doi*" to Namaste India Foods Pvt. Ltd., Fazalganj, Kanpur for a total cost of 1,60,000 on 01.11.2014

Technologies Assessed and Transferred

Two technologies from Animal Biotechnology Centre were transferred to A2 Milk Research Corporation, Raipur and a MOU has signed on 1st December 2014. These are

i) PCR-based method for differentiating Cow and Buffalo milk and

ii) PCR-based method for differentiating A1 and A2 milk.

Resource Generation

Sl. No.	Heads	Amount (₹)
1.	Sale of Milk	32,90,959
2.	Sale of Animals	4,35,000
3.	Sale of fodder/seed	29,736
4.	Rent of guest house	22,906
5.	Training fees	47,400
6.	Any others/ Miscellaneous	77,143
	Total	**46,05,144**

BUSINESS PLANNING AND DEVELOPMENT (BPD) UNIT

Entrepreneurship Development Programmes (EDP) on Commercial Dairy Farming, Milk Processing and Value Addition through BPD & TBI

Technology Business Incubator (TBI) and Business Planning & Development (BPD) Units of NDRI organized Entrepreneur development programmes (EDP) & training programmes on commercial dairy farms, milk processing and value addition. The major objective of the training was to impart knowledge to farmers, entrepreneurs and Government officials to adopt the scientific practices for maximizing the productivity and profitability. A total number of 21 training programme were organized through BPD and TBI from July to December, 2014 participated by 250 trainees from different states across the country with a total revenue of ₹ 28,52458. The trainees included farmers, professionals, students, businessmen. The Methodology of the training programmes were interactive lectures with scientists, progressive farmers, and farm mechanization industries, financial agencies coupled with visits. Trainees were also made to interact with NABARD official and other financial institutions to understand the financial schemes available for entrepreneurs.

Through BPD

Sl. No.	Name of the Training Programme	Period	No. of Candidate	Amount Generated	Organised By
1	Commercial Dairy Farming	26th -31st May, 2014	25	2,52,825	BPD
2	Technology of Cheese Processing	02nd - 07th June, 2014	12	1,30,338	BPD
3	Commercial Dairy Farming	23rd - 28th June, 2014	20	2,29,262.40	BPD
4	Training Programme on Value addition of milk	2nd -6th September, 2014	15	56,936	BPD
5	Training Programme on Value addition of milk	22nd – 26th September, 2014	15	56,936	BPD
6	Training Programme on Value addition of milk	14th -18th October, 2014	15	56,936	BPD
7	Training Programme on Infertility Management	7th – 14th December, 2014	7	1,06,855	BPD
8	Training Programme on Infertility Management	24th– 29th December, 2014	7	1,06,855	BPD
9	Milk and Milk Products Processing for Lalukheri Farmers	23rd – 28th March, 2015	08	30,000	BPD

Through TBI

Sl. No.	Name of the Training Programme	Period	No. of Candidate	Amount Generated	Organised By
1	EDP on Commercial Dairy farming	21st - 26th April, 2014	26	2,34,000	TBI
2	Training Programme on Milk Processing & Related Products	21st - 26th July, 2014	13	1,30,000	TBI
3	EDP on Commercial Dairy farming	25th - 30th August, 2014	29	2,90,000	TBI
4	EDP on Commercial Dairy farming	6th - 11th October, 2014	28	2,80,000	TBI
5	EDP on Commercial Dairy farming	24th - 29th November, 2014	27	2,70,000	TBI
6	Training Programme on cheese Manufacturing	8th - 13th December, 2014	9	90,000	TBI
7	Training Programme on Value addition of milk	27th February – 3rd March, 2015	20	1,06,515	TBI
8	Specialized Training on Ice Cream	For 4 Months	01	20,000	TBI
9	EDP on Commercial Dairy farming	27th February – 4th Match, 2015	15	1,50,000	TBI
10	Specialised Training on Milk and Milk Products Processing	27th February – 3rd March, 2015	01	15,000	TBI
11	Specialised Training on Milk and Milk Products Processing	27th February – 3rd March, 2015	01	10,000	TBI
12	EDP on Commercial Dairy farming	23rd – 28th March, 2015	23	2,30,000	TBI

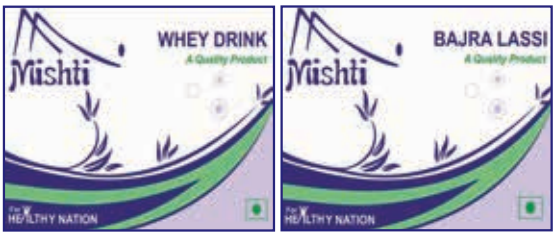
Incubation from TBI

Five Incubatees were enrolled under TBI from July to December, 2014, 2 are for physical incubation (M/s Mishti Farmer Producer Co. Ltd & M/s Santosh Yadav) and two are for virtual incubation (M/s Veerdeepika, Mahendragarh, M/s Maharathy Agro, Roorkee & Kamdhenu Hitkari Manch-Bilaspur) and total ₹ 1,42,000/-revenue generated.

Name: Mishti Farmers Producer Co. Ltd
Incubatee Type: Physical

Description:

- BPD Unit, NDRI licensed Bajra Lassi, Whey Jaljeera Drink and Whey Mango technologies to Mishti Farmers Producer Co. Ltd.



- BPD Unit, NDRI supported farmers by transferring latest available dairy technologies & achieved intended solutions for social impact.
- BPD Unit, NDRI also extended its support to continuously educate them with series of interactions with mentors & developing business acumen in order to compete with intangible market forces.

Name: M/s Santosh Yadav Enterprise
Incubate Type: Physical

Description:

- M/s Santosh Yadav licensed High Protein Iron-Fortified Bajra Biscuit technology from BPD Unit, NDRI Karnal.
- The licensed technology provides high quality nutritious biscuits rich with Fibre, Calcium, Protein and Iron for health conscious consumers.
- BPD Unit, NDRI provided required R&D support & consulting services on cost-effective processing technique for production optimization, business development challenges & revenue generation.

Name: Veerdeepika Pvt. Ltd.
Incubatee Type: Virtual

Description:

- BPD Unit, NDRI extended consulting & advisory support to two enthusiast women entrepreneurs from New Delhi.
- The assistance was provided on setting up a milk plant, pasteurization & milk packaging.
- BPD Unit, NDRI also guided them on business expansion & venturing into other dairy products.

Name: M/s Maharathy Agro, Roorkee
Incubatee Type: Virtual

Description:

- BPD Unit, NDRI extended consulting & advisory support to setting up the dairy farm to the young entrepreneurs.
- BPD Unit, NDRI also guided them on business expansion & venturing into other dairy products.

Entrepreneurs Successfully Launched their Venture

S. No.	Name	Place	Type of Business
1.	Mr. Prashant Kumar	Lakhisari Bihar	Dairy Farm
2.	Mr. Rajesh Kumar Jha	Madhubani Bihar	Dairy Farm
3.	Mr. Rajeev Kumar Kashyap	Nawada Bihar	Dairy Farm
4.	Shubham Chaturvedi	Rambagh Bihar	Dairy Farm
5.	Mr. Kartic Jaiswal	Vaishali Bihar	Dairy Farm
6.	Mr. G. Mohan Jha	Patna Bihar	Dairy Farm
7.	Mr. Akramal Haq	Darbhanga Bihar	Dairy Farm
8.	Mr. Rizman	Darbhanga Bihar	Dairy Farm
9.	Mr. Mohan	Indore	Dairy Farm
10.	Mr. Vikram Pratap Singh	Lucknow	Milk Processing Plant
11.	Mr. Rinku Singh	Indore	Dairy Farm
12.	Mr. Dhanu Singh	Kurukshetra	Dairy Farm
13.	Mr. Sumer	Jaipur	Dairy Farm
14.	Mr. Prashant Kataria	Gurgaon	Dairy Farm
15.	Mr. Sanjay	Bhuj Gujarat	Dairy Farm
16.	Mr. Rakesh Jindal	Bharatpur	Dairy Farm
17.	Mr. Rumit Patel	Ahmedabad	Dairy Farm
18.	Mr. Ramdutt	Surat	Dairy Farm
19.	Mr. Aman Goyal	Gwalior	Dairy Farm
20.	Mr. Sudhir Kumar	Ghajiabad	Dairy Farm
21	Mr. Mushir Allam	Bihar	Dairy Farm
22	Mr. Amrit Raj	Assam	Dairy Farm
23	Mr. Ankit	Fazilea	Dairy Farm & now in process of setting up a Milk Processing Unit
24	Mr. Deepak Bhardwaj	Indore	Dairy Farm
25	Mr. Masood Khan	Hasanpur (Amroha)	Dairy Farm
26	Mr. Neelkamal	Karnal	Setting up Dairy Farm
27	Mr. Parshu Ram	Bhubaneshwar	Setting up Dairy Farm
28	Mr. Shezad Akhtar	Jharkand	Dairy Farm
29	Mr. Piyush Kumar	Mysore	Dairy Farm
30	Mr. Rajat Kumar		Dairy farming in collaboration with NGO

31	Mr. Chandra Bhan Singh	Allahabad	Milk Processing Unit
32	Mr. Sanjay Mahendru	Jalandhar	Milk Products
33	Mr. Bhushan Kapoor	Jalandhar	Milk Processing Unit
34	Mr. Amit Jain	Surat	Milk Processing Unit
35	Mr. Ajit Singh Yadav	Kanpur	Mozzarella Cheese
36	Mr. Prince	Rohtak	Milk Processing Unit
37	Mr. Pankaj Grover	Ludhiana	Mozzarella Cheese
38	Mr. Sumit Gupta	Bhatinda	Milk Processing Unit

Consultancy

Contract Research

Sr. No.	Project	Amount (₹)
1.	CRP testing of Jeevan Pashudha and Jeevan Pashudhan Ultra for Improved Immunity & Prevention of Mastitis in Dairy	8,81,088/-
2.	CRP Cleaning of Wild Buffalo and Udanti Sitanandi	10,00,000/-
3.	CRP Cleaning of Wild Buffalo and Udanti Sitanandi	20,00,000/-
4.	CRP Cleaning of Wild Buffalo and Udanti Sitanandi	28,90,000/-
5.	CRP Cleaning of Wild Buffalo and Udanti Sitanandi	14,90,000/-
6.	Project Report for Chilling Plant	22472
7.	Preparation of Project Report, Dairy Technology Division	39326
8.	Project Work	130551
9.	Preparation of Inventory of Nitrous Oxide & Methane	350515
10.	Project Work on Quality of Mawa	57421

General Consultancy

Sr. No.	Name of Organisation	General Consultancy	Amount (₹)
1.	Mr. Ritesh Kumar, V.P.O. Samalkha, Distt. Panipat	Use of Spray Dryer	11,236/-
2.	Mr. Varun, Kanpur (UP)	General Consultancy	5618/-
3.	Mr. Varun Sethi	General Consultancy	2247/-
4.	Agatti Health Care, Pvt. Ltd., Bombay	Processing of whey in RO System	7865/-
5.	Mr. Rakesh Mittal, Alpha Milk Foods Pvt. Ltd., Delhi	Report Pertaining to Dairy Project	1,32,447/-
6.	Mr. M.K. Gupta, General Manager, Umang Dairy Ltd. Gajraula (UP)	Checking of Production and Quality Assurance of Plant and Test of Curd-o-Magik	1,03,509/-

7.	Gp Capt Sudhir Diwan, Chief Administrative Officer, ICFAI University, Himachal Pradesh, Baddi	Consultancy Service for the ICFAI University	56,180/-
8.	Mr. Siddhesh Vikay Jadhav, Astarc Group, Mumbai	Visiting Fees for Project Site in Konkan Region	11,236/-
9.	Fair Exports Pvt. Ltd. Ghaziabad, (UP)	Consultancy to Setup 100 Buffalo Dairy Farm at Gangoh	5618/-
10.	Mr. Rakesh Mittal, Manager QA, Karnal Milk Foods Ltd.	Consultancy for Layout and other Requirements as per FSSAI,	22,472/-
11.	Cost of Five CD @ ₹ 150		845/-

Revenue Generation

Month	Student training	Non-student training	Contract research	Contract Services	Transfer technology	General consultancy	Total Amount
April	-	-	-	1124	6,85,396	-	6,86,520
May	55,618	1,41,585	-	6180	-	-	2,03,383
June	4,43,595	3,73,050	5,02,140	2247	10,11,240	-	23,32,272
July	2,77,528	80,904	82,61,088	4494	-	12,081	86,36,095
August	11,236	-	-	7,29,120	2,80,900	1,59,413	11,80,669
September	22,472	1,13,872	-	83,880	-	1,03,509	3,23,733
October	-	56,936	61,798	20,624	22,47,200	-	23,86,558
November	22,472	26,966	-	3371	1,91,012	56,180	3,00001
December	-	2,13,710	5,38,487	64,185	17,41,580	11,236	25,69,198
January	1,80,902	22,472	1,74,720	7833	16,07,872	-	19,93,799
February	33,708	-	-	4580	2,51,910	28,090	3,18,288
March	2,01,126	44,944	-	19,102	22,472	-	2,87,644
Total	**12,48,657**	**10,74,439**	**95,38,233**	**9,46,740**	80,39,582	3,70,509	2,12,18,160

Bajra Lassi to Mishti Farmer's M/s Producers company Limited, Karnal

10 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 research management and facilitate the decision support system with the following terms of reference:

- To co-ordinate and synthesize the recommendations or QRT, RAC, IRC, Vision documents 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 expert.
- 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, Consultancies, projects undertaken in the past and on-going projects.

Research Advisory Committee (RAC)

The main functions of the RAC are i) to suggest research programmes based on national and global context in the thrust areas and ii) to review the research achievements of the Institute and to see that these are consistent with the mandate of the Institute. The meeting of the RAC of NDRI, Karnal was held on 12th April, 2014 under the chairmanship of Dr. B. N. Mathur, Former Director, NDRI Karnal.

Institute Research Committee (IRC)

The key functions of Institute Research Committee (IRC) are to critically review the on-going and completed research projects, to consider the new research proposals and to advise on fostering of linkages between the groups/divisions of the Institute in respect of multi-disciplinary/multi-locational projects. The mid-term review of IRC projects of NDRI was taken up during 2nd to 3rd and 5th to 7th January, 2015 at NDRI, Karnal, 21st October, 2014 at SRS, Bangalore and 20th October, 2014 at ERS, Kalyani, respectively. IRC meetings were chaired by Dr. A. K. Srivastava, Director and convened by Dr. R. K. Malik, Joint Director (Res.), NDRI Karnal.

Project Information Management System (PIMS)

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

Vision 2050

PME Unit coordinated the preparation and documentation of Vision 2050 of NDRI. The Vision document of NDRI was prepared after having several brainstorming interactive sessions with scientists at the Divisional level and subsequently at the specialized groups level and then presentation at the Institute level. It was also deliberated at Subject Matter Division at ICAR level.

Evaluation of Contract/Consultancy Projects

PME cell also screened and evaluated contract/ consultancy research proposals received from time to time. PME cell meetings for this purpose were held on 4th December, 2014, 30th December, 2014 and 21st February, 2015.

Database Management

A database through HYPM package of research projects was updated for all the projects in operation during the year 2014. 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.

Technical Screening Committee Meetings

Technical Screening Committee was constituted under the chairmanship of Joint Director (Res.) to evaluate the manuscripts for publication as Books, Technical Bulletins/Manuals etc. Based on the recommendations of the committee, the manuscripts were also sent to outside experts for evaluation. The same were again evaluated in light of the comments received from experts and the contents of the publications got modified pursing the period, four meeting of Technical Screening Committee were held on 24th May, 2014, 23th September, 2014, 1st January, 2015 and 7th April, 2015 and 15 No. of manuscripts were scrutinized and got reviewed.

Research Documentation and Information

The Research Documentation and Information 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. prepared at the Institute and through various journals of National and International repute. During the period under report, Annual Report 2013-2014, and an Institute's publication entitled "A Splendid Journey of NDRI towards the Glorious Era in Dairy Research and Education" were prepared, edited and published through this cell. Research Projects of the Institute were also documented under the Research Programmmes identified by Research Advisory Committee for NDRI, Karnal. Four issues of "NDRI News" - a quarterly newsletter in English were also brought out. The unit also prepared reports on research achievements of NDRI for inclusion in ICAR/DARE Annual Report 2014-2015. The unit prepared various other reports on NDRI by highlighting the significant achievements and technologies developed by the Institute; Initiatives taken by the Institute for the welfare, development and empowerment of women and other gender related issues; Success Stories of progressive farmers based on the extension activities of the Institute; Development of research technologies for the farming community and dairy industry; Transfer of technology in the area of animal sciences; Quarterly Progress Reports containing the achievements of research, finance, purchase and civil works and targets of the next quarter; Monthly Progress Reports consisting significant events; Six Monthly Progress Reports of the research achievements with targets of next six months. The unit also prepared comments of the Institute with respect to recommendations made by the Parliamentary Standing Committee on Agriculture. The unit also prepared information on important conferences, seminars, workshops and meetings for publication in Directory of Events of ICAR; Information on NDRI for inclusion in ARIS Newsletter, ICAR; IAUA Newsletter; VCI Newsletter. The unit prepared the information regarding tentative agenda items for Director's Conference (2014) covering relevant points relating to the Institute; Institutional performance in respect of NDRI; Establishment of linkages with various organizations; IPR issues; Provided information under Right to Information Act, 2005; Information on technologies developed, transferred and commercialized; Prepared concise report on the achievements (last 5 years) of the Institute. The unit prepared XII Plan EFC Memo Document of the Institute (2012-2017); Prepared action taken reports on recommendations emerged during the meetings of QRT/RAC/VCs of AUs/ Directors of ICAR Institutes/IGCG on Agricultural Research & Extension and Farmers Linkages/ Governing Body/Director's Conference/BOM of NDRI/Regional Committee of ICAR No. II, III, IV, V and VI; Consolidated information on research projects undertaken/undergoing at NDRI in the areas of food processing. Post harvest technologies, packaging, new products development, supply chain or allied fields. The unit also prepared and collated information on the issues of post harvest losses for inclusion in the agenda items discussed during the meeting taken by the Hon'ble Prime Minister of India to review the Departments/Ministries i.e. Department of Agriculture and co-operation and Department of Agriculture Research & Education. This unit prepared information on training programmes organized/collaborative programmes under taken/students from Bangladesh and Myanmar/ consolidated information on collaboration with developing counties/prepared write-up on major highlights, activities of last six months for inclusion in the ICAR publication/prepared information on major technologies developed/transferred/ commercialized by NDRI through Technology Management Unit/prepared information on organic animal production/semen sexing in cattle/ consolidated information achievements of Tribal Sub-plan (TSP). This unit prepared replies to (Lok Sabha & Rajya Sabha) Parliament Questions, (31) and Audit (external) queries from time to time and co-ordinated with other Organisations/Institutes by sending the desired information through several questionnaires. Research papers submitted by the scientists were processed by the unit for publication in various journals of National and International repute. In addition, abstracts of papers were also processed for presentation at various Seminars/ Symposia/Workshops/Conferences etc.

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.

11 TRAINING AND CAPACITY BUILDING

A. SCIENTISTS/OFFICERS/SCHOLARS DEPUTED ABROAD

Dr. A. K. Srivastava, Director NDRI participated in FAO Regional Meeting "Dairy Asia Towards Sustainability" and to act as panelist during the session on "Dairying as an Instrument of Inclusive Economic Development" in Bangkok, Thailand from 21st – 24th May, 2014.

Dr. A. K. Chakravary, Principal Scientist, Dairy Cattle Breeding Division acted as an expert of Artificial Insemination under the work plan finalized between ICAR Ministry of Agriculture & Fisheries at Oman from 4th – 8th May, 2014.

Dr. J. K. Kaushik, Principal Scientist, Animal Biotechnology Centre received training on "Dairy Science and Food Biotechnology" from 9th - 14th June, 2014 at Germany.

Dr. A. K. Mohanty, Principal Scientist, Animal Biotechnology Centre participated in Joint FAO/ IAEA consultants meeting as an expert for presentation and discussion in "Early Pregnancy Diagnosis in the Bovine using Nuclear and Molecular Technique" from 11th – 13th June, 2014 at Austria.

Dr. A. K. Tyagi, Principal Scientist, Dairy Cattle Nutrition Division and **Dr. Sumit Arora** Principal Scientist, Dairy Chemistry Division visited Teagase Monopark Food Research Centre Dublin, Ireland under Indo-Ireland Joint Project from 26th – 31st July, 2014.

Dr. Dheer Singh, Principal Scientist, Animal Biochemistry Division visited Leibuiz Institute for Farm Animal Biology Institute at Germany from 25th August, 2014 to 24th September, 2014 for a Joint German DST-DAAD Collaborative Research Project.

Dr. M. S. Chauhan, Principal Scientist, Animal Biotechnology Centre attended 2nd Annual South Asia Bio-safety Conference and deliver lecture of "Application of Reproductitvity Biotechnology for Improvement of Dairy Animal Productivity at Colombo, Srilanka from 15th – 16th September, 2014.

Ms. Rashmi, H. M., Scientist, Dairy Microbiology Division visited University of Pretoria, South Africa to participate in research meeting under IBSA (India, Brazil and South Africa) Collaborative project on "Validating procedures for the measurement of heat resistant spoilage and pathogenic bacteria in milk" from 18th - 24rd January, 2015.

Ms. Kiran Kumari, Ph.D. Scholar, Dairy Microbiology Division presented a poster on "Exploring riboflavin producing lactobacilli from diverse niches and expression pattern genes involved in riboflavin biosynthesis pathway and their techno functional attributes" at Rowett-INRA 2014 Gut Microbiology: From sequence to function at University of Aberdeen, Scotland, U.K. 16th -19th June, 2014.

Ms. Kiran Kumari, Ph.D. Scholar, Dairy Microbiology Division attended an International Seminar on "Pharmaceutical Science and Technology by Faculty of Pharmacy" Universitas, Padjadjaran in collaboration with school of pharmacy of Bandung Institute of Technology, Jatinangor, Indonesia and presented a research paper on Bioprospecting Riboflavin producing Lactobacilli: A new hope for developing countries during the month of September, 2014.

B. SCIENTISTS/OFFICERS PARTICIPATION IN WORKSHOPS/TRAININGS WITHIN INDIA

Name & Designation	Title of Workshops and Training	Period
Dr. A. K. Chakravarty, Head	Brain Storming Session on "Coastal Agricultural Research" at ICAR Research Complex, Goa.	9th April, 2014
Dr. K. Ponnusamy, Head	Workshop on "National Extension Programme (NEP)" in collaboration with IARI, New Delhi.	17th April, 2014
Dr. Sumit Arora, PS Dr. A. K. Singh, PS	NAIP Agri. Biz Idol Camp and Incubation Workshop at IARI, New Delhi.	9th May, 2014
Dr. Diwas Pradhan, Sci.	Three Months Professional Attachment Training on "Microencapsulation of Bio-molecules" at CIPHET, Ludhiana.	12th May to 11th August , 2014
Dr. Laxmana Naik, Sci	Three Month Professional Attachment Training on "A Mandate Area of NDRI as a part of the Module of FOCARS" at Export Inspection, Kochi.	12th May to 11th August , 2014

Dr.(Mrs.) K. P. Indumati, Sci	Three Month Professional Attachment Training on "Food Safety & Quality Assurance" at Mumbai.	12th May to 11th August , 2014
Dr. Diwas Pradhan, Sci.	Three Month Professional Attachment Training on "Microencapsulation of Bio-molecules" at Ex-port Inspection Councied of India (EIC) Laboratory, Mumbai.	12th May to 11th August , 2014
Ms. Priyanka Singh Rao, Sci.	Three Month Professional Attachment Training on "Food Biotechnology" at Central Institute of Risheries Education (CIFE), ICAR, Mumbai.	12th May to 11th August , 2014
Dr.(Mrs.) Richa Singh Sci.	Three Month Professional Attachment Training on "Advanced Instrumentation Facility" at Directorate of Medicinal and Aromatic Plants Research Boriavi, Anand (Gujrat)	12th May to 11th August , 2014
Dr. Meena Malik, Associate Prof.	Workshop on "Priority Setting Monitoring and Evaluation in National Agricultural Research System: Status Experiences and Way Forward" jointly organized by NAIP and International Food Policy Research Institute (IFPRI) at NASC Complex, Pusa, New Delhi.	27th May, 2014
Dr. Sohan Vir Singh, PS Dr.(Mrs.) Madhu Mohini, PS	Workshop on "Climate Change Mitigation Interventions in Agriculture" at CRIDA, Hyderabad.	21st June, 2014
Dr. Avtar Singh, PS	National Workshop on "Livestock Keepers Rights & Breed Saviour Award Ceremony" at NBAGR, Karnal.	8th July, 2014
Sh. Rajeshwar Dayal, STO	Training in Writing for print media and electronic media organized by MANAGE, Hyderabad.	21st – 25th July, 2014
Dr. K. K. Datta, Head	Workshop on "Harnessing Opportunities to Improve Agri-food System" at NASC Complex, Pusa, New Delhi	24th – 25th July, 2014
Dr. A. K. Chakravarty, Head	Brain Storming Session on "Strategy for Accelerating Dairy Development in India" at NASC Complex, New Delhi.	25th July, 2014
Dr. Meena Malik, Associate Prof.	MDP on "PME of Agricultural Research Projects" organized by NAARM, Hyderabad.	4th – 8th August, 2014
Dr. Meena Malik, Associate Prof.	NAAS-IFPRI Brainstoriming Meeting on "Developing PME Indicators and Mechanisms in NARS" at NASC Complex, Pusa New Delhi.	12th August, 2014
Dr. K. P. Ramesha, PS Dr. Mukund A. Kataktalware, PS Dr. M. Manjunatha, PS Mr. Chitranayak , Sci.	Short course on "Harnessing Intellectual Property in Animal Science Sector in the Global Scenario" Organized by ICAR-NIANP, Bengaluru.	18th – 27th August, 2014
Dr. Gopal Sankhala, PS Dr. A. K. Singh, PS	Management Development Programme on "Consultancy Projects Management" organized by National Academy of Agricultural Research Management (NAARM) Hyderabad.	22nd - 27th August, 2014
Dr. S. K. Tomar, PS	An International Workshop on "Development and Application of Lactic Acid Bacteria as Designer Probiotics" at CFTRI, Mysore under the aegis of BBSRC India Partnering Award.	1st -3rd September, 2014
Dr. Latha Sabikhi, Head	An International Training Programme on "Leadership and Career Development for Women Scientists/Technologist" organised by Department of Science & Technology, GoI at Indian National Science Academy (INSA) at New Delhi.	1st - 5th September, 2014
Dr. M. S. Chauhan, PS	Prepare a white paper defining a "National Mission" at SGVP Gurukul, Ahmedabad.	6th - 7th September, 2014
Dr. A. K. Chakravarty, Head	Workshop on "Buffalo Improvement at LRS of RAJUVAS" held at Vallabhnagar, Udaipur, Rajasthan.	9th -10th September, 2014
Dr. M. Karunakaran, Sr. Sci.	Short Term Training Course on "Laboratory Diagnosis of Animal Diseases and Zoonoses" at Eastern Regional Station, Indian Veterinary Research Institute, Kolkata.	18th September 2014

Dr. S. Varalakshmi, PS	International Training Program on "Food Safety, Quality Assurance Systems and Risk Analysis with VLIR-UOS Fellowship" at the University of Ghent, Belgium.	24th September to 20th December, 2014
Dr. Mukund A. Kataktalware, PS	Training Programme on "Laser Software" conducted at ICAR-NIANP, Adugodi, Bengaluru.	7th-8th October, 2014
Mr. Sathish Kumar, M.H., Sci. Dr. Shaik Abdul Hussain, Sci.	2nd Advanced Training Programme on "Texture Analysis" at India Habitat Centre, New Delhi.	7th-8th October, 2014
Dr. A. K. Mohanty, PS	An International Conference/Workshop on "Recent Advances in Structural Biology" at IIT Roorkee.	9th-11th October, 2014
Dr. K. S. Kadian, PS	Stakeholder Workshop on "Innovative Extension Models and Approaches" at IARI, New Delhi.	10th October, 2014
Dr. M. Mandal, PS	Workshop on "Science for Inclusive Growth" held at SN Bose National Centre for Basic Sciences, Salt Lake, Kolkata.	21st October, 2014
Dr. A. K. Chakravarty, Head	Brain Storming Session on "Breeding policy for the dairy herd maintained at Eastern Regional station of NDRI, Kalyani" at West Bengal.	28th October, 2014
Dr. A. K. Singh, PS	"Milk Processing Training" at Milk Co-op Society, Nazira, Sivasagar,Distt. Assam.	28th October to 2nd November, 2014
Dr. M. Karunakaran, Sr. Sci.	"Training on Advances in Livestock Production Management Technologies" at Eastern Regional Station, Indian Veterinary Research Institute, Kolkata.	14th November, 2014
Dr. S. Subash, PS	Rashtriya Krishi Mela 2014 held at GKVK Campus, Bengaluru.	19th - 21st November, 2014
Dr. S. S. Kundu, PS Dr. S. S. Thakur, PS Dr. S. K. Tomar, PS Dr. Chander Datt, PS Dr. Sohan Vir Singh, PS	Regional Stakeholders Workshop organized by "Animal Nutrition Society of India" held at NRC on Mithun, Medziphema, Nagaland.	24th - 25th November, 2014
Dr. A. K. Singh, PS	National Workshop on "Promotion of Self-Employment in Punjab" organized by Mahatma Gandhi State Institute of Public Administration, Punjab in association with NABARD at Chandigarh.	25th November, 2014
Dr. D. Malakar, PS Dr. Sudershan Kumar, Sci.	Short Course on "Advanced Molecular ….Indigenous-Resources" at NBAGR Karnal.	1st – 10th December, 2014
Dr. Ashwani Kumar Roy, Sr. Sci.	Antrarashtriya Ghosti "Vishav Ki Pragati Mai Vigyan Tatha Prodyaki Ka Yogdan" at Matcalf House Delhi.	5th - 7th December, 2014
Dr. K. Ponnusamy, Head	Workshop on "Veterinary Education Research and Extension the Way Forward" at Madras Veterinary College, Chennai.	22th - 24th December, 2014
Dr. A. K. Singh, PS	National Workshop on "Women Empowerment during XII Five Year Plan through Agricultural Mechanization" organized by CSA University of Agriculture & Technology, Kanpur at CSAUAT, Kanpur.	24th - 25th December, 2014
Dr. A. K. Chakravarty, Head	National Workshop on "Methodology of Integrated Sample Survey" at Vigyan Bhawan, New Delhi.	5th - 6th January, 2015
Dr. M. Karunakaran, Sr. Sci.	"Livestock Development Programme" organized at Netaji Subhas Regional Institute of Cooperative Management, Kalyani, West Bengal.	7th January, 2015
Dr. Latha. Sabikhi, Head	Workshop on "Innovations in Agricultural Education and Extension Systems: Outcomes and Lessons Learned" Hotel Radisson BLU, New Delhi.	20th - 21st January, 2015
Dr. Anjali Agarwal, PS	Workshop at NAARM, Hyderabad.	26th February, 2015
Dr. Rajan Sharma, PS	Training Progrmme for "Techncial Committee Members at National Institute of Training for Standardization", Noida organized by Bureau of Indian Standards.	27th – 28th January, 2015

Dr. Latha Sabikhi, Head Dr. S. K . Singla, PS	International Workshop on "Production Animal Health and Welfare Research: Impact and Opportunities", Organised by ICAR and University of Edinburgh, UK (Roslin Institute. NAAS Committee Room, NASC Complex, New Delhi.	16th – 17th February, 2015
Dr. Latha Sabikhi, Head Dr. A. K. Chakravarty, Head Dr. Gautam Kaul, PS	Indo-French Workshop on "Scientific Co-operation for Agricultural Research" organised jointly by ICAR and National Institute for Agricultural Research (INRA), France at NASC Complex, New Delhi.	9th - 11th March, 2015
Sh. Navdeep Singh, Tech Assist,	"Office Automation Using Oracle ERP" at IASRI, New Delhi.	9th - 13th March, 2015
Ms. Teena Chopra, Tech, Assist.	"Office Automation Using Oracle ERP" at IASRI, New Delhi.	16th -20th March, 2015

C. SCIENTISTS/OFFICERS PARTICIPATION IN/SEMINARS/CONFERENCES WITHIN INDIA

Name & Designation	Title of Seminars / Conferences	Period
Dr. Satish Kulkarni, Head Dr. P. K. Dixit, PS Dr. B. Srinivas, PS Dr. Mukund A. Kataktalware, PS Dr. M. K. Ghosh, PS Dr. S. S. Kundu, PS Dr. S. S. Thakur, PS Dr. Neelam Kewalramani, PS Dr. Veena Mani, PS Dr. A. K. Tyagi, PS Dr. S. K. Tomar, PS Dr. Chander Datt, PS Dr. Parveen Kumar,PS Dr. A. Chatterjee Sr. Sci. Dr. M. Mondal, Sr. Sci.	International Conference 'GLANCE 2014' on "Climate Resilient Livestock Feeding Systems for Global Food Security" organized by Animal Nutrition Society of India in collaboration with National Institute of Animal Nutrition and Physiology, Bengaluru at Bengaluru.	20th-22nd April, 2014
Dr. Avtar Singh, PS	"International Biodiversity Day" at NBAGR, Karnal.	22nd May, 2014
Dr. Rakesh Kumar, Sr. Sci.	National Seminar on "Organic Agriculture-Challenges & Prospects" at Palampur.	28th – 29th May, 2014
Dr. A. K. Singh, PS	Global Conference on "Technological Challenges and Human Resources for Climate Smart Horticulture" at Navsari Agriculture University, Navsari.	29th – 31st May, 2014
Dr. C. Bhakat, PS	National Seminar on "Extension and Technological Innovation for Strengthening Small Holder Dairy Farming" held at Directorate of Dairy Development, Department of AH & Fisheries, Ranchi, Jharkhand.	1st -2nd June, 2014
Dr. A. K. Singh, PS	National Seminar on "Nutraceutical Attributes of Soy Milk: A Step Towards Healthy Life" organized by Chhattisgarh Industrial & Technical Consultancy Centre, Raipur and Indian Dietetic Association, Chhattisgarh at Raipur.	8th June, 2014
Dr. A. K. Singh, PS	"2nd UP Agricultural Science Congress" organized by UPCAR at IIAR, Lucknow.	14th -16th June, 2014
Dr. S. K. Singla, PS	National Symposium on "Bihar A Future Milk Source" at Patna.	23rd - 24th June, 2014
Dr. Bimlesh Mann, Head Dr. A. K. Chakravarty, Head Dr. Sumit Arora, PS Dr. Naresh Kumar, PS	Seminar on "Giving Impetus to Dairy Industry in Northern States of India" organized by CII at Hotel Lemon Tree, Gurgaon.	24th June, 2014
Dr. A. K. Singh, PS	Human Resource Conclave on "How to Attract, Retain and Manage Talent?" organized by CLAFMA of India at Pune.	4th July, 2014

