वार्षिक प्रतिवेदन
Annual Report
2013-14

राष्ट्रीय डेरी अनुसंधान संस्थान

(मान्य विश्वविद्यालय) (भा.कृ.अ.प.) करनाल - 132 001 भारत

NATIONAL DAIRY RESEARCH INSTITUTE

(Deemed University) (ICAR) 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

VISION

To see NDRI as an Institution of excellence in Tropical Dairying and Human Resource Management.

MISSION

To serve the cause of dairying by developing quality manpower and generating and disseminating technological knowhow relating to production, processing and marketing of milk and milk products, for the benefit of farming community, milk processing industry, consumers and the Nation as a whole.

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.

CONTENTS

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Dr. S. Ayyappan, Secretary, DARE and Director General, ICAR igniting young minds through his inspiring oration on "Youth for Transforming Indian Agriculture" at NDRI

प्राक्कथन

PREFACE

राष्ट्रीय डेरी अनुसंधान संस्थान, वर्ष 2013–14 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 प्रारंभ की गई 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 सम्पूर्ण परिदृश्य प्रस्तुत करता है।

वर्ष 2013–14 के दौरान संस्थान के अनुसंधान एवं विकास प्रयासों को हमारे सुनिश्चित एवं सुव्यवस्थित अनुसंधान कार्यक्रमों के द्वारा और प्रोत्साहन मिला है। इन अनुसंधान कार्यक्रमों में 89 अन्तःसंस्थानीय तथा 74 बाह्य वित्तीय सहायता प्राप्त अनुसंधान परियोजनाएं सम्मिलित हैं, अतिरिक्त वित्तीय अनुसंधान परियोजनाओं से फंडिंग 132.35 करोड़ रूपए तक पहुंच गई है जो कि राष्ट्रीय डेरी अनुसंधान संस्थान के इतिहास में अब तक सबसे अधिक है। वर्तमान में संस्थान में इस समय तीन अन्तरराष्ट्रीय समन्वय अनुसंधान परियोजनाएं जैसे जर्मन शैक्षणिक विनिमय सेवाएं (डी.एस.टी.–डी.ए.ए.डी.), इंडो–आयरलैंड तथा इंडो–न्यूजीलैंड संयुक्त अनुसंधान परियोजनाएं चल रहीं हैं। विश्व बैंक से वित्तीय सहायता प्राप्त 19 एन.ए.आई.पी. परियोजनाओं के अतिरिक्त राष्ट्रीय डेरी अनुसंधान संस्थान को लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेन्सियों जैसे जैवप्रौद्योगिकी विभाग (डी.बी.टी.) एवं प्रौद्योगिकी विभाग (डी.एस.टी.) राष्ट्रीय डेरी विकास बोर्ड (एन.डी.डी.बी.),

It gives me immense pleasure to present before you the Annual Report of NDRI for the period 2013-14. The report chronicles the significant achievements of the Institute in the area of Dairy Research, Education, Extension and related activities initiated to strengthen these programmes. The information has been so arranged that it provides a holistic view of this premier dairy Institute of the country and its functioning.

During the year 2013-14, the research and development programme of NDRI got further impetus through well-defined and structured research programmes comprising 89 in-house and 74 externally funded research projects. Funding from extramural research projects touched ₹ 132.35 crores, which is the highest ever in the history of NDRI. Presently, the Institute has the distinction of having three International Collaborative Research Projects viz. German Academic Exchange Services (DST-DAAD), Indo-Ireland and Indo-New Zealand research collaborative projects. Besides world bank funded 19 NAIP projects, NDRI has been successful in getting research funding from almost all the leading national agencies i.e. Department of Biotechnology (DBT), Department of Science and Technology (DST), National Dairy Development Board (NDDB), National Bureau of Agriculturally Important Micro-organisms (NBAIM),

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 वित्तीय सहायता प्राप्त करने में सफल रहा है।

संस्थान एक के बाद एक कई क्लोन्ड बछड़े उत्पन्न करके क्लोनिंग के क्षेत्र में अपनी विशेषता स्थापित करने में सफल रहा है। सामान्य प्रसव द्वारा दिनांक 06 सितम्बर, 2013 को 'पूर्णिमा' नामक एक क्लोनड का जन्म हुआ। जन्म के समय इसका भार 44 कि.ग्रा. था। यह कटड़ी 21 दिन तक जीवित रही। यह 'करन कीर्ति' नामक भैंस का क्लोन थी जो कि संस्थान की उच्चतम दुग्ध उत्पादक भैंस थी। 'करन कीर्ति' से दो और क्लोन भी पैदा हुए लेकिन समय से पूर्व उत्पन्न होने के कारण उनकी मृत्यु हो गई। एक संतति परीक्षित सांड नं. 4393 से एक क्लोन्ड़ कटडा दिनांक 10 अगस्त, 2013 को उत्पन्न हुआ। यह कटड़ा श्रेष्ठ था चूंकि यह एक ऐसे सांड का क्लोन था जिसकी मृत्यु कई वर्ष पूर्व हो चुकी थी। इस सांड के प्रशीतित हिम द्रवित वीर्य से वियोजित सोमोटिक कोशिकाओं का प्रयोग इस बडड़े को उत्पन्न करने में किया गया। यह बछड़ा 12 घंटे तक जीवित रहा।

डेरी प्रसंस्करण के क्षेत्र में कुछ महत्वपूर्ण अनुसंधान उपलब्धियां हुई जिनमें एल्जीमियर रोग से लड़ने वाली प्रोफाइलेक्टिक गुणों वाली करक्यूमिन पुष्टिकर लस्सी, तुरन्त प्रयोग हेतु तैयार स्थायी शेल्फ लाइफ वाली डेरी–फल–अनाज आधिारित सम्मिश्रित 'समूदी' सी.एल.ए. युक्त क्रियात्मक मक्खन, क्रियात्मक डेरी एवं गैर डेरी संघटकों का प्रयोग किए। क्रियात्मक प्रसंस्कृत चीज़ स्प्रेड, मिश्रित वसा चाकलेट स्प्रेड तथा मीठा मृदु चीज़ जैसे उत्पादों को तैयार करने की प्रक्रियाओं का विकास सम्मिलित है। व्हे स्किम दूध अंकुरित बाजरा आटा तथा तरल जौं यव्य सत्त्व से प्रतिजैवीय (प्रोबायोटिक) किण्वित व्हे पेय विकसित किए गए। मिस्टी डोई के डी.वी.एस.उत्पादन के लिए प्रौद्योगिकी मानकित की गई। यंत्रीकरण के क्षेत्र में, थ्री स्टेज स्क्रेप्ड सरफेस ऊष्मा विनिमायक (एस.एस.एच.ई.) का संशोधन निरन्तर गाजसाक उत्पादन के लिए किया गया। रंग मापन पर आधारित डेरी उत्पादों के गुणवत्ता मूल्यांकन के लिए मशीन विजिन प्रणाली विकसित की गई।

National Fund for Basic and Strategic Research on Agriculture (NFBSRA), Ministry of Food Processing Industries (MFPI), 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. 'Purnima', a cloned buffalo calf weighing 44 kg was born through normal parturition on September 6, 2013. This calf, which survived for 21 days, was the clone of a buffalo named 'Karan Kirti, having the distinction of being the highest milk producer of the Institute. Two more clones of Karan Kirti were born but died due to premature birth. A cloned calf of a progeny tested bull 4393 was born on August 10, 2013. This calf was unique since it was the clone of a bull, which had died many years back. Somatic cells isolated from the frozen-thawed semen of this bull were used for producing this calf, which survived for 12 h.

In the area of dairy processing, some of the significant research achievements include development of the processes for preparation of products like curcumin fortified *lassi*, having prophylactic attributes against Alzheimer's disease, ready-to-use shelf-stable dairy-fruit-cereal based composite smoothie, functional butter containing CLA, functional processed cheese spread, mixed fat chocolate spread and sweetened soft cheese using functional dairy and non-dairy ingredients. Probiotic fermented beverage was developed from whey-skim milk, germinated pearl millet flour and liquid barley malt extract. Technology was also standardized for the DVS production of misti doi. In the area of mechanization, three stage Scraped Surface Heat Exchanger (SSHE) was modified for continuous production of gajar pak. Machine vision system was developed for quality evaluation of dairy products based on colour measurement.

Likewise, to detect and check the hazard of adulteration in milk and milk products, the

इसी प्रकार दूध तथा दुग्ध उत्पादों में मिलावट की जांच तथा पहचान के लिए राष्ट्रीय डेरी अनुसंधान संस्थान के वैज्ञानिकों ने दूध में मिश्रित यूरिया एवं तटस्थीकारकों की जाँच के लिए स्ट्रिप आधारित परीक्षण विकसित किए गए। आर.पी.एच.पी.टी.एल.सी. का प्रयोग कर घी में वनस्पति तेल की जाँच के लिए एक विधि विकसित की गई तथा पुष्टिकर टोन्ड दूध में विटामिन डी$_2$ के आकलन के लिए एक विश्लेषणात्मक विधि विकसित की गई। दूध में बाह्य थायोसाइनेट की मात्रात्मक जांच के लिए एक रंग आधारित विधि भी विकसित की गई।

राष्ट्रीय डेरी अनुसंधान संस्थान को एक मान्य विश्वविद्यालय तथा अनुसंधान के अग्रणी क्षेत्रों में एक श्रेष्ठ केन्द्र के रूप में भारत के सभी मान्य विश्वविद्यालयों, राष्ट्रीय संस्थानों, अनुसंधान संस्थान चतुर्थ श्रेष्ठ कृषि विश्वविद्यालय है। संस्थान ने वर्ष 2013–14 से दक्षिण क्षेत्रीय केन्द्र, बंगलौर परिसर पर डेरी प्रौद्योगिकी में राष्ट्रीय डेरी डिप्लोमा भी प्रारंभ कर दिया है। पूर्वी क्षेत्रीय केन्द्र परिसर, रा.डे.अनु.संस्थान, कल्याणी पर पशुपालन एवं डेयरिंग में डिप्लोमा वर्ष 2014–15 से प्रारंभ किया जा रहा है। राष्ट्रीय डेरी अनुसंधान संस्थान ने एन.ए.आई.पी. कोंपोनैंट–1 के अन्तर्गत बी.टैक (डेरी प्रौद्योगिकी) कार्यक्रम के लिए ई–पाठ्यक्रम विकसित करके प्रथम स्थान प्राप्त किया है। बी.टैक (डेरी प्रौद्योगिकी) के 49 ई–पाठ्यक्रम विकसित किए गए हैं तथा राज्य कृषि विश्वविद्यालयों के डेरी विज्ञान कालेजों को आन–लाइन तथा आफ–लाइन दोनों विधियों से सफलतापूर्वक सौंप दिए हैं। वर्ष 2013–14 के दौरान राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय द्वारा प्रस्तुत किए जा रहे विभिन्न पाठ्यक्रमों में 12 अन्तरराष्ट्रीय छात्र शिक्षण ग्रहण कर रहे थे। उच्च गुणवत्ता के अनुसंधान कार्य एवं प्रतिस्पर्द्धा की भावना को प्रोत्साहित करने के लिए मास्टर एवं डाक्टरेट के छात्रों हेतु श्रेष्ठ शोध प्रबंध (थीसिस) पुरस्कार देना जारी रहा। शिक्षण के क्षेत्र में पूर्वस्नातक एवं स्नातकोत्तर शिक्षण के लिए 'श्रेष्ठ शिक्षक पुरस्कार' तथा शैक्षणिक उपलब्धियों एवं नवप्रवर्तनों के लिए 'श्रेष्ठ प्रभाग पुरस्कार' भी जारी है।

संस्थान का 12वां दीक्षान्त समारोह दिनांक 14 फरवरी, 2014 को आयोजित किया गया। श्री अरविन्द आर.कौशल, सचिव, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने अपना दीक्षान्त उद्‌बोधन प्रस्तुत किया तथा छात्रों को उपाधियां, स्वर्ण पदक, मेरिट प्रमाण पत्र तथा पुरस्कार

scientists at NDRI developed strip based tests for the detection of added urea and neutralizers in milk. A method was developed for vegetable oil detection in ghee using RP-HPTLC and an analytical protocol was developed for estimation of vitamin D_2 in fortified toned milk. Also a colour based method was developed for the qualitative detection of extraneous thiocyanates in milk.

NDRI as a Deemed University and as a centre of excellence in frontier areas of research has been ranked 41 among all universities, Deemed universities, National Institutions, Research Institutions of India. Also NDRI ranked as 4th top Agricultural University of India as per the published reports. The Institute has also started offering National Dairy Diploma in Dairy Technology at Southern Campus, Bangalore from the year 2013-14. Diploma in Animal Husbandry and Dairying at Eastern campus NDRI, Kalyani is being initiated from 2014-15 onwards. NDRI has taken the lead by developing e-courses for B. Tech. (Dairy Technology) degree program under NAIP component-1. Forty-nine e-courses of B. Tech (Dairy Technology) programme have been developed and successfully delivered to all Dairy Science Colleges of state agricultural universities, both in online as well as off-line mode. During the year 2013-14, a total no. of 12 International students was on rolls in different programmes being offered by NDRI Deemed University. Best Thesis Award for Master's and Doctoral students was continued to encourage the spirit of competition and motivation for quality research work. 'Best Teacher Award' for UG and PG Teaching and 'Best Division Award' for academic achievements and innovations in teaching also continued.

Twelfth Convocation was organized on 14th February, 2014. Sh. Arvind R. Kaushal, Secretary, Indian Council of Agricultural Research, New Delhi delivered the Convocation Address and gave away the Degrees, Gold Medals, Merit Certificates and Awards to the students. Fifth Dr. D. Sundaresan Memorial Oration Award was bestowed upon Dr. S. Ayyappan, Secretary

प्रदान किया। पांचवां डा. डी.सुन्दरेसन स्मारक व्याख्यान संपन्न हुआ तथा यह व्याख्यान डा. एस.अय्यप्पन, सचिव, डेयर एवं महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा दिनांक 11 फरवरी, 2014 को प्रस्तुत किया गया।

डा. के.के. आइय्या स्मारक व्याख्यान दिनांक 28 जनवरी, 2014 को डा. एस.के. बंधोपाध्याय, सदस्य, कृषि वैज्ञानिक चयन मंडल, नई दिल्ली द्वारा दिया गया। डा. एन.एन. दस्तूर स्मारक व्याख्यान इस वर्ष के लिए डा.वी.एस.कटोच, महानिदेशक, भारतीय चिकित्सा अनुसंधान परिषद, नई दिल्ली को दिया गया

वर्ष 2013–14 के दौरान पशु क्लेरोमीटर सी.ओ.$_2$ पर्यावरण चैम्बर, साइकोमीट्रिक चैम्बर, कस्टम डिजाइनड पशु शैल्टर, शरीर क्रियात्मक तथा व्यवहार अभिलेखन प्रणाली की सुविधाओं से युक्त जलवायुवीय परिवर्तनों को कायम रखने वाली पशुधन अनुसंधान केन्द्र स्थापित किया गया। पशुविज्ञान में अग्रणी एवं प्रमुख अनुसंधान के लिए चयापचय फेनोटाइप तथा फीजियो–जीनोमिक प्रयोगशाला स्थापित की गई है। 'दुग्ध गुणवत्ता एवं सुरक्षा के लिए एक अत्याधुनिक रेफरल प्रयोगशाला' का सृजन एक अन्य बड़ी उपलब्धि है। यह प्रयोगशाला दुग्ध एवं दुग्ध उत्पादों के लिए मानक विकास तथा मानव संसाधन विकास/अनुसंधान एवं विकास कार्य आयोजित करने के लिए काफी उपयोगी होगी। युवा व्यावसायियों में डेयरिंग में उद्यमिता को प्रोन्नत करने हेतु एन.ए.आई.पी. के अन्तर्गत नवीन व्यवसाय नियोजन एवं विकास (बी.पी.डी.) एकक सृजित किया गया है।

डेरी गायों के आराम एवं प्रभावी पशु कल्याण हेतु तीन अत्याधुनिक आवास प्रणालियों, कंप्यूटरीकृत डिस्पैंसिंग प्रणाली, कंप्यूटरीकृत दुग्ध दोहन प्रणाली तथा पशु क्रियाकलाप अनुश्रवण प्रणाली प्रारंभ एवं मूल्यांकित की गई। एन.एफ.बी.एस.एफ.ए.आर.ए. परियोजना के अन्तर्गत एक अत्याधुनिक थीरियोजीनोलोजी प्रयोगशाला स्थापित की गई है। इस प्रयोगशाला की सुविधाओं में कोशिका संवर्धन सुविधाएं (जैव सुरक्षा केबिनेट, इनवरटिड फलोरोसैंट माइक्रोस्कोप, सी ओ$_2$ इनक्यूबेटर आदि) हिस्टोलोजी सुविधाएं एवं अन्य मूल अनुसंधान सुविधाएं सम्मिलित हैं।

यह सचिव, डेयर एवं महानिदेशक भारतीय कृषि अनुसंधान परिषद (उपमहानिदेशक, पशुविज्ञान) भारतीय कृषि अनुसंधान परिषद के मार्गदर्शन तथा प्रोत्साहन एवं

DARE and Director General, Indian Council of Agricultural Research, New Delhi on 11th February, 2014. Dr. K.K. Iya Memorial Oration Award was given to Dr. S. K. Bandyopadhyay, Member, Agricultural Scientist Recruitment Board, New Delhi on 28th January, 2014 and Dr N. N. Dastur Memorial Oration Award for the year was bestowed upon Dr. V. M. Katoch, Director General, Indian Council of Medical Research, New Delhi.

During 2013-14, 'Climate Resilient Livestock Research Center' has been set up with facilities for animal calorimeter, CO_2 environmental chambers, psychrometric chamber, custom designed animal shelter, physiological and behavior monitoring system. Metabolic phenotype and physio-genomic laboratory has also been set up for frontier research in animal sciences. Another landmark has been the creation of the state-of-the-art 'Referral Laboratory for Milk Quality and Safety'. This lab would be of immense use for conducting R&D/HRD development and standards development for milk and milk products. A New 'Business Planning and Development (BPD)' Unit has been established under NAIP to promote entrepreneurship in dairying amongst young professionals.

Three state-of-the-art animal housing with computerized concentrate dispensing system, computerized milking system and animal activity monitoring system have been commissioned and evaluated for effective animal welfare and comfort in dairy cows. A state-of-the-art Theriogenology Laboratory has also been established under the NFBSFARA project. The facilities include cell culture facilities (bio-safety cabinet, inverted fluorescent microscope, CO_2 incubator, etc.), histology facilities, proteomics facilities and other basic research facilities.

All this could be achieved with the continued guidance and encouragement of Secretary DARE & Director General ICAR and Deputy Director General (AS), ICAR, and also support and hard work of Assistant Director Generals and Principal Scientists at SMD

सहा. महानिदेशकों तथा एस.एम.डी. (पशुविज्ञान) के प्रधान वैज्ञानिकों एवं रा.डे.अनु.संस्थान परिवार के सभी सम्मानित सदस्यों के सहयोग एवं कठिन परिश्रम से संभव हो पाया है। यह मेरा परम सौभाग्य है कि मैं इस कार्य से जुड़े संयुक्त निदेशकों, प्रभागाध्यक्षों, संकाय, प्रशासनिक/वित्त अधिकारियों एवं संस्थान के कार्मिकों 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 चरमसीमा तक पहुंच सके।

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

(AS) as well as all the esteemed 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/ Finance Officers and 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/Academic Institutions and other Dairy Development Organizations in the country.

Srivastava

(A. K. Srivastava)

EXECUTIVE SUMMARY

National Dairy Research Institute is the 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 educational 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 a 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, 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 157 scientists, 260 technicians, 145 administrative and 550 skilled supporting staff.

BUDGET OUTLAY

The financial outlays of the Institute in terms of actual expenditure for plan and non-plan for the year 2013-2014 was ₹ 14501.47 lakhs and budget sanctioned for plan and non-plan for the year 2013-2014 was ₹ 14531.09 lakhs. These figures include the financial outlays for the strengthening of Deemed University/KVK and Regional Stations.

RESEARCH

A total number of 89 in-house and 75 external research projects were in operation during the year 2013. In order to strengthen basic and strategic research, funding from extramural research projects has touched ₹ 132.35 crores, which is the highest ever in the history of NDRI. Presently, NDRI has three international research collaborative projects including German Academic Exchange Services (DST-DAAD), Indo-Ireland and Indo-Newzealand joint research projects. World Bank through NAIP has funded several research projects in consortium mode wherein NDRI is either the Lead Institute or consortium partner. 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 Dairy Development Board (NDDB), National Bureau of Agriculturally Important Microorganisms (NBAIM), National Fund for Basic and strategic Research on Agriculture (NFBSRA), Ministry of Food Processing Industries (MFPI), Department of Atomic Energy (DAE), Indian Council of Medical Research (ICMR) and Department of Animal Husbandry and Dairying (DAHD). It is worth mentioning that the Institute is handling one consultancy project amounting ₹ 1.85 crores.

The support from NAIP and other 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, evaluation, computing and digitization of information. The grants from NAIP have helped students to opt modern tools and techniques in their dissertation.

RESEARCH

- 'Swarn', a clone of an existing bull Mu-5926 was born on March 3, 2013. This male calf weighing 55 kg, which was born through normal parturition, has the distinction of being

produced though the use of somatic cells isolated from fresh semen.

- 'Purnima', a clone of 'Karan Kirti', which is the highest milk producer in the history of the Institute, was born on September 6, 2013. It survived for 21 days.
- A cloned calf of a progeny tested bull 4393 was born on August 10, 2013. This calf was unique since it was the clone of a bull, which had died many years back. Somatic cells isolated from the frozen-thawed semen of this bull were used for producing this calf, which survived for 12 h.
- Inter-species cloned blastocysts were produced using donor cells from wild buffalo (*Bubalus arnee*) and oocytes from domestic buffalo (*Bubalus bubalis*).
- Buffalo NANOG, LIF and FGF2 gene constructs were developed for transfection into buffalo embryonic stem cells for their over-expression.
- Human insulin gene was expressed in buffalo mammary epithelial cells for production of transgenic cells.
- Oocytes were generated from goat embryonic stem cells.
- Induced pluripotent stem cells were generated from adult goat fibroblast cells.
- Functional RIG1 and MDA5 genes of buffalo were found to follow a pattern of domain organization similar to that found in other mammals. RIG1 and MDA5 receptors were shown to have different affinity towards dsRNA.
- Buffalo RLR genes were found to be ubiquitously expressed in different tissues, irrespective of function of the tissue as immune organ.
- The basal expression of different NLR genes in different immune organs (blood, spleen and tonsil) was studied. Peripheral blood mono nuclear cells from Indian cattle and buffalo were cultured *in vitro* without and with the presence of different specific PRR agonist to measure the NLR and interleukin expression.
- Protein signatures identified in mammary epithelial cells during different stages of lactation revealed potential pathways associated with milk yield and lactation persistency.
- Three potential biomarkers of lactation were identified.
- Sixteen differentially expressed proteins were identified which may have a role in functional differentiation of buffalo mammary epithelial cells.
- Eleven different isoforms of buffalo pregnancy associated proteins were sequenced.
- Recombinant buffalo leukemia inhibitory factor was produced and purified from a mammalian cell line.
- Recombinant buffalo Sperm Acrosome Associated 3 (SPACA3) protein was produced and its binding was localized on oocytes.
- Recombinant collagen binding protein (Cbp) and fibronectin binding protein (Fbp) were produced in *E. coli*.
- Recombinant buffalo and goat lactoferrins (rec-Lf) was produced in yeast. The iron binding dynamics of rec-Lf were found to be similar to those of native lactoferrin isolated from milk.
- A total of 68 Karan Fries cows (29.56%) were selected as elite cows for nominated matings with an average 305-day milk yield as 4841 kg and average EPA as 4620 kg which were 13.90% and 12.29% higher than the herd average (4250 kg) and average EPA (4114 kg). The best 305 day milk yield ranged between 4158 and 8648 kg with an average of 5528 kg.
- A total of 18 KF male calves were reserved on the basis of EPD and dam's best 305 days lactation yield, breed characteristics and physical conformity for selection of young male calves for future breeding. The dam's best 305 days lactation yield of reserved KF males ranged from 4348-6861 kg. The EPD of selected male calves ranged between 5.03 and 12.28%.
- In Karan Fries cows, 47.04 % conception rate was obtained out of 3562 A.I under field conditions up to December, 2012 and 1167 (622 males and 545 females) calves were born in the farmers' herds.
- A total of 215 doses of frozen semen were sold to various agencies/farmers for genetic improvement in the field.
- Forebrain embryonic zinc finger like (FEZL) gene spans over 3.772 kb and 3.789 kb in Sahiwal and Karan Fries cattle, respectively. In Karan Fries (114) cattle, frequencies of 13G/13G and 12G/13G genotypes were 0.965 and 0.035, respectively while all Sahiwal (111) animals were genotyped as 13G/13G homozygotes.

- Entire coding and 5′ flanking regions of S100A8 (Calgranulin) gene comprises of 2.036 kb and 2.080 kb in Sahiwal and Karan Fries cattle, respectively.
- PCR-RFLP assay was developed for S100A8 using HpyCH4V for SNP genotyping in cattle. The overall frequency of GG, GA and AA genotypes at -2 (A/G) SNP locus was found to be 0.884, 0.102 and 0.013, respectively in Sahiwal cattle while it was 0.973, 0.02 and 0.007 respectively in Karan Fries cattle. No significant association between S100A8 genotypes and incidence of clinical mastitis in cattle was observed.
- Murrah buffaloes with AACCGG combined genotype of lactoferrin gene were least susceptible and AACCHH genotyped animals were most susceptible to mastitis.
- AB genotyped Murrah buffaloes with *Hpy*188I-RFLP of CD 14 gene were less susceptible to mastitis as compared to other genotypes.
- Cytogenetical screening of five ET born calves was found to be translocation carriers.
- On the basis of Expected Predicted Difference (EPD) and dam's best 305 days or less lactation milk yield (range 2747- 4090 kg.), a total of ten elite Murrah male calves were reserved for future breeding.
- Five Murrah bulls were selected for test mating under Network Project on Buffalo Improvement.
- The average lactation milk yield of elite Murrah buffaloes increased to 3151.29 kg, which was 47.60% higher than the herd average.
- The NDRI centre supplied 62,054 doses of frozen semen to farmers and dairy development organizations.
- The threshold THI was identified as 75 for fertility traits in Murrah buffaloes. THI should be ≤ 75 for better performance of fertility traits in Murrah buffaloes under sub-tropical climatic conditions.
- The Malnad Gidda is unique dwarf cattle which mostly thrives on grazing and plays a unique role in the farming systems of the heavy rain fall Malnad and coastal regions of Karnataka. Cows giving birth to one calf every year and milking up to nine months are popularly called as *Varshagandhi*. The average lactation milk yield, daily milk yield, peak yield and inter-calving period among the elite cows under field condition was 522.33 ± 69.40 liters, 2.17 ± 0.29 liters, 3.42 ± 0.39 liters and 14.91 ± 0.93 months, respectively. Good number of cows calved more than 15 calves in their life time. The lactoferrin content in Malnad Gidda cattle milk was found to be higher (range 48.98 to 157.10µg/ml).
- Nine commercial semen stations located in different parts of the Southern India maintaining 627 breeding bulls in 21 sheds were evaluated.
- Digestible nutrient intake of cell walls and cellulose improved on concentrate supplements (CS) designed on the basis of fermentation kinetics. Microbial protein production improved about 15 % (overall mean increase 13 to 17 %) compared to pellet feeds. Improvement in SNF was observed with concentrate supplements (CS) designed on the basis of fermentation kinetics.
- Sub clinical mastitis (SCM), a major and silent threat causes high economic losses to the dairy farmers. If subclinical mastitis is transformed into clinical form of mastitis, it reduces the productivity and increases the cost of treatment which ultimately accounts for heavy economic losses to the dairy farmers. The occurrence of SCM depends on various genetic and non genetic factors including housing, parity, season, etc.
- Deoni is a medium sized, dual purpose indigenous cattle and there is a need to reduce days to AFC and CI and there is further scope to augment reproductive performance in Deoni cattle through better nutritional and reproductive management interventions.
- Effect of heat stress on the dermal fibroblast of buffalo was evaluated employing quantitative PCR technique.
- Expression pattern of HSFs-1, 2, 4 HSP-70, and 90 genes in *in vitro* fibroblast cell lines in cattle breeds.
- Identification of genes and proteins in relation to heat stress by transcriptome and proteome in buffalo.
- Genes responsible for skin pigmentation (MC1R and PMEL) expressed highly ($P<0.01$) during winter than summer season in both Tharparkar (TP) and Karan Fries (KF) heifers. The magnitude of expression was higher in TP than KF ($P< 0.01$) especially during winter season indicating the better adaptability of TP cattle than KF cattle.

- Supplementation of chromium propionate improved the health status, immunity and feed intake and reduced the free radical production and cortisol levels during extreme climatic conditions in Sahiwal (SW) calves.
- BAX/BCL-2 ratios were higher in SW and KF cows at both pre and post calving during summer as compared with thermoneutral condition. There was upregulation of P-53 during summer in both SW and KF cows during transition period.
- The Caspase-3 mRNA expression in SW and KF cows decreased significantly on 15 days pre and post partum during summer and thermoneutral condition as compared to 0 day of calving. Also the magnitude of expression during summer was higher at all periods as compared with thermoneutral conditions.
- Vitamin E and A and Zn when supplemented *in vivo* to peripartum dairy animals improved their immunity and productivity, whereas, copper had a negative effect on their productivity. Vitamin A which is thought to be sufficiently available from green fodder is required in extra amount during peripartum period to maintain optimum productivity.
- Excess supplementation of micronutrients *in vitro* significantly ($P<0.01$) decreased the phagocytic activity of blood neutrophils.
- Significantly ($P< 0.01$) lower expression was observed in neutrophilic genes: TLR-2, TLR-4, TNF-alpha, IL-1 and IL-8 at calving. Shape, viability and PA of blood neutrophils changed significantly ($P<0.01$) after migration to the mammary gland to become milk neutrophils.
- Significantly higher ($P<0.01$) apoptosis of blood neutrophils was observed at calving.
- Plasma IGF I was positively related with growth and reproductive performance in male and female Murrah buffalo calves and supplementation of fermented yeast culture proved to be an economic and noninvasive biotechnological tool for increasing productive performance of low body weight Murrah buffalo calves.
- Caprine hepatocytes exhibited to be under stress when exposed to hyperthermic conditions, which resulted in significant decrease in important functional markers of hepatocytes, increased the activity of some antioxidant enzymes and TGFβ secretion *in vitro*. Treatment of hepatocyte cultures with mannan oligosaccharide under hyperthermic conditions reversed the effects.
- The level of plasma growth factors insulin like growth factor - I and nerve growth factor were positively related with sperm functional parameters and fertility status of Murrah buffalo bulls. Sperm function remained unchanged after growth factors were supplemented *in vitro*. Receptors for IGF-1 and NGF growth factors could be localized on spermatozoa qualitatively by immunofluoroscence technique.
- The overall efficiency of milk production and nutrient utilisation was significantly improved on supplementing chromium at 1.0 and 1.5 ppm level in the ration of transition buffaloes.
- Supplementation of rumen protected methionine (6g), lysine (60g) and choline (60g) resulted in increased milk yield and immunity in crossbred cows as compared to control group.
- Supplementation of rumen protected choline (RPC) (27 g/day) improved average daily gain and feed efficiency in crossbred calves and had a beneficial effect in decreasing the blood urea nitrogen, NEFA and improving the liver enzyme activities.
- *Butyrivibrio fibrisolvens* adminstration resulted in modification of rumen metabolic pathways *via* modulation of the absorbed fatty acids thus altering indirectly the regulatory mechanism responsible for CLA accumulation in meat and milk.
- The cost for per kg body weight gain in female Karan Fries calves may be reduced by replacing 10 parts of soybean meal out of 15 parts by cottonseed cake expeller or decorticated cottonseed cake solvent extracted in a concentrate mixture.
- Compared to 16S rRNA gene, mcrA gene OTUs clustered in three orders providing better insights of rumen methanogens diversity in cattle. The results revealed that *Methanobrevibacter phylotype* was predominantly present in Karan Fries crossbred cattle fed on high fibrous diet containing wheat straw and the bacterial culture of *R. flavefaciens* strain FD-1, isolated from the rumen liquor of permanently fistulated buffaloes kept on high fibre diet, showed the potential to be used as feed additive in the diet of ruminants for improving live body weight gain, daily milk yield as well as utilization of nutrients from lignocellulosic feeds.

- On the basis of *in vitro* study, 4 mM dose of bromochloromethane was found to be effective in methane reduction without affecting other rumen fermentation parameters adversely similarly *in vitro* studies, it was observed that 3 % calcium nitrate on DM basis can be used in the ruminant ration as cheap fermentable nitrogen source with overall decrease in methane production.
- Sahiwal calves with low residual feed intake (RFI) had higher feed efficiency and less methane production as compared to medium and high RFI groups.
- The partial nuceleotide sequence encoding *ftfs* genes (acetogens) and 16S rRNA genes (methanothrophs and methanogens) were amplified using PCR. The nucleotide sequence were obtained and deposited in the Gene Bank database under the Bankit number 1570827, 1571273, 1571282, and 1571285 with clones name seq1, kundu, radha and bala for FTHFS, type I, type II methanotrophs and methanogens, respectively.
- Immunosenescence is the foremost reason for increased morbidity and mortality in elderly owing to infectious diseases and inflammatory disorders. A decline in cell mediated immune response, chronic inflammation and aggravation of humoral immunity was evident in aging mice which conclusively suggested a skewed Th2 pathway during aging.
- A process for preparation of a pediocin containing potent powder from industrial cheese whey for application in extending shelf life of milk & milk products was developed. Molecular basis of resistance against pediocin by *Enterococcus faecalis* was elucidated.
- A seven amino acid peptide (peptide C) isolated from β-casein stimulated the proliferation and differentiation of osteoblasts as evident by up regulation of osteoblast differentiation markers viz. Collagen α1 type I, Alkaline phosphatase and Osteocalcin. The peptide C also exhibited inhibitory effect on osteoclast cells by decreasing the number of TRAP (Tartarate resistant acid phosphatase) cells and by decreasing the expression of osteoclast specific genes viz. Tartarate resistant acid phosphatase and Cathepsin K.
- Feeding of A1 "like" variants (A1A1 and A1A2) of β-casein modulated the gut immune response of mice through Th2 pathway as compared to A2 "like" milk. Oral intubation of commercially synthesized BCM5 and BCM7 further confirmed that these peptides were directly involved in inducing gut inflammation.
- BCM-7 was released from A1 "like" (A1A1 and A1A2) but not from A2 "like" (A2A2) variants of β-casein. Release of BCM-7 from milk of A1A1 genotyped KF was three times higher (0.2 mg/g of β-casein) than A1A2 milk.
- Both A1 and A2 alleles of β-casein were found in Indian crossbred cattle Karan Fries (KF) and Karan Swiss (KS) but A1 was found absent in indigenous breeds of cattle (Sahiwal and Tharparker) in limited number of samples.
- Proof of principle of recognition of betacasomorphin-7, a fragment generated from type A1 milk by aptamers has been created. Fifteen aptamers were identified for betacasomorphine7. Dissociation constant of aptamers were in the range of 7.0 -156 nM. The method requires coating of gold nanoparticles with aptamers and recognition is checked by change in colour gold nanoparticles.
- Proof of principle of recognition of aflatoxin M1 by selected aptamers was created. The method requires coating of gold nanoparticles with aptamers and recognition is checked by colour change in gold nanoparticles from red to violet or blue.
- Magnetic nanomaterial was prepared in laboratory. These materials have profound applications in concentration of analytes existing in low concentration for their analysis.
- Consumption of milk from different species (3% fat) inhibits the increase in plasma cholesterol level when given along with cholesterol enriched diet. Feeding of milk from different species increases the level of cholesterol excreted in faeces. Atherogenic index and cholesterol deposition in liver decreases in all the groups fed with milk (3%). Antioxidative capacity is higher for goat and camel milk as compared to other groups and the values of goat milk is comparable to control group.
- Dietary supplementation of probiotic (*L. rhamnosus/ L. plantarum*) fermented milk as well as herbal ingredients to high fat diet indicates the potential of probiotic (especially *L. rhamnosus*) in resisting the progression of obesity in mice. However, the dietary incorporation of herbal ingredient powders (commercial preparations of *Aloe vera* and *Gymnema sylvestre*

used in the study) was not observed to have additive effects.

- Dietary supplementation of probiotic *L. casei* containing fermented milk seems to have a positive effect on intestinal functionality in high fat diet fed conditions in mice.
- Analysis of peripheral blood leukocytes transcriptomic signature highlights the altered metabolic pathways by heat stress in zebu cattle.
- Metagenomic analysis of uterine microbiota identified differential bacterial population between postpartum normal and endometritic water buffaloes *(Bubalus bubalis).*
- The comparative appraisal of apoptotic features in fresh and cryopreserved spermatozoa clearly depicts the onset of active apoptosis during cryopreservation of buffalo spermatozoa through the caspase dependent and caspase independent pathways.
- The new phyto-based soya milk extender was developed in the ready to use concentrated form at the field level with extended shelf life of 30 days at refrigerator temperature for the cryopreservation of buffalo and Karan Fries spermatozoa over the conventionally used egg yolk containing extender.
- Multiwalled carbon nanotubes (WCNTs) were more than three times toxic as compared to Mesoporous Nanoparticles **(**MSNs). Different liver enzymatic biomarkers are efficient indicators of cell damage due to Nanotoxicity.
- Strip based tests were developed for the detection of added urea and neutralizers in milk.
- A Method was developed for vegetable oil detection in ghee using RP-HPTLC.
- An analytical protocol was developed for the estimation of vitamin D_2 in fortified toned milk.
- Based on physico-chemical properties, different methods were assessed for detection of soybean oil and buffalo body fat in ghee.
- Antimicrobial peptides were identified from skim milk by fermentation using selected proteolytic *lactobacillus* strains α_{S1}-CN (24-34), β-CN (197-209), β-CN (199-209), β-CN (193-207).
- Buffalo α_s-casein hydrolysates were assessed for their antioxidant activity.
- A process for preparation of curcumin nanoemulsion optimized using milk proteins and assessed for antioxidant activity in animal model system.
- New colour based test for rapid detection of detergent in milk" was transferred to Rajasthan Co-operative Dairy Federation (RCDF) Ltd. a registered society having its office at "SARAS SANKUL, J.L.N Marg, Jaipur-302 017, Rajasthan. The technology has been transferred on non-exclusive basis for Rs. 6,00,000 (Rupees six lakh only) as one time license fee plus service tax @ 12.36%.. The MOU between NDRI and RCDF was signed on March 19, 2014.
- The body and texture of both the inulin and resistant starch added cheese was inferior to control.
- It was also noted that on 100% sugar replacement in sweetener syrups, the prepared *khoa-jalebi* was slightly low in fat, protein and lactose contents as well as pH. There was also little change in moisture content of the *jalebi* prepared from sorbitol based and xyiltol based syrups.
- The sensory evaluation revealed that milk can be replaced upto 10% when fermented whey and fermentation of milk and whey mixture were used for lassi preparation, while fresh concentrated and lactose hydrolysed whey could be replaced upto 20% of dahi for the lassi preparation. Use of 20% water and 13% sugar were optimum for production of most desirable lassi with the above combination of the whey and dahi.
- The samples from cheese whey, *paneer* whey and skim milk samples were collected from the Experimental Dairy of the Southern Regional Station and tested for the presence of bacteriophages.
- Paneer was coated with casein, whey protein concentrate and tapioca starch coatings and dried. Paneer coated with starch and casein stored well and was of similar quality. Therefore, edible coatings can be recommended for paneer for extension of its shelf life.
- The work on extension of shelf-life of ghee using extracts of fruit and vegetable by-products was undertaken with an intention to replace synthetic antioxidant BHA with natural antioxidants.
- Products like curcumin fortified *lassi* and *chhana* based low calorie spread were developed having prophylactic attributes against Alzheimer's disease.

- A technology was developed to manufacture ready-to-use shelf-stable dairy-fruit-cereal based composite smoothie.
- Functional butter was developed by incorporating CLA and phytosterol and its functionality evaluated through animal bioassay.
- A process was standardized for the manufacture and extension of shelf life of *Kheer mohan* from cow milk.
- A technology developed for manufacture of functional processed cheese spread, mixed fat chocolate spread and sweetened soft cheese using functional dairy and non-dairy ingredients.
- Probiotic fermented beverage was developed made from whey-skim milk, germinated pearl millet flour and liquid barley malt extract.
- Improved textured *dahi* prepared for extended storage was prepared using biotechnological approach.
- Probiotic strains were found to be able to prevent diabetes – a multifaceted metabolic disease by maintaining glucose homeostasis as demonstrated in animal model. Improvement in glucose tolerance and insulin sensitivity in high fat diet fed C57BL/6J mice could be demonstrated using an indigenous strain of *Lactobacillus fermentum* Lf1.
- Gut hormone secretion by indigenous strains of probiotic lactobacilli could be observed using *in vitro* cell line model of endoenterocrine cells. Furthermore, MyD88 was observed to have no role in GLP-1 expression by *L. rhamnosus* GG. However, CD14 and G-proteins might play a role in expression of gut hormones such as GLP-1 for inducing satiety.
- Micro-encapsulation of broad spectrum bacteriocins provides newer way for their controlled release and may, thus, prove to be a promising technique for providing foods with enhanced safety and shelf-life.
- *Lacobacillus gasseri* Lg70 strain, isolated from breast-fed human infants, exhibiting quite high hypocholesterolemic and anti-oxidative potential in animal model studies, has proved to be a promising probiotic organism for use in functional dairy foods.
- Eight strains of fast acidifying *Streptococcus thermophilus* cultures were selected for the preparation of misti doi based on their sugar tolerance potential.
- Technology for the DVS production of misti doi culture was standardized.
- Twenty eight isolates recovered from a total of 26 commercial probiotic products were characterized and screened for their antibiotic sensitivity profile against 50 different antibiotics following the guidelines given by European Commission, 2008. MIC for most of the isolates was found to be higher than recommended by European Commission which is a matter of concern.
- *Lactobacillus* strains of human origin invariably showed better probiotic attributes than those of dairy origin and exhibited distinct genetic diversity.
- *L. fermentum* RS-2 can be used for the prevention of pathogen infections, immunomodulation and treatment of hypercholesterolemia.
- Plant bioactive components i.e. thymol, trans-cinnamaldehyde, eugenol and carvacrol exhibited broad spectrum antimicrobial activity against food borne pathogens and spoilage microflora.
- Spore based assay for detection of *L. monocytogenes* on 96 micro-well plate using marker enzymes and their germinogenic substrate and miniaturized micro well biochip based detection systems were developed.
- Spore-sensor technology (Enzyme) for antibiotic residues in milk at farm level was developed.
- Scale up design of continuous khoa making machine was done for handling concentrated milk.
- Machine vision system was developed for quality evaluation of dairy products based on colour measurement.
- Three stage Scraped Surface Heat Exchanger (SSHE) was modified for continuous production of gajar pak.
- Forced convective mechanism for accelerated production of rabri using in-line system was designed and developed.
- Moisture sorption characteristics of iron and zinc fortified nutrimix (weaning food) based on milk and pearl milet were determined.
- Energy conservation studies was carried out during khoa manufacture in three stage SSHE

- Comparative studies was carried out on physico-chemical characteristics of concentrated milk in mechanized and manual system.
- The profile study on small holder dairy production systems in the southern region was taken up with specific objectives to study the profile of small holder dairy production systems in the selected areas of southern region, to analyse selected case studies of successful small dairy farmers of the region and to study the constraints of smallholder dairy production systems in the southern region. Majority of the respondents possessed 2-5 dairy animals (64-76%). The cost of milk production in the region ranged from ₹ 17-23/litre. It was revealing that dairy farmers are facing umpteen constraints that arrest dairy development and need to be redressed on priority.
- Characteristics of grassroot innovators and the motivational factors were identified. Subsequently, attributes of innovations were highlighted to emphasis a greater role of grassroot innovators in dairying.
- Group approach (SHGs) was found most effective way of income generation and empowerment.
- Dietary manipulation of rumen fermentation using tree leaves of north-eastern India for improving growth performances in calves.
- Cattle embryonic stem cells from *in vitro* produced embryos.
- Development of genetic model for improving the selection efficiency for lactation traits of crossbred cattle at ERS, NDRI, Kalyani, West Bengal.
- Comparative nutritional evaluation and utilization of some newer feed resources in dairy cattle ration.
- Sex chromosome chimerism observed in twin crossbred calves-a case study in ERS.
- Impact analysis of women dairy cooperatives on the economy of rural households in eastern region of India.

EDUCATION

- In addition to ongoing Master's and Doctoral course in different disciplines and B. Tech. (Dairy Technology), the Institute also started Diploma in Dairy Technology at Southern camus, Bangalore from 2013-14. The institute possessed a strength of 837 students having 645 boys and 192 girls and this included 15 foreign students.
- The teaching at the Regional Stations was strengthened. In the period under report, students were deputed to carry out their Dissertations in Masters programme in Dairy Chemistry and Dairy Technology, and Doctoral dissertation work in Animal Breeding, Dairy Chemistry, Dairy Technology and Dairy Economics at the Southern Regional Station, Bangalore. Likewise, facilities at Eastern Regional Station, Kalyani were used for dissertation work of Masters Students in the discipline of Animal Biotechnology, Livestock Production and Management, Animal Nutrition and Dairy Economics.
- E-courses for B. Tech (Dairy Technology) degree programme were completed under NAIP component-1. These courses were reviewed and finalized through peer reviewers and student's reviewers for online and offline delivery to the State Agricultural Universities (SAU's) and other institutions offering the undergraduate

Sh. Arvind R. Kaushal (IAS), Secretary, ICAR & Additional Secretary, DARE giving away degrees to the passing out graduates

program. The second phase of implementation of these e-courses in terms of constant updating and revision in view of the regular feedback was also completed.

- Twelfth Convocation was organized on 14th February, 2014. Sh. Arvind R. Kaushal, Secretary, Indian Council of Agricultural Research, New Delhi delivered the Convocation Address and gave away the Degrees, Gold Medals, Merit Certificates and Awards to the students. Dr. K.M.L. Pathak, Deputy Director General (Animal Sciences), Indian Council of Agricultural Research, New Delhi and Dr. S. Honnappagol, Animal Husbandry Commissioner, were Guests of Honour on the occasion.
- In year 2013-14, NDRI organized Academic Month 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. Academic Month was celebrated from second week of January, 2014 to the second week of February, 2014. "Best Thesis Awards" were also given to Master's and Doctoral students to encourage spirit of competition and motivation for quality research work.
- On 28th January, 2014, Dr. K.K. Iya Memorial Oration was given to Dr. S. K. Bandyopadhyay, Member, Agricultural Scientist Recruitment Board, New Delhi; Dr N. N. Dastur Memorial Oration Award for the year was bestowed upon Dr. V. M. Katoch, Director General, Indian Council of Medical Research, New Delhi and on 11th February, 2014 5th Dr. D. Sundaresan Memorial Oration Award was held and given to Dr. S. Ayyappan, Director General, Indian Council of Agricultural Research, New Delhi.
- Forty-nine e-courses of B.Tech (Dairy Technology) programme were developed and successfully delivered to all Dairy Science Colleges of state agricultural universities of ICAR, both in online as well as off-line mode

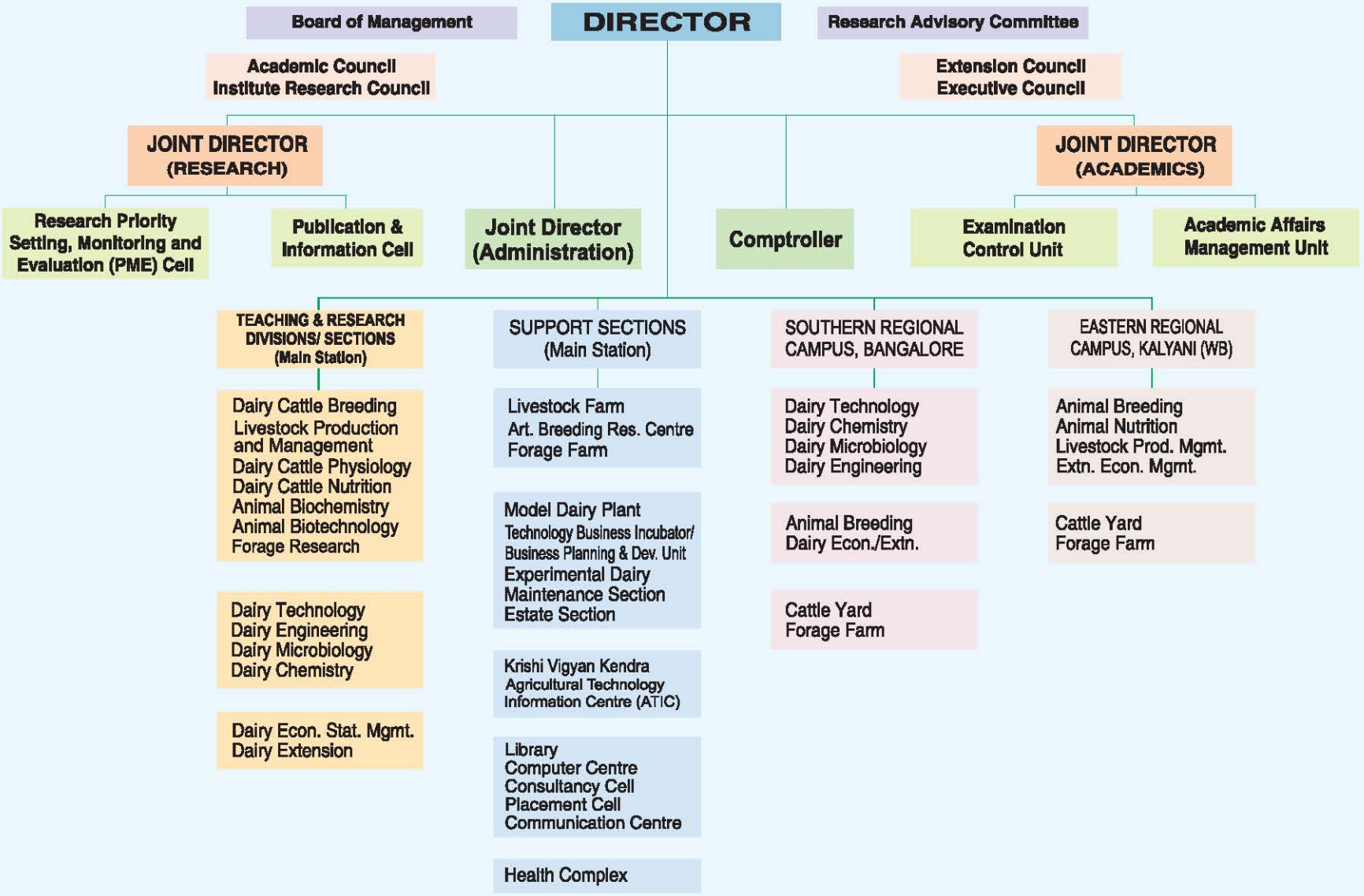
EXTENSION

- Fifty three Kisan Sangoshties were organized with the dairy farmers and farm women in the adopted villages for transfer of technologies developed during the last one year. 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 four off-campus women empowerment training and campaigns organized benefiting 511 farm women. Farm women could generate more income from dairying and maintain healthy atmosphere in their respective family. Four on-campus women entrepreneurship and capacity building programmes on small scale production of value added dairy products organized benefiting 64 farm women.
- Capacity building of unemployed village youth in scientific dairy farming, AI, PD and veterinary first aid in 12 villages in 6 blocks of Karnal district undertaken. Prompt delivery of Veterinary services and wide Artificial Insemination (AI) coverage.
- A total of 6121 visitors (students & Faculty) of 104 colleges/ Institutions/ Universities visited the institute. The groups have been sensitized about the different research, teaching and extension achievements and facilities available in the Institute.
- KVK and DTC organized 230 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 6873 farmers, farm women, rural youth and entrepreneurs. These training programmes were attended by beneficiaries from the entire country. Through its multifarious activities, KVK generated revenue worth Rs.47,15,292/- during the year.
- ATIC NDRI provided 8802 services to 15790 persons of different states, through video sows, lectures, personal discussions, published literature, toll free phone calls and e-mails. The centre generated revenue of ₹ 6,45,064/- from the sale of books (₹ 162379) and from the sale of seeds, FYM, Vermi-Compost (₹ 482685/-). First time NDRI and PAU Ludhiana jointly started a seeds sale point at ATIC NDRI for the benefit of farmers.
- NDRI organized 63 Infertility and Veterinary aid Campaigns, Exposure Visits at nearby villages viz., Nasirpur, Nasirpul tila, vazidpur, Kulwaheri, Budhakhera and Ganjogarhi. A large number of animals were treated against the contagious diseases, infertility and for pregnancy diagnosis and general veterinary cases.

INFRASTRUCTURE

- **Referral Laboratory for Milk Quality and Safety** created at NDRI. This lab would be of immense use for conducting R&D/ HRD development/standards development work for FSSAI.
- **Climate Resilient Livestock Research Center** with facilities for animal calorimeter, CO_2 environmental chambers, psychrometric chamber, custom designed animal shelter, physiological and behavior monitoring system. Metabolic phenotype and physio-genomic laboratory set up for frontier research in animal sciences.
- **New Business Planning and Development (BPD)** Unit was created under NAIP.
- **"Theriogenology" Laboratory:** A state of the art "Theriogenology Laboratory" was established at NDRI under the NFBSFARA project. The facilities include cell culture facilities (bio-safety cabinet, inverted fluorescent microscope, CO_2 incubator, etc), histology facilities, proteomics facilities and other basic research facilities.
- Three state-of-the-art housing systems, computerized concentrate dispensing system, computerized milking system and animal activity monitoring system were commissioned and evaluated for effective animal welfare and comfort in dairy cows.
- Wireless sensor based climate control room was developed and equipped.
- Behaviour monitoring system was also installed in Livestock Farm for behavioural studies.
- A number of new equipments and instruments like pasta making machine, bottle filling/ packaging machine, canning line, soft serve ice cream freezer, ice cream fruit feeder, planetary mixer, bakery mixer or spiral mixer, snack packaging machine, coating pan for mixing, bakery oven, cup filling machine, vegetable processing machine, spectrophotometer, shrink-wrap packaging machine, fruit pulper and walk in cold room were procured under BPD project.
- E-content development lab was established in the Division. It was equipped with all necessary equipments and infrastructure for e-content creation, modification and uploading the e-content for online delivery.
- **Molecular Biology Unit** of Dairy Microbiology Division renovated to give it a modular look equipped with state-of-the-art facilities besides establishment of a Tissue Culture Lab.
- **New wing of Kaveri hostel** constructed and made functional. Total rooms (single seated) constructed 52 for girls. All rooms have attached bathrooms.
- New hostel for boy's i. e **Narmada Hostel** created. The capacity of this hostel is 150 students Boys). All rooms are single seated.
- **Forage museum** established in around 2 acres of land at NDRI.
- **On-line ASRB Examination Centre** made functional.
- Internet facilities developed in all hostels.
- Renovation of International hostel.
- Creation of new facilities of extra Conference Halls/Meeting Rooms in Administrative block.
- Conversion of Utility Section of Dairy Engineering Division into Examination Centre of the Institute.
- Renovation of different sheds and rooms, sheds and providing storage facility in Block No.7 in Farm Area, Repair of existing fencing with galvanized wire (8' height) in Block No.6.
- Renovation of rooms in Workshop and Office premises, Seminar Room/Committee Room in Farm Section.
- Renovation of D. Sundaresan Memorial Auditorium.
- Architectural elevation at Institute Main Entrance, NDRI, Bangalore.
- Renovation of "B & E" Wings of Students Hostel at SRS of NDRI, Bangalore.
- Development of Farm Road in Farm Area of the Institute at SRS of NDRI, Bangalore.
- Construction of Girls Hostel at SRS of NDRI, Bangalore.
- Repairing of Boundary Wall at ERS, NDRI, Kalyani.
- Repairing and Carpeting of metal roads in ERS of NDRI, Kalyani (WB).
- Repair/Renovation of Office corridor of Cattle Yard, at ERS, NDRI, 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	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
	Dr. Arjava Sharma, Director, NBAGR, Karnal
	Dr. P. Khandekar, Principal Scientist, Agriculture Extension, NIANP, Bangalore
	Dr. S. K. Agrawal, Director, Central Institute for Research on Goats, Makhdoom, 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, Dwarka, New Delhi
	Dr. Chanda Nimbkar, Director, Animal Husbandry Division, Nimbkar Agricultural Research Institute, Phaltan, Maharashtra
Member (VC of Agricultural University	Dr. R. K. Mittal, Vice Chancellor,
Nominated by the President, ICAR)	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,

Member (One Eminent Scientist in the Field of Research done in Institute but not employed by ICAR, Nominated by President, ICAR)	Dr. K. Pradhan, Ex- Vice Chancellor, OUAT, C-24/HIG, Baramunda, Colony, Bhubaneswar
Member (One Eminent Agril. Educationist Concerned with the Research work of the Institute but not employed by ICAR, Nominated by President, ICAR)	Dr. S. N. Maurya, Ex-Vice Chancellor, Foot Mill City, P.O., Kamaluaganja, Haldwani
Member (Non Official Persons Representing Agriculture Interest to be Nominated by President, ICAR)	Sh. Devendra Shah, Chairman, Parag Milk Foods Pvt. Ltd., Nariman Point, Mumbai
	Sh. Gurumukh Singh, Progressive Farmer, Tarn-Taran -143303 Panjab
Member (FA, ICAR or his Nominee)	AS&FA, DARE
Member (Commissioner, Rohtak Division, Rohtak)	Commissioner, Rohtak Division, Rohtak
Member Secretary	Sh. J. K. Kewalramani Joint Director (Admn. & Registrar)

Academic Council

Chairman	Dr. A. K. Srivastava, Director, NDRI
Vice-Chairman	Dr. G. R. Patil, Joint Director (A), NDRI
Member	Joint Director (Research)
Members (Four Eminent Scientists from outside the NDRI)	Dr. Kusumakar Sharma, Astt. Director General (EP&D), Indian Council of Agricultural Research, Krishi Anusandhan Bhawan-II, Pusa, New Delhi 110012
	Dr. S. K. Garg, Dean, College of Veterinary Sciencies, Veterinary University, Mathura (UP)
	Dr. A. M. Thakar, Dean, College of Veterinary Sciencies, AAU, Anand-388001 (Guj)
	Dr. B. V. Venkateshaiah, Ex-Dean, Dairy Science College, Hebbal, Yashovana, B1-62, 208 SFS Colony, Yelahanka, Bangalore-560024
Member (DDG Education or his nominee)	Deputy Director General (Edn.) Indian Council of Agricultural Research, Krishi Anusandhan Bhawan-II, Pusa, New Delhi 110012
Members (One Senior Scientist from each Division)	Dr. A. K. Dodeja, Head, DE Division
	Dr. A. K. Gupta, Head, DCB Division
	Dr. S. S. Kundu, Head, DCN Division
	Dr. Y. S. Rajput, Head, ABC Division
	Dr. K. K. Datta, Head, DES&M Division
	Dr. V. K. Gupta, Head, DT Division
	Dr. R. K. Malik, Head, DM Division
	Dr. Bimlesh Mann, Head, DC Division
	Dr. K. Ponnusamy, Head, D. Extn. Division
	Dr. R. S. Manik, I/c ABTC Division
	Dr. Shiv Prasad, I/c LPM
	Dr. Magan Singh, I/c FRMS
	Dr. A. K. Chakravarti, I/c ABRC
	Dr. I. K. Sawhney, COE
	Dr. S. K. Kanawjia, Academic Coordinator
	Dr. Satish Kulkarni, Head, SRS, Bangalore
	Dr. T. K. Datta, Head, ERS, Kalyani

(Two Representatives from PG Faculty)	Dr. Smita Sirohi, PS, DES&M
	Dr. A. K. Singh, Sr. Scientist, DT
Students Member	Ms. Rajalaxmi Behera
	Mr. Deshmukh Pavan Vijayrao
Member-Secretary	Joint Director Admn. and Registrar, NDRI Deemed University

Research Advisory Committee

Chairman (An Eminent Scientist from outside ICAR system, nominated by DG, ICAR	Dr. B. N. Mathur, Ex-Director, NDRI, Q-35, Radhasoami Satsang, Dera Baba Jaimal Singh, Beas, Punjab-143204
Member	Dr. K. M. L. Pathak, Deputy Director General (AS), ICAR, New Delhi
Member	Dr. A. K. Srivastava, Director, NDRI, Karnal
Member	Dr. A. K. Mishra, V. C. Maharashtra Animal and Fishery Sciences University, Seminary Hills, Nagpur-440006 (Maharashtra)
Member	Dr. V. Padmanabhan Reddy, Associate Dean, Sri Venkateshwara Veterinary University, Dr. Y. S. R. Bhavan, Tirupati -517502 (A.P)
Member	Dr. P. A. Shankar, Former Director, Dairy Science College, 1275, 24th Cross, 25th Main BSK Stage, Bangalore-560070
Member	Dr. Khub Singh, Ex- Director NIANP, T-23, Ground Floor, Eldeo Residency Green, Sector- PI, Greater Noida-201306
Member	Dr. K. L. Raheja, Ex-Dean COVAS, 634, Sector-15-A, CCSHAU, Hisar
Member	Dr. P. K. Joshi, Director, South Asia, IFPRI, New Delhi Office, NASC Complex, CG Block, Dev Prakash Shastri Road (Opp. Todapur) Pusa New Delhi-110012
Member Secretary	Dr. G. R. Patil Joint Director (Res.)

Extension Council

Chairman	Dr. A. K. Srivastava, Director, NDRI
Members	Dr. G. R. Patil, Joint Director (Research), NDRI
	Dr. G. R. Patil, Joint Director (Academic), DDG (Extension Education), ICAR
	Dr. A. K. Chakravarty, PS & I/c, ABRC
	Dr. A. K. Singh, Sr. Scientist, DT
	Dr. B. S. Chandel, PS, DES&M
	Dr. O. K. Hooda, PS, DCP
	Dr. Shiv Prasad, PS & I/c LPM & LRC
	Dr. P. S. Oberoi, PS & I/c ATIC
	Mrs. Ritu Chakravarty, Scientist, D. Extn.
	Dr. Avtar Singh, PS, DCB Division
	Dr. T. K. Dutta, Head, ERS, Bangalore
	Dr. D. P. Malik, Additional Comm. (Crops), Govt. of India, Ministry of Agriculture Director General, Dept. of Animal Husbandry & Dairying, Govt. of Haryana,
	Director (Farm Information), Directorate of Extension, Govt. of India
Member Secretary	Dr. K. Ponnusamy, Head, Dairy Extension Division

FINANCE

The financial outlays in terms of actual expenditure for Plan and Non-plan for the year 2013-2014 was ₹ 14501.47 lakhs and the sanctioned budget for Plan and Non-plan in 2013-2014 was ₹ 14531.09 lakhs. These figures include the financial outlays for strengthening of Deemed University/KVK and Regional Stations.

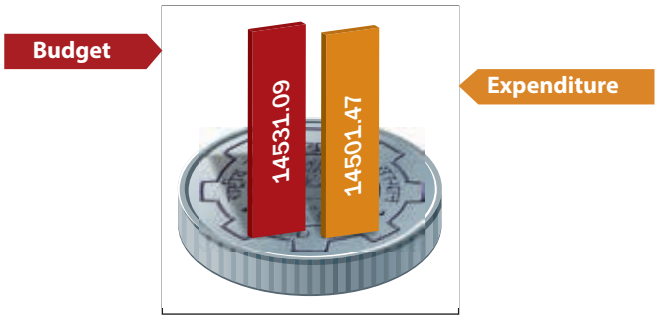
Financial Outlays & Expenditure during 2013-14

(₹ in lakhs)

Head	Budget	Expenditure
Non-Plan	13012.00	12982.77
Plan	1519.09	1518.70
Total	**14531.09**	**14501.47**

The Revenue Receipts of the Institute and the Regional Stations for the year 2013-2014 were ₹ 899.50 lakhs.

FINANCIAL OUTLAY



Position of Manpower at NDRI, Karnal and its Regional Stations as on 31.03.2014

Type of Posts	Existing		Vacant	Additional Proposed **	Total	
	Approved by D/o Expenditure	In position			Sanctioned + Additional	Existing + Additional
Scientific	194	157	37	20	194+20	157+20
Administrative (Group A&B)	35	30	05	-	-	-
Technical	355	260	95	15	355+15	260+15
Administrative (Group B&C)	127	*115	**22	Nil	127+00	115+00
Supporting	755	550	205	11	755+11	550+11
Total	1466	1112	364	46	1431+46	1182+46

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

***Proposal for revival of 12 vacant posts of aforesaid category sent to the Council.*

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 of 68 Karan Fries cows (29.56%) were selected as elite cows for nominated matings with an average 305-day milk yield as 4841 kg and average EPA as 4620 kg which were 13.90% and 12.29% higher than the herd average (4250 kg) and average EPA (4114 kg). The best 305 day milk yield ranged between 4158 and 8648 kg with an average of 5528 kg.

- A total of 18 KF male calves were reserved on the basis of EPD and dam's best 305 days lactation yield, breed characteristics and physical conformity for selection of young male calves for future breeding. The dam's best 305 days lactation yield of reserved KF males ranged from 4348-6861 Kg. The EPD of selected male calves ranged between 5.03 and 12.28 %. Information is being compiled on X – XIII sets of bulls.

- A total of 3562 A.I were performed in KF and as a result 47.04% conception rate was obtained under field conditions up to December, 2012. A total of 1167 (622 males and 545 females) KF calves were born in the farmers' herds and test day milk yield data on 598 Karan Fries have been recorded for evaluation of bulls under field conditions.

- The heritability of first lactation 305-day milk yield (FL305MY), predicted 305-day milk yield using 180-day milk yield (PY305MY), 180-day milk yield (180DMY), fat yield, SNF yield, AFC and FSP traits were 0.053 ± 0.024, 0.050 ± 0.023, 0.050 ± 0.024, 0.154 ± 0.043, 0.111 ± 0.038, 0.108 ± 0.031 and 0.003 ± 0.015, respectively from single trait-sire model (ST-SM) using WOMBAT software. The corresponding heritability estimates of these traits from single-trait animal models (ST-AM) were 0.238 ± 0.087, 0.208 ± 0.010, 0.206 ± 0.010, 0.349 ± 0.091, 0.339 ± 0.094, 0.156 ± 0.058 and 0.010 ± 0.047, respectively. The improvement in heritability of FL305MY, PY305MY, 180DMY, fat yield, fat (%), SNF yield, SNF (%), AFC and FSP traits by ST-AM were 349.10%, 349.05%, 316%, 32.75%, 53.55%, 30.76% and 233.33%, respectively compared to the estimate of ST-SM analysis.

- The annual genetic trends for the first lactation traits (period 1992 - 2009) estimated by BLUP method were 4.85 kg for 305-day/ less milk yield (0.15% of herd average), 3.44 kg for total lactation milk yield (0.09% of herd average), 0.58 days for first lactation length (0.16% of herd average), -1.08 days for AFC (-0.11% of herd average) and -0.59 days for FCI (0.13% of herd average). The annual genetic trends of these traits were in desirable direction but lower in magnitude having high standard errors except for FLL.

- The two-trait animal model of traits combination SNF yield with any one of FL305MY, PY305MY and 180DMY traits was observed to be better method based on improved estimate of heritability compared to other two trait combinations. The three-trait animal model of traits combination AFC and FSP (as covariate) with each of FL305MY, PY305MY and 180DMY traits was observed to be a better method of evaluation among others considered three trait combinations based on improved estimate of heritability. Among four-trait animal models, the model of traits combination SNF yield, AFC and FSP with each of FL305MY, PY305MY and 180DMY traits was found superior to other four-trait animal model of traits combinations based on improved estimate of heritability.

Multiplication and Dissemination of Tharparkar Germplasm

Seven bulls were under regular semen collection. Around thirty thousand doses of frozen semen were produced and one thousand doses of frozen semen were supplied/ sold to the farmers/ developmental agencies. A total of 215 doses of frozen semen were sold to various agencies/ farmers for genetic improvement in the field. In all 29 ejaculates of 4 breeding bulls were assessed for semen quality. The average ejaculate volume, mass activity, individual motility (%), sperm concentration (millions/ml), live (%), abnormalities (%), HOST (%) and acrosomal integrity (%) were 3.48, 3.13, 62.64, 1792.65, 79.08, 3.5, 69.0 and 88.1%, respectively. To widen the genetic base of Tharparkar herd at the Institute, nineteen heifers/cows were purchased from breeding tract of Jaisalmer in Rajasthan.

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

Molecular characterization and identification of polymorphism FEZL gene in Sahiwal and Karan Fries cattle: Forebrain embryonic zinc finger like protein (FEZL) plays an important role in immunity and FEZL gene has been mapped to BTA 22. Sequence characterization using ten sets of primers indicated that the genes span over 3.772 kb and 3.789 kb in Sahiwal and Karan Fries cattle, respectively (NCBI-GenBank accession numbers JX312831 and JX312832).

A total of eight nucleotide variations including three INDELS and five substitution mutations were observed among FEZL gene sequences of *Bos taurus, Bos indicus* (111 Sahiwal) and *Bos taurus X Bos indicus* (114 Karan Fries) cattle. Among the eight nucleotide variations, four mutations including three INDELS were found to be within exon 1, while two mutations were observed within each of intron 1 and intron 3, respectively. The conceptualized amino acid sequence of bovine FEZL gene was found to have an additional Glycine residue and a serine to proline change within exon 1 region at position 182 in Sahiwal and KF cattle.

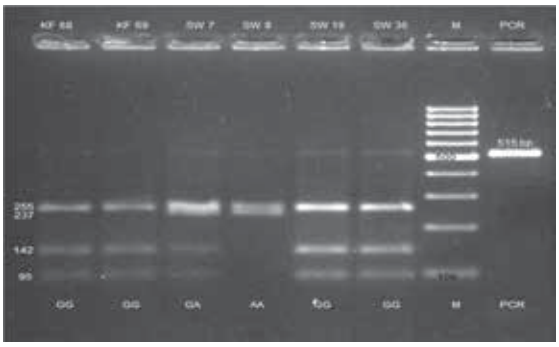
The percent identity of FEZL gene of Sahiwal and Karan Fries cattle was 99% with that of *Bos taurus* and 94% with human. Sequence characterization of ~0.7 kb 5′ flanking region including basal promoter of FEZL gene in Sahiwal and Karan Fries cattle showed highly conserved nature of the gene among bovines. A total of six putative sites for transcription factor binding sites were predicted in the 5′ flanking region of FEZL gene.

The three nucleotide INDEL polymorphism resulting in 12 or 13 Glycine (12G/13G) residues was utilized to identify allelic variants within FEZL gene using FAM dye conjugated forward primer. The expected product size for 12G homozygous genotype was a single peak at 125 base pairs; single peak at 128 base pairs for 13G homozygous genotype and two peaks at 125 and 128 base pairs for 12G/13G heterozygous genotypes.

A total of 114 Karan Fries cattle and 111 Sahiwal cattle were genotyped for 12G/13G polymorphism within exon 1 region of FEZL gene. The results revealed that 96.5% of the animals screened possessed 13G/13G genotype while only 3.5% of the animals possessed 12G/13G genotype in Karan Fries cattle. In case of Sahiwal cattle, all the animals genotyped were found to be 13G/13G homozygotes. FEZL genetic variants were not found to be associated with mastitis in the studied animals.