Dr. A. K. Chakravarty, Head	First meeting of the "State Level Executive Committee of National Livestock Mission", Govt. of Haryana, Chandigarh.	28th July, 2014
Dr. D. K. Gosain, Head	"Meeting with Farmers" at Pune & Zonal Workshop of KVK at Mumbai.	2, 3, 5 to 8th & 9th August, 2014
Dr. Meena Malik, Associate Prof.	9th International and 49th Annual ELTAI Conference on "English from Classes to Masses" held at Vivekanand Global University, Jaipur.	21st – 23rd August, 2014
Dr. S. Subash, PS	"International Agri-business Congress 2014" held Tech India 2014, at BIEC, Bengaluru.	23rd - 24th August, 2014
Dr. Suimit Arora, PS Dr. Rajesh Bajaj, PS Dr. Rajan Sharma, PS Dr. Surjit Mandal, Sci.	"Review Meeting of MFPI Project" at IIS-Pune.	28th August, 2014
Dr. A. K. Chakravarty, Head	"Indo-Dutch JWG Meeting on Agriculture" held at Krishi Bhavan, New Delhi.	2nd September, 2014
Dr. B.C. Ghosh, PS	Humboldt Kolleg on "Interdisciplinary Science: Catalyst for Sustainable Progress" at Indian Institute of Science, Bengaluru.	4th – 6th September, 2014
Mr. Diwas Pradhan, Sci.	"CII Conference" at Hotel Lemon Tree, Gurgaon.	5th September, 2014
Dr. Sumit Arora, PS Ms. Richa Singh, Sci. Ms. Priyanka Singh Rao, Sci.	CII Conference on "Dairy Vision 2025: Opportunities and the Way Forward" at New Delhi.	5th September, 2014
Dr. Magan Singh, Sr. Sci. Dr. K. S. Kadian, PS Dr. Asif Mohammad, Sci.	Seminar on "Congress Grass (Parthenium): A Scourge to Ecosystem: Awareness and Management" at CSSRI, Karnal. Sponsored by CSSRI & Monsanto Pvt. Ltd.	6th September, 2014
Dr. K. P. Ramesha, PS	Conference on "Applying NG: Basic Research, Agriculture & Healthcare" organized by Genotypic Technology Pvt. Ltd. at Bengaluru.	11th September, 2014
Dr. Kaushik Khamrui, Sr. Sci.	"11th National Dairy Product Judging Contest & 7th Dairy & Food Quiz for UG/PG Students" at Anand Agriculture University, Anand (Gujarat).	11th -12th September 2014
Dr. N. Anand Laxmi, PS Dr. Ashok Santra, PS Dr. Sunil Kumar Onteru, Sr. Sci.	2nd International Conference on "Animal and Dairy Science" at Hyderabad.	15th -17th September, 2014
Dr. Ravinder Malhotra, PS	"First Meeting of the Technical Committee of 20th Livestock Census" held at Krishi Bhawan, New Delhi under the aegis of Department of Animal Husbandry, Dairying & Fisheries (AHS Division), Ministry of Agriculture Government of India.	18th September, 2014
Dr. A. K. Tyagi, PS	National Symposium on "From Food to Nutrition" at CLFMA at Cochin.	18th- 19th September, 2014
Dr. H. R. Meena, Sr. Sci.	An International Seminar on "HETIS-2014" at Punjab University, Chandigarh.	19th- 20th September, 2014
Dr. S. K. Kanawajia, PS	Interface Meeting on "Improvement of Yak Husbandry and Upliftment of Socio-economic Status of Yak in the Country" at Jammu and Kashmir.	22nd-24th September, 2014
Dr. P. N. Barnwal, Sr. Sci.	30th National Convention of Mechanical Engineers and National Seminar on "Green Technology in Power Sector", organized by Institution of Engineers (India), UP State Centre, Lucknow, at MED, Madan Mohan Malaviya University of Technology, Gorakhpur.	27th-28th September, 2014
Dr. G. R. Patil, Joint Director (A) Dr. R. K. Malik, Joint Director (Res.) Dr. Latha Sabikhi, Head Dr. A. K. Singh, PS Dr. Sumit Arora, PS	National Seminar on "Functional Dairy Food" organized by SMS College of Dairy Science, Anand Agriculture University, Anand in collaboration with National Academy of Dairy Sciences (NADSI) at AAU, Anand.	11th October, 2014

Dr. Y. S. Rajput, Head	An International Conference on "Nanocon" at Bharti Vidyapeeth Deemed University, Pune.	14th -15th October, 2014
Dr. M. Manjunatha, PS Dr. A. K. Singh, PS Dr. R. R. B. Singh, PS Mr. S. Arora, PS Mr. A. Wadehra, Sci.	An International Conference on "Advances in Food Technology & Health Sciences (ICAFTHS-2014)" conducted by the International Institute of Food & Nutrition (IIFANS), New Delhi.	15th -16th October, 2014
Dr. Mukund A. Kataktalware, PS	An International Conference on "Physiology & Medicine" organized by Department of Zoology, Periyar University, Salem, Tamil Nadu at Salem, Tamil Nadu.	15th-17th October, 2014
Dr. S. Kulkarni, Head Dr. B. Surendra Nath, PS Dr. B. C. Ghosh, PS Dr. B. V. Balasubramanyam, PS Dr. P. K. Dixit, PS Dr. M. C. A. Devi, PS Dr. S. Jeyakumar, PS Dr. P .Heartwin, PS Dr. M. Sivaram, PS Dr. Menon Rekha Ravindra, PS Dr. S. Subash, PS Dr. A. Manimaran, Sci. Mr. Chitranayak, PS	Emerging Statutory & Regulatory Issues for Food Industry organised on the occasion of "World Food Day" NDRI, Bengaluru & AFSTI – Bengaluru.	16th October, 2014
Dr. Rakesh Kumar, Sr. Sci.	An International Symposium on "New Dimensions in Agro meteorology for Sustainable Agriculture" at GBPUA&T, Pantnagar.	16th - 18th October, 2014
Dr. R. K. Malik, Joint Director (Res.)	"Dairy Bij India 2014 and International Conference and Exposition on Dairy Technology" at Hyderabad.	17th October, 2014
Sh. R. S. Gautam, Deputy Director (OL)	"Northern Region Rajbhasha Conference" at Lucknow.	19th October, 2014
Dr. A. K. Chakravarty, Head Dr. A. K. Gupta, PS Dr. I. D. Gupta, PS	ICAR- NAVS Expert Consultation Meet on "Strategies for Enhancing Milk Productivity of Indigenous Cattle" held at NASC complex, New Delhi.	20th October, 2014
Dr. Naresh Kumar, PS	"Scientist - Dairy Industry Partner Interface" at ERS, NDRI, Kalyani.	26th – 28th October, 2014
Dr. L. Sabikhi, Head Dr. S. K. Kanawjia, PS Dr. A. K. Singh, PS Dr. Rajan Sharma, PS	Innovative Dairy Products for Commercialization – an Eastern India Perspective. Dairy Industry Meet and Brain-storming Session (Dairy Industry Development in Eastern India and role of NDRI) at ERS, Kalayani.	27th October, 2014
Dr. Archana Verma, PS	An International Conference on "Challenges and Opportunities in Animal Health" at the Face of Globalization and Climate Change" at DUVASU, Mathura (Uttar Pradesh).	30th October – 1st November, 2014
Dr. Bimlesh Mann, Head	National seminar on "Emerging Problems in Potatoes" at CPRI, Shimla.	1st – 2nd November, 2014
Dr. Sunita Grover, Head Dr. Bimlesh Mann, Head Dr. A. K. Puniya, PS Dr. Vivek Sharma, PS Dr. Rajan Sharma, PS Dr. Rajesh Kumar, PS Dr. Shilpa Vij, PS Dr. Chand Ram, Sr. Sci. Dr. Surajit Mandal, Sci. Ms. Rashmi H. M., Sci. Mr. Diwas Pradhan, Sci.	2nd Probiotic Association of India Annual Conference & International Symposium on "Probiotic & Microbiome: Gut and Beyond" at New Delhi.	3rd - 4th November, 2014

Sh. Sandeep Deswal, STO	"An Annual Training Camp for NCC Cadets" at Police Commando Complex, Neval, Karnal	3rd - 12th November, 2014
Dr. M. Karunakaran, Sr. Sci. Dr. S. Garai, Sci.	An International Seminar on "Integrating Agriculture and Allied Research: Prioritizing Future Potentials for Secure Livelihood", organized at Centre for Human Resource Development, BCKV, Kalyani.	6th - 9th November, 2014
Mr. Diwas Pradhan, Sci.	IAUA Convention, New Delhi.	7th - 9th November, 2014
Dr. M. Karunakaran, Sr. Sci.	"Livestock Development Programme" organized at Netaji Subhas Regional Institute of Cooperative Management, Kalyani, West Bengal.	7th November, 2014
Dr. G. R. Patil, Joint Director (A) Dr. R. K. Malik, Joint Director (Res.) Dr. R. C. Upadhyay, Head Dr. Sunita Grover, Head Dr. A. K. Puniya, PS Dr. J. P. Sehgal, PS Dr. K. K. Datta, PS Dr. S. S. Thakur, PS Dr. Sohan Vir Singh, PS Dr. Magan Singh, Sr. Sci. Dr. Rubina Kumari Baithalu, Sci.	IAUA Convention, New Delhi.	8th November, 2014
Dr. B. S. Meena, Sr. Sci.	"7th National Extension Education Congress (NEEC)" at NEH Region, Umaim, Meghalaya.	8th -11th November, 2014
Dr. T. K. Dutta, Head Dr. M. K. Ghosh, PS Dr. A. Santra, PS Dr. Anupam Chatterjee, Sr. Sci. Dr. S. Gorai, Sci.	National Symposium on "Climate Resilient Forage Production and its Utilization" held at BCKV, Kalyani, West Bengal.	13th -14th November, 2014
Dr. S. K. Jha, PS	National Seminar on "Re-orientation of Agricultural Education" organized at Bihar Agricultural University, Sabour, Bhagalpur, Bihar.	14th -15th November, 2014
Dr. K. P. Ramesha, PS	Conference on "Next Gen Genomics & Bioinformatics Technologies (NGBT)" organized by NIMHANS, Bengaluru.	17th - 19th November, 2014
Dr. Magan Singh, Sr. Sci. Dr. Rubina Kumari Baithalu, Sci.	National Symposium on "Agricultural Diversification for Sustainable Livelihood and Environmental Security" organized by Indian Society of Agronomy, Indian Council of Agricultural Research, New Delhi & Punjab Agricultural University, Ludhiana at PAU, Ludhiana.	18th - 20th November, 2014
Dr. K. Ponnusamy. Head	22nd AERA Annual Conference on "Leveraging Institutional Innovation for Agril. Development" at University of Agricultural Science, Raichur, Karnataka.	18th - 20th November, 2014
Sh. Ram Shankar Gautam, Deputy Director (OL)	"Ek Divsiya Shatriya Rajbhasha Pursakar Samalen" at Aligarh	19th November, 2014
Dr. T. K. Mohanty, PS	National Conference on "Alternatives…Experimentation" at New Delhi.	20th - 21st November, 2014
Dr. Mukund A. Kataktalware, PS	An International Conference on "Impact of Climate Change on Livestock Productivity and Health" organized by National Dairy Development Board, Anand and National Dairy Research Institute, Karnal at NDRI, Karnal.	21st-22nd November, 2014
Dr. Mukund A. Kataktalware, PS Dr. M. Mandal, PS Dr. Mahendra Singh, PS Dr. Pawan Singh, PS Dr. S. K. Singla, PS Dr. Ashwani Kumar Roy, Sr. Sci.	National Symposium on "Physiological Determinants of Climate Resilient and Sustainable Milk Production" organized by Society of Animal Physiologists of India in collaboration with ICAR-CIRB, Hisar at CIRB, Hisar.	27th-28th November, 2014
Dr. T. K. Mohanty, PS Dr. Ajoy Mandal, Sr. Sci Dr. M. Karunakaran, Sr. Sci. Dr. Rubina Kumari Baithalu, Sci.	An International Symposium on "Current Challenges and Translational Research to Augment Animal Reproduction" organized at Madras Veterinary College, Vepery, Chennai.	4th - 5th December, 2014

Sh. R. S. Gautam, Deputy Director (OL)	Seminar on "National Agriculture Scientists" at R.V.S.A.& Technology University, Gwalior.	5th - 7th December, 2014
Dr. Pradip V. Behare, Sci.	"PSI Conference" at IIT, Mumbai.	5th – 10th December, 2014
Dr. Sumit Arora, PS	Conference on "Agriculture & Food Processing" at Agrovision, Reshimbagh Ground, Nagpur.	6th December, 2014
Dr. M.A. Kataktalware, PS Dr. S. Jeyakumar, PS	"International Proteomics Conference cum Workshop" at IIT Bombay.	6th -11th December, 2014
Dr. A. K. Mohanty, PS Dr. Sudershan Kumar, Sci.	"An Annual Meeting and International Conference" at IIT Mumbai.	7th -9th December, 2014
Dr. Bimlesh Mann, Head Dr. Rajan Sharma, PS Dr. Naresh Kumar, PS	An International Conference on "Infrastructure Needs for a Food Control System: Roadmap for Regional Harmonization" at Hotel Royal Plaza, New Delhi.	9th - 10th December, 2014
Dr. R. Senthil Kumar, Sci.	National Seminar on "Extension Management Strategies for Sustainable Agriculture; Challenges and Opportunities (EMASSA-2014)" at TNAU, Madurai.	12th - 13th December, 2014
Dr. T. K. Mohanty, PS Dr. A. K. Singh, PS	"Golden Jubilee Celebration Programme" at ERS NDRI Kalyani.	13th December, 2014
Dr. Bimlesh Mann, Head	23rd Indian Convention on "Food Scientists and Technologists" at NIFTEM Campus, Kundli, Haryana.	13th - 14th December, 2014
Dr. Sunil Kumar Onteru, Sr. Sci.	International Conference on "Molecular Signaling Recent Trends" at IIT Roorkee.	17th - 19th December, 2014
Dr. K. K. Datta, PS Dr. D.K. Jain, PS	74th Annual Conference of "Indian Society of Agricultural Economics" at Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.	18th - 20th December, 2014
Dr. A. K. Dodeja, PS	National Seminar on "Mechanization of Indigenous Dairy Products" at Tirupati.	27th December, 2014
Dr. Archana Verma, PS	102nd Indian Science Congress on "Science & Technology for Human Development" at University of Mumbai, Mumbai (Maharashtra).	3rd - 7th January, 2015
Dr. Nitin Tyagi, PS Dr. Goutam Mondal, Sr. Sci. Dr. M. Mondal, Sr. Sci. Dr. M. Karunakaran, Sr. Sci.	IX Biennial ANA Conference on "Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood" at AAU, Guwahati.	22nd - 24th January, 2015

Shri. T. Nanda Kumar, Chairman, NDDB, Anand inaugurating the National Seminar

Dr. S. Kulkarni, Head Dr. B. Surendra Nath, PS Dr. B. C. Ghosh, PS Dr. B. V. Balasubramanyam, PS Dr. P. K. Dixit, PS Dr. K. P. Ramesha, PS Dr. P. Heartwin, PS Dr. M. A. Kataktalware, PS Mr. Chitranayak, PS Dr. M. Manjunatha, PS Dr. S. Subash, PS Dr. S. Jeyakumar, PS Dr. M. C. A. Devi, PS Dr. Menon Rekha Ravindra, PS Dr. A. Manimaran, Sr. Sci. Mrs. T. R. Thivija Kumari, STO Mrs. K. Geetha Kumari, STO	National Seminar on "Present Status and Future Prospects of Sexed Semen in India" organized by Alumni Association, SRS-NDRI, Bengaluru and KMF, Bengaluru at Bengaluru.	24th January, 2015
Dr. Mohan Mondal, Sr. Sci.	International Seminar on "Prioritizing Integrating Agriculture and Allied Research: Future Potentials for Secure Livelihoods" at FTC Lake Hall, Kalyani, BCKV Campus.	3th - 6th February, 2015
Dr. Menon Rekha Ravindra, PS Smt. F. Magdaline Emarald Eljeeva , PS	"Safety of Foods of Animal Origin for Domestic and Export Markets: Legal Perspectives (IAVPHS-2015)" organized by IAVPHS in collaboration with the Karnataka Veterinary, Animal and Fisheries Sciences University (KVAFSU), Bidar and Commonwealth Veterinary Association (CVA) at Veterinary College, Bengaluru.	10th - 12th February, 2015
Dr. (Mrs) Shilpa Vij, PS	"South Asian Biotechnology Conference 2015" at New Delhi.	12th - 14th February, 2015
Dr. K. P. Ramesha, PS	International Symposium on "Sustainable Management of Animal Genetic Resources for Livelihood Security in Developing Countries & XII Annual Convention of Society for Conservation of Domestic Animal Biodiversity (SOCDAB)" at Madras Veterinary College, TANUVASU, Chennai.	13th -14th February, 2015
Dr. J. K. Kaushik, PS	National Symposium on "Biophysics…… Society" at Jamia Millia Islamia, New Delhi.	15th -17th February, 2015
Dr. Dheer Singh, PS	International Conference on "Reproductive Health (NIIRH)" at NIIRH, Mumbai.	15th -17th February, 2015
Dr. S. Kulkarni Head Dr. L. Sabikhi, Head Dr. Bimlesh Mann, Head Dr. I. K. Sawhney, Head Dr. T. K. Dutta, Head Dr. S. K. Kanawjia, PS Dr. Madhu Mohini, PS Dr. K. P. Ramesha, PS Dr. M. K. Ghosh, PS Dr. Subrata K Das, PS Dr. A. Santra, PS Dr. C. Bhakat, PS Dr. A. Mandal, Sr. Sci. Dr. A. Chatterjee, Sr. Sci. Dr. M. Mondal, Sr. Sci. Dr. M. Karunakaran, Sr. Sci. Dr. S. K. Dass, Sr. Sci. Mr. Yogesh Khetra, Sci. Mr. P. Saha, ACTO Dr. Surinder Gupta, CTO	43rd Dairy Industry Conference, Indian Dairy Association (East Zone) held at Science City, Salt Lake, Kolkata.	19th – 21st February, 2015

Dr. A. K. Singh, PS	Kisan Goshthi and "Regional Agriculture Fair for Eastern Plains" organized by Central Potato Research Institute, Shimla.	19th – 21st February, 2015
Mr. Devaraja, H.C., Sci. Sh. Hari Ram Gupta, CTO	Bilingual International Conference on "Information Technology: Yesterday, Today, and Tomorrow" at New Delhi.	19th – 21st February, 2015
Dr. P. N. Barnwal, Sr. Sci. Er. P.S. Minz, Sci.	3rd International Conference on "Impacting Food Value Chain and Leveraging Innovation" at NIFTEM, Kundli, Sonipat, Haryana, India.	26th - 28th February, 2015
Dr. Sunita Grover, Head Dr. S. K. Tomar, PS Ms. Rashmi H.M., Sci. Mr. Diwas Pradhan, Sci.	Probiotic Seminar "Probiotics – from Bench to Community" at Delhi organized by YIMPSE.	7th - 8th March, 2015
Dr. D. Malakar, PS Dr. M. K. Singh, Sr. Sci.	International Congress on "Embryo Implantation and Pregnancy" at NII, New Delhi.	9th - 11th March, 2015
Mr. Raghu H.V., Sci.	Indo-US Symposium on "Recent Trends in Nano-biotechnology" at Haldi, U.S. Nagar, Uttranchal.	10th March, 2015
Dr. Dheer Singh, PS	National Symposium on "Animals in Research & Testing: A cross talk between…. NSART 2015" at CDRI, Lucknow.	13th -14th March, 2015
Dr. Archana Verma, PS	National Conference on "Biodiversity and Bioresource Utilization" at Saurashtra University, Rajkot (Gujarat).	17th -18th March, 2015
Dr. Sunita Grover, Head	2nd and Final PRC Meeting for the project at M/s. Tropilite Foods Pvt.Ltd. Gwalior.	25th March, 2015

Professor Kaptan Singh Solanki, Hon'ble Governor, Haryana releasing 12th ASC Souvenir during inaugural session at NDRI

12 CONFERENCES/SEMINARS/SYMPOSIA/ WORKSHOPS/TRAINING PROGRAMMES/FIELD DAYS 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:

Elsevier Author Workshop	May 6, 2014
National Symposium on "Food Borne Zonosis"	May 26, 2014
Dairy Seminar on "Dairy Business 2020" for Progressive Dairy Farmers of North India	June 2, 2014
National level training on "Extension Management for Livestock Development" organized by MANAGE	July 2-5, 2014
CAFT Course on "Advances in Technology, Quality and Safety of Functional Dairy Foods"	July 8-28, 2014
Training on "Basic Aspects of Milk Processing" for the employees of Nestle India Ltd	July 15-19, 2014
Entrepreneurship Development Programme on "Milk and Milk Products Processing"	July 21-26, 2014
National training on 'Stem Cell Biology'	August 5-25, 2014
Training on "Breeding Soundness Examination and Andrological Examination of Bull" for VO and QCO of semen station.	August 18-30, 2014
National Summer School on "Engineering Interventions in Processing and Value Addition of Milk and Milk Products"	September 3-23, 2014
9th Convention of Indian Dairy Engineers Association and National Seminar on "Engineering Interventions in Procession and Value Addition of Milk and Milk Products"	September 8-9, 2014
National Seminar on "Dairy Sector: The Key Player for Nutritional Security in India"	September 19-20, 2014
All India Dairy Husbandry Officers Workshop on "Opportunities and Challenges in Dairying for Small Farmers"	September 24-25, 2014
Progressive Farmers Meet	October 7, 2014
Scientists-Dairy Industry Partners Interface Meet on "Development of Dairying Industry in Eastern India" at ERS	October 27, 2014
Brain Storming Session on "Breeding Policy for the Dairy Herd" maintained at ERS	October 28, 2014
Winter School on Whole Genome Analysis and Functional Technologies for Future Designer Milk Food"	October 28 – November 17, 2014
Model Training Course on "Good Dairy Farming Practices"	October 29 – November 5, 2014
International Symposium on "Probiotics and Microbiome : Gut and Beyond"	November 3-4, 2014
Training on Laboratory Techniques for Frozen Semen Lab for Lab Technicians	November 10-15, 2014
Training of Laboratory Techniques for Evaluation and Quality Control of Frozen Semen for In-charge/General Manager of Semen Station	November 17-22, 2014
International Conference on "Impact of Climate Change of Livestock Production and Health"	November 21-22, 2014
International Workshop on "Probiotics in India: Way Forward" under DST (India)-MBIE (New Zealand) Research Project	December 9, 2014

Dr. Jimmy Smith, Director General, ILRI, Nairobi, Kenya delivering plenary lecture on livestock, livelihoods and the future of small holder farmers during 12th ASC at NDRI

Dr. Sanjay Rajaram delivering plenary lecture on emerging technology options for ensuring food, nutrition and energy security during 12th ASC at NDRI

National training programme on "Stem Cell Technology in Farm Animals"	December 9-29, 2014.
Golden Jubilee Celebration Meet on " Dairying in Eastern India : Opportunities and Challenges" at ERS	December 13-14, 2014
Training on Breeding Soundness Examination and Andrological Examination of Bull" for VO and QCO of semen station.	January 12-24, 2015
Brain Storming/ Workshop on "Talent Search in Agriculture" of ASRB, New Delhi	January 16-17, 2015
Seminar on "Sexed of Semen" at SRS	January 24, 2015
12th Agricultural Science Congress	February 3-6, 2015
Training programme on "Artificial Insemination and Scientific Goat Rearing Practices" at ERS	February 23 – March 1, 2015
National Science Day	February 28, 2015
Training programme on "Advance of Tools for Analysis of Phenomic and Genomic Data"	March 5-25, 2015
National Workshop on "Immunophysiology Role of Immune Cells and Cytokine in Immunity	March 23-24, 2015
National workshop on 'Proteomics and Structural Bioinformatics'	March 23-25, 2015

Specific Day(s) Celebrated

World Veterinary Day	May 2, 2014
World Milk Day at ERS Kalyani	June 2, 2014
World Food Day	October 16, 2014
National Milk Day	November 26, 2014
NDRI-Dairy Industry Interface Meeting	December 1, 2014
Senior Citizen Meet	December 9, 2014
National Science Day	February 28, 2015

National Dairy Mela Organized

Dairy Mela at ERS Kalyani	December 11, 2014
National Dairy Mela at NDRI, Karnal	February 25-27, 2014

Rajbhasha Samaroh Organized

Rajbhasha Samaroh and Post Pradarshan Pratiyogita for all offices of Govt. of India located at Karnal	September 15, 2014

Youth Festival and Inter-Zonal Sports Organized

19th All India Inter University Festival - Reverie Renaissance.	April 24 - 26, 2014
ICAR Inter-Zonal Sports Tournament	March 11-14, 2015
15th Inter-Agricultural University Youth Festival	March 18-21, 2015

Sh. D.V. Suresh Kumar, General Manager, State Bank of Patiala, Chandigarh inaugurating "National Dairy Mela" at NDRI

13 DISTINGUISHED VISITORS

16.04.2014 Ms. Winifred Perkins and Mr. Derek Quirke Meet and Livestock, Australia

28.06.2014 Scientists from IBERS, Aberystwyth University, United Kingdom:

Dr. Joseph Gallagher, Head of Bioconversion and Biorefining Group

Dr. Sreenivas Rao Ravella

Dr. David Neil Bryant

Dr. A. Maurice Bosch

14.07.2014 Eight member delegation from Tanzania, the Ministry of Agriculture Food Security and Cooperatives.

16.10.2014 Two member delegation from Sri Lanka Poultry Development Company.

Mr. H.L.T. Sera, Secretary of Ministry of Livestock Development, Sri Lanka.

Mr. Mohamed Cader, Chairman

14.11.2014 Prof. Richard Ipson alongwtih two other senior faculty members/HOD's from University of Copenhagen, Denmark.

03.01.2015 Air Marshal S. Sukumar.

15.01.2015 Thirty-three member delegation from University of Nebraska Lincoln, Nebraska, USA.

16.01.2015 Thirteen member delegation from Wyoming Leadership Education and Development Program (L.E.A.D.), USA.

28.30.2015 Six member delegation from Nepal.

14.03.2015 Sh. R. Rajagopal, Additional Secretary (DARE) & Secretary (ICAR).

30.03.2015 Fifteen member delegation from Afganistan, Bangladesh, Myanmar and Thailand under NDDB Dairy Asia Workshop.

Sh. R. Rajagopal Additional Secretary, ICAR interacting with Director and faculty of NDRI, Karnal during his visit

14 PERSONNEL

INSTITUTE STAFF

As on 31st March, 2015

General Administration

A. K. Srivastava, Ph.D.	Director
R. K. Malik, Ph.D.	Joint Director (Research & Academic)
G. R. Patil Ph.D.	Joint Director (Academic) (Upto 31st January, 2015)
J. K. Kewalramani, B.Sc., M.B.A.	Joint Director (Admn.) & Registrar
S. George, M.A., PGDLA	Comptroller
K. P.S. Gautam, M. Com, B.Ed.	Chief Administrative Officer
S. K. Kanawjia, Ph.D.	Academic Coordinator
I. K. Sawhney, M. Tech.	Controller of Exams
R. C. Meena, M. Com.	Sr. Admn. Officer
Ashok Mallick, B. Com.	Sr. Admn. Officer
Mithlesh Kumar, M.Sc., PGDCFA	Sr. Fin. & Account Officer
Ram Shankar, M.A., P.G.D.T.	Deputy Director (Off. Lang.)
Vishal Acharya, M.A.	Asstt. Fin. & Account Officer
A. G. Barapatre	Asstt. Admn. Officer
R. K. Bansal, M.A.	Asstt. Admn. Officer
Ram Niwas, B.A.	Asstt. Admn. Officer
Ishwar Diyal, B.A.	Asstt. Admn. Officer
S. S. Meena, B.A.	Asstt. Admn. Officer
N. K. Verma	Asstt. Admn. Officer
Rajbir, B.A.	Asstt. Admn. Officer
Braham Prakash, B.A.	Asstt. Admn. Officer
Mukesh Kumar Dua, B.A.	Asstt. Admn. Officer
Dharam Singh Meena, B.A.	Asstt. Admn. Officer
Nirmal Kumar Jain, B.A.	Asstt. Admn. Officer
S. Shashi Kala	Asstt. Admn. Officer (SRS, Bangalore)
S. Singh	Asstt. Admn. Officer (ERS, Kalyani)
Deepak Chopra, B.A.	Security Officer
Sunita Chaudhary	Private Secretary
Shukla Vermani, B.A.	Private Secretary
Prem Kumari, B.A.	Private Secretary
Parvesh Lata, B.A,	Private Secretary
Nirmala Kumari, B.A.	Private Secretary
Simita Roy, B.A.	Private Secretary (ERS, Kalyani)
Shukantla Rani, B.A.	Private Secretary
Ranjana, B.A.	Private Secretary

Scientists and Technical Officers

Dairy Cattle Breeding Division

A. K. Chakravarty, Ph.D.	Head
A. K. Gupta, Ph.D.	Principal Scientist
Archana Verma, Ph.D.	Principal Scientist
I. D. Gupta, Ph.D.	Principal Scientist
Avtar Singh, Ph.D.	Principal Scientist
Anupama Mukherjee, Ph.D.	Sr. Scientist
Om Vir Singh, Ph.D.	Chief Technical Officer
Vinod Kumar, B.Sc.	Sr. Technical Officer
Y. K. Panwar, M.A.	Technical Officer
Ashwani Kumar, M.Sc.	Technical Officer
Mool Chand	Technical Officer
Vikram	Technical Officer

Livestock Production and Management Section

Pawan Singh, Ph.D.	Principal Scientist & Incharge
P. S. Oberio, PS	Principal Scientist
R. K. Mehla, Ph.D.	Principal Scientist
T. K. Mohanty, Ph.D.	Principal Scientist
M. L. Kamboj, Ph.D.	Principal Scientist
S. S. Lathwal, Ph.D.	Principal Scientist
A. Kumaresan, Ph.D.	Sr. Scientist
Ramesh Chandra, Ph.D.	Sr. Scientist
Mukesh Bhakat, Ph.D.	Sr. Scientist
Nishant Kumar, M.Sc.	Scientist
Rubina Baithalu, M.Sc.	Scientist
Shiv Kumar, M.Sc.	Sr. Technical Officer

Dairy Cattle Nutrition Division

J. P. Sehgal, Ph.D.	Head
Neelam Kewalramani, Ph.D.	Principal Scientist
S. S. Kundu, Ph.D.	Principal Scientist
S. S. Thakur, Ph.D.	Principal Scientist
Madhu Mohini, Ph.D.	Principal Scientist
S. K. Tomar, Ph.D.	Principal Scientist
Veena Mani, Ph.D.	Principal Scientist
A. K. Tyagi, Ph.D.	Principal Scientist
Chander Datt, Ph.D.	Principal Scientist
Nitin Tyagi, Ph.D.	Sr. Scientist
Goutam Mondal, Ph.D.	Sr. Scientist
Sachin Kumar. Ph.D.	Scientist
Karan Singh, M.Sc.	Asstt. Chief Technical Officer
Gian Singh, M.Sc.	Sr. Technical Officer
Sumit Narayan, M.Sc.	Technical Officer

Dairy Cattle Physiology Division

R. C. Upadhayay, Ph. D.	Head (Upto 31st January, 2015)
O. K. Hooda, Ph.D.	Acting Head
Sujata Pandita, Ph.D.	Principal Scientist
Parveen Kumar, Ph.D.	Principal Scientist
Mahendra Singh, Ph.D.	Principal Scientist
Sohanvir Singh, Ph.D.	Principal Scientist
N. Anand Laxmi, Ph.D.	Principal Scientist
A. K. Dang, Ph.D.	Principal Scientist
Anjuli Aggarwal, Ph.D.	Principal Scientist
Manju Ashutosh, Ph.D.	Sr. Scientist
Ashutosh, Ph.D.	Sr. Scientist
Ashwani Kumar Roy, Ph.D.	Sr. Scientist
Y. P. Singh, B.Sc.	Technical Officer

Animal Biotechnology Centre

R. S. Manik, Ph.D.	Principal Scientist and In-charge
P. Palta, Ph.D.	Principal Scientist
S. K. Singla, Ph.D.	Principal Scientist
M. S. Chauhan, Ph.D.	Principal Scientist
T. K. Datta, Ph.D.	Principal Scientist
S. De, Ph.D.	Principal Scientist
J. K. Kaushik, Ph.D.	Principal Scientist
A. K. Mohanty, Ph.D.	Principal Scientist
D. Malakar, Ph.D.	Principal Scientist
Rakesh Kumar, Ph.D.	Sr. Scientist
M. K. Singh, Ph.D.	Scientist
S. Kumar, Ph.D.	Scientist

Animal Biochemistry Division

Y. S. Rajput, Ph.D.	Head (Upto 28th February, 2015)
S. K. Atreja, Ph.D.	Acting Head
R. K. Sharma, Ph.D.	Principal Scientist
Gautam Kaul, Ph.D.	Principal Scientist
Dheer Singh, Ph.D.	Principal Scientist
Rajeev Kapila, Ph.D.	Principal Scientist
Suman Kapila Ph.D.	Principal Scientist
S. K. Sood, Ph.D.	Sr. Scientist
Sunil Kumar Onteru, Ph.D.	Sr. Scientist
Ms. Suneeta Meena, M.Sc.	Scientist
Ravi Kant, M.Sc.	Sr. Technical Officer
Mr. Ved Parkash Kalra	Technical officer
Mr. Karm Singh B.A. L.LB.	Technical officer (Upto 31st Junary, 2015)

Dairy Technology Division

Vijay Kumar, Ph.D.	Acting Head (Upto 31st January, 2015)
Latha Sabikhi, Ph.D.	Head
S. K. Kanawjia, Ph.D.	Principal Scientist
A. K. Singh, Ph.D.	Sr. Scientist
Kaushik Khamrui, Ph.D.	Sr. Scientist
Narender Raju Panjagari, Ph.D.	Scientist
Prateek Sharma, M.Sc.	Scientist
Yogesh Khetra, M.Sc.	Scientist
Ganga Sahay Meena, M.Sc.	Scientist
Sathish Kumar, M. H., M.Sc.	Scientist
Devaraja, H.C., M.Sc.	Scientist
Lehri Singh, M.Sc.	Asstt. Chief Technical Officer

Experimental Dairy

A. K. Sharma, B.Sc.	Dairy Superintendent (Chief Technical Officer)
Hari Ram Gupta, M.Sc.	Chief Technical Officer
A. K. Kohli, Dip. (Mech. Engg.)	Asstt. Chief Technical Officer
Probir Mondal, B.Sc.	Sr. Technical Officer
Sanjeev Kumar, M.A.	Sr. Technical Officer
Subhash Chander, Dip. (Electrical)	Technical Officer
Prathvi Raj	Technical Officer

Dairy Chemistry Division

Bimlesh Mann, Ph.D.	Head
Darshan Lal, Ph.D.	Principal Scientist
Raman Seth, Ph.D.	Principal Scientist
Sumit Arora, Ph.D.	Principal Scientist
Vivek Sharma, Ph.D.	Principal Scientist
Rajan Sharma, Ph.D.	Principal Scientist
Rajesh Kumar, Ph.D.	Principal Scientist
Richa Singh , M.Sc	Scientist
Priyanka Singh Rao, M.Sc.	Scientist
K. P. Indumati, M.Sc.	Scientist
Luxmana Naik N., M.Sc.	Scientist
P. C. Singh, M.Sc.	Asstt. Chief Technical Officer

Dairy Microbiology Division

Sunita Grover, Ph.D.	Head
A. K. Puniya, Ph.D.	Principal Scientist
S. K. Tomar, Ph.D.	Principal Scientist
Naresh Kumar, Ph.D.	Principal Scientist
Shilpa Vij, Ph.D.	Principal Scientist
Chand Ram, Ph.D.	Principal Scientist
Surjit Mandal, Ph.D.	Scientist (SS)
Raghu H.V., M.Sc.	Scientist
P. V. Behare, Ph.D.	Scientist
Rashmi H. M., M.Tech.	Scientist
Diwas Pradhan, M.Tech.	Scientist