Identification of polymorphism and characterization of S100A8 gene in Sahiwal and Karan Fries cattle: A total of 2.036 kb and 2.080 kb sequence data covering entire coding DNA and 5′ flanking regions of S100A8 (Calgranulin) gene was generated in Sahiwal and Karan Fries cattle. Comparison of S100A8 gene sequence of different bovine species revealed eight nucleotide variations of which six were from intronic regions and two from exonic regions. The S100A8 coding DNA sequence of Sahiwal and Karan Fries cattle were found to have 100% identity with *Bos taurus* cattle, 99% identity with yak, 97 with both riverine and swamp buffalo. About 1 kb 5′ flanking region of S100A8 gene was sequence characterized which revealed 17 nucleotide changes among different bovine sub-species. 18 putative transcription factor binding sites were predicted within this region.

The SNP locus at position -2 bp upstream to start codon was utilized to develop genotyping assay in order to type the animals for association study. PCR-RFLP assay was developed using the primer pairs for S100A8 fragment-III and the restriction enzyme HpyCH4V to type the SNP in 148 Karan Fries cattle and 147 Sahiwal cattle.



The overall frequency of GG, GA and AA genotypes at -2 (A/G) SNP locus was found to be 0.884, 0.102 and 0.013, respectively in Sahiwal cattle while it was 0.973, 0.02 and 0.007, respectively in Karan Fries cattle. No significant association of S100A8 genotypes and incidence of clinical mastitis in cattle was observed.

Lactoferrin gene variants and their association with mastitis in Murrah buffalo: Genomic DNA was isolated from whole blood of 200 lactating Murrah buffaloes from NDRI herd and coding sequence were amplified using 16 sets of primers and PCR-RFLP analysis was performed using 12

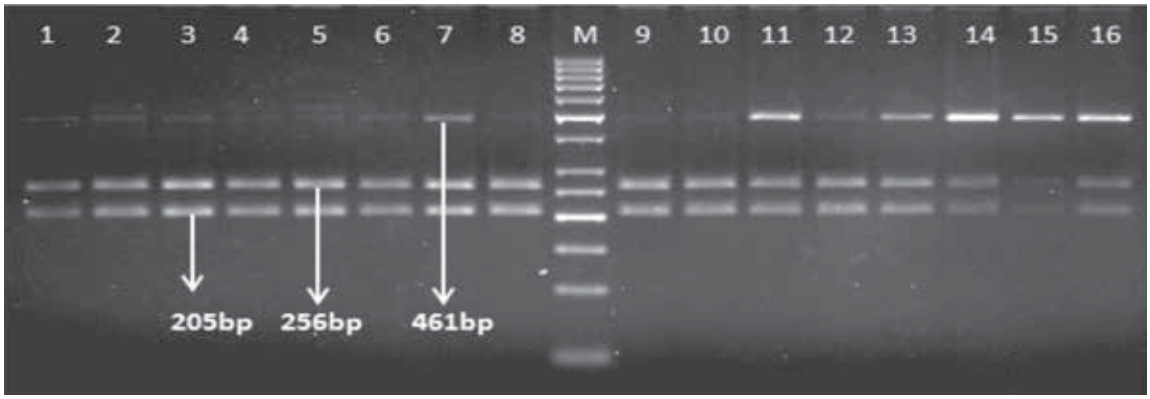
restriction enzymes. Multiple sequence alignment with reference sequence of *Bos taurus* indicated a total of 91 changes in Murrah buffalo, out of which 52 were found in coding region leading to 23 amino acids substitutions.

*Fok*I restriction endonuclease exhibited polymorphic pattern for exon 6 with two genotypes (AA and AB) with respective frequency of 0.625 and 0.375. The frequencies of A and B alleles were 0.81 and 0.19, respectively. *Bcc*I and *Hind*III restriction endonuleases have been used for digestion of exon 7. *Hind* III exhibited monomorphic pattern, while BccI showed polymorphic pattern with three genotypes (CC, CD and DD) with respective frequency of 0.62, 0.22 and 0.16. The frequencies of C and D allele were 0.73 and 0.27, respectively.

*Hpy*188I RE exhibited polymorphic pattern in exon 12, 13 and 17 with three genotypes (EE, EF, FF of exon 12, MM, MN, NN of exon 13 and GG, GH, HH of exon 17). Genotypic frequencies in exon 12 were found to be 0.06 (EE), 0.39 (EF) and 0.56 (FF), MM (0.20), MN (0.58), NN (0.22) in exon 13 and in 0.59 (GG), 0.23 (GH) and 0.18 (HH) in exon 17. The frequencies of E, F, M, N, G and H alleles were 0.25, 0.75, 0.49, 0.51 0.71 and 0.29, respectively.

Chi-square ($\chi 2$) analysis revealed significant association of exons 6, 7 and 17 genotypes with incidence of clinical mastitis. AA, CC and GG genotyped animals were found less susceptible to mastitis as compared to other genotypes. AACCGG combined genotyped animals were found least susceptible to mastitis, whereas, AACCHH genotyped animals were found most susceptible to mastitis as compared to other combined genotypes.

PCR-RFLP of Exon 12 of lactoferrin gene using Hpy188I restriction enzyme



Lane 15 : AA Genotype *Lane 1-6, 8-10, 12 : BB Genotype*
Lane 7, 11, 13, 14, 16 : AB Genotype *Lane M : DNA Ladder (50 bp)*

Molecular characterization and identification of genetic variants of CD14 gene in Murrah buffalo: Cluster of Differentiation14 (CD14) gene is one of the candidate genes for mastitis. A total of Genomic DNA from 100 lactating Murrah buffaloes were amplified using six sets of primers covering complete CD14 gene. Multiple sequence alignment revealed a total of 70 nucleotide changes, out of which 18 SNPs were detected in coding region, leading to 9 amino acids substitutions. On comparison of 1122 bp coding region with Bubaline sequences, three nucleotide changes at C550T, T794C and T975C and two changes at T703A and G1110A were observed with Chinese and Indian water buffalo, respectively leading to amino acid substitutions of L184F, L265P, S235T and R337H.

*Hpy*188I restriction endonuclease exhibited polymorphism in contig 2 with two genotypes (AB and BB) with respective frequency of 0.47 and 0.53. BB genotype was more prevalent in mastitis affected animals. AB genotyped animals were found to be less susceptible as compared to animals with BB genotypes.

Cytogenetical Screening of Pre-Pubertal Animals of Cattle, Buffaloes and Goats for Early Detection of Reproductive Disorders

Natural born twins and their performance: The calving records scrutinized from January 1969 to December 2011 for twinning showed a total of 18,608 calving including 143 twin births took place in three different genetic groups. The overall twinning rate was 0.77%, which was 0.19, 0.83 and 0.92% in Sahiwal, Karan Swiss (KS) and Karan Fries (KF), respectively. In twins

occurrence of stillbirths was 0.00, 11.82, and 18.29% and that of abortions was 16.67, 1.82, and 2.44% in Sahiwal, KS and KF, respectively. However, in singletons occurrence of stillbirths were 2.75, 12.90, and 2.58% and that of abortions was 5.48, 3.93, and 6.58% in Sahiwal, KS and KF, respectively. The mortality rate was higher in twins than singletons in all the three breeds.

The main reasons of disposal of male twins were death, reproductive problems and surplus in all the three breeds. Twinning showed non-significant effect at 6 months body weight in males and in females at 18 months body weight of all the three breeds.

Animals born through embryo transfer technology: A total of 69 calves (32 females and 37 males) produced through ET were the study material. Among these only 7 were physically available in the herd (4 females, 2 males and 1 freemartin). The cytogenetic screening of the ET born animals revealed two males as translocation carriers. The translocation of autosomes was confirmed by C-banding, however, the autosomes involved in translocation is be confirmed. There was one chimaeric (freemartin), and sterile. The cytogenetic screening showed 4 progeny sired by bull–1 and 1 progeny sired by bull–2 as translocation carriers, corresponding to ratio of 3:1 and 10:1 (translocation carrier: non translocation carrier), respectively. The progeny of rest ET born had normal cytogenetic profile. The paternity testing with micro-satellites in targeted samples revealed polymorphism with INRA 023 and TGLA 122 primers. The rest were found to yield almost monomorphic pattern. Band sharing was observed between true sire and progeny whereas the putative sire did not reveal the similarity in the patterns.

The study of disposal pattern revealed 20.8% of the ET born calves were disposed/died within 1 month of age out of which 50% were still births. Around 13 % were disposed within 2-8 month of age. Among the remaining animals, 7.2% were disposed within 1-2 years of age, which rose to 30.4% within 3-5 years of age. Thus, only 19% stayed to 5 years of age or beyond mainly as experimental purpose. So only 10% of the total entered in production and remained in the herd.

Indigenous Breed Project on Sahiwal Cattle

Around twelve thousand doses of frozen semen were produced from three bulls of Set-I and around twenty four thousand doses were produced from seven bulls of Set-II. AI with semen of bulls of second set was started from October, 2013 and semen doses were supplied to DRU units at GLF Hisar, GADVASU, Ludhiana, GBPUA&T, Pantnagar and Bhiwani for AI at those centres. During the period (Jan-Dec, 2013), around thirteen thousand doses of bulls of high genetic merit under both sets were supplied to farmers/developmental agencies through sale in addition to supply of semen for Institute extension/other activities.

Network Project on Buffalo Improvement (Institute Unit)

The breeding programme in the Murrah herd was followed for test mating using semen of test bulls at the institute herd. The dams' best lactation 305 day or less milk yield of the test bulls had ranged from 3805 to 4470 kg and 2971 to 4341 kg, respectively. Average age at first service and age at first calving of buffaloes were 31.95 and 42.44 month. Average age for initiating training and age at first collection of the young Murrah bulls has significantly reduced to 16.7 and 18.0 months. The average service period of buffaloes has been estimated as 131.19 days. The overall female conception rate in the herd was 41.72%. The wet and herd average were increased to 7.80 kg and 4.70 kg, respectively.

A total of ten elite Murrah male calves were reserved for future breeding. The dam's best 305 days lactation milk yield of reserved males ranged from 2747 kg in first lactation to 4090 kg. The center proposed seven Murrah bulls out of which five breeding bulls were selected for test mating under XV Set. The breeding programme in the herd was followed for nominated mating using semen of three Proven Murrah Bulls. About 37.58% Murrah buffaloes were identified as elite animals. The average lactation milk yield of elite Murrah buffaloes increased to 3151.29 kg which was 47.60% higher than the herd average. The best lactational milk yield of elite Murrah buffaloes ranged between 2733 kg in first lactation to 4341 kg.

The NDRI centre has produced 60,915 doses of frozen semen from five test bulls. The centre has supplied 62,054 doses of frozen semen to farmers and dairy development organizations during the period.

Genetic Evaluation of Fertility Traits in Relation to Heat Stress in Murrah Buffaloes

Genetic evaluation of fertility traits (service period, conception rate and pregnancy rate) in relation to heat stress in 581 Murrah buffaloes was studied using 1379 lactation records spread over 20 years (1993 to 2012). The months such as January, February, March, October, November and December were identified as comfort zone (CZ), while April, May, June, July, August and September were identified as heat stress zone (HSZ). THI model 6 was identified as the best suitable heat stress model. The threshold THI was identified as 75 for fertility traits in Murrah buffaloes. The increase in average THI from 68 in the month of March to 75 in the month of April increased the service period in Murrah buffaloes. The months, May and June, were found as Critical Heat Stress Zone (CHSZ) for service period and pregnancy rate, whereas June, July and August month were found as CHSZ for conception rate. There was increase of 28 days service period, decline in 9% conception rate and 7% pregnancy rate with per unit increase in THI value under CHSZ.

The Expected Breeding Value (EBV) for service period was found 1 day higher, while EBV for conception rate and pregnancy rate were decreased about 0.21% and 0.4% under HSZ as compared to CZ in Murrah buffaloes. The Expected Fertilizing Ability (EFA) for conception rate and pregnancy rate of Murrah buffaloes were decreased about 0.42% and 1% for under heat stress zone as compared to comfort zone.

The Expected Breeding Value (EBV) for service period was found 2 days higher, while EBV for conception rate and pregnancy rate were decreased about 0.3% and 0.5% under CHSZ as compared to CZ in Murrah buffaloes. The Expected Fertilizing Ability (EFA) for conception rate and pregnancy rate were decreased about 0.6% and 1.3% under CHSZ as compared to comfort zone.

Network Project on Buffalo Improvement (Field Unit)

A total of 4419 AI were performed in Murrah Buffaloes under field conditions during 2013-14 and as a result 51.08 % conception rate was obtained. The highest conception rate was observed in the month of October (54.76 %) and the lowest was in the month of May (47.05%). Across the villages, the highest conception rate was observed in Darar (59.85%) and lowest was observed in the village Kherimansingh (48.70%). A total of 1225 (660 male and 565 female) Murrah buffalo calves were born in the farmers' herds and performance data on 211 daughters have been recorded for evaluation of bulls under field conditions. The total herd strength of registered females and the breedable females at different centers was 5929 and 5339, respectively. As many as 9 breeding bulls belonging to the 14th set were used for AI during the year.

Fluorescent *in situ* Hybridization (FISH) and Associated Techniques for Characterization of Chromosomes for Detection of Genetical and Reproductive Problems in Cattle, Buffalo and Goats

Studies on different types of chromosomal anomalies and their effect revealed useful and interesting results. Such as three intersexes (60, XX) and one chimaeric (60, XX/ 60, XY) goats with ambiguous external genitalia were observed. The latter is rare case. Fragile-X chromosomes were observed in Sahiwal cattle females (27) with history of repeat breeding, irregular cycle and abortion. Fragile sites (FSs) were detected and confirmed with DNA primers. Chromosomes were evaluated of young calves (81) and fragile sites ranged from 3.95 to 41.89%. There were 34 cases with higher than 30% fragile X-chromosomes, which are expected to have reproductive problems, and are monitored for their performance behavior with age. Three buffalo heifers with 49, XO conditions were detected. One of these died, autopsy showed under developed ovaries. In NDRI cattle yard records of 67 cases of calves born with ET were examined, among these majority did not reach breeding age. Evaluation of chromosomes of AI bulls (51) for numerical and structural details did not show anomaly. Monozygotic twin males born through manipulation of embryos were raised and used as bulls, revealed translocation of chromosomes, which has been transmitted to their progeny.

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

Cloning

Birth of 'Purnima', a Clone of 'Karan Kirti'

'Purnima', a cloned buffalo calf weighing 44 kg was born through normal parturition on September 6, 2013. Purnima, which survived for 21 days, was the clone of a buffalo named 'Karan Kirti, which has the distinction of being the highest milk producer in the history of the Institute. Two more clones of Karan Kirti were born but died due to premature birth.

'Purnima', a Clone of 'Karan Kirti'

Birth of Calves Cloned from Semen-Derived Somatic Cells

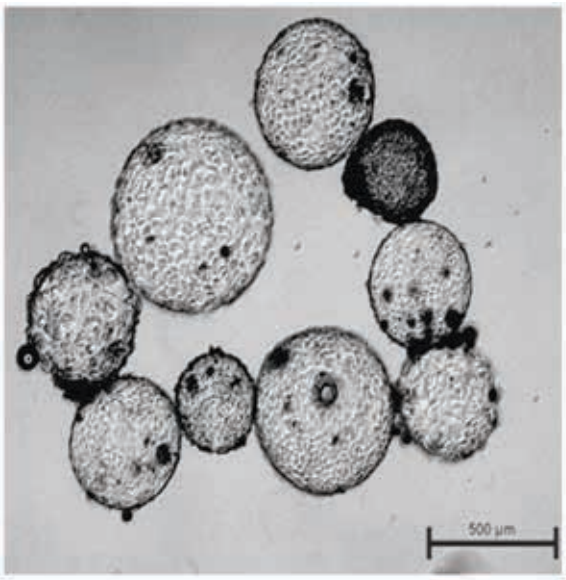
Somatic cells were isolated from the cryopreserved semen of 4 buffalo bulls, 3 of which had died over 10 years earlier, and were established in culture. The cells expressed cytokeratin-18, keratin and vimentin indicating that they were of epithelial origin. The cells were used as nuclear donors for hand-made cloning for producing buffalo embryos. The blastocyst rate and quality, as indicated by apoptotic index, were comparable among embryos produced using cells obtained from fresh or frozen-thawed semen or those obtained from conventional cell sources such as skin. Examination of the epigenetic status revealed that the global level of H3K27me3 but not that of H3K9/14ac and H4K5ac differed significantly ($P<0.05$) among cloned embryos from different bulls. The relative mRNA abundance of HDAC1, DNMT1, P53 and CASPASE 3 but not that of DNMT3a differed in cells and in cloned embryos. Following transfer of 24 cloned embryos produced from fresh semen-derived cells to 12 recipients, one calf weighing 55 kg, which is now 6 months of age and is normal, was born through normal parturition. Following transfer of 20 embryos produced from frozen-thawed semen-derived cells to 10 recipients, 2 became pregnant, one of which aborted in the first trimester; the calf born was severely underweight (17 kg), and died 12 h after birth. The ability of cells derived from fresh and frozen-thawed semen to produce live offspring confirms the ability of these cells to be reprogrammed. These findings pave the way for restoration of highly precious progeny-tested bulls, which has immense economic importance, and can also be used for restoration of endangered species.

'Swarn' with foster mother

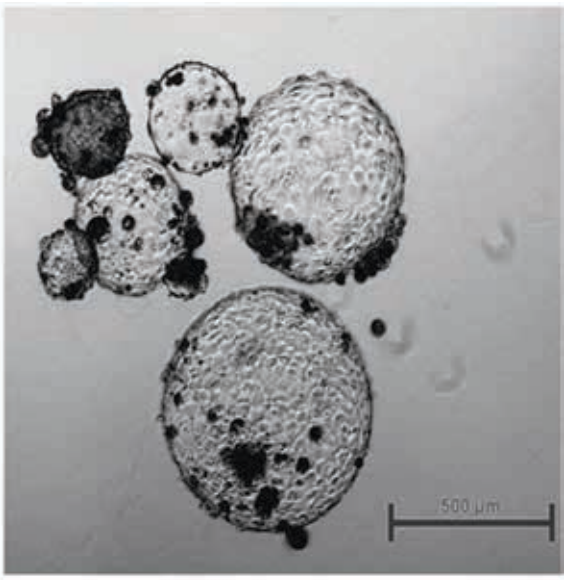
Production of Inter-Species Cloned Blastocysts Using Donor Cells from Wild Buffalo (*Bubalus arnee*) and Oocytes from Domestic Buffalo (*Bubalus bubalis*)

In a study aimed at exploring the possibility of producing wild buffalo embryos by interspecies somatic cell nuclear transfer (iSCNT) through Hand-made cloning using wild buffalo somatic cells and domestic buffalo (*Bubalus bubalis*) oocytes. Somatic cells derived from the ear skin of wild buffalo were found to express vimentin but not keratin and cytokeratin-18 indicating that they were of fibroblast origin. The population doubling time of skin fibroblasts from wild buffalo was significantly ($P<0.05$) higher and the cell proliferation rate was significantly ($P<0.05$) lower compared to that of skin fibroblasts from domestic buffalo. Neither the cleavage nor the blastocyst rate were significantly different between the intra-species cloned embryos produced using skin fibroblasts from domestic buffalo and inter-species cloned embryos produced using skin fibroblasts from wild buffalo. However, the total cell number (TCN) was significantly ($P<0.05$) lower and the apoptotic index was significantly ($P<0.05$) higher for inter-species than that for intra-species

cloned embryos. Following vitrification in Open-Pulled straws (OPS) and warming, although the cryosurvival rate of both types of cloned embryos, as indicated by their re-expansion rate was not significantly different, the apoptotic index was significantly (P<0.05) higher for vitrified-warmed inter-species than that for corresponding intra-species cloned embryos. The global level of H3K18ac was significantly (P<0.05) lower in inter-species cloned embryos than that in intra-species cloned embryos. The expression level of *HDAC1*, *DNMT3a* and *CASPASE3* was significantly (P<0.05) higher, that of *P53* was significantly (P<0.05) lower in inter-species than in intra-species embryos, whereas that of *DNMT1* was similar between the two types of embryos. In conclusion, these results demonstrate that wild buffalo embryos can be produced by iSCNT.



Domestic buffalo cloned blastocyst



Wild buffalo cloned blastocyst

Stem Cells

Over-expression of Buffalo NANOG, LIF and FGF2 in Buffalo Fetal Fibroblasts and Embryonic Stem Cells

Buffalo NANOG ORF was cloned in a eukaryotic expression vector i.e. CT-GFP-TOPO fusion. TOPO-Bu-NANOG G^{+1} construct was developed harboring buffalo NANOG ORF insert. Further, buffalo NANOG ORF was also cloned in other eukaryotic expression vector (pCAGGS-PGKneo) and pCAGGS-Bu-NANOG gene construct was developed. Initially, TOPO-Bu-NANOG G^{+1} construct was transfected in COS-1 cell line and buffalo BAF cells and showed expression of green fluorescent protein (GFP) in both cell types. Subsequently, different concentrations (X: 0.8 µg, Y : 1.60 µg, Z : 3.20 µg) of TOPO-Bu-NANOG G^{+1}, pCAGGS-Hu-NANOG and pCAGGS-Bu-NANOG was transfected into CHO-K1 cell line. The constructs were then transfected into buffalo fetal fibroblast (BFF) cells and ES cells for NANOG over-expression studies. Buffalo LIF and FGF2 ORF were cloned in eukaryotic expression vector pAcGFP1N1 and CT-GFP-TOPO fusion, respectively, and then both were transfected into CHO-K1 cell line. ES cells were cultured on transfected buffalo BFF feeder cells. The colony area (μm^2) was significantly higher ($p<0.05$) in ES cells grown on BFF feeder layer transfected with either human or buffalo NANOG gene construct as compared to control BFF feeder cells. The pluripotency genes (i.e. NANOG, Oct4, c-Myc and FoxD3) were upregulated in the ES cells grown on human or buffalo NANOG transfected BFF feeder cells in presence of LIF and FGF2 growth factors. The ES cell colony area was higher in ES cells grown on buffalo BFF feeder cells transfected with buffalo NANOG, LIF, and FGF2 gene construct alone or in combination than the ES cells grown on non-transfected BFF feeder cells in the absence or presence of both LIF and FGF2 growth factors. Transfection of NANOG, LIF and FGF2 gene construct into BFF cells showed higher abundance of the NANOG, Oct4, Sox2, c-Myc and FoxD3 transcripts in buffalo ES cells in absence of LIF and FGF2 growth factors. The relative abundance of the pluripotency genes was upregulated in ES cells cultured on the transfected BFF feeder cells with NANOG, LIF and FGF2 construct alone or in

double construct. The relative mRNA abundance of Cdx2, Gata6, Gcnf, Tcf3, p53, SMAD1 and SMAD2 was reduced in buffalo NANOG G^{+1} transfected ES cells than the non-transfected ES cells.

The colony area of transfected ES cells with NANOG (29.42±6.54%) and LIF (28.83±6.80%) construct was higher than the non-transfected ES cells (26.34±6.04%), while the colony area of transfected ES cells with FGF2 (12.90±5.64%) and pooled (24.02±5.13%) gene constructs was not significantly different from the control ES cells in absence of LIF and FGF2 growth factors. However, the colony area of all transfected ES cells with NANOG, LIF, and FGF2 and pooled gene construct was higher ($p>0.05$) than the non-transfected ES cells in the presence of LIF and FGF2 growth factors. In the present study, LIF and FGF2 gene constructs improved the colony size of transfected ES cells than the non-transfected ES cells. The relative abundance of LIF transcript in ES cells transfected with buffalo NANOG G^{+1}, LIF, and pooled constructs was higher than that of the non-transfected and mock ES cells. The relative abundance of the FGF2 transcript was higher ($p<0.05$) in the ES cells transfected with FGF2 gene construct than the control, mock and other construct transfected ES cells. The expression of NANOG transcript was significantly higher ($p<0.05$) in ES cells transfected with NANOG construct than the control ES cells, mock and other construct transfected ES cells. Similarly, Sox2 ($p>0.05$), c-Myc ($p<0.05$) and FoxD3 ($p>0.05$) transcripts were higher in the ES cells transfected with NANOG gene construct than the control ES cells. Thus, buffalo transgenic BFF feeder layer and ES cells were generated carrying the NANOG, LIF, FGF2 gene construct (s). The ES cells can be grown on transgenic BFF feeder layer in absence of LIF and FGF2 growth factors.

Generation of Insulin Secreting β cells from Mesenchymal Stem Cells

In order to differentiate goat mesenchymal stem cells (MSCs) to pancreatic islets like cells, these were incubated in conditioned medium with glucose in the presence of nicotinamide (10 mM), activin-A (2 nM), exendin-4 (10 nM), pentagastrin (10 nM), retinoic acid (10 µM) and mercaptoethanol (20 µM). Pancreatic islets-like cells were characterized by amplification of pancreatic endoderm-specific genes i.e., IGF-1, SST, NGN3, PDX-1, ISL-1, c-KIT, THY-1 and GLUT-2. No expression was detected for these genes in undifferentiated MSCs. Pancreatic islets-like cells were further characterized by immunostaining and western blotting of Pdx-1, insulin and Islets-1 specific protein.

Molecular Cloning and Expression of Buffalo Leukemia Inhibitory Factor (LIF) in Eukaryotic System

LIF of buffalo origin was successfully cloned, sequenced and characterized (NCBI GenBank accession number HQ616665). Mammalian expression constructs were prepared for its expression in any mammalian cell line which can be utilized across different labs. Stably transfected COS-1 cell lines expressing rBuLIF fused with GFP were also successfully established.

Transgenesis

Human Insulin Gene Expressed in Buffalo Mammary Epithelial Cells

A mammary gland-specific expression vector was developed to produce human insulin (hINS) on a large scale from transgenic buffalo to meet the demand of hINS in medical use. A hINS mammary gland specific expression vector was generated and its function in buffalo mammary epithelial cells (BuMECs) validated. Human pro-insulin cDNA was cloned from its genomic gene and mutated by overlap extension PCR for introducing furin consensus cleavage sequences (Arg-X-Lys-Arg). A mammary gland-specific buffalo beta-lactoglobulin (buBLG) promoter was used to drive expression of recombinant human insulin in BuMEC cell line. The gene construct was transferred into a BuMEC cell line by liposomal transfection and cultured with G418 drug for 3 weeks to obtain positive transgene cell clones. The hINS expression in cell clones was confirmed by RT-PCR, Immunocytochemistry, Western Blotting and ELISA. The pAcISUBC insulin-expressing clones secreted insulin at varying levels between 0.18-1.43 ng/ml/24 h/$2.0x10^6$ cells.

Expression and Purification of Recombinant Buffalo Interferon-Tau

IFN-τ performs a significant role in implantation as well as establishment of pregnancy as the first pregnancy signalling molecule. To identify the relatively predominant isoforms, total cellular RNA extraction from primary trophectodermal cells, RT-PCR was performed using gene-specific primers designed against known bovine IFN-τ sequence. Cloning of the amplified product and screening of the recombinant colonies gave 13 distinct cDNA variants that encoded for 8 distinct buffalo IFN-τ isoforms. Out of eight isoforms, buffalo IFN-τ1 was

found to be the relatively predominant isoform. It was subcloned in expression vector pET 22b without signal sequence from pJET cloning vector and was expressed in competent BL21(DE3) *E. coli* strain. Expression of the recombinant protein in soluble form was induced by isopropyl β-D-1-thiogalactopyranoside. The recombinant buffalo IFN-τ obtained was confirmed by western blot using anti-HIS antibody.

Oocyte Genomics

The apoptosis event in cumulus cell surrounding the buffalo oocytes was studied to understand how the development ability could be maintained in majority of the oocytes. Increased expression of cathepsin B gene was identified as a key factor responsible for deterioration of oocyte health in the course of *in vitro* maturation. Suppression of cathepsin expression using cysteine protease inhibitor (E-64) in the IVM medium reduced the cath B expression along with other pro-apoptotic genes. The BAX to BCL2 ratio also reduced on E-64 supplementation resulting in lower apoptosis rates as evidenced by the TUNEL assay. The results of the investigation suggest that inhibition of cath B by supplementing E-64 in IVM medium can rescue the cumulus cells undergoing mitochondria dependent apoptosis process by decreasing the expression of pro-apoptotic genes and BAX/BCL2 ratio eventually increasing the development competence of buffalo oocytes. Using an optimized dose of E-64 while culturing the oocytes for IVM in the IVF procedure resulted in higher number of blastocysts as well as better blastocyst quality. This brings in a new strategy to enhance success rate of IVF which could translate to development of better ART protocols.

Epigenetics of Sperm DNA

Wide variation in the fertility of breeding bulls is experienced in a large AI trial in spite of stringent quality control measures applied while deciding the quality of semen before freezing. Differential epigenetic carriage of spermatozoa is suspected as one of the reasons for compromised fertilizing ability of spermatozoa. The DNA methylation pattern in spermatozoa of buffalo bulls of different fertility status was investigated for global methylation changes using a custom designed 180K buffalo (*Bubalus bubalis*) CpG island/promoter microarray. A total of 96 individual genes along with another 55 genes covered under CpG islands were found differentially methylated in sperm of high and low fertile buffalo bulls. Important genes associated with biological processes, cellular components and functions were identified to be differentially methylated in buffalo bulls of differential fertility status. Identified differentially methylated genes were found involved in germ cell development, spermatogenesis, capacitation and embryonic development. The observations hint that epigenetic defects of sperm DNA may play crucial role in determining the fertility of breeding bulls.

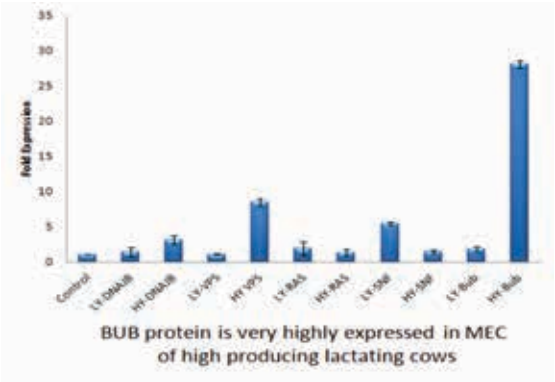
Innate Immunity in Indian Cattle and Buffalo

The innate immune system is the first line of defense against microbial pathogen infection, including viral and bacterial infection, and tissue damage. It is initiated by germ line encoded pattern recognition receptors (PRR) to detect ligands from the pathogen as well as from damage-associated molecular patterns. Ligand (pathogen or internal) recognition by the receptors will lead to production of interferons, pro-inflammatory chemokines and cytokines, and anti-microbial peptides. A growing numbers of these receptors were identified, including membrane associated Toll-like receptors (TLRs), cytosolic retinoic-acid inducible gene I (RIG-I)-like receptors (RIG1, MDA5 & LGP2), nucleotide-binding oligomerization domain (NOD)-like receptors, and double strand DNA sensors such as DAI, IFI16, AIM2 and DDX41. RIG1 and MDA5 have emerged as important intracellular innate pattern recognition receptors that recognize viral RNA and mediate cellular signals controlling Type I interferon (IFN-I) response.

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. The study provided crucial insights into the structure and function of RIG1 and MDA5 receptors in buffalo.

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

Identification of protein signatures in mammary epithelial cells during different stages of lactation: The mammary gland is made up of a branching network of ducts that ends with alveoli which surrounds the lumen. These alveolar mammary epithelial cells (MEC) reflect the milk producing ability of farm animals. In this study, 2-D DIGE and mass spectrometry were used to identify the protein changes in MEC during immediate early, peak and late stages of lactation. Differentially expressed proteins in MEC isolated



BUB protein is very highly expressed in MEC of high producing lactating cows

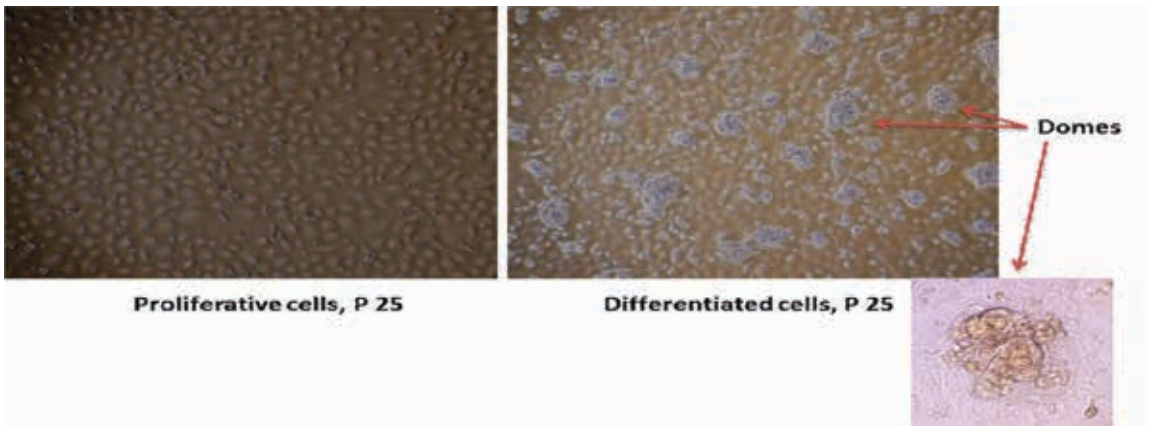
from milk of high and low producing milch cows were compared. Forty one differentially expressed proteins were identified during lactation stages and 22 proteins in high and low milk yielding cows were identified. Bioinformatics analysis showed that majority of the differentially expressed proteins are associated in metabolic process, catalytic and binding activity. The differentially expressed proteins were mapped to the available biological pathways and networks involved in lactation. The proteins up-regulated during late stage of lactation are associated with NF-κB stress induced signaling pathways and whereas Akt, PI3K and p38/MAPK signaling pathways are associated with high milk production mediated through insulin hormone signaling.

Identification of Differentially Expressed Proteins in Buffalo Mammary Epithelial Cells (BuMECs) between Proliferative and Differentiated BuMECs

Differentiated BuMECs in lactating mammary gland are involved in many metabolic processes for production of milk components. Experiment was designed to observe whether proteins get differentially expressed between proliferative and differentiated BuMECs *in vitro* both in cytosolic as well as mitochondrial fractions. For this purpose BuMEC cell line between 25 to 30 passages available in our lab was used. Frozen cells were thawed and grown in growth medium containing DMEM/F12 supplemented with 5 µg/ml bovine insulin, 1 µg/ml hydrocortisone, 10 ng/ml EGF and 10% FBS. Proliferative cells of 70% confluency were taken for subcellular fraction collection. For differentiation growth medium was supplemented with 5 µg/ml prolactin after 4 days of serum starvation. Domes (as an indicator of differentiation) were observed in differentiated cells and these cells were taken for sub cellular fraction collection.

Cytosolic and mitochondrial fractions were collected from these cells by Qproteome mitochondria isolation kit. DIGE (Difference Gel Electrophoresis) was performed of the isolated proteins and then the differentially expressed protein spots were excised from gel and peptide was extracted for MALDI-TOF/TOF mass spectrometry.

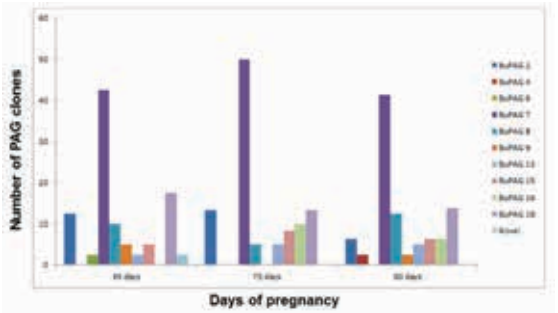
Sixteen unique differentially expressed proteins were identified. Gene ontology analysis of the proteins showed their involvement in different molecular functions like binding, receptor activity, catalytic activity, ion channel activity and transport. The biological processes that they



are involved in include precursor metabolite and energy generation, cell cycle, developmental process, metabolic process, cellular component organization and transport process. DIGE of the mitochondrial fractions showed 5 differentially expressed proteins and interestingly 3 of them were heat shock proteins (chaperones) expressed during stress condition. As we hypothesized, mitochondria of differentiated epithelial cell s are under stress for providing the energy required in synthesizing the milk components, chaperones play the role of proper folding of the partially folded and unfolded proteins synthesized during milk synthesis.

Identification of Various Isoforms of Pregnancy Associated Glycoproteins (PAGs) during Early Pregnancy in Buffalo

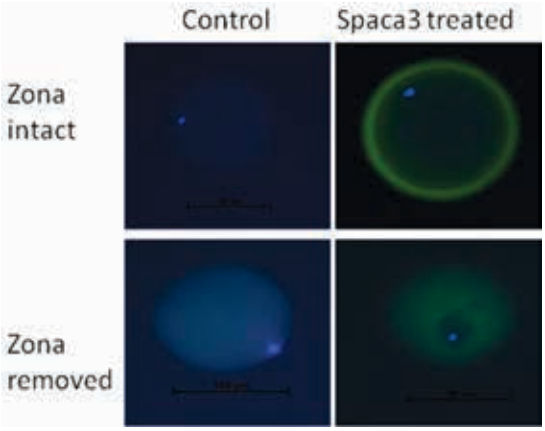
Since, PAGs are made from fetal cotyledons and are released into maternal circulation, their expression has been used as a marker for pregnancy diagnosis and early embryonic mortality. But because of the existence of a large number of PAG isoforms and inadequate information about the time of expression of these isoforms, its use in pregnancy diagnosis remains uncertain in many aspects. It is particularly of concern in buffalo where the information about PAGs is very less. In order to gain insight on the transcript abundance of various isoforms during early pregnancy, cDNA was prepared from the isolated RNA of 12 fetal cotyledons from the early stages of pregnancy (45 d, 75 d and 90 d). The cDNA was cloned in *E. coli* cloning vector. A total number of 360 clones containing recombinant plasmids were cloned and sequenced. Existence of various isoforms of BuPAGs were analyzed. The sequences were correlated with their time of expression. The study revealed that there are a total of 20 BuPAG isoforms expressed during the early stage pregnancy. The identified BuPAG isoforms are BuPAG2, BuPAG4, BuPAG6, 7, 8, 9, 13, 15, 16, 18 and one new isoforms. Out of these BuPAG isoforms, one can be considered as novel as no similar homologue has been reported before. On BLAST it's maximum homology with Bovine (BoPAG 16) and bubaline (BuPAG 6) PAG was found to be 78% and 75%, respectively. BuPAG 7 was observed to be the most abundant isoform at all the stages of pregnancy followed by BuPAG 18.



Frequency of 11 different isoforms of Pregnancy Associated Glycoproteins (PAGs)

Functional Characterization of SPerm ACrosome Associated 3 (SPACA3) Protein

Spaca3 (128 residues) belongs to lysozyme type c enzymes, however, the proteins share only 40-42% sequence identity with lysozyme. Spaca3 could not show lysozyme-like antibacterial activity against *Micrococcus lysodeikticus*. Sequence analysis suggested mutation of catalytic residues in Spaca3 which might result in loss of activity. Two catalytic residues Glu35 and Asp53 in lysozyme were observed mutated to Ala and Asn, respectively, in Spaca3. It is not clear what role Spaca3 might be playing when expressed on sperms. Some reports suggest that Spaca3 might be involved in sperm-oocyte interactions; however the mechanism of interaction is not clear. It was shown that rec-Spaca3 could bind with buffalo oocytes specifically in the zona region. Removal of zona caused no binding of Spaca3 with oocytes, which suggested that the receptors for Spaca3 might be present on zona and help in binding of sperms with occyte. Preliminary results suggested that competitive inhibition of oocyte receptors with rec-Spaca3 caused reduced rate of fertilization.



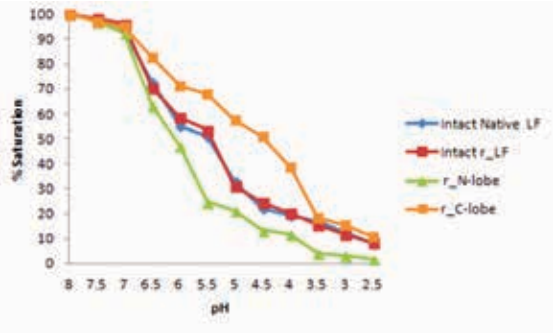
Localization of recLYZL3 binding sites on oocytes by immunostaining. Oocytes were incubated with human anti-spaca3 antibodies followed by incubation with FITC labeled secondary antibodies. The immunostaining of intact zona (Green color) indicates the binding of Spaca3 with zona, since no staining around oocytes with zona removed was observed. In control experiments, the oocytes were incubated directly with secondary antibodies without pre-incubation with anti-spaca3 antibodies. The hoechst 33342 was used to counterstain the nucleus (Blue color)

Recombinant Expression of Fibronectin Binding Protein (Fbp) and Collagen Binding Protein (Cbp) in *E. coli*

The *cbp* gene was amplified from *L. reuteri* and cloned into pET22b expression vector. Colony PCR was performed to confirm cloning. Expression studies showed that Cbp was partially expressed in the soluble fraction. Conditions were optimized for soluble expression of Cbp by varying the temperature, IPTG concentration and surfactant concentration. Fibronectin binding protein gene, *fbp* of 1.7 kbp size from *L. acidophilus* NCFM, was amplified and cloned in the pET22b(+) vector. After PCR confirmation for the presence of the *fnbp* gene in BL21(DE3) *E. coli* host cells, gene expression was studied at various culture conditions. Partial expression in the soluble form was achieved at 16°C. The functionally active proteins will be used to competitively exclude the pathogens under *in vitro* and *in vivo* conditions.

Recombinant Expression of Buffalo Lactoferrins (rec-Lf) in Yeast

Buffalo lactoferrin and its monoferric N- and C-terminal lobes were expressed in yeast expression systems, *Klurouymyces lactis* and *Pichia pastoris*. The recombinant lactoferrin could bind and release iron almost in a similar fashion as the native milk lactoferrin. The expressed lactoferrin could also inhibit papain suggesting the native-like structure and biological activity of recombinant lactoferrin. Exogenously added recombinant buffalo Lf to the buffalo mammary epithelial cell (BuMECs) culture decreased the proliferation and the cell viability of BuMECs in a dose dependent manner. The recombinant lactoferrin also reduced the expression of β-casein and κ-casein in BuMECs. These results suggested that although lactoferrin is a antimicrobial agent, yet at high concentration it could be detrimental to animal cell growth.



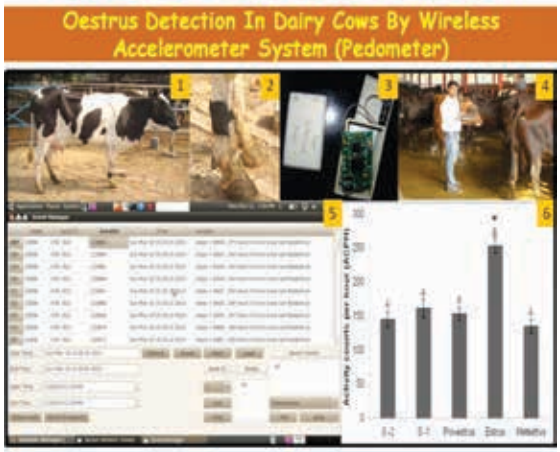
Iron release by recombinant intact Lf, N-lobe and C-lobe of Lf. Curves represent intact native Lf (blue), intact recombinant Lf (red), recombinant N-lobe (green) and C-lobe (orange) of buffalo Lf

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

Development of neuro-fuzzy system for diagnosis of mastitis in cows and buffaloes: Mastitis is a serious problem of all classes of dairy animals, particularly high yielders. In this study aimed to develop the ANN and fuggy logic based mastitis detection model, pattern of change in milk electro-conductivity (EC) and pH from mastitis affected cows and buffaloes were used to quantify Acute Phase Proteins: Serum Amyloid-A (SAA) and Haptoglobin (Hp) values and the linearized parameters were taken for formulation of Artificial Neural Network (ANN) and Fuzzy Logic based models. The milk pH of healthy, subclinical mastitis and clinical mastitis Murrah buffaloes were 6.64±0.35, 6.78±0.41 and 7.09±0.29, respectively. The corresponding mean values in case of Sahiwal were 6.55±0.19, 6.63±0.27 and 6.93±0.37; and in Karan Fries the values averaged 6.68±0.23, 6.79±0.34 and 7.17±0.43, respectively. Likewise, the milk electrical conductivity of normal, subclinical and clinical mastitis affected Murrah buffaloes averaged 4.64±0.35, 6.42±0.72 and 7.54±1.02 mS/cm, respectively. The corresponding mean values in Sahiwal cows were 5.55±0.19 mS/cm, 7.13±0.53 mS/cm and 7.94±0.91 mS/cm and in Karan Fries cows, these were 5.68±0.23, 6.96±0.76 and 7.67±1.13 mS/cm, respectively. The effect of seasons and stage of lactation was prominent in all the breeds. Murrah and Karan-Fries showed an increased milk pH and EC in summer whereas Sahiwal showed higher values in winter. Animals with more than 4 parity order and higher milk production had higher pH and EC of milk. Murrah showed gradual increase in SAA and Hp values from healthy to subclinical and then to clinical mastitis state. In case of cows, however, only SAA showed such trend, Hp values being more in subclinical than in clinical cases. The ANN model of Bayesian regularization gave the maximum accuracy. The fuzzy logic model was also developed for all the three breeds.

Efficiency of wireless sensor device (pedometer) for detection of estrus in Karan Fries cows: This experiment was designed to study the



1, 2-Animal with pedometer; 3-Battery powered accelerometer(Pedometer); 4-Wireless data collection mini computer; 5- Database; 6. Data presentation

efficiency of heat detection through application of indigenously developed pedometer device against the conventional methods as well as to confirm the heat through pedometer by hormonal assay in Karan Fries cows. For the study, two separate experiments were conducted. In Experiment I, activity of Karan Fries cows (n=8) was routinely recorded by pedometer and correlated with normal estrus behaviour, which was recorded by visual observation and rectal palpation. On the day of heat, blood samples were collected for progesterone estimation and cervical mucus for physical properties. Heat intensity was also recorded. In Experiment II, activities of animals (n = 18) were induced by PGF2α injection on the mid cycle postpartum animals and activity was measured using pedometer, with all other procedures remaining similar. The average hourly activity was recorded and was segregated into 6 hour intervals in experiment–I. There was significant (P<0.001) variation in average activity between different periods of the days and highest movement was observed between 1200-1800 hrs and lowest during 0-600 hrs period (1053.445±90.77 and 245.515±35.07, respectively). Comparison of the activities between similar stages in estrus with non estrus phase revealed significant differences. Highly significant increase (P<0.001) in activities was found during 1200-600 pm in cows in estrus phase (2057.86±311.30) and without it (934.99±30.57). Total number of steps during active estrus averaged 4699.25±768.51, which was significantly higher (P<0.05) compared to other stages (proestrus, metestrus and diestrus) of oestrous cycle. Cows in heat displaced more steps (P<0.05) between 600-1200 hrs and 1200-1800 hrs periods *vis-a-vis* when not in heat (1549.41±270.10 vs. 724.86±83.63 and 2057.86±311.30 vs. 934.99±30.57, respectively). In second experiment, significantly higher activity during estrus, 67.5 hrs after PGF2α injection, was observed (252.61±11.10 vs. 152.26±8.90, P<0.05) *vis-a-vis* other stages of cycle. It was concluded that pedometer can be helpful for estrus detection in dairy animals, however, proper algorithm needs to be developed for automation while calculating the exact time of initiation of oestrus so that insemination time can be accurately predicted.

Studies on soil-plant-animal continuum in migratory sheep of arid zone of Rajasthan: Migration of sheep in Rajasthan is a longstanding tradition and the shepherds face a number of problems on the route of migration due to poor communication network. Tracking animals using GPS holds promise in data acquisition and communication for improved surveillance and delivering management inputs for such locations. This study was planned to collect real time information on sheep migration pattern and study the incidence of disease together with soil-plant-animal continuum to address the problems faced by the nomadic flocks in Marwar region. A total of 120 respondents from Marwar region of Rajasthan and 20 farmers' through the migratory route from Pali to Rohtak were randomly selected. For analysis of mineral status in soil, plant and sheep through the migratory route; 100 samples from each category were selected. Results of the study revealed that majority (65.00%) of the farmers belonged to middle age group, were mostly illiterate (85.00%) but could communicate in Marwari, Rajasthani and Hindi. Nearly 38.0% farmers were engaged in sheep rearing and 57.50% in sheep rearing together with agriculture; average flock size being 142. The migration of sheep flocks towards Haryana in search of feeding and water resources (65%) occurred for a period of 6-9 months. During the migration, farmers face number of problems which include; lack of proper living amenities, losses due to diseases, theft of animals among others. Overall satisfaction of farmers regarding veterinary service while at home was 48.52% which drastically dropped to 0.92% during migration The mortality of young lambs and adult sheep en-route migration averaged 21.68% and 6.02%, respectively. The migratory sheep were deficient in Ca, P and Cu and Fe; whereas they had access of Mn and Zn. Minerals being critical for productive and reproductive function, these findings call for special mineral supplement during migration. Though illiterate; this study revealed that modern ICT based technologies, with immense financial stakes for the poor shepherds, could be adopted by the farmers provided such services are delivered

through smart phone with audio-visual mode of communication.

Detection of lameness of cow based on body weight using Artificial Neural Network: Lameness is the third most costliest and widely prevalent clinical conditions of dairy cows after mastitis and reproductive problems. The incidence of lameness is reported to vary between 8.82 and 38.24% depending upon age, sex, parity, breed, milk production and reproductive status of the animals. Higher incidences in exotic and their crossbreds were also reported. The crossbreeding; no doubt, has increased milk production several folds, simultaneously it has also increased the risk of lameness in these crossbreds. Early detection of bovine lameness enables the farmer to provide effective treatment of hoof and leg ailments. In this study, an algorithm was developed for predicting status of leg health from the data collected from the four quadrants WSN based weighing balance developed in the NAIP project. Data pertaining to 589 Karan Fries cows was recorded for the existing status of lameness as target variable, and other non-genetic variables including; percent of body weight distributed to individual legs, parity, status and stage of pregnancy, stage of lactation and daily milk yield as input variables. These variables were used for the development of Multilayer Perception (MLP) and Radial Basis Function (RBF) neural networks (NNs). Simulation of network was carried out using varying data partition strategies for training and validation data sets (60:40, 70:30 and 80:20), number of nodes in hidden layers and different optimization algorithms. It was found that to predict the health status of leg in cows; RBF neural architect with Leven-burg Marquardt (LM) optimization algorithm, gave the best performance in detecting the leg health status in comparison to MLP with highest classification accuracy rate (83.19%) at 80:20 data partition strategy. This implies that ANN models were able to predict the lameness of cows with more than 80% accuracy and can be used to predict the lameness of cows based on body weight and other non genetic parameters.

Performance and behaviour of dairy animals under a model loose housing system: In this comparison, crossbred dairy cows in their early lactation were housed under improved vs. traditional loose housing during winter season by increasing the height of roof (15 vs. 10 feet), width of the covered area (20 vs. 10 feet), sand bedding, fence-line feeding and fly/mosquito proofing. It was revealed that the improved housing management not only improved the milk yield of the cows (19.78 vs. 17.55 kg/cow/d), it also improved the resting time (13:26 vs. 12.52h/cow/d) and the overall cow comfort (88.75 vs. 81.87%) measured as the proportion of the cows resting at any point of time. There was no affect of the housing management type on the DM intake (15.04 vs. 14.84 kg/cow/d), eating time (7.27 vs. 7.07 h/cow/day) and rumination time (8.57 vs. 8.29 h/cow/d). It was inferred that the improved housing management ensured higher milk production and ensured better welfare of the crossbred cows during winter season.

Effect of management and season of birth on growth and age at puberty in Sahiwal heifers: In study 24 Sahiwal heifers, aged 12 months, were divided into two equal groups G1 and G2. The heifers in G1 were fed as per NRC 2001 standards whereas heifers in G2 received 500 g concentrate extra (20 % CP and 70% TDN) over G1. The heifers in G1 and G2 were further subdivided into 2 groups each (G1A1, G1A2, G2A1 and G2A2) after 8 fortnights of experiment so as to have 4 treatment groups of 6 heifers each so that the heifers in G1A2 and G2A2 were administered 4 µg GnRH at monthly interval starting 18 months of age. The overall average daily weight gain during the treatment period as well as the DMI/100 kg BW of the treatment groups did not differ significantly. The age at puberty averaged 630.54±8.66, 610.62±7.5, 625.45±20.66 and 600.83±15.33 days for G1A1, G1A2, G2A1 and G2A2, respectively and the age at puberty was significantly ($P<0.05$) lower in GnRH administered heifers (G1A2 and G2A2) as compared to the other 2 groups. Thus, the supplementation of additional concentrate alone to growing Sahiwal heifers did not improve their age at maturity. However, the administration of GnRH @4µg /heifer/month beginning 18 months of age was effective in advancing the age at puberty by about 3-4 weeks.

Management tools for improving heat detection accuracy, efficiency and conception rate in Murrah buffaloes: Inadequate detection of estrus in buffaloes, particularly during summer months, adversely affects the herd fertility in a number of ways. This study was, therefore, conducted to find out the effect of short-term cooling on conception rate in Murrah buffalo heifers and to study the effectiveness of certain management tools in improving the estrus detection efficiency and accuracy in Murrah buffaloes. Estrus detection was carried out using a teaser bull (4- times bull parading in a day at 0600h, 1000h, 1400h and 1800h), heat expectancy chart along with visual observation of cardinal signs of estrus in treatment group, as against two times bull parading as

carried out in control group. The estrus detection efficiency was calculated by Timm's equation using average estrus interval in buffaloes while estrus detection accuracy was observed by per rectal examination and by estimation of plasma progesterone on the day of estrus. Estrus detection efficiency was found significantly (P<0.05) higher (63.65%) in treatment group as compared to control group (40.70%). Moreover, higher estrus detection accuracy, albeit not statistically, (85.46%) following rectal examination was found in the treatment group as compared to control (79.17%). It was inferred that package involving; 4 times bull parading, heat expectancy chart and the visual observation improved the heat detection efficiency in Murrah buffaloes significantly. Further, short term cooling around breeding (3 hours before & after AI) significantly reduced the body temperature of buffalo heifers during hot and humid season and improved the conception rate in Murrah buffalo heifers. Buffaloes with cervical mucus having typical fern pattern had significantly (P>0.01) higher conception rate (54.90%) as compared to atypical fern pattern (20.00%).

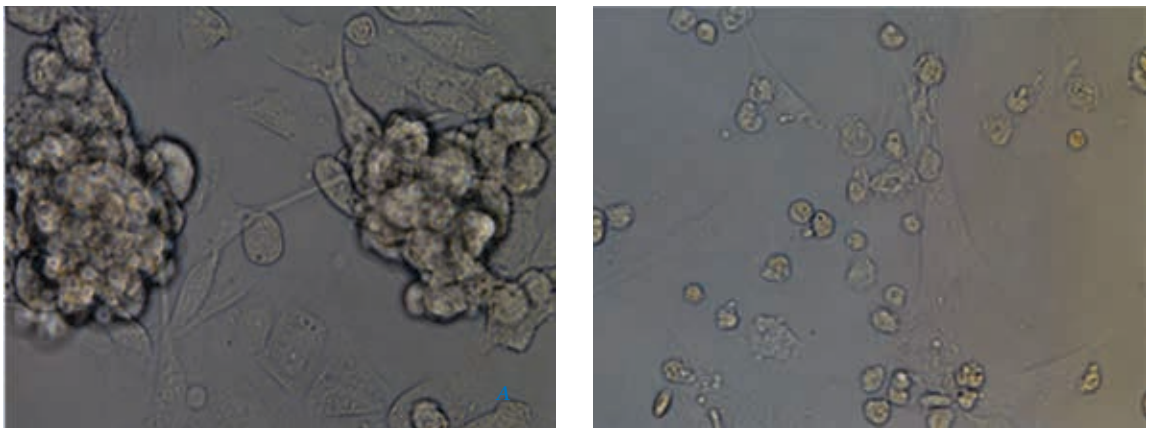
Identification of the risk factors for Retention of Fetal Membrane (RFM) and studied the impact of RFM on production and reproduction performance in dairy cattle and buffaloes: To identify the risk factors for RFM and to analyze the impact of RFM on productive and reproductive performance in dairy cattle and buffaloes, 12 years (2001 to 2012) data were analyzed. A total number of 2547 lactations in KF, 1609 lactations in Sahiwal and 1604 lactations in Murrah buffaloes were analyzed. A multivariable logistic regression model was used to identify risk factors for RFM and quantify their odds ratio (OR). The overall RFM incidence from 2001 to 2012 in KF, Sahiwal and Murrah buffaloes were 26.37%, 15.59% and 13.08% respectively, and significant risk factor for RFM in KF were dystocia (OR=4.29), abortion (OR=3.96), dead calf (OR=4.29), pluriparity (OR=1.47), shorter gestation length (OR=4.31). In Sahiwal cows, dystocia (OR=3.91), abortion (OR=3.98), dead calf (OR=3.72), lower birth weight of calf (OR=1.61) and shorter gestation length (OR=6.39) were significant risk factors. In Murrah buffaloes, dystocia (OR=4.74), abortion (OR=19.21), dead calf (OR=4.39), pluriparity (OR=1.67), shorter gestation length (OR=12.52), lower birth weight of calf (OR=1.95) and calving during summer season (OR=1.75) were significant risk factors for RFM. Significant (P<0.05%) decrease in 305 days milk yield and total milk yield was found in RFM affected KF cows. However, RFM did not influence the lactation length, interval from calving to first service, service period, services per conception and calving interval significantly but, it increased (p<0.05) the incidence of metritis in these animals.

Metabolic and biochemical indicators for RFM in indigenous and crossbred dairy cattle: Peripheral blood concentrations of total cholesterol, total protein (TP), blood urea nitrogen (BUN), glucose, non-esterified fatty acid (NEFA) and beta-hydroxy butaric acid (BHBA) were estimated in RFM and non-RFM cows (on 30, 14, 7, 5, 3, 1 day pre-partum, day of calving and on day 1, 2 postpartum) to study their relationship with RFM in KF and Sahiwal (SW) cows. In cows that developed RFM, the levels of cholesterol, glucose and TP were significantly lower when compared to those that expelled the fetal membranes within 12h. However, the concentrations of NEFA, BHBA and BUN were significantly higher in cows that had RFM compared to those that calved normally. In KF cows affected with RFM, concentrations of NEFA increased significantly from 14th day pre-partum till day 2 postpartum and concentrations of BHBA increased from 7th day pre-partum till 2nd day after calving. Similarly, in SW cows, NEFA and BHBA level increased significantly between day 5 pre-partum till day 2 postpartum in RFM cows. The concentrations of NEFA and BHBA during 30 days due calving was highly related to the RFM. It may be inferred that monitoring the levels of NEFA and BHBA during pre-partum period would help in identifying the cows at the risk of developing RFM.

Expression of short chain fatty acid receptors and pro-inflammatory cytokines in utero-placental tissues altered in cows developing retention of fetal membranes: In spite of extensive research, pathogenesis for RFM and identification of predictive markers for the condition still remains elusive. Since expulsion of fetal membranes is an inflammatory process, studying the expression of inflammatory molecules is expected to give an idea about the pathogenesis of RFM. Expression of pro inflammatory cytokines, short chain fatty acid (SCFA) receptors and adhesion molecules were studied using qRT-PCR in the utero-placental tissues obtained from the cows that expelled fetal membranes normally (n=12) and from the cows that developed RFM (n=12). Concentrations of SCFAs were estimated in the utero-placental tissues using Gas Chromatography. The concentration of butyrate in the utero-placental tissue extract was 3-4 times lower, and GPR41 and GPR43 mRNA expression was 7.7 – 10.0 and 3.4 – 4.4 folds lower (p<0.05) in cows that developed RFM compared to those that expelled the fetal membranes normally.

The expression of IL-1, IL-6, IL-8, TNFα, ICAM and PECAM were higher ($p<0.05$) in the cows that normally expelled the fetal membranes normally compared to those that developed RFM. Since a clear association of butyrate levels, expression pro-inflammatory cytokines, adhesion molecules and SCFAs receptors was observed with expulsion of fetal membranes, modulating the levels of these molecules prior to parturition might help in reducing the incidence of RFM in cows. It was concluded that inflammatory response is essential for normal expulsion of fetal membranes and that inadequate or altered expression of pro-inflammatory cytokines, adhesion molecules and SCFA receptors is associated with RFM in cows.

Method for extraction and culture of spermatogenic and Sertoli cells from live bull calves and breeding bulls: Till date, testis obtained either from slaughter house or through castration was used to isolate and culture the Sertoli or spermatogenic cells. Whereas, the details of the animal remains largely unknown in slaughter house sample based method, the future reproductive ability of the male is compromised in castration method. Thus, there has been a pressing need to standardize a method to isolate the Sertoli or spermatogenic cells from live animal without affecting its future reproductive performance. The percutaneous needle aspiration biopsy method was standardized to extract testicular cells from live bulls and the culture methodology of extracted Sertoli and spermatogenic cells standardized. The day of plating was considered as 0 day of culture. On day 1, the spermatogenic cells and the sertoli cells were separated. The supernatant was enriched with spermatogenic cells and the sertoli cells were bound to lectin. The sertoli cells bound to the lectin plate were detached by using trypsin EDTA (0.25% trypsin, 0.2% EDTA) and washed twice to remove the lectin thoroughly. Then, sertoli cell suspension was centrifuged at 1000 rpm for 2min to get the cell pellet. After getting the sertoli cell pellet, plating was done at a conc. of 100µl/ 3ml culture medium as described above. To ensure proper growth of the cells, media was changed every third day and the growth was checked under microscope. When cell confluence reached 70-80%, subculture was done to maintain the growth and actual performance of the cell. The sertoli cells were sub-cultured for 10 passages with a doubling time between 5-7 days. The viability of the cultured cells was estimated by the Trypan blue exclusion test. It was found that the viability of Sertoli and spermatogenic cells were 93 and 91%, respectively after 10 passages.

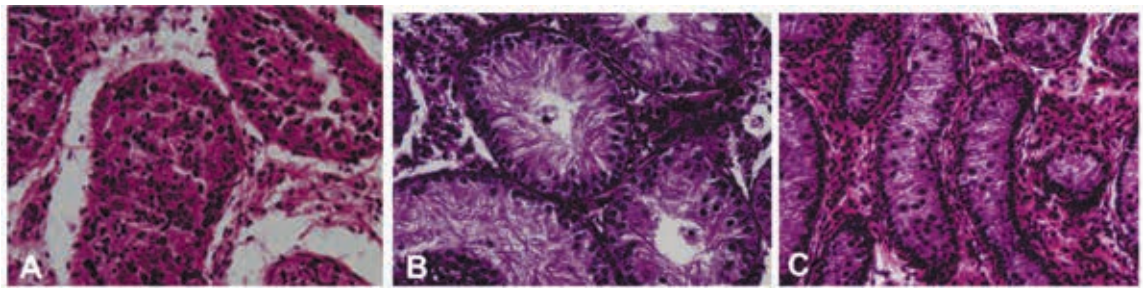


Growth and multiplication of Sertoli (A) and spermatogenic cells (B) during in vitro culture (after 5 passages)

Identified differentially expressed proteins in spermatozoa from high and low fertile crossbred bulls: Conception rates (CR) were estimated for crossbred bulls (Holstein Friesian x Thaprakar, with Holstein inheritance between 50-75%) based on a minimum of 100 artificial inseminations per bull and bulls were classified as high or low fertile. Spermatozoa obtained from bulls of both the categories were subjected to proteomic analysis. To investigate the differentially expressed proteins, 2D-DIGE analysis was performed by using above described purified proteins of spermatozoa of two distinct groups HF and LF, respectively. Proteins extracted from HF and LF spermatozoa were labelled by using CyDye. Gels were scanned in Image Quant and results were analyzed by using DeCyder software. Three images corresponding to the three samples (HF, LF and internal standard) were generated for each gel. Six images were generated in total corresponding to the two gels. 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

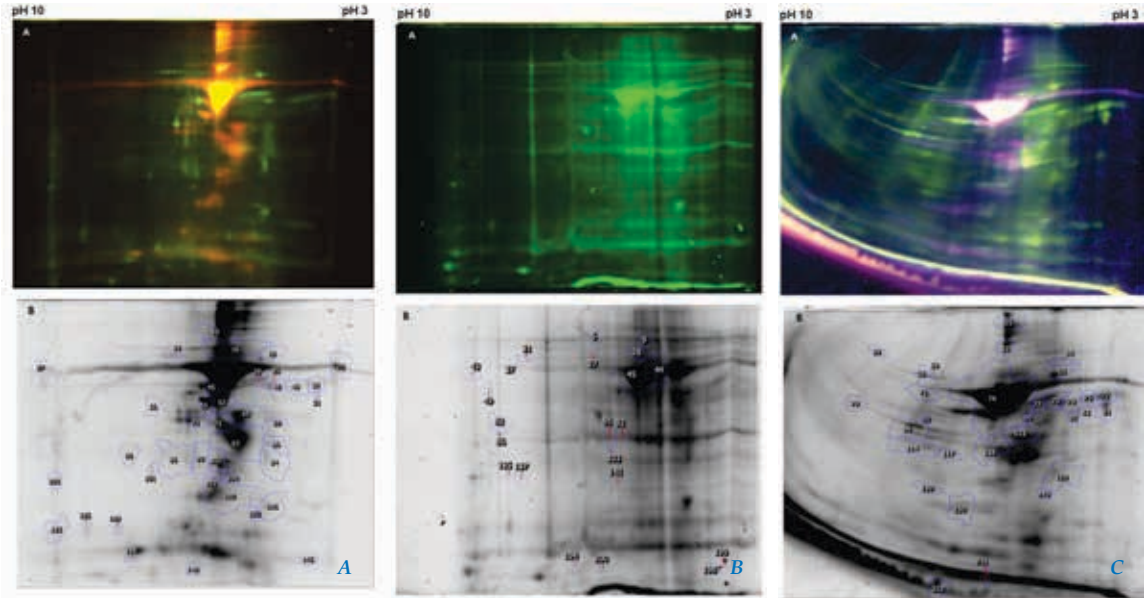
spots were differentially expressed. Among all the selected spots, 15 differentially expressed proteins by MALDI-TOF/MS analysis were identified in which 12 proteins over expressed in HF and 3 proteins were over expressed in LF spermatozoa.

Testicular histology indicates differences in Sertoli cell numbers and arrangements of spermatogenic cells among purebred, crossbred and indigenous bull calves: The histomorphometric characteristics of seminiferous tubules, spermatogenic cells and Sertoli cells in Holstein Friesian (HF-purebred), Karan Fries (KF-crossbred) and Tharparkar (indigenous) bulls were studied. Four peri-pubertal bulls (age 10m) from each breed were utilized for the study. Testicular fine needle aspiration was carried out to study the morphology and biometry of individual testicular cells. Testicular tissue sections obtained by unilateral castration were stained using haematoxylin/eosin stain to study the histo-architecture of the testes. GATA4 antibody was also used to study the population of Sertoli and Leydig cells. It was observed that the diameter and area of the seminiferous tubule was high in HF, followed by KF and Tharparkar bulls. However, the degree of compactness, based on qualitative evaluation, was high in Tharparkar followed by KF and HF bulls. The intensity of Leydig cells was higher in Tharparkar bulls followed by KF and HF. The area of Sertoli cells was significantly ($p<0.05$) higher in HF bulls compared to Tharparkar bulls. The proportion of Sertoli cells was significantly ($p<0.05$) higher in HF and Tharparkar compared to KF bulls. These preliminary findings indicate that variations exist in testicular components among the breeds studied, which might explain fertility differences among these breeds. Further studies are in progress to confirm the findings and to study the testicular architecture at different ages in these breeds.



Testicular section indicating the compactness of seminiferous tubule, intensity of Leydig cells and status of spermatogenesis in peri-pubertal bulls A- Holstein Friesian, B- Karan Fries, C- Tharparkar

Identification of differentially expressed proteins in spermatogenic cells from indigenous, crossbred and exotic bull calves: The proteomic analysis of Sertoli and spermatogenic cells from peri-pubertal Holstein Friesian, Karan Fries and Tharparkar bull calves using difference in Gel Electrophoresis (DIGE) and image scanning identified the presence of total 214 protein spots in spermatogenic cells

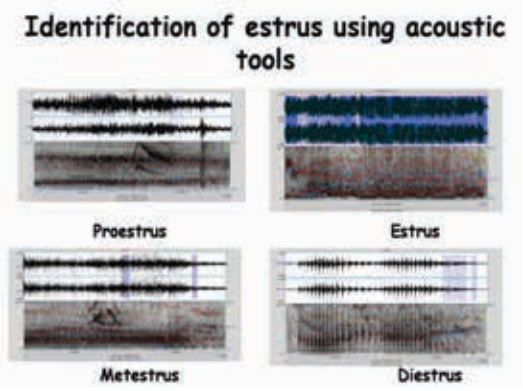


DIGE images of testicular cell proteins with differentially expressed spots as analysed by DeCyderTM software. [A] – HF x KF spermatogenic cells; [B] – KF x TP spermatogenic cells; [C]- HF x KF Sertoli cells

from HF and crossbred bulls. Among these, majority of the spots were differentially expressed in both the groups. For further study, spots having at least two fold differences in expression level between the groups were selected. Based on this, 14 proteins were found over expressed in the spermatogenic cells isolated from Holstein Friesian bulls, whereas 26 protein spots were under expressed in HF compared to crossbred bulls. The differential expression of protein spots ranged from 3.1 to 36.9 folds between two breed groups. After DIGE image analysis, from the panel of differentially expressed proteins, based on the magnitude of differential expression and visibility after silver staining, 12 protein spots were selected for further identification through MALDI-TOF/MS. Out of these 12 proteins, 4 proteins each belonged to the three experimental samples, i.e. from spermatogenic cells of HF x crossbred and TP x crossbred and Sertoli cells of HF x crossbred. The spots 1 to 7 were identified as albumin, and the spot 8 was identified as Phosphatidyl Ethanolamine Binding Protein (PEBP), which was over expressed in the spermatogenic cells of crossbred bulls compared to Tharparkar with a two fold increase in expression. Among the 4 selected spots of Sertoli cells, spots 10 and 11 were identified as albumin, whereas spots 9 and 12 were identified as Gamma Actin (γ-Actin) and RINGO/Speedy protein-A respectively. **γ-Actin** was found to be over expressed in the Sertoli cells of Holstein Friesian bulls, whereas Speedy Protein A was found to be over expressed in crossbred bulls.

Effect of feed energy levels on puberty, sexual maturity and semen quality in buffalo bulls: A study was conducted to investigate the effect of increased feed energy levels on body weight and age at first ejaculation in Murrah buffalo bulls. Eighteen bull calves, at the average age of ~ 9 months and ~190 kg body weight, were taken for the study. These calves were managed in 3 groups of 6 animals each. Control animals were fed on as per the NRC (2001) standard and groups II and III were fed additional 10% and 20 % energy, respectively, over control. Body weight, scrotal circumference, age at first mounting and age at ejaculation were monitored. Average values of different parameters revealed that bulls started mounting at 15.3, 14.2 and 14.3 months of age in the treatment groups C, I & II, respectively with corresponding size of scrotal circumference and the body weights at first mount of the respective groups being 20.3, 20.0 and 20.6cm; and 260.7, 261.3 and 276.2 kg. The average age at first ejaculation in bulls of 3 corresponding groups was 20.4, 18.0 19.3 months. The corresponding values for size of scrotal circumference and the body weights at first ejaculation of the 3 treatment groups were; 23.9, 23.4 and 25.0 cm; and 350.3, 340.2 and 364.1 kg, respectively.

Acoustic assessment of indexical vocalization cues for efficient management of dairy animals: A study was conducted to assess the variations in the acoustic features of buffaloes during various stages of estrous cycle with the purpose of exploring its use in estrus detection. Results revealed that the call duration of buffaloes was significantly longer during estrus and proestrus than metestrus and diestrus ($P<0.05$) phases. Minimum amplitude of the voice did not differ significantly among proestrus, estrus, and metestrus stages but all 3 stages differed significantly from diestrus. Same trend was observed in case of noise to harmonic ratio. Maximum amplitude was significantly higher ($P<0.05$) in proestrus followed by estrus, metestrus and diestrus. Total energy was found significantly higher in proestrus, followed by estrus, metestrus and diestrus. The voice in the Proestrus stage had significantly higher mean pitch and was followed by estrus, metestrus and diestrus. Mean intensity of voice also followed similar trend. Values of various formants increased linearly from F1 to F5 in which F3, F4 and F5 were significantly higher during diestrus while F1 and F2 were higher in metestrus and proestrus periods respectively. Estradiol concentration was positively correlated with call duration, maximum amplitude, total energy, mean pitch and mean intensity of voice, while it was negatively correlated with minimum amplitude, noise to harmonic ratio and formant F1. LH concentrations were negatively correlated with all acoustic features of voice. Among the all acoustic features the call duration, total energy, mean pitch, mean intensity and formants (especially F1) were observed to be the major voice cues which could



Percentage of breedable crossbred female in total breedable population

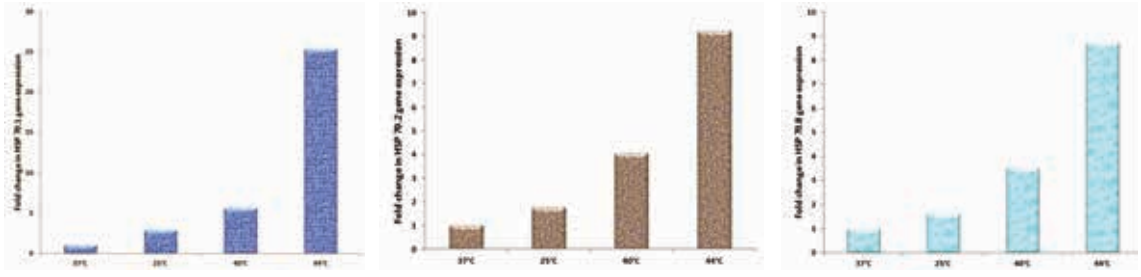
unfold the variation in voice signals of different phases of estrous cycle.

Bacterial and pharmacological concerns of postpartum uterine infections in dairy cattle and buffaloes: Isolation of 22% of coliforms, 12.70% of *E. coli*, 19% of *Streptococcus sp.* 23.53% of *Staphylococcus Sp.* and 22% of *Bacillus sp.* from uterine swab of cows with clinical endometritis was carried out. Antimicrobial sensitivity assay against *E. coli* revealed that gentamicin, ceftriaxone, ampicilin with sulbactum, oxytetracycline (OTC) and chloramphenicol were most sensitive. The minimum inhibitory concentration (µg/ml) of gentamicin and OTC against *E. coli* was found as 5.47 µg/ml and 0.78 µg/ml, respectively. *In vivo* evaluation (n=8; i.u. route for 3 days) of gentamicin, OTC and povidone iodine through fertility parameters revealed OTC was more suitable drug for treatment of clinical endometritis. Milk yield during treatment and after treatment in all the groups remained unchanged. Evaluation of antimicrobial therapy through APPs (haptaglobin: Hp and serum amyloid A: SAA) and cytokines (IL-1β and TNF-α) suggested the diminishing inflammatory processes in antibiotic treated cows and insignificant effect on PI treated cows. Estimation of APPs (Hp, SAA and Alpha 1 acid glycoprotein: AGP), pro-inflammatory cytokines IL-1β, IL-6, TNF-α and IL-8) and energy metabolites/hormones (NEFA, BHBA, IGF-1 and leptin) concentration during transition period revealed plasma Hp could be the better predictor of clinical endometritis than SAA, while AGP was poor predictor during early (7 days) postpartum. Effectors APPs are mostly mediated by IL-1β, IL-6 & TNF-α. It was inferred that, in presence of negative energy balance higher or very low concentrations of pro-inflammatory cytokines, lower concentration of chemoattractant (IL-8) along with higher levels APPs are important risk factors for endometritis.

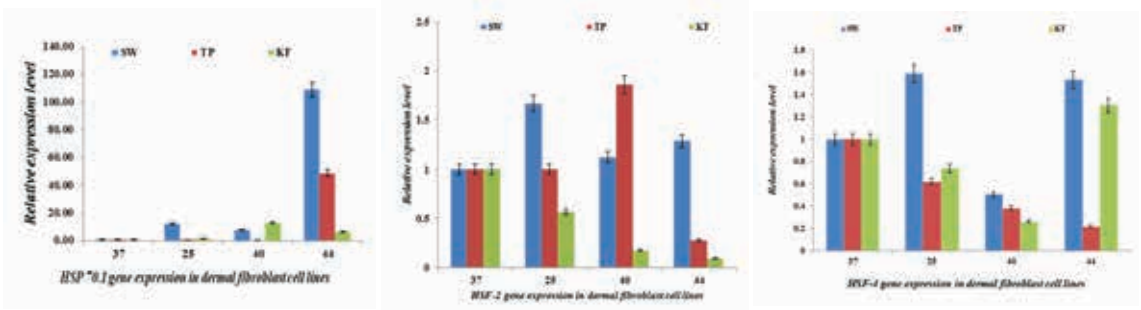
Dairy Cattle Physiology

National Initiative on Climate Resilient Agriculture (NICRA)

Effect of heat stress on the dermal fibroblast of buffalo: The effect of heat stress on the dermal fibroblast of buffalo was evaluated by analyzing the expression of heat shock proteins (HSPs), apoptotic genes (caspases) and matrix metalloproteins (MMPs) by exposing at 25, 37, 40 and 44 °C. The expression of heat shock proteins, apoptotic genes and MMPs were increased with the increase in temperature from 37 to 44°C.

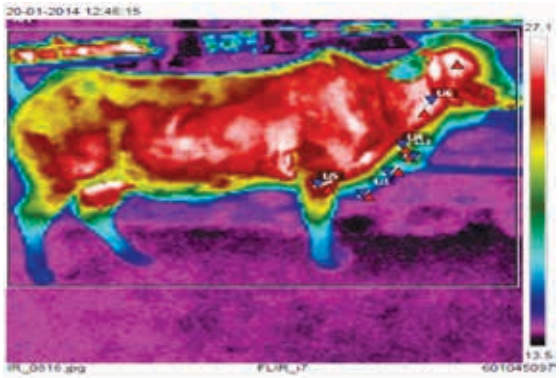


Expression of HSFs, HSPs and MC1R genes in dermal fibroblast of cattle: The effect of heat stress on the dermal fibroblast of Tharparkar, Sahiwal and Karan-Fries cattle was evaluated by analyzing HSFs, HSPs and MC1R using Real Time- PCR and results showed that HSF factors (HSF-1, 2, 4) was down regulated whereas HSP-70.1 and HSP-90 were up regulated at different temperature as compared to control.



Identification of genes and proteins in relation to heat stress in buffalo *(Bubalus bubalis):* The study conducted to decipher the differentially expressed serum proteome profile of *Bubalus bubalis* during heat stress and recovery period applying high thoroughput 2DIGE proteomics approach. The differentially expressed spots showing significant fold change were picked through spot picker and identified through MALDI TOF/TOF and ESI LC MS/MS. In total 55 proteins were identified with high confidence in the buffalo serum. This is the first data for the serum proteome profiling of *Bubalus bubalis***.** The gene ontology analysis of the identified proteins revealed the molecular characterization, biological function and cellular localization of the identified serum proteins whereas the pathway analysis of the identified proteins divulged the presence of complement, coagulation and signalling pathways with high confidence.

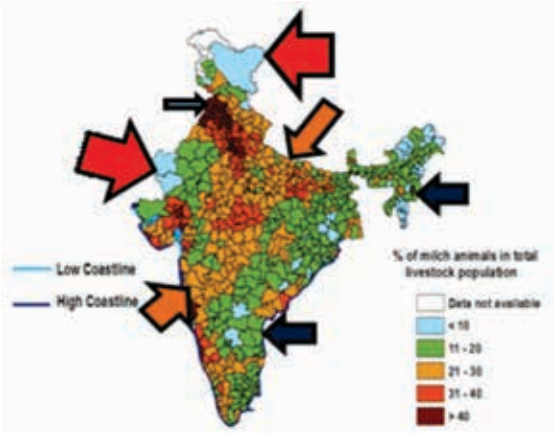
Thermal profiling of cattle and buffalo during different seasons: Thermal profiling of cattle and buffalo was carried out during different seasons. Image analysis using FLIR tool software revealed the difference in the isotherms. Eyes were the hot spot having the maximum temperature when the threshold limit of temperature was selected 27°C. Insulation isotherm detected the insulation breakage from the legs at around 15–18°C which showed the insulation deficiency and when the insulation level falls below a preset value of the energy leakage that depicts vasoconstriction.



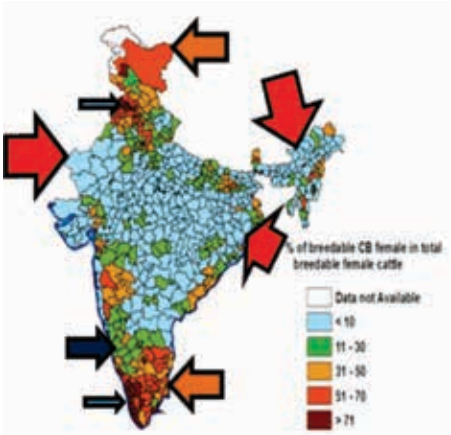
Seasonal variations in blood flow and physiological reactions of Murrah buffaloes: The different physiological parameters and blood flow were measured during summer and winter season. Results showed that blood flow in the abdomen and dorsal site of buffalo was significantly higher during summer than winter. Similarly, physiological responses were significantly higher in summer than winter season.

Vulnerability assessment: For vulnerability mapping, all India district level data of 600 districts for each of the vulnerability component was downloaded, tabulated and cleaned and the maps of individual indicators of the adaptive capacity component are being developed.

Approach: Vulnerability= Adaptive Capacity – (Sensitivity + Exposure).



Percentage of milch population in total livestock population



Percentage of breedable crossbred female in total breedable population

Identification of unique traits in Tharparkar (TP) and Karan Fries (KF) cattle: In order to find out the expression of coat color related genes (MC1R and ASIP) and their relationship with morphological, physiological, haematological and biochemical parameters, present study was carried out on TP and KF heifers during summer and winter season. Physiological responses were significantly ($P < 0.01$) higher during summer than winter season in both the breeds. The

magnitude of increase in physiological responses were significantly ($P < 0.01$) higher in KF than TP heifers. The magnitude of increase in plasma cortisol during summer season was significantly ($P < 0.05$) higher in KF than TP heifers. The levels of metabolic hormones i.e. tri-iodothyronine (T_3) and thyroxine (T_4) were significantly ($P < 0.01$) higher during winter than summer season in both the breeds. However, the levels of essential enzyme for skin pigmentation (tyrosinase) was significantly ($P<0.01$) higher during winter compared to summer in both the breeds. Genes responsible for skin pigmentation (MC1R and PMEL) expressed more ($P < 0.01$) during winter than summer season in both TP and KF heifers. The magnitude of expression was significantly ($P < 0.01$) higher in TP than KF especially during winter season. The coat color of TP was darker than KF cattle, whereas, the hair color was reverse the coat color. The expression genes showed negative correlation with physiological responses. The expression of these genes also showed negative correlation ($P < 0.01$) with heat stress as it was negatively correlated with plasma cortisol level. The results of the present study clearly showed the significant difference in the expression level of skin color related genes (MCIR, PMEL) during both the seasons and between the two breeds of cattle. Further, the changes in their level of expression along with other heat stress related parameters indicated the importance of these genes to adaptation.

Amelioration of thermal stress using chromium propionate: The present study was undertaken on 12 Sahiwal calves, which were further divided equally (6 each) into two groups i.e. control (without chromium propionate) and treatment (with chromium propionate supplementation). Treatment group of animals were fed @ 0.5mg chromium propionate/kg dry matter intake/day during winter and summer seasons for 45 days continuously. Body weight gain was significantly higher in treatment group compared to control group, whereas no significant difference was observed in dry matter intake among two groups. The lower values of antioxidant enzymes (SOD, CAT, GPx and GR) were found in treatment group compared to control group of Sahiwal calves during summer and winter seasons. The levels of stress hormone cortisol were found to be higher in control compared to treatment group. Immunological parameters (IL-1β, IL-2, IL-6 and TNF-α) showed higher immunity status in treatment group compared to control group of Sahiwal calves. Supplementation of chromium propionate improved DMI, body weight gain and immune status of Sahiwal calves. Thus, supplementation of chromium propionate @ 0.5 mg/kgDM/day could be used as one of the major thermal stress ameliorative measure for mitigating the negative impact on body growth and immune status.

There was significant impact of thermal stress and transition period in SW and KF cows. Also the cows were at higher stress during calving period. The Caspase-3 mRNA expression in SW and KF cows decreased significantly ($P<0.0001$) on 15 days pre and post partum during summer and thermoneutral condition as compared to 0 day of calving. Also the magnitude of expression during summer was higher in all periods as compared with thermoneutral conditions in both the breeds at different levels of significance. BAX/BCL-2 ratios were also higher in both the breeds, in all periods during the summer when compared with thermoneutral condition. Ratios were lower on 15 day prepartum in both the breeds during summer. There was upregulation of P-53 during summer in both the breeds and in all periods. FAS mRNA expression increased on 15 day pre and postpartum in summer in both the breeds. While comparing two seasons, there was down regulation of FAS in all periods only in KF cows. There was significant ($P<0.0001$) upregulation of BAK in SW and KF during summer in all the periods. The expression of BAK was significantly lower on 15 day pre and post partum in Sahiwal ($P<0.0001$) in thermoneutral condition and in Karan Fries cows ($P<0.05$) in both seasons. Plasma levels of HSP- 27 were found to be significantly ($P<0.0001$) higher during summer as compared to thermoneutral conditions, but there was no significant change between the periods. The plasma level of IgG significantly ($P=0.004$) decreased on the day of calving with respect to 15 days pre and post calving. Plasma level of leptin was lower on the day of calving with respect to 15 days pre and post calving. Plasma level of IGF-1 levels were significantly ($P<0.0001$) lower during summer as compared to the thermoneutral condition. Also the levels were significantly ($P<0.0001$) lower on the day of calving with respect to 15 days pre and post calving in both the breeds. Thus, upregulation of Caspase 3 and BAK (proapoptotic genes), BAX/ BCL-2 ratio (apoptosis indicator) on the day of calving indicated higher cell loss which was further aggravated by thermal stress. Upregulation of these factors may cause programmed cell cycle

arrest, cellular senescence or apoptosis of PBMC during summers as compared to themoneutral condition. Plasma level of HSP-27 increased and IGF-1 decreased during summer as compared to thermoneutral conditions. Plasma level of leptin and IgG decreased on the day of calving with respect to 15 days pre and post calving.

Molecular basis for modulation of immunocompetence of neutrophilic function *in vivo* and *in vitro* of high producing cows and buffaloes peripartum: A decline in the plasma micronutrients levels around calving was observed which decreased the neutrophilic activity and expression that predisposes the peripartum dairy animals to disease. However, supplementation of Vit.A, Vit E, Cu and Zn modulated the function of blood neutrophils. Maximum beneficial effect was observed in the phagocytic activity (PA) of blood neutrophils of Vit A supplemented buffaloes followed by Vit E, Cu and combination group. Supplementation had no beneficial effect on the function of blood B and T lymphocytes. Supplementation of Vit E and Zn significantly ($P<0.05$) reduced plasma cortisol levels at calving and 30 days postcalving, whereas, Cu increased them. Supplementation decreased milk SCC in Vit E supplemented cows and improved milk yield in Vit A supplemented group. Micronutrients also improved reproductive performance of KF cows. Buffalo neutrophils had more elastase and collegenase enzyme levels. Significantly ($P<0.01$) lower expression was observed in neutrophilic genes: TLR-2, TLR-4, TNF-alpha, IL-1 and IL-8 at calving. Shape, viability and PA of blood neutrophils changed significantly ($P<0.01$) once they migrated to the mammary tissue. Significantly higher ($P<0.01$) apoptosis of blood neutrophils was observed at calving. Under *in vitro* conditions, the response of stressed neutrophils (isolated at calving) varied with micronutrient supplementation.

Evaluation of plasma IGF I and Haptoglobin for augmenting growth and puberty in Murrah buffaloes with fermented yeast culture supplementation: Murrah buffalo calves with less body weight exhibited less concentration of the plasma IGF I hormone and increased with the increase in the plasma concentration of the hormone. Under the present management, the control group calves (male/female) which were not supplemented with fermented yeast culture gained more than 500g/day. But the gain was significantly more ($P<0.05$) in the supplemented group with ADG > 800 g/day. Moreover, supplement like fermented yeast culture @ 12g/animal/day significantly increased the concentration of plasma IGF I and gain in body weight. When the study with supplementation was further conducted for the same group of calves @ 24g/animal/day from fourteen months of age till puberty, it was observed that concentration of plasma IGF I was significantly more in supplemented group ($P<0.05$) and the female buffaloes (5/6) attained puberty at 21±1 months of age. Whereas unsupplemented group (1/6) attained puberty at 24 months of age. In case of male buffaloes 3/6 attained puberty, at 22 months of age.

Hepatocyte culture was optimized with respect to cell number, viability, parameters for assessing the functionality of hepatocytes like lactate dehydrogenase activity, albumin and urea secretion *in vitro* over a period of 72h at 37°C and then they were subjected to hyperthermic conditions at 40 and 42°C for a period of 24, 48 and 72h time intervals under controlled conditions *in vitro*. It was observed that under hyperthermic conditions, the activity of antioxidant enzymes superoxide dismutase, catalase and glutathione peroxidase had increased significantly ($P<0.01$) when compared with the mean±SE activity at 37°C at different time intervals. Results were opposite with respect to functional markers of hepatocytes with significant decrease ($P<0.01$) in albumin secretion *in vitro*. The secretion of TGF β, which is a stress marker, was observed to be significantly greater ($P<0.01$) only at 42°C at 72h interval. On addition of mannan oligosaccharide to the cell culture, reversed the effect of hyperthermia on hepatocyte parameters.

The relationship between blood , seminal plasma IGF I, NGF growth factors and fertility status was studied in Murrah buffalo bulls. It was observed that level of the blood plasma growth factors was significantly more ($P<0.05$) in high fertile group. The parameters with respect to spermatozoa, percentage of motile and viable spermatozoa, sperms with plasmalemma integrity were also significantly greater ($P<0.05$) in high fertile group when compared with low fertile group. *In vitro* supplementation of these factors to spermatozoa *increased* the percentage of sperms with motility and viability for a period of 120 min. when compared with the spermatozoa without treatment in both high and low fertile groups. *In vitro* fertilization experiments with treated spermatozoa groups delivered results

with greater number of cleaved embryos when compared with untreated group.

Metabolic adaptation and early lactation performance of low and high producing cows and buffaloes: Lactating crossbred cows were selected at an average 20 days postpartum and were given 10 days adaptation period. The experimental cows were fed prilled fat @ 75g/day for a period of 90 days. The feeding of prilled fat resulted in a significant increase in milk yield ($P<0.05$) and milk fat ($P<0.05$) without affecting lactose, protein, milk cholesterol in comparison to control group cows. However, plasma NEFA concentration decreased ($P<0.05$) and plasma triglycerides concentration increased ($P<0.05$) indicating that prill fat feeding in early lactation was effective in physiological adjustment of mobilization of body reserves by restricting decline in body weight. The feeding of prilled fat neither caused any detrimental effect on the digestibility of nutrients nor affected plasma hormones, VLDL, BHBA and cholesterol levels; however HDL concentration decreased. The reproductive performance of the cows was improved by early initiation of postpartum cyclicity, service period short and the improved conception rate. The feeding of prilled fat was cost effective and could be used to augment milk secretion and improvement of reproductive performance of cows.

In another experiment, prilled fat was fed to the Murrah buffaloes @ 75 g/d up to day 45 post partum and @ 150 g/d till day 120 of lactation. Supplementation of prilled fat significantly ($P<0.001$) increased milk yield @ 10.96% in the treatment group in comparison to control group, due to significant increase in DMI and more ($P<0.001$) body weights. Plasma glucose levels were significantly ($P<0.05$) different between low and high producing group, but increased in prilled fat fed group significantly ($P<0.05$). Plasma NEFA concentration was more ($P<0.001$) in high producing buffaloes than the low producers. Prilled fat supplementation reduced NEFA levels significantly ($P<0.001$). Digestibility coefficients of DM, OM, CP, ADF, NDF and NFE were significantly less in low producing buffaloes as compared to high producing buffaloes. Prilled fat supplementation improved ($P<0.001$) digestibility of EE and NDF in treatment group over the control group buffaloes. Prilled fat feeding was quite effective in augmentation of milk secretion and earlier physiological adjustment of dry matter intake and body weight decline in buffaloes also.

Influence of guduchi supplementation peripartum to dairy animals on production and reproduction performance at field level: To study the immunomodulatory effect of freeze dried milk obtained from guduchi supplemented buffaloes, 16 mice were divided into two groups of 8 mice each. The control group was fed on freeze dried normal milk obtained from control buffaloes without guduchi supplementation and treatment group was fed on milk obtained from guduchi supplemented buffaloes. The duration of experiment was for four weeks. The 50% (2.5 grams of 5.0 grams) of the synthetic diet was replaced with milk. The average initial and final weight (g) of control group of mice was 25.70±1.94 and 27.65±3.45, respectively while the respective values in treatment group of mice were 24.87±2.06 and 28.50±2.59. The net gain in body weight was 1.95 and 3.63 g in control and treatment groups, respectively. The increase in weight of mice after 4 weeks of feeding was significantly higher ($P<0.05$) in group of mice fed on guduchi milk.

The percent phagocytic activity in control and treatment groups was 52.93±4.34 and 62.61±4.57, respectively registering a significant increase ($P<0.05$). Lymphocyte Proliferation Index in control and treated mice was found to be 0.98±0.09 and 1.38±0.14. Significantly high LPI in treated group of mice fed on guduchi milk as compared to control milk fed group was found. The results indicated that milk obtained from guduchi supplemented buffaloes exhibited immuno-stimulatory effect in mice on feeding for a period of 4 weeks. For obtaining feedback of farmers on guduchi supplementation and evaluation of technology in the field at farmer's doorstep, a survey was conducted regarding awareness of the technology and availability of guduchi from the market and its cost effectiveness. It was observed that availability of Guduchi in powdered form in open market was a constraint. The supplementation of guduchi in the concentrate mixture will also further help in adoption of technology at faster rate.The results revealed that the animals supplemented with guduchi were reportedly healthy due to the improvement of immune system in terms of immune-stimulatory effect. The milk yield improved by >12% through guduchi supplementation. The technology is cost effective in terms of input –output ratio at the level of milk production @ 10 kg/day.

Dairy Cattle Nutrition

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

Addressing Climate Change Scenario

Effect of various levels of bromochlormethane and fiber level on *in vitro* methane production and fermentation pattern: The effect of bromochloromethane (BCM) on methane production and fermentation characteristics was measured by preparing 12 treatment combinations using 3 levels of fibre (HF, MF, LF) and 4 levels of BCM (0, 4, 8 and 12 µM). BCM reduced total gas and methane production (>98% of control) in a dose dependent manner. *In vitro* dry matter digestibility (IVDMD) in different treatment combinations was not adversely affected by BCM but found to increase in most of the cases with total mixed diet containing wheat straw and berseem as a roughage source. Acetate concentration was reduced while, percentage of propionate and butyrate increased. Acetate: propionate (A: P) ratio was reduced by BCM addition in all treatment combinations. On the basis of present study 4 mM dose of BCM seems to be effective in methane reduction without affecting other rumen fermentation parameters adversely.

Nitrate as prophylactic option to mitigate methane emission: The present study was conducted to assess the *in vitro* digestibility, gas production and rumen fermentation parameters with three different substrate (60:40, 50:50 and 40:60) ratio of wheat straw and concentrate (T_1, T_2 and T_3), each supplemented with 3 % calcium nitrate (T_4, T_5 and T_6), g/100 g substrate on DM basis. CH_4 production (% of total gas) decreased significantly (P<0.05) on addition of nitrate to each treatment, lowest CH_4 production (%) was observed in T_4 (18.25 followed by T_5 (19.78 and T_6 (21.64). IVDMD was significantly lower (P<0.05) for the each nitrate supplemented groups when compared with T_1, T_2 and T_3, and a similar tendency was observed in IVOMD. Total N, NH_3-N, NPN, TCA-ppt N (mg/dl) and TVFA (mM/dl) increased significantly with nitrate supplementation. This study indicated that addition of nitrate to the ruminant diet has promising effect in terms of reduction of CH_4 with increased ammonia concentration in rumen. Thus, it can be concluded that calcium nitrate can be used at 3% level of DMI in the ruminant ration as cheap fermentable nitrogen source to reduce methane production.

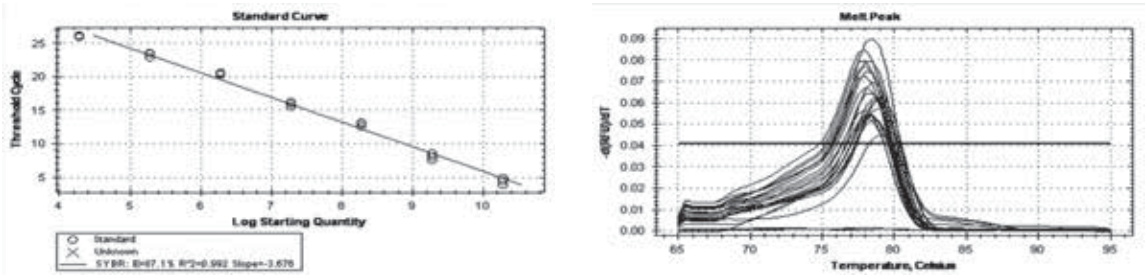
Effect of residual feed intake (RFI) on methane emission in sahiwal calves: Male Sahiwal calves were divided into three groups of low, medium and high RFI. The digestibility coefficients for all nutrients except NDF were significantly (P<0.05) higher in low RFI than medium and high RFI groups. Nitrogen balance and retention was also significantly (P<0.05) higher in low RFI than medium and high RFI animals. Methane production when expressed as g/day was significantly (P<0.05) lower in low RFI group (58.71) as compared to high RFI group (65.62) and as g/kg DMI was also significantly (P<0.05) lower in low RFI than high RFI group. The results showed higher feeding efficiency and reduced methane production in low RFI group of Sahiwal calves.

Molecular Aspects of Dairy Nutrition and Newer Developments

The 16S rRNA and mcr A gene based comparative diversity of methanogens in cattle fed on high fibre based diet: In the present study, the diversity of rumen methanogens in crossbred Karan Fries cattle was determined by constructing 16S rRNA and mcrA (methyl coenzyme-M reductase α subunit) gene libraries using specific primers. All thirteen OTUs or phylotypes from 16S rRNA library clustered with order Methanobacteriales, twelve of which aligned with *Methanobrevibacter spp.*, whereas one OTU resemble with *Methanosphaera stadtmanae*. Out of eighteen OTUs identified from mcrA gene library, fifteen clustered with order Methanobacteriales, two resemble with Methanomicrobiales and remaining one grouped with Methanosarcinales. These results revealed that Methanobrevibacter phylotype was predominantly present in Karan Fries crossbred cattle fed on high fibrous diet containing wheat straw, compared to 16S rRNA gene, mcrA gene OTUs clustered in three orders providing better insights of rumen methanogens diversity in cattle.

***Butyrivibrio fibrisolvens* adminstration has resulted in modification of rumen metabolic pathways *via* modulation of the absorbed fatty acids:** A high CLA producing *Butyrivibrio fibrisolvens* bacteria (140.77µg/ml CLA production at 200 µg/ml linoleic acid for 1hr incubation) was isolated, screened and molecularly characterized with 16S PCR analyses (Fig.1) and administered to

kids (male goats) as well as lactating female goats to check the alterations in rumen biohydrogenation and also in ruminant derived products, meat and milk. Fatty acid analysis through GC revealed a decrease in SFA by 6.24% in kids and 10% in lactating goats; whereas a significant increase in PUFA (4.04% in kids and 5% in lactating goats) was observed. MUFA and UFA increased (P<0.05) by 33% and 43% in kids; and by 5% and 6.34% in lactating goats, respectively. Total CLA in meat and milk was increased by 30% and 50% in kids and lactating goats, respectively. Total SFA was decreased by 10.5% and 24.3% in meat and milk, respectively; whereas total PUFA was increased by 15.6% and 33.56% in meat and milk respectively. The concentration of MUFA remained unchanged in meat but was increased by 40% in milk of lactating goats. UFA and ratio of UFA to SFA was significantly increased by 12.2% and 25% in meat and by 10.56% and 18% in milk in *Butyrivibrio* administered groups. Ratio of n-6:n-3 fatty acid was decreased by 12.5% in meat and 13.25% in milk. However, Linoleic acid isomerase activity was significantly increased by 50% and 62.54% in rumen fluid of kids and lactating goats, respectively. No significant differences in milk yield and composition (fat, protein, SNF and lactose) was observed in different treatments in lactating goats. Further, the effect of *Butyrivibrio* administration resulted in an increase in antioxidant activity in blood. The population density of *Butyrivibrio fibrisolvens* as well as their relative abundance in rumen fluid were significantly higher (P<0.05) in both the administered groups T2 (20.1%) and T3 (34.1%). Therefore, *Butyrivibrio fibrisolvens* administration resulted in modification of rumen metabolic pathways *via* modulation of the absorbed fatty acids, thus, altering indirectly the regulatory mechanism responsible for CLA accumulation in meat and milk.



Real Time PCR Graph, Standard Curve and Melt Peaks of R. flavefaciens

Methane evaluation and methane production from equine hindguts: Common equines feeds were evaluated as per CNCPS and for dry matter degradation and methane emission under *in vitro* conditions using equine faecal inoculums and rumen liquor. Acetogens, methanogens and methanotrophs were identified in horse caecum by molecular technique using universal primers. Methane release was also estimated from equine manure fermentation. The data revealed that the readily degradable fractions of carbohydrate and protein were higher in protein supplements and legume fodders. Intermediately degradable fractions were abundant in agro-industrial by-products and range forages, whereas indigestible fractions were higher in agro-industrial by products. Highest methane emission (g/kg TOMD) was observed in legume fodders (19.29) followed by agro-industrial by-product (14.66), energy supplements (12.40), non-legume fodders (10.78), range forages (9.46), tree leaves (8.69) and protein supplements (7.78). The average methane emission was 1.4 and 9.31 g/day from 10 and 20 kg manure fermentation. Dry matter intake was 2.63 kg/100kg BW, and digestibility coefficient (%) of DM, CP, EE, NDF, ADF and NFC were 59.34, 66.77, 53.48, 46.94, 44.03 and 47.56 respectively. The partial nuceleotide sequence encoding *ftfs* genes (acetogens) and 16S rRNA genes (methanothrophs and methanogens) were amplified using PCR. The nucleotide sequence were obtained and deposited in the Gene Bank database under the Bankit number 1570827, 1571273, 1571282, and 1571285 with clones name seq1, kundu, radha and bala for FTHFS, type I, type II methanotrophs and methanogens, respectively.The presence of acetogens and methanotrophs as identified in the present studies may be a reason for lower methane emission from equine feeds and manure in comparison to ruminants.

Nutrient utilization, blood parameters and mineral metabolism in sahiwal calves with different residual feed intake: Eighteen male Sahiwal calves were divided into low (more efficient) and high (less efficient) RFI groups. The initial and final BW of the animals were recorded to be 124.23 and 115.85 and 154.89 and 144.20, respectively with corresponding RFI values of -0.20 and +0.18 kg/d. The DM intake was lower

(3.26±0.08 vs. 3.43±0.08 kg/d in low RFI compared to high RFI group. The overall DM consumption across the fortnights was 2.45±0.10 and 2.77±0.12 kg/100 kg BW in low and high RFI groups. Mean ADG values were similar (539 and 498 g) in both groups. The digestibility coefficients (%) of various nutrients were: DM (59.68 and 59.14), OM (61.38 and 60.61), CP (63.78 and 63.28), total CHO (55.95 and 55.69), EE (64.43 and 63.18), NDF (55.84 and 54.62) and ADF (44.01 and 42.96%) for low and high RFI groups, respectively which were similar in both the groups. N retention (% of N intake and % of N absorbed) was higher (P<0.05) in low RFI group. Blood glucose values were similar in both the groups. The overall mean values of creatinine (1.27 vs.1.78mg/dl) and blood urea nitrogen (15.45 vs. 22.22 mg/dl) and total plasma protein (7.34 vs.8.24 g/dl) were found to be higher (P<0.05) in high RFI group. Also, the activities of ALT (25.85 vs. 35.72 IU/L) and AST (80.33 vs 100.57 IU/L) were higher in high RFI group of Sahiwal calves. The plasma IGF-1 and GH concentration were similar in both the groups. The feed cost per kg gain was lower in low RFI group. The apparent absorption, urinary excretion and retention of Ca, P, Fe, Cu, Zn and Mn were similar in both the groups. The concentration of Ca, P and Zn in plasma was higher (P<0.05) in low RFI compared to high RFI group. However, the levels were in the normal range in both the groups.

Productivity Enhancement through Supplements and Additives

Effect of isolates of fiber degrading bacteria on body weight changes, milk production and its composition, nutrient utilization in lactating murrah buffaloes: Fibrolytic bacterial strains were isolated from the rumen liquor of buffaloes kept on high fibre diet. Their enzyme activity was measured and the most potent fibre degrading bacterial isolate was selected and was characterized on the basis of its morphology, biochemical properties and molecular properties. It was found to be *Ruminococcus flavefaciens* strain FD-1 used as feed supplement for *in vivo* trial. Twelve lactating buffaloes divided into treatment and control groups of six each were fed with experimental diets and 300 ml live and autoclaved culture of *R. flavefaciens* strain FD-1; on alternate days continuously for one month. No significant difference was observed in the mean body weight changes and daily milk yield between the treated and control groups although the live body weight and daily milk yield was increased in live culture supplemented treated group. There was no effect on milk composition. The difference in mean dry matter intake was significant (P <0.05) between control (11.11 kg/day) and treated groups (11.77 kg/day) during the experimental period. The digestibility of NDF and ADF was found to be higher in treated group by 9.66 and 19.20% over that of the control group although the effect was not significant.

Effect of supplementing rumen protected methionine, lysine and choline on milk yield, composition and blood metabolic profile in lactating crossbred cows: Eighteen crossbred (Karan fries) lactating cows (0 days in milk) were divided into three groups on the basis of MPPA (n= 6 animals per group). All the animals were fed basal ration consisting of wheat straw (20%), chaffed green maize fodder (40%) and compounded concentrate mixture (40%) as per NRC (2001). Animals in treatment group were fed same basal diet except that they were supplemented with 6 g rumen protected methionine and 60g rumen protected lysine in T_1, whereas in T_2, 60 g rumen protected choline was supplemented. The experimental trial lasted for 70 days. Blood samples from all the animals and their respective calves were collected to estimate total plasma Immunoglobulin, plasma glucose, ALT and AST. Results revealed that overall milk yield (kg/d) was significantly (P<0.05) higher in T_1 (18.00±1.63,) and T_2 (18.27±1.96) groups in comparison to C (14.74±2.16,). The milk fat content was also significantly (P<0.05) higher in T_1 and T_2 groups whereas total solid (%) was significantly higher in T_2 group only as compared to control, but the rest of milk components were statistically similar in all the experimental groups. The plasma AST (IU/l) activity was decreased both in cows and their calves, whereas ALT (IU/l) activity gets decreased only in calves of treatment groups. Total plasma immunoglobulin levels in cows (mg/dl) were found significantly higher in treatment groups whereas in calves, the values were similar. It can be concluded that supplementation of protected methionine (6g/cow/d), lysine (60g/cow/d) and choline (60g/cow/d) resulted in increased milk yield and better immunity.

Effect of rumen protected choline supplementation on growth performance, nutrient utilization and metabolic profile in crossbred calves: Twelve crossbred (Karan Fries) calves were randomly divided into two groups on the basis of age and body weight (n= 6 animals per group) and were fed basal ration consisting of wheat straw (10%), chaffed green maize fodder (40%) and compounded concentrate mixture (50%) as per NRC (2001). Calves in treatment group were fed with basal diet plus 27g RPC mixed daily in the concentrate mixture. Experimental

feeding lasted for 90 days in which dry matter intake (DMI), body weight, average daily gain (ADG), body weight gain, feed utilization efficiency, CP intake and TDN intake were recorded fortnightly. Results revealed that there was no significant effect of RPC supplementation on DMI, CP intake and TDN intake (P>0.05). The body weight increased numerically in treatment groups exhibiting a significant (P<0.01) increase in ADG in treatment group (0.62 kg) by 8.78% as compared to control (0.57kg). Similarly, body weight gain was also significantly (P<0.01) higher in treatment group (9.23 kg) as compared to control (8.52 kg). On an average, feed efficiency was also significantly (P<0.05) higher in treatment (0.17kg) group by 6.3% as compared to control (0.16 kg). The digestibility of DM, OM, CP, EE, NDF, ADF and nitrogen balance were not influenced by supplementation of choline (P>0.05). Plasma glucose, cholesterol, high density lipoprotein (HDL), low density lipoproteins (LDL), total protein, albumin, globulin, A:G ratio and total plasma immunoglobulin did not reveal any significant difference between the two groups (P>0.05). However, BUN (mg/dl), plasma NEFA (µmol/litre), ALT and AST (IU/L) decreased significantly (P<0.01) in treatment group (16.91; 95.65; 18.48 and 20.15) as compared to control (17.59; 101.81; 20.28 and 21.15). The plasma triglyceride (mg/dl) and VLDL (mg/dl) also exhibited a significant (P<0.01) increase in treatment group (52.33±0.45 and 10.47±0.07) as compared to control (50.50±0.30 and 10.10±0.06). Thus, the results of the present studies revealed that dietary supplementation of RPC (27 g/d) in the ration of calves is beneficial.

Effect of supplementation of niacin on nutrient utilization and balances in lactating crossbred cows during summer: Eighteen crossbred (Karan Fries) lactating cows (averaging 11.56 DIM; 2nd to 4th lactation) were divided into three groups on the basis of average milk production (n= 6 animals per group) and were fed basal ration consisting of wheat straw (20%), chaffed green maize fodder (40%) and compounded concentrate mixture (40%) as per NRC (2001). Animals in treatment group were fed same basal diet except that they were supplemented with 600 (T_1) and 800 mg/kg DMI (T_2) niacin for 120 days. The maximum temperature, minimum temperature, relative humidity and dry-wet bulb temperature were recorded daily in morning (at 7:30 am) and afternoon (at 2:30 pm) and THI was computed. The results revealed that animals were in moderate and severe stress during morning, whereas during afternoon the animals were in very severe stress. Body weight did not differ (P>0.05) in the three groups. The intake of dry matter (kg/100 kg B.W. and g/kg $W^{.75}$) and intake of digestible DM, OM, CP, EE, NDF and ADF were similar in all the groups (P>0.05). But the DMI (kg/d) was significantly (P<0.05) higher in T_1. Digestibility of DM, OM, CP, EE, NDF and ADF was not influenced (P>0.05) by supplementation of niacin. The nitrogen, calcium and phosphorous balance did not differ among the three groups. However, niacin balance (mg/d) was significantly higher (P<0.01) in treatment groups (12020.01 and 14121.76 in T_1 and T_2, respectively) than control (4715.44). It can be concluded that supplementation of niacin at 600 and 800 mg/kg DMI has no effect on nutrient utilization.

Productivity enhancement of ruminants by supplementing limiting amino acids and vitamins: It was observed that supplementation of 5 g of rumen protected methionine (RPM, 1.98 g of effective methionine) plus 20 g of rumen protected lysine (RPL, 4.42 g of effective lysine) and 54 g of rumen protected choline (10 g of effective choline) to cross bred cows (MPPA 4500 litres) 30 days prepartum, there was no effect on body condition score, nutrient intakes such as crude protein, rumen undegradable protein metabolizable protein (MP) and net energy for lactation, whereas duodenal flows (% of MP) of methionine and lysine, respectively were higher (P<0.01) in protected amino acid supplemented cows. Plasma amino acid profile revealed similar concentration for most of the amino acids. Blood metabolites viz. glucose, cholesterol and blood urea nitrogen did not differ among three groups of animals. Non-esterified fatty acids level decreased (P<0.05) in supplemented groups at -15 d. Phosphatidyl choline, triglycerides and very low density lipoproteins concentration was also higher (P<0.05) in supplemented groups. On the day of calving, vitamin E levels in plasma was higher (P<0.05) in choline supplemented group. Weekly mean plasma concentrations of prolactin and growth hormones were similar among all animals. Among the reproductive parameters, commencement of cyclicity, number of artificial inseminations per conception and number of days open after calving was apparently lower for animals in choline supplemented cows whereas overall conception rate was similar. It was concluded that supplementing pre-partum diets with rumen protected methionine plus lysine and choline improved metabolic health status and post-partum reproductive status of crossbred cows.

Utilisation of Unconventional Feedstuffs

Effect of inclusion of different levels of culled potatoes in replacement of maize in the concentrate mixture on feed intake, nutrient utilization and growth in sahiwal calves: A study

was conducted to find out effect of inclusion of different levels of culled potatoes as a replacement of maize in the concentrate mixture on feed intake, nutrient utilization and growth in Sahiwal male calves. Twenty Sahiwal male calves were divided into four groups of 5 animals each based on their body weight and age and fed on rations as per NRC (2001) for 60 days. Maize grain was replaced by culled potatoes @ 0, 25, 50 and 100% on DM basis in groups T_1, T_2, T_3 and T_4, respectively. The DMI in T_1, T_2, T_3 and T_4 was 2.90, 3.08, 3.14 and 3.12 kg/d, respectively. DM intake (% of BW) was 2.6, 2.9, 2.9 and 2.8 kg/day in the respective groups. CP intake averaged 391.51, 376.47, 389.62 and 373.98 g/day in treatments T_1, T_2, T_3 and T_4, respectively. The digestibility of nutrients (DM, CP, OM, EE, NDF and ADF) and nitrogen retention were similar in all the 4 groups. The average daily gains were found to be 525.00, 477.33, and 503.02, 526.33 g in treatments T_1, T_2, T_3 and T_4, respectively which indicated similar rate of growth. Therefore, maize grain could be replaced by potatoes up to 75% on DM basis in the concentrate mixture having 33% maize without affecting feed intake, growth and nutrient utilization in Sahiwal male calves.

Effect of feeding decorticated cottonseed cake on growth performance of crossbred calves: Eighteen KF crossbred female calves of similar age (8-9 months) and body weight (114-115kg), were divided randomly into three groups of six animals in each group. All the animals were fed same basal ration (concentrate: wheat straw 50:50) along with 10kg oats green fodder/animal/day. Animals in 'T-1'and 'T-2' groups were also fed same diet as that off control 'C' except that 10 parts of soybean meal (control concentrate mixture contained 15% of soybean meal deoiled) was replaced by cottonseed cake expeller in 'T-1' and decorticated cottonseed cake solvent extracted in group 'T-2'. The experiments were conducted for a period of 105 days. Body weight was recorded fortnightly and blood samples collected at monthly interval. An *in vitro* rumen degradability study of different diets was also undertaken to determine the rumen degradability of DM, OM and CP. The *in vitro* rumen dry matter degradability ($IVDMD_R$) (%) significantly higher (P≤0.05) in 'C' (71.41±1.26) followed by 'T-1' (67.92±1.10) and 'T-2' (65.05±0.93) group. The $IVOMD_R$ (%) was significantly higher (P≤0.05) in 'C' (67.03±0.85) and lowest in 'T-2' (55.03±0.91) group. $IVCPD_R$ was significantly lower (P≤0.05) in 'T-2' (56.54±1.25) followed by 'T-1' (59.04±1.41) and 'C' (65.74±1.73). The dry matter intake (kg/day) was 4.14±0.40, 3.83±0.44 and 4.04±0.39 in 'C', 'T-1' and 'T-2' respectively. The dry matter intake (kg/100kg BW) was 2.50±0.42, 2.35±0.45 and 2.71±0.57 in 'C', 'T-1' and 'T-2' respectively, which did not differ significantly. The average daily gains were observed to be significantly higher (P≤0.05) in group 'T-2' (750±51g/day) than group 'C' (634±61 g/day) and group 'T-1' (583±37 g/day). Digestibility of DM, OM, CP, CF, ADF, NDF and NFE not differ significantly in all three groups. Nitrogen balance was significantly higher in 'T-2' (37.30±5.61) and 'C' (30.95±2.61) than 'T-1' (28.78±1.14), all animals were found in positive nitrogen balance. Blood urea nitrogen was significantly higher (P≤0.05) in 'T-2' (18.08±0.64) than 'C' (14.77±0.61) and 'T-1' (14.67±0.58) while blood glucose, total protein, albumin, globulin, albumin: globulin ratio and haemoglobin not differ significantly in all three groups. The cost for per kg body weight gain (Rs) was 73.65, 69.38 and 56.78 in 'C', 'T-1' and 'T-2' respectively. The cost for per kg body weight gain in female karan fries calves may be reduced by replacing 10 parts of soybean meal by cottonseed cake expeller or decorticated cottonseed cake solvent extracted in a concentrate mixture having 15% soybean meal deoiled.

Efficiency of nutrient utilization in teosinte (*Zea mexicana* L.) as affected by nitrogen and phosphorus application

The project was conducted in split plot design with five levels of nitrogen (0, 40, 80, 120, 160 kg N/ha) in main plots and three levels of phosphorus (0,30,60 kg P_2O_5/ha) in sub-plots consisted four (4) replications during 2012 and 2013. The highest (473.13 q/ha) green fodder yield in single cut from teosinte can be met from the application of 160 kg N and 60 kg P_2O_5/ha. Therefore, the farmer can obtain the maximum green fodder production with the use of 160 kg N and 60 kg P_2O_5/ha. The economic optimum dose recommended for Nitrogen was 193.37 kg/ha and for Phosphorus was 58.19 kg/ha to obtain higher green fodder and quality production of teosinte. The treatment combination $N_{160}P_{30}$ kg/ha was recorded as advantageous to the farmers for cultivation of teosinte fodder.

Comparative performance of different fodders sown during post monsoon season

Cultivation of bajra and maize sown in last week of August can provide green fodder during lean period of October-November. Cultivation of cowpea sown on 25th August can help to balance the diet of dairy animals.

Probiotic Fermented Milk and Herbal Ingredients Influence the Diet Induced Adiposity

Effect of dietary supplementation of probiotics (*L. rhamnosus* and *L. plantarum*) and herbal ingredients (*Aloe vera* and *Gymnema sylvestre*) on progression of obesity was evaluated in high fat diet (HFD) fed C57BL/6 mice. Among the different treatment groups, dietary supplementation of *L. rhamnosus* fermented milk to high fat diet exhibited a significant effect in terms of reduced gain in body weight as compared to animals fed high fat diet (HFD) + Skim milk (SM), after 12 weeks. Dietary supplementation of probiotic (*L. rhamnosus*/ *L. plantarum*) as well as herbal ingredients resulted in reduced epididymal fat accumulation as compared to HFD+SM fed group. Adipocytes of HFD fed animals were observed to be larger as compared to control group and maximum positive effect could be observed with *L. rhamnosus* feeding. High fat diet feeding led to a significant increase in the triglyceride level as compared to control group. A similar tendency was observed for TC, LDL-C, VLDL-C. A significant decrease in triglycerides was observed in probiotic (*L. rhamnosus* as well as *L. plantarum*) fed groups relative to HFD+SM group. Fasting blood glucose and insulin levels were found to increase significantly on feeding HFD for 12 weeks. Analysis of expression of Adiponectin and leptin genes indicated the potential of probiotic (especially *L. rhamnosus*) in resisting the progression of obesity. Dietary incorporation of herbal ingredient powders (commercial preparations used) was not observed to have additive effects.

Effect of Probiotic *Lactobacillus casei* Fermented Milk on Intestinal Health Under High Fat Diet Fed Conditions

Effect of milk fermented with a probiotic strain of *L. casei* in modulation of intestinal function with reference to intestinal integrity/permeability and related gene expression was evaluated using Swiss Albino mice fed on high fat diet (HFD). High fat (35%, w/w) diet feeding resulted in a significant increase in intestinal permeability as determined by using 4000 Da fluorescent-dextran and measurement of fluorescenes in blood plasma. A positive effect of dietary supplementation of probiotic fermented milk on intestinal integrity/ permeability could be observed. Expression of two important genes related to intestinal integrity (Occludin and ZO-1 tight junction proteins) was determined by qRT-PCR. Reduced expression of both the tight junction proteins could be observed in HFD fed group, which is in conformity with the increased intestinal permeability observed as a result of high fat feeding. Occludin was found to be up-regulated significantly to a level>2 fold as a result of dietary supplementation of probiotic fermented milk. A similar trend of up-regulation of ZO-1 was also observed in probiotic fermented milk fed group, however, not to a significant level. Though, skim milk supplementation also exhibited positive effects, but these were not found to be statistically significant. The findings of present study suggest a positive effect of dietary supplementation of probiotic *L. casei* containing fermented milk on intestinal functionality in high fat diet fed conditions.

Age-associated Profile of Dysfunctions in Murine Immune System

Several contradictions and inconsistent reports regarding nature of dysfunction of immune system with age are known. The lack of multipoint age comparisons in immune functions contributes to the observed ambiguity in understanding immunosenescence. Therefore, a concurrent analysis of different immune cells was performed in an attempt to delineate the nature of immune dysregulation with progressive aging in mice. Mice of 4, 8, 12 and 16 months old were analyzed for various immune parameters involving neutrophils, peripheral blood lymphocytes, peritoneal macrophages, splenocytes, inflamm-aging markers in plasma and humoral immune response in intestine. Neutrophils registered a remarkable decrease in activities of respiratory burst enzymes and phagocytosis while macrophages recorded a decrease in TLR-2 and TLR-4 expression. Macrophage Chemotactic Protein-1 (MCP-1) and C reactive protein (CRP) levels increased in plasma whereas stimulation index and CD28 expression decreased in lymphocytes. Interleukins analysis

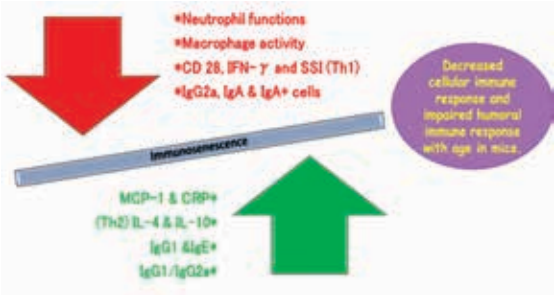


Figure : Age associated imbalance in immunological parameters of mice

(IFN-γ, IL-4, IL-10) showed a remarkable shift towards Th_2 response, which further resulted in increased IgG1/IgG2a ratio and IgE levels in intestine. In conclusion, a decline in cell mediated immune response, chronic inflammation and aggravation of humoral immunity was evident in aging mice which conclusively suggested a skewed Th_2 pathway during aging.

Release of β-casomorphins from Milk and their effect on Gut Immunity

β-casomorphins (BCMs) have been postulated to be implicated in many disorders like heart diseases, Type 1 diabetes and neurological diseases depending upon controversial evidences. Their release from A1 "like" milk during gastrointestinal digestion has been established by many researchers abroad and needs to be validated in indigenous cattle breeds. Native as well as crossbred breeds of cattle were screened for A1 and A2 "like" variants of β-casein with PCR-ACRS (Amplification Created Restriction Site). Presence of A1 and A2 "like" alleles of β-casein was detected in Indian crossbred cattle (Karan Fries) with existence of A1A1, A1A2 and A2A2 genotypes. β-casein were isolated from milk samples of genotyped Karan Fries animals and subjected to hydrolysis by simulated gastrointestinal digestion using proteolytic enzymes (Pepsin, Trypsin and Chymotrypsin), in vitro. Detection of BCMs were carried out in two peptide fractions (A and B) of preparative RP-HPLC collected at RT 24 and 28 min corresponding to standard BCM-5 and BCM-7 by MS-MS and competitive ELISA. One of the RP-HPLC fraction (B) showed the presence of 14 amino acid peptide (VYPFPGPIHNSLPQ) having BCMs sequence while no such peptide or precursor was observed in fraction A by MS-MS analysis. Further hydrolysis of fraction B with elastase and leucine aminopeptidase from A1A1 and A1A2 variants of β-casein isolated from milk revealed the presence of BCM-7 by competitive ELISA. The yield of BCM-7 (0.20±0.02 mg/g β-casein) from A1A1 variant was observed to be almost 3.2 times more than A1A2 variant of β-casein. However, release of BCM-7 could not be detected from A2A2 variant of β-casein. Likewise, release of BCM-5 was also not detected from any of the variants of β-casein. In order to visualize the effect of feeding A1 and A2 "like" variants of β-casein and BCMs (BCM-5 and BCM-7) on gut immunological parameters, experimental mice were orally intubated with respective genetic variant of β-casein and commercially synthesized peptides. It was found that feeding of A1 "like" variants (A1A1 and A1A2) and BCMs (BCM-5 and BCM-7) individually increased ($P<0.01$) Myeloperoxidase (MPO) and leucocyte infiltration remarkably in intestinal tissue than respective control groups. Likewise, considerably increased levels of MCP-1, IL-4, total IgE, IgG, IgG1 and IgG2a were also observed in intestinal fluid in experimental groups than control groups. Expressions of TLR-2 and TLR-4 also increased ($P<0.01$) remarkably on individual consumption of A1 "like" variants and BCM peptides than respective control groups. However, no changes in sIgA, IgA+ and goblet cell numbers were recorded on consumption of any of the β-casein variants and peptides respectively. The present study clearly indicates that individual consumption A1 "like" variant of β-casein or BCM peptides induce immune response in mice gut through Th_2 pathway.

Several aptamers are generated against BCM-7 for their use in development of aptamer based detection of BCM-7. The selection has been made from 10^{13}- 10^{15} random sequences of 72 nucleotides long ssDNA. The process required several round SELEX for obtaining high affinity aptamers. Based on presence of specific structural motif in aptamer, aptamers are grouped. Some of aptamers exhibited dissociated constant in nanomolar range indicating high affinity for BCM-7.

Osteogenic Peptide from Buffalo Milk

The casein was isolated from buffalo milk and hydrolyzed by the digestive enzymes either alone or in combination for duration of 3 hours. Pepsin–Trypsin hydrolysates at 15% degree of hydrolysis showed ACEI and antioxidant activity of 72.55 ± 2.23%/50 µg and 1.759 ± 0.06 TEAC (µmol/mg of hydrolysates), respectively. Ultrafiltration fraction less than one kDa possess highest ACEI and antioxidant activity of 83.0±1.53%/50µg and 2.82±0.04 TEAC, respectively. Out of the 16 fractions on RP-HPLC, 11th fraction of less than one kDa has highest ACEI and antioxidant activity. LC-MS/MS analysis of 11th fraction showed the presence of 15 peptides, of which four peptides were less than one kDa. These peptide A, B, C and D (coded) were derived from αs_1-Casein, αs_2-Casein, β-Casein and κ-Casein, respectively. Synthetic peptide C showed the highest ACEI and antioxidant activity among other peptides. Pepsin–Trypsin hydrolysates of casein and peptide C enhanced the proliferation of rat calvaria cells significantly at the concentration of 50µg/ml and 30ng/ml, respectively. Pepsin–Trypsin hydrolysates of casein reduced alkaline phsophatase activity of calvarial cells while peptide C enhanced the activity. Peptide C enhanced the expression of osteoblastic differentiation marker

genes, collagen α1 type I, alkaline phosphatase and osteocalcin by 1.57, 1.47 and 1.78 folds, respectively. Peptide C suppressed the expression of osteoclastic marker genes, TRAP and cathepsin K upto 70%. Pepsin–Trypsin hydrolysates of casein reduced the expression of osteoblastic differentiation marker genes and osteoclast marker genes while that of captopril and trolox were similar to that of control. Pepsin-trypsin hydrolysates of casein and peptide C showed 55% and 45% reduction in TRAP positive cells, respectively. Peptide C with ACEI and antioxidant activity acts as osteoanabolic and antiresportive agent on rat calvarium osteoblast cells and osteoclasts in vitro, respectively. Therefore, peptide C released from buffalo casein digested by gastrointestinal enzymes could be a potential target to fight against osteoporosis.

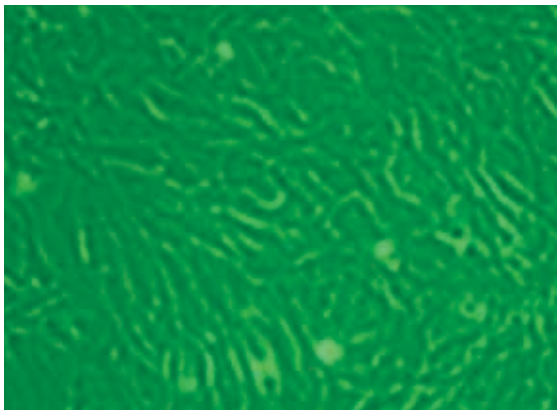


Figure : Calvaria cells on confluency

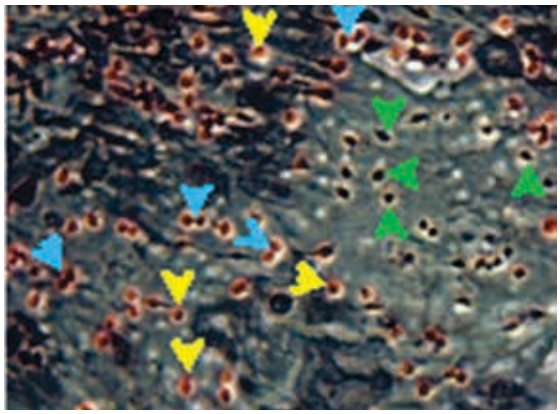


Figure : Bone marrow cells cultured on monolayer of calvaria cell

TRAP positive cells (yellow arrow), TRAP negative cells (green arrow), The bone marrow cells showing fusion (blue arrow)

Milk Fat Digestibility of Dairy Animals

In vitro digestion was conducted for the milk (3% fat) digestion in the presence of pancreatic lipase and bile extract and the release of free fatty acids were measured by pH stat titration method. During the digestion process, the change in fat globules size at different time intervals was observed by the Confocal Laser Scanning Microscopy. After 5 h of pancreatic lipase digestion, the levels of free fatty acids released from camel, goat, cow and buffalo milk were 146.0, 136.8, 118.5 and 102.5 mmol mL^{-1}, respectively. There was no significant difference ($P < 0.05$) between goat and camel milk fat digestion at this point of digestion, but fat digestion in cow milk was significantly lower than in goat and camel milk, whereas fat digestion in buffalo milk was significantly lower than in camel, goat and cow milk ($P < 0.01$). The digestibility of milk fat was found to be depended on the size of the fat globules. Fat globules were observed with the different size range in buffalo (3.9-7.7 µm), cow (1.6-4.9 µm), goat (1.1-3.9 µm) and camel (1.1-2.1 µm) milk (see figure). This indicated that smaller the size of the fat globules, the faster is the lipid digestion as the surface to volume ratio is increased. Therefore, digestibility of milk fat was in the order: camel, goat > cow > buffalo.

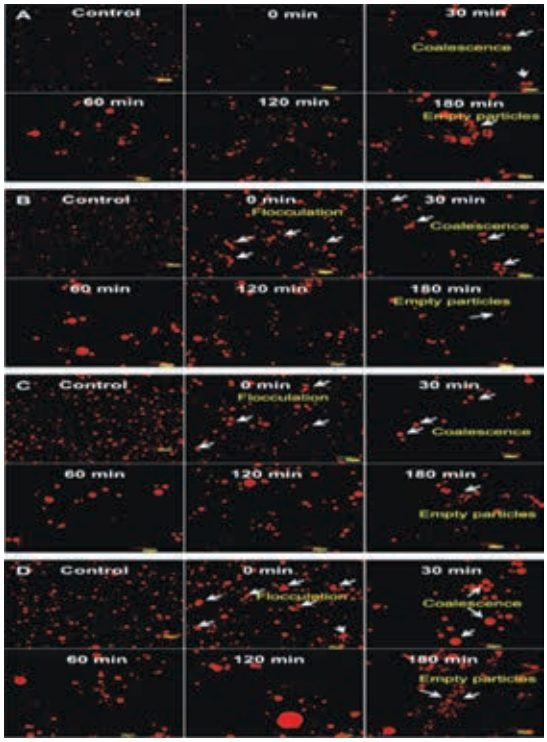


Figure: Confocal microscopy images of fat globules of milk at different time intervals during pancreatic lipase digestion. (A) camel (B) goat (C) cow (D) buffalo. Empty particles, flocculation and coalescence are indicated with arrows

LPS Induced Regulation of *Cyp19* Gene in Buffalo Ovary

Uterine infection after parturition is one of the most common endemic diseases of dairy cows and buffaloes, leading to infertility by disrupting

uterine and ovarian function. Recent reports showed that granulosa cells have a mechanism for direct action of LPS in the ovarian follicle to impair ovarian function and ovulation. Reduced *Cyp19* gene transcripts in granulosa cells and lower peripheral plasma estradiol concentrations are amongst prominent ovarian dysfunction due to LPS. However, molecular mechanism of LPS induced down regulation of *Cyp19* gene, encoding aromatase, key enzyme in estrogen biosynthesis, is not known. To classify the infected and non-infected animals, mucus and blood from the uterine tract and jugular vein were collected after 21 days of postpartum infected and normal animals. Morphologically, normal and infected animals have been categorized based on the presence of clear or translucent mucus and white flecks or off-white pus in mucus, respectively. Estradiol in plasma of animals was measured. Results showed that animals with mucopurulent white flecks mucus have lower peripheral concentration of estradiol as compared with clear mucus producing animals. Expression analysis of *Cyp19* transcripts in leucocytes showed that animals with mucopurulent mucus have low copy number of *Cyp19* gene expression in leucocytes as compared to normal animals. Further, to see the effect of LPS on ovarian function *in vitro,* granulosa cells were cultured and dose dependent effect of LPS was evaluated on *Cyp19* gene expression and estradiol production. Interestingly, result showed that both *Cyp19* gene expression and estradiol production gene were found to be significantly lower than control. To understand the molecular mechanism of *Cyp19* gene down regulation in granulosa cells, the study explored role of CEBPβ in LPS mediated *Cyp19* down regulation. C/EBPβ, a member of a family of basic leucine zipper proteins, is necessary for the formation of corpus lutum and regulation of *Cyp19* in mouse.

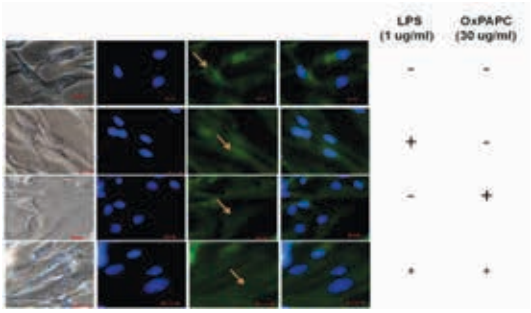


Figure: Effect of LPS and OxPAPC on nuclear levels of C/EBPβ arrows indicate the lacalization of C/EBPβ into nucleus

LPS (1µg/ml) down regulated *Cyp19* expression in granulosa cells at 24hr while at the same time LPS was found to increase expression of C/EBPβ. LPS treatment to granulosa cells increased the nuclear C/EBPβ as compared with control. Chromatin immune-precipitation assay results showed that LPS increased C/EBPβ binding (2.5.fold enrichment) on *Cyp19* promoter as compared to control. These effects were reversed when cells were treated with inhibitor of TLR4 receptor signaling. In addition, immunolocaliaction of C/EBP with and without LPS treatment showed that nuclear localization of C/EBPβ was found to be increased when granulosa cells were treated with LPS. From these present results, it can be concluded that, LPS up regulate CEBP β expression and its translocation to nuclear through TLR4 signaling. Increased nuclear C/EBPβ binds with Cyp19 gene promoter and transdeactivate the gene which in turn decreased Cyp19 gene message and estradiol production during infection. In conclusion, results of the present study showed that LPS mediated down-regulation of *Cyp19* gene could be though transcription factors C/EBPβ.

Genome-wide Differential Regulation of Endometrial Genes Associated with Endometritis

Microarray analysis using affymatrix bovine chip, 125 differentially expressed genes (49 up-regulated and 76 down-regulated) between normal and endometritis uterine tissues in buffalos were identified for understanding the host response to this problem.

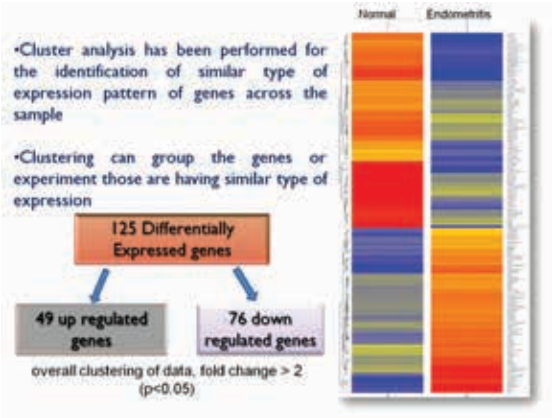


Figure: Genome-wide differential regulation of genes associated with uterine infection

The present study not only validated some differentially expressed genes, but also analyzed the data using bioinformatics softwares like Promoter Analysis Pipeline (PAP) and DAVID to explore the novel transcription factors related to differentially expressed genes, and also to identify the genome wide novel genes regulated by the identified transcription factors. Validation study included up regulating genes such as *FRZB,*

CHST9, GIMAP7, GFRA2 and down regulating genes such as *FOLR1, FBP1, CCNB1, PSAT1, ODC1* during endometritis. It was observed that there were 79 and 67% correlations between the microarray and validation studies for up-regulated and down-regulated gene expressions, respectively. DAVID analysis identified several clusters including immunological gene cluster for up regulated genes and **arginine metabolism** gene cluster for down-regulated genes. The PAP software identified *TEL2* as a significant ($p < 0.05$) transcription factor regulating the up-regulated genes involved in the immunological gene cluster. Further PAP analysis revealed that *TEL2* regulates 4439 genome-wide novel genes. Additionally, novel transcription factor TEL2 identified using PAP analysis was validated between normal and endometritis uterine tissues. Interestingly, the *TEL2* gene expression was down-regulated in endometrial tissue of animals with endometritis, which is a fascinating issue for future studies.

Micro RNA from Buffalo Corpus Luteum

MicroRNAs (miRNAs) are small RNA molecules that regulate gene expression post-transcriptionally. In the present study, cloning and analysis of miRNA in buffalo corpus luteum was studied. Sequence analysis of small number of random clones, identified some conserved and novel miRNA. The identified miRNA are: miR-22-3p, miR-2898, mir5924, miR-6871, miR-2890, miR-127-5p, miR-7193-5p, bta-miR-125b, miR-6089, miR-23b-3p, miR-5924a-3p, miR-4581, miR-125b, mir-6816, mir-125b, Let 7b-5p, mir125a, miR125b.

Apoptotic Markers in Fresh and Cryopreserved Buffalo *(Bubalus bubalis)* Spermatozoa

Comparative studies on apoptotic markers were made on freshly collected buffalo semen of more than + 3.0 mass activity splitted into fresh and cryopreserved in soya milk extender and conventional egg yolk extender. The number of early apoptotic in Soya vs egg yolk extender (4.0 & 5.0%); late apoptotic (41 & 32%) and necrotic cells (8 & 9%) were found to be comparable in the two extenders.

Sperm mitochondrial membrane potential was found to be decreased in cryopreserved spermatozoa (63.23%) . The anti apoptotic protein Bcl2 and proapoptotic proteins Bax and Bak were detected by Western Blot. The cryopreserved spermatozoa showed less abundance of Bcl2 compared to the fresh spermatozoa. The extent of decrease was comparatively less in the spermatozoa cryopreserved using soya milk extender compared to the use of egg yolk extender. An activated cleaved fragment of caspase 3 (27 kDa); caspase 8 precursor (58 kDa) alongwith cleaved fragment (15 kDa) and caspase 9 precursor (50kDa) were found to be increased on cryopreservation of spermatozoa. The relative abundance of caspase 3, caspase 8 and caspase 9 were found to be significantly higher ($110 \pm 4.90\%$) in spermatozoa cryopreserved in egg yolk extender compared to the soya milk extender ($75.11 \pm 5.55\%$) taking fresh spermatozoa as 100%. Cyt. C, a mitochondrial regulatory protein for apoptosis and PARP an indicator of caspase activation were found to be significantly higher ($p > 0.05$) in egg yolk extender compared to the Soya extender. However, AIF activated in fresh spermatozoa was not detected in cryopreserved spermatozoa. The activities of various caspases and DNA fragmentation was found to increase in frozen/thawed spermatozoa compared to the fresh spermatozoa.

Soya Milk Tris Extender (SMT): A New Phyto Based Extender for Cryopreservation of Buffalo and Bovine (Karan Fries) Spermatozoa

To overcome the inherent drawbacks like variables composition, risk of xenobiotics contamination, presence of antifertility factors associated with the use of egg yolk in semen extenders, a phytobased extender called Soya Milk Tris Extender (SMT) was developed. The new extender is composed of 25% (v/v) of Soya Milk in Tris Citrate Buffer (pH 7.0, 274 mM Tris, 87 mM Citric acid and 43 mM Fructose) in place of 20% (v/v) of egg yolk in the conventional Egg Yolk Extender. The lethal and sub lethal damages due to cryopreservation were compared with the conventional Egg Yolk Extender (EYT) and new Soya Milk Extender (SMT). The apoptotsis was found to be the major cause of the cell death compared to the necrotic cell death as lethal damage. The reversible sub-lethal damage was measured as post thaw motility, membrane integrity, viability and acrosomal integrity; membrane architecture; cholestrol/ phospholipid ratio; generation of intracellular secondary messengers viz lysophophatidyl choline, intracellular Ca+2, 1,2 diacyl glycerol and cAMP; Oxidative stress viz generation H_2O_2, superoxide anion, lipid peroxidation; extent of cryocapacitation and protein tyrosine phosphorylation. SMT showed no significant differences ($p>0.05$) in sperm motility, viability, membrane integrity and acrosomal integrity as compared to the egg yolk exrender on cryopreservation. The other parameters were found to be significantly ($p>0.05$) better in spermatozoa cryopreserved in SMT compared to

the EYT extender. Supplementation of additives viz trehalose and taurine, further significantly improved the quality of cryopreserved spermatozoa in both the extenders but in a better way in SMT.

The problem with use of SMT extender in the field requires frequent preparation of soya milk because of its short shelf life of one week at refrigerator temperature. The preservative potassium meta bisulphite at a concentration of 0.2 mg/ml of the extender was found to increase the shelf life up to 30 days under refrigerator conditions. Two soya based formulations in concentrated forms (3X and 10X) are prepared and these prove to be a better substitute to replace the commercial EYT extender for buffalo and bovine semen cryopreservation. The technology is simple, cheap, contamination free and more efficient and requires validation at the field level for its commercialization.