Dairy Engineering Division

I. K. Sawhney, M.Tech.	Head
A. K. Dodeja, Ph.D.	Principal Scientist
Bikram Kumar, M.Tech.	Principal Scientist
P. Barnwal	Sr. Scientist
P. S. Minz, M.Tech.	Scientist
Om Prakash, Diploma (Agri. Engg.)	Chief Technical Officer
S. K. Chaudhary, A.M.I.E.	Chief Technical Officer
Sunil Kumar, M.Sc.	Sr. Technical Officer
J. K. Dabas, M.Tech.	Sr. Technical Officer
Pawan Kumar	Technical Officer
Sh. Parveen Kumar	Technical Officer
Ms. Manju Bala, Astt. Diploma in Architect	Technical Officer

Dairy Economics, Statistics and Management Division

B. S. Chandel, Ph.D.	Head
K. K. Datta, Ph.D.	Principal Scientist
A. K. Chauhan, Ph.D.	Principal Scientist
Smita Sirohi, Ph.D.	Principal Scientist
Ravinder Malhotra, Ph.D.	Principal Scientist
Ajmer Singh	Principal Scientist
A. K. Sharma, Ph.D.	Principal Scientist
Uditya Chaudhary, M.Sc.	Scientist
Tara Chand, B.Sc.	Asstt. Chief Technical Officer

Dairy Extension Division

K. Ponnusamy, Ph.D.	Head
Jancy Gupta, Ph.D.	Principal Scientist
Khajan Singh, Ph.D.	Principal Scientist
K. S. Kadian, Ph.D.	Principal Scientist
S. K. Jha, Ph.D.	Principal Scientist
Gopal Sankhala, Ph.D.	Principal Scientist
B. S. Meena, Ph.D.	Sr. Scientist
H. R. Meena, Ph.D.	Sr. Scientist
Ritu Chakravarty, M.Sc.	Scientist (SG)
R. Senthil Kumar, Ph.D.	Scientist
Asif Mohammad, Ph.D.	Scientist
Parvinder Sharma, Ph.D.	Chief Technical Officer
Mridula Upadhayay, M.A.	Chief Technical Officer
Jai Bhawan Sharma, Dip. In (AH)	Technical Officer

Agricultural Technology Information Centre (ATIC)

P. S. Oberoi, Ph.D.	Principal Scientist & Incharge
Kumar Bharat, M.A.	Sr. Technical Officer
Pramod Kumar, M.Sc.	Sr. Technical Officer

Krishi Vigyan Kendra/Trainers' Training Centre

Dalip K. Gosain, Ph.D.	Progam Coordinator
Surender Gupta, Ph.D.	Chief Technical Officer
Satya Pal, M.V.Sc.	Asstt. Chief Technical Officer
Rajeshwar Dayal, B.Sc.	Asstt. Chief Technical Officer
Mohar Singh, M.Sc.	Asstt. Chief Technical Officer
Kulvir Singh, M. Sc.	Sr. Technical Officer
D. V. Sharma	Sr. Technical Officer
Deepa Kumari, B.Sc., M.A.	Technical Officer
Balraj	Technical Officer
Sudesh Ahuja	Technical Officer
Prem Singh	Technical Officer (31st January, 2015)

Forage Production Section

Ashutosh, Ph.D.	Sr. Scientist & Incharge
Satish Kumar, M.Sc. (Horti.)	Chief Technical Officer
Anil Kumar Dagar, M.Sc.	Sr. Technical Officer
Ravi Rawat, M.Sc. (Entomology)	Technical Officer
Sukhdev Singh	Technical Officer
Mahender Pal	Technical Officer

Forage Research and Management Section

Magan Singh, Ph.D.	Sr. Scientist
Rakesh Kumar, B. Sc. (Agri.)	Sr. Scientist
Uttam Kumar, Ph.D.	Chief Technical Officer
V. K. Meena	Sr. Technical Officer

Livestock Research Centre

S. S. Lathwal Ph.D.	Incharge
Ramesh Chandra, Ph.D.	Sr. Scientist
A. Kumaresan, Ph.D.	Sr. Scientist
Nishant Kumar, M.Sc.	Scientist
Rubina Kumari Bithalu, M.Sc.	Scientist
Chaman Lal, Dip. (Motor Mechanic)	Technical Officer
Rajbir	Technical Officer
Samar Singh	Technical Officer

Animal Health Complex

K.P.S. Tomar, M.V.Sc.	Chief Technical Officer
S. Raju, M.V.Sc	Asstt. Chief Technical Officer
Sahdev Singh, M.Sc.	Sr. Technical Officer

Artificial Breeding Research Centre

T. K. Mohanty, Ph.D.	Principal Scientist, Incharge
A. K. Gupta, Ph.D.	Principal Scientist
Mukesh Bhakat, Ph.D.	Sr. Scientist
J. K. Pundir, B.V.Sc.	Asstt. Chief Technical Officer
R. T. Bansode, M.Sc.	Asstt. Chief Technical Officer
Jintendra Rana, M.Sc.	Sr. Technical Officer
Subhash Chand, B.V.Sc.	Sr. Technical Officer
Amarpal Singh, M.Sc.	Technical Officer

University Office

G. R. Patil, Ph.D.	Joint Director (Academic) (Upto 31st January 2015)
S. K. Kanawjia, Ph.D.	Academic Coordinator
I. K. Sawhney, Ph.D.	Controller of Examinations
A. K. Tyagi, Ph.D.	Chief Hostel Warden
A. Kumaresan, Ph.D.	Hostel Warden
Rakesh Kumar, Ph.D.	Hostel Warden
Yogesh Kheta, M.Sc.	Hostel Warden
P. N. Raju, Ph.D.	Hostel Warden
Rubina Bathalu, Ph.D.	Hostel Warden
K. Singh, Ph.D.	Sports Coordinator
Latha Sabikhi, Ph.D.	I/c Placement Cell

Research Prioritization, Monitoring and Evaluation Cell

R. K. Malik, Ph.D.	Joint Director (Research)
Meena Malik, M.Phil., Ph.D.	Associate Prof. (English)
Braj Kishor, M.A., B.Lib Sci. & MSS	Sr. Technical Officer
Sunil Sharma, M.Sc. (Computer Science)	Technical Officer

Library Services

S. S. Thakur, Ph.D.	Incharge
B. P. Singh, M.A., M. Lib.& Info. Sci.	Sr. Technical Officer

Computer Centre

A. K. Sharma, Ph.D.	Incharge
Anirudha Kumar M.Sc., PGDCA	Chief Technical Officer
Gian Singh, M.Sc.	Assistant Chief Technical Officer
Naresh Kumar Dahiya, M.Tech.	Sr. Technical Officer
Jai Pal, BA, PGDCA	Technical Officer

Communication Centre

Gopal Sankhala, Ph.D.	Incharge
Dharambir, B.A.	Technical Officer
Ganpat Rai, ITI	Technical Officer

Vehicle Maintenance Section

R. K. Mittal, B. E. (Mechanical)	Incharge (Chief Technical Officer)
Ram Chander	Technical Officer

Official Language Unit

Ram Shankar Gautam, M.A. P.G.D.T.	Deputy Director (Off. Lang.)
Kanchan Choudhary, M.A.	Sr. Technical Officer

Security Section

Ashutosh, Ph.D.	Incharge
Deepak Chopra, B. A.	Technical Officer
Rajvir Singh, M.A., PGDCA	Security Supervisor

Maintenance Section

R. M. Chayal, Dip.Civil Engg.	Chief Technical Officer, Incharge
R. K. Bansal, B.E. (Civil)	Asstt. Chief Technical Officer
Pankaj Chawala, M.Tech. (Electrical)	Sr. Technical Officer
S. K. Saini, B. Tech. (Mechnical)	Technical Officer
Tek Chand (ITI Electrical)	Technical Officer
Raj Kumar (ITI Electrical)	Technical Officer
Sanjeev Kumar, B. Tech.	Technical Officer
Sohan Lal, M.A.(Eco.) (ITI Electrical)	Technical Officer
Khem Chand (ITI Electrical)	Technical Officer
Naresh Kanyana (ITI Electrical)	Technical Officer
Balbir Singh (ITI Electrical)	Technical Officer
Sarvan Kumar Munjal (ITI Electrical)	Technical Officer
M. P. Sharma (ITI Electrical)	Technical Officer
Arun Kumar (ITI Electrical)	Technical Officer

Hospitality Cell

Vinod Kumar	Technical Officer
R. S. Dhull	Technical Officer

Health Complex

Smita Sirohi, Ph.D.	Principal Scientist, Incharge
Rekha Sharma, M.B.B.S./DMCH	Chief Medical Officer
Manoj Kumar, M.B.B.S.	Chief Medical Officer
Richa Walia, Diploma Nursing	Technical Officer
Saroj Kathuria, Diploma Nursing & Mid Wifery	Technical Officer
Shish Pal Gupta	Technical Officer
Shashi Bhushan, D. Farma.	Technical Officer
Sarroj Bala, D. Farma.	Technical Officer

Estate Section

Sushil Kumar Kamboj, M.Sc.	Chief Technical Officer, Incharge
Prem Singh, M.A.	Sr. Technical Officer
P. M. Meena, M. Sc.	Sr. Technical Officer

Southern Regional Station, Bangalore

B. Surendra Nath, Ph.D.	Acting Head
Satish Kulkarni, Ph.D.	Head upto 24.02.2015
B. C. Ghosh, Ph.D.	Principal Scientist
B. V. Balasubramanyam, Ph.D.	Principal Scientist
P. K. Dixit, Ph.D.	Principal Scientist
K. P. Ramesha, Ph.D.	Principal Scientist
B. Srinivas, Ph.D.	Principal Scientist
K. Jayaraja Rao, Ph.D.	Principal Scientist
D. N. Das, Ph.D.	Principal Scientist
M. C. Arunmozhi Devi, Ph.D.	Sr. Scientist
P. Heartwin Amala Dhas, Ph.D.	Sr. Scientist
Rekha Ravindra Menon, M. Tech.	Sr. Scientist
Mukund Amritrao Kataktalware, Ph.D.	Sr. Scientist
Chitranayak, M.Tech	Sr. Scientist
M. Sivaram, Ph.D	Sr. Scientist
S. Jeyakumar, Ph.D	Sr. Scientist
F. Magdaline Eljeeva Emerald, ME (Agri.)	Scientist
S. Varalakshmi, M.V.Sc.	Scientist
S. Subhash, Ph.D.	Scientist
Manjunatha M., Ph.D.	Scientist
A. Manimaran, Ph.D.	Scientist
P. Murugananthan, M.Lib. Sci.	Chief Technical Officer
V.R.V. Surendranath Naik, M.D.	Chief Medical Officer
L. Krishna Murthy, M.Sc.	Chief Technical Officer
B. K. Rajeshekaraiah, B.Sc.	Asstt. Chief Technical Officer
Veeraju, B.E. (Civil)	Asstt. Chief Technical Officer
K. L. Sampath, B.Sc.	Sr. Technical Officer
R. Keshvamurthy, B.Sc.	Sr. Technical Officer
Gurunath Gouda Patil, B.Sc.	Sr. Technical Officer
Siddaramanna, Ph.D.	Sr. Technical Officer
T. R. Thivija Kumari, M.A.	Sr. Technical Officer
P. G. Satisha, B.V.Sc.	Sr. Technical Officer
K. P. Lakshminarayanappa DME (Mech.)	Technical Officer
Meganathan, Dip. (Elect. Engg.)	Technical Officer
M. S. Nagarajaiah, Dip. (Civil Engg.)	Technical Officer
K. Geetha Kumari, M.A.	Technical Officer
Janakshi, M.C.A.	Technical Officer
Sreekanta	Technical Officer
K. Ningaraju, M.V.Sc.	Technical Officer
Vimala, B.Sc.	Technical Officer

Eastern Regional Station, Kalyani

T. K. Datta, Ph.D.	Head
M. K. Ghosh, Ph.D.	Principal Scientist
S. K. Das, Ph.D.	Principal Scientist
A. Santra, Ph.D.	Principal Scientist
C. Bhakat, Ph.D.	Principal Scientist
Anupam Chatterjee, Ph.D.	Sr. Scientist
A. Mandal, Ph.D.	Sr. Scientist
D. Mandal, Ph.D.	Sr. Scientist
M. Mondal, Ph.D.	Sr. Scientist
M. Karunakaran, Ph.D.	Sr. Scientist
S. Garai, Ph.D.	Scientist
Alokesh Goswami, M.Sc.	Chief Technical Officer
Amitava Ghosh, M.V.Sc.	Chief Technical Officer
Somnath Dutta, M.V.Sc.	Asstt. Chief Technical Officer
Prabir Saha, M.Sc.	Asstt. Chief Technical Officer
M. L. Ghosh, M.Sc.	Sr. Technical Officer

PERSONALIA

Appointments/Joining

- Dr. R. K. Malik, Head, Dairy Microbiology Division appointed as Joint Director (Research) at NDRI, Karnal w.e.f. 26.08.2014.
- Dr. Latha Sabikhi, Principal Scientist appointed as Head, Dairy Technology Division at NDRI, Karnal w.e.f. 10.09.2014.
- Dr. A. K. Chakravarty, Principal Scientist appointed as Head, Dairy Cattle Breeding Division at NDRI, Karnal w.e.f. 11.09.2014.
- Dr. Laxamana Naik, Ms. Indumati K. P., Ms. Priyanka Singh Rao, Ms. Richa Singh joined as Scientist at Dairy Chemistry Division, NDRI, Karnal w.e.f. 08.04.2014.
- Dr. Diwas Pradhan joined as Scientist at Dairy Microbiology Division, NDRI, Karnal w.e.f. 08.04.2014.
- Sh. Sukhdev Singh, joined at ERS of NDRI, Kalyani as AAO w.e.f. 24.04.2014.
- Sh. K. P. S. Gautam, joined as Chief Admn. Officer at NDRI, Karnal w.e.f. 01.05.2014.
- Sh. Anil Kumar Aggarwal, joined as F&AO at NDRI, Karnal w.e.f. 17.06.2014.
- Dr. Pawan Singh, Principal Scientist appointed as Incharge, LPM w.e.f 02.09.2014.
- Dr. S. S. Lathwal, Senior Scientist appointed as Incharge, LRC w.e.f. 02.09.2014.
- Dr. I. K. Sawhney, Principal Scientist joined as Acting Head, Dairy Engineering Division at NDRI, Karnal w.e.f. 01.10. 2014.
- Dr. J. P. Sehgal, Principal Scientist joined as Acting Head, Dairy Cattle Nutrition Division at NDRI, Karnal w.e.f. 17.10. 2014.
- Dr. B. S. Chandel, Principal Scientist joined as Acting Head, Dairy Economics Statistics & Management Division at NDRI, Karnal w.e.f. 04.12. 2014.
- Dr. (Mrs.) Anupama Mukherjee, Sr. Scientist joined NDRI Karnal after her transfer from NRC-M, Jharnapani, Mediziphema, Nagaland on 19.12.2014.
- Dr. Ajmer Singh, Senior Scientist (Agricultural Economics) joined at NDRI, Karnal on 05.01.2015 after his transfer from Zonal Project Directorate, Zone-I, ICAR, PAU Campus, Ludhiana.
- Dr. Dilip Kumar Mandal, Senior Scientist (LPM) joined at ERS of NDRI, Kalyani on 21.01.2015 after his transfer from ICAR Project Directorate on Cattle, Grass Farm Road, Meerut.
- Dr. O. K. Hooda, Principal Scientist appointed as Acting Head, Dairy Cattle Physiology Division w.e.f. 01.02.2015.
- Mr. Vijendra Singh Meena, Sr. Technical Officer (SMS- Agronomy & Soil Science) joined at NDRI Karnal 09.02.2015 after transfer from CMFRI, Narakkal.
- Dr. Bimlesh Mann, Head, Dairy Chemistry Division appointed to act as Central Public Information Officer under RTI Act w.e.f. 19.02.2015.
- Dr. B. Surendra Nath, Principal Scientist appointed as Acting Head, SRS of NDRI, Bangalore w.e.f. 25.02.2015.
- Dr. S. K. Atreja, Principal Scientist appointed as Acting Head, Animal Biochemistry Division w.e.f. 01.03.2015.
- Dr. T. K. Mohanty, Principal Scientist appointed to act as Incharge, Animal Breeding Research Centre, w.e.f. 16.03.2015.

Promotions

- Dr. S. Jeyakumar, Senior Scientist, in the PB-4 Rs.37400-67400 granted RGP of Rs.9000/- w.e.f. 16.08.2012.
- Dr. Manjunath, Scientist promoted as Senior Scientist in the PB-III Rs.15600-39000 + RGP of Rs.7000/- w.e.f. 10.02.2013.
- Dr. M. A. Kataktalware, Scientist promoted as Senior Scientist in the PB-III Rs.15600-39000+ RGP of Rs.8000/- w.e.f. 26.02.2013.
- Dr. P. Heartwin Amaladhas, Senior Scientist, in the PB-4 Rs.37400-67400 granted RGP of Rs.9000/- w.e.f. 02.09.2013.
- Sh. R. Keshavamurthy, Technical Officer (F/FT) SRS of NDRI Bangalore promoted to the post of Sr. Technical Officer (F/FT) w.e.f. 13.01.2013.
- Sh. Gurunath Gouda Patil, Technical Officer (F/FT) SRS of NDRI Bangalore promoted to the post of Sr. Technical Officer (F/FT) w.e.f. 25.02.2013.
- Sh. Nihal Singh, Technical Officer (F/FT) Animal Breeding Research Centre promoted to the post of Sr. Technical Officer w.e.f. 28.08.2013.

- Sh. Mohinder Pal, Sr. Technical Assistant (W/S) Farm Section promoted to the post of Technical Officer (W/S) w.e.f. 23.09.2013.
- Sh. Sushil Kumar Kamboj, Chief Technical Officer (F/FT), I/c Estate Section granted one advance increment w.e.f. 09.10.2913.
- Sh. S. K. Chaudhary, Chief Technical Officer (W/S), Dairy Engineering Division granted one advance increment w.e.f. 01.11.2013.
- Sh. Om Parkash, Chief Technical Officer (W/S) Dairy Engineering Division granted one advance increment w.e.f. 20.12.2013.
- Sh. Sunil Kumar Sharma, Joint Director (Res.) Office, Sr. Technical Assistant (L/T) promoted to the post of Technical Officer (L/T) w.e.f. 01.01.2014.
- Sh. Sita Ram, Experimental Dairy, Sr. Technical Assistant (L/T) promoted to the post of Technical Officer (L/T) w.e.f. 01.01.2014.
- Sh. Mohar Singh, Sr. Technical Officer (F/FT) KVK promoted to the post of Assistant Chief Technical Officer w.e.f. 01.01.2014.
- Sh. Sumit Narayan, Sr. Technical Assistant (F/FT) Dairy Cattle Nutrition Division promoted to the post of Technical Officer (F/FT) w.e.f. 12.02.2014
- Sh. Ravi Rawat, Technical Officer (F/FT) Farm Section promoted to the post of Sr. Technical Officer w.e.f. 05.04.2014.
- Sh. Ashwani Kumar, Technical Officer (F/FT) Dairy Cattle Breeding Division promoted to the post of Sr. Technical Officer w.e.f. 08.04.2014
- Dr. Rakesh Kumar, Technical Officer (L/T) Dairy Cattle Breeding Division promoted to the post of Sr. Technical Officer w.e.f. 26.04.2014.
- Sh. P. G. Satish, Sr. Technical Officer (F/FT) SRS of NDRI Bangalore promoted to the post of Assistant Chief Technical Officer w.e.f. 22.06.2014.
- Sh. Rajbir, Sr. Technical Assistant (F/FT) LRC promoted to the post of Technical Officer (F/FT) w.e.f. 01.07.2014.
- Mrs. Geetha Kumari, Technical Officer (F/FT) SRS of NDRI, Bangalore promoted to the post of Sr. Technical Officer w.e.f. 01.07.2014.
- Sh. Karan Singh, Assistant Chief Technical Officer (L/T) Dairy Cattle Nutrition Division promoted to the post of Chief Technical Officer w.e.f. 01.07.2014.
- Sh. J. K. Dabas, Sr. Technical Officer (W/S) Dairy Engineering Division promoted to the post of Assistant Chief Technical Officer w.e.f. 07.07.2014.
- Sh. Gian Singh, Technical Officer (F/FT) Dairy Cattle Nutrition Division promoted to the post of Sr. Technical Officer w.e.f. 22.07.2014
- Sh. Amarpal Singh, Technical Officer (F/FT) Animal Breeding Research Centre promoted to the post of Sr. Technical Officer w.e.f. 27.07.2014.
- Sh. Somenath Dutta, Assistant Chief Technical Officer (F/FT) ERS of NDRI, Kalyani promoted to the post of Chief Technical Officer w.e.f. 23.08.2014.
- Sh. Bhagwan Dass, Assistant promoted as AAO at NDRI, Karnal w.e.f. 01.10.2014.

Retirement

- Sh. Sarwar, Chief Technical Officer (L/T), SRS of NDRI Bangalore retired from Council's service w.e.f. 29.03.2014.
- Sh. S. K. Kharb Assistant Chief Technical Officer (FFT), Dairy Technology Division retired from Council's service w.e.f. 30.4.2014
- Sh. B. R. Srinivasamurthy, Technical Officer (F/FT) SRS of NDRI Bangalore retired from Council's service w.e.f. 31.05.2014.
- Ms. Maridula Upadhayay, Chief Technical Officer (P&E), Dairy Extension Division retired from Council's service w.e.f. 30.06.2014.
- Sh. Ranbir Singh, Technical Officer (W/S), Maintenance Engineering Section retired from Council's service w.e.f. 30.06.2014.
- Ms. Saroj Kumari Mehta, Assistant Chief Technical Officer (FFT), Krishi Vigyan Kendra retired from Council's service w.e.f. 30.06.2014.
- Sh. Jai Bhagwan, Technical Officer (F/FT), Dairy Extension Division retired from Council's service w.e.f. 30.06.2014.
- Sh. M. Sreenath, Chief Technical Officer (F/FT) SRS of NDRI Bangalore retired from Council's service w.e.f. 30.06.2014.
- Shri. P. Aravindakshan, Assistant Chief Technical Officer (L/T), SRS of NDRI Bangalore retired from Council's service w.e.f. 31.07.2014.
- Dr. R. P. Singh, Chief Technical Officer (F/FT), Dairy Microbiology Division retired from Council's service w.e.f. 31.08.2014.
- Dr. Lotan Singh, Sr. Scientist (Dairy Economics) ERS of NDRI Kalyani retired from Council's service on 30.09.2014.

- Smt. Saroj Khurana, AAO, NDRI Karnal retired from Council's service on 30.09.2014.
- Shri. M. Najundaswamy, Chief Technical Officer (Library), SRS Bangalore retired from Council's service on 30.09.2014.
- Sh. S. K. Talwar, Assistant Chief Technical Officer (L/T) Communication Centre retired from Council's service on 30.09.2014.
- Mr. Dhanu Sherpa Technical Officer (F/FT), Hospitality Section retired from Council's service on 31.10.2014.
- Mr. Sarwan Kumar, Sr. Technical Officer (W/S), Maintenance Section retired from Council's service on 30.11.2014.
- Mrs. M. K. Vedavathi, Assistant Chief Technical Officer, SRS of NDRI Bangalore retired from Council's service on 30.11.2014.
- Mr. Ramesh Chand, Assistant Chief Technical Officer, (F/FT) Farm Section retired from Council's service on 31.12.2014.
- Mr. G. D. Joshi Chief Technical Officer (Photo), Communication Centre retired from Council's service on 31.12.2014.
- Dr. G. R. Patil, Joint Director (Academics) retired on superannuation from Council's Service on 31.01.2015.
- Dr. R. C. Upadhayay, Principal Scientist and Head Dairy Cattle Physiology retired on superannuation from Council's Service on 31.01.2015.
- Dr. Vijay Kumar, Principal Scientist retired on superannuation from Council's Service on 31.01.2015.
- Dr. C. N. Pagote, Principal Scientist, SRS of NDRI Bangalore retired on superannuation from Council's Service on 31.01.2015.
- Mr. A. Louis, Technical Officer (L/T), SRS of NDRI Bangalore retired on superannuation from Council's Service 31.01.2015.
- Mr. Prem Chand, Technical Officer, Krishi Vigyan Kendra retired on superannuation from Council's Service on 31.01.2015.
- Mr. Karam Singh, Technical Officer (L/T) Animal Biochemistry Division retired on superannuation from Council's Service on 31.01.2015.
- Dr. Y. S. Rajput, Principal Scientist and Head, Animal Biochemistry retired on superannuation from Council's Service on 28.02.2015.
- Mr. Lakhvinder Singh, Technical Officer (W/S) Maintenance Engineering Section retired on superannuation from Council's Service on 28.02.2015.
- Mr. Ram Chander, Technical Officer (W/S) retired on superannuation from Council's Service on 31.03.2015.

Transfer

- Mr. H. Yadav, Assistant Chief Technical Officer transferred to IVRI, Izatnagar and relieved on 12.06.2014.
- Dr. A. Manimaran, Scientist transferred from NDRI Karnal to SRS, Bangalore w.e.f. 13.06.2014.

Relieving

- Ms. Sarita Yadav, Admn. Officer relieved from Council's Services after giving technical resignation on 25.04.2014.
- Dr. Shiv Prasad Kimothi, Principal Scientist relieved from NDRI on his appointment to the post of Assistant Director General (Co-ordination), ICAR New Delhi on 28.08.2014.

Demise

- Mr. J. Nageshwara Rao, Senior Technical Officer (W/S) SRS of NDRI Bangalore passed away on 22.12.2014.

Shri Manohar Lal Khattar, Hon'ble Chief Minister of Haryana giving away Best Poster Presentation Award during concluding session of XIIth ASC at NDRI, Karnal

15 MAIN STATION

RESEARCH DIVISIONS

Dairy Cattle Breeding Division (DCB)

The Division has been actively involved in conducting research in the areas of animal genetics and breeding including cytogenetics, molecular genetics and biotechnology related to dairy animals. The main thrust areas of research are genetic improvement of HF Crossbred & Sahiwal cattle and Murrah buffaloes by progeny testing of breeding bulls and genomic selection of male and female animals for reproduction and reproduction performance, faster multiplication of superior germplasm, development of selection criteria and optimum breeding plans, identification of genetic markers and its association with production/reproduction traits, disease resistance and screening of young males for genetic disorders.

The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at Dairy Cattle Breeding Division during eighth plan continued its activities in imparting training to scientists/teachers from Research Institutes, State Agricultural/Veterinary Universities and Livestock Development Organizations in advanced areas of Animal Genetics and Breeding. A total of 31 National Training Programs have so far been organized under the aegis of CAFT (AG&B) in the Division.

Another important mandate of the Division is the development of skilled human resources in the field of Animal Genetics and Breeding. The Division also contributes in training programs of KVK/DTC and TBI (SINED), consultancy services to farmers and various organizations, supply of superior cattle and buffalo germplasm in the form of frozen semen and surplus breeding bulls to farmers, livestock developmental agencies, state governments and other dairy stake holders in the country.

Structuring of Research Labs/Cells/Sections/Units

The organizational structure for research consists of Animal Breeding Lab., Biometrical Genetics Lab., Sire Evaluation Lab., Molecular Genetics Lab., Livestock Genomic Analysis Lab., Livestock Record Cell and Artificial Breeding Research Complex. Besides this, breeding herds of cattle (Karan Fries, Karan Swiss, Sahiwal and Tharparkar) and Murrah buffaloes are also the integral part of the research component of Dairy Cattle Breeding Division. The Divisional Library has 427 books and 272 M.Sc./M.V.Sc. and 128 Ph.D. theses.

Livestock Production Management (LPM)

The Livestock Production and Management (LPM) Section came into being in June, 2009 after being disassociated from the Dairy Cattle Breeding Division. Earlier, a separate faculty of LPM was working alongwith the Dairy Cattle Breeding Division and post graduate and doctorate degrees were being awarded since the year 1976. Beside research, the faculty of LPM is engaged in teaching at both UG and PG levels and in research in the frontline areas of all applied aspects of dairy animal production and has been successful in evolving many transferable technologies and development of package of practice on the routine care and management of dairy animals. The LPM faculty is also shouldering the responsibility of the routine management of the cattle yard and breeding bulls maintained at the Artificial Breeding Research Center of the Institute, besides supporting the training and extension activities of the institute.

Animal Biotechnology Centre (ABTC)

Biotechnology was initiated at NDRI, Karnal during mid eighties under a UNDP 'Centre of Excellence on Biotechnology' program. The urgent need for application of recent biotechnological advances in reproduction and production to superior females of dairy breeds of ruminants for improving animal productivity in our country formed the basis for the establishment of a state-of-art Embryo Biotechnology Centre (EBC) by financial support from the Department of Biotechnology. Biotechnology was further strengthened by establishment of Livestock Genome Lab and Molecular Biology Unit under National Agricultural Research Project-II. Animal Biotechnology Centre was reorganized in June 1999 by consolidating all the infrastructure facilities created under various programs 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: to undertake biotechnology oriented basic and applied research programmes for improving animal productivity and for developing innovative dairy processes for producing superior quality, safe and wholesome dairy products; to train

manpower in application of Biotechnology in Dairy Production and Dairy Processing; and to organize Masters and Ph.D. programmes in Biotechnology for the NDRI Deemed University. A state-of-the-art biotechnology research facility 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.

Dairy Cattle Nutrition Division (DCN)

The Division undertakes basic and applied research, post-graduate programmes of education and participates in the process of extension education through various training programmes and field level technology development and refinement in the discipline of animal nutrition and forage production. The Division has a well-knit team of highly qualified and experienced scientists occupying different positions. The faculty members have been adequately trained in various priority areas and have visited advanced institutions of repute in European countries, Canada and United States of America to gain expertise and exposure in the respective aspects. The research laboratories are equipped with modern analytical instruments for chemical and physical analysis. The Division has developed excellent laboratory facilities, which are central facilities for research and education not only for the Institute but also for various sister organizations seeking such support from time to time. The central facilities include central fine instrumentation laboratory; laboratory for anaerobic rumen microbial work; laboratory for environment related studies including methanogenesis; quality control laboratory; feed processing unit; nutritional biotechnology laboratory. Some of the sophisticated instruments available include GC-mass spectrophotometer, atomic absorption spectrophotometer, gas-liquid chromatography, HPLC system, ^{15}N- Analyzer, methane analysis equipment using SF_6 technique, spectrophotometer, PCR machine etc. For the last few years precision nutrition and nutrient gene interaction studies are in full swing in the division to observe the study of a particular gene/ *loci* on nutrient utilization and *vice versa*.

Dairy Cattle Physiology Division (DCP)

The discipline of Animal Physiology functioned as a section of erstwhile Dairy Husbandry Division and subsequently of Dairy Cattle Nutrition Division till the end of the 6th Five Year Plan. In the year 1984, it received the status of an independent Division.

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

The notable salient achievements of the division are: higher magnitude of expression of HSPs 27, 90 and 105 genes in Karan Fries than Tharparkar Calves indicated lower heat tolerance of KF calves; zinc supplementation significantly decreased the expression of HSPs and interleukins concentration in cattle (Sahiwal and KF) indicated the role of Zn supplementation in reducing heat stress; thermal image analysis and significant difference in blood flow at different anatomical sites of the body indicated better thermal adaptability of indigenous than crossbred cattle; positive correlation between delayed neutrophil apoptosis, persistent staying of neutrophils at the site of infection along with formation of NETs is one of the strategies to fight against the pathogens in the udder during Staphylococcal mastitis; yeast culture supplementation significantly reduces the attainment of puberty in Murrah heifers and Prilled fat supplementation 35 days pre-partum to 95 days post-partum improved reproductive efficiency in KF cattle.

Animal Biochemistry Division (ABC)

The Division of Animal Biochemistry came into being in September 1984 with the merger of the discipline of Animal Biochemistry of Dairy Chemistry Division and the section of Human Nutrition and Dietetics. Research endeavors of the Division are presently directed towards development of probiotic and prebiotic foods; dairy nutraceuticals and their mechanism of action; validation of health benefit claims of Indian dairy products; nutrigenomics; characterization of buffalo fertility genes; sperm functions and cryopreservation of semen; spermatogonial stem cells research and bioinformatics in dairy processing and production.

The Division has instrument rooms with modern equipments viz. Alpha- and Beta- counters, Ultra-centrifuge, High speed centrifuges, Micro-centrifuges, UV-Visible spectrophotometers, Spectrofluorometer, PCR, Real Time PCR, ELISA Plate readers, High Pressure Liquid

Chromatography, Gas Liquid Chromatography, Inverted and fluorescent microscopes, Ice flaking machines, Freeze dryer, Gel documentation (Imaging) systems, ultra filtration unit, Ultra-low temperature freezers and Carbon dioxide incubators. Division has a cold room for carrying out research at low temperature. Cell culture facilities are also available in the Division.

The salient research achievements of the Division are: development of different types of Probiotic dahi and validation of their health-benefits in reducing serum cholesterol levels, protection against gastrointestinal cancer and management of diabetes in animal models; validation of nutraceutical attributes of dairy ghee in coronary heart diseases, gastro-intestinal and mammary cancer and improvement of immune system, and elucidation of its molecular mechanism; bioavailability of vitamins and minerals from dairy products; levels of conjugated linoleic acid in milk products; body slimming effect of conjugated linoleic acid and its mechanism; characterization and sequencing of milk lysozyme and its use for detection of sub-clinical mastitis; characterization of 8 amino acid transport systems in mammary gland and their induction at the onset of lactation; antiatherogenic properties of milk and its mechanism; hormonal profile of reproductive phases of buffalo; biochemical changes in sperm maturation, capacitation, acrosome reaction and semen freezing; signal transduction mechanism of sperm function; expression and hormonal regulation of fertility related ovarian genes in buffalo; SSCP analysis of CYP19 aromatase gene in anestrus buffaloes; transduction pathways (PI3K and MAPK) in cattle granulosa cells during steroidogenesis and apoptosis.

The contributions of the Division have been amply recognized by three Ahmed Kidwai Memorial Awards, two Jawahar Lal Nehru Awards, Dr. P. G. Nair Award, AAAP/CAPI Outstanding Research Award, Bio-Nutra Senior Award, two Sukumar Basu Memorial Awards, Young Scientist Award, IUIS/FIMSA Travel Bursary Award, K. K. Iya Award, Best Division Award (2014-15), Fellowship of National Academy of Agricultural Sciences (NAAS) Award, NRDC Meritorious Innovation Award, Chellappa Memorial Oration Award and several paper presentation awards.

The Division has laboratories for functional foods and therapeutics; Prebiotics and probiotics; Bioactive peptides and immunology; Bioinformatics; Molecular Endocrinology, Reproductive Biochemistry and Nanoscience. The Division manages Small Animal House that caters to the need of students and scientists for laboratory animals viz. rat, and mouse etc.