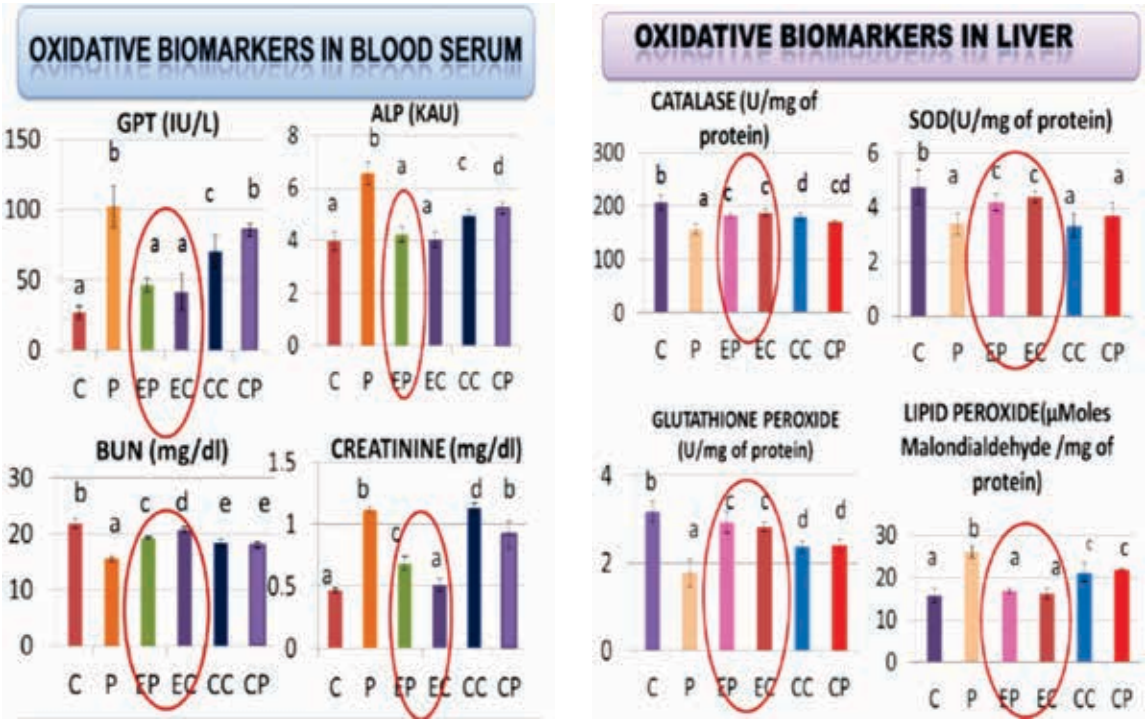
Toxicity of Nonmaterial

Mice exposed to unpurified CNTs exhibited oxidative stress, glutathione depletion dermal hyperplasia, localized alopecia and skin thickening. In vivo toxicity of MWCNTs and MSNs by a comparative assessment at different doses as well as route taking albino mice as an animal model was studied. The acute effect of intraperitonial (IP) infusion of MWCNTs and MSNs on body weight index, total protein level and enzyme markers for liver damage like ALT (Alanine aminotransferase), AST (Aspartate aminotransferase) and ALP (Alkaline phosphatase) were examined at the 7^{th} day after exposure. The mice were treated orally with the single dose of 50 ppm MWCNTs and intraperitonially with10 mg/kg, 25 mg/kg and 50 mg/kg of BW of MSNs and 1.5 mg/kg, 2.0 mg/kg and 2.5 mg/kg BW of MWCNTs. Changes in organ coefficient of different organs were statistically insignificant at all doses. No significant differences in enzyme levels were observed among different doses. Of three enzymes assayed, AST displayed a peculiar pattern especially in MWCNTs (IP) treated group. Total protein level was high in orally treated MWCNTs group. The results showed that MWCNTs even at much smaller doses than MSNs displayed similar toxicity levels, based on which it was concluded that toxicity of MWCNTs is higher than MSNs.

Dr. A. K. Srivastava, Director, NDRI receiving Agricultural Leadership Award-2013

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

Assessment of antioxidant activity of nanoemulsions of curcumin in mice model: The present study was conducted to validate the therapeutic benefits of nanoencapsulated curcumin (Size: 141.6 ± 15.4 nm) over unencapsulated curcumin against paracetamol induced oxidative stress in mice. Treatment with nanoencapsulated curcumin at a dose of 30 mg/kg body weight both in preventive and curative groups of mice significantly attenuated paracetamol induced oxidative stress. Whereas, unencapsulated curcumin at the same dose failed to offer protection against oxidative stress. The enhanced action of nanoencapsulated curcumin was attributed to the reduced size as well as slow release of curcumin from the encapsulated particles thus reducing the overall dose required for the action. Results suggested that the improved bioavailability of nanoencapsulated curcumin can be utilized for the prevention as well as treatment of oxidative stress induced cell damage and associated diseases.

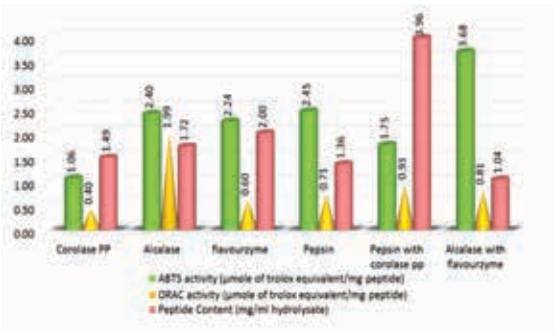


[a–e] Means with different superscripts differ significantly (P < 0.05)

*C: Control mice without any treatment, P: Paracetamol treated mice at a dose of 300 mg/kg BW for 2 days, **Encapsulated curcumin**: Emulsion administration orally 1) **EP** - emulsion was given at a dose 30 mg/kg BW for 4 days prior to paracetamol administration 2) **EC**- emulsion was given at a dose 30 mg/kg BW for 4 days after paracetamol administration for 2 days, **Unencapsulated curcumin** - 1) **CP** - curcumin was given at a dose 30 mg/kg BW for 4 days prior to paracetamol administration 2) **CC -** curcumin was given at a dose 30 mg/kg BW for 4 days after paracetamol administration for 2 days: The values were expressed as Mean ± SEM for 8 mice per group*

a) Antioxident characteristics of buffalo α_s-casein hydrolysates

Buffalo α_s-casein was hydrolysed by commercial proteolytic enzymes of animal (corolase pp, pepsin) and bacterial (alcalase and flavourzyme) origin alone and in combination. For alcalase optimum ABTS$^{\circ+}$ radical activity was 2.40 ± 0.05µmol trolox equivalent per mg peptide and corresponding peptide yield was 1.72 ± 0.07 mg/ml after 8 h of hydrolysis at 1:100 E:S ratio. For



flavourzyme optimum ABTS°+ radical activity was 2.24 ± 0.04 µmol Trolox equivalent per mg peptide and corresponding peptide yield was 1.99 ± 0.01 mg/ml after 6 h of hydrolysis at E:S ratio of 1:5. After 2 h of hydrolysis with pepsin at 1:50; E:S ratio, ABTS°+ radical activity was 2.45 ± .04 µmol trolox equivalent per mg peptide and corresponding peptide yield was 1.36 ± 0.01 mg/ml of hydrolysate. When pepsin was used with corolase pp and alcalase with flavourzyme, optimum ABTS°+ radical activities were 1.75 ± 0.03 µmol trolox equivalent per mg peptide and 3.68 ± 0.02 µmol trolox equivalent per mg peptide and corresponding peptide yields were 3.96± 0.01 mg/ml and 1.04 ± 0.01 mg/ml of hydrolysate, respectively.

b) Cellular evaluation for antioxidative potential of buffalo α_s-casein peptides

Method for generating oxidative stress in Caco-2 cells by H_2O_2 was standardized. It was observed that addition of 5 mM of H_2O_2 decreased cell viability by 50% during 20 h of incubation. Buffalo casein hydrolysates prepared with Alcalase enzyme and passed through 3 KDa filter reduced oxidative stress generated by 5 mM H_2O_2 in Caco-2 cells at 62.5 µg/ml concentration, which can be exhibited by 80% cell viability. In case of casein hydrolysate produced by Corolase PP and filtered through 3 KDa cut off membrane showed 75% increase in cell viability at 666.6 ug/ml concentrations.

Characterization of antimicrobial peptides from *L. acidophilus* NCDC 14: Antimicrobial peptides produced under optimized condition of growth for *Lactobacillus acidophilus* NCDC 14 in skim milk, were separated over RP-HPLC. The chromatogram of the eluent obtained from skim milk hydrolysates by *L. acidophilus* NCDC 14 resolved into 12 major peaks. The protein content of different fraction ranged from 95 - 204 µg/ml. Each fraction was assayed for antimicrobial activity against *E. Coli* ATCC 25922 using the total plate method and expressed in terms of Log N_0/N_f value. The antimicrobial activity of different fractions ranged between 0.40 - 1.5 µg/ml. The immuno inhibitory concentration for fraction 2, 3 and 8 was 42.4, 33.32 and 48.32 µg/ml, respectively. Three peptides (VLGPVRGPFPIIV, GPVRGPFPIIV and SKVLPVPQKAVPYPQRDMPIQAFL) from ß-casein, two peptides (LINNQFLPYPYYAKPA and VALINNQFLPYPYYAKPA) from k-casein and LYQGPIVLNPWDQVKR from α_{s2} casein were found to be major cationic peptides with 35-50% hydrophobicity identified from fraction 2, 3 and 8.

Development of micro-nutrient fortified milk: Toned milk was fortified with iron and vitamin A; calcium and vitamin D_2. Two iron salts viz. ferric pyrophosphate soluble and ferrous gluconate hydrate (25 ppm) and vitamin A acetate (2500 IU/L); two calcium salts viz. calcium phosphate dibasic and calcium citrate tetrahydrate (600 ppm) and vitamin D_2 (600 IU/L) were selected after sensory and physicochemical analysis of fortified milk. When used in combination, the bioavailability of calcium and vitamin D_2 increased which indicated a positive interaction between both the nutrients. Vitamin A along with iron resulted in better bioavailability of iron and vitamin A than milk fortified with iron or vitamin A alone. Dahi and yoghurt prepared from fortified milk did not differ from control which suggest possibility of manufacture of good quality dahi and yoghurt from fortified milk.

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

Development of strip based detection tests for selected adulterants and contaminants in milk: Four strips for detection of neutralizers, urea, glucose and hydrogen peroxide in milk were developed and validated. For detection of neutralizers and urea in milk, the test involved dipping the strip in milk samples followed by visualization of colour of the strip. The colour of the strip changed to deep red in milk containing neutralizers (immediately) and urea (after 2 min) while in pure milk samples, the strip retained its original yellow colour. For detection of glucose and hydrogen peroxide in milk, the test involved putting a drop of milk on the strip followed by visualization of change in colour of the strip. The colour changed to deep pink immediately in case of adulterated milk containing hydrogen peroxide while response time was 2-3 min in case of milk

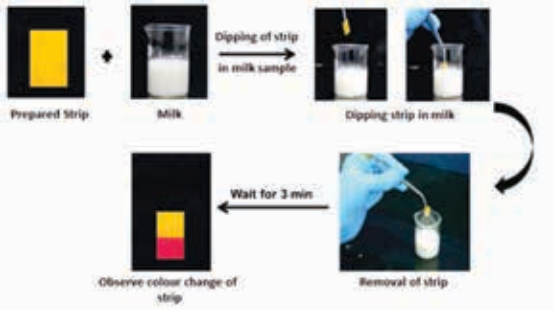
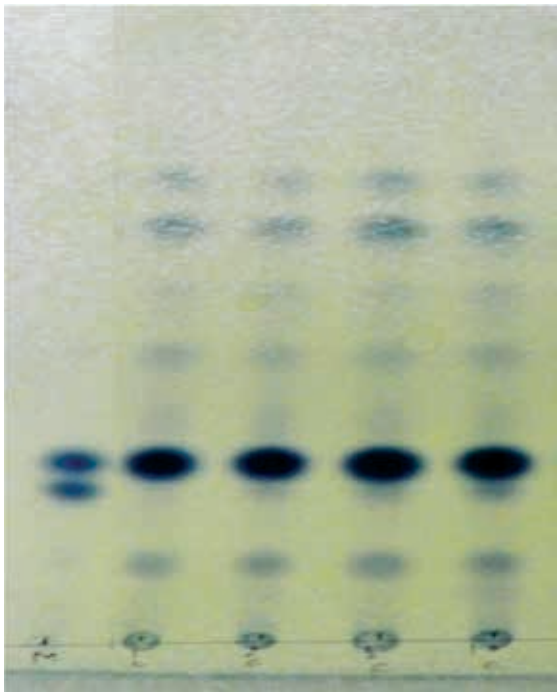


Figure: Various steps in the detection of added urea in milk using strip

containing glucose. In case of negative samples, only light pink colour appears. The sensitivity of these strip was ascertained which was 0.04% for neutralizer, 0.06% for added urea, 0.03% for glucose and 0.02% for hydrogen peroxide. The tests are rapid and results are available within 5 min.

RP-HPLC and RP-TLC protocols developed for the detection of vegetable oils/fats in ghee

The separation of cholesterol and phytosterols (stigmasterol and β-sitosterol) could be achieved by using RP-HPLC over C_{18} column at 205 nm. RP-HPLC analysis of unsaponifiable matter (USM) of pure adulterants oils revealed that β-sitosterol could be used as a marker phytosterol for the detection of adulteration of ghee with adulterant oils. Analysis of USM of adulterated ghee samples revealed that coconut oil up to 5%, refined soybean oil up to 1%; refined sunflower and groundnut oil up to 2% level could be detected in ghee samples. The separation of cholesterol and β-sitosterol was also achieved by using reverse phase thin layer chromatographic plates (RP-18 silica gel-G $F_{254}S$ TLC plates). The Rf value of cholesterol standard was calculated as 0.19 whereas that of β-sitosterol was 0.16. The Rf value of campasterol was in-between cholesterol and β-sitosterol, though the separation of campasterol from β-sitosterol was not very clear. By using this standardized protocol,



A B C D E

A: cholesterol + β-sitosterol; B: Pure ghee; C: 1% groundnut oil in ghee; D: 2% groundnut oil in ghee; E: 5% groundnut oil in ghee

the adulteration of ghee with adulterant oils such as soybean oil, sunflower oil and groundnut oil could be detected up to 1% level and coconut oil addition in ghee could be detected up to 7.5% level.

Detection of soybean oil and buffalo body fat in ghee: Soybean oil (SO) and buffalo body fat (BBF) added in pure cow and buffalo ghee, individually as well as in their combinations, were analyzed for various physico-chemical properties. The study revealed that Butyro-refractometer (BR) reading can be used for detection of vegetable oil at 10% in cow ghee and 15% in buffalo ghee. Similarly using Reichert-Meissl (RM) value both the adulterants could be detected individually at 10% level in both types of ghee. Iodine value could detect easily at 10% level in both types of ghee, while animal body fat was not detected at any of the level studied. Apparent solidification time (AST) test was found suitable for detecting as low as 5% of SO in cow ghee and BBF in buffalo ghee, while complete liquification time (CLT) test could detect BBF at 5% level in both types of ghee. Partitioning of pure and mixture adulterated ghee samples at 15°C and 10°C into two consecutive solid and one liquid fraction revealed that fractionation reduced the detection limit in case of BR reading, RM value, Iodine value and AST. On the basis of the ratios of sum of $C_{4:0}$ to $C_{14:1}$ / sum of $C_{15:0}$ to $C_{20:0}$ fatty acids and vice-versa using gas liquid chromatography (GLC), adulteration at all the levels was easily detected.

Physico-chemical changes of milk fat during preparation of khoa/burfi: The changes taking place in milk fat constants during conversion of milk into khoa and burfi and during their subsequent storage were assessed. The results revealed that there are only very small changes, almost negligible, in the physico- chemical constants of milk fat during preparation of khoa and burfi from raw milk (Cow and Buffalo) and also during their subsequent storage (khoa for 4 days and burfi for 5 and 10 days) at room temperature. However, free fatty acids content was found to increase during this process.

Physico-chemical properties of transglutaminase treated milk proteins and dahi preparation: Process was optimized for the cross linking of milk protein from different species using transglutaminase and effect of the cross linking of milk protein on the rheological properties of Dahi was studied. The conditions for transglutaminase catalyzed cross linkage of proteins in both cow and buffalo milk were optimized. The optimized conditions for cow milk was enzyme concentration of 5 U/g of protein

and for buffalo milk, it was 3 U/g of protein. In cow milk, the order of cross linkage was β-CN> k-CN> αs_1-CN. But in buffalo milk at low levels of polymerization, similar trend was observed, while at higher degree of polymerization k-CN gets more cross linked followed by β-CN. Transglutaminase treatment improved the rheological and sensory properties of dahi prepared from cow/buffalo skim milk and double toned milk. The water holding capacity upto 85 % in skim milk dahi and upto 90 % in double toned milk dahi, firmness up to 1.1 N in cow skim milk dahi and up to 1.8 N in cow double toned milk dahi, these values were almost double in low fat buffalo milk dahi. Syneresis, appearance and consistency of the final product were also improved. The storage stability of low fat dahi at refrigerated temperature was up to 2 weeks.

The optimized condition for goat milk was enzyme concentration of 5U/g of protein, incubation temperature of 40^{0}C for 4 hours. Under these conditions, the extent of cross-linkage of goat milk proteins resulted to the level of 67%. In goat milk, the order of cross linkage was β-CN>κ-CN>α-CN. Transglutaminase treatment of goat milk resulted in change of functional properties of goat milk. Preparation of acid gel by fermentation of goat milk (Dahi) on addition of WPC (1.5%) and pectin (0.3%) resulted in improvement of goat milk gelation properties; however, TGase treatment did not further improve the same. Addition of sodium caseinate at 3% level in goat milk resulted in better gel strength than control. The TGase treatment improved the water holding capacity up to 83%.

Dairy Technology

Ready-to-serve Breakfast Smoothie

Process and ingredients were optimized to prepare shelf stable smoothie. Four variants of smoothie were prepared, using germinated fears of green gram, chickpea, ragi and sorghum. Levels of germinated flour, pectin and sugar levels were optimized through Response Surface Methodology for each variant. The viscosity of the product varied from 152 to 352 cP. Nutritional profiling of the product revealedthat a serving of 200 g product provided approximately 16-22% and 15-21% (in adult men and women, respectively) of iron, 19-33% of calcium, 13-14% of vitamin A and 12-19% of dietary fibre of RDA. Shelf life of the all formulated products were evaluated at 4^{o}C and 30^{o}C. Except the sorghum variant, all others variants were found sensorially acceptable till 90 days at 4^{o}C and 60 days at 30^{o}C. Manufacturing cost of the optimized product varied from Rs. 15.72 to 16.13 per 200 g bottle. A consumer survey report revealed that 86% of consumers were willing to buy the product at Rs. 20/- per 200 g and 40% and above rated this product as excellent.

Production of Functional Butter

Butter was prepared by churning cream fortified with phytiosterol (PS) and conjugatged linoleic acid at the rate of 12% and 5%, respectively. Thirty Wistar rats (120±20g) were made hypercholesterolemic by feeding a diet containing 1% cholesterol and 25% fat for a period of two months. The animals were randomly divided into three groups (10 each) and fed on soybean oil (SD), normal butter (ND) and fortified butter (FD) containing 1% cholesterol up to 8 weeks (treatment-1). After the 8 weeks, 4 rats in each group were sacrificed and their lipid profile of serum, liver and fat extracted from liver tissue, adipose tissue weight were measured. Study was continued with remaining animals (6 each) for 8 weeks without 1% cholesterol (treatment-2). Significant decrease (P≤0.05) in total cholesterol level (9% & 4%), LDL-cholesterol level (21%

& 9%), atherogenic index (48% & 17%), were recorded in FD group as compared to SD and ND respectively. Study revealed that fortified butter performed well in controlling lipid profile of serum. Animal studies were also conducted to study anticarcinogenic effect of functional butter. Increased activity of carcinogen detoxifying enzymes γ-glutamyltranspeptidase and uridinediphosphoglucuronosyl transferase noticed in liver and mammary glands of DMBA treated rats fed with functional butter.

Kheer Mohan from Cow Milk

Preliminary trails were conducted to select the level of fat in cow milk followed by the selection of type and strength of coagulant to produce *chhana* suitable for manufacture of quality *Kheer Mohan*. After that, optimization of independent variables *viz.*, sugar syrup concentration (°Brix), semolina (% by weight of *chhana*) and cooking time (min) was carried out using RSM. The optimized product then packed in standup, white opaque pouches with and without sugar syrup and stored at 4 and 30 ± 1°C. Samples packed with and without sugar syrup, stored at ambient temperature (30 ± 1°C) had shelf life of 30 days with overall acceptability scores of 7.0 and 6.40 respectively. Moreover, samples packet with and without sugar syrup, stored at refrigeration temperature (4 ± 1°C) had shelf life of 60 days with overall acceptability scores of 7.0 and 6.0, respectively in comparison to 6 days observed shelf life of the market sample at ambient temperature. In standardized process, 50% reduction in cooking time was achieved as compared to traditional method of preparation. Net manufacturing cost of the product in 500 g pack size was ₹ 80 which was significantly lower than the market cost of the product (₹ 120 for 500 g).

Mixed-fat Chocolate Spread

Technology was developed for manufacture of Mixed-Fat Chocolate Spread (MFCS) using functional dairy and non-dairy ingredients. Various ingredients i.e., butterfat, olive oil and whey protein concentrate (WPC) or butter milk solid (BMS) were optimized for formulation of product. MFCS based on BMS obtained using standardized method contained 21.36% fat, 5.17% protein, 8.94% lactose, 19.94% sugar and 1.37% ash whereas MFCS based on WPC obtained using standardized method contained 37.87% fat, 6.54% protein, 2.79% lactose, 18.67% sugar and 0.79% ash. WPC based MFCS presence with biopreservative (MicroGARD™) had slower rate of spoilage as compared to MFCS without preservative. The consumer response study revealed that the product was adjudged as 'liked very much' to 'liked extremely'.

Functional Processed Cheese Spread

The study was conducted to enrich the Processed cheese spread (PCS) with three functional ingredients viz., inulin, phytosterols and W-3 fatty acid having cholesterol lowering effect. The consumer acceptance study (107 consumers) revealed that the PCS was liked very much by the consumers due to its flavour and spreadability and the product itself was nutritionally and functionally sound. To validate its hypocholesterolemic effect, developed products were fed to hypercholesterolemic rats and it was observed that serum total, LDL, VLDL cholesterols and atherogenic index decreased and at the same time, liver cholesterol and triglyceride decreased significantly (p<0.05). The technology would be very useful to the consumers as well as industry.

Sweetened Functional Soft Cheese

Sweetened functional soft cheese from buffalo milk was developed by incorporating fructooligosaccharide (FOS), inulin and cocoa as functional ingredients. Optimum levels of cocoa, inulin and FOS were finalized for the functional sweetened soft cheese. The product remained acceptable for 28 days without any preservatives. This product has great potential in the fastest growing functional food market.

Germinated Pearl Millet Contained Whey-Skim Milk Probiotic Beverage

A dairy isolate probiotic *Lactobacillus* strain was used in preparation of a probiotic beverage based on whey-skim milk mixture, germinated pearl millet flour and liquid barley malt extract. Fermentation by the probiotic resulted in reduction in phytic acid (78%) and polyphenols (46%) with simultaneous increase in protein and starch digestibility and the bioavailability of minerals (Ca, Fe, Zn, Mg and P). The high probiotic counts (11-12 log cfu/ml) reduced to 6.36±0.35 log cfu/ml during 30 days of storage. The beverage remained sensorily acceptable up to 18 days. *In vivo* feeding trials on mice led to the following conclusions: better weight gain, food efficiency ratio, protein efficiency ratio and apparent protein digestibility, lower coliform count, higher faecal lactobacilli, superior anti-carcinogenic effect evidenced by reduction in β-glucuronidase activity and more anti-diarrheal effect after challenging with *Shigella*

dystenteriae in the fermented substrate-fed group. No toxicity or malnutrition was induced due to feeding. The cost of probiotic product was ₹ 3.15/100 ml.

Milk-Cereal based Iron and Vitamin A fortified Weaning Food

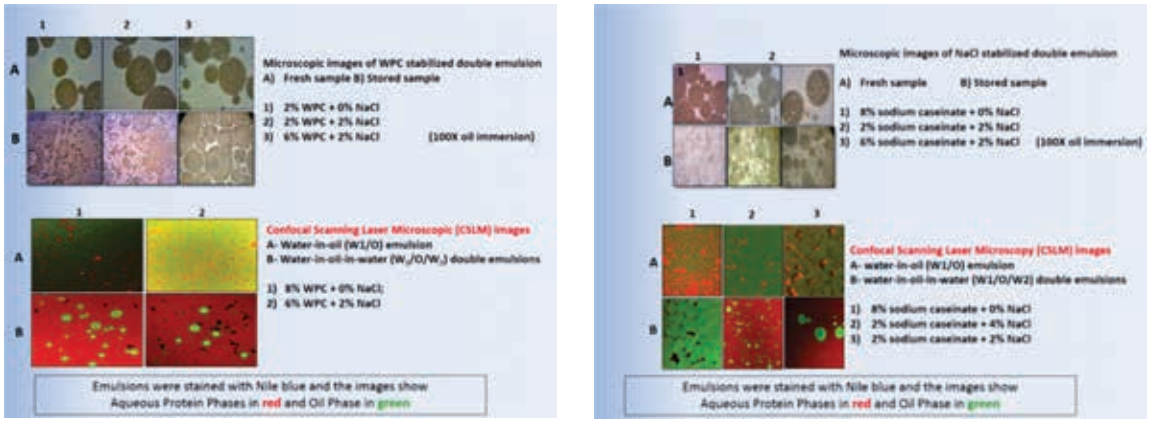
Ingredients and processing parameters for formulation of cereal based weaning food were optimized. Optimized combination of ingredients like processed pearl millet, WPC and processed wheat was extruded. The extruded product was ground in a grinder along with sugar to a powdered form. This powdered product was used as a ready-to-reconstitute weaning food. The product formed was found to have superior textural and flavour characteristics over the earlier product prepared by pressure cooking processing of the barley. The salts of iron for the fortification of above cereal based product were also evaluated and found that electrolytic iron was more acceptable with respect to flavour of the product. Amount of iron finalized for fortification was 9 mg per day. The amount of vitamin A acetate finalized for fortifying the product was 90% of the RDA (360 µg RE per day).

Optimization of Galactooligosaccharide (GOS) Production using Galactosyltransferase Activity Exhibiting Microbial Strains

Screening of fifty out of 80 strains of *S. thermophilus* showed higher β-galactosidase activity (Using SDS, Chloroform and Lysozyme method) whereas 18 out of 30 strains of *Kluyveromyces spp.* showed higher β-galactosidase activity (Using SDS, Chloroform method) and these strains were further characterized up to species level and the results of phenotypic and phylogenetic characterization confirmed 14 strains as *K. marxianus* and 4 as *K. lactis* (accession No. HM473144-48 and HM473170-82 submitted to NCBI gene bank). A process of GOS production, a novel prebiotic was standardized. Protocol for the partial purification of GOS was also standardized. Feeding trails indicated improvement in diabetic, antioxidant stress markers and overall health of GOS fed animals. Higher number of lactobacilli and lower number of coliforms were observed in GOS fed group as compared to diabetic group.

Incorporation of Herbal Components from *Withania Somnifera, Asparagus Racemosus* and *Pueraria Tuberose* in Milk and Developing Delivery System for Herbal Nutraceuticals in Milk Products

The antioxidant activity of herb extracts (aqueous and ethanolic) was evaluated at 200 ppm using the β-carotene–linoleic acid coupled oxidation model system. The antioxidant activity exhibited by ethanolic extracts of *shatavari* (63.22±0.14%), *ashwagandha* (67.70±0.15) and *vidarikhand* (86.05±0.13%) were significantly greater than their aqueous extracts (44.33±0.11%), (49.93±0.19) and (84.44±0.18%). Antioxidant potency and radical scavenging activity of ethanolic and aqueous extracts of herb *shatavari* were found to be significantly ($P < 0.05$) lower when compared with natural (rosemary and green tea extracts) and synthetic (BHA and TBHQ) antioxidants added to fat rich model system at the same concentration. Among the two *shatavari* extracts, ethanolic extracts showed better radical scavenging property. Ghee incorporated with *shatavari* (ethanolic and aqueous) extract was found to be significantly ($P < 0.05$) less effective in controlling development of oxidative degradation products (peroxides, conjugated dienes, free fatty acids) as compared to other natural (rosemary 0.5% and green tea extracts 1%) and synthetic (BHA, 0.02% and TBHQ, 0.02%) antioxidants throughout 21 days



Microscopic images of milk protein based micoremulsions for delivery of herbal extracts in milk and milk products

of storage at 80±1°C. Double layer emulsion with dairy ingredients as matrix materials were created for encapsulating herb bioactives which showed 100% stability and 99-97% encapsulation efficiency.

Geriatric Dairy Food having Prophylactic Attribute against Alzheimer's Disease

Curcumin, the biologically active pigment found in Indian spice turmeric, possesses numerous functional attributes *e.g.*, anti-inflammatory, anti-Alzheimeric, antioxidant, anticarcogenic, antidiabetic, hypotensive, hypocholesteremic, etc. The study was envisaged to develop a protocol for incorporation of curcumin in lassi and ensuring its stability during storage. As curcumin is insoluble in water, two suitable matrix materials *viz.*, β-cyclodextrin (β-CD) and Tween–80 was tried for binding of curcumin. Curcumin, when added as such resulted in approximately 50% retention of the component in lassi. Curcumin when added with Tween-80, 92% retention of curcumin was observed in the product. However, when added with β-cyclodextrin, 93% retention of curcumin was achieved and the product was sensorially better than the product that contained Tween-80 as binding material. The developed product had a shelf life of 20 days at 4±1°C at 90-95% RH when packed in low density polyethylene (LDPE) pouches or in poly ethylene terephthalate (PET) bottles, whereas the control lassi had storage life up to 12 days

Development of e-courses for B.Tech (DT) Degree Programme

E-content development through digitalization of 49 e-courses prescribed under the Fourth Deans Committee syllabus for B.Tech. (Dairy Technology) was completed. All the courses were peer reviewed, each by one Internal and one External reviewer: 26 courses at NDRI, 17 at AAU and 6 at SVVU. All courses (on P-MOODLE) were also reviewed by PG students (three students per course). All 49 courses on P-MOODLE CDs were handed over to NAIP/ ICAR for off-line delivery to SAUs. All e-courses were also uploaded on the NDRI/ Sub-project Website (www.ndri.res.in, www.elearningdt.org.in).

Composite Dairy-cereal based Biscuits with Enhanced Functional Properties

Process was optimized to formulate composite, reduced calorie, zero trans fat biscuits from a dairy-cereal base. Biscuits were made from a multigrain flour composed of selected proportion of three flours: whole wheat, Bengal gram and germinated pearl millet. Sugar was replaced 100% by a combination of maltitol and FOS-sucralose. A significant level of replacement of fat with a polydextrose fat replacer Litesse could be achieved. In order to increase dietary fibre, resistant starch was incorporated in appropriate concentration. Traditional bakery shortening was replaced completely by inter-esterified trans-fat free shortening. The sensory qualities and texture of biscuits could be improved with the aid of an enzyme bouquet consisting of proteinases, amylases, xylenases and hemicellulases.

Dairy-Fruit-Pulse Based Breakfast Smoothie with Enhanced Functional Attributes

This project aimed at formulating a dairy-fruit-cereal based RTD breakfast smoothie with increased protein and reduced calorie contents from carbohydrate. A breakfast smoothie based on germinated chickpea flour along with a fruit (mango), vegetable (carrot), honey, milk sources, soy protein isolate (SPI) and sucralose was formulated. The phytic acid and vitamin A contents were 31.46 mg/100 g and 240.65 IU/L. Shelf life studies revealed that the smoothie remained acceptable even after 90 days at 4°C, 75 days and 60 days at 30°C and 40°C, respectively. The cost of developed product was estimated at ₹ 19.43 per 200 ml serving (packaged in glass bottles) at the prevailing prices. One such serving (200 ml) of product provides approximately 14% of protein, 8% of dietary fibre and 2.5% of Vit-A of Recommended Daily Allowance.

Texturization of *Dahi* for Extended Shelf-life

The project aimed to produce good quality *dahi* in terms of improved body and texture and reduced whey syneresis with minimum possible total solids levels moderated by enzyme treatment. Transglutaminase enzyme was used successfully in the product to improve the texture. The enzyme treated product was firmer than the control *dahi* as illustrated by sensory and instrumental measurements. The addition of transglutaminase improved body and texture, increased viscosity, firmness and work of adhesion and reduced whey syneresis in *dahi*. The product was acceptable over 21 days of storage. The cost of developed product was Rs. 6.03/ 100 g when packaged in polystyrene cups.

Process Development for Reduced Calorie Eggless Muffins

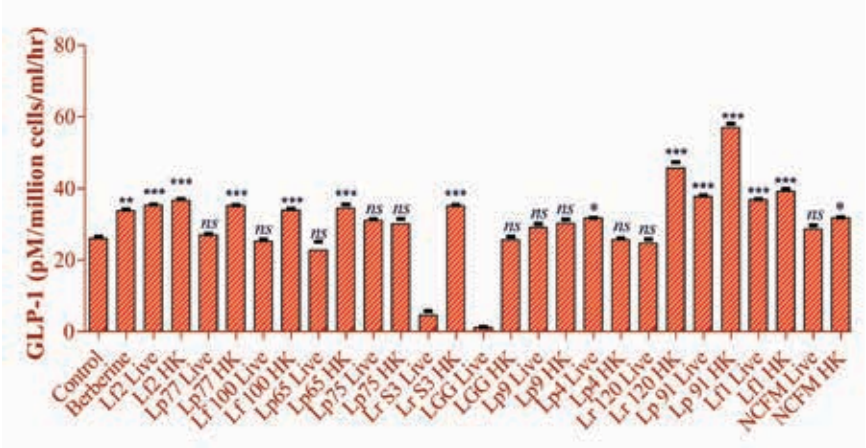
The formulation and process technology was developed for the manufacture of reduced calorie eggless muffins. Combination of milk proteins and sugar replacer (sucralose along with bulking agent) was used for development of reduced calorie eggless muffins. The optimized eggless muffin contained 17.43, 6.06, 1.62 and 50.58% fat, protein, ash and carbohydrate, respectively. The fat, protein, ash and carbohydrate content in reduced calorie eggless muffins were 16.10, 6.01, 1.63 and 53.53%, respectively. The calorific value of eggless muffin and reduced calorie eggless muffin were 383.45 and 347.06 kcal/100 g, respectively. The calorie content was reduced 21.08% in reduced calorie eggless muffins compared to muffins prepared with egg.

Dairy Microbiology

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

Screening probiotics and prebiotics for expression of Glucagon like peptide-1 (GLP-1), a satiety inducing hormone, as prophylactics against diabetes mellitus – 2: STC-1pGIPNeo cells, used in this study induced highest GLP-1 secretion and expression as well as maximum fold level of expression of GIP (3.58±0.75) with *L. plantarum* Lp91 (Lp91). Different preparations of Lp91 viz. live cells, heat killed cells and sonicated cells elicited the secretion of GLP-1 from STC-1 cells respectively to 27.54, 149.42 and 45 pM GLP-1/10^6 cells/ hr with maximum secretion observed with heat killed preparation. Further, the cell culture medium was optimized to get maximum secretion of GLP-1. On simulating gut conditions, again heat killed cells of Lp91 elicited GLP-1 secretion by 101.31 pM in comparison to that of control wherein constitutive secretion of 33.42 pM could be recorded. Both secretion and expression of incretins in STC-1pGIPNeo cells on treatment with Lp91 was investigated at different time intervals and most significant up-regulation was recorded at 120 min. duration, where both berberine (4.422) and heat killed Lp91 (1.257) stimulated pro-glucagon gene expression. Similarly, expression of GIP, another satiety inducing gut hormone involved was also monitored at different time intervals under similar conditions. Both live and heat killed preparations were effective in up-regulating GIP gene expression after 120 min of co-incubation. GLP-1 secretion was also observed to be maximum at 120 min and increased in a time dependent manner by both Lp91 and *Lactobacillus fermentum* Lf1 (Lf1). On testing the live and heat killed preparations of indigenous probiotic strains, heat killed form of Lp91 was able to stimulate the highest secretion as shown in the following Figure.

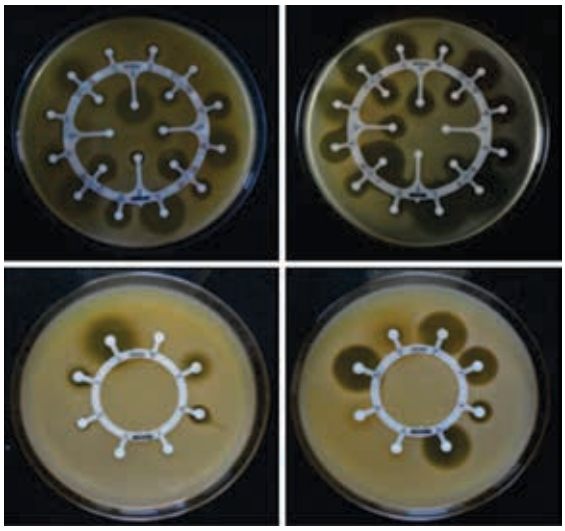
Healthy foods: Production of stable and active probiotics: *Lactobacillus casei* NCDC 298 and *Lactobacillus rhamnosus* NCDC 610 were procured from NCDC, NDRI. The growth and acidification patterns of the cultures were studied in whey medium both at flask and fermenter scale (2.5 L culture volume). The total viable counts reached ~9.5 log cfu/ml at stationery phase after 12 h at 37°C from an initial count of ~7.0 log cfu/ml. The



GLP-1 Secretion from STC-1pGIP Neo Cells induced with probiotic lactobacilli

pH of media decreased to 3.8-4.0 from an initial value of 6.5-6.7. The specific growth rates (μ) of *L. casei* NCDC 298 and *L. rhamnosus* NCDC 610 were 0.42 and 0.43, respectively. Further, the growth patterns of *L. casei* NCDC 298 and *L. rhamnosus* NCDC 610 in whey medium were also studied under fermenter scale (5.0 L culture volume) by external neutralization at 37°C. At pH 6.0 and 6.5, specific growth rates (μ) of *L. casei* NCDC 298 and *L. rhamnosus* NCDC were 0.45 and 4.8, respectively. Stationary phase with total viable counts ~9.5 log cfu/ml reached after 10 h from an initial count of ~7.0 log cfu/ml. The cell biomass was harvested, washed and resuspended in sodium glutamate milk to get viable cell concentration in the range of 10-11 log cfu/ml and preserved by freeze drying. The viable cell counts in freeze dried powder were 12 to 13 log cfu/g.

Status of antibiotic resistance among commercially available probiotic bacteria: A total of 28 isolates (mainly *L. rhamnosus*, *L. plantarum*, *L. reuteri*, *L. casei*, *L. fermentum*, *L. acidophilus*) recovered from 26 commercial probiotic products were characterized for antibiotic resistance. All the recovered organisms were screened for their antibiotic sensitivity profile against 50 different antibiotics using disc diffusion method as per the guidelines given by European Commission, 2008. Most of these isolates were resistant against a wide array of antibiotics. The MIC as determined using E-test strips for most of the isolates was found to be higher than recommended by European Commission, 2008 which is a matter of concern. These results obtained from E-test were further confirmed by using broth microdilution method. The broth microdilution and E-test results were found to be in good agreement.



Antibiotic susceptibility of Lactobacillus isolates using Disc diffusion method

Digestive enzymes (alpha-glucosidase and alpha-amylase) inhibitory probiotic lactobacilli for controlling postprandial hyperglycemia: A total of 77 isolates of *lactobacilli* were isolated from different dairy and plant sources by direct plating or by enrichment method and were confirmed by biochemical identification (i.e. human milk, 5; faeces, 26; dahi, 10; raw milk, 20; bamboo shoot, 8; fermented products, 8). The isolates were further identified by genus specific PCR, confirming the identity of all the putative isolates as lactobacilli. Out of reach 30 isolates of faecal origin were found to be non-α-glucosidase producer, followed by bamboo shoot, dahi and human milk, while it was much less in the raw and fermented milk products. The selected isolates were further screened for the inhibition of α-glucosidase using yeast enzymes.

Diversity of exopolysaccharides produced by lactic acid bacteria: Milk and Dahi samples were collected from different dairies of Karnal, Ambala, Kurukshetra, Shahbad and Nilokheri town as well as from households of nearby villages of Karnal District for isolation of exopolysaccharide (EPS) producing lactic acid bacteria. A total of 205 EPS producing lactic cultures were isolated from these samples. These isolates were identified as the members of the genera *Lactococci*, *Lactobacilli*, *Streptococci* and *Enterococci* as identified by biochemical and molecular techniques. Out of these, 48 prolific EPS producing cultures were selected based on the formation of capsule and production of higher amount of ropiness in skim milk tubes by visual method. These selected isolates were further identified mainly as the members of *Lactococci* and *Lactobacilli*. A few lactic cultures were also identified as *Lactobacillus delbreuckii* subsp. *bulgaricus* (7), *Lactobacillus acidophilus* (6) and *Lactobacillus rhmnosus* (2) by species specific PCR.

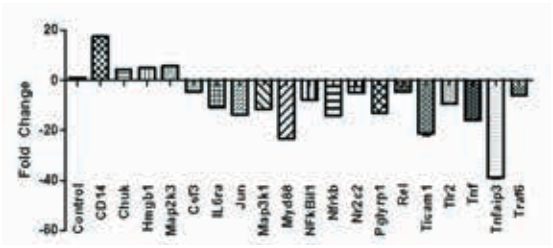
Preservation potential of bioactive components of essential oils in dairy foods: *In vitro* antimicrobial activity of plant bioactive components *viz.*, carvacrol, thymol, eugenol, linalool, menthol, citral, trans-cinnamaldehyde and vanillin of essential oils against food borne pathogens and spoilage microorganisms (*Listeria monocytogenes* ATCC 15303, *Staphylococcus aureus* MTCC 3160, *Bacillus cereus* NCDC 66, *Enterococcus faecium* NCDC 211, *E. faecalis* NCDC 223, *Escherichia coli* ATCC 25922, *Pseudomonas aeruginosa* MTCC 741, *Saccharomyces cerevisiae* NCDC 42, *S. cerevisiae* NCDC 49, *Kluyveromyces marxianus* NCDC 46, *Candida guillermondi* NCDC 44, *Aspergillus niger* NCDC 267, *A. niger* NCDC 315, *A. flavus* NCDC 268, *Rhizopus oryzae* NCDC 52) was evaluated. Antimicrobial activity of bioactive components

revealed thymol, trans-cinnamaldehyde, eugenol and carvacrol as most potent inhibitors of food borne spoilage bacteria and pathogens at low concentrations and menthol, vanillin, linalool, and citral as poor inhibitors. The results on inhibition of yeasts and molds indicated that trans-cinnamaldehyde as most effective antifungal agent followed by citral and eugenol.

Mechanistic evaluation of probiotics on gut satiety hormones in human cell lines to combat obesity (DBT BioCARe): A total of 125 samples of raw milk, cheese, dahi, lassi, kimchi, faeces, etc. were collected from different locations. Among the samples tested, lactobacilli isolates were found to be fairly wide spread, as all the samples resulted in successful isolation of lactobacilli. The LAMVAB media supplemented with bromocresol green and vancomycin was found to be the most suitable for the selective isolation of lactobacilli from faeces. Out of 206 isolates, 164 were Gram positive, out of which 137 isolates were catalase negative that were presumptively considered as lactobacilli for further work. The molecular characterization using genus specific primers additionally confirmed all these isolates as lactobacilli.

Production of antioxidant and antihypertensive bioactive peptides from milk proteins by proteolytic lactobacilli: Ninety five different *Lactobacillus* cultures were obtained from different sources were screened for the proteolytic activity qualitatively by plating on nutrient skim milk agar. All the cultures showed variable proteolytic activity as revealed by discrete zones of clearance. Thirteen cultures showed strong proteolytic activity by producing > 20 mm zone of clearance on milk agar. These cultures were subjected to antimicrobial activity against different pathogens (*Shigella dysenteriae, E. coli, L. monocytogens, Salmonella typhi, B. cereus, S. aureus*) which showed weak to moderate antimicrobial activity. R5 and R29 strains were further subjected to release bioactive peptides in skim milk medium. This skim milk fermentate showed 12-16 mm zone of inhibition against above pathogens.

Expression analysis of diabetes mellitus – 2 biomarkers induced by probiotic lactobacilli: Both live and heat killed forms of Lp9, Lp91, Lp75, LpS7, *L. fermentum* Lf1 significantly down regulated the expression of NF-κB (30-50 %) in Panc-1 cells both under post and co-culture treatment conditions in conjunction with TNF-α as revealed by Real Time PCR (RT-qPCR) and luciferase reporter assays. Amongst the three strains selected (Lp9, Lp91 and LpS7), Lp91 and LpS7 exhibited higher anti-inflammatory and anti-oxidative potential as revealed by significant up regulation of SOD-2 and GPx expression along with down regulation of TNF-α, IL-1β, IL-8, MCP-1 and COX-2 in Panc-1 cells. Majority of the *Lactobacillus* isolates along with two reference strains (*L. casei* and *L. rhamnosus*) demonstrated significant alpha-glucosidase inhibition (60-80 %). Similarly, treatment with four of the isolates Lb1-Lb4 and *L. paracasei* led to 25 % inhibition of DPP IV. Maximum secretion of GLP-1 and GIP was recorded with Lb-3 along with two reference strains of *L. johnsonii* and *L. rhamnosus* as determined by RIA and ELISA respectively. However, the expression of GLP-1 and GIP as determined by Real Time Quantitative PCR demonstrated maximum expression of the two gut hormones with Lb-4, Lb-6 along with the reference strains viz. *L. acidophilus*, *L. casei*, *L. plantarum*, *L. rhamnosus* and *Bifidobacterium bifidum*. *L. rhamnosus* was investigated for expression profiling of a panel of Toll like receptor signalling pathway genes (84 in numbers) by PCR array. Majority of the Interleukins (IL-6, TNF-α) and Transcription factors (NF-κB, JNK) were down regulated to a significant level. MyD88 was significantly down regulated and CD14 was over expressed. CD14 and G-proteins might play a role in expression of GLP-1 since no GLP-1 expression was recorded on using G-protein and CD14 inhibitors. Besides this, expression of different free fatty acid receptors was up regulated significantly in presence of selected isolates *i.e.* GPR-41 and 120 by Lb-6, GPR-40 and 41 by *L. casei* and only GPR-40 by *L. rhamnosus*.



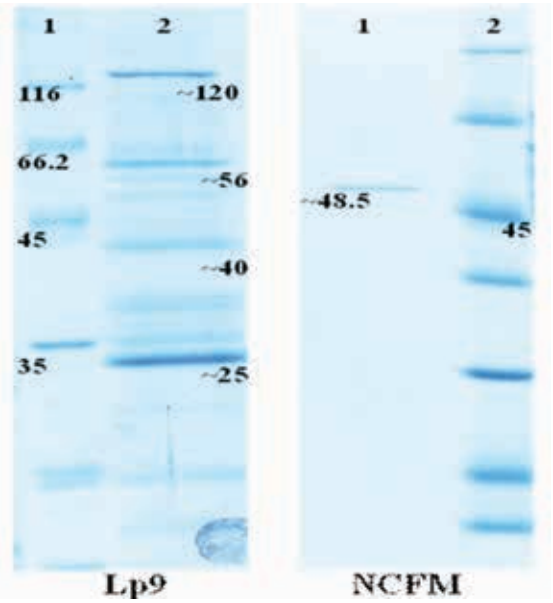
Expression analysis of Mouse Toll Like Receptor Signalling pathway using PCR array

Conjugated linoleic acid producing lactobacilli for controlling obesity in mouse model: A total of 285 *lactobacilli* were isolated from different sources and were screened to get high t10, c12 CLA producer, as it is the most efficacious option available to treat obesity, after synthetic drugs. In UV screening method, 61 isolates showed production of CLA in the range of 19.5 - 76.4 µg/ml in MRS and for a comparative study, 20 isolates were further tested in skim milk medium. In skim milk medium significantly higher production of CLA was noticed for eight lactobacilli. The PCR

identification revealed that *L. plantarum* as the predominant species representing 46% isolates, followed by *L. gasseri* (30%), *L. fermentum* (20%) and *L. salivarius* (5%). Amongst these, *L. plantarum* DDHI15 (90.6 µg/ml) produced more CLA in skim milk than *L. plantarum* DDHI 64 in MRS (76.4 µg/ml). In GC, isolate DDHI15, showed higher t10, c12 CLA production in SM and was reconfirmed by GCMS. Based on the probiotic properties, *L. fermentum* DDHI27 was selected as the best culture for animal studies. Higher CLA production was optimized by using the parameters viz. LA-0.5mg/ml, pH 6.0 and incubation 48h. Its progressive supplementation in SM containing derived t10, c12, to high fat diet C57Bl/6j obese mice significantly lowered the plasma leptin (~1.5 folds) and blood glucose (~1.2 folds), normalized the blood lipid profiles, reduced the body weight in HFD treated group compared to HFD control. Moreover, it positively altered the expression of SREBP-1c (2.0 folds), C/EBP-α (3.0 folds), FAS (1.8 folds) and UCP-2 (1.6 folds) in adipose tissues genes to control obesity.

Selection and characterization of potential probiotic *Lactobacillus gasseri* strains from human infant feces: On subjecting two hundred *L. gasseri* isolates recovered from breast fed human infant faeces (0-3 month's age) to different acid (pH-1.5, 3.0 and 6.5) and bile concentrations (1% and 2% bile), only nine strains were found to resist the gastric pH of 2.0 and 2% bile and were selected for further *in-vitro* evaluation for cell surface hydrophobicity, BSH activity, *in vitro* cholesterol assimilation, *in vitro* anti-oxidative potential, antibiotic resistance and *in vitro* adhesion to Caco-2 cell lines. These isolates were further evaluated for safety by testing for gelatinase, hemolysis and DNase activity and were found to be safe. The *L. gasseri* isolate Lg70 was selected for further *in vivo* bio-functional attributes. The *in vivo* bio-functional property was evaluated in rats for its hypocholesterolemic and anti-oxidative effect and mice model were used for immune-modulation studies. The peritoneal macrophages activity and lysosomal enzyme activity were significantly ($P<0.005$) increased several folds in the mice fed with milk fermented with Lg70 in comparison to control group. The mice that received fermented milk showed high concentration of IgA in intestinal fluid in comparison to control group. The isolate Lg70 was also evaluated for its hypocholesterolemic and anti-oxidative potential. When rats were fed with cholesterol enriched diet supplemented with milk fermented by Lg70 for three months, a reduction of 29.71% ($P<0.005$) in TC was observed and the reduction in LDL-C and triglycerides was 49.54% ($P<0.005$) and 20.69% ($P<0.005$), respectively. The number of lactobacilli increased and coliforms decreased significantly in feces of rats receiving Lg70. To evaluate the anti-oxidative potential rats were fed with thermally oxidized soy oil for three months. The activities of three anti-oxidative enzymes viz. catalase, super oxide dismutase and glutathione peroxidase were significantly decreased in the erythrocytes of rats receiving milk fermented with Lg70 in comparison to control group. The activity of these enzymes in liver was found to increase in rats fed with Lg70 in comparison to control group because the liver is the major organ confronting the external oxidized lipids. The results of the present study show *L. gasseri* strain Lg70 to be a promising probiotic candidate. Lg70 can be, thus, used in formulation of functional dairy foods to combat life style diseases.

Production and purification of native and recombinant surface-layer protein (S-layer protein) from probiotic *Lactobacillus* spp.: Native S-layer protein from Lp9 and NCFM was extracted by lithium chloride and a single protein band of ~ 48.5kDa on SDS-PAGE was obtained from NCFM, whereas in case of Lp9, four protein bands were recorded. One of the bands sizing ~56kDa revealed significant sequence similarity to the cell surface protein of *L. plantarum* WCFS1. The primers were designed with EcoRI and XhoI restriction sites for Lp9; and NcoI and XhoI restriction sites for NCFM for cloning in pET-22b (+). Recombinant clones of rS-Lp9 and rS-NCFM were confirmed by PCR, double digestion of recombinant vector

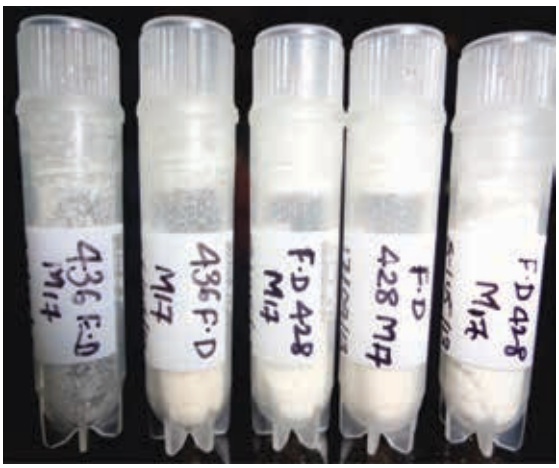


Surface layer protein from *L. plantarum* 9 and *L. acidophilus* NCFM

and nucleotide sequencing. Sequencing results showed 99.3% and 99.9% sequence similarity of recombinant genes with the native genes of both Lp9 and NCFM, respectively. The recombinant S-layer protein transformants were induced for expression of protein by IPTG and lactose. However, the expression of the protein could not be recorded with IPTG at any of the concentrations (0.1, 0.5, 1.0 and 5mM) and temperatures (37, 22 and 16°C) used. On the other hand, induction with lactose at 1.0 and 5.0 mM at 37°C led to the expression of ~ 48.5kDa rS-layer protein as inclusion bodies in case of NCFM but not in Lp9. For soluble expression of protein, further efforts were made by reducing the temperature to 22°C and 16°C; and giving heat and cold shock before induction. However, the protein was expressed only as insoluble inclusion bodies, which can be further purified and refolded.

Defined strain direct vat set (DVS) starter culture for *Misti Doi*: Out of 19 *S. thermophilus* cultures, NCDC 436 was selected based on its high sugar tolerance, fast curd setting and good acidification profile for the preparation of *Misti doi*. Growth performance of NCDC 436 was comparable to NCDC 428 in both whey based medium and M17 broth. Biomass of NCDC 436 and 428 cultures were prepared in whey based medium and M17 broth by batch culturing (42°C for 6 h) followed by harvesting and washing. The cell pellet was resuspended in sodium glutamate milk (cryo-protective medium) to achieve viable cell count in the range of 10-11 log cfu/ml and was preserved by freeze drying. The viable cell counts in freeze dried powder were 11 to 12 log cfu/ g and freeze dried cell pellet was stored at -20°C in cryo-vials. The suitability of the cultures for preparation of *Misti doi* was evaluated on the basis of curd setting time, physico-chemical, microbiological and sensory characteristics. The quality of *Misti doi* prepared using concentrated freeze dried cultures

Preparation of Misti Doi in earthen pot



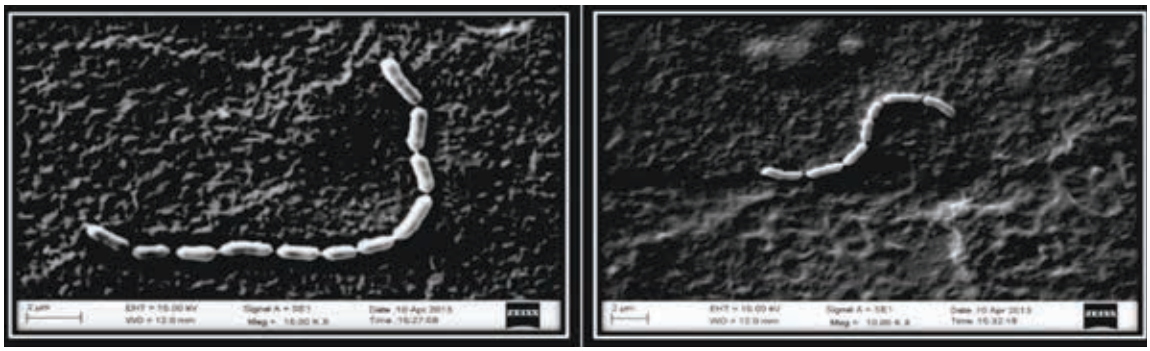
Freeze-dried DVS culture (Misti doi culture)

was comparable to that of fresh cultures and can be used as DVS/DVI.

***In vitro* screening of probiotic properties of lactobacilli isolated from human and dairy sources:** A total of 31 lactobacilli isolates from human and dairy sources, belonging to three different species were subjected to a subtractive system of *in vitro* analyses, which included desirable traits and their safety status. Twenty-seven isolates were able to survive at pH 2.5 for 3 h, of which fifteen isolates grew at pH 2.0 for 3 h in acidified MRS broth at 37°C. Out of these 15 strains were further screened for tolerance to 2.0% oxgall, in which 10 isolates showing good survivability were evaluated for bile salt hydrolase activity. Except three isolates (BIF2, BIF7 and BIF20), no precipitation was observed in case of any of the isolates in the presence of sodium tauroglycocholate. Nevertheless, all of these were able to deconjugate sodium taurocholate and sodium taurodeoxycholate. All the 10 isolates showed discernible antibacterial activity against common pathogens like *E. coli, L. monocytogenes, S. typhi and B. cereus*. The cell surface hydrophobicity of isolates ranged from 28 to 37% in the presence of n-hexadecane or xylene. Besides, all isolates showed the ability to auto-aggregate (19 to 30%). Majority of the acid and bile tolerant isolates were found sensitive to seventeen of the twenty antibiotics tested. All isolates demonstrated resistance to Nalidixic Acid, Norfloxacin and Vancomycin except BIF7 and BIF77, which showed intermediate resistance and sensitivity to Norfloxacin respectively. None of the evaluated isolates exhibited haemolytic or mucinolytic activities.

Antimicrobial, immunomodulatory and hypocholesterolemic effects of native strains

of probiotic lactobacilli: Two probiotic strains of native origin namely *L. fermentum* RS-2 and *L. rhamnosus* RSI-3 with *L. rhamnosus* GG as control were evaluated for their antimicrobial, adhesion on Caco-2 cell lines, cholesterol assimilation, and bile salt hydrolase (Bsh) activities by *in vitro* methods and further for their immunomodulatory activities by *in vivo* method. Although, all the three strains invariably inhibited the growth of Gram-negative and Gram-positive pathogenic bacteria viz. *S. typhi* NCDC 113 and *L. monocytogenes* ATCC 53135, RS-2 displayed better antimicrobial activity. RS-2 was also found to have better adhering capability as compared to RSI-3 as revealed by adhesion score, per cent adhesion and scanning electron microscopy. Hence, *L. fermentum* RS2 was selected for assessing its immunomodulation property on challenge with *S. typhi* and *L. monocytogenes* using mice model. Feeding of probiotics was found to be associated with an improved immunological status but no significant difference was observed in IgA, and IgG concentration among the different groups of mice. Probiotics also significantly reduced the colonization of pathogens in spleen, liver, and large intestine. Cholesterol assimilation ability of probiotic RS-2, RSI-3, and LGG was observed to be 59.36%, 29.44%, and 51.85% respectively. The efficiency of RS-2 to grow and hydrolyse sodium taurocholate was higher as compared to RSI-3, while GCA and TDCA were hydrolyzed more efficiently by RSI-3 as compared to RS-2. BSH activity, as quantified by the amount of glycine liberated from conjugated bile salts, indicated that substrate specificity was more towards single bile compared to mixed biles. The efficiency to deconjugate conjugated bile was higher in LGG followed by RSI-3 and RS-2.



Adhesion of *L. fermentum* RS-2, on Caco-2 cell line as studied by SEM

Production of bioactive peptides through fermentation of soy based milk by lactobacilli: *Lactobacillus* strains (*L. plantarum* C_2 and C_6, *L. rhamnosus* C_8, C_{25}, C_{28}, and C_{34}) isolated from cheese were identified by 16sRNA sequencing along with a reference strain of *Lactobacillus helveticus* NCDC 288. Fermentation of soy derived milk was done using all the cultures separately and 10, 5 and 3 kDa peptide fragments were prepared using MWCO membranes. Total cell count of *L. plantarum* C_2 increased from 5.9 to 10.29 log cfu/ml after 48 h of incubation and with *L. helveticus* NCDC 288, it increased from 5.7 to 10.4 log cfu/ml. The pH of all the cultures in soy milk decreased significantly from 6.9 to 2.9 or 3 after 48 h of incubation at 37°C and acidity of soy milk during fermentation with *L. plantarum* C_2 increased from 0.117 to 1.8%. All the cultures used in the present study demonstrated ability to produce α–galactosidase with *L. helveticus* NCDC 288 exhibiting highest activity (13.20 nmol/ml/min), followed by *L. rhamnosus* C_8 (12.57 nmol/ml/min) and *L. plantarum* C_2 (12.50 nmol/ml/min). Antioxidative activity of all the cultures was found to be appreciable with highest radical scavenging capacity shown by 10 kDa peptide fragments of *L. plantarum* C_2 (911.224 TEAC µM), followed by *L. helveticus NCDC 288* (884.757 TEAC µM) and *L. rhamnosus* C_{25} (874.695 TEAC µM). The zones of inhibition of indicator organisms tested ranged between 8 to 29 mm in dia. A highest zone of inhibition was measured against *E. coli* (29 mm) and *S. typhi* (28 mm) when soy milk was fermented with *L. plantarum* C_2. *In vitro* antihypertensive activity of fermented soy milk was tested using HHL substrate and 62.5% inhibition was observed when soy milk was fermented using *Lactobacillus plantarum* C_2.

Development of reduced cholesterol probiotic butter: *In vitro* effect of prebiotics (inulin and maltodextrin) on cholesterol assimilation potential of six *Lactobacillus* strains *viz.*, *L. delbreuckii* ssp. *bulgaricus*-2, *L. rhamnosus* GG (LGG), *L. plantarum* LT-4, *L. plantarum* LT-7, *L. plantarum* LT-9 and *L. delbreuckii* ssp. *bulgaricus*-11 were evaluated in broth and cream. *L. rhamnosus* GG exhibited highest probiotic counts in presence of the above prebiotics followed by *L. delbreuckii* ssp. *bulgaricus*-11 in broth. Similarly, *L. rhamnosus* GG showed highest cholesterol assimilation activity (49.76±0.21%)

in broth supplemented with inulin followed by *L. delbreuckii* ssp. *bulgaricus*-11 (47.67±0.19) in 24 h. On the other hand, *L. delbreuckii* ssp. *bulgaricus*-11 resulted in exuberant growth in 24 h as compared to *L. rhamnosus* GG and other lactobacilli in cream. Cholesterol reduction by *L. delbreuckii* ssp. *bulgaricus*-11 and *L. rhamnosus* GG was 17.28±0.16 and 11.8±0.21%, respectively in cream. Inoculum size of 3% and incubation temperature of 37˚C and 42˚C were found to be optimum for cholesterol reduction in cream for *L. delbreuckii* ssp. *bulgaricus*-11 and LGG. Highest cholesterol reduction (23.44±0.11 %) was observed with 3% maltodextrin by *L. delbreuckii* ssp. *bulgaricus*-11 at 42˚C/24 h as compared to control (16.76±0.14%). Finally, *L. delbreuckii* ssp. *bulgaricus*-11 and maltodextrin were selected for cholesterol reduction in cream for preparation of probiotic butter with reduced cholesterol. Butter was prepared from cream (35% fat) supplemented with maltodextrin @ 3% and ripened with *L. delbreuckii* ssp. *bulgaricus*-11 at 42˚C/24 h. Cholesterol reduction in butter was found to be 21.07±0.64 and 17.08±0.83% for test sample and control, respectively.

Influence of stress on antibiotic resistance in lactobacilli from traditional dairy products: Amongst a number of isolates from different dairy based samples, 41 were confirmed as lactobacilli using genus specific PCR that were further identified at species level. Out of these, 36 were *L. plantarum*, 2 *L. casei* and 3 *L. salivarius*. Finally 11 isolates were taken for studying the sensitivity pattern against different antibiotics. Nine isolates were strictly sensitive against majority of tested antibiotics (viz. ampicillin, chloramphenicol, erythromycin, gentamycin, kanamycin, streptomycin, vancomycin, linezolid and vancomycin) but all the isolates were resistant with ciprofloxacin. Assessment of stress on antibiotic sensitivity using low pH, bile salt tolerance and high temperature was carried out. All the stresses were significant in changing the sensitivity pattern of selected isolates but high temperature showed better results, as it led six of the isolates to become resistant against ampicillin, chloramphenicol, clindamycin, kanamycin and gentamycin. Changes in antibiotic susceptibility of lactobacilli were substantially different for the same stress agent depending on the time of exposure.

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

Micro-encapsulation of bacteriocins for their controlled release: Out of a total number of 1200 lactic acid bacterial isolates, only 55 isolates were found to be bacteriocinogenic and amongst them, only 8 isolates showed good antimicrobial activity against some of the Gram-positive as well as Gram-negative food-borne pathogens and spoilage bacteria. Five isolates belonged to the genus *Lactobacillus* and three isolates to *Lactococcus*. Bacteriocins of these strains were quite heat stable and active over a wide range of pH. Bacteriocin produced by an isolate *Lactococcus lactis* sp. *lactis* C63, however, showed broad spectrum of inhibition including *E. coli, Yersinia, Citrobacter, Proteus, Enterobacter, Klebsiella, Serratia* and was selected for further studies. Maximum bacteriocin activity was observed in MRS broth after 22 h incubation at pH 6.5 and 7. Bacteriocin from C63 was partially purified by 0-60% ammonium sulphate saturation, which yielded 82% recovery of the bacteriocin activity. The SDS-PAGE and *in-situ* gel activity revealed that the bacteriocin has a molecular weight of about 4-5 kDa. The bacteriocin was found to be sensitive to all the proteolytic and to a non-proteolytic enzyme (amylase). The bacteriocin may, thus, be designated as a glycoprotein. The CFCS of C63 was microencapsulated in four different wall materials (20:80 v/v): Sodium alginate (2% w/v), Sodium alginate (2% w/v) + guargum (0.4% w/v), Sodium alginate (2% w/v) + guargum (0.4% w/v) + phosphatidylcholine, Sodium alginate (2% w/v) + chitosan (0.4% w/v). Release kinetics of microencapsulated and un-encapsulated bacteriocin were studied against *K. pneumoniae*. C63 isolate gave negative test for haemolysis, gelatin liquefaction and DNAse. The C63 isolate was found to be sensitive to clinically important antibiotics.

Whey to biofuel: bioethanol production by stress tolerant and metabolically engineered yeast from whey: A total of 200 isolates of yeast could be recovered from different dairy products. More than 9% of the isolates showed ethanol tolerance up to 10% whereas 8% of total isolates were tolerant to 25 % lactose. All the putative strains were identified as *Kluyveromyces* sp. All the strains showed good growth and strains 6C17 and 6C18 were found to be the highest biomass producers. Further, based on their ethanol production profiling at different sugar levels, the maximum ethanol production was observed to be ~ 3% (v/v) in 5% lactose medium. Simultaneously, on assaying residual sugar at different time intervals, least residual lactose concentration was observed with strains 6C17 and 6C18. In addition, their β-galactosidase production potential was also evaluated spectrophotometerically. Out of total 10 strains of *Kluyveromyces* sp., two strains were found

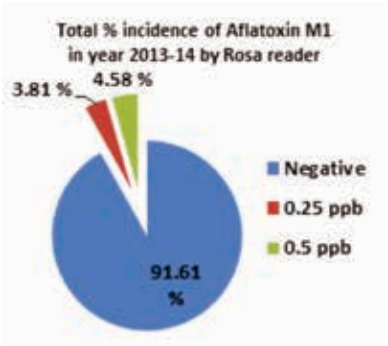
hyper β-galactosidase producers namely 6C17 and 6C18. Five strains of *Kluyveromyces marxianus* procured from Microbial Type Culture Collection (MTCC, Chandigarh) were also evaluated for β-galactosidase production in whey and strain MTCC 1389 was found β-galactosidase hyper producer with ~ 988 miller units. On the other hand 6C17 and 6C18 produced ~ 1140 and 830 miller units of β-galactosidase.

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

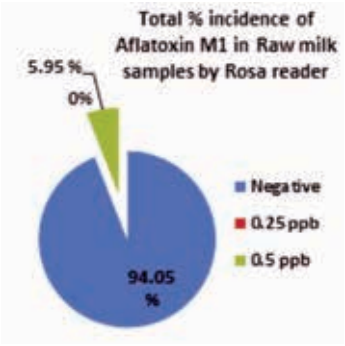
NAIP project on Development of biosensors and micro-techniques for analysis of pesticide residues, aflatoxin, heavy metals and bacterial contamination in milk: A spore based assay for detection of *L. monocytogenes* on 96 micro well plate using marker enzymes and their germinogenic substrate has been developed which enables the detection of *L. monocytogenes* with log cells of 1.74 ± 0.8 with in real time of 4.0 ± 0.30h after initial pre-enrichment of targeted sample(s) in Listeria selective enrichment medium (LSEB) for 16.0 ± 0.15h. The assay protocol requires pre-enrichment of milk sample in LSEM followed by obtaining enriched cells. The enriched cells obtained are incubated with different germinogenic substrates and dormant spores in a 96 well plate. The plate is then incubated for 4h at 37°C. After incubation, fluorogenic substrate is added for detection of spore germination in well plate. The 96 well plate is to be read at specific excitation/emission wavelength using microbiological plate reader. The assays can detect up to 5 log cells in 4h of incubation. The contaminants like Enterococci, *S. aureus*, *E. coli* other than *Listeria* spp. do not interfere in the assay. The spore based assay has been validated in the lab with spiked/natural raw and pasteurized milk samples.

Outreach Project on "Monitoring of Drug Residues and Environmental Contaminants"

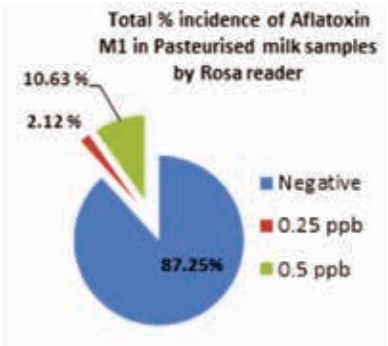
Survey work of aflatoxin M_1 in milk: A total of 131 milk samples (raw 83 and pasteurized 48) procured from Delhi and UP area were analyzed for the presence of Aflatoxin M_1 using Rosa reader and AOAC approved charm assay. An incidence of 4.58 % at ≥ 0.5 ppb and 3.81 % at 0.25 ppb was observed. In raw milk samples, a total incidence of 5.95 at ≥ 0.5 ppb was observed and none of the raw milk samples was found positive at ≥ 0.25 ppb. On the other hand, the same incidence in pasteurized milk samples was observed as 10.63 % and 2.12 %.



Total % incidence of Aflatoxin M1 in year 2013-14 by Rosa reader

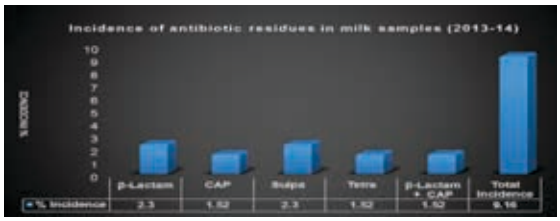


Total % incidence of Aflatoxin M1 in Raw milk samples by Rosa reader



Total % incidence of Aflatoxin M1 in pasteurized milk samples by Rosa reader

Survey work on antibiotic residues in milk: A total of 131 milk samples (raw 83 and pasteurized 48) procured from Delhi and UP area were analyzed for the presence of antibiotic residues during the period from 2013-2014. Milk samples collected during the year showed incidence of 9.16 % at MRL dose specified by codex for different antibiotics.



Note: CAP: chloramphenicol; Tetra: Tetracycline

Incidence of antibiotic residues in milk samples collected during 2013-14

Development of spore based sensor/assay for detection of antibiotic residues in milk: The most sensitive strain of *Bacillus sterothermophillus* was screened for marker enzyme (s) and its specific substrate was selected. The spore production of selected strain was optimized and subsequently, its prototype was developed. The kit prototype was evaluated for its antibiotic sensitivity under

field conditions. The optimized procedure includes stage I and II wherein chromogenic substrate was lyophilized (stage-I) and spores were seeded in germination medium (stage-II). In stage I, 100 ±10 µl of milk sample was added to lyophilized chromogenic substrate and mixed well. The entire content from stage-I was transferred into ampoule (Stage II) containing 100 ±10µl spores seeded with 200 ±20 µl of germination medium. This is followed by incubation at 64±2°C for 2.00-2.15 min. The appearance of yellow color indicates spore germination and release of specific marker enzyme and its interaction with substrates depicts the absence of antibiotic residues in milk. No yellow color development indicates inhibition of spores and presence of antibiotic residues in milk.

Development of enzyme substrate assay for detection of *L. monocytogenes* in milk: A 'Two-stage enzyme assay'' was developed for the detection of *L. monocytogenes* in milk based on the principle of targeting "enzyme-substrate reaction for specific marker enzyme (s) to release free chromogen that can be visually detected by colour change. Initially, growth pattern of *L. monocytogenes* was studied in three different commercial media and a significant increase in log count was observed in Listeria Enrichment Broth (64.28%) followed by 62.5% and 46.28% in University of Vermont Medium and Fraser broth, respectively. The Fraser broth having higher selectivity in terms of its inhibition pattern against potential contaminants was further modified and developed into a chromogenic medium by addition of esculin and ferric ammonium citrate @ of 0.1 and 0.05%, respectively. The antimicrobial spectrum of modified medium i.e. Listeria selective enrichment medium (LSEM) was found to be increased significantly against *Enterococcus faecalis* (7.15 log cfu), *S. aureus* (5.38 log cfu), *L. casei* (7.32 log cfu), *L. fermentum* (7.54 log cfu), *B. cereus* (6.45 log cfu), *E. coli* (7.34 log cfu), *Salmonella abony* (7.43 log cfu), *E. aerogenes* (6.52 log cfu) and *K. pneumonia*e (7.32 log cfu). The two stage enzyme assay can confirm the presence of *L. monocytogenes* within real time of 4.30±0.30h (Stage-II) after initial pre-enrichment of food samples in LSEM for 25±1.0h (Stage-I) and demonstrated parallel results with standard reference method. The assay was validated in the lab with spiked reconstituted milk and few raw and pasteurized milk as well as cheese samples collected from different sources.

Development of enzyme substrate based biosensor for monitoring *E. coli* in milk and milk products: An "Enzyme (s) substrate assay'' was developed for the detection of *E. coli* in milk and milk products. The concentrations of growth supplements namely peptone, yeast extract, lactose and potassium chloride were optimized based on log counts and the medium was modified with different selective agents. The antimicrobial spectrum of modified medium i.e. *E. coli* selective medium (ECSM) was found to be increased significantly against *S. abony* (6.23 log cfu), *Shigella flexneri* (4.35 log cfu), *Y. enterocolitica* (4.28 log cfu), *Serretia marcescens* (4.63 log cfu), *E. faecalis* (4.19 log cfu), *B. cereus* (4.45 log cfu), *L. fermentum* (5.54 log cfu) and *L. casei* (5.32 log cfu). ECSM was further developed into a chromogenic medium by addition of different substrates like α-D-glucoside, α-D-galactoside, β-D-glucuronide, β-D-glucoside and β-D-glucopyranoside with their concentration varying from 10 to 30 mM. Different marker enzyme(s) for *E. coli* and other contaminants were screened and formulation of enzymes along with their substrates were optimized for the development of enzyme assay. Appearance of green color in ECSM supplemented with marker enzymes/substrates confirmed the presence of *E. coli*, while yellow color indicates non-faecal contamination. The ECSM with novel features of high sensitivity/selectivity would be a cost effective substitute for selective enumeration or detection of *E. coli* within 12 ± 0.25 h when compared with existing prior art.

Development of spore germination based bioassay for *E. coli* using germinogenic substrate and marker enzymes: The developed assay for *E. coli/E. coli* O157:H7 in milk involved the use of selected marker sugars besides a set of specific marker enzyme(s) which included β-D-galactosidase, α-D-galactosidase, β-D-glucuronidase, β-D-glucosidase, α-D-glucosidase, α-D-mannosidase and amino-peptidase. Initially, a comprehensive screening of these marker enzymes was carried out in different strains of *B. megaterium* (spores/cells) and *E. coli.* Different sugars like dextrose, lactose, fructose, cellobiose, mannose, xylose, β-gentiobiose, α-methyl-D-glucoside, sucrose, maltose and nitrogenous compound like glucosamine demonstrated their capability to act as a germinant for *B. megaterium* spores. Spore germination based concept was developed successfully with pure markers enzyme(s), however, it did not work well with *E. coli* on account of being uptake of sugars used as germinogenic substrate(s). Subsequently, the assay protocol was modified and selected germinants were used as marker sugars for development of uptake principle. An array of assay parameters such as concentration of different sugars as germinant

(100 mM - 300 mM), volume of spore suspension (20 µL/ 6.65±0.25 log cfu), incubation time (3.00 h at 37°C) and inoculum level of target bacteria (20µL/ 7.02±0.21 log cfu were optimized. The sensitivity of spore based assay was 5.24±0.25 log count with detection time of 3.00 h after pre-enrichment (5.00±0.30 h) of pure cells/spiked milk in *E. coli* selective medium (EC-SM) at 37°C. The bioassay was screened for its selectivity with different Gram negative and Gram positive contaminants and also evaluated with milk samples under field conditions and positive signals were achieved. The assay was further miniaturized on biochip by adding 0.5 µl of reaction mixture and measurement was done based on IOD values using EMCCD system.

An innovative approach for detection of *L. monocytogenes* in milk using spore based sensors: *Bacillus megaterium* 2949 spores used as biosensing agents, were screened for the presence of the specific marker enzymes to have an additive effect on spore germination signal. Among the germinant and germinogenic substrate screened D-dextrose, D-mannose and L-alanine were able to germinate *B. megaterium* 2949 spores within 30 min quite appreciably. The selected germinogenic substrates were optimized individually for experimental parameters such as heated spore level requirement, concentration, volume of *L. monocytogenes* suspension and incubation time for development of spore based assay. The *L. monocytogenes* cell suspension, spore suspension and incubation time for spore germination at 37°C, concentration of germinogenic substrates, esculin and L-alanine β-napthylamide were optimized for the transformation of the assay into 96 well plate microtitre spore based assay having a germination signal viz. 21.52±2.92, 24.43±5.48, 25.82±2.83, 36.68±8.48 and 0.79±0.02 fold for germinogenic substrates methyl β-D-glucopyranoside, methyl α-D mannopyranoside, glycogen, esculin and L-alanine β-napthylamide respectively. The LOD of developed assay in buffer was found to be 5.0±0.5 log count in 4h and 30 min whereas in case of milk system, it was achieved with 16±0.30 hrs enrichment time of 1.0±0.14 log cells in Novel LSEM. The assay was further miniaturized on biochip micro well by adding 0.5 µl of reaction mixture and measurement was done based on IOD using EMCCD system. Validation of the assay was performed in natural milk system with ISO11290-1:1996 horizontal method and VIDAS® bioMérieux system. Three samples showed black color reaction after 16.0±0.30 hrs of incubation in LSEM.

Evaluation of "Two stage enzyme assay for detection of *L. monocytogenes* in milk and milk products: "Two-stage enzyme assay" developed for detection of *L. monocytogenes* in milk and milk products could detect *L. monocytogenes* in milk within 28±1.0h and was validated in Food Safety and Quality Assurance laboratory with spiked milk samples. Out of 95 samples, four samples were found to be positive for *L. monocytogenes* by developed method, 11290-part-1 1996 and as well as by API *Listeria* kit, respectively. Three samples of raw milk, ice cream and cheese, 3 samples of paneer showed black color in LSEM (stage-1) and while no color was developed in ESM (stage-2), hence not confirming the presence of *L. monocytogenes.* None of the pasteurized butter and dried milk samples showed the presence of *Listeria* spp./*L. monocytogenes* when analyzed by the developed "two stage enzyme assay" or ISO 11290-part-1 1996 method. Based on raw milk and pasteurized milk, cheese, milk powder analysis, the incubation time was recommended for presumptive and confirmatory detection of *L. monocytogenes* in the developed two stage enzyme assay. Working performance of the developed two stage enzyme assay was validated in different milk and milk products and similar results were observed with ISO-11290 part-1 1996 method for detection of *L. monocytogenes*.

Screening of Enterococci in milk using developed media and functionalized biochip: Among 160 samples analysed for Enterococci by EBSAM based on ß–D-glucosidase activity, enterococci counts were observed to be in the range of 0-1, 1-2, 2-3 and 3-4 log/mL at around 18-24, 14-18, 11-14 and 9-11 h respectively. Although, the counts taken on solid conventional media i.e. CAA demonstrated similar pattern, but results were obtained in 48 h of incubation. The comparative counts revealed a significant correlation in raw (r~0.975) and pasteurized milk (r~0.99). The developed media were also evaluated at M/s SGS wherein milk was spiked @ 1.36 and 3.32 log counts/mL of Enterococci and showed black color after 17 and 10 h of incubation at 37°C . The developed medium was also evaluated for its selectivity by screening with different contaminants and their growth could be restricted up to of 8.15 , 7.60 , 7.33 , 5.76, 3.50 log counts/mL of LAB, Gram–ve and Gram+ve pathogens, yeast and moulds and *Bacillus cereus,* respectively. Spore germination based assay for detection of Enterococci was optimized on 96 well plates by adding 30 µl of heated spores along with 90 µl of reaction mixture and fluorescence was measured using microbiological plate reader.

The germination of spores at different log counts of Enterococci i.e. 6.6, 5.4, 4.8 and 3.6 was 13.54, 6.11, 1.61 and 0.75 fold, respectively. The protocol was further modified and a significant increase in germination from 13.54 to 20.00 fold was observed. Assay was optimized further on biochip micro well functionalized with spores by adding 0.5 µl of reaction mixture and measurement was done based on change in density and IOD using EMCCD system. The available data indicated a significant increase in IOD and sensitivity could go up to 1-log counts of Enterococci.

Efficacy of biofilm formation by *Enterobacter sakazakii*: A total of 45 *E. sakazakii* from different sources were selected based on the growth on tryptic soy agar and were further screened for Gram's reaction, catalase and oxidase test. The positive isolates (27) were confirmed by molecular identification with PCR using species specific primers, whereas 11 were identified as *E. sakazakii*. These isolates were found positive for the virulent characteristics (i.e. hemolysis, haemagglutination and DNase production). The stainless steel coupons and enteral feeding tubes were used to check the ability and efficacy of *E. sakazakii* for biofilm formation up to 10 days and it was observed that the cell number increased up to 2nd day, but, thereafter, cells started to dislodge. It can be stated that the biofilm formation by *E. sakazakii* was more in case of enteral feeding tubes as compared to stainless steel coupons. The study indicated that *E. sakazakii* can be present in dairy and environmental milieu, and the feeding tubes used for the purpose of feeding to neonates can be a potential source of fatal infection of *E. sakazakii*.

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

Network project on Veterinary Type Cultures – Dairy Microbes: Two hundred and forty isolates of *Streptococcus thermophilus*, *Lactococcus* spp., *Lactobacillus* spp. and *Leuconostoc* spp. were isolated from fermented milk products samples collected from different parts of Himachal Pradesh, Punjab, Haryana and Rajasthan. A total of 58 lactic acid bacteria comprising strains of *Lactococcus* spp., *Leuconostoc* spp., *Lactobacillus* spp. and *Streptococcus thermophilus* were preserved as freeze dried ampoules and deposited at NCDC/ VTCC culture bank. The technological properties such as acidification profiles, flavour production, proteolysis, exo-polysaccharides (EPS) production, etc. were evaluated and the cultures can be used for manufacturing of various fermented dairy products with improved technological qualities.

Veterinary Type Culture – Rumen Microbes: Anaerobic fungi isolated from 'Karan Fries 'crossbred cattle were polycentric and larger in size (8-12 mm), as these possess nucleated rhizoids and produce sporangia on each rhizoid. Based on the presence of constricted hyphae, pointed sporangia and zoospore flagellation patterns, four isolates were identified as *Anaeromyces* spp. (uniflagellated zoospores) and rest four as *Orpinomyces* spp. (polyflagellated zoospores). Highest CMCase activity was shown by *Orpinomyces* sp. NFRI-13 after 96 h. However, after 24 h, it was *Anaeromyces* sp. NFRI-6 and later *Orpinomyces* sp. NFRI-1 that showed maximum enzyme activity at 48 and 72 h. This indicates that every strain has its own characteristic pattern of enzyme production with respect to the stage of growth or time of incubation. On the other hand, in case of avicelase *Anaeromyces* sp. NFRI-4 exhibited maximum enzyme activity throughout the incubation. For xylanase, initially *Anaeromyces* sp NFRI-6 after 24 h followed by *Orpinomyces* sp. NFRI-13 at 48h and later *Orpinomyces* sp. NFRI-1 dominated the production. Among different enzyme activities, xylanase production was highest, followed by CMCase and avicelase.

Dairy Engineering

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

Development of scale up design of continuous khoa making machine for handling concentrated milk: In order to increase the capacity of three stage SSHE, the variation in capacity was studied by varying milk concentration and steam pressure. The milk concentration was varied in the range of 30-50% TS and steam pressure of first and second stage was kept in the range of 4-6 kg/cm^2 and 2-3 kg/cm^2 respectively. The steam pressure in third stage SSHE was kept fixed at 1 kg/cm^2. The rotor speed of first, second and third stage was kept fixed as 200,175 and 15 rpm, respectively. It was observed that capacity

was increased from 120 kg/h (steam pressure in first stage-4kg/cm^2, second stage-2 kg/cm^2 and feed concentration-30% TS) to 180 kg/h (steam pressure in first stage-6 kg/cm^2, second stage - 3 kg/cm^2 and feed concentration 50% TS). The sensory scores of the final products were also observed as color (4.0 to 4.5), flavor (7.5 to 8.5) and texture (8.0 to 9.0). Thus with an assumption that plant would run for three shifts in a day with one and half hour cleaning time, the capacity of the system was estimated to be around 3500 kg/day

Machine vision system for quality evaluation of dairy products based on colour measurement: Machine vision system (MVS) was designed on the basis of ISO guidelines for Graphic technology. The control circuit was designed using the software TinyCad (v. 2.8). MVS was fabricated and various components of the system such as camera, computer, control unit, etc. were integrated. Data acquisition and analysis unit was based on 64 bit architecture using Window 7 (32 bit). The system can be operated using any of the following viewing geometries: a. Light and product on parallel planes with camera at an inclination b. Light-camera and product on parallel planes. Provision was made for loading of product into the system for colour measurement. Product loading platform was designed for smaller size dairy and food samples. For large size products, window port can be used. The system was calibrated for D65 standard illumination.

Dairy Economics, Statistics & Management

Inclusion of Smallholders in the Dairy Development Process

The study revealed that the proportional expenses on dairying to total production expenditure at the household level is inversely related to land ownership whereas as income from dairying to total family income of the households is also inversely related to land ownership. Therefore, dairying has capacity to reduce poverty at the household level and it should be an integral part of poverty alleviation programmes. The study revealed that 1% incremental increase in crop income would trigger total income inequality by 1.38% with a caveat that other things are unchanged. On the other hand, the income from off farm, dairy farm and livestock source has a equalising effect on the distribution of total income for all categories of farm households, which otherwise corroborates the hypothesis of relative income equalising effect through dairying and other livestock farming compared to distribution of incomes through crop. The income from dairy farming reduces the income inequality. It also confirms that growth through inclusive dairying does not worsen income distribution, but helps in reducing absolute poverty and inequality. Promotion of economic development and reduction of poverty will depend on the capacity of dairy farming to contribution to smallholder income and employment.

Factors Determining the Veterinary Services

The study has shown the importance of identifying factors that determined the likelihood of using veterinary services in India. About 29,020 dairy sample households from secondary source were selected for the analysis in this study. There was a positive relationship between herd size and use of veterinary services. Principal source of income from agriculture positively influenced the likelihood to use veterinary services once again and reinforced that dairy sector should not look in isolated manner rather it should be treated in the integrated farming system mode. The study pointed out that the veterinary services, being only one element of dairy value chains, are sustainably enhanced when linked to other innovations and market-oriented activities that optimise productivity gain. Direct government involvement in veterinary services was justified on social and climate resilient agriculture rather economic grounds particularly in the Indian smallholder dairy farming system. The institutions which support veterinary services could become more effective, if they undertake suitable organisational changes to disseminate the latest animal healthcare technologies to the marginalised dairy farmers. The model from empirical point of view is very important to predict whether household will be using the veterinary services or not after incorporating the value of the explanatory variables.

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

Web-enabled user friendly software: Milk Production Economic Analysis Package (MILKEcAP-1.0) was developed for the estimation of economics of milk production of local cattle, crossbred cows and buffaloes. The software has three modules for database management

pertaining to village level information, complete enumeration of the milch animal stock of the households and the detail information pertaining to the breeding, feeding, management of animals, quantity and prices of fixed and variable inputs used as well as output generated in the production process. The software has build-in feature of estimating the fixed and variable cost components on per animal basis.

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

The average milk yield of local and crossbred cattle is higher among the smallholder dairy producers in the hill region of Uttrakhand (2.2 and 6.0 *l*/day, respectively) as compared to their counterparts in the tribal region of Chattisgarh (0.9 and 3.9 *l*/day, respectively). The indigenous animals subsist predominantly on grazing in the study area of Chattisgarh. The breeding and management practices followed by the livestock keepers are very poor. The deplorable condition of common property resources used for grazing animals and unscientific dairy farming practices suggest that in the fast changing market environment, the existing production system would be rendered unsustainable.

In Uttrakhand region, due to low level of milk production, only 43% of the milk output is marketed, mainly through the unorganised milk marketing channels. The dairy cooperative societies in the region have poor outreach among the smallholders as only 35% of the sample households were its members. The producer price of cow and buffalo milk was ₹ 22/l and ₹ 25/l, respectively. The farmers are using non-conventional feed resources like, leaves of Banjh, Timila and Bhimal, especially in the summer season. The females carry out the drudgerous task of bringing grass and fodder from field, cleaning, etc. and spend about 44% of their work hours in dairy farming activities. Men spend much lesser time (26% of work hours) in dairy and perform the less arduous tasks. Such kind of division of labour across gender is socially unsustainable from the long term perspective.

Value Chain Analysis of Milk and Milk Products in Co-operative Sector in Haryana

Value addition is a mechanism to accelerate the earning from milk by presenting innovative and desirable products which meet the customer demand and requirement. Milk is a basic raw material for all dairy products and earning per unit of milk is increased through value addition. This also helps to provide remunerative price to milk producers. In terms of value of output, milk is the single largest agricultural commodity in the country. Organised dairy sector plays a significant role in procurement, value addition and marketing of milk in the state. Presently, there are 5 dairy plants in the Co-operative sector with a milk processing capacity of 4.7 lakh litres per day. The Co-operative plants are located in Jind, Ambala, Rohtak, Ballabgarh and Sirsa, respectively. Along with pasteurised liquid milk, the plants also manufacture various value added dairy products, viz., Paneer, Kaju Pinni, Milk cake, Paneer, Lassi, Chhach, Ice-cream, Ghee, butter, etc. These milk and milk products are sold at about 89 milk booths/outlets located in various parts of the state. Presently, the consumer price of ghee is ₹ 377 per kg, butter is ₹ 329 per kg, full cream milk is ₹ 44, standard milk is ₹ 40, tonned milk is ₹ 36 and double tonned milk is ₹ 32 per litre, respectively.

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

Several intelligent models based on soft computing approaches: connectionist and Adaptive Neuro-Fuzzy Inference System (ANFIS) models have been developed to predict the sorption isotherms (adsorption and desorption) at four different temperatures, that is, 15, 25, 35, and 45°C over a water activity range of 0.11–0.97 in a milk and pearl millet–based weaning food, fortified Nutrimix. The prediction potential of these soft computing models was compared with that of the conventional empirical models (i.e., BET, Caurie, Halsey, Oswin, and GAB models) that were also developed in this study. The performance of the neuro-fuzzy hybrid model seems to exhibit the best with prediction accuracy ranging between 0.09 and 0.34 for adsorption and between 0.23 and 0.35 for desorption in terms of Root Mean Square percent error (RMS%) as compared to that of the connectionist model with accuracy between 2.52 and 4.93 for adsorption and between 2.49 and 4.50 for desorption and that of the best classical empirical sorption model; that is, the GAB model with an accuracy between 5.48 and 10.60 for adsorption and between 5.54 and 9.54 for desorption.

Also, the intelligent models were developed based upon the aforementioned soft computing approaches, to predict sorption (adsorption and desorption) characteristics at three temperatures, i.e., 25°, 35° and 45 °C over a water activity range of 0.11–0.97 in dried acid casein prepared from

buffalo skim milk. Several conventional empirical sorption models (i.e., Oswin, Smith, Halsey and Caurie, modified Mizrahi and GAB) were used for fitting the sorption data. The ANFIS models predicted the adsorption characteristics with an accuracy ranging between 0.09 and 0.2 RMS% vis-à-vis the best classical empirical GAB model, which attained RMS% between 1.93 and 5.78; while for desorption characteristics, ANFIS models attained RMS% between 0.15 and 0.33 as compared to that of the best conventional empirical GAB model with RMS% ranging between 1.4 and 4.95. The connectionist models predicted the adsorption characteristics with an accuracy ranging between 1.32 and 2.60 RMS%, while for desorption characteristics, the connectionist models attained RMS% between 1.56 and 4.08

It was inferred that the hybrid soft computing ANFIS model can potentially be used as a superior alternative technique over simple connectionist models and the conventional empirical sorption models to effectively predict equilibrium moisture content in the fortified Nutrimix powder and dried acid casein.

Economic Viability of Commercial Dairy Farms in Jabalpur District of Madhya Pradesh

The transformation in Indian dairy sector in the recent years has undergone massive changes and acquired commercial characteristics to an appreciable extent. Indian livestock sector witnessed considerable concentration towards dairy and milk production. As the demand for milk and milk products is increasing rapidly, the dairy farming has to be taken up as a commercial enterprise to tap the market opportunities. The data for the study were collected from 60 commercial dairy farms drawn from Jabalpur district of Madhya Pradesh. The data were subjected to tabular and ratio analyses. It was observed in the analysis that the capital investment on commercial dairy farms was intensive with the average investment per farm ranged from ₹ 70.77 lakhs on small farms to 5.57 crores on large farms. The absolute investment per farm increased with herd size, whereas the investment per SAU decreased as the herd size increased. Around 58% of the commercial dairy farms were making total investment up to ₹ 1.5 crores. The cost of maintenance of a milch animal was found to be ₹ 226.85, ₹ 220.15 and ₹ 197.90 on small, medium and large categories of commercial dairy farms, respectively. The profitability of commercial dairy farms was found considerably high earning ₹ 6.82. lakhs, ₹ 20.02 lakhs and ₹ 41.40 lakhs of net returns per farm per annum on small, medium and large farms, respectively. While the net returns per day were increasing with increase of herd size, the net returns per milch animal per day were reducing with the increase of herd size. The cost of milk production on commercial dairy farms was estimated to be ₹ 32.78 per litre on an average. The financial performance of commercial dairy farms was favourable as the liquidity, solvency and efficiency ratios were three times better than standard values. The capital turnover on commercial dairy farms was little more than one revealing recovery of capital investment only once in a year and also an indication of capital intensive nature. All the ratios were more favourable on small farms as compared to medium and large farms. The actual milk productivity realised and average herd size kept by all farms, were higher than the break-even point milk production per animal and herd size, respectively. The break even herd size was found 48, 173 and 430 milch animals on small, medium and large farms, respectively.

It was inferred that though the commercial dairy farms were capital intensive but promise higher returns to owner/investor and have favourable financial performance. The profitability of the farms could be further improved by attaining higher milk productivity. The commercial dairy farms experienced economies of scale as the costs per animal or litre of milk decreased with the increase of herd size or milk production. The important package of practices observed on the farms were replacement of animals and feeding high concentrates to maintain productivity. Concentrates represented more than 50% of the total costs on farms and the replacement cost ranged between 7 to 11%.

Performance and Impact of Dairy Co-operatives in Kashmir Region

The study was carried out to evaluate the performance and impact of dairy cooperatives in Kashmir region. The study was based on secondary data collected from J&K Milk Producers Cooperative Limited and primary data collected from sample households in Pulwama, the top milk producing district in the region. The results indicated that the physical and the financial performance of most of the dairy cooperative societies (DCS) was far from satisfactory, primarily due to poor membership and low level of milk procurement. Out of 344 DCS analysed in the study, only a handful of 15 DCS had registered moderate to good level of performance.

The important determinants of market participation in cooperatives were procurement prices and location of the milk collection centres. The farmers in the region prefer door-step collection of milk rather than reaching out to the milk collection centres. The younger farmers and those who are socially more active, preferred cooperatives to alternate milk marketing channels.

The cooperatives did not have any significant impact on the productivity of milch animals in the region as no input or extension support services were provided to its members. The net income from milk production was higher on households participating in cooperative market channel due to higher procurement prices paid by the co-operatives.

From the long-run perspective, payment of higher procurement prices would not be a sustainable proposition for the DCS unless the level of milk procurement increases. In order to enhance the procurement, several steps are required such as aggressive membership expansion, installing bulk milk coolers to facilitate milk collection twice a day, and above all, targeting on raising the productivity of milch animals through provisioning of input support services to the cooperative members.

Economic Analysis of Traditional Milk Marketing Chain in Karnal District of Haryana

Cost per litre of milk for milch buffalo was worked out to be ₹ 27.07, ₹ 27.16 and ₹ 28.77 for small, medium and large herd size categories, respectively, with an overall average of ₹ 27.50 per litre. Net return per litre of milk was found to be ₹ 1.32, ₹ 1.50, ₹ 1.20 across respective categories of households with an overall average of ₹ 1.43. Cost per litre of milk for milch crossbred cow was worked out to be ₹ 23.12, ₹ 22.93 and ₹ 24.30 for small, medium and large herd size categories respectively, with an overall average of ₹ 23.35 per litre. Net return per litre was found to be ₹ 0.53, ₹ 0.92 and ₹ 0.45 across respective categories, with an overall average of ₹ 0.73.

Marketed surplus as percentage of milk production of the households was 67.98, 70.02 and 71.21 percent for small, medium and large herd size category of households, respectively. The percentage of marketed surplus to the household production increased with increase in herd size category. The household in the study area had preference to informal sector to dispose off their milk. The disposal pattern of milk showed that about 92% marketed surplus disposed off through traditional marketing chain consisting of milk vendors, creameries/private dairies and contractors, while only about 8% by modern milk marketing chain comprising of milk cooperative societies.

The channels were taken in to consideration for comparison where at least one agency was involved in the process of milk marketing. Producer's share in consumer's rupee was highest as well as price spread was lowest in case of Channel-II. Marketing efficiency worked out by using Acharya's modified method showed that Channel-II was more efficient than Channel-III and IV. As an overall comparison of margins received by different intermediaries and producers, the producer's margins were observed lower, i.e., for buffalo milk ₹ 1.43/litre and for crossbred cow milk ₹ 0.73/litre than the intermediaries involved in the chain viz., Vendor-A (₹ 7.45/litre), Vendor-B (₹ 3.26/litre), Creameries (₹ 5.16/litre) and Contractors (₹ 3.56/litre), respectively.

Channel-I: Producer-Consumer; Channel-II: Producer-Creameries-Consumer; Channel-III: Producer-Milk Vendor-Consumer; Channel-IV: Producer-Milk Vendor-Contractor-Consumer

A Study on Consumption Pattern and Consumer Preferences for Fermented Functional Dairy Foods in Metropolitan Maharashtra

The present study was conducted in Maharashtra State as information available for functional dairy foods was very scanty. Total 120 respondents were selected for analysis of consumption pattern from Mumbai and Pune. The purchase locations for functional dairy foods were selected randomly and from those purchase locations respondents were selected as 70 from supermarket, 30 from Amul parlour and 20 from retail dairy products stores, respectively. Out of total, 83% of respondents knew the concept of functional dairy foods. About 68.42% of consumers were interested to know about the functional dairy foods. More than 76% consumers of functional dairy foods were consuming functional foods from less than one year. In all income groups, highest consumption expenditure was on probiotic drinks while lowest consumption expenditure on probiotic lassi. On an average, each household consumes Yakult about 0.77 kg/month while fortified dahi was consumed about 0.36 kg/month. Low fat dahi consumption in each household was found to be 0.32 kg/month. About 51% of consumers would like to consume conventional dairy foods on daily basis while functional dairy foods were like to consume on monthly basis. Supermarket was the highest preferred purchase location for both conventional as well as functional dairy foods. The income of household and dietary pattern has the significant

effect on consumption expenditure of functional dairy foods. Among the probiotic drinks Yakult was the most preferred brand while Mother Dairy b-active probiotic dahi was most preferred among the probiotic dahi. Danone low fat dahi was the most preferred brand among the low fat dahi categories.

Consumption Pattern of Milk and Milk Products in Lucknow City (Uttar Pradesh)

The study revealed that liquid milk was consumed by all sample households 90.83%, 80.83% and 77.50% of sample households consume desi ghee, paneer and sweets and other products, respectively. Households consuming butter, milk powder as a tea whitener and baby food, khoa and curd were found to be 67.50%, 41.67%, 41.67%, 26.67%, respectively. The average per capita monthly expenditure in different occupation groups was ₹ 4447.37 and out of this total expenditure 44.03% was spent on food items including milk and milk products and 55.97 per cent of total expenditure was spent on non food items. The consumption pattern of milk and milk products among different occupational groups revealed that professional class consume higher quantity of milk and milk products (₹ 1106.07) followed by government service class (₹ 530.23), business and retailers class (₹ 408.18) and semi-skilled labour class (₹ 277.95). It was also observed that percentage share of expenditure on milk and milk products increased (from 10.14% to 17.34%) with the increase in level of income. Among the individual milk and milk products, expenditure on liquid milk was the highest (4.28%) followed by sweets (3.17%), paneer (1.61%) desi ghee (1.60%), khoa (1.00%), milk powder (0.93%), curd (0.54%) and butter (0.25%). Consumption pattern of milk and milk products increased with increase in family budget. Further the per capita monthly expenditure on milk and milk products was found to be ₹ 700.27 in non vegetarian class and ₹ 600.49 in vegetarian class. Surprisingly, percentage of total expenditure on fluid milk was found to be of higher magnitude in non vegetarian households than vegetarian households. In this study, expenditure elasticity were found to be more than unity in case of milk powder (1.84), curd (1.72), desi ghee (1.12), butter (1.75), paneer (1.55), khoa, sweets and other products (1.09), restaurant and refreshment (1.29), total non-food items (1.22) reflecting that these items were relatively expenditure elastic. The expenditure elasticity of liquid milk (0.46), cereal and their substitute (0.27), pulses and their products (0.48), sugar and jaggery (0.37), edible oils and fats (0.29), fish meat and egg (0.47), fruits and vegetables (0.79), spices (0.65), total food including milk and milk products (0.79) was observed to be less than unity signifying that these items were necessary for sample households, i.e., essential commodities and indicating the proportionate expenditure decreases with rise in total expenditure. Income elasticity were found to be more than unity in case of milk powder (1.49), curd (1.54), butter (1.72) and paneer (1.25) reflecting that these items were relatively income elastic. This implied that an increase in income would lead to greater changes in the consumption of milk powder, curd, butter, paneer. The consumption of milk and milk products are greatly influenced by expenditure on other items of consumption as well as socio-economic status of the households. To look into the effect of these factors, consumption function was fitted by using stepwise regression procedure and it was found that monthly income of the household (MINC), per capita monthly expenditure on fruits and vegetables (FVEG), and per capita monthly expenditure on sugar (SUG) positively and significantly affect the per capita expenditure on milk and milk products. In case of vegetarian group household per capita expenditure on milk and milk products was significantly affected by per capita expenditure on fruits and vegetables (FVEG) per capita expenditure on non food items (NFOOD) and monthly income of the household (MINC). The results for non vegetarian group showed that an increase in the monthly income of the household (MINC) as well as per capita expenditure on fruits and vegetables (FVEG) significantly increased the per capita expenditure milk and milk products.

Economic Analysis of Bovine Marketing in Organised Cattle Fairs of Rajasthan

The present study was undertaken through a detailed study of existing organisational and functional structures, channels operating for transaction of different livestock species along with associated costs and marketing efficiency in each channel, factors affecting prices of different animals and most importantly, the constraints faced by different marketing functionaries. Out of 10 cattle fairs, 4 cattle fairs, viz., Ramdev, Veer Tejaji, Jaswant and Puskar were selected on the basis of maximum average bovine transaction during 2000-01 to 2009-10. A sample of 30 sellers and 30 buyers from each cattle fair were selected randomly for primary data collection. Tabular and statistical analysis formed the basis of analytical framework. Cattle fairs of Rajasthan were controlled by Department of Animal Husbandry, Govt. of Rajasthan. Sellers, buyers and traders were the major marketing functionaries and brokers were

banned. Arrival of cattle, buffalo and total animals declined with a Compound Annual Growth Rate (CAGR) of -1.51, -1.62 and -1.94%, respectively over 1996-97 to 2010-11. However, income and expenditure during same period grew at a CAGR of 4.93 and 4.04 per cent, respectively. There was ban on male cattle below 3 years age from going to other states which discouraged its purchase by outside buyers. Out of total bovine transacted by sample sellers and buyers, bullocks accounted for major share (30.80%) followed by milch cow (17.68%), cattle young stock (12.58%), buffalo bull (12.17%) and milch buffalo (10.88%), respectively. Further, bovine sellers were relatively more inequitably distributed than bovine buyers. Six marketing channels, viz., i) Farmer-Farmer, ii) Farmer-Local Trader-Farmer, iii) Farmer-Local Trader, iv) Farmer-Distant Trader-Farmer, v) Farmer-Distant Trader and vi) Farmer-Local Trader-Distant Trader existed for marketing of different kinds of bovine. The most efficient channel was Farmer-Farmer for all bovine categories as producer's share in consumer's rupee was highest in it. Age, general appearance, breed where significant factors that influenced prices of bullocks. In case of lactating cows, milk yield, breed and general appearance whereas in case of dry cows, general appearance, mammary system and breed were the major factors that effected price. Further, breed, milk yield and general appearance for lactating buffaloes and general appearance, mammary system and breed for dry buffaloes were major factors that influenced prices. Immediate cash requirement and scarcity of feeds and fodder were the major reasons for sale of different types of bovine. Rearing for milk purpose was the main reason for purchasing milch animals whereas, use in agricultural operations and transportations were main reasons for purchasing cattle bullocks and buffalo bulls. For sellers, inadequate infrastructure as well as feeds and fodder at fairs and delay in *Rawanna* date were major constraints. Development of infrastructure, permission to buyers to leave after transaction, withdrawal of ban imposed on male cattle below 3 years age for taking to other states, improving market information services and supply of technological inputs in adequate quantity are suggested to improve the performance of cattle fairs of Rajasthan.

Dairy Extension

Study of Milk Production Innovation System: A NDRI Perspective

The major actors of local milk production innovation system identified at Karnal, Kalyani and Bangalore were NDRI, Vendors, Dairy Farmers, Panchayat Presidents, Stockmen, Veterinary Officers and Input Dealers. Information need analysis showed while farmers in Karnal ranked 'Suitable CB dairy animals to their region' (80.00%), 'selection of milch animal' (86.67%) and 'high yielding breeds of cattle' (78.89%) in Bangalore and Kalyani, respectively got the highest rank. Similarly, 'vaccination schedule' (77.78%) in Karnal, 'knowledge and diagnosis of common diseases' (90.00%) in Bangalore and 'knowledge and diagnosis of common diseases' (72.22%) in Kalyani got the highest rank in health care domain. 'Round the year fodder production' (80.00%) in Karnal, 'conservation of green fodder' (84.44%) in Bangalore and 'variety of fodder crops' (96.67%) got the highest rank in Kalyani.

Utilization Pattern of Information Communication Technology (ICT) by Dairy Farmers: A Comparative Study in Plain and Hilly Regions of Uttarakhand

Agriculture was the primary and dairying was the secondary enterprise for majority of respondents both in plain and hilly regions in the study area. Availability of ICTs calculated using Digital Opportunity Index (DOI), was low (0.12) in Uttarakhand. Mobile was the most widely used ICT, owned by almost 98 percent respondents. In plain region, more than one-third respondents used mobile phone for calling KCC (Kisan Call Centre) while in hilly regions none of the respondent was found to use KCC. Inadequate availability of infrastructure, lack of power, electricity failure or frequent and long hours power cut, high cost of ICTs and lack of time and interest to use ICTs were the major constraints faced by the farmers in both regions.

Job Performance and Job Satisfaction of Veterinary Surgeons in Haryana

Majority of Veterinary Surgeons (VS) were male, belonged to young age group (upto 35 years), had short service experience (<8 years) and medium span of control. Majority of respondents had medium level of job performance and moderate response to job satisfaction level. Age, service experience, training received, source of information utilization, and job involvement had positive and significant relationship with job performance and job satisfaction. Distance of posting, span of control and job stress had significant negative relationship. Lack of transport facilities for VSs for field visit, arbitrary target fixation for

AI (Artificial Insemination) by the DAH&D, non-consideration of ideas and suggestions of the VSs, poor research-extension linkage in the DAH&D, misadvise of farmers by quacks were the major constraints experienced by veterinary surgeons in performing their duties.

Impact of Trainings organized by Krishi Vigyan Kendra on Dairy Farming in Satna District of Madhya Pradesh

Trainees have slightly more knowledge in breeding and feeding (48.33%), management practices (43.33%) and health care (40%) as compared to non-trainees. High cost of commercial feed and low price of milk, inadequate availability of land for green fodder cultivation and repeat breeding problem were the serious constraints faced by dairy farmers in effective use of trainings conducted by KVKs in the study area. Non-availability of funds in time, large operational area, domination of privileged section of society were major constraints faced by trainers in training. It was concluded that training had increased overall knowledge of trainee about improved dairy farming practices.

Buffalo Husbandry Practices among Dairy Farmers in Unnao District of Uttar Pradesh

Crop farming was the primary enterprise for majority of respondents (50.00%) in the study area. The study explored that average milk yield was, 5.36±1.2 litre/day/buffalo; lactation length, 293.5±27.1 days/buffalo, lactation milk yield, 1636.4±189 litres/buffalo; peak yield, 8.1±1.9 ltire/buffalo; dry period, 156.4±39.6 days/buffalo; age at first calving, 1482±162 days/buffalo; service period, 142±26 days/buffalo; service per conception, 2.57±0.45 times/buffalo; and calving interval, 450.2±35.1 days/buffalo found in the study area. The study further explored that mass media exposure, personal localite, personal cosmopolite channel, land holding, herd size, milk consumption, milk sale and overall knowledge were found highly significant and positively correlated with the adoption of buffalo husbandry practices. High cost of treatment, unavailability of timely vaccination facilities, poor affordability of supplement feed/mineral mixture and inadequate knowledge to detect heat signs in buffaloes were the major constraints faced by the farmers in the study area.

Sustainability of *Gangatiri* Breed in Eastern Uttar Pradesh

Rearing *Gangatiri* cattle contributed 56.73% to overall annual income of farmers. The result showed that most of respondents (53.70%) practised grazing of cattle for 6-10 hrs. FMD, bloat and mastitis were most frequently occurring diseases. Majority of respondents did vaccination only during government programme. The cattle rearing of respondents was measured as composite sustainability index (CSI), which ranged from 0 to 1, and most of respondents (67.59%) had medium CSI score ranging from 0.3 to 0.6. Suggesting that cattle rearing had lineage toward sustainability. Sustainability of *Gangatiri* cattle rearing was positively and significantly associated with education status, herd status, operational herd holding, milk production and extension contact. Farmers perceived that *Gangatiri* is suitable to rear under local climatic condition and can be maintained easily with locally available resources.

Livestock-rearing Practices among Dhangar Nomadic Tribe of Maharashtra

Livestock rearing was the main occupation of the majority (62.50%) of the respondents. Dhangars reared mainly two breeds of sheep (Deccani and Madgyal), two breeds of goat (Osmanabadi and Sangamneri), one breed of cattle (Red Kandhari) and two breed of buffalo (Nagpuri and Pandhapuri). Majority of the (80.80%) of the respondents reported that grazing was the main source of feed and fodder for their livestock. Majority (65%) of the dhangars treated their small animals at their own home by using locally available ethno-veterinary practices whereas for large ruminants they took their animals to nearest veterinary hospital or call veterinary personnel. Scarcity of fodder and water and incidences of different diseases were the major constraints perceived by the Dhangars.

Impact of Kisan Call Centre on Technological Adoption among Dairy Farmers of Tamil Nadu

Kisan Call Centre beneficiaries had better educational status, operational land holding, milk production, annual income and information utilization as compared to non-beneficiaries. About 64.67% of the respondents contacted KCC level – II to obtain information on improved dairy farming practices. Around 63.00% of the beneficiaries expressed their medium level of gratification towards KCC for minimizing their time and cost. The results depicted that feeding, management and fodder production were found to have greater extent of adoption among the beneficiaries as compared to non-beneficiaries who adopted more on the aspects of breeding and health care practices. The overall extent of adoption was found significantly higher for beneficiaries than

non-beneficiaries. About 47.00% of the beneficiary dairy farmers had favorable attitude towards KCC agro advisory services. Major constraint expressed by 90.89% of the beneficiary respondents was inaccessibility of KCC's toll free number 1800-180-1551 from mobile and one rupee coin booth. The major constraint of 96.67% of the level - I KCC officials was difficulty in providing answers on specific areas of dairying.

Vulnerability and Adaptation Strategies on Climate Change Among Livestock-rearers in Coastal and Alpine Regions of India

The study revealed that 91.87 and 81.67% of livestock rearers of coastal and alpine, respectively, were aware of changing climatic scenario. Further, Pudukkottai district of Tamil Nadu was most vulnerable whereas East Godavari district of Andhra Pradesh was the least vulnerable among eastern coastal districts. Vulnerability value of each household of coastal region were having negative value whereas 99.17% the households of alpine region were having positive score. It was also found that 37.75% of livestock rearers of coastal region were in higher level of adoption category whereas 35.13% of livestock rearers of alpine region were in both lower and higher level category.

Preference and Perception of Stakeholders towards Health Foods

Majority of the respondents choose different dairy-based health food products as part of regular diet. "Nutrient contents" of the health foods was the most important factor influencing preference of health foods followed by "health of respondents", "availability" and "prices" of health food products. Majority (55%) of the consumers had low level of perception regarding health foods; however, in the cases of doctors and producers, 75 and 50%, respectively, were having high level of perception about health foods. 63.33% of stakeholders opined about flavoured milk either extremely good or slightly good. 67.78% perceived yogurt taste either extremely good or slightly good. The study revealed that traits like age, education, income, dietary habit, mass media exposure, consumption of health foods, purchasing of health foods, information and knowledge about health foods, nutritional information about health foods and family health status were positively and significantly correlated with the perception of consumers as well as doctors at one percent level of significance. Among the constraints, availability was found the major constraint for not buying such health foods.

Southern Regional Station, Bangalore

Evaluation and Improvement of Indigenous Cattle of Malnad Region of Karnataka

The Malnad Gidda are unique dwarf cattle distributed predominantly in Malnad and adjacent coastal districts of Karnataka. Green leaves are spread everyday as bedding material over the dung and urine and cleared once in one to two months. The birth weight of calves was 7.91 ± 0.58kg. The average lactation milk yield, daily milk yield, peak yield and inter-calving period among the elite cows under field condition was 522.33 ± 69.40 liters, 2.17 ± 0.29 liters, 3.42 ± 0.39 liters and 14.91 ± 0.93 months, respectively. They have the reproductive uniqueness of regular calving (inter calving period of 396 ± 33 days) under low input regime. *Nagi* – the wonder cow has already given birth to 20 calves in 25 years. Malnad Gidda cattle with pale brown animal are known as *Kapile/Kapila* and considered as sacred. The Total Lymphocyte Count and the hemoglobin content in Malnad Gidda was 8729.17 ± 208.93 TLC/ul and 10.36 ± 0.32 g/dl, respectively.

Nagi - wonder cow gave 20 calves in 25 years

Elite Malnad Gidda cow with calf

The SRS of NDRI has introduced bull exchange programme to avoid inbreeding and selected elite males based on mother's milk yield for semen collection and propagation. The lactoferrin content as estimated by Sandwich ELISA in Malnad Gidda cattle milk was found to be higher than other cattle and buffalo breeds of the region. Genotyping in bovine beta-casein gene showed the frequency of A_1 allele in Malnad Gidda, Deoni, Holstein Friesian males and Graded HF cattle was 0.014, 0.00, 0.143, and 0.30, respectively. Our study revealed a high degree of genetic variation in GHR, GnRHR, IGF1 and IGFBP-3 genes among Malnad Gidda, Holstein Friesian, Jersey, and Deoni cattle.

Evaluation of Commercial Semen Station

Nine commercial semen stations located in different parts of the Southern India maintaining 627 breeding bulls in 21 sheds were evaluated. The orientation of bull sheds in all semen stations was East-West. Individual pens were provided to all the bulls, however, bulls in seven sheds were tethered round the clock without any access to loafing/open area. The average floor space (Mean ± SE) per bull in a covered area and open area was 12.04±1.83 m^2 and 16.45±1.55 m^2, respectively. The roof height at eave and ridge was 3.49±0.17 m and 5.35±0.32 m, respectively. The average length, width, and depth of feeding manger was 2.07±0.18 m, 0.67±0.04 m, 0.29±0.01 m, respectively. Mostly bull sheds had asbestos sheets (85.71%) as a roofing material followed by aluminium sheets (9.52%) and tiles (4.76%). On an average the quantity of green fodder, straw/ hay, concentrate, and mineral mixture fed was 29.55±2.23 kg, 3.44±0.29 kg, 4.58±0.38 kg and 54.25±8.9 gm, respectively. Most of the semen stations adopted combination of one or the other micro-climate modification strategies *viz*., cross ventilation, fans, fans with sprinklers, fans with foggers, fans with gunny bag curtains, exhaust fans and reflective roof coating, etc.

Development of Protocol to Formulate Designer Concentrate Supplement

In vitro gas production (IVGP) on 34 concentrate feedstuffs, 3 roughages, 12 concentrate supplements (CS), 4 complete roughage based diets were measured. IVGP at different time intervals was subjected to first order kinetic model with one rate constant to derive fermentation kinetics (IVFK). Heterogenous feedstuffs having similar IVFK were made into homogenous groups. Feedstuffs were drawn from 6 homogenous groups to formulate CS. No change in the IVFK of CS was observed due to associative effect of different feedstuffs. Synergistic effect of CS (SCS) improved when feedstuffs were selected on the basis of IVFK. Digestible CP, NDF and cellulose intakes (g/kg $W^{0.75}$) were improved because of 15 % increase in MBP ($P < 0.01$) and milk production was improved 1 to 5 % ($P = 0.17$). Apparent improvement in total solids (TS) and solids-non-fat (SNF) was observed due to SCS. Project was concluded with following findings:

- IVGP of grains = agro-industrial-co-products ≥ oilseed meals.
- Based on fermentation rate heterogenous feedstuffs were grouped to homogenous sets.
- IVFK of different feedstuffs was remained unaltered in the CS.
- Digestible nutrient intake of NDF was improved.
- Microbial protein production (MPP) improved by about 15 % (overall mean increase 13 to 17 %) compared to pellet feeds.
- Characteristic difference in IVFK was observed between grain and OSM + AICP on MPP.
- No definite trend in milk yield was observed, however, improvement in SNF % was observed.

Role of Non-genetic Factors Affecting Subclinical Mastitis

Sub clinical mastitis (SCM), a major and silent threat causes high economic losses to the dairy farmers. The occurrence of SCM depends on various genetic and non genetic factors including housing, parity, season, *etc*. Under the present study conducted on 1005 HF graded/crossbred animals maintained at farmers' field at Kolar district of Karnataka, SCM was recorded highest as 14.19% in animals managed at sheds with indigenous tiles on the roof and flooring made up of stone slab followed by animals under asbestos roof with concrete floor as 8.47%. SCM was found to be lowest as 3.17% of cows in shed with tile roof in combination with kutchha floor which indicated that the occurrence of subclinical mastitis in ordinary housing was controlled by sufficient hygiene practices by small or marginal farmers. It was observed that the incidence of SCM was highest in fourth parity (25.75%) followed by second (25.15%) and third parity (23.95%), respectively. Season being one of the important non genetic factors influenced the occurrence of SCM. In the present study, it was observed that the

highest incidence of SCM was recorded in summer season (52.33%) followed by winter (38.37%) and rainy seasons (9.88%), probably the organisms causing mastitis were present at above threshold level with less availability of fodder in comparison to winter and rainy season.

Reproductive Performance of Deoni Cattle under Organized Farm Management

Deoni is a medium sized, dual purpose indigenous cattle of Maharastra, Karnataka and Andhra Pradesh. Considering the important role of indigenous cattle and their rearing by small holder dairy producers, the conservation and improvement of the Deoni germpalsm is of most importance. Studies on reproductive performance of these animals are scanty under organized farm sector. Therefore, the present investigation on reproductive performance based on the pedigree records of Deoni cattle of NDRI-SRS herd was carried on for the period of 2002 to 2012. Results of the analysis revealed that the overall mean±SE for age at first service (AFS in days), age at first calving (AFC in days), services per conception (SPC in number), breeding interval or first to successful service (FTSS/BI in days) and gestation length (in days) was 994.50±16.84, 1324.32±19.38, 2.33, 95.58 and 280.91, respectively in Deoni heifers. Similarly, in parous Deoni cows, the mean values for calving interval or intercalving period (in days), services per conception (SPC in number), calving to first service/voluntary waiting period (CTFS/VWP in days), breeding interval or first to successful service (FTSS/BI in days), service period (SP in days) and gestation length (in days) were observed as 434±4.7, 2.7, 86±1.6, 71±4.0, 148±3.7 and 282±0.4, respectively. There is a need to reduce days to AFC and CI and there is further scope to augment reproductive performance in Deoni cattle through better nutritional and reproductive management interventions.

Induction of Estrus and Fertility Augmentation

There is a need to explore various strategies to induce puberty and reduce age at first calving in Deoni animals. Hence, a study was conducted on 20 prepubertal Deoni heifers of 2.4 to 3.6 years old (28 to 42 months) maintained at Cattle Yard, SRS to evaluate the effect of supplemental feeding with CO-Synch and CIDR protocol on induction of estrum and subsequent fertility. In group I, a total of 10 heifers were tied individually for stall feeding along with nutritional supplementation. In group II (untreated control), 10 heifers were maintained as such in loose housing system and they had free access to feed and water under routine farm management. Heifers in group I, were administered deworming drug prior to start of supplemental feeding and deticking/ deworming drug a week before synchronization programme. On day 0, each heifer in treatment group was administered GnRH (Receptol®) injection i/m @ 2.5 ml/heifer and was inserted with CIDR (EAZIBREED CIDR® 1380). On day 7 PGF_2a *(Cloprostenol-Vetmate®)* injection was administered i/m @ 2 ml/heifer followed by CIDR removal on day 8. Fixed time AI (FTAI) was performed at 48 and 72 hours after $PGF_2\alpha$ injection, with GnRH injection i/m @ 2.5 ml/heifer at 72 hours. None of the heifers in control group showed heat signs and no AI was done. Pregnancy was confirmed in inseminated heifers on day 30 post insemination using progesterone based assay kit (HeatAid®) and ultrasonography. Out of 10 heifers, 8 were found pregnant with a synchronized pregnancy rate of 80%.

Association of ATP1A1 Gene Polymorphism with Thermo-Tolerance and Production Performance in Deoni Cattle

ATP1A1 gene is a candidate gene for heat shock response which is sensitive to oxidative stress. The genetic characterization of ATP1A1gene in entire coding region was carried out in Deoni breed of cattle using PCR-SSCP analysis. The association of identified polymorphism/s with thermo-tolerance, productive and reproductive performances was investigated and analyzed using GLM procedure of SAS software. Based on the differences in the SSCP patterns, allelic variants were identified and corresponding PCR products were custom sequenced. Sixteen SNPs were identified in ATP1A1 gene of Deoni cattle, out of which eleven SNPs were in the non-coding region and five identified SNPs were in the coding region. Statistical analysis revealed that TT genotype at loci C3076T in fragment 3 comprising exon 3, with a frequency of 82.5% had higher lactation length and lactation yield compared to other genotypes in Deoni cattle. The Heat Tolerance Coefficient (HTC) was calculated from recorded rectal temperature using Rhoads formula and used in analysis. Deoni cows having CT genotype at position 4291, TT genotype at position 4394 and 4472 and AA genotype at position 4649 showed positive association with lactation length and lactation yield. The genotype AA at position 15739 showed a negative association with lactation length, whereas the observed SNP positively affected the age at first calving. The significant association was observed between the SSCP pattern of ATP1A1 gene with

physiological parameters which indicated that ATP1A1 gene could be used as a candidate gene for developing markers for thermo-tolerance.

Molecular Characterization of Argininosuccinate Synthetase Gene in Holstein Friesian and Jersey Males

Citrullinemia is (recessive autosomal) an inborn error of urea metabolism due to deficiency of the urea cycle enzyme, Argininosuccinate Synthetase (ASS). Affected calves display severe neurological dysfunction and death within one week as a result of a deficiency of the enzyme Argininosuccinate Synthetase. The disease is caused by a cytosine to thymine transition at codon 86 from exon 5 of the *ASS* gene that can be amplified by PCR and verified by digesting the resulting amplicon with *Ava* II. In the present investigation, PCR-RFLP and PCR-SSCP analyses were carried out in Holstein Friesian and Jersey males to screen for the presence of mutant allele of citrullinemia in the population and to characterize Argininosuccinate synthetase (ASS) gene. Genomic DNA from 131 Indian Holstein and 78 Jersey bulls was extracted from blood using high salt method. No carriers of citrullinemia were detected in the study. The genetic variants in all 15 exons of ASS gene were determined by PCR-SSCP analysis. Based on the differences in the SSCP patterns, allelic variants were selected and corresponding PCR products were sequenced to confirm polymorphisms. The analysis of Exon 2 in HF revealed AG transition at position 7947 of ASS gene. The observed polymorphism (AG) at position 7947 resulted in substitution of an amino acid from Isoleucine to Valine. The detected polymorphisms in exon 3 and 4 in Jersey cattle, exons 7 and 15 in HF cattle and exon 10 in both HF and Jersey cattle resulted in silent mutations.

Identification of Single Nucleotide Polymorphisms (SNPS) in TLR2 Gene and its Association with Somatic Cell Score in Milk of Holstein Friesian Crossbred Cattle

The present study was carried out to investigate genetic polymorphism of *TLR2* gene exon 1 and exon 2 in 214 Holstein Friesian crossbred cows. Molecular characterization of *TLR2* gene was carried out by PCR- SSCP analysis. Exon 1 was amplified as a whole fragment while exon 2 of *TLR2* gene was amplified in overlapping fragments covering the whole exon 2 and then SSCP analysis was carried out. It was found that the presence of six SNPs *viz*., *A827G* (exon 2.2), *C1088G* (exon 2.3), *C2155A* (exon 2.5), *G2281C* (exon 2.5), *G2410A* (exon 2.6) and *C2600T* (exon 2.6) in exon 2 of *TLR2* gene., SNPs *G2410A* and *C2600T* were found to be significantly associated ($p< 0.1$) with somatic cell score (SCS). In this investigation, a change of genotype GG (LSM for SCS 3.089 ± 0.197) to AA (LSM for SCS 3.375 ± 0.176) resulted due to presence of SNP *G2410A*, in the studied HF crossbred animals. This SNP was associated with an increased number of somatic cells in milk and thus, susceptible to mastitis infection. On the contrary, animals with genotype GG were more resistant to mastitis and genotype AG was highly susceptible. Similarly for SNP *C2600T*, when a fixed model for least squares analysis was used including all the genetic effects together, it was found that the genotype CC (LSM 3.089 ± 0.197) showed moderately significant lower SCS ($p< 0.10$) than the genotype TT (LSM 3.375 ± 0.176).

Estimation of Genetic Merit of First Lactation Milk Yield in Deoni Cattle Incorporating Genotype Information

The study was conducted in 108 Deoni cattle maintained at Cattle Yard, Southern Regional Station of National Dairy Research Institute, Bangalore to predict the genetic merit of first lactation milk yield (FLMY) conventional animal breeding and modern molecular techniques. Genetic merit *i.e.* breeding value of first lactation milk yield was computed by least squares technique and incorporating genotype information of Cytochrome P450-11-beta hydroxylase-1 (CYP11B1) and Peroxysome Proliferator Activating Receptor Gamma Co-activator-1-alpha (PPARGC1A). Least squares means (LSM) of FLMY incorporating genotype information was 549.98 ± 46.05 kg with 79.73% coefficient of variation (CV). LSM of FLMY without incorporating genotype information was estimated at 518.33 ± 39.51 kg with 79.59%. The estimated LSM excluding genotype information was close to its true phenotypic mean of FLMY i.e. 516.11 ± 40.30 kg. On comparison no significant difference of Coefficient of determinants (R^2-value) and Pearson correlation coefficient with true phenotype value was observed in the models incorporating and without incorporating genotype information which was 95.11 and 94.69% and 0.975 and 0.973, respectively. Akakike Information Criterion (AIC) and Spearman correlation coefficient with the true phenotypic value of the model incorporating genotype were 830.16 and 0.728. Whereas, those values for the model without incorporating genotype information were 1001.70 and 0.680, respectively. Lower AIC and higher r_s^2 value indicated that the model with genotype information was more precise than the model excluding genotype information.

Associative Effect of Carbohydrate and Protein from Agro-Industrial Co-products on Rumen Microbial Protein and Milk Production in Deoni Cows

Study evaluated advantage of crude protein (CP) and carbohydrates (CHO) in agri-industrial-co-products (ACPs) on microbial protein (MBP), milk yield (MY) and milk composition. Significant difference in proximate and cell wall composition (P<0.01) of wheat (WB) and deoiled rice brans; green gram (GGC) and hyacinth bean chunis (HBC); bengal gram (BGH), hyacinth bean, pigeon pea and soy husks (SH); and, almond and groundnut shells was observed. Biological value was evaluated using *in vitro* gas production (IVGP) kinetics. Twenty Deoni cows were supplemented by sorghum grain (CG), WB (T1), SH (T2), HBC (T3) and 50%GGC+50%BGH (T4). Supplements (CS) were fortified with 3% mineral mixture, 2% salt and made isonitrogen by 1 to 3% urea. Nutrient intake from CS were different (P<0.01) but, straw intake was comparable. Total (P<0.01) and digestible CP (P<0.01), ether extract (EE; P<0.01) and acid detergent fiber (P<0.05) intakes differed significantly. MBP (gN/d) was more on CG (225) than T1 (69), T2 (40), T3 (54) and T4 (180). 4% Fat corrected MY in corresponding Gps was 3.47, 3.85, 2.78, 3.90 and 3.90 kg/d (P = 0.72). Coefficient of variation (CV) was higher in CG (16 %) than TGs (1 to 9%). Milk fat was 3.65, 4.05, 4.0, 3.7 and 4.17%, respectively in CG, T1, T2, T3 and T4 (P=0.56). Efficiency of milk production was comparable between groups. Study revealed that MBP production and efficiency were lesser on ACPs than grain but, MY, composition and efficiency were comparable. ACPs supplementation reduced CV in MY and apparently improved milk fat.

Synthesis of Protein Hydrolysates from Dairy and Fish By-product as Anabolic Diet Supplements to Growing Calves

The study was undertaken to conserve fish waste (FW), cheese whey (CW) and RL (RL) to nutritional product and reducing environment contamination. FW was diluted in 1:2 ratio with water, buffer or CW. Protease, trypsin and RL were used for hydrolysis of fish-CW mix. Protein yield and hydrolysis was higher when protease, trypsin and RL concentrations were 2, 3 and 20%, respectively. Protease and RL concentrations of 1.5 to 2.0% and 10 to 20% were optimum based on protein recovery and degree of hydrolysis. Dry matter (DM) content of residue was 13% and hydrolysate was 8 %. Protein content in the powder mix base (PMX) and, protease (PTH) or RL (RLH) hydrolysate was 8 and 18 or 19%, respectively. *In vitro* gas production was 157, 212 and 214 ml/g of PMX, PTH and RLH, respectively. TGP on PTH and RLH with sugar base (60:40) was 136 and 130 ml/ml compared to 282 ml/ml with sugar (100%) syrup. Fermentation rate of PMX (7%) and syrup base (10%) were significantly (P< 0.01) different. The fermentation rate of PTH and RLH powder, and PTH and RLH syrup was 8, 9, 7 and 8%, respectively (P< 0.01). RLH powder had 7% higher DM digestibility (DMD) than PTH powder (72%) however, difference was statistically insignificant. It was inferred that FW and CW in 1:2 ratio with 10 to 20% of RL as catalyst yielded hydrolysate that was comparable to 1.5 to 2% of commercial protease.

Isolation and Identification of Bacteriophages and Evaluation of Starter Culltures for the Phage Resistance

The samples from cheese whey, *paneer* whey and skim milk samples were collected from the Experimental Dairy of the station and tested for the presence of bacteriophages. Number of samples collected for screening: cheese whey: 42, paneer whey: 16 and skim milk: 18 samples. The samples were preprocessed by centrifuging at 3000g for 20 min and stored at 4°C. Two tests were attempted viz., Turbidity test and Double layer plaque assay. For the turbidity test, overnight starter cultures (16 nos) i.e. 9 Antagonistic cultures and 7 Department cultures were used. Paneer whey, cheese whey and skim milk were filtered through 0.45 µ syringe filter (PVDF membrane) and the filtrate was screened with the selected cultures in a 96 well flat bottom plates. The turbidity test was standardized as follows: 150 µl of each culture was added in each well followed by the addition of 1 drop of 1M $CaCl_2$ after that 150 µl of cheese whey, paneer whey and skim milk was then added to the respective wells and the plate was incubated overnight at 37°C. The results showed that there was a clear supernatant in the well for Mozzarella cheese culture with cheese whey and dahi culture with cheese whey and paneer whey. This indicates the possible presence of phages for mozzarella cheese and dahi cultures. The clear supernatant solution was collected and stored at 4^0C for further tests.

Utilization of Lactose Hydrolysed Whey

The project is taken up with the objective of utilizing whey in the preparation of probiotic lassi and buttermilk. During the period under report, probiotic strains of *L. acidophilus* cultures were obtained from the NCDC, NDRI, Karnal. The paneer whey was concentrated to about 20% TS and the lactose in the whey was hydrolysed by

using lactase enzyme. When the concentrated whey was treated with 1% lactase enzyme and incubated at 42^{0}C for 60 min., about 50% lactose hydrolysis could be achieved. Lassi was prepared by partially replacing the milk with the concentrated and lactose hydrolysed whey (TS adjusted to 12%). The concentrated and lactose hydrolysed whey was added to milk at three different conditions, i.e., mixing of fresh concentrated and lactose hydrolysed whey without fermentation to dahi, fermenting the lactose hydrolysed whey and then mixing with dahi, and adding the lactose hydrolysed whey to the milk and then fermenting the mixture. The sensory evaluation of the products revealed that milk can be replaced upto 10% when fermented whey and fermentation of milk and whey mixture were used for lassi preparation, while fresh concentrated and lactose hydrolysed whey could be replaced upto 20% of dahi for the lassi preparation. Use of 20% water and 13% sugar were optimum for production of most desirable lassi with the above combination of the whey and dahi.

Development, Characterization and Evaluation of Edible Films and Coatings for Selected Dairy Products

Paneer was coated with casein, whey protein concentrate and tapioca starch coatings and dried. After coating and drying, the samples were packed in 65µm thick LDPE bags and were stored at 10-12°C up to 15 days. The effect of these biopolymer coatings on the physico-chemical, microbial and sensory characteristics of paneer was determined. Paneer samples coated with edible coatings were taken at 0, 5, 10 and 15 days interval and were analyzed for physico-chemical, microbiological and sensorial changes at defined intervals during storage. There were no significant differences in the fat, protein and ash contents of the different samples during storage. However, there were considerable moisture and weight losses from uncoated paneer during storage. On the other hand, paneer coated with starch and casein stored well and was of similar quality. The overall acceptability of control was 5.8 while it was highest (7.7) in starch-coated paneer. Amongst the edible film-coated samples, whey protein concentrate was least preferred as a coating. Uncoated paneer samples packaged in LDPE pouches became unacceptable after 8 days. The edible film coated paneer remained good for 20 days. Therefore, edible coatings can be recommended for paneer for extension of its shelf life.

Utilisation of Concentrated and Lactose Hydrolysed Whey in the Preparation of Khoa

Investigation was attempted to utilize concentrated and lactose hydrolysed whey in the preparation of *khoa*. The findings showed that addition of 1.0% lactase enzyme to concentrated whey (20%TS) and incubated for 45°C for 120 minutes resulted in 74% lactose hydrolysis. The use of concentrated and lactose hydrolysed whey (CLHW) increased sweetness, softness and granularity of *khoa*. The *khoa* prepared with incorporation of 20% and 30% CLHW showed higher browning compared to that in *khoa* with 10% CLHW and control *khoa*. The rheological studies showed that the hardness, springiness, gumminess and chewiness decreased while cohesiveness increased, with increasing the level of CLHW in khoa. The *khoa* made with incorporation of 10% CLHW was comparable to control *khoa* for all sensory parameters. The sensory and rheological parameters of *khoa* made by incorporation of 10% CLHW with 30% moisture content was comparable to control *khoa* with 35% moisture. The chemical analysis showed that control *khoa* and experimental *khoa* had moisture content of 35.08, 29.9, fat 22.0, 21.7, protein 15.64, 16.45 and lactose 23.46, 24.53 respectively. The addition of CLHW in *khoa* reduced a_w, pH and increased acidity. The experimental and control *khoa* samples packed in three different packaged materials that is LDPE pouches, vegetable parchment paper and Al-foil had a shelf life of three days at 37°C. The total bacterial count of *khoa* packed in all the packaged materials was found to increase during storage period.

Technology of Synbiotic Cheddar Cheese with Enhanced Functionality

An attempt was made to prepare Cheddar cheese with inulin and resistant starch to increase the functionality of cheddar cheese. *Lactobacillus rhamnosus* as probiotic culture at 1 and 2% of curd with different combinations of prebiotics at 2 and 4% of curd were incorporated at salting in Cheddar cheese and ripened for 60 days. pH dropped initially in all cheese and again increased as ripening progressed but the pH drop was maximum in inulin added cheese compared to control and resistant starch added cheese during ripening. Inulin added cheese showed significantly ($p<0.05$) higher rate of increase in FFA and soluble protein content during initial 90 days of ripening and thereafter, the rate of increase slowed down. FFA and soluble protein production in resistant starch added cheese moderately increased during the ripening with increasing levels of incorporation to cheese till 150 days of ripening. Maximum FFA of 7.65 mmol KOH/100 g fat and ripening index of 59.34% were

observed in 4% inulin added cheese till 90 days of ripening and thereafter the maximum FFA of 9.12 mmol KOH/100g fat and ripening index of 71.63% were observed in 4% resistant starch added cheese at 150th day ripening period. Electrophoretic study showed more degradation of α-casein than β-casein during ripening irrespective of types of prebiotic added. Inulin incorporated cheese scored maximum flavour but had inferior crumbly, brittle body and texture than others. Similar pattern was observed in synbiotic Cheddar cheese. More dietary fibre was retained in resistant starch added cheese than inulin added cheese.

Incorporation of Concentrated Whey in the Production of Lassi

The study aimed at optimizing process conditions for the production of lassi by utilizing concentrated cheese and paneer whey. The concentration of whey was restricted to 11.5% TS to match the standards of toned milk which is generally used in the production of dahi which is the base material for lassi production. The study revealed that concentrated whey with 11.5% TS could effectively be blended up to 20% level without significantly affecting the sensory parameters of lassi produced by incorporating 10% sugar. Cheese and paneer whey could be utilized as extenders and thus contributing for economic benefits of cheese and paneer industry. The optimized lassi from cheese whey contained 18.03% TS, 1.68% fat, 2.0% protein, 3.76% lactose and 0.59% ash while the product from paneer whey contained 17.99% TS, 1.7% fat, 1.86% protein, 3.83% lactose and 0.6% ash. The composition of control samples were 17.98% TS, 2.08% fat, 2.22% protein, 3.13% lactose and 0.55% ash. The physio-chemical characteristics of lassi prepared with incorporation of cheese/paneer whey differed significantly in comparison with control samples. The addition of concentrated whey resulted in thinning effect as reflected by consistency, viscosity and index of viscosity values. The syneresis of whey incorporated lassi was observed to be higher than control samples. The shelf life studies indicated that the lassi beverages prepared with the incorporation of whey could be stored for 9 days at 5°C and only for one day at 30°C similar to the control samples.

Process Optimization for the Preparation of Biscuits by Incorporating Oats and Cheese

Oats were incorporated in cheese flavoured biscuits. Rolled oats were incorporated at 25, 35 and 45% of maida in biscuit formulation. Cheddar and processed cheese were tried for flavouring purpose at three levels each, viz. 30, 40 and 50% on flour basis. It was observed from textural study that by oat incorporation the dough hardness reduced. The oat incorporated dough showed the reduced hardness from 25.05 to 21.73 N for 0 to 30%. Sensory evaluation results revealed that the sample containing 25% oat incorporated biscuits scored highest in most of the attributes including overall acceptability. Addition of cheese to the 25% oat incorporated dough showed the reduced hardness and changes in visco-elastic characteristics. While in the biscuit formulation 30% of Cheddar cheese and 40% of processed cheese were optimized based on the sensory analysis. Baking condition of 165°C for 25-27 min was optimized for oat and cheese incorporated biscuits. Storage study showed changes in moisture content which varied from 3.52 to 3.94% and 4.41 to 5.32% Cheddar and processed cheese containing biscuits, respectively. Similarly, FFA contents were 0.104 to 0.190 and 0.082 to 0.169% oleic acid for Cheddar and processed cheese biscuits, respectively. It was seen that hardness of biscuits was decreased by cheese incorporation. The moisture and β-glucan contents were 3.93% and 4.32%; 0.62 and 0.60% for Cheddar cheese and processed cheese added biscuits, respectively. It was concluded that good quality biscuits can be prepared by incorporating rolled oats and Cheddar or processed cheese in biscuit formulation.

Technological Studies on Manufacture of *Khoa Jalebi* using Sugar Substitutes

The study was conducted to develop the sugarless *khoa jalebi* using sugar-free syrups prepared by sugar substitutes. Firstly, the sweetness intensity and quality of sugar substitutes was studied. Minimum detectable concentrations of sucralose, acesulfame-K, aspartame, levulose mixture, sucralose mixture were found to be 12.5-25 ppm, 12.5-25 ppm, 61.5 ppm, 2.8% and 2%, respectively. The maximum acceptable concentrations of aspartame, sucralose and acesulfame-K were found to be 1500 ppm, 800 ppm and 1000 ppm, respectively. There was no effect on quality of sweetness of all the sweeteners up to 30 min of holding at 60°C. It was found that 800 ppm of aspartame, acesulfame-K and sucralose were equivalent in sweetness to 10%, 10% and 18-20% sugar solutions, respectively. In case of bulk sweeteners, 60% sorbitol, 50% xylitol and 20% mannitol solutions were found equal in sweetness to 30-40%, 50% and 10-15% of sugar solutions, respectively (w/v). The sweetener syrups were prepared by combining bulk sweeteners and intense sweeteners in various proportions to get

sweetness similar to that of 60% sugar syrup. The viscosity of the syrups was adjusted to that of 60% sugar syrup by adding maltodextrine in the range of 15 to 25%. *Khoa jalebi* was prepared using the developed sugar-free syrups were found slightly firmer and chewy, whereas that prepared with levulose and sucralose mixture formulations was observed to have similar sensory characteristics as control.