Dairy Chemistry Division (DC)

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; evaluating role of phospholipids in stability of dairy products; revealing chemistry of ghee and ghee residue flavour; antioxidant properties of ghee residue; chemical makeup and structural integrity of milk fat globule membrane; influence of various processing parameters on the major minerals and trace elements and their partitioning; rapid and simple methods for the determination of SNF in milk; formulation of quality standards of milk and milk products now prescribed by the Central Committee of Food Standards under the Ministry of Health as well as Bureau of Indian Standards; modification of Gerber test for simultaneous estimation of milk fat and availability of fat for detection of adulteration; simple tests for the detection of adulteration of milk and milk products; methods of manufacturing of butter and cheese colour from annatto seeds; preparation of rennet from fistulated calves and vegetable sources; structure and bacteriostatic role of lactoferrin; characterization and crystallization of buffalo lactoperoxidase; functional properties of WPC; renovation of rancid ghee and role of antioxidants in enhancing the shelf life of fat rich dairy products; effect of processing treatments on vitamins; status of pesticides and antibiotic residues in milk and milk products; methodologies for non-dairy whitener; low fat frozen dessert; calcium fortified milk; coconut filled Gouda cheese and low cholesterol ghee; a platform test for detection of detergent in milk; a colour based test to detect adulteration of milk with 2.5 to 10% soya milk; a multi-purpose device for dialysis and Buffer exchange and concentration.

Different analytical methods developed for testing of milk & milk products include: 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; an analytical protocol developed for the estimation of vitamin D2 in fortified toned milk and based on physico-chemical properties different methods assessed for detection of soybean oil and buffalo body fat in ghee. Antimicrobial peptides identified from skim milk by fermentation using selected proteolytic lactobacillus strains includingαS1-CN (24-34), β-CN (197-209), β-CN (199-209), β-CN (193-207). Buffalo αs-casein hydrolysates assessed for their antioxidant activity. Process for preparation of curcumin nano-emulsion optimized using milk proteins and assessed for antioxidant activity in animal model system.

The Division has state-of-the-art air conditioned Seminar room, Lecture room equipped with interactive board, LCD projectors, Visualiser, Podium etc., Quality control Lab, Undergraduate and Postgraduate labs, Instrument room, Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ neutraceuticals and quality assurance). Recently, a well equipped chemical quality control lab has been developed under National Referral Centre.

Dairy Technology Division (DT)

The Dairy Technology Division is one of the first Divisions set up at National Dairy Research Institute, Karnal. It is involved in teaching, basic and applied research, training and consultancy activities in the area of dairy processing and dairy product manufacture. The Division currently has ten well-equipped laboratories viz., Sensory Evaluation Laboratory, Packaging Laboratory, Indigenous Milk Products Laboratory, Cheese and Fermented Milks Laboratory, Functional Ingredients and Applications Laboratory, Food Technology Laboratory, Formulated Dairy Products Laboratory, Dairy By-Products Laboratory, Rheology Laboratory and e-learning Laboratory. The Division houses a range of advanced analytical instruments e.g., micro-fluidizer, food texture analyzer, colour meter, high speed homogenizer, freeze dryer, water activity meter, viscometer, rapid visco analyser, laminar air flow units, automatic Soxhlet extractor, spectrophotometer, vacuum packaging system, ultrafiltration and reverse osmosis units, MAP analyser etc., which are necessary for undertaking cutting edge research in dairy processing. Another unique feature of infrastructure available to the Division for undertaking R&D work for scaling up of the laboratory concepts to the pilot/ semi-commercial scale is a well equipped Experimental Dairy capable of processing 10,000 liters of milk into a diverse range of dairy products. The dairy is equipped with all modern equipments like pasteurizer, homogenizer, cheese and fermented product manufacturing units, butter and ghee manufacturing equipments, ice cream-manufacturing unit, multistage evaporator and spray dryer. The other equipments installed in the Division are Pilot-scale vacuum dryer, ice cream manufacturing unit, HTST milk pasteuizer, membrane processing units, rotary oven and extrusion cookers.

Dairy Microbiology Division (DM)

Dairy Microbiology Division is currently engaged in research, teaching, consultancy, training and technology transfer in specialized field of Dairy Microbiology. Broadly, the research work of the Division covers the areas related to starter cultures and fermented milk products; direct vat starters (DVS); indigenous probiotics, their functional efficacy and gut microbiota, prebiotics and synbiotics; bioactive peptides, microbial metabolites and biopreservatives; biosensors, quality assurance and food safety as well as rumen micro-organisms. The Division has played a leading role in establishing National Collection of Dairy Cultures (NCDC) with current repository of more than 600 cultures and National Referral Centre for milk quality and safety. The Division has recently transferred technologies on two indigenous strains of probiotics, Misti Dahi, Rapids kits for antibiotic residues, Listeria monocytogenes and Enterococci to potential stake holders in our country for their industrial application. Few more such products like carbonated lassi, vitamin B12 rich propioni-yoghurt, blueberry fortified probiotic dahi, real time test for detection of E. coli and antibiotic residues in milk have been developed and are under process of validation for their commercialization. The faculty is also involved in imparting teaching and guidance for both under-graduate and post-graduate programmes. The Division offers M. Tech and Ph.D programmes in Dairy Microbiology. Besides, division is also contributing in teaching Microbiology courses for B. Tech (Dairy Technology) students. The Division offers contractual and consultancy / training services such as supply of starter cultures, freeze-

drying of cultures, microbiological analysis and setting standards for regulatory compliance of dairy products in our country. Division regularly organizes need based specialized short term symposia/conferences/seminars covering basic and applied areas of Dairy Microbiology including quality assurance, food safety, starter cultures and fermented health foods for HRD development in our country.

Dairy Engineering Division (DE)

Dairy Engineering Division was established as one of the major research divisions since the inception of the Institute. It is contributing in teaching, research, training and industrial consultancy. The Division has research laboratory facilities to cater to the needs of specific areas and programmes such as Process Engineering, Process Equipment Design, Unit Operations and Instrumentation. In addition to this, there are post-graduate teaching laboratories, Research & Development Workshop and Equipment testing hall to support both research and teaching activities. During the past three decades, the Division has achieved breakthrough in developing a number of process equipment for manufacturing indigenous milk products. Many of these equipments have been patented and efforts are being made to transfer them to the equipment manufacturers. The Division has tie-ups with equipment manufacturers and users for their collaboration in development or in adoption of the developed equipments. The Division has developed prototypes for the manufacture of khoa, paneer, rasgolla, malai laccha etc on the industrial scale and paneer gadget and cream separator attachment for small scale applications. Recent research achievements include preparation of scale design of continuous khoa making machine, process for accelerated production of rabri using in-line system, continuous manufacture of gajar pak using three stage SSHE. Three stage SSHE is fully automatic state-of-the-art system for continuous manufacture of khoa, basundi, burfi, rabri and ghee. Current research areas are machine vision technology for quality evaluation of dairy product and development of weight based filling system for viscous dairy products. The Division also conducts specialized training to the graduate engineers during summer.

Dairy Economics Statistics & Management (DES&M)

The Division of Dairy Economics, Statistics and Management was created during the IV Five Year Plan. In the early stage, the focus of research in the Division was on conducting research in economics of milk production and processing, with thrust on cost-returns studies. During subsequent periods, the research programmes of the Division enveloped more intricate and broader aspects of dairy enterprise encompassing backward and forward linkage factors for facilitating technology evaluation and transfer. The Division, over the years, has developed good infrastructure in terms of scientific manpower, teaching and training aids, divisional library and computer unit. In response to the research demands of the clientele systems, the Division has been orienting its research priorities and conducting the research accordingly. From simple economic analysis of milk production, the Division envisaged to work 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)

Dairy Extension Division was established at NDRI, Karnal in May, 1961 to undertake extension activities, besides teaching and research in Extension Education. Research endeavors of the Division are in the areas of information and communication technologies, organizational behaviour, information management, participatory technology development and impact studies of dairy innovations. The faculty has also been engaged in human resource development through post graduate and doctoral programmes at NDRI.

The main extension programmes of the Institute such as Dairy Mela and demonstrations, field days, etc are organized by the Division. Research-Extension-Industry-Farmer Interface is also organized by the division to provide an opportunity for the convergence of all stake holders working together for dairy development. Interface not only helps the dairy organizations to find solutions for today's problems, but also to realize the vision for the future. The Division also organizes technology transfer campaigns, infertility and veterinary aid campaigns, kisan sanghosthi and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, helps in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers.

A new Extension Education Programme "Dairy Education at Farmers' Door" was initiated in February, 2009, to strengthen the effective dissemination of dairy production and processing technologies among farming community. An another new Extension Approach "Farmers' Farm School" in village Gorgarh was initiated in August, 2014, for updating farmers knowledge in the field of dairy farming, in particular and agriculture, in general.

SUPPORT SECTIONS

Livestock Research Centre

The total milk production of the herd during the current year was 1174312.5 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 10.8 and 11.3 kg per head per day, respectively. The milking average of Sahiwal cows and Murrah buffaloes was 7.3 and 7.9 kg per animal per day, respectively. One Sahiwal cow (SW-2182) produced best milk yield of 21.5 kg in peak lactation. Best yield in Murrah buffalo (MU- 490) was 20.5 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 33.0 kg (KF-7120) and 23.5 kg (KS-4390), respectively.

Bovine Strength of Cattle and Buffaloes as on 31.03.2015

Age group	Cattle						Buffaloes	Total Bovines
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Local	Total	Murrah	
Calves upto 6 months								
Male	17	07	02	07	-	33	32	65
Female	18	04	01	22	-	45	33	78
Heifers	136	55	10	136	-	337	131	468
Cows	156	48	23	173	-	400	231	631
Male stock (young)	18	02	-	01	-	21	36	57
Bullocks/Teaser	-	-	-	-	01	01	-	01
Total	345	116	36	339	01	837	463	1300

Flock Strength of Goats as on 31.03.2015

Age Group	Alpine x Beetal	Sannen x Beetal	Total
Female			
Kids upto 6 months	18	08	26
6-12 months	04	--	04
Yearling	26	10	36
Goats	52	15	67
Male			
Kids upto 6 months	39	05	44
Bucks	17	03	20
Total	156	41	197

Milk Production at NDRI, Karnal during the year 2014-15 (01.04.2014 to 31.03.2015)

Total Milk Production (kg)	**1174312.5 kg**
Average Number of Animals in Milk per day: Cattle	**221**
Buffaloes	**114**
Goats	**36**

Sale of Livestock during the year 2014-15 (01.04.2014 to 31.03.2015)

Mode of Disposal	Cattle	Buffaloes	Goats	Total
Public Auction	158900.00 (146)	972200.00 (40)	73100.00 (23)	1204200.00 (209)
On Book Value	332111.00 (35)	258494.00 (21)	2210.00 (01)	592815.00 (57)
Grand Total	491011.00 (181)	1230694.00 (61)	75310.00 (24)	1797015.00 (266)

Auction of animals was conducted on 19th & 20th September, 2014 and 20th & 21st March 2015.
Figure in parentheses indicates the total number of animals sold.

Performance of Dairy Animals during the year 2014-15 (01.04.2014 to 31.03.2015)

Particulars	Genetic Groups				
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
Average number of animals in milk per day	65	13	12	131	114
Average number of dry animals per day	81	33	07	45	83
Milking average (kg) per day	7.3	5.9	10.8	11.3	7.9
Overall average (kg) per day	3.2	1.7	6.8	8.4	4.6
Best yield (kg) in a day	21.5	18.0	23.5	33.0	20.5
Animal Number	SW-2182	TP-1290	KS-4390	KF-7120	MU-490

Flock Performance of Goats during the year 2014-15 (01.04.2014-31.03.2015)

Particulars	Genetic Groups	
	Alpine x Beetal	Sannen x Beetal
Average number of animals in milk per day	29	07
Average number of dry animals per day	12	08
Milking average (kg) per day	1.3	1.4
Overall average (kg) per day	0.9	0.7
Best yield (kg) in a day	4.2	4.0
Animal Number	AB-155	SB-232

Students performing cultural activities during Youth Festival

Month-wise Milking Average (kg) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal 2014-15 (01.04.2014 to 31.03.2015)

	Cows						Buffaloes				Goats			
Months	Sahiwal		Tharparkar		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
April, 14	73	7.2	21	5.9	12	11.1	153	12.9	100	7.9	19	1.8	06	1.7
May	71	7.5	18	6.4	12	10.6	148	12.3	103	8.0	22	1.6	06	1.5
June	68	7.8	15	7.5	11	10.3	141	11.3	104	8.2	24	1.2	06	1.1
July	70	7.7	17	6.8	12	9.9	131	10.5	105	7.7	25	0.9	03	1.2
August	67	7.7	16	6.5	14	9.9	132	10.2	112	7.2	19	0.7	04	0.8
September	67	7.2	14	5.5	14	10.8	136	10.5	113	7.1	12	0.7	02	1.3
October	69	6.7	10	5.2	14	10.9	130	10.7	110	6.9	14	1.1	03	1.4
November	63	6.9	09	4.6	14	9.9	122	11.7	107	7.7	45	1.3	11	1.5
December	56	7.0	11	3.1	12	9.9	121	11.1	111	8.3	47	1.4	12	1.6
January, 15	60	6.9	09	5.0	11	11.0	120	11.9	124	8.3	44	1.3	12	1.4
February	59	6.9	08	5.6	11	11.2	115	12.3	139	8.3	38	1.3	09	1.6
March	56	7.4	09	5.7	12	9.8	120	10.6	146	8.5	37	1.3	09	1.7
Average	65	7.3	13	5.9	12	10.8	131	11.3	114	7.9	29	1.3	07	1.4

Month-wise Milking Average (kg) as Fat Corrected Milk of Cows and Buffaloes Maintained at NDRI Karnal (April 2014-March 2015)

Month	Sahiwal 4%Fat		Tharparkar 4%Fat		Karan Swiss 4%Fat		Karan Fries 4%Fat		Murrah 6%Fat	
	Av. No. of Animals in milk/ day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/ day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/ day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/ day	Av. FCM yield (kg.)/ Animals / day	Av. No. of Animals in milk/ day	Av. FCM yield (kg.)/ Animals / day
Apr. 2014	73	7.92	21	6.46	12	11.66	153	13.43	100	9.73
May 2014	71	8.16	18	7.09	12	11.09	148	12.85	103	10.40
June 2014	68	8.72	15	8.47	11	10.21	141	11.82	104	10.89
July 2014	70	8.59	17	7.97	12	11.22	131	11.58	105	9.97
Aug. 2014	67	8.95	16	7.70	14	10.92	132	11.18	112	9.38
Sep. 2014	67	8.03	14	6.47	14	11.62	136	11.40	113	9.34
Oct. 2014	69	7.86	10	6.07	14	11.99	130	11.89	110	9.32
Nov. 2014	63	7.72	9	5.40	14	10.33	122	12.46	107	9.99
Dec. 2014	56	8.17	11	3.59	12	10.87	121	12.22	111	10.80
Jan. 2015	60	7.69	9	5.63	11	11.90	120	13.21	124	10.82
Feb. 2015	59	7.20	8	5.81	11	11.02	115	12.20	139	9.46
Mar. 2015	56	7.96	9	6.16	12	11.17	120	11.29	146	10.46
Average	65	8.08	13	6.40	12	11.17	131	12.13	114	10.05

Fat and SNF Percentage of Cattle and Buffaloes during the year 2014-15 (April 2014 to March 2015)

First Lactation					
Particulars	**Cows**				**Buffaloes Murrah**
	Sahiwal	**Tharparkar**	**Karan Swiss**	**Karan Fries**	
No. of observation	268	3	43	388	352
Average fat %	4.77	4.43	4.40	4.41	8.37
Range	3.67-5.88	3.99-5.10	3.65-5.40	3.53-5.69	6.00-10.59
No. of observation	268	3	43	388	352
Average SNF%	8.82	8.63	8.80	8.76	9.67
Range	8.49-9.11	8.55-8.77	8.51-9.08	8.02-9.13	9.06-10.26
All Lactations					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No. of observation	790	132	140	1580	1393
Average fat %	4.70	4.81	4.41	4.38	8.28
Range	3.50-5.88	3.78-5.69	3.60-5.48	3.49-5.69	6.00-10.67
No of observation	790	132	140	1580	1393
Average SNF%	8.81	8.81	8.78	8.76	9.65
Range	8.49-9.14	8.51-9.13	8.51-9.10	8.02-9.13	9.00-10.27

Production and Reproduction Performance of Cattle Initiating their Lactation during 2013 and Completing in 2014

Traits	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
First Lactation					
Age at 1st calving (Months)	41.26 (45)	35.54(5)	43.99(6)	36.42(39)	40.39 (35)
Total milk yield (kg)	2438 (17)	1685(5)	4052(4)	4130(30)	2251 (35)
305 or less days milk yield (kg)	2055 (18)	1569(5)	3291(6)	3398(39)	2114 (35)
Lactation length (days)	317 (17)	281(5)	418(4)	383(30)	309 (35)
Dry period (days)	123 (8)	145(5)	210(1)	52(13)	94 (09)
Service period (days)	139 (8)	121(5)	389(1)	182(13)	139 (16)
Calving interval (days)	425 (8)	409(4)	676(1)	444(13)	445 (09)
All Lactation					
Total milk yield (kg)	2123 (85)	1418(18)	3495(18)	4088(107)	2486 (119)
305 or less days milk yield (kg)	1956 (85)	1352(18)	3082(21)	3584(123)	2224 (124)
Lactation length (days)	282 (85)	235(18)	315(18)	343(107)	306 (119)
Dry period (days)	157 (40)	179(9)	138(6)	65(36)	111 (40)
Service period (days)	150 (40)	90(9)	161(6)	172(36)	134 (71)
Calving interval (days)	429 (40)	413(9)	449(6)	440(36)	420 (40)
Average number of lactations	3.36 (85)	2.67(18)	3.00(21)	2.60(120)	2.46 (119)
Best Lactation 305 days					
Milk yield (kg)	3910	2842	5113	6738	4024

Animal number	1843	1251	4405	6915	6630
Lactation number	5	3	4	4	2
Best Lactation					
Milk yield (kg)	5431	3451	6404	8136	4689
Animal number	2069	1251	4405	6915	6626
Lactation number	1	3	3	6	1
Lactation length (days)	522	456	538	487	537

Artificial Breeding Research Center

The Artificial Breeding Research Centre (ABRC) having 131 breeding bulls (Sahiwal-39, Tharparkar-16, Karan-Fries- 30, Karan Swiss - 02 and Murrah - 45), is engaged in progeny testing programme for Sahiwal, Murrah and Crossbred Karan Fries Bulls, as well doing active research on bull management, semen cryobiology, spermatogenesis; bull fertility assessment and dissemination of quality germplasm to the farmers and developmental agencies.

Research Highlights

- The centre developed Sahiwal Bull management strategies through systematic exercise, application of halter and bull handler for better sexual behaviour during semen collection on dummy with artificial vagina and reduction of average age of first semen donation of the young Sahiwal bulls (21.3 months).
- The centre has developed feeding management practices with 10% high energy than the ICAR recommendations of feeding of buffalo males during pre-pubertal age to attain early sexual maturity (18-19 months), better mating ability and semen production performance.
- The semen freezing of first cloned buffalo bull (Shresth) in the world was further strengthened and 6900 doses of frozen semen available at ABRC for fertility evaluation. Pregnancy was established with frozen semen of world's first cloned Murrah buffalo (Shresth) bull.
- Five Murrah breeding bulls were selected under Network Project on Buffalo Improvement for the 15th set of progeny testing programme.
- Cryopreservation of semen of breeding bulls: During 2014-15, frozen semen of nine Murrah bulls under 'Network project on Buffalo improvement', fifteen Sahiwal bulls under AICRP on 'Genetic improvement of Sahiwal cattle' and sixteen Karan Fries crossbred bulls under Progeny Testing of KF bulls were preserved for distribution to different participatory center. The center also preserved the semen of six elite Tharparkar bulls maintained for multiplication of Tharparkar germplasm. Bull semen under progeny testing programme are supplied to different centre in the country for test mating, collection of data on conception rate and progeny testing parameters etc.

New Initiatives

- The centre strengthened the biosecurity measures by restricting the visitors and farmers and distribution of semen from the Semen Parlour.
- The center has also strengthened the facilities for scientific management of male animals/ dairy bulls, cryopreservation facility for storage of germplasm, semen processing laboratory, advance training facility on animal breeding / reproduction management and frozen semen technology and dissemination of superior germplasm of cattle and buffaloes.
- The centre procured some critical equipments and software for management of information of bulls as well as semen.
- The centre has screened sexually transmitted bacterial, viral and protozoan diseases viz., TB, JD, Brucellosis, IBR, Campilobacteriasis and Trichomoniasis of all breeding bulls as well as semen straws for IBR. All bulls and semen samples were found negative from these diseases.
- The centre has screened microbiological load of semen with the help of Dairy Microbiology Division for 156 breeding bulls and all bulls' semen found within the acceptable range of microbial load as per MSP for frozen semen.

- Four training programs conducted for the Veterinary officer, quarantine officer and other technical staff of different Semen stations under World Bank funded, National Dairy Plan-I: by NDDB.

Breeding bulls at ABRC during 2014-15

Murrah Bulls		Sahiwal Bulls		Karan Fries Bulls	
14th Set	15th Set	10th Set	11th Set	13th Set	14th Set
6014	6007	1681	2004	7242	7564
6044	6139	1727	2019	7289	7616
6066	6290	1815	2030	7304	7629
6136	6410	1817	2037	7322	7643
-	6333	1852	2056	7462	7650
-	-	1854	2073	7485	7684
-	-	1909	2136	7517	7708
-	-	1958		7521	7709
4	5	8	7	8	8

Reproduction Management

The center performed 1326 artificial insemination of breeding bulls in the institute Livestock Research Center and monitored the reproductive efficiency of NDRI herds.

A.I and PD of Breeding bulls at NDRI herd during 2014 (January to December)

Month	Sahiwal		Karan Fries		Karan Swiss		Tharparkar		Murrah	
	AI	PD	AI	PD	AI	PD	AI	PD	AI	PD
January	21	7	36	17	4	1	3	1	33	13
February	14	3	30	7	3	-	5	4	44	27
March	40	16	29	10	3	1	11	6	32	13
April	21	11	43	12	4	2	3	2	19	7
May	27	15	39	11	5	1	9	4	24	8
June	39	16	43	8	6	2	8	1	11	3
July	22	8	34	3	3	-	12	4	15	4
August	26	12	33	8	4	3	7	2	31	9
September	39	16	63	19	6	1	11	6	57	24
October	31	13	34	17	2	1	5	4	42	23
November	31	16	57	27	4	1	8	3	47	22
December	15	7	40	18	2	-	3	2	33	15
Total A.I	326	140	481	157	46	13	85	39	388	168

Reproductive Status of NDRI Herd during 2014 (January to December)

Particulars	Breed				
	SW	TP	KS	KF	MU
Cow/Buffalo					
Nos. of Observation	68	23	5	67	112
Service Period (days)	132.70	113.30	167.00	136.52	150.43
No. of Service/Conception	1.47	1.52	1.6	1.73	1.35
Heifer					
Nos. of Observation	37	11	2	39	20

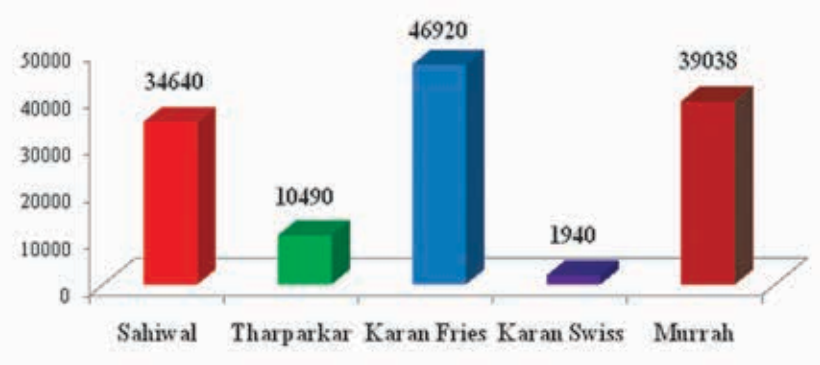
Av. age at Maturity (Month)	29.32	30.72	32.50	27.28	34.10
Av. age at Conception (Month)	32.75	35.72	32.50	29.30	36.25
No. of Service/Conception	1.81	1.45	1.00	1.61	1.85
Conception Rate (%)					
Conception Rate Ist service.	48.10	48.88	35.29	32.98	53.80
Conception Rate 3rd service	77.84	82.22	52.94	65.46	87.13
Over All Conception Rate	42.94	45.88	28.26	32.64	43.30

Production of Superior Germplasm

The centre is involved in production and conservation of superior male germplasm of cattle and buffaloes. During 2014-15 a total of 1,33,028 doses of frozen semen were produced.

Month wise production of frozen semen doses 2014 – 2015.

Month	Doses of Frozen Semen	Month	Doses of Frozen Semen
April - 13	28380	October - 13	5168
May - 13	29250	November - 13	6820
June - 13	12990	December - 13	11730
July -13	13280	January - 14	4080
August -13	12010	February - 14	0
September-13	9320	March - 14	0
Total	105230	Total	27798



Breed wise Production of Superior Germplasm (April, 14 - March, 15)

Dissemination of Superior Germplasm

The centre is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes. During the year (Table 5) ABRC disseminated 23, 359 ml doses liquid semen of Sahiwal, KF and Murrah bulls to local farmers and also disseminated / supplied 62,190 doses frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers and various dairy development organizations / institutes/ gaushalas of 15 states viz., Haryana, Punjab, Uttarakhand, Delhi, U.P, Rajasthan, Bihar, Chhattisgarh, Himachal Pradesh, Karnataka, Madhya Pradesh, Assam, Nagaland, West Bengal and Tamilnadu.

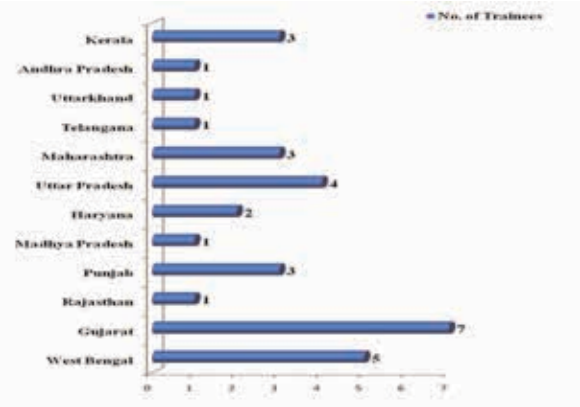
Month-wise Dissemination of Semen Doses (2014 – 2015)

Month	Liquid semen doses (ml) to Farmers	Frozen semen doses to Farmers / Institutes / Dairy Development Agencies
April-14	1677	1816
May – 14	1885	1335
June – 14	1510	1440
July -14	1775	364
August -14	2140	925
September-14	2810	3383
October- 14	1925	2480

November- 14	2042	1273
December- 14	1895	2870
January – 15	1750	2140
February – 15	1880	2732
March - 15	2070	2757
Total	**23,359**	**23,515**

Training Organized

During the period, ABRC conducted four training programme for under NDP-1 to the semen station officials and technical staff for 32 participants of 12 states.



State wise participation of Trainees of Semen station under NDP-I

Photographs of Training Programme

Any other relevant information

- Distribution of breeding bulls: The centre distributed 29 surplus breeding bulls (Karan Fries - Eight, Sahiwal - Five, Tharparkar - Five and Murrah - Eleven) to government agencies / farmers. A total of ` 3,49,731/- revenue generated through sale of bulls.
- ABRC has developed Training modules on various aspects of artificial insemination, frozen semen technology and infertility management for various national and International participants.
- Advisory service to the farmers in use of A.I., different breeding activities and other aspects of dairy bull management were the regular activities of the centre.

Revenue generation

ABRC has generated ₹ 7,38,230/- as revenue for the institute through sale of liquid and frozen semen during 2014-15.

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 out the requirements for transfer of technology programmers of Institute and partial fulfillment of the grain component of feed.

Allocations of the Farm Land to different Units

Production Unit	Area (ha)
Forage Production Section	245.62
Revolving Fund Scheme (Seed Production Unit)	80.00
Forage Research Management Centre	1.62
Dairy Demonstration Unit(KVK)	13.52
Dairy Mela Ground	3.44
Hostel, Power House, Play Ground	13.2
Total land	**357.22**

Fodder/Seed/Feed Production and supply

A total of 1,26,327.50 quintal good quality green fodder was produced from high yielding varieties of fodder crops of Maize, Sorghum, Sorghum x Sudan hybrids and Cowpea during K**harif** season and lucerne, Berseem, Oats Chinese Cabbage, Turnip and winter Maize in R**abi** season. Similarly grain crops of Oats, and Barlay were also grown. A total of 1,95,160.25 q of fodder including 1,79,702.75 q. green fodder 13,235.00 q Silage and 2,222.50 q. dry fodder was supplied to cattle yard.. Total production of grains of Barley, Oats was 3351.20 q.

Production and Productivity of Forage Crops in form of Green Fodder

Crop	Area(ha)	Average Yield (q/ha)	Production (q)
Berseem+Mustard	18.13	759.19	13,764.25
Oats+Berseem+Mustard	15.24	999.50	15,232.50
Barley + Berseem + Mustard	4.45	1024.55	4559.25
Oats/Oats + Mustard	85.13	432.17	36,791.00
Oats + Maize	4.05	302.03	1,223.25
Maize + Mustard	9.77	146.49	1,431.25
Mustard	2.59	546.52	1,415.50
Lucerne	5.11	415.11	2,121.25
Barley	2.40	309.37	742.50
Maize	81.51	213.20	17,378.00
Jowar (Multicut)	27.00	421.83	11,389.50
Jowar (Single cut)	34.79	215.82	7,508.50
Mackchari	15.95	308.74	4,924.50
Maize + Cowpea	8.74	224.65	1,963.50
Maize + Mustard	6.47	173.37	1,121.75
Cowpea	1.41	262.41	370.00
Cowpea + Maize	8.38	198.26	1,661.50
Jowar (Single cut)+ Makchari	4.05	245.30	993.50
Jowar (Multicut) + Bajra	2.43	488.47	1,187.00
Moong	2.02	271.78	549.00
Total	339.62	-	1,26,327.50

Production and Productivity of Grain Crops

Crop	Area(ha)	Average Yield (q/ha)	Production (q)
Oats	28.62	17.46	499.76
Barley	69.95	40.76	2851.44
Total	98.57	-	3.351.20

Fodder Supply to Cattle Yard during 2014-15

Month	Green (q)	Silage (q)	Dry (q)	Total (q)
April	13254.00	2497.25	132.25	15,883.50
May	11958.75	2811.00	407.25	15,177.00
June	12856.75	1834.25	-	14,691.00
July	16128.25	407.50	-	16,535.75
August	14660.75	760.00	-	15420.75
September	14639.50	-	45.50	14,685.00
October	12681.00	-	604.25	13,285.25
November	10897.00	2335.25	882.75	14,115.00

December	18255.50	1400.25	150.50	19,806.25
January	19898.00	1149.50	-	21,047.50
February	16067.75	40.00	-	16,107.75
March	18405.50	-	-	18,405.50
Total	1,79,702.75	13,235.00	2,222.50	1,95,160.25

Forage Conservation

Sufficient quantity of green fodder of oats was conserved as silage 13,235 q. & 2,222.50 q. of dry fodder as wheat, barley and oats straw in the form of by- product of these crops was produced. To fulfill the nutritional requirements of the herd during lean period and to provide required dry matter during winter months, when DM content in the lush green forages is very low silage and wheat/oats straw were supplied.

Revenue Generation

Through sale of farm produce an amount of ₹ 15,35,088.00 was saved by the use of Farm Produce as Seed/Feed.

Revenue Generation by the Sale of Farm Produce

Item Sold	Quantity (q.)	Rate (Rs./q.)	Amount (`)
Barley Grains	2304.53	1250/-	28,80,664.00
Barley Seed	43.44	1500/-	65,160.00
Farm Yard Manure	769 pkts.	20/- per pkt.	15,380.00
Timber wood sold by public Auction			
i) Sheesham Wood	78.15	800/-	62520.0
ii) Eucalyptus/Kikar Wood	496.60	455/-	2,25,953.0
iii) Misc. wood	168.25	300/-	50,475.0
Total			33,00,152.00

Budget Saved by use of Farm Produce as Seed/Feed

Produce	Quantity (q)	Rate (`/q)	Amount (`)
Oats Seed	88-55	3000/-	2,65650.00
Oats Feed	443-75	1400/-	6,21,250.00
Barley Feed	518-55	1250/-	6,48,188.00
Total	1050-85		15,35,088.00

Revolving Fund Scheme on Seed Production

During the year under the report 131.25 q. seeds of improved varieties of fodder crops 1497.75 q grains and 43,659.75 q green fodder 876.50 q dry fodder and 1235 Nos. of FYM packets (5 kg. each) were produced and total ₹ 97,68,199.00 Revenue was generated under Revolving Fund Scheme on Seed Production.

Experimental Dairy Plant

Experimental Dairy Plant has been set up at this Institute with the objective of providing necessary infrastructure facilities to the scientists for the scaling up of new products/processes developed in the laboratories on the pilot scale as well as to provide training facilities to the students in the operation of dairy plants. After meeting the requirements of research and teaching, the plant is used for converting the surplus milk into variety of dairy products such as, milk powder, pasteurized butter, ghee, paneer, burfi, kalakand, lassi, ice cream, processed cheese etc. These products are sold through the Milk Parlour located at the Institute's main entrance.

Special Features

- Experimental Dairy provides practical, teaching and training facility to students and research facility to scientists of the NDRI Deemed University.
- It also provides training facility to outside students of various universities/colleges in the Dairy field. A total no. of 72 students from several institutions was provided training during the financial year 2014-15.

- Experimental Dairy-self sustaining dairy has been running under Revolving Fund Scheme since 1989-90. Revenue generated through scheme is being utilized for development of infrastructure of Experimental Dairy.

- Experimental Dairy is certified under Quality management system ISO 9001-2008 and HACCP-15000 by BIS, Chandigarh.

- The revenue generated during the financial year 2014-15 is 4,99,84,440/- from the sale of milk and milk products.

Computer Centre

Computer Centre is a central facility to provide computational support to the scientists and administration; and imparting training to students/scholars. The Computer Centre offers two Computer Science courses to under-graduate students and one course to post-graduate students including Ph.D. scholars. There is a well established Computer Laboratory for students' teaching, equipped with state-of-the-art 64-bit i5 computer systems together with multi-function laser printers. These computers systems are equipped with different software, i.e., operating system such as Unix/Linux, MS-Windows; statistical/scientific computing system such as SAS 9.3, MATLAB, etc., Also, compliers for various programming languages including Fortran, C, C++, Visual Studio, etc., are available. The Institute has a well established Local Area Network (LAN) connecting all the research divisions and sections through optical fiber/UTP cabling to cover the main buildings and through ADSL switches for distantly located buildings, thereby providing connectivity to all the scientists, technical/administrative staff and students. Students' hostels are also connected to Institute LAN through Wi-Fi network to enable them to access the Internet and library resources round the clock. A video conferencing facility is also operational at the Institute.

Online Examination Centre

An online examination centre is operational for conducting various exams of ICAR-ASRB such as Net/ARS-Preliminary Examinations, etc. The NET 2014(II) and Assistant Grade Direct Recruitment online examinations were conducted successfully during September 22-28, 2014 (in 55 Agriculture disciplines) and during January 5-29, 2015, respectively. As many as 1139 candidates availed this facility for the NET 2014(II) online exam, while 2426 candidates appeared for the Assistant Grade Direct Recruitment (Preliminary) online exam at this centre.

Management Information Service

Computer Centre continued to prepare daily fortnightly and monthly MIS reports relating to milk production, supply of feeds and fodders, herd performance, animal management system, etc., for decision support to the appropriate authorities using in-house developed software. The processing of pay bills and GPF transactions pertaining to the staff as well as generation of various reports was also carried out by the Centre.