Utilization of Concentrated Whey in the Preparation of Dahi

In the present study, process was optimized to utilize concentrated paneer whey and cheese whey for the preparation of dahi. The texture analysis showed that the firmness of the gel was lower in the dahi samples prepared with blends of milk and whey compared to control product. Dahi was prepared utilizing the blends of milk and concentrated paneer whey had better textural and sensory properties than that made utilizing blends of milk and concentrated cheese whey. Higher level of calcium and lower level of protein in the concentrated paneer whey could be attributed for such a difference. Trials showed that the degree of fermentation, as measured by acidity and pH, during incubation was lower in milk-whey blends. The total acidity and pH of control dahi and the product produced from the blends of milk and concentrated whey, however, was within the range. The acidity (% LA) of control and dahi made from blends of milk and concentrated paneer whey in the ratio of 2:1 and 3:1 was 0.815, 0.838, 0.824% LA, respectively. The corresponding values for pH were 4.46 (control), 4.32 and 4.41, respectively. In the case of concentrated cheese whey added samples, the acidity was 0.806, 0.803, and 0.808% LA, respectively for control, 2:1 and 3:1 blends; the corresponding values for pH were 4.4 (control), 4.3, and 4.3. With regard to the stage homogenization, the net increase in acidity and pH levels during and at the end of the 10 hour fermentation in the samples homogenized before heat treatment did not differ significantly with those for the samples homogenized after heat treatment. Dahi samples were prepared using blends of whey having 11.5% total solids. However, they have lower fat and protein content and higher level of lactose and ash. Dahi prepared using blends of milk and concentrated paneer or concentrated cheese whey had a shelf life of 8 days at 4^0C which is comparable to the control product. Based on the results obtained in this investigation, it can be concluded that paneer whey or cheese whey concentrated to a total solids level of 11.5% could be blended with toned milk up to 25% (v/v) for making dahi of acceptable quality.

Development and Evaluation of Milk Fortified with Omega-3 Fatty Acids, Phytosterols and Soluble Dietary Fibre

Work was carried out to optimise the incorporation of flaxseed oil, phytosterol and polydextrose into milk at levels that would not affect the sensory attributes of milk. Based on the different combinations of the fortificants tried, it was observed that flaxseed oil, phytosterols and polydextrose can be incorporated at 0.5, 0.5 and 1% levels, respectively without affecting the inherent sensory and physico-chemical properties of liquid milk. Proximate composition and physico-chemical properties of fortified milk were comparable to control/normal milk. The fortified milk provided about 289 mg of ALA, 412 mg of phytosterols and 1 g of polydextrose per 100 g. Two servings (serving size = 240 ml) of the fortified milk per day would provide almost the entire recommended requirement of omega-3 fatty acids (ALA), phytosterols and soluble fibre (polydextrose). Heat treatments like pasteurization and boiling did not affect the sensory characteristics of the fortified milk while sterilization had affected the colour and flavour of milk probably due to Maillard browning. The storage had little impact on the levels of all the three fortificants. Fortified milk could be converted to dahi with acceptable sensory properties and normal physico-chemical and microbiological properties. The textural quality, as determined by subjective and objective methods, of the dahi prepared from fortified milk was, however, lower probably due to the presence of emulsifier and polydextrose. Dahi samples prepared using control and fortified milk were acceptable even up to 8 days of storage at 4°C and the changes in the physico-chemical, textural and microbiological properties were comparable between control and fortified products. The total cost of production per liter of fortified milk was estimated at ₹ 64.

Evaluation of Physico-Thermal and Textural Properties of Chhana Podo and Optimization of its Baking Process Using Response Surface Methodology

Baking conditions of *chhana podo* were optimized using response surface methodology, and the physico-thermal and textural properties of *chhana podo* during baking were predicted. *Chhana podo* was prepared by kneading *chhana*, sugar and semolina (20:6:1) to a homogeneous and smooth dough and baked at 120, 135 and 150°C for 120 min.

During baking, the core temperature, moisture content, specific volume, weight loss, oven spring, crust colour, crumb grain characteristics, textural and thermal properties were measured at specific intervals.. Baking increased the browning index of the product from the initial value of 15.67 to 95.35, 101.49 and 112.08, respectively at 120, 135 and 150°C. In general, crumb grain characteristics like mean cell area, cell density and cell to total area ratio increased with increase in baking time and temperature. Textural parameters like hardness, chewiness and gumminess increased with baking time and temperature whereas springiness, cohesiveness and resilience increased up to 40 min and then decreased. The thermal conductivity, thermal diffusivity and volumetric specific heat ranged respectively from 0.359 to 0.223 W/m.K, 0.112 to 0.105 mm^2/s and 3.09 to 2.00 MJ/m^3k. The crust and crumb moisture contents followed first- and zero- order reaction kinetics ($R^2 \geq 0.98$), respectively. All colour parameters followed logistic model kinetics ($R^2=0.99$). The time-temperature combination for baking of *chhana podo* was optimized as 135°C for 104 min using face-centered central composite response surface design. Moisture diffusivity was modeled using Fick's second law of diffusion and it increased from $3.55x10^{-7}$ to $5.98x10^{-7}$ m^2min^{-1} with increase in air temperature from 120 to 150°C.

Moisture Sorption and Thermodynamic Properties of Dietetic Gulab Jamun

The effect of sugar replacement with artificial sweeteners and bulking agent in dietetic *gulab jamun* on its moisture sorption properties were investigated. Samples were equilibrated in desiccators containing saturated salt solutions of known water activity (0.11 – 0.97) and moisture sorption data for sugar soaked (control) and dietetic samples were determined by static gravimetric method at 20, 30 and 40 and 50 °C. The sorption data manifested in type II iostherm curve with distinct deliquescence in the condensed water exhibiting no temperature dependency. The experimental data was modeled using GAB, Oswin, Henderson and Caurie's isotherm models. GAB's model was found to describe the sorption behaviour of both products adequately up to $a_w <$ 0.8. The predicted values for equilibrium moisture agreed well with experimental data. Only the control sample depicted hysteresis phenomena in the multilayer region (a_w 0.30 - 0.70) of the isotherm. The hysteresis of the control sample was quantified in terms of its amplitude, hysteresis unit and energy. The peak value for hysteresis amplitude was recorded at the upper end of hysteresis loop and varied between 70 - 80%. The hysteresis units and energy were estimated at 4.6, 7.40, 7.06, 2.99 units and 622.35, 1008.67, 904.85, 439.82 J/kg water at 20, 30 and 40°C, respectively. Thermodynamic properties of the products were computed relative to its moisture content. The isosteric heat and entropy during desorption was higher than adsorption for the control samples, the dietetic sample recorded similar values for adsorption and desorption.

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

The project on extension of shelf-life of ghee using extracts of fruit and vegetable by-products was undertaken with an intention to replace synthetic antioxidant BHA with natural antioxidants. By-products such as orange peel, pomegranate peel, tomato waste and grape seeds were identified. Preliminary studies on extraction of antioxidants from orange peel and their effect on color and flavor of ghee were conducted. Orange peel was dehydrated at an optimum temperature of 60°C. Powder was prepared from dehydrated peel, packed in LDPE and stored in deep freezer for further use. One to two per cent orange peel powder was incorporated to butter and clarified to get ghee. Ghee was analysed for antioxidant effect (peroxide value, TBA and conjugated dienes) of orange peel powder. Solvent extract of orange peel powder was also incorporated into cream, ghee prepared and color and flavor changes observed in ghee. The results were encouraging as sensory panelists did not observe any undesired colour and flavor in ghee incorporated with orange peel extract.

A Profile Study of Smallholder Dairy Production Systems in Southern Region

The profile study on small holder dairy production systems in the southern region was taken up with specific objectives to study the profile of small holder dairy production systems in the selected areas of southern region, to analyse selected case studies of successful small dairy farmers of the region and to study the constraints of smallholder dairy production systems in the southern region. The socio-personal and socio-economic profile of small dairy holders revealed that majority of the respondents were middle-aged (54-68%), with 10-20 years of farming experience (62-70%) with marginal farm holding of less than one hectare (56-76%). Majority of the respondents possessed 2-5 dairy animals (64-76%). The milk procurement price ranged from Rs.18-30/litre in the region while

the milk sale price ranged from Rs.30-35/litre. The cost of milk production in the region ranged from Rs.17-23/litre The average milk yield per animal/per day in the region ranged from 6.0-8.5 kg/day. The case study analysis was done from the two selected successful small dairy households in the study area, which traced the history of dairying as experienced by the selected respondents.

The constraint analysis revealed that the major constraints in dairy farming in the region primarily enveloped acute water shortage, non-remunerative milk procurement price, high cost of cattle feed, non-availability of green and dry fodder, low productivity of dairy animals, non- availability of farm labour, etc. This indeed warrants suitable technological and governmental intervention for alleviating the problem and provides a fillip to dairy development in the region.

Successful Dairy Woman with Kamadhenu from Kolar, Karnataka

Dairy Entrepreneurship Development of Rural Women: An Action Research

The project is primarily focused on developing two successful dairy based women self help groups in scientific dairy farming practices and also dairy processing activities through institute interventions. As per the plan of work for the second year, in order to establish the dairy based women SHG, the project team has identified the two SHG groups from two different villages of Bangalore Rural District of Karnataka State, in association with local NGOs. The two women SHGs selected were Bhuvaneshwari Group at Suradenapura, promoted by Peoples Trust NGO and Group Center No 143, promoted by Samastha Micro Finance Group. The preliminary survey about their activities and their expectations and constraints in doing dairy based activities were discussed at village level meetings and group members were motivated to start dairy based activities and two SHGs expressed their willingness to take up the dairy based activity. The off campus training programmes on dairy production technologies like, clean milk production practices, fodder cultivation, scientific animal rearing practices, etc. were provided to the beneficiaries. After mobilizing the SHG members, the preparations for the entrepreneurship training packages are being taken at present. The socio-economic profile of the two SHG members were collected and analyzed.

Economic Analysis of Milk Production in Nainital District of Uttarakhand State

Dairy farming is one of the important economic activities in the rural mountainous areas of Uttarakhand and it is closely associated with farming systems.The study was carried out during 2012-13 in Nainital district and 100 farm households formed the sample for the study from plain and hill regions of the district. In plain region, cost of milk production per litre of milk, for local cow (LC), crossbred cow (CB) and buffalo (B) was computed at ₹ 27.61, ₹ 19.17 and ₹ 27.19, respectively. Share of Feed cost in the total cost varied from 61% (LC) to 64% (CB & B). The share of labour cost ranged between 21% (B) to 29% (CB). The net returns were negative for the local cows, while, crossbred cows and buffaloes yielded positive net returns. In the case of hill region, cost of milk production per litre of milk, for local cow, crossbred cow and buffaloe was computed at ₹ 26.47, ₹ 19.23 and ₹ 26.88, respectively. Share of feed cost in the total cost varied from 58% (B) to 64% (CB). The share of labour cost ranged between 24% (CB) to 30% percent (LC & B). The net returns were negative for the local cows, and for crossbred cows and buffaloes it was positive net returns. Crossbred and buffalo milk production are yielding positive returns in the region and constraints facing the farming community need to be addressed suitably, which would give fillip to milk production in the region. Better extension network, other supporting services coupled with organized marketing facilities would provide spring board for dairy development in the regions.

A Study on Entrepreneurial Profile of Dairy Farmers in the Northern Districts of Tamil Nadu

The study was undertaken to analyse the socio-personal, economic and psychological profile of dairy farmers, to analyse the factors influencing entrepreneurship of dairy farmers and to identify the constraints experienced by the dairy farmers in entrepreneurship of dairy farming. Thirty respondents were selected from each of the four villages. From the results it was concluded that most of the respondents were in middle age group and most of the dairy farmers possessed marginal land holding and a medium herd size with an average of four animals per household. It was found that among the respondents most of the farmers had medium level of extension participation and knowledge about dairy farming with favourable

attitude towards dairy enterprise. The study indicated medium level of entrepreneurial behaviour index among the respondents to the selected attributes of entrepreneurship viz., innovativeness, achievement motivation, decision making ability, risk orientation, co-ordinating ability, planning ability, information seeking behaviour, cosmopoliteness and self confidence. The overall entrepreneurial behaviour index among dairy farmers was positively and significantly related with the independent variables viz., education, dairy farming experience, social participation, annual income, land holding, livestock possession, milk yield, extension participation and knowledge of farming enterprise. High cost of cattle feed, non remunerative price for milk and non availability of land for grazing were predominant constraint faced by the farmers in the study area.

Eastern Regional Station, Kalyani

Impact Analysis of Women Dairy Cooperatives on the Economy of Rural Households in Eastern/ NE Region of India

The study was conducted in six states (West Bengal, Bihar, Orissa, Jharkhand, Sikkim, and Nagaland) of the Eastern/NEH region for impact analysis of dairy co-operatives on member house hold families. The stocking rate of milking animals was estimated and found higher in case of Nagaland and Sikkim (4-5 animals) on member households as compared to non member households followed by West Bengal, Bihar. While lowest number of milking animals were observed in case of Jharkhand (2 milking animals) which required help through intensive dairy development programs in the state. Average per capita milk consumption was observed higher (49.37g) on members as compared to that of non members (22.62g). Overall 74.0 % members and 63.0 % non-member milk producers have knowledge of different dairy production technologies.

Manipulation of Rumen Fermentation using Tree Leaves of North-Eastern India

In Arunachal Pradesh, the forests are endowed with various species of tree fodders, which are not only used for livestock feeding, but also provide good wood as well as used as fire woods. Some of the locally available tree leaves which are commonly fed to yaks e.g., blemkar *(Buddija asitica)*, domkar *(Symplocus racemosa)*, salyx *(Salyx humboltiana)*, maar *(Costanpsis sp.)*, zimbu *(Lingustrum myrsinites)*, baggar *(Berberis spp.)*, phrengpa *(Quercus walliasehiana)*, khamsuma, ngeksingh *(Symplocos cratagoides)*, maarma *(Spiral spp.)* and matekpa *(Quercus fenestrate)* had been collected and their nutrient compositions were evaluated. These trees are generally grown/ located about 4,000 to 10,000 ft above mean sea level (msl). Lowest biomass yield (mean leaf yield per tree per year) was observed in blemkar tree (0.2 to 0.3 quintal leaf per tree per year) and highest biomass yield was observed in Maar trees (3.5 to 4 quintal leaf per tree per year). Fresh tree leaves e.g., blemkar, domkar, salyx, maar, zimbu, baggar, phrengpa, khamsuma, ngeksingh, maarma and matekpa contained 26.7, 40.3, 23.9, 32.8, 36.6, 45.7, 48.8, 33.1, 31.8, 39.3 and 44.6 % DM on fresh basis. OM and CP content of tree leaves varied from 88.9 to 96.1 and 11.3 to 15.1 % where as NDF and cellulose content varied from 45.6 to 57.9 and 13.2 to 24.1 % on DM basis respectively. Highest IVTDMD was observed in maar *(Costanpsis sp.)*, tree leaves (60.2 %). In vitro methane production of blemkar *(Buddija asitica)*, domkar *(Symplocus racemosa)*, salyx *(Salyx humboltiana)*, maar *(Costanpsis sp.)* and zimbu *(Lingustrum myrsinites)* leaf was 30.5, 32.7, 28.3, 27.8 and 31.8 ml/g leaf DM under *in vitro* gas production test. TVFA production varied from 1.8 to 9.7 mEq/dl incubation medium. NH_3-N concentration in the incubation medium was 12.3, 15.1, 14.7, 13.8 and 14.2 mg/dl due to incubation of blemkar *(Buddija asitica)*, domkar *(Symplocus racemosa)*, salyx *(Salyx humboltiana)*, maar *(Costanpsis sp.)* and zimbu *(Lingustrum myrsinites)* leaf, respectively with incubation media *in vitro*. Rumen protozoa present in the collected rumen liquor and incubation medium was B type population due to presence of *Epidinium* sp. and the absence of *Polyplastron multivesiculatum*. Number of total rumen protozoa varied from 22.5 x 10^3 to 28.1 x 10^3 per ml incubation media. It was concluded from the preliminary *in vitro* studies that salyx (*Salyx humboltiana*) and maar *(Costanpsis sp.)* were the best tree leafs/fodder for feeding to the livestock in Arunachal Pradesh

Evaluation of Lactation Traits of Crossbred Cattle at ERS, NDRI, Kalyani

Data on 731 lactation records which comprises of first to thirteen lactations of 274 Jersey crossbred animals extended over 39 years (1974-2012) were used to study the effect of different non-genetic factors on lactation traits, to estimate the genetic and phenotypic parameters of lactation traits and to evaluate and compare the production performance with respect to lactation traits of crossbred cattle of different genetic combinations/groups. In the present study, the genetic composition of animals revealed that majority of animals falls in 3-breed cross (41%) followed by 2-breed (33%) cross. The

overall least-squares means for 305-days milk yield (MY305D) and total milk yield (TMY) of crossbred animals were 2727.70±52.74 and 3306.36±68.57 kg, respectively with average lactation length of 403.02±9.24 days. The lactation number of animals had significant (P<0.01) effect on 305DMY and TMY of animals but the effect was found non-significant (P>0.05) for LL. The period of calving had highly significant (P<0.01) effect on MY305D, TMY and LL of animals. Significant (P<0.01) differences in 305 days milk yield and TMY existed among cows calved in different seasons but the season of calving had non-significant (P>0.05) effect on lactation length of animals. Days of lactation (milking) were found statistically significant (P<0.01) as linear covariate for TMY of animals.

The heritabilities of MY305D, TMY and LL of animals were estimated by sire model, simple animal model and repeatability model and all the models were compared to select the most appropriate model for lactation traits. The heritability estimates for MY305D, TMY and LL of animals were 0.65±0.14, 0.54±0.13, and 0.25±0.09, respectively under sire model, whereas, the correspondence figures were 0.49±0.04, 0.45±0.05 and 0.19±0.05, respectively under simple animal model. However, in repeatability model, the heritability estimates for MY305D, TMY and LL were 0.42±0.05, 0.42±0.06 and 0.13±0.07, respectively under this model. This study revealed that heritability estimates for lactation traits of animals by sire model were biased due to ignorance of maternal effects of dam, however, in repeatability model, the heritability estimates for lactation traits were more precise as compared to estimates obtained by sire model and simple animal model. Hence the repeatability model, that includes direct genetic effect and permanent environmental effect due to dam, was the most appropriate genetic model for analyzing the lactation traits of crossbred cattle. The phenotypic and genetic correlations of MY305D with TMY and LL ranged from medium to moderately high (0. 41 to 0.99). Similarly, the genetic and phenotypic correlations of TMY with LL were also high (r_p = 0.69, r_g= 0.71) and significant.

The genetic group of animal had significant (P<0.01) influence on all the lactation traits under study except lactation length of animals. Among the different crosses, the half-bred of Jersey and Tharparkar crosses produced higher 305-days milk (2981.65±51.14kg) and total milk yield (3636.09±66.86 kg) as compared to animals of other genetic groups. The animals having less than 50% Jersey inheritance produced lowest 305DMY (2495.35±92.44 kg) and TMY (2948.68±121.01 kg) among all crosses and therefore, the animals having ½ Jersey x ½ Tharparkar genetic combination may be the best suitable genotype for obtaining the optimum productivity in this agro-climatic region.

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

Azolla microphylla was evaluated as alternative feed fecourse for livestock. The fresh yield of *Azolla* was around 200-230 g/sq m/day. Chemical analysis indicated that it was a good source of plant protein (210.7-296.7 g kg^{-1} DM) and fair source of other nutrients. The effect of fresh *Azolla microphylla* supplementation in crossbred cattle was studied in a lactation trial of 90 days. The animals in control group (T0) were fed on conventional ration of paddy straw, green fodder and concentrate mixture as per recommendation of NRC 2001. In the treatment group (T1) 2kg of fresh *Azolla* was supplemented over conventional ration. The average milk yield (kg/d) over 6 fortnights was significantly higher (P<0.01) in T1 (7.14±0.08) than T0 (6.42±0.13). Fat corrected milk (FCM) yield also showed similar trend with average values being 7.04±0.15 and 7.92±0.09 for T0 and T1, respectively. Supplementation of *Azolla* caused an increase in milk yield by 11.2% and FCM yield by 12.5% without any significant change in milk constituents. Total dry matter intake per kg FCM yield was significantly (P<0.05) lower in the treatment group than in control group indicating better feed conversion efficiency.

Fresh *Azolla microphylla* was found to have potential to serve as a green supplement for the dairy cattle for the improvement in milk yield especially where/ when green fodder availability is scanty.

3 TRANSFER OF TECHNOLOGY

Dairy Extension

Field/Farm Technician (FFT) Laboratory

The Field/Farm Technician (FFT) Laboratory of Dairy Extension Division provide a base for extension work in the adopted villages around Karnal and keeps the records of all extension activities of the division. The major activities being carried out through these Centers are:

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

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

Activities Conducted in Adopted Villages from April, 13 –March, 2014

Sr. N.	Activities conducted	No. of cases
1	A.I. in cows	1769
2	Conception rate (%)	38.33
3	A.I. in buffaloes	917
4	Conception rate (%)	30.67
5	No. of cross- breed calves born	423
6	No. of buffalo calves born	256
7	General treatment	414

Infertility and Veterinary Aid Campaigns

During the April, 2013 – March, 2014, 61 Veterinary Camps were held and 3796 cases were treated for reproductive disorders and various Veterinary ailments. Ecto-endo-parasite control programmes were also conducted. Special attention was given to improve the productive and reproductive performance of dairy animals

Kissan Sanghosthies

Fifty three sangosthies were organized at village 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 to find the solutions to their day to day problems. During these sessions the feedback was also collected on the extension programmes.

Dairy Education at Farmers' Door (DEFD)

The innovative Extension approach "Dairy Education at Farmers' Door" initiated by NDRI continued in the year 2013-14. A team of NDRI scientists consisting of specialists from production, processing and management groups visited nearby selected villages on every second Saturday. The Extension Scientist in the team acted as coordinator and identified the village as per functional linkages. This programme facilitated the effective dissemination of dairy production and processing technologies among farming community at their door, and the scientist could understand the practices adopted by farmers and also the constraints faced by them.

Dairy Samachar

Quarterly Dairy Samachar were compiled, edited and published by Division of 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.

Educational Visits and Tours (April 13 to March 2014)

A total of 6121 visitors (students and faculty) from 104 Colleges/Institutions/Universities visited NDRI. Extension division coordinated the programme by taking the visitors to the facilities and apprising them about for innovations made by NDRI.

Fodder Museum: To maintain the green fodder availability round the year, a 2 acre fodder museum was established at NDRI in which following four fodder production modules have been developed.

Perennial Grass: Presently 16 varieties of perennial grasses (napier-7, Guinea-3, Nandi grass-1 Anjan-3, paragrass-1, Bahia grass-1) were planted at fodder 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 :10 species of fodder have to be planted in ensuing kharif season.

Horti-pastrol : 100 lemon plants have to be planted in ensuing kharif season.

Advisory Services

The Extension Division provided regular advisory services through postal, e-mail and telephonic services 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.

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 poorest amongst the poor in the rural areas.

At KVK, need based training courses were designed for different types of clientele. After training, follow up extension programme was undertaken. While designing the courses, the entire concept of farming system was taken into consideration to make the enterprises economically viable for the farmers. The trainings started with field units, different farms, live demonstration units, workshops and terminated in discussion assembly. For making training programmes more effective, the KVK developed close linkages with different government, non-government and voluntary agencies and line departments.

Training Programmes Organized by KVK (April, 2013 to March, 2014)

Title of the course	Duration (days)	No. of courses	No. of beneficiaries	Mandays trained
On Campus				
Dairy Production				
At KVK	5	9	568	2735
Sponsored	3-5	66	1968	9776
Dairy Processing				
At KVK	5	7	99	495
Sponsored	4-5	4	56	266
Crop Production	3	2	51	153
Vermiculture				
At KVK	3	3	65	195
Sponsored	3	1	30	90
Bee-keeping	4	3	122	506
Fish Farming	4	2	39	156
Home Science	1-14	13	254	1069
Horticulture Sponsored	5	1	20	100
Total (A)		**111**	**3272**	**15541**
Short Integrated Training Programmes (B)	**1-2**	**94**	**3026**	**3291**
Total (A+B)		**205**	**6298**	**18832**

Off Campus				
Dairy Production	1	4	90	90
Dairy Processing	1	1	16	16
Crop Production	1	6	93	93
Vermiculture	1	1	14	14
Home Science	1-2	13	363	423
Total (B)		**25**	**576**	**636**
Grand Total (A) + (B) +(C)		**230**	**6874**	**19468**

(Revenue generated from sponsored courses = ₹ 21,23,426/-)

FRONT LINE DEMONSTRATIONS (FLD) ON OILSEEDS & PULSES (2013-14)

Front Line Demonstration (FLD) is a National Programme to promote and popularize the production of the oilseed and pulse 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. Following FLD programme were conducted during 2013-14.

S. No.	Crop	Varierty	Total No. of Demo.	Area (ha.)	Av. yield
1.	Mustard	Pusa Vijay	8	3.0	17.36
		CS-54	6	2.0	16.42
		CS-56	10	4.0	16.47
2.	Gram	BG-1103	16	3.23	19.83
3.	Summer Moong	MH-421	16	6.0	7.28
4.	Jowar Fodder (multicut)	Sudax Chari-1	12	3.22	531.0
5.	Maize Fodder	African Tall	8	2.0	508.0
6.	Paddy	PB-6 (1401)	3	1.21	55.57
		PUSA-1121	4	1.61	48.0

Extension Activities of KVK

- KVK carried out animal health management activities in the adopted villages, namely: Taprana, Kailash, & Phusgarh and Jundla Gate, Karnal. In these centres 12611 cases were attended, out of which 128 cases were for general treatment, 115 of infertility treatment, 136 for dehorning, 2796 for pregnancy diagnosis and 3583 A.Is. in dairy animals. Through Artificial Insemination 1824 calves were born.

- 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.

- Zero Tillage technology in Wheat crop production was demonstrated to various groups of farmers and farm women of the Karnal district and also to the farmers of other states.

- A meeting of Scientific Advisory committee of KVK was held on 27th December, 2013 under the chairmanship of Director, NDRI Karnal in which the progress report of the KVK was presented and action plan for the year 2014 was proposed. In this meeting officials of the line departments and the local ICAR Institutes participated.

- KVK organized World Breast Milk Feeding Day in village Kailash Distt. Karnal on 05th August, 2013 in which 62 rural women participated. The theme of the day was the importance of breast feeding for infants.

- "National Nutrition Week"' (1st - 7th September 2013) was organized in KVK in which 85 farmers and farm women participated. They were educated about the low cost homemade nutritional diets particularly for adolescent children and pregnant women and clean milk production.

- Conservation agriculture technologies in cultivation of wheat were demonstrated to various groups of farmers and farm women of the Karnal district and also to the farmers of other states.

- KVK under the Cereal System Initiative for South Asia programme organized various experiments and front line demonstrations on direct seeding of rice.

- KVK played an important role in organizing National Dairy Mela that was held on 25th - 27th February, 2014. More than 14000 visitors including progressive dairy famers, dairy entrepreneurs and farm women across the country participated in the Mela.

- KVK organized exhibitions on 16th September, 2013 on Foundation Day at CCSHAU, Uchani, Karnal; on 15th October, 2013 at D.W.R., Karnal on occasion of Innovation and Seed Day and on 25th -27th February, 2014 during National Dairy Mela organized by NDRI, Karnal.

REVENUE GENERATED

Total revenue generated at KVK through various activities during April, 2013 to March, 2014 was ₹ 48,65,782/.

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 institutes, research 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 visit 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.

Dissemination of Technological Information

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

1. Personal interaction with visiting farmers.
2. Display of models, etc; organizing / participating in Melas and Exhibitions.
3. Audio/Video shows
4. Visits to dairy farm
5. Information through toll free telephone number (1800-180-1199)
6. Providing Publications.
7. Providing material inputs like improved seed varieties, area specific mineral supplements, etc.

Services Rendered in Agricultural Technology and Technology Products from April, 2013 to March, 2014

S. No.	Services/ Transaction	Process	Service standard	*No. of such services attended during the reported Year	No. of such services pending beyond 100 days
1	Guidance of agricultural technology products	Personal contact by the service sectors with the responsible person of the ATIC	1200 days	8802*	NIL

* Detail of No. of Services

Sr. No.	Detail of services	No. of Services*	No. of Persons
1.	Dairy/Agriculture related information through video show and lecture	179	7167
2.	Personal discussion with subject-matter-specialist on dairy farming	134	134
3.	Information through dairy/agriculture literature	395	395
4.	Information on seed/fertilizer/compost	2401	2401
5.	Information through telephone (Toll-free) on agriculture & dairying etc.	5681	5681
6.	Information through e-mail on agriculture & dairying etc.	12	12
Total		**8802**	**15790**

Sale of Seeds & books through ATIC (April 2013 - March 2014)

SI. No.	Name of crop	Variety	Quantity (kg)	Amount (Rs)
Seed Production Unit (RFS)				
1.	Paddy	Pusa-44	8390.00	289960.00
2.	Turnip	-	02.00	300.00
3.	Oats	Kent	4140.00	124200.00
4.	Mustard (Grain)	Chinese cabbage	121.00	6050.00
	Mustard seed	Chinese cabbage	35.00	525.00
5.	Paddy (Grain)	Pusa-44	340.00	4250.00
6.	Paddy (Grain)	P-1121	750.00	18750.00
7.	FYM (Loose) in Quintal	-	220.00	3880.00
8.	FYM (Packets)	-	1736	34720.00
9.	Vermi Compost	-	05 Pkt.	50.00
Total			**-**	**482685.00**

BOOKS

1.	Number of books sold : 1646 Books	162379.00
	Grand total	**645064.00**

Sh. Arvind R. Kaushal, Secretary, ICAR & Additional Secretary, DARE delivering Convocation Address at NDRI on 14th February, 2014

4 DAIRY EDUCATION

Academic Programmes

The following courses were offered by NDRI Deemed University during the academic session 2013-14. 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) Agricultural Economics/Livestock Economics; xii) Agricultural Extension/Veterinary Extension and xiii) Agronomy (Forage Production). The institute is going to start M.VSc. (Animal Reproduction, Veterinary Obsterics & Gynaecology) and M.Sc. "Food Quality & Safety Assurance" from academic session 2014-15.

The Institute offers Doctoral programmes in all the above disciplines except Agronomy (Forage Production). The Institute is going to start Ph.D. Agronomy (Forage Production) and Vet. Obst. & Gynaecology discipline from the academic session 2014-15.

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 management at Southern Campus, Bangalore. The Institute is going to start Diploma in Animal Husbandry at Eastern Campus, Kalyani from 2014-15.

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	₹ 7,560/- per month for two years plus ₹ 6000/- per annum as contingency.
Ph.D.	₹ 10,500/- per month for three years and ₹ 10,000/- per annum as contingency.
Ph.D. (In-service)	₹ 1,000/- per month for three years and ₹ 10,000/- per annum as contingency.

ICAR Junior Research Fellowship

Master's degree	₹ 8,640/- per month (for non veterinarians) and ₹ 12,000/- per month (for veterinarians) for two years and ₹ 6,000/- per annum as contingency.

ICAR Senior Research Fellowship

Ph.D.	₹ 12,000/- per month (for non veterinarians) for 1st and 2nd year and ₹ 14,000/- for 3rd year; and 10,000/- per annum as contingency.
Ph.D.	₹ 14,000/- per month (for veterinarians) for 1st and 2nd year and ₹ 15,000/- for 3rd year; and ₹ 10,000/- per annum as contingency.
Ph.D. (In-service)	₹ 1000/- per month for 3 years and ₹ 10,000/- per annum as contingency.

National Talent Scholarship

The National Talent Scholarship (NTS) @ ₹ 1,000/- 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 Rs. 20,000 to 60,000/- per month. In addition to employment a number of students also opt for higher studies in India and abroad. The major functions of the Cell are as follows:

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

Counselling for Admissions

Counselling for admission to UG and PG programme was held by the Education Division of ICAR on 15th, 27th, 30th June and 1st July, 2013, respectively at NASC Complex, New Delhi.

Entrance Examination

An All India Competitive Entrance Examination for admission to Ph.D. programme for the session 2013-14 was conducted by NDRI on 10th May, 2013 at three centers i.e. Karnal , Bangalore and Kalyani.

Admissions

Admission for the academic session 2013-14 for Diploma in Dairy Technology, B.Tech. (Dairy Technology), M.Sc./M.V.Sc./M.Tech. and Ph.D. programmes were made and the admission process was closed on 30th August, 2013.

A total of 27 students joined Diploma in Dairy Technology, 29 students joined B.Tech. (Dairy Technology), 129 whereas students including three foreign national, joined Masters' programme 104 students including three foreign nationals joined the Ph.D. Programme.

Degrees Awarded during the 12th Convocation

B.Tech. (Dairy Technology)	:	39
Master in Dairying	:	128
Ph.D.	:	59

Meetings

- 74th, 75th and 76th meeting of the Standing Committee on Course Curricula and Academic Affairs was held on 11th, 25th October, 2013 and 30th January, 2014.
- 52nd, 53rd meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 28th September, 2013 and 30th January, 2014.
- 39th meeting of Standing Committee on Scholarship, Financial and Academic Progress was held on 30th January, 2014.
- 35th Meeting of Academic Council was held on 28th October, 2013.
- 36th meeting of Academic Council was held on 12th February, 2014.

Twelfth Convocation of NDRI Deemed University

Twelfth Convocation of NDRI Deemed University was held on 14th February, 2014. Shri Arvind R. Kaushal, Secretary, Indian Council of Agricultural Research delivered the Convocation Address. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI Deemed University presented the Convocation Report.

Three toppers 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.

Merit Certificate to 20% of the total pass out students in B. Tech. (DT) Programme based on performance in course work were also awarded.

Merit certificate to topper of each discipline in Master's and Ph.D. degree programme for

performance in course work as per the eligibility criteria were also awarded.

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
Processing	Ms. Sari T.P.	Dr. Bimlesh Mann	Dairy Chemistry
Social Science & Management	Mr. Ranjith Kumar	Dr. B. S. Meena	Agriculture Extension
Production	Mr. Dev Priya	Dr. S. K. Singla	Animal Biotechnology

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

Group	Name of the Student	Name of the Guide	Discipline
Processing	Mr. Apurba Giri	Dr. S.K. Kanawjia	Dairy Technology
Social Science & Management	Mr. Sanjit Maiti	Dr. S.K. Jha	Agriculture Extension
Production	Mr. Dinesh Kumar	Dr. D. Malakar	Animal Biotechnology

Dr. D. Sundaresan Memorial Lecture Award-2014

Dr. D. Sundaresan Memorial Lecture Award-2014 was bestowed on Dr. S. Ayyappan, Secretay, DARE and Director General, ICAR, New Delhi. Dr. Ayyappan delivered the lecture on 11th February, 2014 on the topic "Youth for Transorming Indian Agriculture". The award carries an amount of ₹ 20,000, a citation, shawl and a certificate

Dr. N. N. Dastur Oration Award-2014

Dr. N. N. Dastur Oration Award-2014 been bestowed on Dr. V. M. Katoch, Director General, ICMR. Dr. Katoch delivered the oration on 10th February, 2014 on the topic "Environment and Food in Relation to Human Health". The award carries an amount of ₹ 20,000, a citation, shawl and a certificate

Dr. K. K. Iya Oration Award-2014

Dr. K. K. Iya Oration award-2014 was bestowed on Dr. S. K. Bandopadhyay, Member, ASRB. Dr. Bandopadhyay delivered the lecture on 28th January, 2014 on the topic "Useful Science Versus Sciences for Justifying Existence : A Key Issue for Performance Evaluation". The award carries an amount of ₹ 20,000, a citation, shawl and a certificate.

Best Divisional Award for Academic Achievements and Innovations in Teaching

The Heads of Divisions presented the innovations and significant achievements made during 2013 in education/research and consultancy on 1st February, 2014 on the recommendation of the jury, "Best Divisional Award" was presented to Dairy Microbiology Division.

"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 on Dr. S.K. Kanawjia, Principal Scientist, Dairy Technology Division at UG level and Dr. A. Kumaresan, Senior Scientist, Livestock Production & Management at PG level.

Appreciation letters for excellence in teaching at UG and PG levels were given to Dr. Rajan Sharma, Senior Scientist, Dairy Chemistry Division and Dr. P.N. Raju, Scientist, Dairy Technology Division.

Memorandum of Understanding Signed

NDRI signed MOUs for collaboration in the areas of mutual interest with National Institute of Food Technology Entrepreneurship and Management, Kundli, Distt. Sonepat, Haryana.

5 HONOURS / AWARDS

- National Dairy Research Institute (NDRI) was conferred **Agriculture Leadership Award-2013** recently in a glittering function at Taj Palace, New Delhi. The award was presented to **Dr. A. K. Srivastava,** Director jointly by H.E. Hon'ble Governor of Uttar Pradesh, Sh. B.L. Joshi and Sh. Tariq Anwar, Minister of State for Agriculture & Food Processing Industries in the presence of the Chief Minister, Punjab and Architect of Green Revolution in India - Prof. M.S. Swaminathan.

- National Dairy Research Institute NDRI was conferred **Education Leadership Award** at 21st Dewang Mehta Business School Award Ceremony on 23rd October, 2013 at Taj Lands End, Mumbai. The award was bestowed upon NDRI recognizing talent and leadership amongst Educational Institutes across India.

- **Dr. M.S. Chauhan, Dr. P. Palta, Dr. R.S. Manik, Dr. S.K. Singla, Dr. Dheer Singh** and **Dr. M.K. Singh** were felicitated by DG, ICAR for their work in NAIP project entitled "Characterization and Differentiation of Embryonic and Spermatogonial Stem Cells in Cattle and Buffaloes", which was adjudged as the Best Project under Component 4.

- **Dr. Gurpreet Kaur** was awarded "**Jawaharlal Nehru Award for PG Outstanding Doctoral Thesis Research in Agriculture and Allied Science 2012"**. She worked on "Bacteriocin Resistance among Dairy Pathogens & Spoilage Bacteria and Strategies for its Mitigation" under the guidance of Dr. R. K. Malik, Head, Dairy Microbiology.

- **Dr. Sanchita Garai**, Scientist (Extension) participated in ICAR Award Ceremony' 2012 on 16th July, 2013 and received **"Jawaharlal Nehru Award"** for Outstanding Doctoral Thesis Research in Social Science. She worked on "Information Communication Behaviour and Group Dynamics of Self Help Group Members of New Alluvial Zones of West Bengal".

- **Dr. S. K. Kanawajia,** Principal Scientist, Dairy Technology Division, was awarded with **"Best Teacher Award"** (Undergraduate) for the year 2013-14 at 12th Convocation held on 14th February, 2014

- **Dr. A. Kumaresan**, Senior Scientist, Animal Reproduction was awarded with **"Best Teacher Award"** (Postgraduate) for the year 2013-14 at 12th Convocation held on 14th February, 2014.

- **Dr Rajan Sharma,** Sr. Scientist and **Dr. P. Narender Raju,** Scientist got **"Certificate of Appreciation"** in recognition of Outstanding Contributions as a teacher at NDRI for the year 2013-14 at 12th Convocation held on 14th February, 2014.

- **Dr. Y. S. Rajput,** Head, Animal Biochemistry Division received **"Sukumar Basu Memorial Award"** for biennium 2011-12 on the occasion of 52nd Convocation of Indian Agricultural Research Institute, New Delhi on 21st February, 2014.

- **Dr. Suman Kapila,** Principal Scientist, Animal Biochemistry Division won **"Bio Nutra Senior Award"** for the paper entitled, "Characterization of Novel Osteogenic Peptide from Milk" during the National Conference on Bioactive Compounds and Functional Foods in Health and Disease Management from 15th -16th November, 2013 held at NIFTEM, Kundli, Sonepat.

- **Dr. Bimlesh Mann,** Head, Dairy Chemistry Division was awarded **"Prof Jiwan Singh Sidhu Award (2012)"** in the 7th International Food Convention organized by CSIR-CFTRI, Mysore, DFRL, Mysore and NIFTEM, Sonipat from 18th - 21st December, 2013.

- **Dr. K. P. Ramesha** Principal Scientist, SRS, Bangalore was awarded **"Best Zoologist Award"** in the year 2014 by Society for Applied Biotechnology at AABS/SAB Sponsored "International Conference on Biodiversity, Bioresources and Biotechnology" held at Mysore.

- **Dr. Pradip Behare** received **"Best Oral Presentation Award"** on "Novel Biothickening Lactic Cultures for Preparation of Indigenous Fermented Milk Products" at 6th International Conference on Fermented Foods, Health Status and Social Well-being held at Anand, Gujarat, from 6th - 7th December, 2013.

- **Dr. Dibyendu Chakraborty, Dr. Avtar Singh, Dr. M.S. Tantia, Dr. Archana Verma, Dr. A.**

K. Chakravarty and **Mr. D. Kumar** were awarded "**Second Best Oral Presentation Award"** for research paper "Identification of SNP Markers Associated with Cystic Ovarian Disease in Sahiwal Cattle" in the 32nd Annual Convention and International Symposium on "The 21st Road Map for Veterinary Practice, Education & Research in India and Developing Countries" from February, 14-16, 2014 at Sher-e-Kashmir Agricultural Sciences & Technology of Jammu, R. S. Pura, Jammu.

- **Dr. Mukund A. Kataktalware** received the **Best Oral Presentation- I Prize** for the oral presentation of a research paper entitled "**Bull Housing Management Practices under Commercial Semen Production System**" on 29/01/2014 during fourth technical Session on "Health, Breeding & Reproduction Management" of the National Seminar on "New Dimensional Approaches for Livestock Productivity and Profitability Enhancement under Era of Climate Change" conducted by College of Veterinary Science & Animal Husbandry, Anand Agricultural University, Anand during 28th-30th January, 2014.

- **Mr. D. Joshna, Mr. A. Padmaja, Mr. P. Aravindakshan, Dr. C. N. Pagote** and **Dr. K. Jayaraj Rao** was awarded **"Second Best Presentation in Oral Presentation"** for the paper entitled "Process Standardisation for Chakka based Fruit Desserts" presented at International Conference on Food Technology: Impact on Nutrition and Health. ICFIN – 2013) 23rd – 24th December, 2013. JNU New Convention Centre, Jawaharlal Nehru University, New Delhi, organised by International Institute of Food and Nutritional Sciences (IFANS), New Delhi.

- **Ms. Sari TP** got **"Best M.Tech Thesis Award"** in the processing group on dissertation work "Evaluation of Physico-chemical and Biological Characteristics of Micro/ Nanoemulsions Encapsulating Curcumin" during 12th Convocation of the NDRI Deemed University held on 14th February, 2014.

- **Dr. R. Senthil Kumar,** Scientist, **Dr. B.S. Meena,** Sr. Scientist, **Mrs. Ritu Chakravarty,** Sr. Scientist, **Dr. K. S. Kadian,** Principal Scientist, Dairy Extension Division and **Dr. S. V. Singh**, Principal Scientist, Dairy Cattle Division received **"Best Paper Presentation Award"** for the paper entitled "Perception and Adaptation of Dairy Farmers on Climate Change in Haryana" at International Conference which was held on 5th – 8th December, 2013 in UAS, Bangalore.

- **Mr. M. Kumar, Dr. H. Kaur, Dr. A. Tyagi, Dr. V. Mani, Dr. A. K. Dang,** and **Dr. R. S. Deka** were awarded **"Best Paper Award"** for the paper entitled "Ameliorative Effect of Chromium on Immune Response and Antioxidant Status in Buffalo Calves (*Bubalus bubalis*) during Summer Season" in the 2nd Indian Academy of Veterinary Nutrition and Animal Welfare (IAVNAW) Conference on Human Welfare held on 19th - 21st September, 2013 at SKUAST, Jammu.

- **Mr. S. R. Kumar, Dr. B. S. Meena, Dr. R. Chakravarty, Dr. K. S. Kadian** and **Dr. S. V. Singh** were awarded **"Best Paper Award"** for the paper entitled "Climate Variability and Crop Livestock Farming System" during International Conference on Extension Educational Strategies for Sustainable Agricultural Development - A Global Perspective, held from 5th - 8th December, 2013 at UAS, Bangalore, India.

- **Dr. H. R. Meena** got **"Best Paper Presentation Award"** in the National Seminar 2013 on Social Dimensions of Extension Education in Holistic Development of Rural Livelihood, held at Chandra Bhanu Gupt Agriculture PG collage, Bakshi ka Talab, Lucknow, UP 26th -27th April, 2013

- **Mr. K. N. Papinwar, Dr. B. Surendra Nath and Mr. D. H. Patel** were awarded **"Best Paper"** in the Category of Dairy Processing for the article entitled "Antimicrobial Packaging for Food Preservation" by in Indian Journal of Dairy and Biosciences Vol. 20 for the years 2009 and 2010.

- **Mr. D. K. Swain, Mr. M. S. Kushwaha, Mr. I. Bhatt, Ms. M. Kaur, S. Toki, and Dr. A. K. Dang** were awarded **"Best Paper Award"** for the paper entitled "Delayed Apoptosis, Delayed Neutrophil Cargo Removal and NET are Weapons of Pathogen Killing Employed by PMN, during *Staphylococcal* Mastitis" in the 2nd Meeting of Society of Veterinary Science and Biotechnology and National Seminar on Biotechnological Approaches to Challenges in Animal Health and Production held at College of Veterinary

Science and Animal Husbandry, DUVASU, Mathura on 6th-7th March, 2014.

- **Ms. S. Kumari, Dr. Shiv Prasad, Dr. T. K. Patbanda, Dr. R. Pathak, Dr. P. Boro, Dr. S. S. Layek, Dr. S. Ravi, Dr. T. K. Mohanty, Dr. A. Manimaran** and **Dr. A. Kumaresan** received "**Best Paper Award"** by ISSAR during the National Symposium held at Nagpur, Maharashtra during 8th – 10th January, 2014.

- **Mr. Rijusmita Sarma Deka, Dr. Veena Mani, Dr. Munnendra Kumar, Dr. A. K. Tyagi, Dr. Harjit Kaur, Dr. Neelam Kewalramani, Dr. Chander Datt and Dr. S. S. Kundu** were awarded **"Best Paper Award"** for the paper entitled "Effect of Chromium Supplementation on Lymphocyte Proliferation, Neutrophil Phagocytic Activity and Blood Antioxidant Status in Periparturient Buffaloes". Oral Presentation in National Symposium on "Buffalo for Sustainable Food Security" ISBD to be held at Guwahati 15th - 16th March, 2013.

- **Mr. Muneendra Kumar, Dr. Harjit Kaur, Dr. Amrish Kumar Tyagi, Dr. Veena Mani, Dr. A. K Dang Mr. Rijusmita Sarma Deka** were awarded **"Best Paper Award"** for the paper entitled "Ameliorative Effect of Chromium on Immune Response and Antioxidant Status in Buffaloes Calves (*(Bubalus bubalis*)" during Summer in 2nd National IAVNAW Conference on "Nutrition –Health Interactions for Optimum Livestock Production & Human Welfare held Sept 19-21,2013 at Sher-e Kashmir University of Agricultural Science & Technology, Jammu

- **Mr. S. P. Sawant, Dr. Madhu Mohini** and **Dr. M. S. Mahesh** were awarded **"Best Paper Award"** for the paper entitled **"**Nitrate as Proprophylactic Option to Mitigate Methane Emission: An *in vitro* Study" presented in Second National Conference, organised by Indian Academy of Veterinary Nutrition and Animal Welfare, (19th – 21st September, 2013) at Jammu.

- **Ms. Aparna Sudhakaran V; Ms. M. Anupama, Ms. Anju A. Achuthan, Dr. V. K. Batish** and **Dr. Sunita Grover** have been awarded the **"Best Paper Award (First Prize)"** for the paper entitled "Probiotic Dairy Foods for Managing Cardiovascular Diseases" published in "Technical Aspects Area" in the Indian Dairyman for the calendar year 2012.

- **Dr. Shilpa Vij, Mr. Shital Borkar, Mr. Subrota Hati, Dr. R. K. Malik and Ms. Gurpreet Kaur** received **"Best Paper Award"** at XIL Dairy Industry Conference organized by Indian Dairy Association in Chennai from 12th - 14th Dec. 2013 for the research paper published in Indian J. Dairy Science. Antibiotics Resistance Pattern of Common Disease Causing Pathogens. *Indian J Dairy Science,* 65 : 47-51.

- **Mr. Kumaresh Halder, Prof. Bikram Kumar, Mr. P. S. Minz** and **Dr. R. Malhotra** were awarded "**Best Paper Award"** (Dairy Processing Area) published in Indian Journal of Dairy Science for the research paper "Batch Capacity Optimization for Kinematic Half-turn Nut Paneer Pressing Mechanism" during 41st Dairy Industry and Conference organised by IDA during 12th-14th December, 2013 at Chennai.

- **Mr. P. S. Minz, Dr. A. K. Dodeja** and **Dr. Smita Sirohi** were awarded **"Best Paper Award"** (Commercial Aspets Area) published in Indian Dairyman for the research paper "Indian Dairy Equipment Manufacturing Sector: An Overview" during 41st Dairy Industry and Conference organised by IDA during 12th-14th December, 2013 at Chennai.

- **Mr. K. Halder, Mr. B. Kumar, Mr. P. S. Minz,** and **Dr. R. Malhotra** were awarded **"Best Paper Award"** on the paper entitled "Batch Capacity Optimization for Kinematic Half-turn Nut Paneer Pressing Mechanism" by Indian Dairy Association, New Delhi at 45th Dairy Industry Conference held at Chennai during 12th -14th December, 2013.

- **Mr. Shiv Raj Singh** and **Dr. K. K. Datta** were awarded **"Best Theme Paper Award"** on the paper "Indian Dairy Sector and Foreign Direct Investment: Prospects & Challenges" by at 45nd Dairy Industry Conference, held in 12th -14th December, 2013 at Chennai.

- **Mr. Mahesh Kumawat, Prof. Bikram Kumar** and **Mr. P. S. Minz** were awarded **"Second Best Paper Award"** (Dairy Processing Area) published in Indian Journal of Dairy Science

for the research paper "Optimization of Process Parameters for Manufacture of Khoa using Response Surface Methodology" during 41st Dairy Industry and Conference organised by IDA during 12th-14th December, 2013 at Chennai.

- **Dr. S. Jeyakumar**, was awarded "**Best Poster Prize"** by the Indian Association for the Advancement of Veterinary Research during 13th Indian Veterinary Congress and XX Annual Convention of IAAVR & International Conference on "Thrust Areas in Veterinary Research, Education, Regularity Reforms and Governance for Quality Service to Farmers" organized at Institute of Animal Health and Veterinary Biologicals and Veterinary College, KVAFSU, Hebbal, Bangalore on 16th -17th April, 2013.

- **Mr. V. Jamuna, Dr. A. K. Chakravarty, Dr. C. S. Patil, Dr. Vijay Kumar** and **Dr. A. Mahajan** received **"Best Poster Presentation Award"** entitled "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 on 6th -7th February, 2014.

- **Mr. S. Saini, Mr. S. Kalra, Dr. A. K. Mohanty** and **Dr. J.K. Kaushik** were awarded **"Best Poster Award"** on paper "Docking of N-acetyl Glucosamine (NAG) with Sperm Lysozyme Like Protein (SLLP)' at National Symposium on "Emerging Trends in Agri-bioinformatics" organized by DWR, Karnal.

- **Ms. S. Kumari, Dr. Shiv Prasad, Dr. A. Kumaresan, Dr. T. K. Mohanty, Dr. S. Ravi, Dr. A. Manimaran, Dr. T. K. Patbanda, Dr. R. Pathak, Dr. P. Boro, Dr. L. Sreela** and **Dr. S. Kerketta** received "**Best Poster Award"** by ISAPM during the National Symposium held at Anand, Gujarat during 28th - 30th January, 2014.

- **Ms. Kiran Thakur** was awarded **"Best Poster Presentation Award"** on "Adhesion Properties of Riboflavin Producing Lactobacilli Species on HT-29 Cell Lines" at National Conference on "Bioactive Compounds and Functional Foods in Health and Disease Management (BFHDM -2013) National Institute of Food Technology Entrepreneurship and Management (NIFTEM) Sonepat, Haryana on 15th – 16th November, 2013.

- **Mr. H. Dwarakanath, Mr. P. Gurumurthy, Mr. H. Sutariya, Dr. K. Jayaraj Rao,** and **Dr. C. N. Pagote** was awarded **"Best Poster Paper"** for the poster paper entitled "Effect of Freezing on the Textural Attributes of Paneer during Storage" presented at 41st DIC, 14th - 16th March 2013, Bombay Exhibition Centre, Goregaon (E), Mumbai.

- **Ms. Shakuntala, Mr. P. Geetha, Mr. K. S. Swapna, Mr. P. Aravindakshan, Dr. C. N. Pagote** and **Dr. K. Jayaraj Rao** was awarded the **"Best Poster Paper"** for the poster paper entitled "Influence of Manufacturing Parameters on Quality of Surati Panir" presented at National Seminar on "Changing Scenario of Dairy Food Safety and Standards in the Backdrop of FSSAI Act – 2006" 26th -27th April, 2013 Dairy Science College, KVAFSU, Hebbal, Bangalore.

- **Late Dr. P. K. Roy,** Ex-Principal Scientist and **Dr. A. Chatterjee,** Senior Scientist were awarded **"Best Poster Award"** for the paper entitled "Chemical Composition of Organically vis-à-vis Conventionally Grown Fodders" In : National Seminar & XX Annual Convention on "New Paradigms in Livestock Production : From Traditional to Commercial Farming and Beyond" 28-30 January, 2013 organized by 'Indian Society of Animal Production and management' at NDRI, Karnal.

- **Dr. Tegene Negesse,** Hawassa University, Hawassa, Ethiopia completed his "**Post Doctoral Research under CV Raman International Fellowship"** for African Researchers awarded by Depatment of Science and Technology, Govt. of India, New Delhi in Dairy Cattle Nutrition Division from 26th June to 24th December, 2013. It was Facilitated by Federation of Indian Chamber of Commerce and Industry. His topic of research was "Variability in Residual Feed Intake in Murrah Buffalo Heifers".

- **Dr. Naresh Kumar** was nominated as a member of **"Scientific Panel for Biological Hazards"** by the Food Safety and Standard Authority (FSSAI**)** of India.

- **Mr. Mohammad Raies-UL-Haq,** Ph.D. student awarded "**Appreciation Award"** for academic session 2012-13 in recognition of his outstanding research work in the field of dairy processing.

- **Dr. Naresh Kumar** received "**Appreciation Certificate"** for presenting a topic entitled "Food Safety Standards in Global Trade : Key Challenges Ahead for Dairy Industry in India" during 2nd International Conference on Emerging Food Safety Risk : Challenges for Developing Countries and Workshop on Food Safety and Quality held during 9th - 11th January, 2014 at NIFTEM, Sonepat, Haryana, India.

- **Dr. Naresh Kumar** received "**Appreciation Certificate"** received for presenting a topic entitled "Current Food Safety Standards in Global Trade and Key Challenges for Regulatory Compliance in Dairy Industry" during Two days Seminar on Dairy Animal Management, Quality Assurance and Marketing of Milk and Milk Products, organized by PCDF, 'Parag' Lucknow on 20th - 21st February, 2014.

- **Dr. Naresh Kumar** received "**Appreciation"** for transfer of technologies on *L. monocytogenes* and *Enterococci* by Honorable Member of Planning Commission Shri Kasturinandan during "Agri-business Meet" convened by NAIP on 16th - 17th July, 2013 at NASC complex, ICAR, New Delhi**.**

- Certificate of appreciation was presented to **Dr. A. K. Puniya** in recognition of his outstanding contribution as reviewer for the 2013 Annual Biomedical Research Conference for Minority Students, in Nashville, Tennessee, USA.

- **Ms. Kiran Thakur** received **"Best Young Scientist Award"** for her oral presentation on the topic entitled "Isolation, Identification and Characterization of Riboflavin Producing Lactobacilli from Diverse Niches" in 7th Asian Conference on Lactic Acid Bacteria (ACLAB7) held in New Delhi from 6th – 8th September, 2013

- **Dr. Y. S. Rajput,** Head ABC, **Dr. R. C. Upadhyay,** Head DCP, **Dr. R.S. Manik, Dr. S. K. Singla, Dr. M. S. Chauhan, Dr. T.K. Datta, Dr. S. K. Kanawjia, Dr. Darshan Lal,** Principal Scientists NDRI, **Dr. S. Kulkarni,** Head SRS, Bangalore, **Dr. T. K. Dutta,** Head ERS, Kalyani were awarded the **"Fellowships of National Academy of Dairy Science, India"** in February 2014.

- **Dr. S. K. Singla** was awarded with a **"Fellowship by Indian Dairy Association**".

- **Dr. K. Ponnusamy**, Head Dairy Extension was conferred with "**GCBR Award-2013"** for Popularization of Biological Science on the Occasion of National Workshop, Achieving Food Security in the Face of Climate Variability by Gugly Centre for Biological Research on 26th November, 2013 at Bhubaneswar.

- Dairy Extension Division bagged "**First Position"** in the Dairy Mela 2014 Exhibition organised by National Dairy Research Institute, Karnal during 25th - 27th February, 2014.

- **Dr. K. P. Ramesha** awarded **"Best Veterinarian Award"** in the year 2011-13 by Karnataka Veterinary Association for Outstanding Contribution to Veterinary Profession.

- **Dr. K. P. Ramesha** awarded "**Indira Gandhi Sadbhavna Gold Medal Award"** in the year 2013 by Global Economic Progress and Research Association at 15th International Conference on Individual Achievement and Service to the Nation held at Bangalore.

- **Dr. K. P. Ramesha** award was **"Conferred to Fellow of the Society for Applied Biotechnology"**.

- **Dr. S. Kulkarni** was nominated to **"Tamil Nadu Milk Federation (Aavin)"** as an Independent Director – Technical for a period of 3 years.

Dr. M. Mondal, Sr. Scientist became **"Fellow of Association for the Advancement of Biodiversity Science (F.A.B.Sc.)"** from January, 2014.

Dr. M. Mondal, Sr. Scientist received **"Innovative Young Biotechnologist Award (IYBA)"** of DBT, Govt. of India, 4th year.

6 RESEARCH 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/ Co-PI	Funding Agency	Duration	Total Cost (₹ in Lakh)
1.	National initiative on climate resilient agriculture	R. C. Upadhyay	CRIDA (ICAR)	2010-17	3691.25
2.	Cost and returns in milk production: Developing standardized methodology and estimates for various production system.	Smita Sirohi	DAHD	2012-14	61.58
3.	Fluorescent *in situ* hybridization (Fish) and associated techniques for characterization of chromosomes for detection of genetical and reproductive problems in cattle, buffalo and goat.	B. R. Yadav	DBT	2011-14	43.11
4.	Elucidating molecular and cellular and mechanisms of ovarian and uterine cells function underlying the infertility associated with post-partum uterine infection in buffalo.	Dheer Singh	DBT	2011-14	59.79
5.	Genetic diversity and haplotyping of innate immune genes in Indian cattle and buffalo	S. De	DBT	2012-15	42.46
6.	Application of probiotics in alleviating allergic responses and immuno-seneescene.	Rajeev Kapila	DBT	2011-14	53.72
7.	Molecular basis for modulation of immuno-competence of neutrophilic function *in vivo* and *in vitro* of high producing cows and buffaloes peri-partum.	A. K. Dang	DBT	2010-13	50.00
8.	Developing & evaluation of multiple micro-nutrient (mineral & vitamins) fortified milk for consumer market.	Sumit Arora	DBT	2010-13	42.59
9.	Buffalo genome information resource.	S. De	DBT	2012-14	27.47
10.	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	27.97
11.	Establishment of facilities for research and training in stem cell technology in pigs.	M. S. Chauhan	DBT	2012-16	37.38
12.	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	2011-14	50.00
13.	Digestive enzymes (a-glucosidase and a-amylase) probiotics lactic acid bacteria for controlling postprandial hyperglycemia	A.K. Puniya	DBT	2012-15	22.60
14.	Improvement in fertilizability of cryopreserved buffalo bull semen by minimizing cryo capacitation and apoptosis like changes" (Collaboration with GADVASU, Ludhiana)	M. S. Chauhan	DBT	2012-14	17.77
15.	Bioacoustics tool: A novel non-invasive approach for efficient monitoring of health and productivity in dairy animals	S. S. Lathwal	DBT	2013-16	64.09
16.	Development of geriatric dairy food having prophylactic attribute against Alzheimer's disease	Kaushik Khamrui	DST	2011-14	22.00
17.	Diversity of exopolysaccharides produced by lactic acid bacteria	Pradip Behare	DST	2013-16	21.96

18.	Phylogenetic study of ruminal bacteria and its potential for CLA production and gene expression pattern of linoleic acid isomerase and reductase with different dietary supplementary supplementation and its subsequent utilization as probiotics for animals	A. K. Tyagi	DST	2012- 14	5.00
19.	Understanding role of micro RNA (mRNA) mediated gene regulation during folliculogenesis and lutinization: a comparative study in buffalo and cow.	Dheer Singh	DST-DAAD	2011-14	8.25
20.	Confirmation of lactation performance and animal safety of dairy animals of *Bos* species treated with recombinant bovine samatotropin	A. Manimaran	Eli Lilly Asia Inc. ELANCO Bangalore	2012-14	185.00
21.	Evaluation and improvement of indigenous cattle of Malnad region of Karnataka-DAH&VS	K. P. Ramesha	Govt. of Karnataka Bangalore	2011-13	64.72
22.	Network programme on veterinary type culture (VTC)-Rumen Microbes.	A. K. Puniya	ICAR	2010-13	17.25
23.	Indigenous breed program (Sahiwal cattle)	A. K. Gupta	ICAR	2010-13	25.00
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	50.00
25.	Monitoring of drug residues and other environmental pollutants-outreach project of ICAR	N. K. Goel	ICAR Fund	2009-13	71.00
26.	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	54.06
27.	Status of antibiotic resistance among commercially available probiotic bacteria.	S. K. Tomar	ICMR	2012-15	43.00
28.	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	2012-14	87.26
29.	Evaluating corn hybrid on the quality of silage and growth performance in crossbred calves.	A. K. Tyagi	Monsanto India Pvt. Ltd.	2012 - 13	8.5
30.	Dairy Extension education and services at Farmers' door through mobile extension unit: Action research.	Jancy Gupta	NABARD	2010-13	14.36
31.	Elucidating the physiological and genomic regulation process of follicular development, oocyte maturation and embryogenesis in buffalo.	T. K. Datta	NAIP	2008 -2014	394.18
32.	Characterization and differentiation of embryonic, adult and spermatogonial stem cells in cattle and buffaloes.	M. S. Chauhan	NAIP	2008- -20 14	374.91
33.	Analysis of mammary gland transcriptome and proteome during lactation and involution in indigenous cattle and buffalo for identification of probable mammary biomarkers.	A. K. Mohanty	NAIP	2008 March-14	330.02
34.	Genetic basis of inferior sperm quality and fertility of crossbred bulls.	S. De	NAIP	2009-2014	151.21
35.	Development potency of parthenogenetic goat embryos.	D. Malakar	NAIP	2009- March-14	117.40

36.	Value chain on zone free cloned embryos for quality animal production from elite buffaloes and pashmina goats.	S. K. Singla	NAIP	2009-14	824.11
37.	Development of wireless sensor network for animal management.	T. K. Mohanty	NAIP	2008-14	248.62
38.	Rumen microbial diversity in domesticated and wild ruminants and impact of additives on methanogenesis and utilization of poor quality fibrous feeds.	S. K. Sirohi	NAIP	2008-14	78.89
39.	Development of e-courses for B. Tech.	A.A. Patel	NAIP	2009-14	362.76
40.	Novel Approaches for the production of nutraceuticles from milk and Indian herbs for potential use in functional dairy foods.	A. K. Singh	NAIP	2009-14	230.38
41.	A value chain on composite dairy foods with enhanced health attributes by ICAR.	A. K. Singh	NAIP	2009-14	357.98
42.	Development of biosensors and micro-techniques for analysis of pesticide residues aflatoxin, heavy metals and bacterial contamination in milk.	N. K. Goel	NAIP	2008-14	2256.01
43.	Detection and mitigation of dairy pathogens and detection of adulterants using chemical biology.	Y. S. Rajput	NAIP	2009-2014	158.39
44.	Strengthening statistical computing for NARS.	R. Malhotra	NAIP	2010-March-14	55.24
45.	Strengthening of digital library and information management under NARS (e Granth)	B. R. Yadav	NAIP	Upto March 2014	38.41
46.	Developing commissioning operating & managing an on-line system for NET/ARS Prelim examination by ASRB ICAR	A. K. Srivastava	NAIP	Upto March 2014	32.45
47.	Implementation of management information system (MIS) including financial system (FMS) in ICAR	J. K. Kewalramani	NAIP	Upto March 2014	31.41
48.	E-Publishing and Knowledge System in Agricultural Research.	Meena Malik	NAIP	Upto March 20 14	15.00
49.	Network project on buffalo Improvement-Field Unit (CIRB Hisar-125001).	Avtar Singh	Network	2007-17	60.20
50.	Network project on buffalo improvement-institute herd (CIRB Hisar-125001).	A.K. Chakravarty	Network	2007-17	00.00
51.	Scheme on dairy microbes under network mode.	R. K. Malik	Network	2010-13	95.00
52.	Micro-encapsulation of bacteriocins for their controlled release.	R. K. Malik	NFBSFARA	2011-14	52.75
53.	Investigations on high pressure induced effect on quality characteristics of buffalo milk	A. K. Singh	NFBSFARA	2011-13	66.02
54.	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	77.11
55.	Early detection of pregnancy in cow and buffalo by pregnancy associated proteins (PAPs).	A.K. Mohanty	NFBSFARA	2012-15	200.39
56.	Infertility in crossbred bulls:Search for spermatogenic cell markers for early prediction on fertility.	A.Kumaresan	NFBSFARA	2012-16	241.30
57.	Development of transgenic goat for production of human lactogerrin.	M. S. Chauhan	NFBSFARA	2012-16	253.68
58.	Countering gastrointestinal tract pathogens by adhesion-promoting probiotic surface proteins.	J. K. Kaushik	NFBSFARA	2012-15	123.68
59.	Enhancing development competence of oocytes for better *in vitro* fertilizing ability.	T. K. Datta	NFBSFARA	2013-16	107.17

60.	Imprinted polymers for sensing and removal of selected antibiotic and pesticide residue.	Y. S. Rajput	NFBSFARA	2013-15	28.84
61.	Evaluating the impact of ration balancing on methane emission in dairy animals.	S. S. Kundu	NDDB	2013-14	58.20
62.	Luteinizing hormone based sensor for estrus detection in buffaloes.	Dheer Singh	NFBSFARA	2013-16	141.25
63.	Estimation of hormonal profile, metabolites and milk composition during lactation in bovines and validation of bovine growth hormone RIA Kit.	Mahendra Singh	DAE	2013-15	24.96
64.	Development of strip based detection Tests for selected adulterants and contaminants in Milk	Rajan Sharma	SERB (MOFPI)	2013-14	49.84
65.	Development of parthenogenetic goat from embryonic stem cells.	M. K. Singh	NFBSFARA	2013-17	76.33
66.	Healthy Foods: Production of stable and Active Probiotics.	Surajit Mandal	MFPI	2013-15	35.82
67.	Production of buffalo casein hydrolysates enriched with antioxidative and immunomodulatory peptides and their application for the development of functional beverage.	Rajesh Kumar	MFPI	2013-15	50.00
68.	Mineral bound with based ingredients: Preparation, characterization and application.	Sumit Arora	MOFPI	2013-15	46.85
69.	Development of resilient probiotic foods designed for the Indian Market conditions.	R. K. Malik	DST	2013-15	99.98
70.	Whey to Biofuel: Bioithanal Production by stress tolerant and metabolically engineered yeast from whey.	Shilpa Vij	NFBSFARA	2013014	112.4
71.	Cloning and molecular characterization of buffalo milk lactadherin for augmenting animal fertility.	Aasma Turan	DBT	2013-16	39.35
72.	Recombinant expression of lactobacilli aminopeptidases for the production of bioactive peptides.	J. K. Kaushik	DBT	2013-2016	45.48
73.	Preparedness of livestock rearers among the tribal in Disaster Prone Areas of Uttarakhand.	H. R. Meena	ICSSR	2014-2016	29.23
74.	Development of chromatographic and PCR based methodology to ascertain the Quality of milk fat and its validation under field conditions.	Vivek Sharma	SERB	2013-14	14.85
	Total				**13028.28**

Dr. S. Ayyappan, Hon'ble Secretary DARE and Director General, ICAR felicitated by Director NDRI during Dr. D. Sundaresan Memorial Lecture on 11th February, 2014

7 EMPOWERMENT OF WOMEN AND MAINSTREAMING OF GENDER ISSUES

DAIRY EXTENSION DIVISION

Forty three women empowerment training and campaigns were organized in order to create awareness in the field of dairying and home science and also improve the skills of the farm women so that they could generate more income from dairying and maintain healthy environment in their families. By these programme, 600 farm women were trained.

Name of the Programme	On Campus/ Village	Total Courses Conducted	No. of Participants
Entrepreneurship development and capacity building of farmwomen on small scale production of value added milk products	Women Empowerment Lab.	4	64
Capacity Building of farm-women in scientific dairy farming	Subri, Bazidpur, Shahpur, Bazidpur	16	225
Capacity building of farm women in value added milk products	Subri, Bazidpur, Shahpur, Bazidpur	14	182
Awareness campaign on clean milk production practices	Shahpur	1	14
Capacity building of farm women in fruits and vegetables preservation	Kulwehri, Subri	4	59
Awareness campaign on balanced diet	Subri	1	17
Awareness campaign on child care and nutrition	Kulwehri, Subri	2	27
Awareness campaign in women empowerment through Self Help Group (SHGs)	Amritpur Kalan	1	12
Total		**43**	**600**

A new initiative was taken to establish women empowerment lab for capacity building of different self help groups of NDRI, DRDA and NGOs. This lab was established with the objective to create awareness and impart skills in the field of dairy processing and fruit and vegetable preservation and also mobilize these groups to take up vocation in these areas. For this lab., all items of Dairy Processing Unit viz. Eco Milk Testing Machine, Refractrometer, pH Meter, Moisture Balance were procured.

KRISHI VIGYAN KENDRA (KVK)

- Four off campus training programmes of 1-2 days duration were organized in fruits and vegetables preservation for 130 women in various villages of Karnal district.
- Provided training to 30 women of SC Category in stitching of ladies garment in KVK Damla district Yamuna Nagar (Haryana).
- Training was provided to 20 women in preparation of milk products at KVK Damla district Yamuna Nagar (Haryana).
- A two days training was provided to the 20 women from Gurgaon at HTI, Uchani district Karnal to apprise them about various small enterprises in food processing.
- Four off campus training programmes were organized in various villages of district Karnal for 103 rural women on various topics like storage of food grains, kitchen gardening, child care and milk processing.
- Two training programmes were organized five days duration each on scientific dairy farming for 40 women from state of Himachal Pradesh sponsored by Block Development Office, Choupal, Shimla and Project Director ATMA district Kangra apart one for 30 women from Rajasthan sponsored by Project Director, ATMA, Ajmer at KVK, NDRI Karnal.
- A four day special programme was organized on Scientific Dairy Farming for 40 women from Gujarat sponsored by Project Director, ATMA, district Kutch.
- KVK celebrated World Breast Milk Feeding Week on 5th August 2013 in village Kailash district Karnal in which 62 rural women participated.
- Following on campus training programmes were organized for skill development and entrepreneurship development for women from Karnal district.

Topic	Duration	No. of course	No. of women participants
Preservation of fruits & vegetables	1-3	3	54
Preparation of milk based products	2-5	4	76
Embroidery	14	1	18
Clean milk production	2-3	2	71
Block printing	5	1	19
Food processing	3-4	2	31
Preparation of low cost nutritious recepies	2	1	18
Total			**287**

On-campus training programme organized for women at NDRI

8 PUBLICATIONS

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LIVESTOCK PRODUCTION MANAGEMENT

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Dr. N. N. Dastur Memorial Oration Award to Dr. V. M. Katoch, Director General, ICMR

Dr. K. K. Iya Memorial Oration Award to Dr. S. K. Bandyopadhyay, Member, Agricultural Scientist Recruitment Board

9 CONSULTANCY, PATENTS & COMMERCIALISATION OF TECHNOLOGIES

Industrial Consultancy Services

In year 2013-14, 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. During **2013-14**, the Institute provided services to 184 organizations and generated a total revenue of **₹ 1, 54, 42, 239/-.**

Institute Technology Management Committee (ITMC)

ITMC is highest decision making body at the institute level for the all mandatory decisions related to intellectual property management and commercialization, etc. ITMC/ITMU encourages inventors to submit patent applications. The pricing of technology is also decided by ITMC. During the year 2013-14, five ITMC meetings were held on 1st April, 2013, 7th June 2013, 25th July, 2013, 27th September, 2013 and 15th February, 2014. Patent applications are examined during ITMC meetings for their novelty and commercial applicability before these are being recommended for submission to patent office.

Transfer of Technology

The following technologies were commercialized

S. No.	Title of Technology Commercialized	Mode of Transfer (MoU/ Licensing Agreements Signed)	Purchaser of Technology	License Fee
1.	A novel selective medium and micro-technique for detection of *Enterococci* in milk	5th July, 2013	Neugen Diagnostics (India) Pvt. Ltd. Hyderabad	₹ 7,50,000
2.	Two stage enzyme based assay" for detection of *L. monocytogenes*in milk	5th July, 2013	Neugen Diagnostics (India) Pvt. Ltd. Hyderabad	₹ 3,50,000
3.	Iron fortified biscuits	5th July, 2013	Shree Shivani Agro. Indore, M.P.	₹ 55,000
4.	Cation & anion mineral mixture	15th July, 2013	Kamdhenu Feeds, Saharanpur, U.P.	₹ 25,000
5.	Cation & anion mineral mixture	15th July, 2013	Shree Jee Feed Supplements, Jaipur, Rajasthan	₹ 25,000
6.	Cation & anion mineral mixture	12th February, 2014	Shakti Livestock Feeds (P) Ltd., Meerut U.P.	₹ 1,00,000
7.	New colour based test for rapid detection of detergent in milk	19th March, 2014	Rajasthan Co-operative Dairy Federation Ltd., Jaipur	₹ 6,00,000

NDRI Industry Meet

The scientists at NDRI have developed a number of technologies that have relevance in milk quality, milk safety, health foods, fortified milk products, dairy equipments, mineral mixtures, etc. These technologies were presented before officials from industries in NDRI – Industry Meet organized on 6th January, 2014. The industries have shown interest in technologies of detergent detection test, strip test for neutralizers, strip test for urea, antibiotic detection in milk, whey-mango beverage, whey jaljeera mix, bajralassi, butter melter, ghee making machine, feed blocks and mineral mixtures. The live demonstrations of detergent test and strip test for detection of neutralizers and urea in milk were given to impress upon the simplicity in adaption of test by dairy industry. The industrial participation was from Rajasthan Co-operative Dairy Federation Ltd, Jaipur; Delhi Milk Scheme, Delhi; Hetauda Dairy Industries (P) Ltd. Nepal; Kamdehnu Hitkari Manch, Bilaspur, Himachal Pardesh; MART, Noida; Green Agri Miles Pvt. Ltd., New Delhi and Sachdeva Milk Dairy, Sangrur. Dr. G.R. Patil, Joint Director inaugurated the meet.

Patent Applications Submitted to Patent Office

1. A novel enzyme substrate based rapid assay for detection of *L. monocytogenes* in milk. (Patent Application No. 1357/DEL/2013)
2. Aptamers specific for aflatoxin M1 and B1. (Patent Application No. 1864/DEL/2013)
3. A peptide with osteoanabolic and antiresorptive activity. (Patent Application No. 2778/DEL/2013)
4. A strip based detection of added urea in milk and process for the same. (Patent Application No. 3472/DEL/2013)
5. Aptamer specific for Betacasomorphin7 (BCM7). (Patent Application No. 3703/DEL/2013)

List of Patent granted

1. Process for manufacture of spray dried cheddar flavour base/ concentrate. **(Patent No. 257068, 30-08-2013)**
2. Lab scale process for preparation of low cholesterol ghee. **(Patent No. 257783, 01.11.2013)**
3. A PCR based method of differentiating cow and buffalo milk. **(Patent No. 257958, 22.11.2013)**

The following were assessed and transferred by the Extension Division of NDRI

- Timely heat detection in dairy animals
- High yielding location specific fodder crops
- Scientific calf rearing practices
- Information system on clean milk production
- Scientific udder health management practices
- Value added dairy based food products

Transfer of MOU between NDRI and RCDF: Sh. Pritam Singh - MD, RCDF and Principal Secretary, Dairy Development, Govt. of Rajasthan representing RCDF and Dr. G.R. Patil, Joint Director (Acad) representing NDRI

NDRI Industry Meet organised on 6th January, 2014

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. Strategic planning of research endeavours and research infrastructure development; establishment of linkages with research organizations at national and international levels; research monitoring through internal and external mechanisms; development of research database and technology bank and research documentation by undertaking publications of the Institute are the major functions existing and visualized to achieve the mandate of the Institute by R&D activities.

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 4th February, 2013 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 5th - 8th August, 2013 at NDRI, Karnal, 12th August, 2013 SRS, Bangalore and 23rd July, 2013 ERS, Kalyani, respectively. IRC meetings were chaired by Dr. A. K. Srivastava, Director/or Dr. G. R. Patil Joint Director (Res.), NDRI Karnal.

National Agricultural Innovation Project (NAIP)

There are nineteen NAIP projects; in which NDRI is either a lead centre or consortium partner. Although major thrust of NAIP projects at NDRI is on basic and strategic research, but with the award of NAIP project on 'e-courses on Dairy Technology, dairy education will also get boost. A number of laboratories have been renovated and high cost equipments have been procured under this programme. The facilities are being used by scientists and students in pursuing research work in front line areas such as cloning, stem cell, nanotechnology, biosensor, proteomics and genomics.

Consortium Implementation Committee (CIC) and Consortium Advisory Committee (CAC) meetings were held regularly to (i) address administrative problems (ii) to provide technical guidance and (iii) to monitor progress. CAC is headed by renowned scientist external to ICAR system. It has provided opportunity to NDRI to develop linkages with IITs and CSIR laboratories.

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.

Database Management

A database of research projects was updated for all the projects in operation during the year 2013. 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 and six monthly reports submitted to ICAR.

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 2012-2013 was 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 during this period. The unit also prepared reports on research achievements of NDRI for inclusion in ICAR/DARE Annual Report 2013-2014. 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 month; 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 (2013) 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 report on mid-term review of XI plan; initiated the exercise for formulation of XII plan EFC memo document of the Institute; Prepared action taken reports on recommendations emerged during the meetings of QRT/RAC/Visit of DDG (AS) at Regional Stations/Governing Body/ Director's Conference/BOM of NDRI/Regional Committee ICAR; 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 for submission to National Director NAIP for Monitoring and Evaluation System for NAIP, ICAR with the objective to make ICAR as the Catalyst Agent for Management of Change in the Indian National Agricultural Research System. This unit prepared replies to Parliament questions 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.

'Swarn' male cloned calf with the team of scientists that produced it

Sh. Shashank Anand, Supdt. of Police, Karnal launching iron and vitamin fortified milk at the milk parlour

11 HUMAN RESOURCE DEVELOPMENT

Scientists/Officers/Scholars Trained Abroad

Dr. A. K. Srivastava, Director NDRI, Karnal participated in CGIAR Livestock and Fish Annual Review Meeting at Ethiopia during 20th - 22nd May, 2013.

Dr. A. K. Puniya, Principal Scientist, Dairy Microbiology Division was deputed for training on "Development of Molecular Markers for Identification of Rumen Fungi" at U.K. from 11th May to 2nd November, 2013.

Mr. Pravin Sawale, Ph.D. (Dairy Technology) participated in the 6th International Granulation Conference at The University of Sheffield, United Kingdom w.e.f. 26th - 28th June, 2013.

Dr. Sohanvir Singh, Principal Scientist, DCP Division, NDRI, Karnal attended the training in the area of "Carbon Stock Assessment (Carbon Financy)" at Phillipines from 8th - 15th July, 2013.

Dr. Bimlesh Mann, Principal Scientist, DC Division participated and presented a paper at Joint Annual Meeting 2013 of the American Dairy Science Association (ADSA) and American Society of Animal Science (ASAS), Indiana Convention Center, Indianapolis, Indiana, USA from 8th - 12th July, 2013.

Dr. S. K. Sirohi Principal Scientist, DCN Division presented lead talk in the Fourth International Conference on "Sustainable Animal Agriculture for Developing Countries (SAADC 2013)" held at Lanzhou University, Lanzhou, China from 27th - 31st July, 2013.

Dr. Rajan Sharma, Senior Scientist, DC Division, NDRI, Karnal was deputed to attend Khurama Programme Technology Transfer Course at University of Wisconsin-Madison (UW), USA from 20th July to 8th August, 2013.

Dr. Naresh Kumar, Principal Scientist, DM Division was deputed to attend 21st session of Codex Committee on Residue of Veterinary Drugs in Foods (CCRVDS) at USA from 26th - 30th August, 2013.

Dr. A. K. Srivastava, Director, NDRI, Karnal was deputed to attend the consultation meeting on "Farm Animal Genetics Resources Evaluation Conservation and Management in SAARC Countries" at Sri Lanka from 5th - 6th September, 2013.

Dr. A. K. Tyagi, Principal Scientist, DCN Division, NDRI, availed Erasmus Mundus Scholarship in Food Science Technology & Nutrition at Belgium from 16th - 30th September, 2013.

Dr. A. K. Srivastava, Director, NDRI, Karnal participated in the Regional Workshop on "Youth and Agriculture Challenges and Opportunities" at Isalambad, Pakistan from 23rd -24th October, 2013.

Dr. A. K. Tyagi, PS, DCN Division, NDRI participated in the International Livestock Nutritional Conference at Lahore, Pakistan from 23rd - 24th October, 2013.

Dr. B. S. Chandel, PS, DESM Division, NDRI participated in the conference on "Mainstreaming Livestock Value Chain" ACCRG, Ghana from 5th - 6th November, 2013.

Dr. A. K. Chakravarty, PS & I/C ABRC participated in the sixth meeting on "High Yielding during Buffaloes Semen Collection, Quality Assurance, Preservation and Transportation" at Dhaka, Bangaldesh from 16th - 17th November, 2013.

Mr. Tanedjeu Sonfack Kemgang student of **Dr. Suman Kapila,** Principal Scientist, Animal Biochemistry Division, got **"Travel Grant Award"** for presenting poster entitled, "Comparative Evaluation of Immunomodulatory Potential of three Probiotic Lactobacilli Strains" in the 2013 Fall Conference of the Korean Association of Immunologist held at Seoul, Korea from 7th – 8th November, 2013.

Dr. R. K. Malik, Head, DM Division, NDRI Karnal availed Eraasumu Mundus Scholarship Programme at Hochsscule, Anhalf (FH) in Koethen, Germany on "European Programme Commission in Food Science and Nutrition" from 8th – 21st May, 2013.

Dr. Dheer Singh, PS, ABC Division participated 10th World Buffalo Congress and 7th Asian Buffalo Congress during 6th – 8th May, 2013 at Thailand.

Dr. Dheer Singh, PS, ABC Division to attend the Workshop on Indo German (DST-DAAD) Joint Research Project from 1st – 30th June 2013.

Dr. Mohan Mandal, Sr. Scientist, ERS, Kalyani participated in the Workshop on "Reproductive

Biotechnology for Agricultural Research" at SARDI, Australia from 11th – 14th February, 2014.

Dr. A. K. Srivastava, Director, NDRI, Karnal was invited to deliver a lecture on "Dairying in India: The White Gold for Nutritional Security" at University of Hong Kong, on 17th February, 2014 at School of Biological Sciences the University of Hong Kong.

Dr. A. K. Srivastava, Director, NDRI, Karnal was invited to speak at the Riddit Institutes Agrifood Summit in Wellington, New Zealand and to visit the Riddit Institute in Palmerston North to discuss collaborative research programme during 19th – 21st February, 2014.

Ms. Kiran Thakur participated in Hands on Workshop on "New Approach for Microbial Study organized by Singapore Society for Microbiology and Biotechnology" on 25th - 26th September, 2013. Department of Microbiology, Yong Loo Lin School of Medicine, National University of Singapore National University of Singapore, Singapore

SCIENTISTS/OFFICERS PARTICIPATION IN WORKSHOPS/SEMINARS/ CONFERENCES/TRAININGS WITHIN INDIA

Name & Designation	Title of Workshop/Seminar/ Conferences Training	Period
Dr. M. S. Chauhan, PS	Delivered lecture on "Stem Cell and Cloning in Farm Animals in Biotechnology" at Jharnapani, Nagaland	3rd April, 2013
Dr. M. S. Chauhan, PS Dr. A. K. Mohanty, PS Dr. D. Malakar, PS	Delivered lecture in the National Symposium on "Emerging Trends in Biotechnology" at IVRI Izatnagar.	8th -10th April, 2013
Dr. Pawan Singh, PS Dr. T. K. Mohanty, PS Dr. R. K. Baithalu, PS	Workshop on "Advancement in Semen–analysis and Production" at New Delhi organized by IMV.	16th April, 2013
Dr. M. A. Kataktalware, PS Dr. S. Subash , PS Dr. S.Varalakshmi, PS	International Conference on "Thrust Areas in Veterinary Research, Education, Regulatory Reforms and Governance for Quality Services to Farmers" at IAH&VB, Hebbal, Bangalore.	16th-17th April, 2013
Dr. M. L. Kamboj, PS	National Conference on "Animal Disaster Management" at FICCI, New Delhi.	17th -18th April, 2013
Dr.(Mrs) Bimlesh Mann, PS Dr. Gautam Kaul, PS	Presented a paper entitled "Application of Nanotechnology" in Brainstorming Workshop of NASC New Delhi.	23rd April , 2013
Dr. Naresh Kumar, Sr. Sci.	Indian Agri-business Incubation Conference (NIABI 2013) at Hyderabad.	26th April , 2013
Dr. Dheer Singh, PS	DBT-HRD Program at Department of Animal Biotechnology, LLR University of Veterinary & Animal Sciences, Hisar.	26th April, 2013
Mrs. Ritu Chakravarty, Sr. Sci. Dr. B. S. Meena, Sr. Sci. Dr. Gopal Sankhala, Sr. Sci. Dr. S. K. Jha, Sr. Sci. Dr. Asif Mohammad, Sci.	Brain Storming session on "Development in Agricultural Extension and Research" held at IARI, New Delhi.	26th April, 2013
Dr. H. R. Meena, Sci.	National Seminar 2013 on "Social Dimensions of Extension Education in Holistic Development of Rural Livelihood", held at Chandra Bhanu Gupt Agriculture PG collage, Bakshi Ka Talab, Lucknow, UP.	26th – 27th April, 2013
Dr. B. Surendra Nath, PS Dr. K. Jayaraj Rao, PS Mrs. M. K. Vedavathi, Sci. Mrs. Vimala, Sci.	National Seminar on "Changing Scenario of Dairy and Food Standards in the Backdrop of FSSAI Act 2006" at Dairy Science College, Bangalore.	26th – 27th April, 2013
Dr. O. K. Hooda, PS	Workshop on "Climate Resillient Shelter & Stress Management in Small Ruminants in Hot and regions of India" at CSWRI, Avikanagar.	2nd May, 2013

Dr. Rubina Kumari Baithalu, Sci.	Three months Professional attachment training on a mandate area of NDRI as a part of Module of FOCARS at CIFA, Bhubaneshwar	17th May to 16th August, 2013
Dr.(Mrs.) Meena Malik, Associate Professor	Presented a paper at "ELT Conference on 'Who', 'What, 'How ELT in the Global Context at Amity University Lucknow.	18th -19th May, 2013
Sh. Mithlesh Kumar, Sr.F&AO	Training Programme on "Financial Management & Audit Sensitization" at A-52, Sector 62, Institutional Area, Phase-II, Noida (UP)	20th – 24th May, 2013
Dr. T. K. Mohanty, PS Dr. A. Kumaresan, PS Dr. Mani Maran, Sci.	M/s ELANCO sponsored rBST Studies Review Meeting at NASC Complex, Pusa, New Delhi.	31st May, 2013
Dr. S. Subash, PS	Workshop on "Extension Strategies to Strengthen Animal Husbandry and Fisheries Sectors" held at MANAGE, Hyderabad.	20th - 21st June, 2013
Dr. P. S. Minz, Sci.	National Seminar on "New Vistas in Food Processing with Quality Assurance for Augmenting Rural Prosperity" held at Maharana Pratap University of Agriculture & Technology (MPUA&T), Udaipur.	21st – 22nd June, 2013
Dr. M. Mondal, Sr. Sci. Dr. A. Chatterjee, Sr. Sci.	First International and Third National Conference on "Biotechnology, Bioinformatics and Bioengineering" held at Tirupati, Andhra Pradesh.	28th-29th June ,2013
Dr. K. K. Datta, Head Dr. Rajan Sharma, PS	Foundation Day Celebrations at Southern Regional Station, of NDRI, Bangalore.	1st July, 2013
Dr. S. K. Tomar, PS	90th year of establishment by SRS, NDRI, Bangalore	1st July, 2013
Dr. Narender Raju Panjagari, Sci.	Training programme on "Testing and Quality Evaluation of Packing Material" at Mumbai.	11th - 12th July, 2013
Dr. A. Manimaran, Sci.	Emerging & Transboundary Diseases of Global Importance Organized by Tamil Nadu Vety. & AS University at Madras Vety. College, Chennai.	15th - 16th July, 2013
Dr. Mukesh Bhagat, Sr. Sci.	Refresher Course on "Agricultural Research Management" at NAARM, Hyderabad.	15th - 27th July, 2013
Dr. Rajan Sharma, PS Dr. Naresh Goel, PS Dr. Raghu, H.V. Sci.	Presented the technology of "Detection of detergent in milk" during Agri-Tech Investors Meet at NASC Complex, New Delhi.	18th -19th July, 2013
Dr. (Mrs.) Meena Malik, Associate Professor	Made Oral Presentation at 8th International and 44th ELTAI Conference on "21st Century Learners Learning Styles and Strategies" at SRM University, Chennai.	18th – 20th July, 2013
Dr. Dheer Singh, PS	Symposium on "Impact of Endocrine Disruptors on Reproductive Health" at Department of Reproductive Biology, All India Institute of Medical Sciences, New Delhi.	20th July, 2013
Dr. S. K. Tomar, PS	Third Annual Review Workshop of "National Fund For Basic Strategies & Frontier Application Research in Agriculture" held at NASC, New Delhi	22nd – 23rd July, 2013
Dr. R. K. Malik, Head Dr. S. K. Tomar, PS Dr. Latha Sabikhi, PS	India Dairy Summit, 2013 on "Sustainable and Inclusive Solutions towards a Second White Revolution" Organized by Confederation of Indian Industry, Hotel Lalit, New Delhi	24th July, 2013
Dr. V. K. Gupta, Head	Annual Workshop of CAFT Directors, organized by the Agricultural Education Division of ICAR on the theme "ICT for Capacity Building in Agricultural Education" IASRI, New Delhi.	26th – 27th July, 2013
Dr.(Mrs.) Madhu Mohini, PS	Workshop on "IPCC Green House Gas Ubvebtirt Traububg" at India Habitat Centre, New Delhi	29th – 31st July, 2013
Dr. Dheer Singh, PS	DBT sponsored BIRAC-CDSA regulatory meet "From Science to Commercialization" at Delhi.	30th - 31st July, 2013

Dr. D. Malakar, PS	International Conference and to deliver talk on a research paper at Kottayam, Kerala.	9th -11th August, 2013
Dr. S. Kulkarni, Head Dr. B. Surendra Nath , PS Dr. P. K. Dixit, PS Dr. K. P. Ramesha, PS Dr. B. Srinivas, PS Dr. M. Sivaram, PS Dr. M. C. A. Devi, PS Dr. S. Jeyakumar, PS Dr. M.A. Kataktalware, PS Dr. S. Varalakshmi, PS Dr. S. Subash, PS Mr. Chitranayak, Sci. Mr.. B. R. S. Murthy, Sci. Mr. K. L. Sampath, Sci.	South Asia's 3rd Feed Dairy & Livestock Industry Congress, held at Dairy Tech. India 2013, at BIEC, Bangalore.	24th August, 2013
Dr. A.K. Dodeja, Head Dr. I. K. Sawhney, PS Dr. B.C. Ghosh, PS Dr. P.S. Minz, Sci.	National Seminar on "Mechanized Production of Indian Dairy Products" held at Hotel Hilton, Mumbai.	2nd -3rd September, 2013
Dr. I. K. Sawhney, PS	Annual Convention of Dairy Engineers-2013 at Hotel Hilton, Andheri, Mumbai.	2nd -3rd September, 2013
Sh. Pradeep Behare, Sci.	7th Asian Conference on "Lactic Acid Bacteria" at Indian Habitat Centre, New Delhi.	6th -8th September, 2013
Dr. Narender Raju Panjagari, Sci.	National Nutrition Week one day seminar and to deliver a talk on "Good Nutrition & Quality of Milk Issues & Solution" at Jaipur (Rajasthan)	7th September, 2013
Dr. K. K. Datta, Head Dr. B. S. Chandel, PS Dr. A. K. Chauhan, PS	21st Annual AERA Conference "Sustainable Agricultural Growth for Improving Rural Livelihood Security at Sher-e-Kashmir, Univ. of Sci. & Technology of Kashmir, Srinagar.	10th -12th September, 2013
Dr. M.A. Kataktalware, PS	Participated in the Interface Meet of Scientists with Veterinary Officers of Karnataka, Entrepreneurs and Malnad Gidda Farmers' organized by IVRI, Izatnagar and SRS of NDRI, Bangalore at Sirsi, North Kanara, Karnataka.	16th September, 2013
Mrs. M. K. Vedavathi, PS Mrs. Vimala, PS	Technical workshop on "Risk based Approaches for Food Safety Management" at Hindustan Unilever, Bangalore.	18th September, 2013
Dr.(Mrs.) Madhu Mohini, PS Dr. S. N. Rai, Emeritus Scientist	National Conference on "Nutrition Health Interactions for optimum Livestock Production and Human Welfare" at Sher-e-Kashmir, Univ. of Sci. & Technology of Kashmir, Srinagar.	19th- 21st September, 2013
Sh. J. K. Kewalramani, Joint Director (Admn.) & Registrar	Workshop on "Right to Information Act, 2005" at ISTM, JNU (Old) Campus of Palms Marg, New Delhi.	23rd September, 2013
Dr. M. Sivaram, Sr. Sci.	Training Programme on "Data Analysis using SAS Software (SAS for NARS)" at Project Directorate of Animal Disease Monitoring and Surveillance (PDADMAS), Hebbal, Bangalore.	24th-28th September, 2013
Dr. A. K. Singh, Sr. Sci.	National Workshop on "Skilling India for Next Decade…Frame Work" at Hotel Ashoka, Chankayapuri, New Delhi.	30th September, 2013
Dr. Rajan Sharma, PS	Meeting with FSSAI Officials to discuss the food additives of various standards such as milk fat, evaporated milk, sweetened condensed milk, fermented milk, whey powder, milk powder, edible casein and cheese.	1st October, 2013

Dr. Surajit Mandal, PS Dr. Pradip V. Behare, Sci.	6th International Conference on "Fermented Foods, Health Status and Social Well Being" at AAU, Anand	6th October, 2013
Dr. S. Kulkarni, Head Dr. C. N. Pagote, PS Dr. B. Surendra Nath, PS Dr. P. K. Dixit, PS Dr. K. P. Ramesha,PS Dr. B. Srinivas, PS Dr. M. Sivaram, PS Dr. S. Jeyakumar, PS Dr. S. Subash, PS MR. B. R. S. Murthy, Sci.	Dairying in India: "Driver for Agricultural Growth" program Organized by IDA (SZ) at Bangalore.	11th October, 2013
Dr. Vivek Sharma, PS Dr. Rajesh Kumar, PS	Seminar on "Food Analysis" held at Hotel Jaypee Sidharath, Delhi.	14th October, 2013
Dr.(Mrs.) Meena Malik, Associate Professor	NAIP sponsored National Training Workshop on "Scientific Report Writing and Presentation" at NAARM, Hyderabad.	17th – 22nd October, 2013
Mr. G. S. Meena, Sci.	National training on "Application of High Pressure and Pulsed Light Technology Technologies for Food Processing at C.I.F.T, Cochin.	18th – 31st October, 2013
Dr. Mohan Mondal, Sr. Sci. Dr. Anupam Chatterjee, Sr. Sci. ERS Kalyani	2nd International Conference on "Agriculture Food Technologies & Environment –New Approaches" (AFTENA- 2013) held on at Jawaharlal Nehru University, New Delhi.	19th -20th October, 2013
Dr. M. K. Singh, PS	Gave a talk on Cell Sorting by flowcytometry at Nanaji Deshmukh JNKVV Campus, Adhartal, Jabalpur, M.P.	21st October, 2013
Dr. M. Manjunath, Sci.	Training programme on "Advances in Experimental Design for Development of Technology in Agriculture" at IASRI, New Delhi.	23rd October to 21st November, 2013
Dr. M.C.A. Devi, PS Dr. S. Subash, PS	8th National KVK Conference at UAS, Bangalore.	23rd - 25th October 2013
Dr. I. K. Sawhney, PS Dr. A. K. Sharma, I/c Computer	International Conference on "Mathematical Techniques in Engineering Application (ICMTEA-2013)" at Graphic Era Hills University Dehradun.	24th – 25th October, 2013
Dr. P. N. Raju, Sci.	Orientation Workshop for "Business Planning & Development Units in NARS" organized by NAARM at Hyderabad.	24th – 26th October, 2013
Dr. P. N. Raju, Sci.	Hands on Experience cum Training on "Business Incubation" conducted jointly by NAARM, Hyderabad & CIFT, Kochi.	25th October, 2013
Dr. M. S. Chauhan, PS	Delivered lecture in the workshop to be a resource person on "Basic Techniques……Cultures" at D.A.V. College, Amritsar.	29th -30th October, 2013
Dr. B. C. Ghosh, PS	Seminar on "The Future of Health & Wellness - Nutraceuticals & Functional Foods" at Hotel Le Meridien, Bangalore organised by Bangalore Chamber of Industry and Commerce.	7th November, 2013
Dr. K. K. Datta, Head	National Seminar on "Agri-Business Potential for North Eastern States" at Agricultural University of Barapani, Meghalaya.	8th – 9th November, 2013
Dr. Rajan Sharma, PS Dr. K. Jayaraj Rao , PS Dr. Shaik Abdul Hussain, Sci.	Made Presentation at "Dairy Summit 2013" organized by GLAD Events in Association with Dairy Technology Society of India (DTSI) at Hyderabad.	9th -10th November, 2013
Dr. Gautam Kaul, PS	Conference on "Medical Biochemistry" and to deliver talk at CMC Ludhiana.	14th November, 2013

Dr. Raghu H.V., Sci.	Conference on "Bioactive Compound & Functional Food in Health and Disease Management" at NIFTEM, Kundli.	15th -16th November, 2013
Dr. B. C. Ghosh, PS	International Humboldt Kolleg on «Bench to Bedside Translational Research – Potential Benefits of Interdisciplinary Collaboration" at Kasturba Medical College, Manipal.	15th -17th November, 2013
Dr. I. K. Sawhney, PS Dr. A. K. Sharma, I/c Computer	7th International Conference on "Advanced Computing and Communication Technology ICACCT-2013" at APIIT, Panipat.	16th November, 2013
Dr. R. K. Malik, Head	Regional Level Science Congress – 2013 organised by Jawahar Navodaya Vidyalaya at Niwarsi, Distt. Kurukshetra.	16th November, 2013
Dr. Raghu H.V., Sci.	International Symposium on "Frontier Discoveries and Innovations in Microbiology and its Interdisciplinary Relevance (FDMIR-2013)" at MDU, Rohtak.	17th – 21st November, 2013
Dr. M. Sivaram, Sr. Sci.	Discussion Meeting of the project "Inventory of Tree Volume and Biomass Allometric Equations for South Asia" at Kerala Forest Research Institute, Peechi.	18th-19th November, 2013
Dr. Mahendra Singh, PS Dr. Parveen Kumar, PS Dr. Sohan Vir Singh, PS Dr. S. K. Tomer, Sr. Sci. Dr. Mukesh Bhagat, Sr. Sci	XII Annual Conference and National Symposium on "Physiological and Nutri-genomic Interventions to Augment Food Security and Animal Welfare" at DDUPC VV, Mathura.	19th – 21st November, 2013
Dr. R. C. Upadhyay, Head Dr. A. Kumaresan, Sr. Sci. Dr. A. Manimaran, Sci. Dr. T. K. Datta, PS Dr. Dheer Singh, PS	13th Annual Conference of ISVPT and National Symposia on "Biopharmaceuticals and Nanotechnology in Theraoeustics and Development of Anti Cancer Drugs from Botanicals" at Veterinary College, SKUAST, Jammu.	20th – 22nd November, 2013
Dr. A. K. Sharma, I/c Computer	Training of Nodal Officers under the aegis of NAIP Sub Project "Developing…Examination" at ASRB New Delhi.	21st- 22nd November, 2013
Dr. Archana Verma, PS	Presented research paper on "Genetic Variability in ……Murrah Buffalo" organized by Department of Biotechnology at Moti Lal Nehru National Institute, Allahabad.	21st -23rd November, 2013
Dr. A. K. Mohanty, PS	National Seminar on 'Crystallography' at J.L.N.U. New Delhi.	21st -23rd November, 2013
Dr. R. K. Malik, Head	International Conference on "Women and Development" organised by Punjabi University, Patiala.	23rd November, 2013
Dr. K. Ponnusamy, Head Dr.(Mrs.) Latha Sabikhi, PS	Management Development Programme on "Leadership Development" at NAARM Hyderabad.	26th November, 2013 to 7th December 2013
Dr. Dheer Singh, PS	A National Symposium on "Recent Advances in Reproductive Health, Zoology" at Banaras Hindu University, Varanasi.	28th - 30th November, 2013
Dr. A. K. Sharma, I/c Computer	Delivered expert lecture in the Training programme "Development of Web….Management" at IASRI, New Delhi.	30th November, 2013
Dr.(Mrs.) Shilpa Vij, Sr. Sci.	Conference on "8th International Conference on Yeast-2013 at Chandigarh.	4th -7th December, 2013
Dr. M.C.A. Devi, PS Dr. S. Subash, PS Dr. S. K. Jha, Sr. Sci. Dr. Rakesh Kumar, Sr. Sci.	3rd International Conference on "Extension Educational Strategies for Sustainable Agricultural Development: A Global Perspective" held at University of Agricultural Sciences, Bangalore.	5th -8th December, 2013
Dr. Kaushik Khamrui, Sr. Sci. Sh. Pradeep Behare, Sci.	6th International Conference on "Fermented Food, Health Status and Social Welfare" at Anand.	6th -7th December, 2013

Dr. V. K. Gupta, Head	Workshop on "Cross Cutting Experiences" in ICT sub-projects under NAIP at New Delhi.	6th -7th December, 2013
Dr. M. A. Kataktalware, PS	International Conference on "Extension Educational Strategies for Sustainable Agricultural Development – A Global Perspective" organized by the University of Agricultural Sciences, Bangalore and International Society of Extension Education at UAS, GKVK, Bangalore.	5th -8th December, 2013
Dr. R. C. Upadhyay, Head	Guest Speaker on the topic "Environmental Stressons on Yaks" during training programme on "Yak Welfare in Transhumance Rearing System" at Dirang, Arunachal Pradesh.	9th December, 2013
Sh. S. George, Comptroller	Training Programme on "Financial Management & Audit Sentization" at International Centre for Information System and Audit (ICISA) Noida.	9th – 13th December, 2013
Dr. A. Kumaresan, Sr. Sci.	Sensitization on "E-course for B.V.Sc.& AH Degree Programme" at Madras Veterinary College, Chennai.	10th December, 2013
Dr. Parveen Kumar, PS	General Body Meeting and the Annual Conference on "Indian Dairying: Growth and Trade Issues" at Chennai Trade Centre, Chenai, Tamil Nadu.	12th - 14th December, 2013
Dr. R. K. Malik, Head Dr. S. Kulkarni, Head Dr. Sohan Vir Singh, PS Dr. K. S. Kadian, PS Dr. S. K. Kanawjia, PS Dr. C. N. Pagote, PS Dr. P. K. Dixit, PS Dr. K. P. Ramesha, PS Dr. B. Srinivas, PS Dr. M. Sivaram, PS Dr. S. Varalakshmi, PS Dr. S. Subash, PS Dr.(Mrs.) Shilpa Vij, Sr.Sci. Mrs.Vimala, Sci. Mrs. Vedavathi M.K, Sci. Mr. K. L. Sampath, Sci.	42nd Dairy Industry Conference organized by IDA (South zone) at Chennai Trade Centre, Chennai.	12th - 14th December, 2013
Dr. Bimlesh Mann, Head	Presented research proposal entitled "Preparation and …..Foods" at IIT, Madras.	13th December, 2013
Dr.(Mrs.) Madhu Mohini, PS	National Symposium on "Productivity Enhancement Improved Animal Health and Nutrition" at Lucknow	13th – 15th December, 2013
Dr.(Mrs.) Jancy Gupta, PS Dr. I. D. Gupta, PS	National Seminar on "New Technology of Agricultural and Allied Sciences: Achievement & Challenges" at CIFE, Mumbai.	14th – 16th December, 2013
Sh. Vishal Acharya, AF&AO	Special Training Programme on "Financial Issues" at NIFM, Faridabad.	16th – 20th December, 2013
Dr. Rajeev Kapila, Sr. Sci. Dr. A. K. Dang, Sr. Sci.	5th Congress of Federation of India Physiological Societies on Physiology Ethnopharmacology Biotechnology & Health Therapecutics" at S.V. University, Triputi (AP).	17th -19th December, 2013
Dr. P. Heartwin Amaladhas, PS Dr. S. Varalakshmi, PS	IFCON International Conference held at Mysore Organized by Central Food Technological Research Institute and presented a poster.	18th -19th December, 2013
Dr. S. K. Tomar, PS	Global Consultation on "Millets Promotion for Health & Nutritional Security" held at Directorate of Rice Research (DRR), Rajendranagar, Hyderabad.	18th -20th December, 2013

Dr. Bimlesh Mann, Head Dr. Vijay Kumar Gupta, PS Sh. Devaraja H.C., Sci. Dr. Raghu H.V., Sci. Sh. Sathish Kumar MH, Sci. Dr. Yogesh Khetra, Sci.	7th International Food Convention (IFCON-2013) on "Nutritional Security through Sustainable Development Research & Education for Health Foods" Association of Food Scientists and Technologists (India), Mysore, Karnataka.	18th -21st December, 2013
Dr. Bimlesh Mann, Head Dr. K. Jayaraj Rao, PS	International Conference on "Food Technology Impact on Nutrition and Health (IFCIN-2013) at JNU, New Delhi.	23rd– 24th December, 2013
Dr. Y. S. Rajput, Head, ABC Dr. Naresh Kumar, Sr. Sci. Dr. A. K. Singh, Sr. Sci.	Workshop on "Valuation and Pricing of Technologies" at NASC Complex, New Delhi.	26th December, 2013
Dr. K. K. Datta, Head	Annual International Conference on "Education Diversity and Democracy" at Department of Eco. Uni. of Colcatta at ISI, Kolkata.	28th – 30th December, 2013
Dr. Rajan Sharma, PS	Brainstorming Meet on "Functional Value of Camel Milk as Compared to Milk of different Species – Cow, Buffalo, Goat and Sheep" at National Research Center on Camel at Bikaner.	3th January, 2014
Dr. Shiv Prasad, PS Dr. A. Kumaresan, Sci.	Interface meeting on "Improvement of Production and Health of Tharparkar Cattle" at CAZRI, Jodhpur.	5th - 7th January, 2014
Dr. K. S. Kadian, PS	National Seminar on the theme "Reorientation of Agricultural Research to ensure National Food Security" at HAU, Hissar.	6th -7th January, 2014
Dr. T. K. Mohanty, PS Dr. Rubina Kumari Baithalu, Sci.	National Symposium on "Fronties Reproductive Biotechnology for Enhancing Animal Fertility and Fecundity: Global Perspective an XXIV Annual Convention of the Indian Society for Study of Animal Reproduction" at Nagpur.	8th – 10th January, 2014
Dr. Y. S. Rajput, Head Dr. Rajan Sharma, PS Dr. Naresh Goel, PS Dr. Raghu, H.V., Sci.	2nd International Conference on "Emerging Food Safety Risks: Challenges for Developing Countries and Workshop on Food Safety & Quality", NIFTEM, Kundli.	9th – 11th January, 2014
Dr. K. P. Ramesha, PS	Brainstorming Workshop on Strategy related to "Conservation and Productivity Enhancement of farm Animal Genetic Resources" at NASC, New Delhi.	10th January, 2014
Dr. Dheer Singh, PS	Workshop on "Panel with Course Directors of National Training" under NAIP at PUSA, New Delhi	13th January, 2014
Dr. Naresh Kumar, Sr. Sci.	CAC Meeting proposed at BITS, Pilani -KK Birla Goa Computer on Biosensor NAIP Project No.C4/ 4180001-04 at Goa.	18th January, 2014
Dr. Chand Ram, Sci.	Conference on "Food Safety and Environment" Toxin India Habitat Centre, Lodhi Road, New Delhi.	20th -21st January, 2014
Dr. M. S. Chauhan, PS Dr. A. K. Mohanty, PS Dr. M. Mondal, Sr.Sci.	Workshop on "Reproductive Biotechnologies for Enhancement of Livestock Productivity" at National Institute of Animal Biotechnology,, Hyderabad.	20th -21st January, 2014
Dr. Rashmi. H.M., Sci.	CAFT programme on "Computational and Statistical Advances in Bioinformatics for 'omics' Data" at New Delhi.	21st January to 10th February, 2014
Dr. M. Manjunatha, PS Dr. P. Heartwin Amaladhas, PS Dr. F. Magdaline Eljeeva Emerald, PS	3rd Innovative and Progressive Farmers Meet at NIANP (ICAR), Bangalore.	22th January, 2014
Dr.(Mrs.) Meena Malik, Associate Professor	Workshop on "Global Trends and Issues in English Language Teaching: Challenges and Opportunities" organized by Department of Humanities at NIT, Trichy.	24th – 26th January, 2014

Dr. T. K. Mohanty, PS Dr. A. K. Roy, Sr. Sci. Dr. A. Kumaresan, Sr. Sci. Mr. Chitranayak, Sci.	Five day NAIP Sponsored Management Development Workshop on "Technology Management for Researchers" at NAARM Hyderabad.	27th – 31st January, 2014
Dr. Pawan Singh, PS Dr. M.A. Kataktalware, PS Dr. M. Bhakat, Sci.	National Seminar on "New Dimensional Approaches for Livestock Productivity & Profitability Enhancement under Era of Climate Change" & XXI Annual Convention of Indian Society of Animal Production & Management at College of Veterinary Science & AH Anand, Anand Agriculture University, Anand.	28th -30th January, 2014
Dr. K. P. Ramesha, PS	International Conference on "Biodiversity, Bioresources and Biotechnology" at Mysore.	30th - 31st January, 2014
Dr. Archana Verma, PS	International Conference on "Biotechnology & Bioinformatics" at Yashada Auditorium, Banner Road, Pune.	1st -2nd February, 2014
Dr. Sumit Arora, PS	Stakeholder consultation on staple food fortification in Haryana "Enriching Foods, Enriched Foods" at Panchkula.	6th February, 2014
Dr. K. Ponnusamy, Head	Training on "Science Technology & Emerging Trends in Governance" at ISTM, New Delhi.	3rd – 7th February, 2014
Dr. Dheer Singh, PS	101st Indian National Science Congress at University of Jammu, Jammu.	3rd – 7th February, 2014
Dr. Archana Verma, PS Dr. D. Malakar, PS Dr. Avtar singh, PS	XI National Symposium on "Harmonizing Phenomics and Genomics for Sustainable Management of Livestock for Upliftment of Rural Masses" at NBAGR, Karnal.	6th– 7th February, 2014
Dr. Sohan Vir Singh, PS Dr. Dheer Singh, PS Dr. M. S. Chauhan, PS Dr. Rubina Kumari Baithalu, Sci. Dr. A. Manimaran, Sci. Dr. Mukesh Bhagat, Sci.	International Conference on "Reproductive Health: Issues and Strategies under Changing Climate Scenario & 24th Annual Meeting of ISSRF" at IVRI, Izatnagar, Bareilly.	6th – 8th February, 2014
Dr. Magan Singh, Sr. Sci. Dr. Rakesh Kumar, Sr. Sci.	World Congress on "Agro-forestry "Trees for Life Accelerating the Impacts of Agro-forestry" at Delhi.	10th – 14th February, 2014
Dr. K. P. Ramesha, PS	IPR Summit-Conference on Innovation and IPR "Interfacing Innovation and IPR for Business Success" at Bangalore organized by Confederation of Indian Industry.	13th -14th February, 2014
Dr. Shilpa Vij, PS	National Conference on "Innovative Techniques in the Development of Functional Foods and Nutraceuticals" held at SLIET, Longowal.	14th – 15th February, 2014
Dr. T. K. Mohanty, PS Dr. A. Kumaresan, Sci.	Advisory Committee Meeting of NFBSFARA Project at AIIMS, New Delhi .	15th February, 2014
Dr. R. K. Malik, Head Dr. Rashmi. H. M., Sci.	Probiotic symposium on "Probiotics, Microbiome and Gut Function – Transforming Health and Well- Being" at New Delhi.	15th -16th February, 2014
Dr. Pradyuman Barnwal, Sr. Sci.	International Conference on "Innovative Trends in Mechanical Material Manufacturing Automotive, Automobile and Aeronautical Engineering" at Jawahar Lal Nehru University, New Delhi.	15th -16th February, 2014
Dr. Dheer Singh, PS	Delivered a plenary lecture at the National Symposium on "Animals of LASAI" at Dept. of Zoology, Banaras Hindu University, Varanasi.	16th -18th February, 2014
Dr. Rajan Sharma, PS Dr. Raghu, H.V., Sci.	State Level Seminar on "Dairy Animal Management, Quality Assurance and Marketing of Milk and Milk Products" organized by PCDF, Lucknow.	20th – 21st February, 2014
Dr. A. K. Sharma, I/c Computer Dr. Ravinder Malhotra, PS	16th Annual Conference of "Society of Statistics Computer & Application" at Bhagat Phool Singh Mahila Vishwa Vidayala, Sonepat.	24th -26th February, 2014

Dr. P. N. Raju, Sci.	Systematic Approach to Training at Madras Veterinary College at Chennai.	25th February to 1st March, 2014
Dr. J. K. Kaushik, Sr. Sci.	25th BT is net Annual coordinator meeting at "National Institute of Oceanography", Dona Paula, Goa.	26th February to 3rd March, 2014
Dr. M. S. Chauhan, PS	Delivered guest lecture, "Stem Cell and Human Medicine" at MDU, Rohtak	1st March, 2014
Dr. Y. S. Rajput, Head	2nd Annual Meeting of Society of Veterinary Science & Bio-technology & National Seminar on "Bio-technological Approachers to Challengers in Animal Health & Production" at AH, DUVASU, Mathura.	6th -7th March, 2014
Dr. A. K. Mohanty, PS Dr. M. S. Chauhan, PS Dr. S. K. Atreja PS	National Seminar on "Biotechnological Challenges in Animal Health and Production at Department of Veterinary Biochemistry College of Veterinary Science and Animal Husbandry, Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura (UP).	6th -7th March, 2014
Dr. Dheer Singh, PS	National Training program on "Bioinformatics" at Department of Animal Biotechnology, AAU, Anand, Gujrat.	7th March 2014
Dr. V. K. Gupta, Head	Workshop on "ICAR as the Catalyzing Agent for Management of Change in the Indian NARS: Component-1" organized by NAIP at NASC Complex, New Delhi.	7th -8th March, 2014
Dr. M. S. Chauhan, PS	National Seminar on "Advances in Stem Cell Research and Cloning" at M.D.U. Rohtak.	8th March, 2014
Dr. R. K. Malik, Head Dr. Latha Sabikhi, PS	Expert Consultative Meet on "Expert Consultation Meeting on Prospects and Problems in Dairy Production and Processing Technologies in Eastern India" organised by National Academy of Dairy Science BHU, Varanasi.	10th March, 2014
Dr. Sumit Arora, PS Dr. Naresh Kumar, Sr. Sci.	National Seminar on "Enhancing Productivity & Food Safety of Dairy Processing Industry" at New Delhi.	13th March, 2014
Dr. Bimlesh Mann, Head Dr. Dheer Singh, PS	Training Programme on "Application of Nanotechnology" at CAZRI Jodhpur.	13th March, 2014
Dr. A. K. Chakravarty, PS	National Seminar on "Innovation in Dairy Processing in India Post Operation Flood Scenario" at Nadia (WB)	14th -15th March, 2014
Dr. V. K. Gupta, Head	Workshop on "Technology Enhanced Learning" at NAARM, Hyderabad	14th -15th March, 2014
Dr. R. K. Malik, Head Dr. B. Surendra Nath, PS Dr. T. K. Dutta, 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. K. Karunakaran, Sr. Sci. Dr. M.Mondal, Sr.Sci.	National Seminar on "Innovations in Dairy Processing in India – Post Operation Flood Scenario" organized by Faculty of Dairy Technology, WB University of Animal and Fishery Science (WBUAFS).	14th -15th March, 2014
Dr. A. K. Mohanty, PS Dr. J. K. Kaushik, Sr. Sci.	Project Development Workshop of National Fund at NAARM, Hyderabad .	20th -22nd March, 2014
Dr. M. Mondal, Sr. Sci.	Interface Meeting and Mithun Festival held at NRC on Mithun, Nagaland	27th -28th March, 2014

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:

Five Day Training Programme on "Hands on Training on Technological Aspects of Composite Dairy Foods".	23rd - 27th April, 2013
World Veterinary Day.	27th April, 2013
Awareness Programme for Developing the Product "Multiple Micro-Nutrient Fortified Milk".	27th April, 2013
Brain Storming Session on "Buffalo Estrus Biology".	28th – 29th April, 2013
Training Programme on "Chemical and Microbiological Quality Assurance for Dairy Supply".	1st - 7th May, 2013
Consultative Meeting of Pricing of Milk organized by Haryana Kisan Ayog at NDRI, Karnal.	31st May, 2013
World Milk Day.	1st June, 2013
National Symposium on "Child Nutrition Security in India Way Forward with Milk".	1st June, 2013
Foundation Day Celebrations of NDRI at SRS.	1st July, 2013
Short Course on "Recent Advances on Proteomics for Biomarker Discovery".	8th -17th July, 2013
Narakas Karnal Ke Sadasya Karyalaya Hetu 5 Divseeya Anuvaad Prashikshan Karyakaram.	15th – 19th July, 2013
Orientation Programme for Newly Admitted Students.	2nd August, 2013
Workshop on FMS/MIS.	7th August, 2013
CAFT Training Programme on "Innovative Approaches in Processing and Packaging of Milk and Milk Products".	7th – 8th August, 2013
Foundation Day of Model Dairy Plant.	17th September, 2013
Entrepreneurship Development Programme on "Commercial Dairy Farming".	26th September, 2013
Rajbhasha Karyashala.	28th September, 2013
Training Programme on "Advances in Production, Functional, Rheological and Quality Aspects of Traditional Indian Dairy Products".	9th – 28th October, 2013
One Day Awareness Programme and Workshop on "Intellectual Property Rights in Agriculture and Allied Sciences".	1st October, 2013
Training Programme on "Commercial Dairy Farming".	4th - 13th November, 2013
Expert Consultative Meet on Protein Malnutrition.	6th November, 2013
Brain Storming Session on "Milk Genomics and Human Health".	7th November, 2013
Rajbhasha Mukhya Samaroh.	11th November, 2013
Brain Storming Session on "Transition Cow Management to Optimize Reproduction Efficiency".	16th November, 2013
Training Programme on "Pasupalan Vikas Hetu Chara Utpadan Evam Sanrakshan".	18th – 22nd November, 2013
National Training Programme on "Climate Resilient Livestock and Production System".	18th November to 1st December, 2013
XVII National Conference of Agricultural Statistics.	27th – 28th November, 2013

Prof. V. N. Sharda, member ASRB addressing the faculty of NDRI at World Milk Day on 1st June, 2013

Training Programme on "Stem Cells".	2nd – 23rd December, 2013
Entrepreneurship Development Programme on "Commercial Dairy Farming".	10th – 13th December, 2013
NDRI-Industry Meet.	6th January, 2014
National Workshop under NAIP Component-I "Development of e-courses" for B.Tech. (DT) Degree programme.	8th January, 2014
Stakeholders Meeting on "Cattle Development and Problems of Dairy Farmers in Haryana".	8th January, 2014
Short Training on "Analysis of Milk, Milk products and Cattle Feed" for Dairy Personnel from Directorate of Dairy Development, Kerala.	10th – 17th January, 2014
Training Programme on "Advanced Training on Cloning Research for Quality Buffalo Production".	13th – 22nd January, 2014
Brain Storming Session on "Potential of Animal System for CLA Enhancement".	18th January, 2014
Brain Storming Session on "Micronutrient Initiative : A Silent Solution to Hidden Hunger".	24th January, 2014
Model Training Course on "New Extension Strategies for Sustainable Dairy Development" at SRS, Bangalore.	27th January, 2014
Dr. K. K. Iya Memorial Oration.	28th January, 2014
Training Programme on "Commercial Dairy Farming".	29th January to 7th February, 2014
Seminar on "Evolution to Revolution in Dairy Education".	31st January, 2014
Convocation of NADSI and Seminar on "Climate Resilient Dairying".	8th February, 2014
N. N. Dastur Memorial Oration.	10th February, 2014
Dr. D. Sundaresan Memorial Oration.	12th February, 2014
National Dairy Mela.	25th – 27th February, 2014
National Science Day.	28th February, 2014
CAFT Training Programme on Advanced Breeding and Allied Technologies for Enhancing Livestock Productivity".	5th – 25th March, 2014
Training programme on "Clean Milk Production" for Tribal Women Farmers under TSP at ERS, NDRI, Kalyani.	11th – 14th March, 2014
Business Meet of DDMS of NABARD Haryana Regional Office.	24th March, 2014

Dr. R. S. Paroda addressing the delegates during XVII National Conference of Agricultural Research Statisticians on "National Priorities in Agricultural Statistics and Informatics"

13 DISTINGUISHED VISITORS

21-22.05.2013 **Mr. Sipke Joost Hiemstra,** Head, Animal Genetic Resources Group Centre for Genetic Resources Wageningen University and Research Centre, The Netherlands.

09.07.2013 **Mr. Allan Mustard**, Minister-Counsellor for Agricultural Affairs alongwith **Dr. Santosh Singh**, Sr. Agricultural Specialist, Embassy of United States of America, New Delhi**.**

18-19.8.2013 **Mr. Md. Mashiur Rahman**, Director General, **Dr. Kamrul Ahsan**, Director (Training), Bangladesh Academy for Rural Development (BARD), Minister of Local Government, Rural Development & Cooperative Government of the People's Republic of Bangladesh, Camilla, Bangladesh led by **Dr. Khushnood Ali**, Technical Officer & Head, Research Division for Secretary General, AARDO, New Delhi.

22.08.2013 **Sh. A. K. Thakur,** Secretary, Department of Animal Husbandry, Dairying & Fisheries, Govt. of India and **Dr. A. S. Nanda,** Animal Husbandry Commissioner.

29.09.2013 **Nigerian delegation** under West Africa Agricultural Productivity Programme (WAAPP).

01.10.2013 FIJI Delegation

1. His Excellency **Mr. Inia Batikoto Seruirato**, Minister for Agriculture, Fishries & Forest.
2. **Mr. Yogesh J Karan**, High Commissioner.
3. **Mr. Filipe Aliferite,** Permanent Secretary for Rural Martime Dev. & National Disaster Management.
4. **Dr. Ganesh Chand**, Vice Chanceller.
5. **Mr. Om Prakash Goundar**, Second Secretary, Fiji High Commission.

24.10.2013 Fifteen member delegation from World Society for Protection of Animals (WSPA).

7-8.01.2014 IAS Officer Trainees (2013 batch), IAS, UPSC, Winter Study Tour attached with NDRI, Karnal.

16.01.2014 Twelve member student delegation from USA.

30.01.2014 Dr. Gregory Harper from CSIRO, Australia 2014.

03.02.2014 H. E. Lyonpo Yeshey Dorji, Minister for Agriculture and Forest, Royal Government of Bhutan (RGOB).

10.02.2014 Dr. Rodrigo Martins Alves de Mendonca and Dr. Mario Gracia, Universidade Federal de Minas Gerais, Brazil.

13.02.2014 Twelve member delegation from NARC, Nepal.

18.03.2014 Iwama San and Mr. Vipin Biala-Officials from Yakult Danone India Pvt. Ltd.

29.03.2014 Newly appointed faculty members, Lala Lajpat Rai University of Veterinary and Animal Sciences.

14 PERSONNEL

Institute Staff

As on 31st March, 2014

General Administration

A. K. Srivastava, Ph.D.	Director
G. R. Patil, Ph.D.	Joint Director (Academic)
G. R. Patil, Ph.D.	Acting Joint Director (Research)
J. K. Kewalramani, B.Sc., M.B.A. & Registrar	Joint Director (Admn.)
S. George, M.A., PGDLA	Comptroller
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
Sarita Yadav, B.P.T., PGDPMIR	Admn. Officer
Ram Shankar, M.A., P.G.D.T.	Deputy Director (Off. Lang.)
Vishal Acharya, MA	Asstt. Fin. & Account Officer
Kuna Ram Kisku	Admn. Officer (ERS, Kalyani)
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. Shashi Kala	Asstt. Admn. Officer (SRS, Bangalore)
S. S. Meena, B.A.	Asstt. Admn. Officer
Saroj Khurana, M.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
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, BA	Private Secretary

RTI Cell

J. K. Kewalramani, B.Sc., M.B.A.	Appellate Authority
Y. S. Rajput, Ph.D.	Public Information Officer
Meena Malik, M. Phil. Ph.D	Asstt. Pub. Information Officer
P. K. Dixit, Ph.D.	Asstt. Pub. Information Officer
R. A. Dey, Ph.D.	Asstt. Pub. Information Officer

Scientists and Technical Officers

Dairy Cattle Breeding Division

A. K. Gupta, Ph.D.	Acting Head
A. K. Chakravarty, Ph.D.	Principal Scientist
Archana Verma, Ph.D.	Principal Scientist
I. D. Gupta, Ph.D.	Principal Scientist
Avtar Singh, Ph.D.	Principal Scientist
Om Vir Singh, M.V.Sc., Ph.D.	Chief Technical Officer
Vinod Kumar, B.Sc.	Sr. Technical Officer
Y. K. Panwar, M.A.	Technical Officer
Rakesh Kumar Tonk, Ph.D.	Technical Officer
Ashwani Kumar, M.Sc.	Technical Officer
Mool Chand	Technical Officer
Vikram	Technical Officer
Y. P. Singh, B.Sc.	Technical Officer

Livestock Production and Management Section

Shiv Prasad, Ph.D.	Principal Scientist & Incharge
R. K. Mehla, Ph.D.	Principal Scientist
T. K. Mohanty, Ph.D.	Principal Scientist
M. L. Kamboj, Ph.D.	Sr. Scientist
S. S. Lathwal, Ph.D.	Sr. Scientist
A. Kumaresan, Ph.D.	Sr. Scientist
Ramesh Chandra, Ph.D.	Sr. Scientist
A. Manimaran, M.Sc.	Scientist
Prasant Kumar, M.Sc.	Scientist
Shiv Kumar, M.Sc.	Sr. Technical Officer

Dairy Cattle Nutrition Division

S. S. Kundu, Ph.D.	Head
J. P. Sehgal, Ph.D.	Principal Scientist
Neelam Kewalramani, 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
P. S. Oberioi, Ph.D.	Principal Scientist
Chander Datt, Ph.D.	Sr. Scientist
Nitin Tyagi,	Sr. Scientist
Goutam Mondal	Sr. Scientist
Raj Bahadur, B.Sc.	Asstt. Chief Technical Officer
Karan Singh, M.Sc.	Asstt. Chief Technical Officer

Dairy Cattle Physiology Division

R. C. Upadhayay, Ph. D.	Head
O. K. Hooda, Ph.D.	Principal Scientist
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

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
Rajesh Kumar	Sr. Scientist
M. K. Singh, Ph.D.	Scientist
S. Kumar, Ph.D.	Scientist

Animal Biochemistry Division

Y. S. Rajput, Ph.D.	Head
S. K. Atreja, Ph.D.	Principal Scientist
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
Shisha Singh	Technical Officer

Dairy Technology Division

Vijay Kumar, Ph.D.	Head
S. K. Kanawjia, Ph.D.	Principal Scientist
Latha Sabikhi, 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
G. K. Goyal, Ph.D.	Emeritus Scientist

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
P. C. Singh, M.Sc.	Asstt. Chief Technical Officer

Dairy Microbiology Division

R. K. Malik, Ph.D.	Head
Sunita Grover, Ph.D.	Principal Scientist
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.Sc.	Scientist
R. P. Singh, Ph.D.	Chief Technical Officer
Chamela Ram	Technical Officer
V. K. Batish, Ph.D.	Emeritus Scientist

Dairy Engineering Division

A. K. Dodeja, Ph.D.	Head
I. K. Sawhney, M.Tech.	Principal Scientist
Bikram Kumar, M.Tech.	Principal Scientist
P. Barnwal	Sr. Scientist
Prashant Saurabh 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

Dairy Economics, Statistics and Management Division

K. K. Datta, Ph.D.	Head
B. S. Chandel, Ph.D.	Principal Scientist
A. K. Chauhan, Ph.D.	Principal Scientist
Smita Sirohi, Ph.D.	Principal Scientist
Ravinder Malhotra, Ph.D.	Principal Scientist
A. K. Sharma, Ph.D.	Sr. Scientist
Uditya Chaudhary, Ph.D.	Scientist
Rishi Kanta Singh, M.Sc.	Scientist
Tara Chand, B.Sc.	Sr. 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
Rajpal Sharma, B.A.	Technical Officer

Krishi Vigyan Kendra/Trainers' Training Centre

Dalip K. Gosain, Ph.D.	Progam Coordinator
Surender Gupta, Ph.D.	Chief Technical Officer
Saroj Mehta, M.Sc., B.Ed.	Chief Technical Officer

Satya Pal, M.V.Sc.	Asstt. Chief Technical Officer
Rajeshwar Dayal, B.Sc.	Sr. Technical Officer
Mohar Singh, M.Sc.	Sr. Technical Officer
Kulvir Singh, M.Sc.	Sr. Technical Officer
D. V. Sharma	Sr. Technical Officer
Prem Singh	Technical Officer
Forage Section	
Ashutosh, Ph.D.	Sr. Scientist & Incharge
Satish Kumar, M.Sc. (Horti.)	Chief Technical Officer
Uttam Kumar, Ph.D.	Chief Technical Officer
Ramesh Chand, B.Sc. (Agri.)	Chief Technical Officer
Anil Kumar Dagar, M.Sc.	Sr. Technical Officer
Sukhdev Singh	Technical Officer
Ravi Rawat, M.Sc. (Entomology)	Technical Officer

Forage Research and Management Centre

Dr Magan Singh, Ph.D.	Sr. Scientist
Dr Rakesh Kumar, B.Sc. (Agri.)	Sr. Scientist
Mr Ramesh Chand	Chief Technical Officer

Livestock Research Centre

Shiv Prasad, Ph.D.	Principal Scientist, Incharge
R. K. Mehla	Principal Scientist
S. S. Lathwal	Sr. Scientist
T. K. Mohanty, Ph.D.	Sr. Scientist
M. L. Kamboj, Ph.D.	Sr. Scientist
Ramesh Chandra, Ph.D.	Sr. Scientist
A. Kumaresan, Ph.D.	Sr. Scientist
A. Manimaran, M.Sc.	Scientist
Nishant Kumar, M.Sc.	Scientist
Rubina Kumari Bithalu	Scientist
S. Raju, M.V.Sc.	Asstt. Chief Technical Officer
Chaman Lal, Dip. (Motor Mechanic)	Technical Officer
Deepa Kumari, B.Sc. (HSc), MA	Technical Officer

Animal Health Complex

M. K. Srivastava, M.V.Sc.	Chief Technical Officer
K.P.S. Tomar, M.V.Sc.	Chief Technical Officer
Praveen Kumar, M.V.Sc.	Asstt. Chief Technical Officer
Sahdev Singh, M.Sc.	Sr. Technical Officer

Artificial Breeding Research Centre

A. K. Chakravarty, Ph.D.	Principal Scientist, Incharge
A. K. Gupta, Ph.D.	Principal Scientist
Pawan Singh	Principal Scientist
T. K. Mohanty, 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)
S. K. Kanawjia, Ph.D.	Academic Coordinator
I. K. Sawhney, Ph.D.	Controller of Examinations
A. K. Tyagi, Ph.D.	Chief Hostel Warden
Gopal Sankala, Ph.D.	Hostel Warden
S. V. Singh, Ph.D.	Hostel Warden
Dheer Singh, Ph.D.	Hostel Warden
Bimlesh Mann, Ph.D.	Hostel Warden
Ritu Chakravarty, M.Sc.	Hostel Warden
A. K. Singh, Ph.D.	Sports Coordinator
Latha Sabikhi, Ph.D.	I/c Placement Cell
Sarita Yadav, B.P.T., PGDPMIR	Admn. Officer

Research Prioritization, Monitoring and Evaluation Cell

G. R. Patil, 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

Library Services

B. R. Yadav, 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
G. D. Joshi, M.A.	Chief Technical Officer
S. K. Talwar, M.A., P.G.D.	Asstt. Chief Technical Officer
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
Sarwan Kumar	Sr. Technical Officer
S. K. Saini	Technical Officer
Tek Chand (ITI Electrical)	Technical Officer
Devinder Kumar (ITI Wireman)	Technical Officer
Raj Kumar (ITI Electrical)	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	Technical Officer
Ranbir Singh	Technical Officer
Sarvan Kumar	Technical Officer
Lakhvinder Singh	Technical Officer
M. P. Sharma	Technical Officer

Hospitality Cell

D. Sherpa	Technical Officer
Vinod Kumar	Technical Officer
R. S. Dhull	Technical Officer

Health Complex

R. K. Malik, Ph.D.	Principal Scientist, Incharge
Rekha Sharma, M.B.B.S.	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

Estate Section

Sushil Kumar Kamboj, M.Sc.	Chief Technical Officer, Incharge
Prem Singh, M.A.	Sr. Technical Officer
P. M. Meena	Sr. Technical Officer

Southern Regional Station, Bangalore

Satish Kulkarni, Ph.D.	Head
C. N. Pagote, Ph.D.	Principal Scientist
B. Surendra Nath, Ph.D.	Principal Scientist
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
P. Murugananthan, M.Lib. Sci.	Chief Technical Officer
M. Nanjundaswamy, M. Lib.Sci.	Chief Technical Officer
V.R.V. Surendranath Naik, M.D.	Chief Medical Officer
M. Sreenath, M.Sc.	Chief Technical Officer
L. Krishna Murthy, M. Sc.	Chief Technical Officer
P. Aravindakshan, M.Sc	Asstt. Chief Technical Officer
M.A. Usha, B.Sc.	Asstt. Chief Technical Officer
M. K. Vedavathi, B.Sc.	Asstt. Chief Technical Officer
B. K. Rajeshekaraiah, B.Sc.	Asstt. Chief Technical Officer
Veeraju, B.E. (Civil)	Asstt. Chief Technical Officer
J. Nageshwara Rao, Dip. (Mech)	Sr. Technical Officer
K. L. Sampath, B.Sc.	Sr. Technical Officer
Thivija Kumari, M.A.	Sr. Technical Officer
P. G. Satisha, B.V.Sc.	Sr. Technical Officer
R. Keshvamurthy, B.Sc.	Sr. Technical Officer
Gurunath Gouda Patil, B.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
B. R. Srinivasamurthy, B.Sc.	Technical Officer
K. Geetha Kumari	Technical Officer
Janakshi, M.C.A.	Technical Officer
Sreekanta	Technical Officer
K. Ningaraju, M.V.Sc.	Technical Officer
A. Louis, B.Sc.	Technical Officer
Vimala, B.Sc.	Technical Officer

Eastern Regional Station, Kalyani

T. K. Datta, Ph.D.	Head
P. K. Roy, Ph.D.	Principal Scientist
R. A. Dey, Ph.D.	Sr. Scientist
Lotan Singh, Ph.D.	Sr. Scientist
S. K. Das, Ph.D.	Sr. Scientist
Anupam Chatterjee, Ph.D.	Sr. Scientist
M. K. Ghosh, Ph.D.	Sr. Scientist
Ajoy Mandal, Ph.D.	Sr. 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
H. C. Yadav, M. Tech.	Sr. Technical Officer

Inauguration of the Blood Donation Camp by Dr. Vandana Bhatia, Chief Medical Officer, Karnal

Personnel Milestones

Joining

- Dr. Ashok Santra, Sr. Scientist joined at ERS of NDRI, Kalyani w.e.f. 8.4.2013.
- Dr. (Ms.) Rubina Kumari Baithalu, Scientist (LPM) joined at NDRI, Karnal w.e.f. 10.4.2013.
- Dr. Shaik Abdul Hussain, Scientist (DT) joined at NDRI, Karnal w.e.f. 11.4.2013.
- Dr. Mohan Mondal, Sr. Scientist (AP) joined at ERS of NDRI, Kalyani w.e.f. 16.4.2013.
- Dr. Rakesh Kumar, Sr. Scientist (ABT) joined at NDRI, Karnal w.e.f. 20.4.2013 on his transfer from CIFT, Kochi.
- Dr. K. Ponnusamy, Head, Dairy Extension Division joined at NDRI, Karnal w.e.f. 31.5.2013.
- Dr. Chitra Nayak, Sr. Scientist (Electronics & Instrumentation) from CIRCOT, Mumbai joined at SRS w.e.f. 11.6.2013.
- Dr. Rakesh Kumar, Sr. Scientist (Agronomy) joined at NDRI, Karnal w.e.f. 25.6.2013.
- Dr. H. R. Meena, Sr. Scientist (Vety. Extension) joined at NDRI, Karnal w.e.f. 22.07.2013.
- Dr. M. Sivaram, Sr. Scientist (Animal Science) joined at SRS, NDRI, Bangalore w.e.f. 01.08.2013.
- Dr. M. Karunakaran, Sr. Scientist (ARG) joined at ERS, NDRI, Kalyani w.e.f. 08.08.2013.
- Dr. Champak Bhakat, Sr. Scientist (LPM) joined at ERS, Kalyani w.e.f. 24.08.2013.
- Dr. P. Barnwal, Sr. Scientist (ASPE) joined at NDRI, Karnal w.e.f. 11.09.2013.
- Dr. R. K. Malik, Principal Scientist and Acting Head (DM) joined as Head, Dairy Microbiology Division at NDRI, Karnal w.e.f. 27.12.2013.
- Dr. Bimlesh Kumari, Principal Scientist joined as Head, Dairy Chemistry at NDRI, Karnal w.e.f. 03.01.2014.
- Dr. Siddaramanna, T-6 (F/FT) joined at SRS on 01.08.2013 after getting relieved from Karnataka Veterinary, Animal and Fisheries Science University, Bidar on 31.07.2013.

Promotions

- Dr. K. Jayaraj Rao, Sr. Scientist (AGB) SRS, Bangalaore was promoted to Principal Scientist w.e.f 1.1.2009.
- Dr. Bandla Srinivas, Sr Scientist (AN) SRS, Bangalaore was promoted to Principal Scientist w.e.f. 1.1.2009.
- Dr. D. N. Das, Sr. Scientist (AGB) SRS, Bangalaore was promoted to Principal Scientist w.e.f 22-3-2012.
- Dr. S. Jeyakumar, Scientist (SS) SRS, Bangalaore was promoted to Senior Scientist w.e.f. 16.08.2009.
- Dr. P. Heartwin Amaladhas, Scientist (SS) SRS, Bangalaore was promoted to Senior Scientist w.e.f. 02.09.2009.
- Dr. Menon Rekha Ravindra, Scientist (SS) SRS, Bangalaore promoted to Senior Scientist w.e.f. 22.2.2011.
- Ms. F. Magdaline Eljeeva Emerald, Scientist (SS) SRS, Bangalaore promoted to next higher grade w.e.f. 4. 7. 2011.
- Dr. Champak Bhakat Senior Scientist (LPM) ERS, Kalyani promoted to Principal Scientist w.e.f. 15.12.2012.
- Dr. Mohan Mandal, ERS, Kalyani Scientist promoted as Scientist (SS) w.e.f. 8.1.2011.
- Mrs. Deepa, T-4 (F/FT) promoted as T-5 (F/FT) w.e.f. 09.07.2009.
- Sh. Sanjiv Kumar, T-5 (F/FT) promoted as T-6 (F/FT) w.e.f. 10.01.2011.
- Sh. Prem Singh, T-5 (F/FT) promoted as T-6 (F/FT) w.e.f. 01.01.2010.
- Sh. Deshwirt Sharma, T-5 (F/FT) promoted as T-6 (F/FT) w.e.f. 01.01.2010.
- Smt. Bhpinder Kaur, Ex. T-7/8 (Information) promoted as T-6 (Information) & T-7/8 (Information) w.e.f. 03.02.2000 & 03.02.2005, respectively.
- Mrs. Ranjna, PA was promoted as Private Secretary w.e.f. 17.08.2013
- Sh. Ramesh Chand, Assistant Chief Technical Officer (F/FT) promoted as Chief Technical Officer (F/FT) w.e.f. 01.01.2013.
- Sh. Tara Chand, Sr. Technical Officer (F/FT) promoted as Assistant Chief Technical Officer (F/FT) w.e.f. 01.01.2013.
- Sh. R. Keshava Murthy, Technical Officer (F/FT) promoted as Sr. Technical Officer (F/FT) w.e.f. 13.01.2013.
- Sh. G. G. P. Patil, Technical Officer (F/FT) promoted as Sr. Technical Officer (F/FT) w.e.f. 25.02.2013.

- Sh. Vinod Kumar, Technical Officer (F/FT) promoted as Sr. Technical Officer (F/FT) w.e.f. 01.07.2013.
- Sh. Jai Pal, Sr. Technical Assistant (L/T) promoted as Technical Officer (L/T) w.e.f. 01.07.2013.
- Sh. Chandan Solanki, T-3 (L/T) relieved on 31.12.2013 to join the post of Scientist and to undergo FOCARS-99 training at NAARM, Hyderabad.
- The following Sr. Scientists were promoted as Principal Scientists:
- Dr. Shipla Viz, Sr. Scientist (Biotech.) w.e.f. 01.01.2011.
- Dr. Rajan Sharma, Sr. Scientist (DC) w.e.f. 12.04.2012.
- Dr. Vivek Sharma, Sr. Scientist (DC) w.e.f. 12.04.2012.
- Dr. Rajesh Kumar, Sr. Scientist (DC) w.e.f. 23.04.2012.
- Dr. Madan Lal Kamboj, Sr. Scientist (LPM) w.e.f. 01.09.2012.
- Dr. Chand Ram, Sr. Scientist (DM) w.e.f. 11.07.2013.
- The following scientists have been promoted to the next higher grade under Career Advancement Scheme:
- Dr. Rishikanta Singh, Scientist (DESM)
- Dr. Manoj Kumar Singh, Scientist (ABTC)
- Dr. Sudarshan Kumar, Scientist (ABTC)
- Dr. Senthil Kumar, Scientist (D. Extension)
- Dr. Kaushik Khamrui, Sr. Scientist (DT)
- Dr. A. Kumaresan, Sr. Scientist (Animal Reproduction)
- Dr. S. Jeyakumar, Senior Scientist, in the PB-4 Rs.37400-67400+ RGP of Rs.9000/- with effect from 16.08.2012.
- Dr. Manjunath, Scientist, in the PB-III Rs.15600-39000 + RGP of Rs.7000/- with effect from 10.02.2013.
- Dr. M. A. Kataktalware, Scientist, promoted to the post to the Senior Scientist in the PB-III Rs.15600-39000+ RGP of Rs.8000/- with effect from 26.02.2013.
- Dr. P. Heartwin Amaladhas, Senior Scientist, in the PB-4 Rs.37400-67400+ RGP of Rs.9000/- with effect from 02.09.2013.