In a new initiative by ICAR, the Institute is among the first institutions to implement the MIS/FMS ERP solution for a transparent and paperless office. The Computer Centre is extending its technical and ICT infrastructure support for smooth functioning of this ERP system.

Scientific Data Processing

The Centre processed scientific data pertaining to research projects of the Institute including students' dissertations/theses. The recently acquired sophisticated statistical computing software, SAS is extensively utilised for the purpose.

Agriculture Knowledge Management Unit

The Agriculture Knowledge Management Unit (AKMU) is fully functional with the Internet and e-mail connectivity through National Knowledge Network node (1 Gbps) provided by the National Informatics Centre (NIC) Govt. of India and through leased line (2 Mbps) provided by ERNET India Ltd. AKMU is equipped with state-of-the-art, Unified Threat Management (UTM) System FortiGate-600C and Network-Analyser-200D. These devices enforce essential security mechanism (antivirus/antimalware, antispam, vulnerability management), including firewall, VPN, intrusion prevention, application control and Web content filtering, etc. AKMU is also undertaking the implementation of ICAR programmes like Personnel Management Information System (PERMISNet), National Information System for Agriculture Education Network (NISAGENet) and Half Yearly Progress Monitoring System (HYPM). Also, Statistical Cell is functioning under Computer Centre, which disseminates university related information to various state- and national-level government agencies.

Website

The ICAR-NDRI Website (http://www.ndri.res.in) disseminates latest information to its various stakeholders and end-users about Research, Teaching, Faculty, News, Success Stories, RFD, Related Links, Opportunities, Tenders, Office Circulars, Forthcoming Workshop/Conference/Winter School announcements, Institute Publications (Annual Reports/Newsletters), RTI related information, Telephone Directory, University Information (B.Tech., M.Sc. and Ph.D. Rules, Admission Notice), etc.

Library

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 100 periodicals are subscribed to keep track of the current scientific/technical developments. There are 91,509 volumes which includes 51,780 books, 33,457 bound journals, 4,504 thesis, 268 microfiches, 1,500 CDs. Library has an excellent computer section having fifty workstations for students and staff of the institute. Students use these to get current information in the advanced research areas and for communication.

The Library provides Internet, Email, Documentation, Reference, Current Awareness Services, CD-ROM Literature scanning through CD-ROM of CAB Abstract, Food Science Technology Abstract, AGRIS, Derwent Biotechnology Abstract, Indian Standards and ISO Standards on food products including milk and dairy products on CD-ROM. The Library also provides Photocopying, Document Scanning, Printing and Computerised Issue-Return and reservation facilities.

The NDRI Library is an active partner of Agricat (a sub-portal under WorldCat). Presently ~49,650 catalogue records of Library, NDRI available on Agricat/WorldCat. Library digitized ~2000 contents/records of institute outputs, which includes valuable books, publications, reports, conference proceedings and reprints etc. available on KrishiKosh-Institutional Repository of Indian National Agricultural Research System. In addition of above complete online library catalogue is also available on URL: library.ndri.res.in by using Koha-Library Management System.

Communication Centre

Audio-Visual Lab

During the year 2014-2015, the AV Lab handled Sound & Projection Systems in Dr. D. Sundaresan Auditorium, Dr. N. N. Dastur Auditorium, Pinaki Hall, University Conference Hall, Jayanti, Matangi, Hanu Varta Halls & ABTC Conference Hall for National and International Conference Seminar/Workshop & VIP meeting. Besides this, Audio Visual Lab provided the A.V. aids for students' activities in the play ground and hostels. A.V. Lab provided facilities for sound and projection to 225 assignments at the Institute during the year 2014-15.

Video Lab

Being a Central facilities of the Institute, the facilities of audio video editing, recoding of audio & video clipping on DVD & VCD, dubbing & mixing were extended to the students & staff; scientists for their research projects and video coverage of 79 events of the Institute consisting of National seminars, Workshops, conferences, cultural programmes, Dairy mela, Cattle shows, Kisan sanghosthies, Exhibitions & other functions. A total number of 205 DVD on the above programme were made. DVD (8 Nos.) on clean milk production were sold to various state departments, Agriculture Universities, ICAR Institute & development agencies throughout the country.

Exhibitions Organised

SL. No.	Exhibition	Organisers	Date
1.	NAIP Agribusiness Idea Camp	ICAR, IARI, IVRI, NAIP, CIPHET and NDRI	9th May, 2014
2.	Career and Education Expo 2014	Heena Banquets Hall, Karnal	17th -18th May 2014
3.	ICAR Institutes-SAUs-Development Departments & Stakeholders Interface	NDRI-ICAR- hub Centre	18th October, 2014
4.	Rabi Kisan Mela	IIWBR, Karnal	30th October, 2014
5.	India International Trade Fair-2014	Ministry of Agriculture, Govt. of India	14th - 27th November, 2014

6.	Agriculture Exhibition	Indian Society Of Agronomy, ICAR and PAU, Ludhiana	18th – 20th November, 2014
7.	CII Agrotech.-2014	CII, Parade Ground, Chandigarh	22nd -25th November, 2014
8.	Kisan Mela	Department of Agriculture, Karnal	27th November, 2014
9.	Gau Samvardhan Sammellan	Animal Husbandry Department, Govt. of Haryana	6th January,2015
10.5	Progressive Punjab Livestock Expo-2015 at Shri Mukatsar Sahib	Government of Punjab through Punjab Livestock Development Board in association with PHD Chamber of Commerce & industry	8th -12th January, 2015
11.	Agri-Expo-2015	NASC and NDRI, Karnal During Agriculture Science Congress- 2015	3rd to 6th February, 2015
12.	Progressive Punjab Agriculture Summit-2014	Government of Punjab in association with HPH Chamber of Commerce & Industry, Mohali	16th -19th February, 2015
13.	National Dairy Mela-2015	NDRI, Karnal	25th - 27th February, 2015
14.	National Science Day-2015	NDRI, Karnal	28th February,2015
15.	Rabi Kisan Mela	CSSRI, Karnal	9th March, 2015
16.	Agri. Leadership Summit-2015 from at Leisure Valley, Sector 29, Gurgaon, Haryana.	Government of Haryana	13th – 15th March, 2015
17.	Regional Agriculture fair(RAF) for North Zone	IVRI, Izatnagar in association with Department of agriculture and Cooperation, Directorate of Extension, Ministry of Agriculture, Govt. of India	17th -20th March, 2015
18.	Buffalo Mela and Exhibition	CIRB, Hisar	18th March, 2015

Revenue Generation

1.	Hiring rent from Dr. D. Sundaresan Auditorium	₹ 6,25,446.00
2.	Photography	₹ 5,546.00
3.	VCD on Clean Milk Production	₹ 1,352.00
	Total Amount.	₹ 6,32,344.00

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; providing generator supply to office area in case of power failure; Liaison works with HSEB, CPWD, Haryana State Pollution Control Board and Local Authorities; maintenance of the water supply and sewage disposal system in the Institute; planning and inspection of new buildings in the Institute; maintenance of STP and Bio Gas Plants and other miscellaneous works of the Institute.

Human Health Complex

The Human Health Complex (HHC) was established in 1991. It is catering to the health needs of the employees and students at NDRI as well as to the other sister ICAR Institutes situated at Karnal. Medical Officers render medical aid in Allopathy, Ayurveda and Homoeopathy systems of medicine. Well qualified and trained nursing staff, laboratory technicians and pharmacists assist the Doctors in providing the desired medical facilities. A Physiotherapy Unit exits at the complex premises for the benefit of the patients suffering from various chronic ailments such as lower back-ache, cardiac ailments, hypertension and various types of muscular, arthritis and ailments, etc. clinical diagnostic lab is well equipped with a fully automatic haematolyzer and a semi-auto biochemical analyzer.

Model Dairy Plant

A state-of-the-art Commercial Dairy Plant was established during 1996 at NDRI, Karnal through the financial assistance and installed on turnkey basis by the National Dairy Development Board. The Plant has been designed to handle 60,000 liters (Ltrs.) of milk per day and is presently running in full capacity.

Special Features

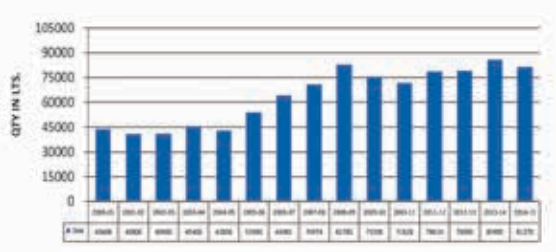
- Model Dairy Plant provides one year In-plant training to the students of B.Tech. (DT) of the N.D.R.I. Deemed University during the 4th year of the course curriculum.
- The students are provided with complete infrastructure for training, which helps them in gaining sufficient experience in managing the modern commercial Dairy Plant and instills confidence in handling real life problems in production management.
- It also provides infrastructure facilities to the scientists of NDRI for scaling up R & D concepts from laboratory scale to industrial scale under commercial environment.

Model Dairy Plant (MDP), an autonomous unit of ICAR, is independently managed by a committee, whose Chairman is the Director of NDRI. The other committee members are:

- Representative of NDDB
- A.D.G., ICAR
- Managing Director, Mother Dairy Fruit & Vegetable Pvt. Ltd., Delhi
- General Manager (MDP) as Convener.
- The Head, Dairy Technology Division, NDRI has been identified as Coordinator for matters related to Model Dairy Plant.

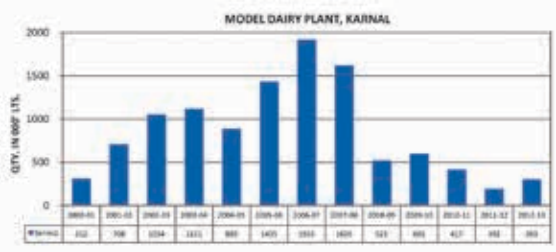
Liquid Milk Processing / Packaging (Capacity 60,000 LPD)

MDP is currently engaged in processing and packaging of milk for Mother Dairy in five different variants (Full Cream, Standard, Toned, Double Toned and Skim Milk). MDP is presently processing / packing 70 – 75 TLPD of polypack Milk in all the varieties for Mother Dairy, Delhi. The plant is running in three shifts and the supplies from MDP are dispatched in the evening & morning to Delhi market thereby utilizing the plant to more than its full capacity.



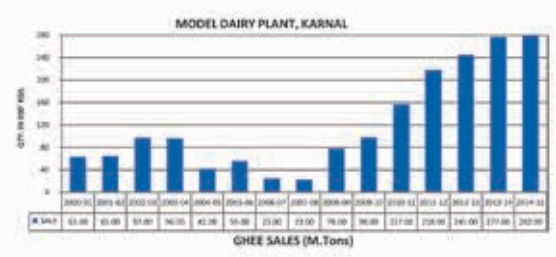
Ice Cream Manufacture (Capacity 7000 LPD)

MDP has an agreement with Mother Dairy for processing / packing of Ice-cream in Mother Dairy brand on job work to the tune of 7000 liters per day. The production of ice-cream is further enhanced to 12000 LPD during the summer season. The ice cream manufactured at MDP is of different varieties i.e. Vanilla, Strawberry, Mango, Butter Scotch etc. and as per the requirements of Mother Dairy.



Ghee Manufacturing (Capacity 800 kg per day)

MDP manufactures Cow Ghee from Cow Butter purchased from different State Federations and its production is taken up as per demand. The average production/sale of ghee is 20-25 metric tons per month. All the Ghee manufactured at MDP is being sold through the MDP Sale Counter.



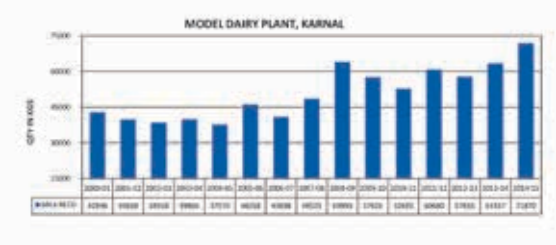
Cheese and Paneer (Capacity 1500 kg per day)

MDP is also engaged in training students in manufacturing of Cottage Cheese, Processed Cheese, Paneer on trial basis. The section is operated occasionally for the purpose of taking

trials and making the students familiar with the manufacturing details.

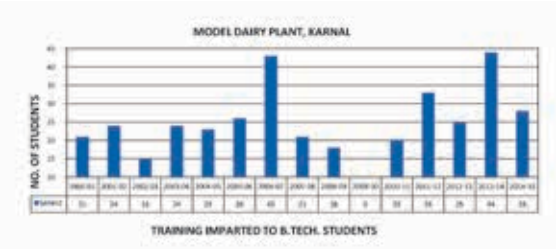
Procurement of Milk

MDP does not have its own infrastructure for milk procurement and is receiving milk on behalf of Mother Dairy from the units of Punjab/Rajasthan/ Uttar Pradesh State federations on NMG rates. The average milk procurement per day is around 55,000 to 60,000 LPD, which is sufficient to meet day to day demand of different milk variants being packed at MDP.



Training to the Students

As its primary objective, Model Dairy Plant is providing In-plant training to the 4th B.Tech. (DT) students of NDRI (Deemed University). The students are provided with In-plant Training Manual comprising of unit wise operation covering all the sections of the Dairy Plant. Since its inception in 1996, Model Dairy Plant has provided training to fourteen batches of B.Tech. (DT) students. The student trainees are provided ₹ 1500/- per month as stipend. So for, 511 students have been trained at MDP.



Students are given hands on experience for plant operations and are trained to manage the shift activities of the plant under the guidance of trained technical staff. In addition to the above, students are also made to involve in other activities like KAIZENs, Small Group Activities etc. The feedback regarding Inplant Training, from the student's trained at MDP and now working in different capacities with different organizations is quite positive and encouraging.

Quality Management System

Model Dairy Plant is presently certified under the Food Safety Management System **ISO 22000:2005.**

HRD Programmes

MDP has well trained technical staff to handle the various operations of the Plant for further upgrading the knowledge and skill of the employees, MDP is continuously taking up HRD programs from external agencies for up-gradation of knowledge and motivation of the employees & student trainees, which has been quite beneficial and helpful both to the employees and the organization.

Visits by Dignitaries

Model Dairy Plant is regularly visited by dignitaries from India & abroad. Faculty members and students of different institutions also visit the plant. Visitors and dignitaries, so far visited, have appreciated the quality of work vis-à-vis hygiene and the facilities made available for training the students of Deemed University NDRI.

Highlights of MDP in the year 2014-15

- PLC based Milk Pasteurizer is installed with the latest technology.
- The operational profit is ₹ 175.00 lakh for the year 2013-14. Which is highest so far?
- Ice Bank Tank coil is changed.
- Nutritious Pinni is launched.
- Ghee sale is app. 282 MT this year, which is higher than the last year.
- Received 3rd National Quality Award form Mother Dairy Fruits & Vegetables Pvt. Ltd.

Group of participants at the workshop on probiotics

16 REGIONAL STATIONS

SOUTHERN REGIONAL STATION, BANGALORE

The National Dairy Research Institute was started at Bengaluru in 1923 as Imperial Institute of Animal Husbandry and Dairying. It was the forerunner institution in starting dairy education programmes to meet the manpower requirements of the Nation's dairy industry. Upon shifting of the Institute Head Quarters to Karnal in 1955, the establishment at Bengaluru continued as the Southern Regional Station of NDRI. The Station has been catering to the research, training and extension needs of the dairy farmers and dairy industry of the Southern Region. The Station functions with the following mandate and objectives.

Mandate

- Identify the region specific problems of dairy production, processing and management on continuing basis and evolve suitable solutions.
- Establish centers for technology development, assessment and dissemination.
- Establish centers of advanced studies for R & D and HRD with the Station as the Southern Campus of NDRI Deemed University.

Objectives

- Faster multiplication of superior germplasm of region specific breeds of cattle and buffaloes through interventions.
- Process upgradation for the industrial production/packaging of region specific dairy products.
- Establishment of the regional referral centre for quality assurance of dairy products.
- Economic analysis of various aspects of dairying and establishment of data bank for strategic development of dairying in the region.
- Establishment of model villages with integrated development focused on dairying.
- Transfer of technologies suitable for the crop-livestock production systems prevalent in agro-climatic conditions of the region.
- Training of farmers and industrial entrepreneurs at technology development centers.
- Undertake advanced HRD programmes to meet the needs of the industry.

Infrastructure

The Campus is endowed with necessary infrastructure in terms of qualified staff, farmland, dairy herd, laboratories, library, staff dispensary, hostel facilities etc. The Campus envelopes a land area of about 46 hectares. About 16 hectares of land is utilized for the cultivation of various forage crops for meeting the feeding requirement of the dairy herd of the institute. About 160 zebu cattle of Deoni breed and 40 crossbred cattle constitute the dairy herd of the Institute.

The Campus has good laboratory and infrastructural facilities for carrying out research work on molecular genetics, screening of microbes, chemical and microbiological analyses of dairy products, testing of dairy equipments, manufacturing of various dairy products, effluent analysis etc. There are network connected computer facilities to facilitate data analysis, documentation, e-mail communication and programming packages for students.

A LAN with a modern web server networks the computers of different sections and Internet facilities are provided to all the sections through the server. An effluent treatment plant and effluent-testing laboratory are established and are functioning at the station. A sensory evaluation laboratory for evaluation of dairy products has also been established.

The library is stocked with 12506 books, 10691 bound volumes of journals, 2320 theses and 1295 reprints. Library subscribes to 125 Indian / Foreign Journals relevant to various disciplines of Dairy Science. In addition, a few journals were also received on gratis basis from different Institutions / organizations of the country and abroad. Library Automation Software procured for facilitating the automation of library functions and 9350 Bibliographical details about the books have been updated into the software. Library also provides Internet services, photo copying facility, news paper clipping services and reference services to readers. The Library serves as a referral centre for many students and professionals in the field of dairying and food science across the country.

There is a good hostel and guest house facility for the stay of students and visitors. The staff dispensary at the Campus caters to the medical needs of students, staff and retired employees. The clinical laboratory of the dispensary also has facilities for taking up preliminary investigations. For facilitating conduct of meetings, seminars, conferences etc there are Seminar Halls, Committee Rooms and Auditoria.

The research, training and transfer of technology programmes at the Campus are carried out through different sections viz., Animal Breeding & Artificial Insemination, Cattle yard & Forage Production, Dairy Technology, Dairy Chemistry & Bacteriology, Dairy Engineering, Dairy Economics & Statistics, Dairy Extension and Education & Training. The Campus has staff strength of about 150 including 21 Scientific and 30 Technical staff.

The experimental dairy of the institute has all the facilities for manufacturing various milk and milk products. The Dairy Technology Section is involved in regular training programmes and also providing in-plant training to the students from various institutions. Training is also imparted to the entrepreneurs. The surplus milk is being sold as market milk and some quantity of milk is also converted into various dairy products for sale through the parlour of the Institute.

Education and Training

Educational Programmes

The course work for Ph.D (Dairy Engg.), M.Tech (Dairy Engg.), M.Tech (DT), M.Tech (FQSA) and Diploma (DT) is being conducted at the Station. The students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Animal Nutrition, Agricultural Economics and Dairy Extension Education are being guided for their Doctoral and Masters' dissertation work.

Short term training programmes are being imparted in 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.

Training Programmes (2014-15)

Short-term Trainings/In-plant & In-lab Trainings/ Project work	No. of Batches	No. of Participants
Project Work (Animal Biotechnology)	01	01
Project Work (Dairy Technology)	01	01
Orientation for Dairy Entrepreneurship	01	05
In-lab Training (Dairy Microbiology)	03	07
Project Work (Dairy Microbiology)	02	07
Commercial Dairy Production	01	10
In-plant Training (Dairy Engineering)	02	27
Total	**11**	**55**

A training programme on Veterinary Ultrasonography and its application in Dairy cattle reproduction was conducted on 15.12.2014, as a sponsored programme of KMF Bengaluru and 15 veterinary officers took benefit of the training.

Scholarships and Fellowships

The Ph.D. and M.Tech. Students are getting either NDRI Fellowship or Fellowship from other agencies as shown below:

Scholarship/Fellowship	Ph.D	M.Tech.
NDRI Fellowship	18	30
ICAR-SRF/JRF	01	05
CSIR-SRF Fellowship	01	--
Moulana Azad National Fellowship	01	--
INSPIRE (SRF)	01	--
In-service Candidates	05	--

Four B.Tech (DT) final year students from College of Dairy Technology, Pusad (MAFSU, Nagpur) and four students from College of Dairy Technology, Veterinary Campus, MAFSU, Latur, Dist Udgir (Maharashtra) have completed in-plant training (26.1.2014 – 25.5. 2014).

- **Hindi Week** was celebrated in the Institute from 22.09.2014 to 30.09.2014. During the celebrations, Hindi competitions were conducted for the Staff members as well as for their Children and Students of the Station.

- **World Food Day** was celebrated on 16.10.2014 and a technical session on the theme 'Emerging Statutory and Regulatory Issues for Food Industry' was organized in association with the Bengaluru chapter of AFST (1). Dr. R. Jayaraman, Former VP (R&D) Britannia Industries, Dr. Bhuvanendra Kumar, Novozymes, Bengaluru, Dr. Sachin Achintalwar, Senior Manager, Regulatory Affairs, AB Mauri India Pvt. Ltd., Dr. M. Anuradha, Director Research & Biotech Finishing School, Dr. Satish Kulkarni and Dr. B. Surendra Nath made presentations & participated in the deliberations.

- Guidance and counseling were imparted to the PG students for their career guidance & placement. The students have secured good placements in organizations such as COMFED, GEA Westfalia, IDMC Neospark, MILMA, State Departments and Academic Institutions, etc. A pre-placement workshop on soft skills development was held on 22 November 2014 to help the current batch of students in their career development. Technical consultants from the industry as well as HR consultants mentored the students at SRS on various aspects of placement.

- Dr A. K. Srivastava, Director, ICAR – NDRI Karnal & Dr K. M. L. Pathak, DDG (AS), ICAR New Delhi visited SRS of NDRI on 18.12.2014 and reviewed the progress of activities primarily concerned with research. The DDG (AS) addressed the staff and students and assured of his continued support to strengthen the SRS. The Director, NDRI then made detailed presentation of Vision 2050 of NDRI encompassing research, teaching and extension activities & invited the suggestions of the Scientists for its further improvement.

Extension Activities

- During the period under report, 626 visitors in 19 batches comprising students, farmers, entrepreneurs and trainees from various parts of Southern region visited the Institute. The visitors were taken round the institute to various units/labs as per their needs and were explained about the ongoing activities.

- Technical advisory services were rendered to the forty nine needy clientele during their personal visits to the Institute and also through mail and phone queries. The profile of advisory included technical know-how to start a dairy farm, training programmes on scientific dairy farming for farmers, farmwomen, rural youth and dairy entrepreneurs, packaging and marketing of milk and milk products, information on dairy equipments for indigenous dairy products, availability of good quality HF bulls for breeding purpose, information on high-yielding dairy breeds, availability of publications on scientific dairy farming aspects, technical know-how, feasibility and consultancy facilities for dairy business projects.

- An Orientation Programme was organized on 1st June, 2014 for fifteen B.Tech. students from MPKV, Rahuri and VNMKU Parbhani, Maharastra on one month Summer Training program. The trainees were provided with needed information on scientific dairy farming by brief-ups / discussions on ongoing research and extension activities and visit to dairy production & processing units as per their needs.

- Model Training Course on "New Extension Strategies for Sustainable Dairy Development" was organized during 20th – 27th January, 2014, sponsored by Directorate of Extension, Department of Agriculture & Cooperation, Ministry of Agriculture, Government of India, New Delhi. The training programme was a capacity building activity for the field extension officials of state development departments to update the recent advancements in dairy development and newer extension strategies for effective dissemination of the technologies among clientele groups. The programme benefitted seventeen officials from different states of the country.

- A Special Training Programme was organized on 'Scientific Dairy Farming and Preparation of Indigenous Dairy Products' for the selected Self-Help Groups (SHG) members from Suradenapura and Hanumanahalli Villages of Bengaluru Rural District during October 2014, as a part of the ongoing research project

of the station. The Institute's interventions were initiated with an orientation training to the SHGs on group dynamics, followed by exposure visits, on-campus and on-farm demonstrations for technical know-how and skill orientation.

- Extension literature on dairy production and processing was distributed to the needy clientele groups, visitors and trainees during their visits to the institute. Extension literature on 'Clean Milk Production" in regional languages was prepared and published during January, 2014 for the benefit of the farming community during their visits to the institute.

- Participated in Dairy Tech India 2014, International Exhibition on Dairy Products, Livestock and Technologies held during 22nd to 24th August, 2014 at Bengaluru International Exhibition Centre (BIEC), Bengaluru. Dairy processing technologies developed and standardized at the Institute were depicted as posters and product display at NDRI stall with information on Indigenous breeds of South India and recommended dairy management practices for the benefit of the clientele groups.

- Participated in Krishimela 2014 organised by University of Agricultural Sciences (UAS) Bengaluru held during 19th to 21st November, 2014 at GKVK Campus, Bengaluru. The exhibition was well attended by farmers, entrepreneurs and industrialists from all over the State and other States of the region.

- As a new initiative at SRS, the 'Dairy Education at Farmer's Door', was organized regularly since April 2014 in the selected clusters of villages of Bengaluru South and North Taluks and visits were made by the multi-disciplinary team on Second Saturday of every month to the selected villages. The multi-disciplinary team visited individual farms and interacted with the farmers regarding dairy farming aspects and the problems faced in dairy farming. Necessary technical advice was rendered on various aspects of scientific dairy farming, green fodder production, clean milk production and dairy animal management aspects to the farmers and farm women at their doorsteps. Clean India Campaign was organized during October, 2014 at the selected villages to sensitize clean milk production by awareness creation through expert talk, discussion and distribution extension literature on clean milk production.

Experimental Dairy Milk and Milk Products Sale

S. No.	Product	Quantity sold	Amount (₹)
1.	Milk sweet (kg)	469.8	112752
2.	Flavoured milk (pkt)	7575	90900
3.	Process cheese (pkt)	5565	417375
4.	Paneer (kg)	1499.75	299950
5.	Gulabjamun mix (pkt)	306	13770
6.	Cheese puri mix (pkt)	288	12960
7.	Chhana podo (pkt)	491	29460
8.	Kunda (cups)	1163	27912
9.	Curd (pkt)	2540	30480
10.	Khoa (kg)	73	18980
11.	Cream (kg)	13	2470
12.	Milk (lit)	34629	1004241
	Total		**2061250**

Livestock Research Centre

Production and Reproduction Performances of Deoni Animals

Herd strength at Livestock Research Centre, NDRI SRS comprises 202 animals in which 161 are Deoni and 41 Holstein Friesian (HF) crossbreds. Deoni herd comprises 57 adult females, 48 young stocks of age group upto 6 months age; 28 in nos. of 6M-1Y age; 28 nos. in 1-2 years age and 18 in above 2 years of age. The number of bulls and bullocks in Deoni breed are 6 and 8, respectively. During last one year, the mean monthly milk yield for Deoni was 2680.7 ± 27.85 kg. The mean daily milk yield was recorded as 3.75 ± 0.78 with a peak yield of 9.5 kg/day. The mean age at first calving of Deoni animals was recorded as 47.02 ± 1.02 months. The mean 305 day milk yield was recorded as 1143.75 kg lactation milk yield. Highest lactation milk yield recorded in a cow was 1288.1 kg in 354 days of lactation. Animals producing > 1000 kg lactation milk yield contributed 21.43% to the lactating animals. Lactation length above 200 days comprise 30% within the lactating animals. Periodical deworming was practiced in the herd.

The herd strength of HF crossbred cattle was 41 in nos. The number adult female, young stock of up to 6 month age, 6 month -1 year, 1-2 year and above 2 years were 40, 8, 4, 3 and 6, respectively. During last one year, the mean monthly milk yield for HF crossbred animals were 4428.58 ± 43.49 kg. In HF crossbred animals, 305 day lactation yield was recorded as 3333.58 kg. The mean daily milk yield was recorded as 11.55 ± 0.50 kg. The peak yield was 20.5 kg/day. Annual vaccination against FMD, Anthrax and HS & BQ was carried out. Mortality was within 2.25 per cent.

Production and Reproduction Performances in Deoni Animals

Month	Daily Milk Yield (kg/ day)	AI done	Calves born	Total milk yield
April 2014	3.68	4	5	3081.00
May 2014	3.90	4	1	3097.50
June 2014	4.34	12	-	2823.00
July 2014	3.76	16	2	2303.00
August 2014	3.54	12	3	2210.00
September 2014	3.58	10	2	2684.10
October 2014	4.01	1	6	2894.20
November 2014	3.92	7	3	2953.9
December 2014	3.47	15	2	2652.0
January 2014	3.41	11	4	2516.00
February 2014	3.7	9	6	2273.00
Mean	3.75	9.18	3.40	2680.70

Production and Reproduction Performances in HF Crossbred Animals

Month	Daily milk yield (kg/day)	AI done	Calf born	Monthly milk yield
April 2014	8.95	4	-	4316
May 2014	11.00	5	1	5006
June 2014	11.42	13	-	5140
July 2014	10.04	12	-	4670
August 2014	9.54	7	3	4397
September 2014	10.50	5	1	4092.8
October 2014	11.61	1	-	4244.5
November 2014	13.51	2	-	4300.1
December 2014	13.65	3	-	4259.0
January 2015	13.60	6		4936.0
February 2015	13.30	1		3353.0
Mean	11.5	5.4	1.7	4428.582

Forage Production: (April, 2014 to February, 2015)

Month	Napier	Guinea	Para	Cereals + legumes	Total (q)	Daily average
April 2014	547.5	13.5	700.5	-	1261.5	42.05
May 2014	626.5	132.5	692.2	-	1451.2	46.81
June 2014	868.0	346.0	481.0	-	1695.0	56.50
July 2014	971.5	411.0	519.0	-	1901.5	61.33
August 2014	538.5	214.5	883.0	176.0	1812.0	58.45
September 2014	263.5	166.0	914.5	535.0	1879.0	62.63
October 2014	469.5	545.0	461.0	514.5	1990.0	64.19
November 2014	509.0	350.5	553.5	516.5	1929.5	64.31
December 2014	373.0	226.0	890.0	339.5	1828.5	58.98
January 2015	369.0	28.0	1162.5	146.0	1705.5	55.01
February 2015	259.5	25.5	959.5	39.0	1283.5	45.83

EASTERN REGIONAL STATION, KALYANI

The Eastern Regional Station was established at the Central Dairy in Calcutta in 1964 and was shifted to Kalyani, Nadia district in 1966, about 50 km north of Calcutta and was located in the Administrative Building of Kalyani University. The Regional Animal Nutrition Research Centre of the ICAR till then located at Haringhata, West Bengal, was merged with the ERS of NDRI with effect from June 1, 1968. In 1978 the Government of West Bengal granted 100 acres of land at Kalyani where cattle sheds, forage unit, staff quarters etc. were gradually built up. The Station built its own laboratory building and the entire station started functioning within the same campus from May, 1987.

The main objective of establishing the Eastern Regional Station is to identify the major constraints of dairy production in Eastern and North Eastern India and to offer solutions through research and extension activities to these problems. It serves as a vital link between the NDRI, Karnal and the far-flung areas of the Eastern and North Eastern regions of the country for transfer of technology developed at the Institute and provides appropriate feedback after trial for perfection. The research work undertaken at this station is mainly strategic and applied in nature and the thrust of research is to improve the socio-economic conditions of dairy farmers of this region.

The Computer Center facilitates the huge database and analysis of experimental data. The Institute has internet connectivity through VSAT/NKN, which is useful for searching literature and references. In addition, the data pertaining to milk production, fodder and feed supply, reproductive performance and meteorology are also being maintained on day-to-day basis.

The Eastern regional station of National Dairy Research Institute has infrastructure facilities like Cattle Herd, Fodder Production Farm, Research Laboratories, Library, Guest House, Computer Section etc. There are six research sections namely Animal Nutrition, Livestock Production & Management, Animal Breeding, Dairy Economics, Dairy Extension and Animal Biotechnology, which are actively engaged in research, training and extension work.

The Cattle Yard of the station maintains around 150 cattle belonging to Jersey crossbreds. Fodder Farm section is engaged in cultivation of quality fodder crops in 27 hectare area for supplying of fodder crops to the Institute farm animals.

Keeping in view the enormous demand for milk in the Eastern Region, low milk production potential of the native stock, shortage of feed and fodder resources and diversified agro-climatic and socio-economic conditions, this research station has a great role to play in the field of dairy development in this region.

Events and Extension Activities

- **World Veterinary Day** was celebrated on 26th April, 2014 by the ERS-NDRI, Kalyani, with the theme of "Animal Welfare" to create awareness on the importance of animal health and its welfare. The programme was organized with seminar, exhibition and farmers'-scientists' interaction on animal welfare issues prevailing at this region. Approximately 100 people including dairy farmers, Students, Trainees, Scientists and Technicians attended the celebration. Various programmes like expert lectures on animal welfare issues in relation to breeding, feeding, management and health care of livestock, quiz competition on dairying and distribution of technical folders to dairy farmers were organized throughout the day. Women farmers showed their active participation in learning the welfare issues for better management of livestock.

- **World Milk Day** was celebrated on 2nd June, 2013 by the ERS-NDRI, Kalyani to create awareness on the importance of milk on human health and nutrition, clean milk production from dairy animals *etc.* and to publicize the importance of livestock and livestock products in socio-economic upliftment of resource-poor dairy farmers in the region. Dairy farmers from different parts of West Bengal with more women representation, progressive farmers and experts participated the programme actively. Students of tribal community were the key participants in this celebration.

- **ERS-NDRI-Dairy Industry Meet** was organized on 27th October, 2014 at ERS-NDRI, Kalyani, Nadia, West Bengal under the Chairmanship of Prof. (Dr.) A. K. Srivastava, Director, NDRI to discuss the various issues and challenges of dairy industry in the Eastern part of India. Scientists from NDRI, Karnal and ERS-IVRI

and other researchers/officers from State Livestock offices were present in the meet. Representatives from Kishan Milk Union, Krishnagar, Ichamati Milk union, Red Cow Dairy Ltd., Kolkata, Natures Dairy, Hooghly, NEST Dairy, Kolkata, Metro Dairy, Kolkata and other Dairy industry partners, NABARD, Kolkata, NGOs', and progressive farmers from West Bengal also participated in this Industry meet. The keynote address pertaining to issues and challenges of dairy industry at this region was delivered by Prof. (Dr.) A. K. Srivastava, Director, NDRI. Technologies developed were presented afterwards by Scientists of NDRI, Karnal to the participants from Industries with a focus on commercial transfer of technologies.

- **A Brain Storming Session on "Breeding policy of ERS, NDRI herd"** was organized on 28th October, 2014 at ERS-NDRI, Kalyani, Nadia, West Bengal under the chairmanship of Dr. R. K. Malik, Joint Director (Research), NDRI, Karnal. Experts from NDRI, Karnal, ERS-IVRI, Kolkata, West Bengal University of Animal and Fishery Sciences, State Livestock sectors were present in this session and actively participated in the discussion to frame out the new breeding policy of ICAR-NDRI-ERS herd.

- **A Dairy Mela** was organized as a part of Golden Jubilee Celebration on 11th December, 14, in the adopted village Muratipur (near Kalyani, West Bengal). Dr. G. R. Patil, Joint Director (Academic), NDRI chaired the celebrations. Approximately 200 people including Livestock farmers, Students, Trainees, Scientists, Technicians and Local officials attended the celebration. Various programmes were organized throughout the day viz. Cattle Health- cum- Fertility Camp, Cattle Show and Judging, Distribution of mineral mixture to the livestock owners, Display of Transferable Technologies through Posters, Quiz on Dairy Cattle Management, Distribution of bilingual (English and Bengali) Technical Folders to the dairy farmers, distribution of prizes to the best cattle owners /dairy farmers etc. Different Institutes/Organizations showcased their technologies in the Mela.

- Eastern Regional Station of National Dairy Research Institute (ERS-NDRI), Kalyani, Nadia celebrated the **Golden Jubilee Meet** on 13th December 2014, under the chairmanship of Prof. (Dr.) A. K. Srivastava, Director, NDRI. The theme was Dairying in Eastern India: Opportunities and Challenges. Representative from various dairy industries State Agriculture University (SAUs), ICAR Institutes and farmers from different districts also participated in this celebration. Golden Jubilee 'SOUVENIR' and 'ERS-NDRI at a Glance' was released on this occasion. The achievements of ERS-NDRI for the last 50 years were presented by Dr. T. K. Dutta, Head, ERS.

- The innovative Extension approach "Dairy Education at Farmers' Door" was initiated by NDRI. This programme was flagged off by this Eastern Regional Station on 10th January, 2015 at Muratipur village of Nadia district and visits were made by the multi-disciplinary team on 2nd Saturday of every month. This programme facilitated the effective dissemination of dairy production technologies among farming community at their door and scientists also could understand constraints faced by the local farmers.

- One day training cum demonstration programme on "Urea Treatment of Paddy Straw and its Importance to Animal Health" was organized at ERS, NDRI on 2nd September 2014. Thirteen farmers from adopted villages participated the programme.

- Two 10 days each, training programme on "Scientific Dairy Farming Practices" were organized 13th - 22nd October 2014 and 19th -28th January 2015. Total 23 trainees actively participated.

- Seven days training programme on "Artificial Insemination and Scientific Goat Rearing Practices" was organized during 23rd February, 2014 to 1st March, 2015. Twenty one unemployed youths from different districts of West Bengal had participated in the training. The participants were provided the training on scientific housing and management, feeds and feeding practices, disease control measures, estrus detection, artificial insemination and application of biotechnological tools in goat production.

- One 42 day Training Programme on "Artificial Insemination & Veterinary First Aid" was organized at ERS, NDRI, Kalyani. A total number of 11 participants were trained.

- Nine two day inter institutional collaborative Orientation/Induction programmes on "Dairy Cooperatives & Advance Scientific Dairy Farming Practices" were organized in collaboration with Kishan cooperative milk

producers Union Ltd. Krishnanagar. A total number of 186 dairy farmers from different district of West Bengal actively participated programme in six batches.

- Two (one day) programmes on "Anoestrous & Deworming" were organized on 17th April 2014 & 6th June 2014 at Muratipur village of Nadia District. Total thirty nine (71) farmers came with seventy five (128) animals for treatment.

- Two (one day) programmes on "Veterinary First Aid & Animal Health" were organized on 9th June 2014 & 30th December 2014 at Dakhhin Chandamari village of Nadia District. Total Seventy three (73) farmers came with one hundred sixty four (164) animals for treatment.

- One day programme on "Animal Health & Anoestrous" was organized on 9th February 2015 in the Dasnagar village of Sriniketan block of Birbhum District. Total fourty three (43) farmers came with one hundred twenty three (123) animals for treatment. 50 kg mineral mixture was also distributed among 43 farmers.

- Two Rural Exhibition/Fairs were attended by ERS, NDRI at different places of Eastern India, 19th to 21st February 2015 at Patna, Bihar organized by Central Potato Research Institute and Ajodhya Hills Parjatan Utsav 2015 from 23rd to 25th February 2015 at Ayodhya hills of Purulia district organized by Purulia Zilla Parishad.

- "Dairy Vikash Kendra" which was established by ERS, NDRI in Muratipur village for providing A.I. facililities and treatment of dairy animals successfully provided AI facilities to 92 cows and treatment to 651 animals, distributed 187.5 kg mineral mixture among 136 farmers for their animals.

- Extension literatures on dairy animal production and management aspects was distributed to visitors, trainees, dairy farmers and needy clients for dissemination of needed technical information. Five technical folders were prepared in Bengali for benefit of dairy farmers of the local area and one technical folder "How to Formulate a Project Proposal for 10 Dairy Cow Unit" was prepared for beginners for established dairy farm.

- Conducted 15-days Internship training programme of B.V.Sc. & A.H. students (49 students) of West Bengal University of Animal & Fishery Sciences, Belgachia, Kolkata at ERS-NDRI, Kalyani since 3rd January- 1st, June, 2015 in different batches.

- Fodder demonstrations were made on Sorghum and Maize production in different villages of Burdwan district.

- A frontline demonstration was organized on "Azolla Production for Animal Feeding" at Alukaranbarh village Purba Medinipur on 30th December 2014. Ten farmers participated in in practical demonstration of Azolla Cultivation methods.

Technology Assessed and Transferred to Farmers

Development of suitable semen preservation and artificial insemination protocol for Bengal goat

Bengal goat is the precious germ plasm of West Bengal known for its excellent meat and skin quality. Early castration of male for meat purpose resulted in less availability of quality breeding bucks in the villages. Artificial insemination (AI) provides an answer to this problem. Semen was collected from Bengal bucks by artificial vagina and successfully preserved in liquid state using Tris egg yolk citrate buffer. A total number of 21 numbers of rural youth were trained to carry out artificial insemination in goats. Buck semen preserved using the standardized buffer is provided to the trained personals through Sanjevani Khamar goat farm, Hooghly district of West Bengal for artificial insemination purpose to different districts of West Bengal state namely, Hooghly, Bardhman, Purulia, West Medinapur, Malda, Mursidabad, South Dinajpur and North 24 Parganas. Preserved semen is used for AI up to five days of storage in ice/ refrigeration condition. About 100 to 200 inseminations were carried out per week using the preserved liquid semen. 47.26 % kidding rate was recorded in artificial insemination using preserved buck semen.

Livestock Farm

Annual Performance of ERS-NDRI Herd (2014)

Particulars	Jersey Cross
Herd strength as on 31.12.2014	162
Total milk production (kg)	146251.0
Av. no. of cows in milk/day	51.4
Av. no. of cows in dry/day	18.5
Wet average (kg)/day	7.8
Herd average (kg)/day	5.74
Age at first calving (month)	37.5
No. of inseminated	103
No. of pregnant	43
Conception rate (%)	41.7
Service period (days)	119
Inter calving period (days)	457
Mortality (%)	6.8

Milk Production Performance at ERS-NDRI Herd (1.1.14-31.12.14)

Months	Milk Production	Wet Average	Herd Average	Average	Average
(2014)	(kg)	(k g)	(kg)	FAT %	SNF %
January	10268.5	7.14	4.86	4.78	8.66
February	10766.5	7.98	5.4	4.32	7.81
March	12268.0	8.18	5.43	4.79	8.65
April	11884.5	8.31	5.42	4.68	8.41
May	13166.5	8.12	5.61	4.84	8.68
June	14088.5	8.61	6.18	4.64	8.39
July	14236.5	8.39	6.24	4.75	8.66
August	12905.0	7.94	6.47	4.75	8.66
September	12052.0	7.56	6.11	4.78	8.67
October	12395.5	7.5	6.1	4.78	8.66
November	11111.0	7.12	5.61	4.56	8.37
December	11108.5	6.72	5.43	4.72	8.65
Overall Average	**12187.58**	**7.80**	**5.74**	**4.70**	**8.52**

Forage Farm

Forage Farm section is engaged in cultivation of quality fodder crops in about 27-30 hectares (NDRI, Kalyani and IVRI, Kalyani land) and supplied chaffed or unchaffed green fodder to the Cattle Yard.

Besides cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machineries including tractors, chaff cutter etc. There is a small vermin-compost unit used for production of vermi-compost and also for training and demonstration purpose. There is an agri-meteorological observatory where regular observations are taken for various meteorological parameters like relative humidity, max. and min. air temperature, soil temperature at different depth, wind speed and direction, Rainfall etc. There are about 700 plants of teak, shesham *etc.* growing in the Institute premises. Besides, there is a fodder herbarium for training and demonstration purpose. The Forage Section has necessary facilities for covering the theoretical and practical part of training on fodder crop production.

Production of Different Fodder Crops at ERS Fodder Farm during 2014-15

Type of fodder	Quantity (Qtl.)
Berseem / Berseem+ Mustard, Lucernre/Lucerne+Mustard /Sole Cowpea/ Sole Ricebean	1451.80
Maize / Maize+Cowpea	2514.20
Oats/ Oats + Mustard/Barley	2863.75
Sorghum / Coix	6121.45
Hybrid Napier Grass/ Guinea Grass	63.05
Total	13014.25

Library

The Library contains 1505 books, 3360 volumes of bound journals and other periodicals in the field of Dairying. Besides, Annual Reports of different Institutes and proceedings of various workshops and seminars are also available for reference. Presently 20 journals are subscribed.

This station has laboratory facilities for the research work of M.Sc. and Ph.D. scholars. Field visits, Farmer- Scientist Interface and orientation programmes are organised at regular intervals for the farmers of Dairy Cooperative Societies and NGOs on request. Training programmes on "Scientific Dairy Farming", "Dairy Cattle Management" and "AI and Veterinary First Aid" for dairy farmers are also being organized from time to time. The feasible technologies are being taken up for transfer through these trainings, field visits and village extension programmes where all efforts are being made by the Institute to popularize latest suitable technologies in order to enhance dairy farming activity.

Dr. K. P. Ramesha receiving the "Indian Dairy Association Fellowship Award 2014-15" during the 43rd Dairy Industry Conference on 19th February, 2015 at Kolkata

17 RESULTS-FRAMEWORK DOCUMENT (RFD)

SECTION 1: VISION, MISSION, OBJECTIVES AND FUNCTIONS

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.

MANDATE/OBJECTIVES

1. To strengthen higher education and capacity building for dairy R&D in the country
2. Improvement of productivity, fertility and adaptability of dairy animals
3. Innovations to enhance value addition, processing efficiency, quality and safety of dairy products
4. To promote dairy enterprises through transfer of technology

FUNCTIONS

1. Conducting research in the areas of Dairy Production, Processing and Marketing.
2. Demand driven 'Human Resource Development' to meet the requirements of Dairy Sector & R&D Institutions.
3. Dissemination of innovative dairy production and processing technologies for socio-economic transformation.

A view of Dairy Mela

Dr. Gurbachan Singh, Chairman, ASRB, New Delhi at Dairy Mela 2015

Section 2: *Inter se* priorities among key objectives, success indicators and targets

S. No.	Objectives	Weight	Actions	Success indicators	Unit	Weight	Target/criteria value				
							Excellent	Very good	Good	Fair	Poor
							100%	90%	80%	70%	60%
1	To strengthen higher education and capacity building for dairy R&D in the country	30	Educate & assess students for undergraduate degree B.Tech. (DT)	Graduate degrees awarded	Number	10	28	24	20	16	12
			Educate, guide & assess students for Masters & Doctoral degrees	Masters & Doctoral degrees awarded	Number	15	150	130	110	90	60
			Organization of advanced training programmes/ CAFT, winter & summer schools	Training programmes organized	Number	5	6	5	4	3	2
2	Improvement of productivity, fertility and adaptability of dairy animals	25	Production, evaluation and dissemination of quality germplasm	Dissemination of quality frozen semen doses	Number	9	75000	70000	65000	60000	55000
			Genetic profiling of cattle & buffaloes and technological interventions for augmentation of productivity, fertility & adaptability	Animals screened/ year for molecular genetic profiling	Number	6	325	300	275	250	225
				Biotechnological interventions in relation to reproduction and production	Number	6	4	3	2	1	0
			Quality fodder seed production	Quantity of seed produced	Quintal	4	1000	900	800	700	600
3	Innovations to enhance value addition, processing efficiency, quality and safety of dairy products	25	Production and standardization of dairy/ functional dairy products	Process technology developed/ standardized	Number	11	12	10	9	8	7
			Screening of potential dairy microbes	Probiotic & functional starters evaluated	Number	7	15	13	10	7	4
			Screening of potential dairy microbes	Probiotic & functional starters evaluated	Number	7	15	13	10	7	4
			Innovation on dairy products' quality and safety	Quality control methods/ techniques/ bioassay/ number of kits developed	Number	7	4	3	2	1	0

4	To promote dairy enterprises through transfer of technology	9	Provide training to the farmers	Training programmes organized	Number	7	120	110	90	80	70
			Production of technical literature for the use of farmers and other stakeholders	Technical literature produced	Number	2	15	12	10	8	6
	Efficient Functioning of the RFD System	3	Timely submission of Draft RFD (2013-14) for approval	On-time submission	Date	2	15/5/2013	16/5/2013	17/5/2013	20/5/2013	21/5/2013
			Timely submission of results for RFD (2012-13)	On-time submission	Date	1	01/5/2013	02/5/2013	05/5/2013	06/5/2013	07/5/2013
	Administrative Reforms	4	Implement ISO 9001 as per the approved action plan	% implementation	%	2	100	95	90	85	80
			Prepare an action plan for innovation	On-time submission	Date	2	30/7/2013	10/8/2013	20/8/2013	30/8/2013	10/9/2013
	Improving internal efficiency/ responsiveness/service delivery of Ministry/ Department	4	Implementation of Sevottam	Independent Audit of Implementation of Citizen's Charter	%	2	100	95	90	85	80
				Independent Audit of implementation of public grievance redressal system	%	2	100	95	90	85	80

Section 3: Trend Values of the Success Indicators

S.No.	Objectives	Actions	Success indicators	Unit	Actual value for FY 11/12	Actual value for FY 12/13	Target value for FY 13/14	Projected value for FY 14/15	Projected value for FY 15/16
1	To strengthen higher education and capacity building for dairy R&D in the country	Educate & assess students for undergraduate degree B.Tech. (DT)	Graduate degrees awarded	Number	33	28	24	28	30
		Educate, guide & assess students for Masters & Doctoral degrees	Masters & Doctoral degrees awarded	Number	167	150	130	150	160
		Organization of advanced training programmes/ CAFT, winter & summer schools	Training programmes organized	Number	5	6	5	6	7
2	Improvement of productivity, fertility and adaptability of dairy animals	Production, evaluation and dissemination of quality germplasm	Dissemination of quality frozen semen doses	Number	76808	80000	70000	75000	80000
		Genetic profiling of cattle & buffaloes and technological interventions for augmentation of productivity, fertility & adaptability	Animals screened/year for molecular genetic profiling	Number	445	360	300	400	450
			Biotechnological interventions in relation to reproduction and production	Number	1	2	3	3	4
		Quality fodder seed production	Quantity of seed produced	Quintal	1015	1034	900	950	1000
4	Innovations to enhance value addition, processing efficiency, quality and safety of dairy products	Production and standardization of dairy/ functional dairy products	Process technology developed/ standardised	Number	10	11	10	10	11
		Screening of potential dairy microbes	Probiotic & functional starters evaluated	Number	15	14	13	14	15
		Innovation on dairy products' quality and safety	Quality control methods/ techniques/bioassay/ number of kits developed	Number	3	4	3	3	4
	To promote dairy enterprises through transfer of technology	Provide training to the farmers	Training programmes organized	Number	116	92	110	115	120
		Production of technical literature for the use of farmers and other stakeholders	Technical literature produced	Number	10	11	12	13	15

Efficient Functioning of the RFD System	Timely submission of Draft RFD (2013-14) for approval	On-time submission	Date	-	-	16/5/2013	-	-
	Timely submission of results for RFD (2012-13)	On-time submission	Date	-	-	02/5/2013	-	-
Administrative Reforms	Implement ISO 9001 as per the approved action plan	% implementation	%	-	-	95	-	-
	Prepare an action plan for innovation	On-time submission	Date	-	-	10/8/2013	-	-
Improving internal efficiency/ responsiveness/ service delivery of Ministry/ Department	Implementation of Sevottam	Independent Audit of Implementation of Citizen's Charter	%	-		95	-	-
		Independent Audit of implementation of public grievance redressal system	%	-		95	-	-

Section 4: Acronyms

S. No.	Acronym	Description
1	CAFT	Centre for Advanced Faculty Training
2	DT	Dairy Technology
3	R&D	Research and Development
4	B.Tech.	Bachelor of Technology
5	NDRI	National Dairy Research Institute
6	NGO	Non-Government Organization

Section 4: Description and Definition of Success Indicators and Proposed Measurement Methodology

S. No.	Success Indicator	Description	Definition	Measurement	General Comments
1	Graduate degrees awarded	Teaching of course, conducting theory & practical evaluation for the award of bachelor degree (B.Tech.) in dairy technology	Award of bachelor degree (B.Tech.) in Dairy Technology	Number	Trained manpower for dairy industry
2	Masters & Doctoral degrees awarded	Teaching of course, conducting theory & practical evaluation and guiding student for their research work for Masters and Doctoral Degrees	Award of Masters and Doctoral Degrees in thirteen disciplines of dairy sciences	Number	Supply technocrats to R&D of dairy sector
3	Training programmes organized	Human resource development are undertaken through trainings in recent advances of dairy sciences	Conducting advanced faculty trainings and organizing summer and winter schools	Number	Training programmes are organised for scientists on recent advances of dairy sciences.
4	Dissemination of quality frozen semen doses	Enhance productivity through breed upgradation by dissemination of quality semen	The superior germplasm of bovines will be produced, evaluated for its quality and then disseminated	Number of semen doses	Institute maintains high pedigree bulls to produce, evaluate and disseminate quality semen
5	Animals screened/year for molecular genetic profiling	Characterisation and identification of polymorphism of candidate genes related to production, reproduction, health and thermoregulatory genes.	Screening of elite cattle and buffaloes for their molecular genetic profiling.	Number	Candidate genes are identified for their polymorphism, reproduction, health and thermoregulatory traits
6	Biotechnological interventions in relation to reproduction and production	New findings in the field of biotechnology related with embryo production, stem cells, cloning, transgenics, genomics of oocytes , etc.	Results of biotechnological trials/ experiments	Number of results/ interventions	Biotechnological approaches are used to improve production and reproductive performances

7	Quantity of seed produced	Improve quality and supply of feed & fodder throughout the year	Production of quality fodder seed at NDRI farm	Quantity in quintals	The quality fodder seed is produced of wheat, oat, barley, maize, etc.
8	Process technology developed/ standardised	Innovations to enhance value addition, standardization of process & processing efficiency.	Development of functional dairy products to meet specific requirements of consumers.	Number	The new products create demand and value addition by incorporating the required nutritional quality.
9	Probiotic & functional starters evaluated	Screening of dairy starters & probiotics based on superior features like acid & flavour production, bacteriocin, neutraceutical & therapeutic properties and genetic diversity.	Dairy starters collected and evaluated for their potential benefit	Number	Methodologies are used to evaluate dairy starters/ or probiotics for their superior features
10	Quality control methods/ techniques/ bioassay/ number of kits developed	Ensure quality and safety of dairy products & detection of adulteration through development of tools & techniques	Innovation in term of quality control methods/ techniques/ bioassays and number of detection kits developed	Number	Adulteration of milk and milk products is serious threat to dairy sector
11	Provide training to the farmers	Capacity building of farmers on dairy and other agricultural activities	Conduct on-campus training programmes	Number of training programmes organized	Training of farmers in agricultural and animal husbandry practices to improve productivity and income
12	Technical literature produced	Advances in dairy sciences are published in the form of training and lab manuals, books, technical bulletins and folders	Publication of training and lab manuals, books, technical bulletins and folders	Number	Technical literature is prepared from findings of the research studies for its wider circulation

Section 5 : Specific Performance Requirements from other Departments

Location Type	State	Organization Type	Organization Name	Relevant Success Indicator	What is your requirement from this organization	Justification for this requirement	Please quantify your requirement from this Organization	What happens if your requirement is not met
State	All states	Departments, NGOs & farmers	State Department of Animal Husbandry, NGOs & Farmers	Semen doses	Indenting of semen doses	Dissemination of semen doses depends on requirement from different state institutions	75000 doses	Will be disseminated in the next year

Section 6: Outcome/ Impact of activities of Organization/Ministry

S. No.	Outcome/Impact of organization	Jointly responsible for influencing this outcome/ impact with following organization(s)/ department (s) /ministry (ies)	Success indicator (s)	Unit	2011-12	2012-13	2013-14	2014-15	2015-16
1.	Highly qualified manpower in dairy and related discipline	-	Award of B. Tech., masters & doctoral degrees	Number	143	155	170	190	195
2.	Development of quality dairy products	-	Products/ processes develop(ed)	Number	13	14	10	13	14
3	Enhancing milk productivity	State AH Department State Agricultural and Veterinary Universities	Improvement	Percent	2.1	2.0	1.9	1.8	1.7

Annual Performance Evaluati on Report of RSCs i.e. Institutes for the year 2013-14 (April 1, 2013 to March 31 2014)

Name of the Division: **Animal Science**
Name of the Institution: **National Dairy Research Institute, Karnal**
RFD Nodal Officer: **Dr. B.S. Chandel, PS, DESM**

Objectives	Weight (%)	Actions	Success indicators	Unit	Weight (%)	Target/criteria value					Achievements	Performance	
						Excellent	Very good	Good	Fair	Poor		Raw Score (%)	Weighted raw score (%)
						100%	90%	80%	70%	60%			
To strengthen higher education and capacity building for dairy R&D in the country	30	Educate & assess students for undergraduate degree B.Tech. (DT)	Graduate degrees awarded	Number	10	28	24	20	16	12	39	100	10
		Educate, guide & assess students for Masters & Doctoral degrees	Masters & Doctoral degrees awarded	Number	15	150	130	110	90	60	183	100	15
		Organization of advanced training programmes/ CAFT, winter & summer schools	Training programmes organized	Number	5	6	5	4	3	2	7	100	5
Improvement of productivity, fertility and adaptability of dairy animals	25	Production, evaluation and dissemination of quality germplasm	Dissemination of quality frozen semen dozes	Number	9	75000	70000	65000	60000	55000	91547	100	9
		Genetic profiling of cattle & buffaloes and technological interventions for augmentation of productivity, fertility & adaptability	Animals screened/year for molecular genetic profiling	Number	6	325	300	275	250	225	340	100	6
			Biotechnological interventions in relation to reproduction and production	Number	6	4	3	2	1	0	4	100	6
		Quality fodder seed production	Quantity of seed produced	Quintal	4	1000	900	800	700	600	1343	100	4

Innovations to enhance value addition, processing efficiency, quality and safety of dairy products	25	Production and standardization of dairy/ functional dairy products	Process technology developed/ standardized	Number	11	12	10	9	8	7	12	100	11
		Screening of potential dairy microbes	Probiotic & functional starters evaluated	Number	7	15	13	10	7	4	15	100	7
		Innovation on dairy products' quality and safety	Quality control methods/ techniques/bioassay/ number of kits developed	Number	7	4	3	2	1	0	5	100	7
To promote dairy enterprises through transfer of technology	9	Provide training to the farmers	Training programmes organized	Number	7	120	110	90	80	70	111	91	6.37
		Production of technical literature for the use of farmers and other stakeholders	Technical literature produced	Number	2	15	12	10	8	6	17	100	2
Efficient Functioning of the RFD System	3	Timely submission of Draft RFD (2013-14) for approval	On-time submission	Date	2	15/5/2013	16/5/2013	17/5/2013	20/5/2013	21/5/2013	15/5/2013	100	2
		Timely submission of results for RFD (2012-13)	On-time submission	Date	1	01/5/2013	02/5/2013	05/5/2013	06/5/2013	07/5/2013	01/5/2013	100	1
Administrative Reforms	4	Implement ISO 9001 as per the approved action plan	% implementation	Percent	2	100	95	90	85	80	60	0	0
		Prepare an action plan for innovation	On-time submission	Date	2	30/7/2013	10/8/2013	20/8/2013	30/8/2013	10/9/2013	28/7/2013	100	2
Improving internal Efficiency/ responsiveness/ service delivery of Ministry/ Department	4	Implementation of Sevottam	Independent Audit of Implementation of Citizen's Charter	Percent	2	100	95	90	85	80	100	100	2
			Independent Audit of implementation of public grievance redressal system	Percent	2	100	95	90	85	80	95	90	1.8

Composite score = 97.17

हिन्दी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित अनुसंधान संस्थान है जो कि देश मे डेरी विकास कार्यक्रमों के लिए अनुसंधान एवं विकास तथा मानव संसाधन विकास में सहयोग के लिए पूर्ण रूप से समर्पित रहा है । वर्ष 1923 में बैंगलोर में स्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में करनाल से स्थानान्तरित कर दिया गया । इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो कि बंगलौर एवं कल्याणी में स्थित है। दक्षिण व पूर्वी क्षेत्रीय केन्द्र स्थानीय क्षेत्र में कृषि वातावरण के अनुरूप डेरी विकास के लिए अनुसंधान एवं सहयोग प्रदान करने में लगे हुए हैं। शैक्षिक कार्यक्रमों के संचालन हेतु संस्थान को मान्य विश्वविद्यालय का दर्जा प्राप्त है ।

संगठनात्मक स्वरूप

संस्थान की प्रबन्ध प्रणाली भारतीय कृषि अनुसंधान परिषद् के मान्य विश्वविद्यालय की प्रशासनिक पद्धति के अनुरूप ही है। संस्थान के अनुसंधान, शिक्षण, प्रशिक्षण, विस्तार शिक्षा और प्रशासनिक कार्यकलाप के क्षेत्र में नीति–निर्धारण और निर्णय का दायित्व प्रबंध मडंल, अनुसंधान सलाहकार परिषद, विद्या परिषद एवं विस्तार परिषद, समितियों को सौंपा गया है। निदेशक इस संस्थान का कार्यपालक अधिकारी है। संयुक्त निदेशक, निदेशक को अनुसंधान, शिक्षण एवं विस्तार कार्यकलापों को संपन्न कराने में सहयोग प्रदान करते है। संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र (1) डेरी उत्पादन (2) डेरी प्रसंस्करण तथा (3) डेरी विस्तार/प्रबन्धन है। सभी अनुसंधान एवं विस्तार कार्यक्रम संस्थान के मुख्यालय तथा इसके दो क्षेत्रीय केन्द्रों पर संस्थान के तेरह प्रभागों/अनुभागों डेरी पशु प्रजनन पशुधन उत्पादन एवं प्रबंधन, डेरी पशुपोषण, चारा अनुसंधान, डेरी पशु शरीर क्रिया विज्ञान, पशु जीवरसायन, पशु जैवप्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी इंजीनियरी, डेरी सूक्ष्मजीव विज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र सांख्यिकी एवं प्रबन्धन प्रभाग के अन्तर्गत संपन्न होते है। संस्थान में एक कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक), कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण केन्द्र भी है। संस्थान में पशुधन फार्म, चारा फार्म, एवं प्रबंधन केन्द्र, पशु स्वास्थ्य परिसर, मॉडल डेरी संयंत्र, टेक्नोलोजी बिजनस इनक्यूबेटर, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय सेवा एंव राष्ट्रीय जैवसूचना केन्द्र, कंप्यूटर केन्द्र, संपदा अनुभाग तथा अनुरक्षण इंजीनियरी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे वित्त, क्रय, भंडार, स्थापना, राजभाषा एकक तथा सुरक्षा के कार्यकलाप संयुक्त निदेशक (प्रशासन) एवं कुलसचिव के नियंत्रण में है जबकि वित विभाग वित नियंत्रक (कम्पट्रोलर) के नियंत्रण में हैं। संस्थान में इस समय 156 वैज्ञानिक 232 तकनीशियन, 141 प्रशासनिक तथा 506 निपुण सहायक कर्मचारी सेवारत हैं ।

बजट

संस्थान का वर्ष 2014–2015 में योजना और गैर–योजना शीर्ष में वास्तविक व्यय बजट 16043.64 लाख रूपए था तथा वर्ष 2014–15 के लिए योजना एवं गैर–योजनाशीर्ष के लिए कुल बजट 16127.00 लाख रूपए स्वीकृत किया गया। इसमें मान्य विश्वविद्यालय तथा कृषि विज्ञान केन्द्र तथा क्षेत्रीय केन्द्रों का बजट भी सम्मिलित है।

अनुसंधान

वर्ष 2014 के दौरान कुल 72 अन्तःसंस्थानीय तथा 54 बाह्य अनुसंधान परियोजनाओं का कार्य चल रहा था। मूल एवं महत्वपूर्ण अनुसंधान कार्यो को सुदृढ़ करने के अतिरिक्त वित्तीय अनुसंधान परियोजनाओं से फंडिंग रू0 124.00 करोड़ रूपए तक पहुंच गई है जो कि राष्ट्रीय डेरी अनुसंधान संस्थान के इतिहास में अब तक सबसे अधिक है। राष्ट्रीय डेरी अनुसंधान संस्थान में इस समय चार अन्तर्राष्ट्रीय अनुसंधान समन्वय परियोजनाएं चल रही है जिसमें जननक्षमता से संबंधित जीन निर्धारण पर जर्मन शैक्षिक विनिमय सेवाएं (डी.एस.टी.–डी.ए.ए.डी.) परियोजना, डिजाइनर डेरी उत्पादों पर लेक्टिक अम्ल बैक्टीरिया के अनुप्रयोग तथा विकास पर इंडो–यू.के.परियोजना, भारतीय बाजार परिस्थितियों के लिए डिजाइन किए गए लचीले प्रतिजैवीय आहारों के विकास पर इंडो–न्यूजीलैंड परियोजना तथा दूध में रोगजनक जीवाणुओं तथा ऊष्मा प्रतिरोधी अपशिष्टों के प्रबंधन के लिए प्रक्रियाओं के मानकीकरण पर इंडो–दक्षिणी अफ्रीका–ब्राजील संयुक्त अनुसंधान परियोजनाएं सम्मिलित हैं। राष्ट्रीय डेरी अनुसंधान संस्थान लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेन्सियों जैसे जैवप्रौद्योगिकी विभाग (डी.बी.टी.), विज्ञान एवं प्रौद्योगिकी विभाग (डी.एस.टी.), कृषि एवं ग्रामीण विकास के लिए राष्ट्रीय बैंक (नाबार्ड), राष्ट्रीय डेरी विकास बोर्ड (एन.डी.डी.बी.), राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो (एन.बी.ए.आई.एम.), कृषि पर मूल एवं महत्वपूर्ण अनुसंधान के लिए राष्ट्रीय फंड (एन.एफ.बी.एस.आर.ए.), खाद्य प्रसंस्करण उद्योग मंत्रालय (एम.एफ.पी.आई.), परमाणु ऊर्जा विभाग (डी.ए.ई.), भारतीय चिकित्सा अनुसंधान परिषद (आई.सी.एम.आर.) तथा पशुपालन एवं डेयरिंग विभाग (डी.ए.एच.डी.) से बाह्य वित्तीय सहायता प्राप्त करने में सफल रहा है।

फंडिंग एजेन्सियों से प्राप्त सहायता ने वैज्ञानिकों को स्टेम कोशिका, भैंस की क्लोनिंग, ट्रांसक्रिपटोन, एम्ब्रयोजनेसिस, बायोसैंसर, नैनोप्रौद्योगिकी, क्षेत्रीय पशुओं में एबायटिक दाब, न्यूट्रास्यूटिकलस तथा क्रियात्मक आहारों पर कार्य करने के लिए प्रोत्साहित किया है। परियोजनाओं के मानीटरिंग एवं मूल्यांकन को सुदृढ़ करने के लिए तथा सूचनाओं के परिकलन एवं अंकीकरण के लिए भी फंड प्राप्त किए गए। फंडिंग एजेन्सियों से प्राप्त अनुदान

ने छात्राओं को अपने शोध–निबन्धों में आधुनिक उपकरण एवं तकनीकियों के चयन के लिए भी सहायता प्रदान की है।

अनुसंधान

★ सामान्य प्रसव द्वारा दिनांक 23 जुलाई, 2014 को एक क्लोनड बछड़ा 'रजत' पैदा हुआ। रजत हैंड गाइडिड क्लोनिंग तकनीकी द्वारा उत्पन्न हुआ। यह उच्च कोटि के सन्तति परीक्षित मुर्राह भैंस के झोटे (एम.यू.4393) के प्रशीतित द्रवित वीर्य से वियोजित सोमेटिक कोशिकाओं के प्रयोग से उत्पन्न किया गया। इस मुर्राह झोटे की कई वर्ष पूर्व मृत्यु हो चुकी है।

★ सामान्य प्रसव द्वारा दिनांक 12 दिसम्बर, 2014 को एक क्लोनड कटड़ी 'दिपाशा' का जन्म हुआ। दिपाशा आशा नामक एक जंगली भैंस का क्लोनड है। जिसे छत्तीसगढ़ में अपनी सुरक्षा में रखा गया।

★ सामान्य प्रसव द्वारा दिनांक 05 फरवरी, 2015 को एक क्लोनड कटड़ी 'अपूर्वा' का जन्म हुआ। मूत्र से वियोजित सोमेटिक कोशिकाओं को प्रयोग करके अपूर्वा को उत्पन्न किया गया।

★ सामान्य प्रसव द्वारा दिनांक 02 मई, 2014 को एक क्लोनड कटड़ी 'लालिमा' का जन्म हुआ। लालिमा राष्ट्रीय डेरी अनुसंधान संस्थान के पशुधन फार्म की श्रेष्ठ मुर्राह भैंस (एम.यू.5345) का क्लोन है।

★ क्लोनड भैंस गरिमा–II ने सामान्य प्रसव द्वारा दिनांक 27 दिसम्बर, 2014 को दूसरी क्लोनड कटड़ी 'करिश्मा' को जन्म दिया।

★ एनडीआरआई में पशु जैव प्रौद्योगिकी के क्षेत्र में कई महत्त्वपूर्ण उपलब्धियां अपने आप में विश्व रिकार्ड है तथा वर्ष 2014 में लिमका बुक में दर्ज की गई।

★ प्रचलित वैज्ञानिक पत्रिका 'साइंटिफिक इंडिया' में वर्ष 2014 की 20 उपलब्धियों में इस संस्थान में चल रहे क्लोनिंग कार्यक्रम को नौंवा स्थान दिया गया।

★ भैंस के क्लोनड भ्रूणो को ट्रोफोब्लास्टर कोशिकाओं, मूत्र एवं दुग्ध से उत्पन्न सोमोटिक कोशिकाओं तथा लिम्फोसाइट का दाता कोशिकाओं के रूप में प्रयोग कर सफलतापूर्वक उत्पन्न किया गया।

★ फाइब्रोब्लास्टर से उत्पन्न क्लोनड ब्लास्टोसिस्ट दुग्ध से उत्पन्न कोशिकाओं, लिम्फोसाइटस, ट्रोफोब्लास्ट कोशिकाओं तथा परखनली (इन–विट्रो) निषेचन द्वारा उत्पन्न क्लोनड में कई महत्वपूर्ण जीनों में उनकी विकासात्मक क्षमता, एपोपटोसिस स्तर, एपिजेनेटिक स्तर तथा अभिव्यंजना स्तर में अन्तर पाया गया।

★ भैंस के ट्रोफोब्लास्ट कोशिकालाइनों को परखनली निषेचन, हैंड–गाइडिड क्लोनिंग तथा पार्थेनोजेनेसिस द्वारा उत्पन्न ब्लास्टोसिस्टस से विकसित किया गया। एक फीडर–फ्री इन विट्रो कल्चर प्रणाली विकसित की गई जिसने उनकी दीर्घावधि संवर्धन को सक्षम बनाया।

★ यह प्रदर्शित किया गया कि चमकीले क्रेजी ब्लू के साथ अभिरंजन करके हैंड गाइडिड क्लोनिंग के लिए विकासात्मक सक्षम डिम्बाणु जनकोशिकाओं के चयन के लिए प्रभावकारी ढंग से प्रयोग किया जा सकता है।

★ एपिजेनेटिक संशोधकों के साथ भैंस की दाता कोशिकाओं के उपचार से क्लोन्ड भ्रूणों की गुणवत्ता एवं ब्लास्टोसिस्ट दर में संशोधन प्रदर्शित किया गया।

★ क्लोनड़ कटड़ियों एवं कटड़ों के भ्रूण एक्सलिंकड जीनों में अपनी विकासात्मक क्षमता, एपिजेनेटिक स्तर, लिंग–आधारिता प्रतिलिपि पैटर्न तथा एपिजेनेटिक संशोधकों की प्रतिक्रिया में भिन्न पाए गए। मादा भ्रूणों में असामान्य एक्स–लिंकड जीन अभिव्यंजना बार–बार पाई गई।

★ भैंस के भ्रूणों की इन–विट्रो संवर्धन के दौरान आक्सीजन दाब को 20–5 प्रतिशत तक कम करना उनकी विकासात्मक क्षमता तथा गुणवत्ता में सुधार पाया गया तथा एपोपटोसिस स्तर को कम करता है।

★ भैंस के ट्रांसजीनिक क्लोनड भ्रूण उत्पन्न किए गए जिनमें पी ए सी जी एफ पी – बीयू.एस.सी.डी. एक स्तनीय ग्रन्थि विशिष्ट अभिव्यंजक वैक्टर विद्यमान था जो कि स्तनीय ग्रन्थि एपिथिलिअल कोशिकाओं में स्कंदित लिनोलिक अम्ल के उच्च स्तर को परिवर्तित करने में सक्ष्म पाए गए।

★ भैंस के डिम्बाणुजनकोशिका में एक असाधरण नॉन कोडिंग आर.एन.ए. (बी.ओ.ए. 290 यू.) की जांच की गई तथा इसकी संबद्धता अभिव्यंजि प्रोटीन के साथ संस्थापित की गई। डिम्बाणुजन कोशिकाओं को विकासात्मक क्षमता प्रदान करने के लिए यह संभवतः महत्त्वपूर्ण पाई गई।

★ जी.वी.बी.डी विषय की कालानुक्रम भैंस के डिम्बाणुजनकोशिका की क्षमता के साथ सम्बद्ध पाए गए। जी.वी. स्थिति पर अस्थायी रूप से डिम्बाणुजनकोशिका रखना उनकी विकासात्मक डिम्बाणुजनकोशिका रखना उनकी विकासात्मक क्षमता में वृद्धि रखने में लाभप्रद पाया गया।

★ दुग्ध वसा गोलिका मेम्ब्रेन एपिडर्मल विकास तत्व 8 के क्रियात्मक विशेषता का एस.एच.आर.एन.ए. का प्रयोग कर जीन नीरवता द्वारा निष्पादन किया गया। यह पाया गया कि एम.एफ.जी.ई. 8 फार्म पशुओं में दुग्ध–स्त्रवण के दौरान रूपविधान तथा कोशिका आकृति के रखरखाव के लिए लाभप्रद पाई गई।

★ गोपशुओं के मूत्रा से प्रोटीन के उत्सर्जन के लिए विभिन्न विधियों को आशान्वित किया गया। प्रथम बार एल.सी. – एम.एस./एम.एस. द्वारा गोपशु मूत्र में कुल 1600 प्रोटीनों की पहचान की गई।

★ गायों में प्रारंभिक गर्भाधान (~20 दिन) निदान की जांच के लिए तीन संभावित मूत्र प्रोटीन जैवमार्करों (बोवाइन एलर्जल,

मैनन–बाईडिंग लेक्टिन सराइन पेप्टीडेज 2, अल्फा –1 – माइक्रोग्लोब्यूलिन, ग्लूटामिनाइल पेप्टाइड साइक्लो ट्रांस फिरोज) की पहचान की गई। गर्भाधान (16 वें से 45 वें दिन) के दौरान गोपशु सीरम में तीन प्रोटीन नामत: विटामिन बाइंडिगं प्रोटीन, एपोलिपोप्रेप्टिन ए तथा कांम्लीमेंट 3 सुव्यवस्थित पाए गए।

★ भैंस के पुनर्सयोजक गर्भाधान संबंधित ग्लाइकोप्रोटीन पी.ए. जी.1 तथा पी.ए.जी. 2 ई. कोलि में अभिव्यंजित पाए गए।

★ प्रारंभिक गाभिन भैंस (~2 मास) के फीटल कोटिलिडोन में विभिन्न ट्रासंक्रिप्ट विश्लेषण से प्रकट होता है कि प्रोस्टेट – विशेष एंटीजन प्रारंभिक गर्भाधान के दौरान अति–अभिव्यंजित हैं।

★ लेक्टिक एसिड बैक्टीरिया के एस. लेयर प्रोटीन (एस.एल. पी.) तथा पुनर्सयोजित ग्यूकस बाईडिंग (एफ–यू.बी.) प्रोटीन जीवविज्ञान सक्रिय रूप में अभिव्यंजित थे। ये प्रोटीन मानव आहारनली ऊतक तथा आहार नली कोशिका लाइनों के साथ बाध्यता प्रदर्शित करते हैं।

★ शुक्राणु एक्रोसोम सम्बद्ध 3(एस.पी.ए.सी.ए. 3) प्रोटीन की भैंस के भ्रूण के प्रारंभिक विकास में महत्त्वपूर्ण भूमिका पाई गई।

★ लेक्टोबेसिलस जातियों के पुनर्सयोजक ल्यूसिल अमीनोपेप्टीडेज जीवविज्ञान सक्रिय रूप में अभिव्यंजित पाए गए।

★ भैंस के हैप्टोसाइट को कई अतिकोशिकीय मेट्रासाइसी तथा फीडर फाइब्रोब्लास्ट कोशिकाओं पर एक सप्ताह तक सफलता पूर्वक संबर्धित किया गया।

★ बहु विषयक पशु माडल का प्रयोग कर मुराह भैंसों के आनुवांशिक मूल्यांकन जिन में जननक्षमता तथा उत्पादन प्रदर्शन भी सम्मिलित है का विकास किया गया।

★ उच्च जनन क्षमता तथा दुग्ध उत्पादन के लिए मुर्राह भैंसों के चयन के लिए बहु विषयक आवर्त्ती पशुमाडल का विकास किया गया।

★ युवा मुर्राह सांडों से वीर्य के प्रथम संग्रहण की आयु तथा प्रशिक्षण प्रारंभ करने के लिए औसत आयु महत्त्वपूर्ण रूप से क्रमशः 17.60 तथा 21.75 मास तक कम हो गई।

★ मुर्राह नसल के सांडों के वीर्य की प्रथम उपयोग के समय आयु (ए.ए.एफ.यू.) का आंकलन किया गया जो कि पशुसमूह में भैंसों की गर्भाधान दर में सुधार के लिए सन्तति परीक्षण कार्यक्रम के अन्तर्गत सांडों के प्रारंभिक चयन में सहायक हो सकती है।

★ प्रजनन प्रदर्शन के संबंध में मुर्राह भैसों के गर्मी के दाब के आंकलन के लिए श्रेष्ठ टी.एच.आई. माडल की पहचान की गई। मुर्राह भैंसो में श्रेष्ठ प्रजनन प्रदर्शन के लिए टी.एच.आई. ≤75 होनी चाहिए।

★ पशु समूह में साहीवाल सांडों के श्रेष्ठ गर्भाधान दर प्राप्त करने के लिए वीर्य को प्रथम बार प्रशीतित करने की आयु मानकीकृत की गई।

★ थारपारकर गायों के जीवन पर्यन्त दुग्ध उत्पादन के पूर्वानुमान के लिए एक विधि विकसित की गई।

★ उच्च उत्पादन एवं प्रजनन क्षमता के लिए करनफ्रीज गोपशुओं के चयन के लिए बहु विषयक मूल्यांकन विधि मानकित की जा रही है।

★ करन फ्रीज गोपशुओं में प्रजनन क्षमता के आनुवांशिक प्रवृत्ति तथा प्रथम दुग्ध स्त्रवण उत्पादन विशेषकों के वार्षिक फेनोटाइपिक तथा आनुवांशिक प्रवृत्ति (1992 – 2011) वांछित स्थिति में पाए गए।

★ पशुसमूह में उप–जननक्षमता समस्याओं के साथ डेरी पशुओं की पहचान के लिए साइटोजैनेटिक एवं आण्विक साइटोजेनेटिक तकनीकियां विकसित की गई।

★ कैंडीडेट जीन के आनुवांशिक परिवर्तक/एस.एन.पी. (मुर्राह भैंसों में एम.बी.एल 1 जीन) की पहचान की गई। जी.सी. जीनोटाइपड मुर्राह भैंसों में थनैला रोग की कम संभावनाएं पाई गई। कैंडीडेट जीन के आनुवांशिक परिवर्तक/एस.एन.पी. करन फ्रीज गोपशुओं में सी;डी. 14 जीन की भी पहचान की गई। ए.ए. तथा सी.सी. जीनोटाइपड करनफ्रीज गोपशुओं में थनैला रोग की कम संभावनाएं पाई गई जबकि ए.बी. तथा सी. डी. जीनोटाइपड पशुओं में थनैला रोग की अधिक संभावनाएं पाई गई।

★ संस्थान को थनैला रोग से संबंधित छः कैंडीडेट जीनो के लिए एन.सी.बी.आई. जीन बैंक प्राप्ति क्रमांक प्राप्त हुआ।

★ कृषकों के पशु समूह में मुर्राह भैंसों में औसत गर्भाधान दर 52.27 प्रतिशत पाई गई तथा कुल 1860 बछड़े (955 बछड़े एवं 905 बछड़िया) पैदा हुई जबकि क्षेत्रीय परिस्थितियों के अन्तर्गत सांडों के मूल्यांकन के लिए 183 बछड़ियों पर प्रदर्शन द्वारा रिकार्ड किया गया।

★ थारपारकर एवं करणफ्रीज (के.एफ.) बछड़ों के पैरीफर रक्त मोनोन्यूक्लियर कोशिकाओं (इन विट्रो एवं इन विवो) में एच.एस.पी. 27, 90 तथा 105 जीनों की अभिव्यजंना 25° सेंटीग्रेड की अपेक्षा 44° से.ग्रे. पर महत्त्वपूर्ण रूप से अधिक थी। इन जीनों की अभिव्यंजना में फफूदों की वृद्धि थारपारकर की अपेक्षा करन फ्रीज में महत्त्वपूर्ण रूप से अधिक थी जो कि यह इंगित करती है कि करन फ्रीज बछड़े थारपारकर की तुलना में कम ऊर्जा सहन करने वाले थे।

★ एच.एस.पी. 40, 70 तथा 90 इंटरल्यूकिन – 6 तथा इन्टरल्यूकिन – 10 की एम. आर. एन. ए. अभिव्यंजना उच्च तापमानों (42° सें.ग्रे.) पर महत्त्वपूर्ण रूप से अधिक थी तथा उनका संकेंद्रण साहीवाल की अपेक्षा करनफ्रीज में काफी अधिक था। एस.एस.पी. में महत्त्वपूर्ण रूप से कमी तथा जेड एन. सम्पूरण द्वारा दाब को कम करने में जेड एन की संभावित भूमिका है।

★ अवरोधित न्यूट्रोफिल एपोपटोसिस के बीच सकारात्मक सहसंबंध, संक्रमण के स्थान पर न्यूट्रोफिलस का चिरस्थायी

रोकथाम तथा एन.ई.टी. की संरचना सटेफलोकोकल थनैला के दौरान अयन में रोगजनकों के विरूद्ध लड़ने की रणनीति के रूप में कार्य करता है।

★ भैंसों के शुष्क अवधि के दौरान वाष्पणिक शीतलन पी.आर. एल.आर., एस.ओ.सी.एस.1, एस. ओ. सी. एस. 3 तथा एल – सलेक्टिन के विभिन्न एम.आर.एन.ए. जीन अभिव्यंजना द्वारा इंगित के अनुसार प्रसव के नजदीक इम्यून स्तर प्रजननक्षम बनाता है।

★ खमीर संवर्धन के साथ सम्पूरित मुर्राह कटड़ियाँ 20 मास की आयु में युवा होती हैं जबकि जिन कटड़ियों को यह नहीं दिया जाता वे 28 मास की आयु में युवा होती हैं।

★ जो भैंसे 32 मास की आयु में युवा होती हैं उनकी अपेक्षा 27 मास की आयु में युवा होने वाली भैंसों में प्लाज्मा नेस्फाटिन 1 तथा लेप्टिन सान्य उच्च थे तथा ग्रेहलिन सान्द्रण निम्न थे।

★ फार्म पशुओं में दुग्धस्त्रवण के दौरान रूपविधान तथा कोशिका आकृति के रखरखाव के लिए दुग्ध वसा गोलिका मेम्ब्रेन एपीडरमल विकास तत्त्व 8 (एम.एफ.जी.ई. 8) अनिवार्य है।

★ गायों में प्रारंभिक गर्भाधान निदान (~ 20 दिन) की जांच के लिए तीन संभावित मूत्र प्रोटीन जैवमार्करां की पहचान की गई। प्रोस्टेट विशिष्ट एंटीजन (पी.एस.ए.) प्रारंभिक गर्माधान के दौरान अति अभिव्यंजित है।

★ डिम्बाणुजनकोशिका परिपक्वन की अवधि भैंसों में ऊष्मा दाब द्वारा प्रभावित होती है। इस समय उच्च तापमान प्रदर्शन से भ्रूण विकास दर को खतरा होता है।

★ मलनाद गिदा गोपशुओं में लेक्टोफेरिन जीन के अनुरूप विश्लेषण से 16 ट्रांसिशन तथा 5 ट्रासंवर्शन उदघाटित हुए। डिओनि गोपशुओं की तुलना में मलनाद गिदा गोपशुओं में लेक्टोफेरिन अंश (225.20± 31.40) महत्त्वपूर्ण रूप से अधिक था। संकर पशुओं में यह (42.59 से 91.89 एन.जी/एल) तथा मुर्राह भैंसों में (11.75 से 47.13, 4 जी/ एम.एल. था।

★ आनुवांशिक अन्तराल विश्लेषण उदघाटित करता है कि वैचूर तथा पनगानूर में (0.331) उच्चतम आनुवांशिक अन्तराल तथा मलनाद गिदा एवं पनगानूर में (0.125) न्यूनतम था।

★ पी.सी.आर. – आर.एफ.एल.पी. विधि द्वारा आनुवांशिक विविधता का मूल्यांकन करने के लिए राष्ट्रीय डेरी अनुसंधान संस्थान के दक्षिण क्षेत्रीय केन्द्र के पशुधन अनुसंधान केन्द्र पर रखे गए बेतरतीब चयनित 150 डिओनि गोपशुओं से जीनोमिक डी.एन.ए. वियोजित किया गया।

★ मलनाद गिदा के लिए वीर्य संग्रहण तथा क्रायोपरिरक्षण विधियां विकसित की गई तथा राष्ट्रीय डेरी अनुसंधान संस्थान के दक्षिण क्षेत्रीय केन्द्र, बैंगलोर पर मलनाद गिदा के प्रशीतित वीर्य की 4400 डोज उत्पन्न की गई।

★ दक्षिण क्षेत्रीय केन्द्र, बैंगलोर के पशुधन अनुसंधान केन्द्र तथा एल.आर.आई.सी. (के.बी.ए.एफ.यू.) बिदार पर रखे गए 225 डिओनि पशुओं पर एक विस्तृत मोर्फोमीट्रिक अनुमापन किए गए।

★ मलनाद गिदा–कर्नाटक का एक विशिष्ट बौना गोपशु अभिलक्षित किया गया। इस नस्ल की नियमित ब्याँत की प्रजनन विशेषता (396± 33 दिन की अन्तः ब्याँत अवधि) है तथा यह प्रतिदिन 1 से 6 लीटर दूध देती है। काफी संख्या में गाय अपने जीवन काल में 15 से अधिक बछड़े उत्पन्न करती हैं। 'नागी' एक ऐसी गाय है जो अपनी 25 वर्ष की आयु में पहले ही 20 बछड़े उत्पन्न कर चुकी है।

★ भैंस के शुक्राणुओं के इन विट्रो संधारिता तथा क्रायोपरिरक्षण पर हीट शाक प्रोटीन –90 (एच.एस.पी. –90) महत्त्वपूर्ण रूप से कम होता पाया गया।

★ भैंस के शुक्राणुओं के एक्टिन (एफ साइटोसकेल्टिन प्रोटीन) पोलिमराइजेशन तथा टाइरोसिन फास्फोराइलेशन एक दोहरी प्रक्रिया के रूप में भैंस के इन विट्रो संधारिता तथा क्रायों परिरक्षण पर महत्त्वपूर्ण रूप से वृद्धि हुई।

★ ग्रेन्यूलोज कोशिकाओं पर एल.पी.एस. (एल.μ.जी./एम.एल) उपचार में टी एल आर 4 सिम्नलिग के द्वारा उतेजक जीन अभिप्रेरित करता है जबकि सी.एल.ए. (10μ एम) ग्रेन्यूलोज कोशिक एटीन्यूटस पर पूर्वउपचारित करता है। अभिप्रेरित उतेजक जीन नाभिक पर एन.एफ. – के.बी. अवरोधक – स्थानान्तरण द्वारा अभिव्यंजित होते हैं।

★ मदकाल के अभिप्रेरण एवं समक्रमण के लिए चालू प्रसव पश्चात डिओनि गायों की प्रजनन क्षमता में सुधार के लिए एक बहुमूल्य प्रौद्योगिकी के रूप में कार्य कर सकती है।

★ के.पी. 10 का प्रयोग कर गायों के लिए मदकाल समक्रमण प्रोटीकाल की नई विधि विकसित की गई।

★ किसपेप्टिन (किस स्प्रे) के लिए गोपशु विशिष्ट अन्तः नासीय स्प्रेयन्त्र का विकास किया गया।

★ सान्द्रित मिश्रण में सोयाबीन का प्रतिस्थापन जिसमें कासिया तोरां (पवांर) जैसे कीमती प्रोटीन स्त्रोत की खोज की गई।

★ जई की सूखी घास की तुलना में जई की साइलेज जिन भैंसों को खिलाई गई उनमें आन्त्र मीथेन उत्सर्जन कम (पी.<0.05) पाया गया।

★ अध्ययन से पता लगता है कि भैंसों के बढ़ते हुए बछड़ों के राशन में लाइसिन तथा रूमेन संरक्षित मीथिओनाइन के संपूरण से विविध प्रोटीन के कम प्रभाव हैं।

★ धान की भूसी के छोटे हिस्सों के आकार में 2.5 सें.मी. आकार की कमी ने रेशे की पाच्यता में सुधार कर दिया है तथा आन्त्र मीथेन उत्सर्जन को 5% तक कम कर दिया है।

★ ब्यूट्रिविबरिओ फाइबरिसोल्वनस की स्वंदेशी जाति को एक संयोज्य के रूप में प्रोटीन ने दुधारू बकरियों में 2.5 गुणातक दूध में सी.एल.ए. अंश में सुधार कर दिया है।

★ जिन बछड़ों को मक्का के बीज की खली अथवा कपास की बीज की खली वाले आहार दिए जाते हैं उनकी तुलना में सरसों की खली वाले आहार दिए जाने वाले बछड़ां में अल्प मात्रा वाले खनिजों की जैव उपलब्धता अधिक पाई गई।

★ ताजे अजोला माइक्रोफाइला 1.5 कि.ग्रा. प्रति पशु प्रतिदिन की दर से सम्पूरण कराने से संकर ओसर पशुओं की विकासदर में महत्त्वपूर्ण सुधार हुआ है तथा इससे पशुओं के स्वास्थ्य पर कोई प्रतिकूल प्रभाव नहीं पड़ा है।

★ थनैला रोग द्वारा प्रभावित स्वदेशी गायों तथा भैंसों के दूध की विद्युत – रासायनिक गुणों को निर्धारित किया गया।

★ क्षेत्रीय विशिष्ट खनिज मिश्रण (कालमिन) को बढ़ती हुई काली बंगाली बकरियों को 2.0 ग्राम प्रतिदन प्रति पशु की दर से देने पर उनके विकास तथा युवा होने की आयु में वृद्धि के लिए लाभप्रद पाया गया।

★ राशन को किफायती बनाने के लिए बढ़ते हुए संकर नस्ल के बछड़ो के राशन में मक्का की कणी की अपेक्षा पशुआहार ग्रेड गेहूँ का प्रयोग किया जा सकता है।

★ यह पाया गया कि हरे चारे तथा बाजरे की (होर्डियम बलगेयर एल.) किस्में बिजाई के समय तथा कटाई की अवस्था के द्वारा प्रभावित होती हैं।

★ विभिन्न कल्टीवर्स में पोषक तत्वों तथा पौधों की सधनता के प्रबंधन द्वारा मक्का के चारे की उपज तथा गुणवत्ता में सुधार किया गया।

प्रसंस्करण

★ अल्प सोडियम युक्त प्रसंस्कृत मोजरेला चीज को बनाने की एक प्रौद्योगिकी विकसित की गई।

★ इंडियन फार्मस्टेड आर्टिसनल चीज को बनाने की एक प्रक्रिया मानकित की गई।

★ जैवप्रोद्योगिकीय प्रक्रिया का प्रयोग कर वितरण के दौरान शैल्फलाइफ तथा स्थिरता बढ़ाने के लिए संशोधित संरचना वाली लेक्टोबेसिलस गेसेरी युक्त एक प्रतिजैवीय (प्रोबायोटिक) दही तैयार की गई।

★ विभिन्न पैकजिंग सामग्री के साथ सूक्ष्म पौष्टिक तत्व युक्त पुष्टीकर बाजरा–दूध आधारित न्यूट्रीमिक्स के लिए, शैल्फ लाइफ प्रिडिक्शन माडल विकसित किए गए।

★ स्वदेशी प्रतिजैवीय जातियों तथा उनके पोस्ट बायोटिक तैयारियां जी.एल.पी–1 स्त्राव को अभिप्रेरित किया तथा मानव एवं चूहों के अन्तर अन्तास्त्रावी कोशिकाओं से प्रोग्लूकागोन अभिव्यंजित किया।

★ खोआ जलेबी में प्रयोग के लिए शुगर फ्री सिरप तैयार किए गए।

★ अल्कालाइन यूरिया 'पेज' पर इलेक्ट्रोफोरेटिक अध्ययन ने नियंत्रण की अपेक्षा पूर्व जैवीय के साथ चीज में प्रोटीन का उच्च अवक्रमण प्रदर्शित हुआ। परिपक्वन के दौरान β केसीन की अपेक्षा α केसीन का अवक्रमण अधिक था। परपिक्वन की लम्बी अवधिक के कारण अधिक पेप्टाइड संरचना अवलोकित की गई।

★ स्वीकार्य गुणवत्ता के साथ बटरमिल्क तथा लस्सी तैयार करने में लेक्टोज हाइड्रोलाइटिक उत्पादों, ग्लूकोज तथा गलेक्टोज की विद्यमानता में लेक्टोज के आकलन के लिए एक क्लोरोमीट्रिक विधि मानकित की गई।

★ कर्ड राइस बनाने के प्रयास किए गए। मसाले जैसे धनिए की पत्तियां, कड़ी पत्ता, अदरक, मेथी के बीज तथा सरसों के बीज आदि मिलाने के स्तर का अनुमान लगाया।

★ गाय तथा भैंस दोनों के दूध के स्प्रे ड्राइंग की ऊर्जा तथा ऊर्जा विश्लेषण किया गया। गाय के दूध की स्प्रे ड्राइंग की ऊर्जा क्षमता 6.68% आंकलित की गई।

★ संतरे के छिलके को प्राकृतिक प्रतिआक्सीकारकों के एक सस्ते प्राकृतिक स्त्रोत के रूप में प्रयोग किया जा सकता है जो कि आक्सीकर ह्रास को रोकने के लिए घी जैसे वसा से भरपूर डेरी उत्पादों में प्रयोग किया जा सकता है।

★ पनीर के नमूनों की औसत कठोरता मान 45.5 एन पाया गया। दबाने का समयपनीर के कड़ेपन को काफी प्रभावित करता है तथा यह कड़ेपन के भाग को महत्वपूर्ण रूप में बढ़ा देता है।

★ पेप्टाइड टब्ल्यू.पी.3एफ 5 तथा सी.पी.1 एफ 7 व्हे प्रोटीन तथा केसीन हाइड्रोलाइसेट से संशोधित होते हैं तथा एल.हेविटिक्स एन.सी.डी.सी.288 के/ के.डीए. अंश प्रोग्लूकागोन की अभिव्यंजना को नियमित करते है तथा जी.एल.पी.–1 का स्त्रवण करता है।

★ बिफिडोबेक्टीरिया की मानवसंसाधनों से वियोजित 12 जातियां जैव रासायनिक एवं आण्विक विधियों द्वारा सही प्रकार से पहचान की गई। उनमें से तीन जातियां (एन.बी. आई.एफ–2,5,7) पर्याप्त विट्रो प्रतिजैवीय तथा क्रियात्मक गतिविधियों के साथ संपन्न पाए गए।

★ दो अति बहुफलदायक ट्रिहलोज उत्पादक जातियां प्रोपियोनिबेक्टीरिअम (पी.एफ 13, पी.एफ.18) वियोजित तथा अभिलक्षित की गई। एक उत्परिवर्ती (एम.7) की उत्पति के द्वारा ट्रिहलोज उत्पादन (1.7 गुना) में महत्वपूर्ण वृद्धि पाई गई। प्रोपियोनिबेक्टीरिया के स्ट्रेस टालरेन्स तथा ट्रिहलोज अंश के बीच सकारात्मक परस्पर संबंध पाया गया।

★ प्रोपियोनिबेक्टीरिया का प्रयोग कर डेरी अपशिष्ट से ट्रिहलोज के उत्पादन के लिए एक लागत प्रभावी प्रौद्योगिकी विकसित की गई।

★ राइबोफ्लेविन उत्पादन के लिए डेरी तथा गैर डेरी संसाधनों से 52 वियोजित जैवसंभावित से तथा इसके ओपरोन अभिलक्षण, 19 हार्बर्ड संपूर्ण रिब जीनस तथा वियोजित के टी.एल.एफ.आई ने अधिकतम विटामिन उत्पादन (2.71±0.05एम.जी./एल) प्रदर्शित किया।

★ विशिष्ट जीवाणुओं की मौजूदगी में बीजाणु अंकुरण प्रोटोकाल आशान्वित हुआ तथा इस्ट्रेज़,β ग्लूकोसिडेज, α ग्लूकोसिडेज, αग्लूकोसिडेज तथा αएमीलेज जैसे किण्वक वायवीय जीवाणु उत्पादक बैक्टीरिया में संस्थापित हुए।

★ बीजाणु अंकुरण, कीटनाशी प्रदर्शन तथा सबस्ट्रेट मिलाने की अमापन प्रोटोकाल 10पी.पी.बी. अथवा पेस्टीसाइड तक की संवेदनशीलता के साथ आशान्वित की गई।

★ एक किण्वक सबस्ट्रेट अमापन 12±0.25 घंटे के जांच समय के साथ फ्री क्रोमोजन निर्मुक्त करने के लिए विशिष्ट मार्कर किण्वकों के लिए 'किण्वक–सबस्ट्रेट प्रतिक्रिया' अभिलक्षित दूध में ई.कोलि की जांच के लिए विकसित की गई।

★ मार्कर शर्करा द्वारा बीजाणु अंकुरण के परिवर्तन पर आधारित दूध में ई.कोलि/ई.कोलि 0157:एच7 की जांच के लिए बायोचिप प्रयुक्त ई.एम.सी.सी.डी. प्रणाली पर एक लघु अमापन विकसित की गई।

★ एक विलक्षण वातनिरपेक्षी फंफूंद ओनटोमाइसिस ऐंकसरी जन. नोव. स्पै. नोव एक भारतीय ऊंट (केमलस ड्रोमिडेरियस एल) के अमाशय के अग्रभाग से वियोजित की गई। आन्तरिक अभिलेखन स्पेसर (आई.टी.एस) तथा डी.एन.ए. के लार्ज सबयूनिट (एल.एस.यू) क्षेत्र के फाइलोजेनिटिक विश्लेषण भी अपनी विशिष्टता के साथ प्रदर्शित किए गए।

★ नौ दाब सहिष्णु क्लाइवरोमाइसिस स्पै. इथिनोल उत्पादन के लिए वियोजित, अभिलक्षित तथा विश्लेषित किए गए। क्लाइरामाइसिस 6 सी. 17, एक थर्मो–एथिनोल सहिष्णु जाति 42° तापमान पर 20% (डब्ल्यू/वी.) चीनी में 10% (वी./वी.) उत्पन्न करती है। इसके अतिरिक्त 6 सी. 17 जाति द्वारा ग्लेक्टोज़ उपयोग की वृद्धि आनुवांशिक परिचालन द्वारा क्रियान्वित की जा रही है।

★ एल. प्लानटेरम सी2 का प्रयोग कर सोया दूध से जैवसक्रिय पेप्टाइड उत्पन्न किए गए। 10के. डी.ए.पेप्टाइड अंशों ने अधिकतम प्रतिआक्सीकर (1795 टी ई ए सी, μ एम) तथा प्रतिसूक्ष्म जैवीय क्रिया (14 एम.एम.) प्रदर्शित की तथा 3के. डी.ए. अंश ने एन्जियोटेंसिन कनवर्टिंग किण्वन प्रक्रिया का निषेध किया।

★ लेक्टोबेसिलस एल.आर.28 तथा एल.आर.22 ने स्किम दूध में अनुकूलतम परिस्थितियों के अन्तर्गत क्रमशः 35.25 तथा 32.34 μजी./एम.एल.फ़ोलेट उत्पन्न किया। एल.आर.28 संवर्धन जी.आई.टी. में विद्यमान रहा तथा पशु माडल में अच्छी अतिसार विरोधी क्रिया प्रदर्शित की।

★ फ्रीज ड्राइंग द्वारा प्रत्यक्ष उत्पाद प्रतिजैवीय (डी.पी.पी.), लेक्टोबेसिलस केसी. एन.सी.डी.सी. 298 संवर्धन के लिए जैवप्रक्रिया मानकित की गई।

★ लेक्टोबेसिलस स्पै. किण्वन द्वारा अल्फा–ग्लूकोसिडेज़ निरोधक दुग्ध जैवसक्रिय पेप्टाइड उत्पन्न किए गए।

★ विभिन्न निजी सान्द्रणों पर आक्सीकर दाब के विरूद्ध संरक्षण के लिए केसीन हाइड्रोलाइसेट मानकित किए गए। यह कोई साइटोटाक्सिक प्रभाव प्रदर्शित नही करता तथा काको–2 कोशिकाओं में एच2 ओ.2 प्रवृत आक्सीकर दाब के विरूद्ध साइटोसंरक्षित प्रभाव प्रदान करने के लिए पाया गया।

★ झिल्लिका रिएक्टर पर समाकलित जल अपघटन द्वारा प्रतिआक्सीकर पेप्टाइड से भरपूर हाइड्रोलिसेट के उत्पादन के लिए एक विधि मानकित की गई।

★ लौह–संशोधित दुग्ध प्रोटीन तथा जस्ता–संशोधित दुग्ध प्रोटीन सम्मिश्र तैयार करने के लिए विधियां तैयार की गई।

★ उच्च चयनता तथा संवेदनशीलता के सेफालेक्सिन के प्रतिकूल आण्विक अंकित पोलिमर (एम.आई.पी.) एक पोरोजीनिक सामग्री में लक्षित अणुओं (सेफालेक्सिन) के साथ क्रियात्मक मोनोमर, क्रास लिंकर, रेडिकल इनिशिएटर के सह–पालिमराइजेशन के द्वारा संश्लेषित किए गए।

★ दुग्ध प्रोटीनों का प्रयोग कर अल्पमिश्रित इनकेप्सुलेटिंग लौंग का तेल तैयार किया गया तथा उनके प्रतिसूक्ष्मजैवीय कार्यों के लिए मूल्यांकित किया गया।

★ दूध में सिफालेक्सिन की जांच के लिए पोलिक्लोनल रोगप्रतिकारकों का प्रयोग कर प्रतिस्पर्द्धात्मक संरचना पर आधारित एक तीव्र एवं अर्द्ध–मात्रात्मक प्रवाह अमापन विकसित किया गया।

★ घी तथा रेंडरड वसा (विशुद्ध पशु शरीर वसा) से डी.एन.ए. के उत्सर्जन के लिए एक प्रोटोकॉल मानकित की गई।

★ डेरी उत्पादों के रंग मापन के लिए एक मशीन विजिन सिस्टम कलर डैस्क विकसित किया गया।

★ चिपचिपे डेरी उत्पादों के लिए भार आधारित मापक एवं भराव प्रणाली का डिजाइन तैयार किया गया।

★ पिस्टन दाब प्रौद्योगिकी के सिद्वान्त पर पेड़ा निर्माण प्रणाली का डिजाइन तैयार किया गया तथा यंत्रीकृत की गई।

★ खीर के इन – लाइन उत्पादन के लिए एक प्रक्रिया तैयार की गई।

★ ऊष्मीय तेल आधारित विघुत दुग्ध ऊष्मायन प्रणाली विकसित की गई।

★ व्यस्क चूहों में लेक्टोबेसिलय रेम्नोसस (एम.टी.सी.से : 5897 तथा एल. फर्मेटम (एम.टी.सी.सी: 5898) के साथ तैयार प्रतिजैवीय किण्वित दूध के उपभोग पर रोगजनक ई. कोलि पर टी एच 1 टीएच 2 इम्यून होम्योस्टेसिस, प्रतिआकसीकर स्तर तथा प्रतिरोधशक्ति में महत्त्वपूर्ण सुधार संस्थापित किया गया।

★ एक ओस्टिओजीनिक सेवन अमीनों अम्ल लागं पेप्टाइड तथा इसके विखंडों के ट्रांसएपिथिलिअल संवहन के प्रमुख रूट का काको – 2 कोशिकाओं का प्रयोग कर अध्ययन किया गया, कोशिकीय पेप्टीडेज द्वारा पेप्टाइड जलअपघटित हो गया। पेप्टाइड का ट्रासंएपिथिलिअल संवहन का प्रमुख रूट तथा इसका विश्लेषित विखंड एस.ओ.पी.टी 2 /पेपटी 1 था।

★ लेक्टोबेसिलस रैमनोसस एस. 1 के 3 (एस.टी.सी.सी. 5957) का दीर्घावधि उपभोग ने चूहों में सेलमोनीला टाइफि के साथ चुनौतियों के विपरित मुख्यतः अनुकूल प्रतिरक्षा तथा अन्तर्जात के सक्रियण के द्वारा श्लेष्मीय स्तर पर संरक्षात्मक योग्यता प्रदर्शित की।

★ बीटाकासोमार्फिन – 7 (बी.सी.एम – 7) की एक सेवन अमीनो एसिड लांग पेप्टाइड के रूप में पहचान की गई जो कि ए. 1 दूध के पाचन के दौरान उत्पन्न की गई लेकिन ए. 2 दूध के पाचन के दौरान ऐसा नही हुआ। जैविक तरल पदार्थो में बी.सी. एम. 7 के आकलन के लिए विधि विकसित करने हेतु बी.सी. एम. – 7 के विरूद्ध एप्टामर्स उत्पन्न किए गए, अभिलक्षित एवं मानकित किए गए।

★ चूहों पर किए गए इन विवो अध्ययनों पर आधारित मेसोपोरस सिलिका नेनोपार्टिकलस (एम.एस.एन.) की अपेक्षा, मल्टीवाल्ड कार्बन नेनोट्यूबस (एम.डब्ल्यू.सी.एन.टी.) की विषाक्तता अधिक पाई गई।

★ एलोवीरा प्रतिजैवीय आइसक्रीम बनाने के लिए एक प्रक्रिया विकसित की गई जिसे बढ़ते हुए प्रतिरक्षा नियंत्रक गुणों के साथ क्रियात्मक आहार के रूप में प्रयोग किया जा सकता है।

★ टर्मिनालिया अर्जुन औषधि पर आधारित क्रियागत दुग्धपेय तैयार करने की एक प्रक्रिया विकसित की गई।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के पार्लर पर उपभोक्ताओं के लिए शाकाहारी पिज्जा तथा बाजरा लस्सी प्रारंभ की गई।

★ चुंबकीय चिह्नित बहुलक आक्सीटैट्रासाइक्लिन, सेफालेक्सिन तथा सेफक्यूनोम को जल, दूध, शहद एवं अण्डे के सफेद भाग से 63–93% तक हटाने मे लाभप्रद पाए गए।

★ सैवन अमीनो अम्ल लांग आस्टीओजेनिक पेप्टाइड के संवहन मार्ग काको –2 कोशिकाओं में अभिग्राहकों के द्वारा मध्यस्थ पाए गए।

★ सीरम ग्लूकागोन जैसे पेप्टाइड – 1(जी.एल.पी. –1) स्तर गमएकेकिया के साथ आहार संपूरण पर बढ़ गया है। आहार में गम एकेकिया/इनुलिन एपिडिडाइमल वसा को कम करने में सहायक है।

★ गोल्ड नेनोपार्टिकलस के हरित संश्लेषण की एक नई विधि विकसित की गई।

★ दूध में मिलावटों (तटस्थीकरों, यूरिया, ग्लूकोज, हाइड्रोजन परआक्साइड तथा माल्टो डेक्सट्रिन) की तीव्र जाचं के लिए पेपरस्ट्रिप आधारित परीक्षण विकसित किए गए। ये परीक्षण दुग्ध प्राप्ति स्थल तथा घरेलू स्तर पर किए जा सकते हैं।

★ गोल्ड नेनोपार्टिकलस का प्रयोग कर दूध में मेलामाइन की जांच के लिए एक क्लोरीमीर्टिक परीक्षण विकसित किया गया। गोल्ड नेनोपार्टिकलस मेलामाइन के लिए अति विशिष्ट है तथा 0.05 पी.पी.एम के सान्द्रण तक मेलामाइन की जांच की जा सकती है।

★ घी में वनस्पति तेलों/वसा की मिलावट की जांच के लिए ट्रेसर संघटकों पर आधारित तीव्र एच.पी.एल.सी. तथा टी.एल.सी. आधारित प्रोटोकॉल विकसित किए गए।

★ पुष्टिकरण उद्देश्य के लिए दुग्ध प्रोटीन – खनिज तथा लेक्टोज – खनिज सम्मिश्रण तैयार करने की विधियां विकसित की गई।

★ दूध में प्रतिजीवाणु अवशिष्टों की जांच के लिए एक नई किण्वक – बीजाणु आधारित क्रोमोजैनिक अमापन (ई.एस. बी.ए.) विकसित किया गया।

★ एक पेपर स्ट्रिप आधारित प्रोटोकाल 10 पी.पी.बी. की जाचं सीमा के साथ कीटनाशी (पेस्टीसाइड) के आरगेनो फास्फोरस वर्ग का पता लगाने के लिए प्रोटोकाल प्राप्त किया गया।

★ व्हे का प्रयोग करके लेक्टोबेसिलस स्पै के लिए एक लागत प्रभावी फूड ग्रेड माध्यम विकसित किया गया।

★ अच्छी विशेषताओं वाली तीव्र अम्लीकृत उच्च शर्करा सहिष्णु लेक्टिक संबर्धनों का प्रयोग करके संशोधित शारीरिक संरचना वाले व्यावसायिक स्तर पर उच्च कोटि की 'मिस्टी दही' के उत्पादन के लिए एक विधि विकसित की गई।

★ तुरन्त उपयोग हेतु तैयार शेल्फ स्थिर डेरी – फल अनाज पर आधारित सम्मिश्र स्मूदी, कम कैलोरीवाले अंडे के बिना मफिन, स्टार्च आधारित प्रशीतित डेरी कस्टर्ड, कम कैलोरी वाले सम्मिश्रित डेरी –अनाज आधारित बिस्किट खीर मोहन किण्वक – मीडिएटिड संशोधित टैक्सचर दही बनाने की विधियां विकसित की गई।

★ संभावित औषधीय जैवसक्रियों के इन्केप्सुलेशन के लिए मेट्रिक्स सामग्रियों के रूप में डेरी अवयवों के साथ एक दोहरी सतहीय मिश्रण विकसित किया गया।

★ वनस्पति तेलों के साथ दुग्ध वसा प्रतिस्थापित करके क्वारग किस्म की चीज विकसित की गई।

★ परम्परागत संदेश की तुलना में कैलोरिफिक मान में 30% तक कमी कर आहारिक सन्देश तैयार किया गया।

★ पनीर की शेल्फ लाइफ में वृद्धि के लिए खाद्य कोटिंग के लिए एक प्रौद्योगिकी विकसित की गई।

★ चयनित भारतीय डेरी उत्पादों में विभिन्न तापमानों पर आर्द्रता सोर्पशन विशेषताओं के पूर्वानुमान के लिए अभिज्ञ माडल विकसित किए गए।

★ जिन स्थानों पर पर्याप्त जल पाया जाता है उसकी अपेक्षा जल की कमी वाले क्षेत्रों में दुग्ध उत्पादन की जल उत्पादकता अधिक थी। अतः सुरक्षित एवं अर्द्ध – क्रान्तिक क्षेत्रों में डेरी कृषकों काक नाजुक स्थितियों में डी.आई.एस.आई. तथा सिंचाई जैसी प्रभावी जल प्रबंधन प्रक्रियाओं को अपनाना चाहिए।

★ एशियाई देशों के साथ भारतीय डेरी व्यापार तथा आर्थिक सहभागिता समझौता से लाभ के मात्रात्मक मूल्यांकन पर एक अध्ययन से व्यापार में उच्च अस्थिरता, व्यापार में विविधता तथा बाजार केन्द्रीकरण में कमी पाई गई। भारत ने अपने

आयात तथा निर्यात बाजार को परम्परागत डेरी उत्पादों से मूल्यवर्धित उत्पादों में परिवर्ति कर दिया है। सीमाशुल्क में कमी पर अनुकरण प्रक्रिया का सुझाव था कि भारत को केवल फिलिपाइन्स, वियतनाम तथा म्यंमार निर्यात से लाभ है।

★ दुग्ध उत्पादन आर्थिक विश्लेषण पैकेज 'मिल्क सी.ए.पी. – 1.0' दुग्ध उत्पादन की लागतों का अनुमान लगाने की विधि के मानकीकरण के लिए विकसित किया गया।

★ बिहार के राष्ट्रीय शान्ति प्रभावित क्षेत्रों में कृषकों द्वारा कृषि से प्लायन तथा आत्महत्या के कारणों जैसे दो ज्वलन्त मामलों के उत्तर तलाशने के लिए दो 'समुत्थानशील पैमाने' विकसित किए गए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान ने मोबाइल प्रचार यूनिट द्वारा विस्तार कार्यो को प्रभावी रूप से प्रदर्शित किया तथा नाबार्ड के साथ समन्वित परियोजना के अन्तर्गत करनाल जिले के डेरी कृषकों उत्पादन एवं आय में वृद्धि प्रदर्शित की।

★ राष्ट्रीय डेरी अनुसंधान संस्थान द्वारा हस्तांतरित डेरी उत्पादन प्रौद्योगिकियों के प्रभारी मुल्यांकन से प्रकट होता है कि अपनाए गए गाँवों में विस्तार मध्यस्थता के कारण प्रथम बार ब्याने की आयु तथा अन्तः – ब्याँत अवधि में महत्त्वपूर्ण रूप से कमी आई है।

शिक्षण एवं प्रशिक्षण

★ पूर्वी क्षेत्रीय केन्द्र, कल्याणी पर पशुपालन एवं डेयरिंग में डिप्लोमा प्रारंभ किया गया।

★ पीएच.डी. (डेरी प्रौद्योगिकी) कार्यक्रम के लिए 'एडवांसिस इन कार्बोहाइड्रेट टैक्नोलोजी' (डी.टी. – 723) नामक एक नया पाठ्यक्रम प्रारंभ किया गया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान का तेहरवां दीक्षांत समारोह दिनांक 14 फरवरी, 2015 को आयोजित किया गया। प्रोफेसर कप्तान सिंह सोलंकी, माननीय राज्यपाल हरियाणा इस अवसर पर मुख्य अतिथि थे। डा. मंगला राय, पूर्वसचिव एवं महानिदेशक, भा.कृ.अनु.प., नई दिल्ली ने दीक्षांत उद्बोधन प्रस्तुत किया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान ने वर्ष 2014–15 में दीक्षांत समारोह से पहले शैक्षणिक सप्ताह आयोजित किया इसमें स्मारक व्याख्यान तथा विभिन्न विभागाध्यक्षों द्वारा शिक्षण में शैक्षिक उपलब्धियों के प्रस्तुतिकरण तथा नवीन विधियों जैसे शैक्षणिक कार्यो की श्रृंखला आयोजित की। इसके अतिरिक्त श्रेष्ठ थीसिस पुरस्कार के लिए छात्रों का चयन, पैनलिस्टों द्वारा विचार–विमर्श किया गया। उच्च काटि का अनुसंधान कार्य करने के लिए प्रतिस्पर्धा की भावना जगाने तथा उन्हे प्रोत्साहित करने के उद्देश्य से 'श्रेष्ठ थीसिस पुरस्कार' भी मास्टर एवं डाक्टरेट छात्रों को प्रदान किए गए।

★ डा. के.के. अइया स्मारक व्याख्यान पुरस्कार डा. नगेन्द्र पी. शाह, प्रोफेसर, खाद्य विज्ञान एवं डेरी प्रौद्योगिकी, हांगकांग विश्वविद्यालयः डा. एन. एन. दस्तूर स्मारक व्याख्यान पुरस्कार डा. हर्ष कुमार भानवाला, अध्यक्ष, राष्ट्रीय कृषि एवं ग्रामीण विकास बैंक (नाबार्ड) मुम्बई को प्रदान किया गया। तथ डा. डी. सुन्दरेसन स्मारक व्याख्यान पुरस्कार डा. एन.के. गांगुली, पूर्व महानिदेशक भारतीय पशुचिकित्सा अनुसंधान, परिषद, नई दिल्ली को प्रदान किया गया।

★ संचार एवं नियोजन दक्षता पर चार कार्यशालाए 27 सितम्बर, 10 अक्तूबर, 11 नवम्बर तथा 20 नवम्बर 2014 को आयोजित की गई।

★ चालू बी.टैक. (डेरी प्रौद्योगिकी) तीसरे वर्ष के छात्रों (2016 की कक्षा) के लिए दो एक–दिवसीय कार्यशालाएं आयोजित की गई। प्रथम कार्यशाला पर्सनैलिटी डवलपमैंट एंड साफ्ट स्किलस पर दिनांक 14 मार्च 2015 को मैसर्ज सक्सैस सूत्रा एजुकेशनल इंस्टीटयूट, दिल्ली द्वारा आयोजित की गई जबकि दूसरी आई.एस.ओ. तथा एच.ए.सी.सी.पी. पर दिनांक 29 मार्च 2015 को मैसर्ज इन्टरटेक, पंचकूला द्वारा आयोजित की गई।

विस्तार कार्यकलाप

★ अपनाए गए गाँवों में डेरी कृषकों तथा कृषक महिलाओं के लिए वर्ष 2014–15 के दौरान विकसित प्रौद्योगिकियों के हस्तांतरण के लिए 48 किसान संगोष्ठियां आयोजित की गई। कृषकों को प्रजनन प्रबंधन प्रक्रियाओं थनैला नियंत्रण, रोग बचाव मापदंड, स्वच्छ दुग्ध उत्पादन प्रक्रियाओं, मूल्य संवर्धित डेरी उत्पाद तैयार करना, चारा की कमी अवधि में चारे का प्रबंधन तथा पूरे वर्ष हरे चारे के उत्पादन के बारे में भी जागरूक किया गया।

★ महिलाओं के लिए परिसर पर 38 महिला सशक्तिकरण प्रशिक्षण एवं शिविर आयोजित किए गए। इससे 540 कृषक महिलाओं ने लाभ उठाया। ग्रामीण महिलाएं डेयरिंग से अधिक आय अर्जित कर सकती हैं तथा अपने–अपने परिवारों में स्वस्थ वातावरण कायम रख सकती हैं। मूल्य संबर्धित डेरी उत्पादों को लघुस्तर पर उत्पादन करने के लिए संस्थान परिसर से बाहर सात महिला उद्यमिता एवं क्षमता निर्माण कार्यक्रम आयोजित किए गए जिससे 144 ग्रामीण महिलाओं ने लाभ उठाया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण केन्द्र ने पूरे देश के 5485 कृषकों, ग्रामीण महिलाओं, ग्रामीण युवाओं तथा उद्यमियों के हित के लिए फसल उत्पादन, बागवानी, मधुमक्खी पालन, मत्स्य पालन, गृहविज्ञान जैसे कृषि से संबंधित क्षेत्रों एवं डेयरिंग के विभिन्न पहलुओं पर 167 प्रशिक्षण कार्यक्रम (परिसर पर एवं परिसर से बाहर आयोजित किए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के एटिक केन्द्र ने विभिन्न राज्यों, के 11339 व्यक्तियों को वीडियो शो, व्याख्यानों, व्यक्तिगत चर्चाओं, प्रकाशित साहित्य, टोल फ्री फोन कालस

तथा ई. मेल के द्वारा 6454 सेवाएं प्रदान की। केन्द्र ने कुल 113612/– रूपए का राजस्व पुस्तकों की बिक्री द्वारा तथा 4545627/– रूपए बीजों की बिक्री द्वारा अर्जित की। कृषकों के लाभ के लिए राष्ट्रीय डेरी अनुसंधान संस्थान तथा पंजाब कृषि विश्वविद्यालय, लुधियाना द्वारा संस्थान के एटिक केन्द्र पर संयुक्त रूप से एक बीज बिक्री केन्द्र प्रारंभ किया है।

★ राष्ट्रीय डेरी अनुसंधान संस्थान ने समीपस्थ गाँवों अर्थात, कुलवेहड़ी, बुढ़ाखेड़ा, दीपो, युग्तो तथा धमनहेड़ी जैसे गाँवों में 48 बांझपन के/पशुचिकित्सा सहायता शिविर आयोजित किए। कुल 1275 पशुओं का संक्रामक रोगों, बांझपन तथा गर्भाधान निदान एवं सामान्य पशु चिकित्सा संबंधी समस्याओं का उपचार किया गया।

★ अखिल भारतीय पशुपालन अधिकारी कार्यशाला डेरी विस्तार विभाग द्वारा दिनांक 24–25 सितम्बर, 2014 को आयोजित की गई। कार्यशाला का विषय 'लघु कृषकों के लिए डेयरिगं के अवसर एवं चुनौतियां' था।

★ राष्ट्रीय डेरी अनुसंधान संस्थान ने दिनांक 25–27 फरवरी, 2015 को राष्ट्रीय डेरी मेला आयोजित किया। मेले में सारे देश से 14000 से अधिक लोगों ने भाग लिया जिनमें प्रगतिशील डेरी कृषक, डेरी उद्यमी एवं ग्रामीण महिलाओं ने भाग लिया।

★ महिलाओं को प्रोन्नत करने के लिए दो स्वयं सेवी समूह (एस.एच.जी.) चलाए जा रहे हैं जो कि बैंगलोर जिले के आस पास पूर्ण रूप से डेयरिगं संबंधी कार्यकलाप चला रहे हैं। सदस्य कृषको की जीविका पर इन प्रशिक्षणों एवं निवेशों की आपूर्ति का अनुकूल प्रभाव था।

★ राष्ट्रीय डेरी अनुसंधान संस्थान का एक नया शैक्षणिक कार्यक्रम 'कृषकों का फार्म स्कूल' गाँव गोरगढ़, करनाल में प्रारभ किया गया। इस स्कूल में 20 सक्रिया कृषकों को छात्रों के रूप में पंजीकृत किया। राष्ट्रीय डेरी अनुसंधान संस्थान के वैज्ञानिक प्रत्येक शुक्रवार एवं शनिवार को नियमित कक्षाएं ले रहे हैं।

★ भारतीय कृषि अनुसंधान परिषद – राष्ट्रीय डेरी अनुसंधान संस्थान के बी.पी.डी. यूनिट द्वारा उद्यमिता विकास द्वारा अक्तूबर 2014 से दिसम्बर 2014 तक सात प्रशिक्षण कार्यक्रम चलाए गए। व्यावसायिक डेरी फार्मिगं' पर बी.पी.डी. के द्वारा दो उद्यम विकास कार्यक्रम चलाए गए जिसमें 55 प्रशिक्षणार्थियों ने भाग लिया। त्रिपुरा राज्य से 14 पशुचिकित्सा अधिकारियों को डेरी पशुओं में बांझपन प्रबंधन के क्षेत्र में दो बैचों में प्रशिक्षित किया। आसाम से 20 युवाओं के एक समूह को 'मूल्यवर्धित डेरी उत्पादो पर प्रशिक्षण दिया गया। देश के विभिन्न भागों से सात युवा उद्यमियों ने 'चीज निर्माण' पर ई.डी.पी. कार्यक्रम के अन्तर्गत मैसर्ज मिस्टी फार्मर प्रोडयूसर कम्पनी लिमिटेड, करनाल ने 'बाजरा लस्सी' तथा अन्य डेरी उत्पाद करनाल बाजार में प्रारंभ किए। कम्पनी का 250 डेरी कृषकों का एक सुदृढ़ जाल है।

आधारीय संरचना

★ राष्ट्रीय डेरी अनुसंधान संस्थान को डेरी उत्पादन डेरी प्रसंस्करण तथा डेरी प्रबन्धन के क्षेत्र में अनुसंधान शिक्षण, प्रशिक्षण एवं परामर्श के लिए आई.एस.ओ 9001:2008 प्रमाणन प्राप्त हुआ है।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर लड़कों के लिए नया छात्रावास (150 सीटर) तथा लड़कियों के लिए एक छात्रावास (50 सीटर) का निर्माण किया गया तथा चालू किया गया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर खेल परिसर/बहुउद्देशीय हाल (कल्की भवन)/20 कमरों का अतिथि गृह बनाया गया तथा चालू किया गया।

★ दुग्ध गुणवत्ता एवं सुरक्षा हेतु रेफरल प्रयोगशाला को चालू किया गया।

★ पूर्वी क्षेत्रीय केन्द्र, कल्याणी पर पशुशरीर क्रिया तथा प्रजनन प्रयोगशाला संस्थापित की गई।

★ बिजली की अबाधित आपूर्ति के लिए 500 के वी के का जनरेटर सैट संस्थापित किया गया।

★ डेरी प्रौद्योगिकी प्रभाग में परम्परागत डेरी उत्पाद प्रयोगशाला के नवीकरण का कार्य प्रगति पर है।

★ नए उपकरण एवं यन्त्र जैसे हाई शियर होमोजनाइजर, स्प्रेडेबिलिटि रिग, स्पेक्ट्रोफोटोमीटर, दुग्ध विश्लेषक, खोआ बनाने की मशीन तथा क्रीम अलग करने का यन्त्र संस्थापित किए गए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर डेरी प्रौद्योगिकी प्रभाग के सामने वाहनों के लिए पार्किंग स्थल बनाया गया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुधन उत्पादन एवं प्रबंधन अनुभाग के अन्तर्गत अनुसंधान कार्य हेतु लाच्छा फर्श वाले 9' लम्बाई X 3' चौड़ाई X 9' ऊचाई आकार वाले 16 अजोला तालाब निर्मित किए गए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर कार्यालय क्षेत्र सब स्टेशन बिल्डिंग में पुराने मुख्य एल.टी. पैनलों की मरम्मत की गई।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर केन्द्रीय भंडार की पूरी छत पर प्री कोटिड जी.आई. शीट रूफिंग तथा फाइबर सीलिंग का कार्य पूरा हुआ।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुधन अनुसंधान केन्द्र पर युवा बछड़ों के बाड़े। युवा सांड़ों के बाड़े के पांच बड़े शैड़ों की मरम्मत।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर निदेशक कार्यालय के सामने के कमरों को सम्मेलन कक्ष आदि में परिवर्तित करने के लिए मरम्मत कार्य।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के डेरी अर्थशास्त्र, सांख्यिकी एवं प्रबन्धन प्रभाग के चार व्याख्यान हाल का मरम्मत कार्य।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के फार्म क्षेत्र में ब्लाक नं. 7 में संग्रहण सुविधा प्रदान करना तथा शैडों की मरम्मत।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुधन अनुसंधान केन्द्र पर ब्याने के ब्लॉक के तीन बड़े शैडों की मरम्मत।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल के पशुधन अनुसंधान केन्द्र की दक्षिणी ओर (600 आर फीट) मौजूदा फैन्सिंग बाड़ की मरम्मत।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर आडिरोरिअम के आस–पास अहाते (कंपाऊण्ड) की लाइटों की मरम्मत।

★ पूर्वी क्षेत्रीय केन्द्र, कल्याणी पर मैटलड सड़कों, पशुशाला, चारा अनुभाग, प्रशिक्षण केन्द्र तथा विभिन्न प्रयोगशालाओं आदि की मरम्मत।

राजभाषा एकक

राजभाषा कार्यकाल (2014–15)

★ संस्थान राजभाषा कार्यान्वयन समिति की वर्ष में चार बैठकें आयोजित की गई। इन बैठकों में राजभाषा कार्यान्वयन के क्षेत्र में संस्थान की प्रगति का आंकलन किया जाता है एवं भावी कार्यक्रमों हेतु रूपरेखा तैयारकर उन्हें कार्यान्वित किया जाता है।

★ संस्थान में विगत वर्षों की भांति इस वर्ष भी 17 सितम्बर से 30 सितम्बर 2014 तक राजभाषा पखवाड़ा का आयोजन किया गया। पखवाड़े के शुभारंभ के अवसर पर दिनांक 15.9.2014 को वैज्ञानिकों एवं तकनीकी वर्ग के कार्मिकों तथा शोध छात्रों हेतु 'शोधपत्र/पोस्टर प्रदर्शन प्रतियोगिता आयोजित की गई। इसके अतिरिक्त इस पखवाड़े के दौरान नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों हेतु दिनांक 25.9.2015 को टिप्पण एवं मसौदा लेखन प्रतियोगिता का आयोजन किया गया। इस कार्यक्रम में 20 कार्यालयों के 43 कार्मिकों ने भाग लिया।

★ संस्थान के निदेशक महोदय जो कि नगर राजभाषा कार्यान्वयन समिति के अध्यक्ष हैं, उनकी अध्यक्षता में इस समिति की पहली छःमाही बैठक दिनांक 27 जून, 2014 को सैनिक स्कूल, कुंजपुरा में संपन्न हुई एवं दूसरी छःमाही बैठक 22 दिसम्बर, 2014 मास में पंजाब नैशनल बैंक में आयोजित की गई। इन बैठकों में संस्थान की ओर से निदेशक महोदय, मुख्य प्रशासनिक अधिकारी, उपनिदेशक (राजभाषा) वरिष्ठ तकनीकी अधिकारी ने भाग लिया। राजभाषा कार्यान्वयन संबंधी प्रत्येक कार्यालय में सरकारी काम–काज राजभाषा हिन्दी में करने के लिए विभिन्न बिन्दुओं पर चर्चा कर निर्णय लिए गए।

★ संस्थान राजभाषा कार्यान्वयन समिति की बैठक में लिए गए निर्णय के अनुपालन में संस्थान के वरि0 प्रशासनिक अधिकारियों एवं सहायक प्रशासनिक अधिकारियों की एक विशेष बैठक मुख्य प्रशासनिक अधिकारी की अध्यक्षता में दिनांक 28.1.2015 को आयोजित की गई जिसमें प्रशासनिक कार्यों में राजभाषा कार्यान्वयन को बढ़ाने के लिए विचार विमर्श किया गया एवं कृत राजभाषा कार्यों की समीक्षा की गई।

★ नगर राजभाषा कार्यान्वयन समिति, करनाल द्वारा संस्थान में किए जा रहे नगर राजभाषा कार्यान्वयन संबंधी उल्लेखनीय कार्यकलापों हेतु वर्ष 2013–14 के प्रथम पुरस्कार से पुरस्कृत किया गया। यह पुरस्कार निदेशक महोदय के साथ उपनिदेशक (राजभाषा) ने प्राप्त किया।

★ संस्थान की वार्षिक गृह पत्रिका 'दुग्ध–गंगा' के चतुर्थ अंक का सफल प्रकाशन किया गया। यह कृषकों एवं पशुपालकों के लिए अत्यन्त उपयोगी है। वैज्ञानिक, शोधछात्र एवं तकनीकी अधिकारी अपने विषय से संबंधित लेख राजभाषा हिंदी में लिख कर इस पत्रिका में प्रकाशन हेतु भेजते हैं। इस पत्रिका का विमोचन सचिव राजभाषा विभाग, गृह मंत्रालय, भारत सरकार के कर कमलों द्वारा दिनांक 30–4–2014 को नराकास सदस्य कार्यालयों के प्रशासनिक अध्यक्षों की विशेष बैठक में किया गया।

★ संस्थान के वैज्ञानिकों से प्राप्त वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, वार्षिक प्रतिवेदन, प्रशासनिक पत्र/परिपत्र/ज्ञापन, गोपनीय प्रश्नपत्र, विभिन्न समारोह के अवसर, समारोहों इत्यादि की प्रेस रिपोर्ट, गणमान्य अतिथियों, मंत्रियों आदि के उद्बोधन, व्याख्यान एवं अनेक प्रकार का अनुवाद कार्य इस एकक द्वारा किया जाता है।

★ गैर हिन्दी क्षेत्रों से अध्ययन हेतु आए एम.एससी./एम.टैक./पीएच.डी. के छात्र जिन्हें मैट्रिक स्तर तक हिंदी का ज्ञान नहीं है उन्हें हिंदी शिक्षण का कार्य इस एकक के स्टाफ द्वारा किया जाता है।

★ मूल रूप से हिंदी में टिप्पण एवं मसौदा लेखन प्रोत्साहन योजना के अन्तर्गत राजभाषा हिंदी में अपना कार्य करने वाले कार्मिकों को प्रोत्साहित एवं पुरस्कृत किया जाता है। इस योजना में सभी वर्ग के अधिकारी एंव कार्मिक भाग ले सकते हैं। इस क्रम में इस वर्ष संस्थान के 11 कार्मिकों को पुरस्कृत किया गया।

★ संस्थान के वैज्ञानिकों एवं तकनीकी अधिकारियों को मूल हिंदी वैज्ञानिक लेख लेखन हेतु प्रोत्साहित करने के लिए प्रोत्साहन योजना विगत कई वर्षों से चालू है। इस प्रोत्साहन योजना के अन्तर्गत मूल रूप से हिंदी में लिखे हुए विभिन्न पत्रिकाओं में प्रकाशित लेख/आलेख/शोधपत्रों को मूल्यांकित कर पुरस्कृत किया जाता है ताकि राजभाषा कार्य में प्रगति हो सके। इस बार वर्ष 2011–12 एवं 2012–13 के दौरान लगभग 53 वैज्ञानिकों एवं तकनीकी अधिकारियों को पुरस्कृत किया गया।

GUIDE MAP OF NDRI, KARNAL

ADMINISTRATIVE BLOCK

DIRECTOR'S OFFICE (Ist. Floor)	1
JOINT DIRECTOR (ACADEMICS)	1
JOINT DIRECTOR (RESEARCH)	1
JOINT DIRECTOR (ADMN.) (Ist Floor)	1
UNIVERSITY OFFICE	1
COMPUTER CENTER	1
RESEARCH PRIORITIZATION, MONITORING AND EVALUATION CELL	1
OFFICIAL LANGUAGE CELL	1
MINI AUDITORIUM	1
RECEPTION CELL	1

DIVISIONS, SECTIONS AND SUPPORTING UNITS

DAIRY MICROBIOLOGY	2
LIBRARY	3
DAIRY TECHNOLOGY (Ground & Ist. Floor)	4
DAIRY ECONOMICS, STATISTICS & MANAGEMENT (Ist. Floor)	4
EXPERIMENTAL DAIRY	5
ANIMAL BIO-CHEMISTRY (Ground Floor)	6
DAIRY CHEMISTRY (Ist. Floor)	6
DAIRY CATTLE NUTRITION (Ground Floor)	7
DAIRY CATTLE PHYSIOLOGY (Ist. Floor)	7
DAIRY CATTLE BREEDING (2nd Floor)	7
LIVESTOCK PRODUCTION & MANAGEMENT	7
DAIRY ENGINEERING (Ground, Ist & 2nd Floor)	8
DAIRY EXTENSION (2nd Floor)	8
BUSINESS PLANNING & DEVELOPMENT UNIT	8
LIVESTOCK FARM	9
GENERATOR HOUSE	10
TECHNOLOGY BUSINESS INCUBATOR (TBI)	11
ANIMAL HEALTH COMPLEX	12
SMALL ANIMAL HOUSE	13
KENDRIYA BHANDAR	14
FEED PLANT	15
MAINTENANCE SECTION	16
FORAGE RES. & MGMT. CENTRE	17
BIO - GAS PLANT	18
SEWAGE TREATMENT PLANT	19
ARTIFICIAL BREEDING RES. CENTRE	20
KRISHI VIGYAN KENDRA	22
DAIRY TRAINING CENTRE	23

RESIDENTIAL

DIRECTOR'S BUNGALOW	33
JOINT DIRECTOR'S RESIDENCE	34
F-TYPE QUARTERS	35
E-TYPE QUARTERS	36
D-TYPE QUARTERS	37
C-TYPE QUARTERS	38
B-TYPE QUARTERS	39
A-TYPE QUARTERS	40

OTHERS

AUDITORIUM	40
MODEL DAIRY PLANT	41
HEALTH COMPLEX	42
STAFF CLUB	43
BADMINTON HALL	44
NURSERY	45
GOVT. PRIMARY SCHOOL	46
COMMUNITY CENTER	47
ELECTRICAL SUB-STATION	48
SHOPPING CENTER	49
CAFETERIA	50
COMMUNICATION CENTER	51
SECURITY SECTION	52
MILK PARLOUR	53
ATIC BUILDING	54
ANIMAL BIOTECHNOLOGY CENTRE	55
STUDENTS' PLAY GROUND	56
INDOOR STADIUM	57

STUDENT HOSTELS

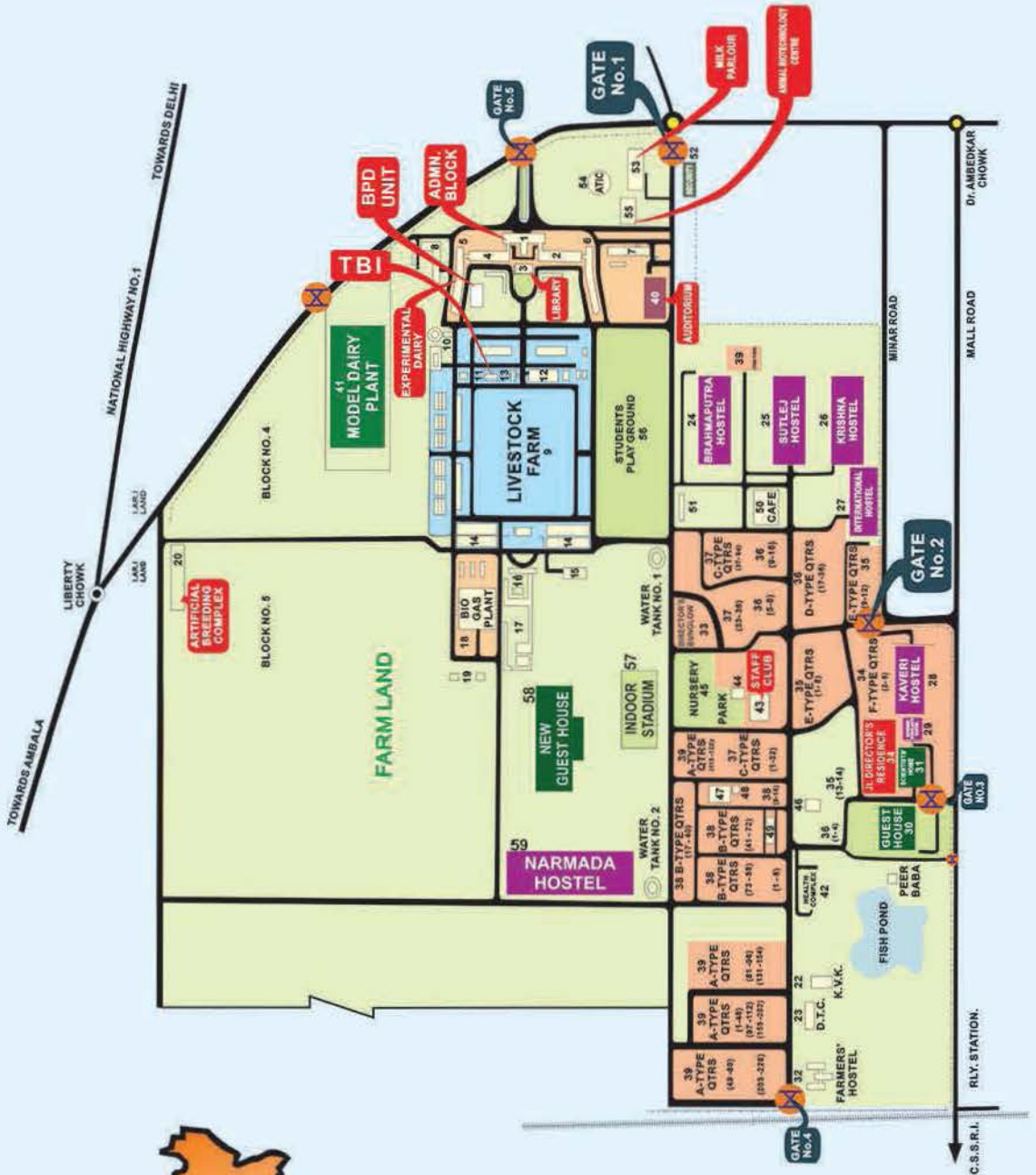
BRAHMAPUTRA	24
SUTLEJ	25
KRISHNA	26
INTERNATIONAL HOSTEL	27
KAVERI	28
MARRIED SCHOLARS'	29
ALAKHNANDA	40
NARMADA HOSTEL	59

GUEST ACCOMMODATION

GUEST HOUSE	30
SCIENTISTS' HOME	31
FARMERS' HOSTEL	32
NEW GUEST HOUSE	58

A newly constructed Indoor Stadium 'Kalki Bhawan' at NDRI, Karnal

GUIDE MAP OF NDRI, KARNAL



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

ICAR-NATIONAL DAIRY RESEARCH INSTITUTE
(Deemed University)
(ICAR) Karnal - 132 001 India
Tel.: 0184-2252800 | Fax : 0184-2250042 | E-mail : dir@ndri.res.in
Website : www.ndri.res.in