Retirements/Transfers

- Dr. G. K. Sachdeva, Principal Scientist, Sh. T.L. Jaggi, T-5 (F/FT), Sh. Balbir Singh, T-5 (L/T) and Mr. S. C. Biswas, T-5 (L/T) retired on superannuation from Council's service on 30.04.2013.
- Dr. R. A. Dey, Senior Scientist (Agri. Extension) retired on superannuation from Council's service on 29.06.2013.
- Dr. A. S. Harika, Principal Scientist/Incharge (FM) retired on superannuation from Council's service on 26.06.2013.
- Dr. A. A. Patel, Head (DT) took voluntary retirement from Council's service w.e.f. 08.08.2013.
- Dr. (Mrs.) Sanchita Garai, Scientist, (Dairy Extension) was transferred from NDRI, Karnal to ERS, NDRI Kalyani w.e.f. 26.08.2013.
- Dr. R. S. Gandhi was relieved on 21.9.2013 to join as ADG (AP&B), ICAR, Hqrs., New Delhi.
- Sh. Shiv Balak Rai, Technical Officer (W/S) retried from Council's service w.e.f. 31.10.2013.
- Sh. Rishi Pal, Sr. Technical Officer (L/T) retried from Council's service w.e.f. 31.12.2013.
- Sh. Nihal Singh, Technical Officer (F/FT) retried from Council's service w.e.f. 31.12.2013.
- Sh. Rajpal Sharma, Technical Officer T-5 (F/FT) ATIC retired from Council's service w.e.f. 31.01.2014.
- Sh. N.S. Sirohi, Chief Technical Officer T-9 (F/FT) Dairy Extension retired from Council's service w.e.f. 31.01.2014.
- Mr. K. R. Kisku, AO, ERS, Kalyani retired from Council's service w.e.f. 31.01.2014.
- Sh. Bhagwat Singh, Technical Officer T-5 (W/S) ERS, Kalyani retired from Council's service w.e.f. 28.02.2014.
- Dr. B.R. Yadav, Acting Head (DCB) retired from Council's service w.e.f. 31.03.2014.
- Sh. Sarwar, Assistant Chief Technical Officer T-7/8 (L/T) retired from Council's service w.e.f. 31.3.2014.

Demise

- Dr. S. Vijayalakshmi, Retd. Principal Scientist & Acting Head, SRS Bangalore expired on 26.09.2013.
- Dr. P. K. Roy, Principal Scientist (LPM), ERS of NDRI, Kalyani expired on 16.10.2013.
- Dr. Sunil Kumar Sirohi, Principal Scientist (DCN) NDRI Karnal expired on 26.02. 2014.

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 and biotechnology related to molecular genetics. The main thrust research areas are genetic improvement of crossbred and Sahiwal cattle and Murrah buffaloes by progeny testing of breeding males and judicious selection of males and females, faster multiplication of superior germplasm, evolving selection criteria, development of optimum breeding plans, genetic polymorphism studies at molecular level and its association with production/reproduction traits, disease resistance and thermo-tolerance, screening of young males for genetic disorders and assessment of male fertility.

The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at Division of Dairy Cattle Breeding during eighth plan continued its activities on strengthening research, teaching and imparting training to scientists/teachers from Research Institutes, State Agricultural/Veterinary Universities and Livestock Development Organizations in advanced areas of Animal Genetics and Breeding. A total of 30 National Training Programs have so far been organized under the aegis of CAFT (AG&B) in the Division. The Division also assists KVK/DTC and TBI (SINED) in training programs, consultancy services to farmers and various organizations, supplies superior germplasm in the form of frozen semen and breeding males to farmers, livestock developmental agencies, state governments and other stake holders.

The Division has 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 is also the integral part of the research component of Dairy Cattle Breeding Division.

Livestock Production Management Section (LPM)

The Livestock Production and Management (LPM) section came into being in June, 2009 after being carved out of Dairy Cattle Breeding Division of the Institute. However, separate faculty of LPM alongwith Board of Studies was in existence since 1976 and post graduate and doctorate degree programmes in LPM were continuing. The faculty of LPM is engaged in conducting 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 practices on the routine care and management of dairy animals. The faculty of LPM is engaged in teaching both at UG and PG levels. The LPM faculty is also shouldering the responsibility of the routine management of the cattle yard and breeding bulls maintained at the Animal Breeding Research Center of Institute besides supporting the training and extension activities of the Institute. The objectives of the section are: (i) to maintain elite germplasm repository of dairy animals of the identified breeds; (ii) development of state-of-the-art dairy animal management facilities and infrastructure for high yielding dairy animals; (iii) to carry out research in collaboration with different divisions, in the upstream areas of dairy animal production; (iv) to standardize the package of management practices and to demonstrate state-of-the-art dairy animal production system to clients and to provide consultancy to the needy farmers and entrepreneurs for establishment of commercial dairy farms.

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 built up 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 (1) central fine instrumentation laboratory (2) laboratory for

anaerobic rumen microbial work (3) laboratory for environment related studies including methanogenesis (4) quality control laboratory (5) feed processing unit (6) 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 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: (i) to conduct basic and applied research and impart training in various aspects of Animal Physiology; (ii) 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: development of temperature humidity index (THI) maps of India, development of sensitive radio-immunoassays for several protein and steroid hormones; development and validation of sensitive enzyme immunoassays for progesterone, oxytocin, GH, LH, FSH, cortisol, testosterone, prolactin, estradiol-17β and PGFM; application of progesterone measurement in body fluids for fertility improvement viz. estrus confirmation, pregnancy/non pregnancy detection, monitoring cyclicity and identification of ovarian disorders, application of estrone sulphate determination in milk for confirmation of pregnancy and fetal viability; indigenous production of progesterone antiserum and anti-rabbit IgG (second antibody) and their application in hormone immunoassays; parturition induction, superovulation and embryo transfer; neonate physiology; temporal endocrine interrelationships during different phases of growth, reproduction and lactation; application of endocrine techniques for growth enhancement and fertility improvement, optimum frequency of feeding and milking; induction of lactation, augmentation of lactation through growth hormone administration, estimates of udder capacities, residual milk and milk secretion rates; somatic cell counts in milk of bovines during different stages of lactation; draught evaluation system, work efficiency of crossbred and indigenous bovine and buffalo bullocks and optimum work-rest cycle for working bullocks. Presently, its research thrust in three main areas is namely Growth and Reproductive Physiology, Lactation Physiology and Environmental Physiology. The Division has also undertaken research projects funded by the BARC, World Bank, Department of Biotechnology, NDDB and DST-DAAD. National Initiative on Climate Resilient Agriculture (NICRA) has been going for basic and strategic research to identifying unique traits in cattle and buffaloes for resilient livestock production system. A Network Project on impact, adaptation and vulnerability of Indian agriculture to climate change with emphasis on livestock was taken up. Linkages have also been established for collaborative research ventures with other ICAR Institutes viz. IVRI, Izatnagar and CIRB, Hisar and SAU's for strengthening research on climate resilient livestock.

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 1) To undertake biotechnology oriented basic and applied research programmes for improving animal productivity and for developing innovative dairy processes for producing superior quality, safe and wholesome dairy products, 2) To train manpower in application of Biotechnology in Dairy Production and Dairy Processing and 3) To organize M.Sc. and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

The three main labs at the Animal Biotechnology Centre are Embryo Biotechnology Lab, Animal Genomics Lab and Proteomics Lab. A state-of-the-art biotechnology research facility was created in 2007 to consolidate the biotechnology research at NDRI. The new lab facility offers a working space of more than 20,000 sq. ft. and has specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research, Structural Biology, etc.

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 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, 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 five types of Probiotic dahi and validation of their health-benefits in reducing serum cholesterol levels, protection against gastrointestinal cancer and management of diabetes; 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 Division has the laboratories for Nutregenomics, functional foods and therapeutics; Prebiotics and Probiotics; Bioactive Peptides and Immunology; Bioinformatics; Molecular Endocrinology, Reproductive Biochemistry and Sensor. The Division manages Small Animal House that caters to the need of students and scientists for laboratory animals viz. rat, mouse, rabbit and hamster, etc.

Dairy Chemistry (DC)

The mandate of the Division is to conduct fundamental and applied research for understanding chemistry of milk and milk products, to impart educational programmes for undergraduate and postgraduate courses and to provide R&D support towards chemical-quality control related problems of the dairy industry. The Division has contributed significant knowledge on the chemistry of milk and milk products. The salient achievements are: evaluation of physico-chemical properties of buffalo milk and alteration in its calcium and casein levels and micellar stability enabling manufacture of satisfactory products like cheese, condensed milk and rasogolla; humanization of buffalo milk and glyceride structure of buffalo milk fat; evaluating role of phospholipids in stability of dairy products; revealing chemistry of ghee and ghee residue flavour; antioxidant properties of ghee residue; chemical makeup and structural integrity of milk fat globule membrane; influence of various processing parameters on the major minerals and trace elements and their partitioning; rapid and simple methods for the determination of SNF in milk; formulation of quality standards of milk and milk products now prescribed by the Central Committee of Food Standards under the Ministry of Health as well as Bureau of Indian Standards; modification of Gerber test for simultaneous estimation of milk fat and availability of fat for detection of adulteration; simple tests for the detection of adulteration of

milk and milk products; methods of manufacturing of butter and cheese colour from annatto seeds; preparation of rennet from fistulated calves and vegetable sources; structure and bacteriostatic role of lactoferrin; characterization and crystallization of buffalo lactoperoxidase; functional properties of WPC; renovation of rancid ghee and role of antioxidants in enhancing the shelf life of fat rich dairy products; effect of processing treatments on vitamins; status of pesticides and antibiotic residues in milk and milk products; methodologies for non-dairy whitener, low fat frozen dessert, calcium fortified milk, coconut filled Gouda cheese and low cholesterol ghee; a platform test for detection of detergent in milk; a colour based test to detect adulteration of milk with 2.5 to 10% soya milk; a multi-purpose device for dialysis; buffer exchange and concentration.

Different analytical methods developed for testing of milk and milk products: Strip based tests developed for the detection of added urea and neutralizers in milk; Method developed for vegetable oil detection in ghee using RP-HPTLC; An analytical protocol developed for the estimation of vitamin D_2 in fortified toned milk and based on physico-chemical properties different methods assessed for detection of soybean oil and buffalo body fat in ghee. Antimicrobial peptides identified from skim milk by fermentation using selected proteolytic *lactobacillus* strains including α_{S1}-CN (24-34), β-CN (197-209), β-CN (199-209), β-CN (193-207). Buffalo α_s-casein hydrolysates assessed for their antioxidant activity. Process for preparation of curcumin nanoemulsion optimized using milk proteins and assessed for antioxidant activity in animal model system. The Division has state-of-the-art Seminar room and Lecture room, Quality control lab, Undergraduate and Postgraduate labs, Instrument room, Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ neutraceuticals and quality assurance).

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. At present the Division has got eight well-equipped laboratories *viz*., sensory evaluation laboratory, packaging laboratory, indigenous milk products laboratory, cheese and fermented milks laboratory, infant food laboratory, food technology laboratory, dairy by-products 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. Another unique feature of the 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. Pilot-scale vacuum dryer, ice cream manufacturing unit, HTST milk pasteuizer, membrane processing units, rotary oven, extrusion cookers, etc. are also available in the Division.

Dairy Microbiology Division (DM)

The Division of Dairy Microbiology has been contributing significantly in both basic as well as applied aspects of Dairy Microbiology. The DM faculty has been extensively involved in development of human resource and imparting educational programmes for both under graduate and postgraduate level courses. The Division offers contractual and consultancy services such as supply of starter cultures and microbiological analysis of milk and milk products and organizes short term specialized training programmes for dairy industry personnel and students from other universities/colleges.

The Division is currently engaged in handling research and teaching activities in the field of Dairy Microbiology and Biotechnology. Broadly, the research work of the Division covers the areas related to Molecular Biology and Genetic Engineering, Starter Cultures and Fermented Milk Products, Probiotics, prebiotics and Bioactive peptides, Quality Assurance and Public Health, Biopreservatives, Ultrastructure of Dairy Organisms/Products and Rumen Microbiology. National Collection of Dairy Cultures (NCDC) is a singular facility of its kind in the country. The NCDC caters to the requirement for cultures from dairy industry and research organizations. Besides, a referral center with funding (19.62 crores) under NAIP project no C4/418001-04 is currently

under progress for its establishment at NDRI for addressing the scientific issue on milk safety in our country. The laboratories of the Division including Molecular Biology Unit have been renovated with state-of-the-art facilities. At present, the main focus of DM Division is on probiotics, food safety, bioactive peptides and value added dairy products.

Dairy Engineering Division (DE)

Dairy Engineering Division was established as one of the major research divisions since 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 scaled up and paneer gadget and cream separator attachment for small scale applications. Recent research achievements include preparation of scaled up design of continuous khoa making machine, process for accelerated production of rabri using in-line system, coninous 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. Recently, a machine vision lab was established to initiate frontier research and for application of machine vision technologies in the dairy industry. The Division also conducts specialized training for 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 Extn.)

Dairy Extension Division was established at NDRI, Karnal in May, 1961 to undertake extension activities, besides teaching and research in Extension Education. Research endeavors of the division are in the areas of Information and Communication Technologies, organizational behaviour, information management, participatory technology development and impact studies of dairy innovations. The faculty has also been engaged in human resource development through post graduate and doctoral programmes of NDRI.

The main extension programme of the institute such as Dairy Mela and demonstrations, field days, etc are organized by the Division. Research-Extension-Industry-Farmer Interface is also organized by the Division to provide an opportunity for the convergence of all stake holders working together for dairy development. Interface not only helps the dairy organizations to find solutions for today's problems, but also to realize the vision for the future. The Division also organizes technology transfer campaigns, infertility and veterinary aid campaigns, Kisan Sanghosthies and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, helps in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers.

A new Extension Education Programme "Dairy Education at Farmers' Door" is initiated in February, 2009, to strengthen the effective dissemination of dairy production and processing technologies among farming community.

Livestock Research Centre (LRC)

The total milk production of the herd during the current year was 1343882.4 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 12.7 and 13.2 kg 4% FCM per head per day, respectively. The milking average of Sahiwal cows and Murrah buffaloes was 7.7 (4% FCM) and 9.2 (6% FCM) kg per animal per day, respectively. One Sahiwal cow (SW-1931) produced best milk yield of 20.0 kg in peak lactation. Best yield in Murrah buffalo (MU- 490) was 19.0 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 34.0 kg (KF-7238) and 25.0 kg (KS-4395), respectively.

Bovine Strength of Cattle and Buffaloes as on 31.03.2014

Age group	Cattle						Buffaloes	Total Bovines
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Local	Total	Murrah	
Calves upto 6 months								
Male	19	10	01	15	-	45	14	59
Female	18	08	01	25	-	52	23	75
Heifers	128	45	12	108	-	293	108	401
Cows	132	46	19	181	-	378	170	548
Male stock (young)	08	-	-	01	-	09	15	24
Bullocks/ Teaser	-	-	-	-	01	01	-	01
Total	305	109	33	330	01	778	330	1108

Flock Strength of Goats as on 31.03.2014

Age Group	Alpine x Beetal	Sannen x Beetal	Total
Female			
Kids upto 6 months	35	08	43
6-12 months	--	--	--
Yearling	28	16	44
Goats	28	06	34
Male			
Kids upto 6 months	04	01	05
Bucks	12	04	16
Total	107	35	142

Milk production at NDRI, Karnal during the year 2013-14 (01.04.2013 to 31.03.2014)

Total Milk Production (kg)		1343882.4 kg
Average Number of Animals in Milk per day:		
	Cattle	236
	Buffalo	101
	Goats	32

Sale of Livestock during the year 2013-14 (01.04.2013 to 31.03.2014)

Mode of Disposal	Cattle	Buffaloes	Goats	Total
Public Auction	217800.00 (174)	276600.00 (11)	101200.00 (30)	595600.00 (215)
On Book Value	600893.00 (52)	481494.00 (37)	40180.00 (25)	1122567.00 (114)
Grand Total	**818693.00 (226)**	**758094.00 (48)**	**141380.00 (55)**	**1718167.00 (329)**

- Auction of animals was conducted on 20th & 21st September, 2013 and 21st & 22nd March 2014.
- Figures in parentheses indicates the total number of animals sold.

Performance of Dairy Animals during the year 2013-14 (01.04.2013 to 31.03.2014)

Particulars	Genetic Groups				
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
Average number of animals in milk per day	70	15	15	136	101
Average number of dry animals per day	57	20	07	48	65
Milking average (kg) per day	7.0	5.9	12.6	12.4	7.3
Overall average (kg) per day	3.8	2.5	8.6	9.2	4.5
Best yield (kg) in a day	20.0	17.0	25.0	34.0	19.0
Animal Number	SW-1931	TP-1183	KS-4395	KF-7238	MU-490

Flock performance of Goats during the year 2013-14 (01.04.2013-31.03.2014)

Particulars	Genetic Groups	
	Alpine x Beetal	Sannen x Beetal
Average number of animals in milk per day	25	07
Average number of dry animals per day	06	05
Milking average (kg) per day	1.3	1.1
Overall average (kg) per day	1.0	0.7
Best yield (kg) in a day	3.1	2.7
Animal Number	AB-28	SB-209

Month-wise Milking Average (kg) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal 2013-14 (01.04.2013 to 31.03.2014)

	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	73	7.1	16	5.5	17	11.9	145	13.0	105	7.6	28	1.5	04	1.2
May	75	7.8	18	5.8	16	11.1	142	12.1	98	7.8	30	1.4	07	0.8
June	78	7.2	20	6.1	13	12.8	139	12.0	99	7.3	31	1.4	07	1.0
July	79	6.8	18	5.8	12	11.9	137	10.8	101	7.0	32	1.2	07	0.9
August	79	6.3	17	5.0	14	12.5	143	10.4	96	7.2	31	1.0	06	0.9
September	75	6.8	17	4.9	16	12.6	137	10.9	97	7.1	26	0.8	05	0.7
October	64	7.3	12	6.4	18	11.5	126	12.3	94	7.6	18	0.6	03	0.6
November	61	7.4	10	6.7	17	12.3	123	13.1	97	7.2	12	0.8	03	0.9
December	62	7.0	12	5.5	18	12.1	123	13.8	101	7.4	23	1.3	10	1.1
January	63	6.8	11	6.4	17	12.7	128	13.1	109	7.2	25	1.5	12	1.5
February	63	6.9	12	6.8	15	11.6	140	13.5	106	7.5	24	1.6	11	1.3
March	68	6.5	18	6.1	14	12.2	152	13.8	103	7.7	23	1.7	10	1.3
Average	70	7.0	15	5.9	15	12.6	136	12.4	101	7.3	25	1.3	07	1.1

Month-wise Milking Average (kg) as Fat Corrected Milk of Cows and Buffaloes Maintained at NDRI, Karnal (April 2013-March 2014)

Month	Sahiwal 4%Fat		Tharparkar 4%Fat		Karan Swiss 4%Fat		Karan Fries 4%Fat		Murrah 6%Fat	
	Av. No. of animals in milk/ day	Av. FCM yield (kg.)/ Animals / day	Av. No. of animals in milk/day	Av. FCM yield (kg.)/ animals/ day	Av. No. of animals in milk/ day	Av. FCM yield (kg.)/ animals/ day	Av. No. of animals in milk/ day	Av. FCM yield (kg.)/ animals/ day	Av. No. of animals in milk/ day	Av. FCM yield (kg.)/ animals/ day
April, 2013	68	7.59	12	8.70	14	12.33	159	14.37	105	8.97
May, 2013	75	8.46	18	6.51	16	11.59	142	13.17	98	9.37
June, 2013	78	8.06	20	6.70	13	12.65	139	12.28	99	8.50
July, 2013	79	7.51	18	6.64	12	12.25	137	11.65	101	9.55
August, 2013	79	7.00	17	5.43	14	13.93	143	11.09	96	9.32
September, 2013	75	7.17	17	5.41	16	12.98	137	11.21	97	8.56
October, 2013	64	8.37	12	7.53	18	12.54	126	13.02	94	9.72
November, 2013	61	8.08	10	8.17	17	12.78	123	13.64	97	9.11
December, 2013	62	7.86	12	6.53	18	12.98	123	14.67	94	9.76
January, 2014	63	7.96	11	7.14	17	13.89	128	14.47	109	9.43
February, 2014	63	7.03	12	6.60	15	11.54	140	13.52	106	8.22
March, 2014	68	7.10	18	7.04	14	12.65	152	14.95	103	9.68
Average	70	7.68	15	6.87	15	12.68	137	13.17	100	9.18

Fodder and Concentrate during the year 2013-14 (01.04.2013 to 31.03.2014)

Months	Type of Fodder (Qntls.)				Concentrate
	Green	Dry/Hay	Silage	G. Total	(kgs)
April, 13	13209.25	220.46	81.00	13510.71	94700.00
May	6362.50	260.25	6865.50	13488.25	107712.00
June	13438.75	370.75	1501.00	15310.50	119888.00
July	15832.75	320.00	368.50	16521.25	107233.00
August	20263.75	85.00	--	20348.75	106317.00
September	15547.50	45.00	--	15592.50	106100.00
October	12070.25	810.25	--	12880.50	105400.00
November	10380.25	1265.80	--	11646.05	117200.00
December	19935.25	729.05	--	20664.30	100500.00
January, 14	19813.50	843.15	--	20656.65	116200.00
February,14	18992.00	845.00	--	19837.00	94650.00
March, 14	22925.50	238.15	--	23163.65	94100.00
Total	**188771.25**	**6032.86**	8816.00	203620.11	1270000.00

Fat and SNF Percentage of Cattle and Buffaloes during the year 2013-2014

Particulars	First Lactation				
	Cows				Buffaloes
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
No. of observations	184	61	47	522	308
Average fat %	4.68	4.75	4.23	4.26	7.97
Range	3.50-5.82	3.90-6.12	3.56-5.10	3.45-5.64	5.66-10.24
No. of observations	184	61	47	522	308
Average SNF%	8.73	8.74	8.71	8.71	9.80
Range	7.93-9.24	8.53-9.10	8.52-8.97	8.12-9.07	9.23-10.84

All Lactations					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No. of observations	847	174	175	1700	1270
Average fat %	4.57	4.66	4.22	4.27	7.90
Range	3.19-6.18	3.56-6.15	3.52-5.49	3.00-5.68	3.55-10.44
No of observations	847	174	175	1700	1270
Average SNF%	8.75	8.73	8.72	8.71	9.79
Range	8.03-9.70	8.51-9.10	8.47-9.01	7.99-9.16	9.13-10.92

Protein and Lactose Percentage of Cattle and Buffaloes during the year 2013-2014

First Lactation					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No. of observations	184	61	47	522	308
Average protein	3.30	3.28	3.23	3.20	3.91
Range	2.68-3.76	2.86-3.77	2.91-3.64	2.76-3.80	3.19-4.45
No. of observations	184	61	47	522	308
Average Lactose	4.91	4.92	4.89	4.84	5.81
Range	4.28-5.54	4.50-5.66	4.63-5.15	4.34-5.76	5.05-6.22

All Lactations					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No. of observations	847	174	175	1700	1270
Average protein	3.28	3.28	3.23	3.20	3.87
Range	2.68-3.96	2.79-3.88	2.77-3.86	2.46-3.98	3.07-4.68
No. of observations	847	174	175	1700	1270
Average lactose	4.90	4.91	4.87	4.86	5.81
Range	4.05-5.78	4.47-5.77	4.18-5.77	4.24-5.99	5.04-6.83

Production and Reproduction Performance of Cattle Initiating their Lactation during 2012 and Completing in 2013

Traits	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
First Lactation					
Age at 1st calving (Months)	41.08 (35)	48.72 (6)	3591 (6)	41.43 (52)	41.87 (36)
Total milk yield (kg)	2465 (8)	1536 (6)	4492 (6)	4168 (48)	2209 (26)
305 or less days milk yield (kg)	2262 (8)	1462 (6)	3702 (6)	3603 (50)	2007 (26)
Lactation length (days)	344 (8)	251 (6)	382 (6)	363 (47)	342 (26)
Dry period (days)	60 (3)	179 (4)	75 (2)	67 (33)	94 (8)
Service period (days)	152 (7)	90 (4)	215 (2)	153 (33)	130 (20)
Calving interval (days)	103 (7)	374 (4)	507 (2)	415 (28)	470 (8)
All Lactations					
Total milk yield (kg)	1769 (83)	1459 (16)	4197 (18)	4497 (149)	2333 (82)
305 or less days milk yield (kg)	1748 (83)	1428 (16)	3919 (19)	3907 (157)	2431 (82)
Lactation length (days)	266 (82)	254 (16)	331 (18)	337 (149)	343 (82)
Dry period (days)	130 (49)	162 (9)	89 (13)	75 (91)	101 (31)
Service period (days)	131 (61)	107 (9)	137 (13)	165 (91)	129 (64)
Calving interval (days)	143 (60)	388 (9)	426 (13)	425 (91)	439 (31)
Average number of lactations	3.44 (83)	1.81 (16)	2.52 (19)	2.73 (159)	2.24 (82)

Best Lactation 305 days					
Milk yield (kg)	4063	2655	5830	8511	3915
Animal number	1783	1274	4402	6791	498
Lactation number	5	1	3	5	2
Milk yield (kg)	4686	2719	6107	11301	5240
Animal number	1783	1274	4410	6791	498
Lactation number	5	1	1	5	2
Lactation length (days)	427	311	379	479	562

Figures in parentheses indicate number of animals

Artificial Breeding Research Centre

The Artificial Breeding Research Centre (ABRC) with a capacity of 131 bulls (Sahiwal-38, Tharparkar-13, Karan-Fries- 34, Karan Swiss -02 and Murrah - 44), is the largest Institute Breeding Bull Center in the country. The centre developed infrastructure for maintaining cloned buffalo bull, storage for dry fodder and Semen Parlour for distribution of germplasm to farmers. The center 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.

Research Highlights

- The centre developed the innovative application of bio-stimulation (estrous mucous) and as a result five out of eight sahiwal bulls (more than three years age but not donated semen consistently) started to produce good quality semen.

- The centre has developed feeding management practices to reduce the age for initiating training and age at first semen ejaculation in Murrah bulls. Average age for initiating training and age at first ejaculation of the young Murrah bulls has significantly reduced to 16.7 and 18.0 months.

- The semen freezing of first cloned buffalo bull (Shresth) in the world was further strengthened and 6500 doses of frozen semen with PTM more than 60 % are available at ABRC.

- The centre procured some critical equipments and software for monitoring management information of bulls.

- The centre screened sexually transmitted bacterial and viral diseases viz., TB, JD, Brucellosis, IBR, Campilobacteriasis and Trichomoniasis of all breeding bulls and semen of breeding bulls. All bulls and semen samples were found negative from sexually transmitted diseases.

- The centre screened the chromosomal abnormalities of 78 breeding bulls and all bulls were found free from any chromosomal abnormalities.

- The centre screened microbiological load of semen of 59 breeding bulls and all bulls were found within the range of microbial load as per MSP of cryopreservation of semen.

- The centre initiated the electronic recording the behaviour study of breeding bulls to develop measures for improving further the production of germplasm.

- Management and cryopreservation of semen of breeding bulls : During 2013-14, the center collected and preserved the frozen semen of nine Murrah bulls under "Network Project on Buffalo Improvement", sixteen Sahiwal bulls under AICRP on 'Genetic improvement of Sahiwal Cattle' and fifteen Karan Fries crossbred bulls under Progeny Testing of KF bulls. The center also preserved the semen of seven out of 16 Tharparkar bulls maintained for multiplication of Tharparkar breed of cattle.

Breeding bulls at ABRC during 2013-14

Murrah Bulls		Sahiwal Bulls		**Karan Fries Bulls**	
14th Set	15th Set	10th Set	11th Set	12th Set	13th Set
6014	6007	1681	2004	7088	7242
6044	6139	1727	2019	7096	7289
6066	6290	1815	2030	7134	7304
6136	6410	1817	2037	7141	7322
-	6333	1852	2056	7178	7462
-	-	1854	2066	7205	7485
-	-	1909	2073	7249	7517
-	-	1958	2094	-	7521
4	**5**	**8**	8	7	8

Reproduction Management

The center performed 1293 artificial insemination of breeding bulls and monitored the reproductive efficiency of NDRI herds.

Reproductive Status of NDRI Herd during 2013

Particulars	**Breed**				
	SW	**TP**	**KS**	**KF**	**MU**
Cow/Buffalo					
No. of Observations	82	29	7	113	91
Service Period (days)	115.54	98.82	120.71	116.96	141.13
No. of Service/Conception	1.32	1.41	1.71	1.33	1.32
Heifer					
No. of Observations	44	5	1	21	33
Av. Age at Maturity (Month)	28.04	29.40	23.00	27.04	29.42
Av. Age at Conception (Month)	29.18	29.40	26.00	28.19	32.51
No. of Service/Conception	1.47	1.20	2.00	1.38	2.00
Conception Rate (%)					
Conception Rate 1st service.	48.36	50.00	50.00	40.65	44.27
Conception Rate 3rd service	77.82	85.71	62.50	67.75	76.04
Over All Conception Rate	42.90	50.00	32.55	35.40	42.58

Production of Superior Germplasm

The centre is involved in production and conservation of superior male germplasm of cattle and buffaloes. During 2013-14, the centre produced 1, 80,997 doses of frozen semen

Dissemination of Superior Germplasm

The centre is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes. During the year ABRC disseminated 23, 430 ml doses liquid semen of Sahiwal, KF and Murrah bulls to farmers of different states and also disseminated/supplied 1,04,949 doses frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers and various dairy development organizations/institutes/ gaushalas of 11 states viz., Delhi, Haryana, Punjab, Uttarakhand, U.P, Rajasthan, Bihar, Chhattisgarh, Himachal Pradesh, Karnataka, Madhya Pradesh.

The centre distributed 17 surplus breeding bulls (Karan Fries - Five, Sahiwal - Four, Tharparkar - Three and Murrah - Five) to government agencies/farmers. ABRC developed Training modules on various aspects of artificial breeding, frozen semen technology and commercial dairy farming for DAHDF, MOA, Govt. of India, PLDB and International participants. Advisory service to the farmers in use of A.I., different breeding activities.

Training Organized

During the period, ABRC conducted four training programme for workers of Frozen Semen Station of Dharoli, District Jind and stockman of Central Herd Registration Scheme, Rohtak. ABRC imparted training to newly appointed ARS scientists under mandatory training of ARS, and participants from Frozen Semen Station, BAIF, Jind and Tripura Govt.

Revenue Generation

Looking in to the demand and quality of the cattle and buffalo germplasm and to increase the revenue of the institute, ABRC generated ₹ 13,68,530/- for the institute through sale of liquid and frozen semen during 2013-14.

Forage Research And Management Centre

The foremost responsibility of Forage Research and Management Centre is to produce adequate quantity of good quality green fodder to meet out nutritional requirements of the Institute herd. After meeting the day to day requirement of fodder, some area is utilized for production of fodder seed and other grain crops to meet out the requirements for transfer of technology programmes of institute and partial fulfillment of the grain component of feed.

Allocations of the Farm Land to different Units

Unit	Area (ha)
Forage Production Section	256.68
Seed Production Section /Forage research Farm	40.25
Dairy Demonstration Unit (KVK)	13.52
Dairy Mela Ground	3.44
Hostels, Power House, Play Ground	2.83
Transfer to PDC Meerut (excluding Pond area)	40.5
Total	**357.22**

In all, 1,83,265.75 quintal good quality green fodder was produced from high yielding varieties of fodder crops of maize, sorghum, sorghum Sudan grass hybrids and cowpea during kharif season and lucerne, berseem, oats chinese cabbage, turnip and winter maize in rabi season. Similarly grain crops of oats, wheat and barley were also grown. During the period under report a total of 204451.25 q of fodder including 194741.50 q green

Production and Productivity of Forage Crops in form of Green Fodder

Crop	Area(ha)	Average yield (q/h)	Production (q)
Berseem +Mustard	66.56	823.35	54802.50
Oats	113.28	348.57	39485.50
Turnip	13.24	639.06	8461.25
Oats + Maize +Mustard	1.62	437.03	708.00
Lucerne	5.91	396.10	2341.00
Mustard	13.44	478.68	6433.50
Maize	97.52	254.85	24853.00
Jowar (Single cut)	13.86	260.44	3609.75
Jowar (Multi cut)	40.00	600.96	24038.75
Maize + Jowar	23.82	172.73	4114.50
Cowpea + Bajra	2.75	131.09	360.50
Maize +Makchari	3.24	562.96	1824.00
Makchari	8.90	466.91	4155.50
Bajra	19.37	288.28	5584.00
Cowpea	8.38	154.86	1299.75
Jower + Bajra	2.30	519.23	1194,25
Total	**434.19**	**-**	**1,83,265.75**

Production and Productivity of Grain Crops

Crops	Area (ha)	Average yield(q/h)	Production (q)
Wheat	17.65	39.98	670.30
Barley	4.05	34.51	139.75
Oats	50.41	9.27	467.40
Total	**72.11**	-	**1,277.45**

Straw Production of Wheat, Barley, Oats and Paddy

Month	Crop	Qty (q.)
May 2013	Wheat Straw	193.75
	Barley Straw	78.75
	Oats Straw	1024.25
November 2013	Paddy Straw	83.00
Total		1,379.75

fodder 8816.00 q silage and 893.75 q dry fodder was supplied to cattle yard. Total production of grains of wheat, barley and oats was 1277.45 q.

Forage Conservation

Sufficient quantity of green fodder of oats was conserved as silage 11020.50 q and 1,379.75 q of dry fodder as wheat, barley, paddy 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 and providing tractors on lease an amount of Rs. 18,78,914.36 was realized and an amount of Rs. 18,38,580.00 was saved by the use of farm produce as seed/feed.

Revolving Fund Scheme on Seed Grain Production

During the year 48.97 q. seeds, 191.50 q. grains, 17198 q. green fodder and 307.50 q. dry fodder was produced under Revolving Fund Scheme and total Rs. 28,65,901.25 Revenue was generated.

Total Revenue generate Rs. 28,65,901.25

Mechanization at NDRI Farm

The Forage Production Section at NDRI introduced new implements and equipments for increasing work efficiency, quality of sowing. New implements like Roto seed drill and fertilizer-cum-seed spreader were purchased and some modification were done for efficient use. Teflon made bush system was also introduced.

Forage Museum: 2 acre (87120 square feet)

To maintain the green fodder availability round the year a forage museum was established at Forage Production Section. Presently 16 varieties of perennial grasses (napier-7, Guinea-3, Nandi grass-1Anjan-3, paragrass-1, Bahia grass-1) were planted at forage museum. In rabi season three varieties of berseem, two varieties of oats and one variety of turnip was cultivated at forage museum site.

Berseem Crop

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 81 students from several institutions were provided training during the year 2013-2014.

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 2013-14 is ₹ 4,81,75,427/- 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 training to students/scholars. The Computer Centre offers two Computer Science courses to under-graduate students and one course to post-graduate students. 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.

The Institute has a well established Local Area Network (LAN) connecting all the divisions/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 Officers and students. Student hostels are also connected to Institute LAN through Wi-Fi network to enable the students to access the Internet and library resources round the clock. The computer systems support FORTRAN, C, C++ and Visual Programming languages compilers.

ASRB Online Examination Centre

An online examination centre has been established under the NAIP Sub-project, "Developing, Commissioning, Operating and Managing an online system for NET/ARS-Preliminary Examination by ASRB, ICAR" for conducting NET/ARS-Preliminary Examination by ASRB, ICAR. In all 570 candidates undertook the online exam at this centre.

Management Information Service

Computer Centre prepared 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 has implemented the MIS/FMS ERP solution for a transparent and paperless office. The Computer Centre extended its technical and ICT infrastructure support for this ERP system.

Scientific Data Processing

The Centre processed scientific data pertaining to research projects of the Institute including students dissertations/theses work submitted by the research scholars. The sophisticated SAS statistical computing software (recently acquired under the aegis of the NAIP funded subproject: SSCNARS) is extensively utilised for the purpose. The Computer Centre provided scientific data analysis consultancy to 190 users comprising 28 scientists and 162 research scholars using in-house developed scientific programme and SAS statistical computing software.

Agriculture Knowledge Management Unit

The Agriculture Knowledge Management Unit (AKMU) established with the help of ICAR 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 (1 Mbps) provided by ERNET India Ltd., via Unified Threat Management (UTM) System. Computer Centre procured state-of-the-art UTM FortiGate-600C and Network-Analyser-200D for AKMU. 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 programme 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 level and national government agencies.

Website

The NDRI Website is dynamic with role based security features in place. The web content was regularly updaed to keep he information up-to-date.

NET 2014(I) Online Examination conducted by the ASRB in progress at NDRI Karnal Centre

Library

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 200 periodicals are subscribed to keep track of the current scientific/ technical developments. There are 89,871 volumes which includes 51,460 books, 32,457 bound journals, 4,186 theses, 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 Library, NDRI is an active partner of NAIP Sub-project "Strengthening of Digital Library and Information Management under NARS (eGranth)". The project has major mandate to have a union catalogue of all participating libraries with integration/ collaboration of Online Computer Library Center (OCLC)". In this project the participating libraries are to uploaded their catalogue/ database of all the available books journals and other resources on OCLC plateform in MARC21 format. Presently ~49,250 catalogue records of Library, NDRI available on WorldCat. Library digitized ~500 contents/records of institute outputs, which includes valuable books, publications, reports, conference proceedings and research articles etc. 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-Video and Photo Lab.

The facilities of audio video recording on DVD & VCD, dubbing & mixing and photos editing were provided to the staff, students & research Scholars for their researches & research projects. Video coverage of 55 events of the Institute consisting of National & International Seminars, Convocation, Meeting, Conferences, National Dairy Mela, Exhibitions, Kisan Sangosthi, Cultural programmes of the Institute and Cattle shows, etc. were carried out in ICAR and 92 Nos. of DVD/ VCD were supplied.

Exhibitions Organised

1	Indian Dairy Summit -2013 at Delhi.	24th September, 2013
2	National Workshop on Out Scaling Farm Innovation at NASC, Delhi.	3rd -5th September, 2013
3	Kisan Mela on Maize and Sugar Cane at Uchani, Karnal.	16th September, 2013
4	Innovation-cum-Seed Day at DWR, Karnal.	15th October, 2013
5	Trade Fair at Pragati Maidan, Delhi.	14th -27th November, 2013
6	Kisan Sammellan at Jajjhar, (Haryana).	19th January, 2014
7	Buffalo Mela at CIBR, Hisar.	1st February 2014
8	Kisan Mela at Sugarcane Breeding Institute, Karnal.	5th February, 2014
9	Krishi Vasant at C.I.C.R. Nagpur.	9th -13th February, 2014
10	Progressive Punjab Agriculture Summit at Chati Chiri (Mohali), Punjab.	16th -19th February, 2014
11	National Dairy Mela at NDRI, Karnal.	25th -27th February 2014
12	Rabi Kisan Mela at CSSRI, Karnal.	1st March, 2014
13	Kisan Mela organized by Young Association at Village Rakhara Dist. Patiala (Punjab)	15th March, 2014

Revenue Generation

1	Revenue from Dr. D. Sundaresan Auditorium	₹ 9,14,931.00
2.	Photography	₹ 10,154.00
	Total	**₹ 9,25,085.00**

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. Diagnostic clinical lab is well equipped with a fully automatic haematolyzer and a semi-auto biochemical analyzer.

Technology Business Incubator

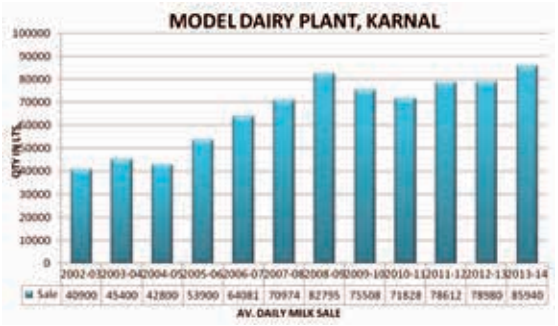
Technology Business Incubator (TBI) established with the support of DST and registered as a society in the name of "Society for Innovation & Entrepreneurship in Dairying" (SINED) organised during the financial year 2013-14. Three courses in Dairy Processing and related milk products and five on Commercial Dairy Farming and two Short Training Programmes on Infertility Management for veterinary officials and one training programme on Breeding and Reproduction Health Management in Dairy Animals for "Orissa Government" were also organised. Four incubatee companies worked with TBI under incubation programme, two for milk processing of different milk products, one for mineral mixtures and one for bakery products. One virtual incubatee company joined and two other virtual incubatee companies graduated in 2013-14.

Model Dairy Plant

A state-of-the-art Commercial Dairy Plant was established during 1995 at NDRI, Karnal through the financial assistance and installed on turnkey basis by the National Dairy Development Board. The Plant has been designed to handle 60,000 liters (Ltrs.) of milk per day and is presently running in full capacity. Model Dairy Plant is presently certified under the Food Safety Management System (FSMS) ISO 22000:2005.

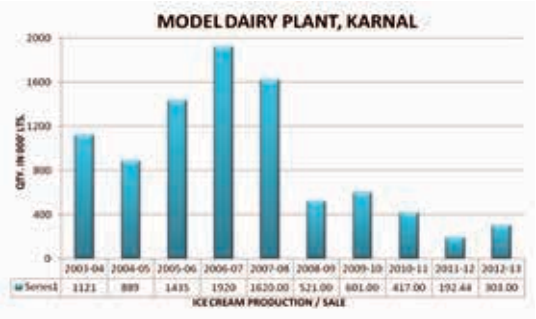
Special Features

- 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. A total of 451 no. of students have been trained so far.
- 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.
- 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 – 80

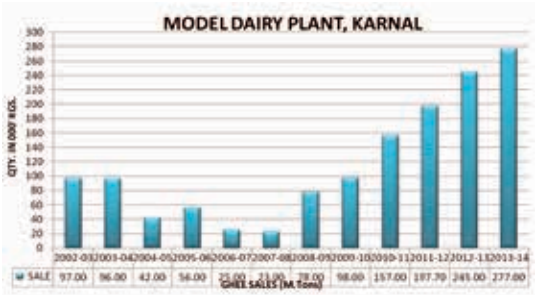


TLPD of polypack Milk in all the varieties for Mother Dairy, Delhi.

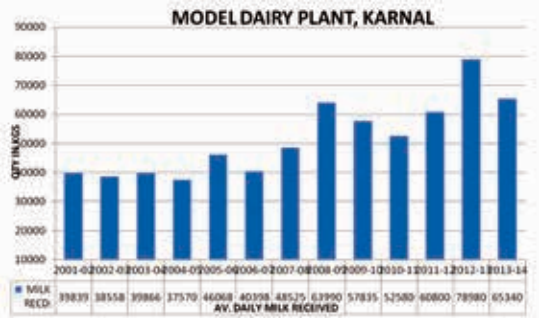
- MDP also processes and packs Ice-cream for Mother Dairy to the tune of 7000 liters per day (yearly average for 240 days operation) thereby utilizing the full capacity of the unit. The ice cream manufactured at MDP is of different varieties i.e. Vanilla, Strawberry, Shahi Malai, Kewra, Thandai, Butter Scotch, etc. and as per the requirements of Mother Dairy.



- MDP manufactures cow ghee from cow butter purchased from different State Federations and its production is not taken as per demand.The average production/ sale of ghee 20-25 MT/month. All the ghee manufactured at MDP is being sold through the MDP Sale Counter.



- MDP impacts training to students in manufacturing of cottage cheese, processed cheese, paneer on trial basis.



- MDP receives milk on behalf of Mother Dairy from the units of Punjab / Rajasthan and their NGC milk collection centres on NMG rates. The average milk procurement per day is around 60,000 to 70,000 LPD, which is sufficient to meet day to day demand of different milk variants being packed at MDP.

Dr. G. R. Patil, Joint Director (Academics) receiving 'Education Leadership Award - 2013'

16 REGIONAL STATIONS

Southern Regional Station, Bangalore

The National Dairy Research Institute was started at Bangalore 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 Bangalore 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.

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 46.3 hectares. About 21 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 250 zebu cattle of Deoni breed and 50 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 campus. A sensory evaluation laboratory for evaluation of dairy products has also been established.

The library is stocked with 12,467 books. 10,857 bound volumes of journals, 2,018 theses and 1,295 reprints. Library subscribes to 125 Indian / Foreign Journals relevant to various disciplines of Dairy Science. In addition, few journals were also received on gratis basis from different Institutions/organizations of the country and abroad. Library Automation Software procured for facilitating the automation of library functions and 9859 Bibliographical details about the book have been updated in to the software. The Library also provides internet services, photo copying facility, News Paper Clipping Services, Reference Services and Inter Library Loan facilities 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. The Library has also facility for online journal referral.

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., a seminar hall and a mini auditorium with very good facilities have been developed recently.

The research, training and transfer of technology programmes at the Campus are carried out through different sections viz., Animal Breeding and Artificial Insemination, Cattle Yard and Forage Production, Dairy Technology, Dairy Chemistry and Bacteriology, Dairy Engineering, Dairy Economics and Statistics, Dairy Extension and Education and Training. The Campus has staff strength of 164 including 22 Scientific and 38 Technical staff.

The experimental dairy of the Institute is recently renovated and has all the facilities for manufacturing various milk and milk products. The section is involved in regular training programmes and is also providing in-plant training to the students from various institutions. Training is also imparted to the entrepreneurs. The excess of milk is being

sold as market milk and some quantity of milk is also converted into different dairy products for sale through the parlour of the Institute.

Education and Training

Educational Programmes

Ph.D. Programmes for carrying out dissertation work are being offered in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Dairy Economics and Dairy Extension. In addition to conducting the course work for Ph.D. in Dairy Engineering and M. Tech Programme in Dairy Technology and Dairy Engineering, guidance is being provided to the PG students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics and Breeding, Animal Biotechnology, Animal Nutrition, Dairy Economics and Dairy Extension for carrying out their dissertation work. Short term Training Programmes are being imparted in Processing, Quality Assurance, Dairy Production and Extension for the students, dairy farmers/entrepreneurs and personnel from Co-operative Federations and Private Organisations. Apart from this, in-plant training and in-lab training was given to the UG and PG students of other Colleges/Universities. PG students of other Universities also conducted their project work in the laboratories of the Station.

A new programme viz. Diploma in Dairy Technology has been started from August, 2013. Thirty students have been admitted to this programme.

Counseling process for admission to the Diploma in Dairy Technology Programme was held at SRS of NDRI, Bangalore on 1st August, 2013.

Training Programmes (2013)

Name of the Training Programmes	No. of Batches	No. of Participants
Commercial Dairy Production	03	30
Dairy Cattle Feed Analysis and Feed formulation	01	04
Propagation and Maintenance of Starter Culture	01	04
Training on Livestock Genomics and IP Protection in Livestock Biotechnology	01	03
In-plant Training (DT)	05	22
In-lab Training (DE)	01	01
In-lab Training (DT)	01	02
Orientation on Sensory Evaluation of Cheese, Dahi and Yoghurt	01	15
Preparation of Cheese and other Related Products	01	05
Project Work	03	03
Total	17	87

A total revenue of ₹ 2,46,846/- was collected towards the training fees for the above training programmes during the year 2013.

Scholarship/Fellowship	Ph.D.	M.Tech.
NDRI Fellowship	10	23
ICAR-SRF/JRF	02	02
RGNF-JRF	01	--
INSPIRE (SRF)	02	--

- Guidance and counseling was imparted to the PG students for their career advancement and recruitment process was conducted by the various organizations like M/s. Wrigley India Pvt. Ltd., GCMMF, IDMC, Hatsun Agro Product Pvt. Ltd., Mehsana Milk Union and Academic Institutions.
- Literary and cultural activities are conducted for the students of our campus during the Hindi Day and National Festival Celebrations. Sports were also conducted during the Independence Day and Republic Day Celebrations.
- Nine B.Tech (DT) final year students from College of Dairy Technology, Pusad and Latur (Maharashtra) completed their in-plant training in June, 2013
- Eight B.Tech (DT) 3rd year students from College of Dairy Technology, Veterinary Campus, MAFSU, Latur, Dist Udgir (Maharashtra) completed their In-plant Training in December 2013.

Extension Activities

- A total no. of 558 visitors in 22 batches comprising of students from various educational institutes of southern region, farmers, entrepreneurs and trainees 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 advice was rendered to the thirty of the needy clientele during their personal visits to the Institute through mail correspondence and phone enquiries. The profile of information needs included feasibility of modern and mechanized mega dairy project, availability of high yielding dairy breeds, information regarding hand operated milk machines, dairy processing technologies and scientific dairy farming aspects, know–how on preparation of indigenous dairy products, training programmes in dairying for rural women and farmers, preparation of project reports for dairy business, export potential for dairy products, packaging and marketing of milk and milk products, availability of dairy cultures for food industry and on knowhow to start up a commercial dairy farm.
- Orientation programmes were organized for four batches of Progressive Farmers from Thrissur, Kerala during June 2013.
- One day orientation programmes was organized for thirteen students from Dairy Technology College, Sri Venkateshwara Veterinary University, Tirupathi on 27th July 2013.
- An exposure visit cum training programme at the institute was organized on 4th April 2013 for the IIHR trainee farmers from Thrissur, Kerala under ATMA programme, Department of Agriculture, Govt. of Kerala.

Farmers' training programme

- One day training programme on, "Scientific Dairy Farming Practices" was organized on request for the progressive dairy farmers of Kasargod, Kerala under ATMA programme on 10th April 2013.
- A refresher programme was organized on 31st May, 2013 for the NIANP trainees on Trainers' Training programme facilitated for the Animal Husbandry Officers / Directors of Department of Animal Husbandry, Dairying and Fisheries from various Central and State Govt. from different states.
- A Collaborative Training Programme on "New Dimensions in Extension for Extension Functionaries in Dairy Sector" was organized by SRS, NDRI and National Institute of Agricultural Extension Management (MANAGE), Hyderabad, held from 16th to 19th September 2013 at SRS, NDRI Bangalore. The training program was well attended by fourteen participants comprising Deputy Directors /Assistant Directors from State Animal Husbandry Departments from the states of Punjab, Meghalaya, Kerala, Tamil Nadu, Pondicherry and Karnataka.
- Participated in Dairy Tech India 2013, International Exhibition on Dairy Products & Processing, Packaging and Allied technologies held during 23rd to 25th August, 2013 at Bangalore International Exhibition Centre (BIEC), Bangalore.
- Participated in National Conference on All India KVK Meet 2013 jointly organized by ICAR and UAS, Bangalore from 23rd to 25th October, 2013 at GKVK Campus of University of Agricultural Sciences (UAS), Bangalore.
- Participated in International Krishi Mela 2013 organized by University of Agricultural Sciences (UAS), from 7th to 11th November, 2013 held at GKVK Campus of UAS Bangalore.
- Participated in Rashtriya Krishi Mahila Mahotsav (Women in Agriculture Day) organized by IIHR, Hesaraghatta, Bangalore during 7th and 8th December, 2013 at Lal Bagh Bangalore. The initiative was encourage the woman beneficiaries into creating awareness on various income-generative activities in the field of agriculture, horticulture, animal husbandry and dairying. As an event for women empowerment showcasing of women friendly technologies was exhibited

Dr. S. Ayyappan, Hon'ble Secretary, DARE and DG, ICAR at the Krishi Mahila Mahotsav 2013 organised by IIHR Bangalore

by the participating institutes. Farm women entrepreneurs from various districts of Karnataka, Andhra Pradesh and Tamil Nadu participated and marketing opportunity for their farm and home-made products was created during this event. Women beneficiaries from the adopted villages of NDRI participated in the event.

- Participated in 42nd Dairy Industry Conference (DIC) organized by Indian Dairy Association (South Zone) held during 12th to 14th December, 2013 held at Chennai Trade Center Chennai.
- Extension literature on dairy production and processing aspects was distributed to the visitors and needy clients for dissemination of needed technical information. An extension folder on 'Clean Milk Production' was prepared in Tamil for the benefit of dairy entrepreneurs and dairy farmers of the locale.
- An interactive meeting and awareness program on scientific dairying was organized for women SHGs of selected villages, Suradenapura and Rajankunte on 8th July 2013.
- Two SHG group members from Bidathi Ittamadu and P.Rampura villages were trained on group dynamics and dairy entrepreneurship development on 12th July 2013.
- World Milk Day was observed at SRS of NDRI by students and staff of NDRI on 1st June, 2013 and awareness campaign was organized for the public on importance of milk and milk products.

New Initiatives

- A new cluster of villages was identified to implement Rural Extension Programme and Dairy Education at Farmers Door Program.
- A study was initiated on small holder dairy production systems of all the southern states to elucidate the present dairy farming trend/ status in the region which includes the constraint analysis of the small dairy farming systems.
- Empowerment of rural women SHGs through implementation of IRC project Dairy Entrepreneurship Development of Rural Women: An Action Research. This project involves association of NDRI with interested NGOs working in the field of dairying and rural development.

Experimental Dairy

Milk and Milk Products Sale (January 2013 to December 2013)

S. No.	Product	Quantity sold	Amount (₹)
1.	Milk sweet, kg	397.5	95400
2.	Flavoured milk, pkt	5702	58412
3.	Process cheese, pkt	5312	398400
4.	Paneer, kg	1435.5	238900
5.	Butter, kg	270.5	75740
7.	Gulabjamun mix, pkt	332	14940
8.	Cheese puri mix, pkt	356	16020
9.	Chhana podo, pkt	1091	56300
10.	Kunda, cups	670	14000
11.	Ice cream (S), cups	473	5676
12.	Ice cream (O), cups	1862	18620
13.	Ice cream (O), FP	49	4410
14.	Ice cream (S), FP	87	7370

15.	Yoghurt, cups	979	10231
16	Curd, pkt	2568	30816
17.	Khoa, kg	10	2400
18.	Cream, kg	26	5200
19.	Skim milk, lit	140	3360
20.	Milk, lit	45814	1266772
Total			**2322967**

Livestock Farm

Livestock farm located at NDRI, SRS, Bangalore maintains "Deoni", an important dual purpose indigenous breed. During last one year, the mean monthly milk yield for Deoni and HF crossbred animals were 3026.86 ± 149.50 and 4992.63 ± 379.33 kg, respectively. The mean age at first calving of Deoni animals was recorded as 1460.0 ± 67.9 days. The mean lactation milk yield of Deoni, the dual purpose cows during last one year was found to be 808.03 ± 87.0 kg in a lactation length of 201.31 ±13.9 days. The mean daily milk yield, peak yield and days to attain peak yield were reported as 3.7±0.2; 5.7±0.5 kg and 10±1.4 days respectively. The mean inter calving period in Deoni cows was 446.83 ± 23.7 days. In HF crossbred animals, 305 day lactation yield was recorded as 3013 ± 190.8 kg. The mean values for daily milk yield, peak yield and days to attain peak yield were 10.0 ± 0.6; 14.8 ± 0.62 kg and 21.6 ± 3.19 days, respectively. The mean calving interval in HF crossbred cows were 398.71 ± 23.7 days.

Productive and Reproductive Performance (Mean ± SE) of Dairy Herd

Breed	Lactation length (in days)	Lactation yield (in kg)	Daily milk yield per lactation (in kg)	Days to attain peak yield	Peak yield (in kg)	Age at first calving (in days)	Inter calving period (in days)
Deoni	201.31± 13.9	808.03± 87.0	3.7±0.2	10±1.4	5.7±0.5	1460.0 ± 67.9 (48.7 months)	446.83 ± 23.7 (15 months)
HF Crossbred	305	3013 ± 190.8	10.0 ±0.6	21.6± 3.19	14.8± 0.62	-	398.71 ± 23.7 (13.3 months)

Eastern Regional Station, Kalyani

The Eastern Regional Station was established at the Central Dairy in Calcutta in 1964 and was shifted to Kalyani during 1966, Nadia district, about 50 km north of Calcutta and was located in the Administrative Building of Kalyani University. The Regional Animal Nutrition Research Centre of the I.C.A.R. till then located at Haringhata, West Bengal, was merged with the E.R.S. of N.D.R.I. 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 National Dairy Research Institute (NDRI) is a premier institute devoted to research on dairying. The main institute is located at Karnal, Haryana. The main objective of establishing the Eastern Regional Station is to identify the major constraints of dairy production in eastern and north eastern India and to offer solutions through research and extension activities to these problems. It serves as a vital link between the NDRI, Karnal and the far-flung areas of the eastern and north eastern regions of the country for transfer of technology developed at the institute and provides appropriate feedback after trial for perfection. The research work undertaken at this station is mainly strategic and applied in nature and the thrust of research is to improve the socio-economic condition of dairy farmers of this region.

The research work during the period of 1964-1972, were mainly related to Animal Nutrition. During the period of 1972-1976, it was related to Animal Nutrition and Dairy Chemistry and Bacteriology, and during the period of 1977-1985, related to Animal Nutrition, Animal Breeding, Soil Science Dairy Economics and Dairy Extension. Since 1986 research is mainly focused on Animal Nutrition, Livestock Production and Management, Animal Breeding, Forage Production, Dairy Economics & Statistics and Dairy Extension. Animal Biotechnology Section started functioning during 2005. The Station has infrastructure facilities like Research Laboratories, Cattle Herd, Fodder Farm, Library, Computer Section, Guest House, etc.

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.

Support Sections

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 Dairy 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. 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. The computer center facilitates the huge database and analysis of experimental data. The institute has internet connectivity through VSAT, which is useful for searching literature and references. In addition, the data of milk production, fodder and feed supply, reproductive performance and meteorology are also being maintained on day-to-day basis.

This station has laboratory facilities for the research work of M.Sc. and Ph. D. scholars. Field visits, Farmer- Scientist Interface, 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 organised time to time. The feasible technologies are being taken up for transfer through these trainings, field visits and village extension programmes where all efforts are being made by the Institute to popularize latest suitable technologies in order to enhance dairy farming activity.

Livestock Farm

Reproductive Performance of ERS-NDRI Herd

Particulars	Jersey Cross
Herd strength as on 31.12.2013	153
Total milk production (kg)	110999.0
Av. no. of cow's in milk/day	48.0
Av. no. of cow's dry/day	19.7
Wet average (kg)/day	6.34
Herd average (kg)/day	4.49
Age at first calving (month)	38.8
No. of inseminated cows	79
No. of pregnant cows	46
Conception rate (%)	58.2
Service period (days)	114
Inter calving period (days)	432
Mortality (%)	9.8

Milk Production Performance at ERS-NDRI herd (January to December, 2013)

Months (2013-2014)	Milk Production (kg)	Wet Average (kg)	Herd Average (kg)	Average FAT %	Average SNF %
January	8709.5	5.63	4.25	5.48	8.59
February	8777.5	6.52	4.68	4.75	8.57
March	9660.0	6.80	4.67	4.75	8.57
April	8935.5	6.39	4.45	4.82	8.61
May	9821.0	6.32	4.56	4.73	8.62
June	10720.0	7.16	5.08	4.69	8.63
July	10192.0	6.91	4.70	4.76	8.63
August	10011.0	6.59	4.63	4.76	8.64
September	9631.0	6.20	4.52	4.75	8.63
October	8298.5	5.73	4.20	4.78	8.64
November	7708.5	5.74	3.97	4.78	8.64
December	8534.0	6.06	4.12	4.78	8.64
Overall Average	110999.0	6.34	4.49	4.69	8.66

Forage Farm

Forage Farm Section is engaged in cultivation of quality fodder crops in about 27 hectares area and manages harvesting and supply of fodder crops either chaffed or unchaffed to the Cattle Yard.

Besides cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machineries including tractors, chaff cutter, etc. There is a small vermin-compost unit used for production of vermin-compost and also for training and demonstration purpose. There is an agri-meteorological observatory where regular observations are taken for various meteorological parameters like relative humidity, max. and min. air temperature, soil temperature at different depth, wind speed and direction, rainfall, etc. There are about 700 plants of teak, shesham, etc. growing around the Institute premises. Besides, there is a fodder herbarium for training and demonstration purpose. The Forage Section has necessary facility for covering the theoretical and practical part of training in fodder crop production.

Production of Different Fodder Crops at ERS Fodder Farm during 2013-14

Type of fodder	Production (Quintals)
Berseem/berseem + mustard, lucerne/lucerne+mustard, cowpea sole	1850.95
Maize /maize + cowpea	2272.30
Oats/oats + mustard	2971.00
Sorghum /sorghum+cowpea, sorghum+ricebean	4789.60
Hybrid napier + guinea grass + para grass	628.90
Total	**12512.75**

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.

Computer Centre

The Computer Center facilitates the maintenance of database. The Institute has Internet connectivity through VSAT, which is useful for searching literature and references.

TSP-Upliftment of Socio-economic Condition of Tribal People Through Integrated Livestock Farming in North Eastern Hill Region/Eastern Part of India

- Two health camps and two vaccination camps were organized in the Bali Island of South 24 Parganas of West Bengal. Different dairy production management systems were demonstrated to the livestock farmers. Health and vaccination camps were also organized in the Ayodhya hills in Purulia district of West Bengal Some fodder seeds (maize and cowpea) and rooted slips of some fodder grass were also distributed to the farmers who rear livestock. A total number of 555 cows, 483 goat 560 poultry and 47 sheep were rendered health check up and treatment during the programme at Bali Island. A total number of 459 cows, 352 goat, 73 poultry and 21 sheep were rendered health check up and treatment during the programme at Ayodhya Pahar, Purulia. A total number of 250 cows, 195 goats was vaccinated during the programme at Bali Island and 152 cows, 206 goats were vaccinated during the programme at Ayodhya Pahar, Purulia.
- One 3 day training programme on "Clean Milk Production" was organized at ERS, NDRI for tribal women farmers from 12th March to 14th March 2014. Twenty Santhal tribe women farmers of Nadia district participated.
- One 8 day training programme on "Scientific Dairy Farming Practices" was organized at ERS, NDRI for tribal farmers from 24th March 2014 to 31st March 2014. Twelve tribal farmers of Jalpaiguri district of North Bengal were actively participated.
- A 9 day training programme on "Scientific Dairy Farming Practices for North Eastern Region for Tribal Farmers" was organized from 5th – 13th December, 2013for 15 Tribal Farmers (under TSP Project) for Bodoland Territorial Council (BTC), Assam.
- A Training and Demonstration on "Azolla Production for Livestock Feeding" was organized on 20th December, 2013. Eighteen Livestock Development Officers from the Department of Animal Resource

Development, Nadia district, West Bengal attended the Training Program.

- Off Campus training and demonstration on azolla cultivation was organized on special invitation from Ramkrishna Ashram KVK, Nimpith, West Bengal, ERS-NDRI imparted training to twenty two Block Livestock Development Officers (BLDO) on 31st December, 2013.

Extension Activities

- Two villages Muratipur and Dakhhin Chandamari of Nadia district of West Bengal were adopted officially in 2nd February 2014 by this institute. One "Dairy Vikash Kendra" in Muratipur village was established for providing A.I. facilities and treatment of dairy animals to nearer cluster of villages of Nadia district.
- One day programme "vaccination camp, frontline fodder demonstration " was organized on 17th Jan 2014 in the Muratipur village of Nadia District. Fifty one (51) farmers came with one hundred ten (110) animals for treatment.
- One day programme "vaccination camp" was organized on 24th Jan 2014 in the Dakhin Chandamari" village of Nadia District. Thirty three (33) farmers came with eighty three (83) animals for treatment.
- One day programme "Anoestrous and Deworming" camp was organized on 21st February 2014 in the Muratipur village of Nadia District. Eleven (11) farmers came with thirty (30) animals for treatment.
- One day programme "Deworming" camp was organized on 28th February 2014 in the Dakhhin Chandamari village of Nadia District. Eighteen (18) farmers came with twenty five (25) animals for treatment.
- ERS, NDRI participated in Krishi Mela on 22nd February 2014 at Chaltaberia Dutta pukur, North 24 Parganas. One programme "Veterinary and First aid Camp" was also organized by this institute. Team of ERS provided treatment to 20 animals and interacted with farmers. One Dairy quiz competition programme was also organized with krishi mela organizing committee for the farmers.
- A veterinary-cum-infertility camp was organized at Burar village, Raina Block of Burdwan district on 30th July 2013. Forty dairy farmers were present on that programme with 50 animals,
- One Inter-institutional collaboration programme Health Camp-cum-Scientist Farmers' Interface was organized with ERS of NDRI; ERS of IVRI and KVK, Budbud of CRIJAF on 13th August, 2013 in the two adopted villages of KVK, Budbud (Atpara and Jagulipara). Thirty five cows were treated for anoestrous and other health related problems.
- A veterinary-cum-animal health camp was organized at Dakhhin Chandamari village (adopted village of ERS of NDRI), Chakdah Block of Nadia district on 20th November 2013. A total of 52 dairy farmers with 132 animals attended this camp. Mineral mixtures @ 500gm were distributed to 34 farmers. In all 132 animals were treated anoestrus and other health related problems.
- Two days Orientation / Induction programme on "Dairy cooperatives and advance scientific dairy farming practices" was organized in collaboration with Kishan Co-operative Milk Producers Union Ltd. Krishnanagar from 3rd - 29th March 2014 for 135 dairy farmers from different districts of West Bengal.
- Field day was organized on 20th Jan 2014. Fourteen number of women dairy farmers from Muratipur village of Nadia district actively participated.
- One day exposure visit was organized on 17th February 2014. Thirty number of Self Help Group members and official of WBCADC, Kalna II, Burdwan participated.
- Two training cum azolla demonstrations were organized for 30 farm women in Dakhhin Chandamari village on 20th January 2014 and 1st February 2014.
- One Frontline azolla demonstration was organized at premises of one farmer's house in Muratipur village on 14th February 2014. Fourteen farmers participated in step by step practical demonstration of Azolla Cultivation methods.

हिन्दी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित अनुसंधान संस्थान है जो कि देश में डेरी विकास कार्यक्रमों के लिए अनुसंधान एवं विकास तथा मानव संसाधन विकास में सहयोग के लिए पूर्ण रूप से समर्पित रहा है। वर्ष 1923 में बंगलौर में स्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में करनाल में स्थानान्तरित कर दिया गया। इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो कि बंगलौर और 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 को दर्जा प्राप्त है।

संगठनात्मक स्वरूप

संस्थान की प्रबन्ध प्रणाली भारतीय कृषि अनुसंधान परिषद 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 मंडल, अनुसंधान सलाहकार परिषद, विद्या परिषद एवं विस्तार परिषद समितियों को सौंपा गया है। निदेशक इस संस्थान का कार्यपालक अधिकारी है। दोनों संयुक्त निदेशक, निदेशक को अनुसंधान शिक्षण एवं विस्तार कार्यकलापों को संपन्न कराने में सहयोग प्रदान करते हैं। संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र (i) डेरी उत्पादन (ii) डेरी प्रसंस्करण तथा (iii) डेरी विस्तार/प्रबन्धन हैं। 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 प्रबन्धन, डेरी पशुपोषण, चारा अनुसंधान, डेरी पशु शरीरक्रिया विज्ञान, पशु जीव रसायन, पशु जैव प्रौद्योगिकी, डेरी इंजीनियरिंग, डेरी रसायन, डेरी सूक्ष्मजीवविज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र सांख्यिकी एवं प्रबन्ध प्रभाग के अन्तर्गत संपन्न होते हैं। संस्थान में एक कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक) कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण केन्द्र एवं पशु प्रजनन अनुसंधान केन्द्र भी हैं। संस्थान में पशुधन फार्म, चारा अनुसंधान एवं प्रबन्धन केन्द्र, पशु स्वास्थ्य परिसर, टेक्नोलोजी बिजनेस इन्क्यूबेटर, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय सेवा एवं राष्ट्रीय जैवसूचना केन्द्र, कंप्यूटर केन्द्र, संपदा अनुभाग तथा अनुरक्षण इंजीनियरी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसेः क्रय, भंडार, स्थापना तथा सुरक्षा के कार्यकलाप संयुक्त निदेशक (प्रशासन) एवं कुलसचिव के नियंत्रण में है। जबकि वित्त–विभाग कम्पट्रोलर के नियंत्रण में है। संस्थान में इस समय 157 वैज्ञानिक, 260 तकनीशियन, 145 प्रशासनिक एवं 550 निपुण सहायक कर्मचारी सेवारत है।

बजट

संस्थान का वर्ष 2013–14 में योजना एवं गैर–योजना शीर्ष में वास्तविक व्यय बजट 14501.47 लाख रूपए था तथा वर्ष 2013–14 के लिए योजना एवं गैर योजना शीर्ष के लिए कुल बजट 14531.09 लाख रूपए स्वीकृत किया गया। इसमें माननीय विश्वविद्यालय कृषि विज्ञान केन्द्र तथा क्षेत्रीय केन्द्रों का बजट भी सम्मिलित है।

अनुसंधान

वर्ष 2013 के दौरान कुल 89 अन्तःसंस्थानीय तथा 75 बाह्य अनुसंधान परियोजनाओं का कार्य चल रहा था। मूल एवं महत्वपूर्ण अनुसंधान कार्यों को सुदृढ़ करने के लिए अतिरिक्त वित्तीय अनुसंधान परियोजनाओं से फंडिंग 132.35 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 तीन अन्तर्राष्ट्रीय अनुसंधान समन्वय परियोजनाएं चल रही है जिसमें जर्मन शैक्षणिक विनिमय सेवाएं (डी.एस.टी–डी.ए.ए.डी), इंडो आयरलैंड तथा इंडो न्यूजीलैंड संयुक्त अनुसंधान परियाजनाएं सम्मिलित हैं। विश्व बैंक ने संयुक्त रूप से कुछ अनुसंधान परियोजनाओं को वित्तीय सहायता देना स्वीकार किया है। जिनमें राष्ट्रीय डेरी अनुसंधान संस्थान या तो नेतृत्व करेगा अथवा सहायक सहयोगी होगा। राष्ट्रीय डेरी अनुसंधान संस्थान लगभग सभी अग्रणी राष्ट्रीय फंडिंग एजेन्सियों जैसे जैवप्रौद्योगिक विभाग (डी.बी.टी.) विज्ञान एवं प्रौद्योगिकी विभाग (डी.एस.टी.) राष्ट्रीय डेरी विकास बोर्ड (एन.डी.डी.बी.) राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो (एन.बी.ए.आई.एन.) 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। यहां यह उल्लेखनीय है कि संस्थान ₹ 1.85 करोड़ राशि की एक परामर्श परियोजना का संचालन कर रहा है।

एन.ए.आई.पी. एवं अन्य फंडिंग एजेन्सियों से प्राप्त सहायता ने वैज्ञानिकों को स्टेम कोशिका, भैंस की क्लोनिंग, ट्रांसक्रिपटोन, एम्ब्रयोजेनिसिस, बायोसैंसर, नैनोप्रौद्योगिकी, क्षेत्रीय पशुओं में एबायटिक दाब, न्यूट्रास्यूटिकलस तथा क्रियात्मक आहारों पर कार्य करने के लिए प्रोत्साहित किया है। सूचनाओं के परियोजना

मानीटरिंग तथा मूल्यांकन एवं परिकलन तथा अंकीकरण को सुदृढ़ करने के लिए भी फंड प्राप्त किए गए। एन.ए.आई.पी. से प्राप्त अनुदान ने छात्रों को अपने शोध निबंधों में आधुनिक उपकरण एवं तकनीकियों के चयन के लिए भी सहायता प्रदान की है।

अनुसंधान

★ एक श्रेष्ठ सांड एम.यू. 5926 का क्लोनड कटड़ा 'स्वर्ण' दिनांक 18.3.2010 को उत्पन्न हुआ। यह कटड़ा सामान्य प्रसव द्वारा उत्पन्न हुआ तथा जन्म के समय इसका भार 55 किलोग्राम था तथा इसमे ताजे वीर्य से वियोजित स्टैम कोशिकाओं के द्वारा उत्पन्न होने की विशिष्टता प्राप्त हैं

★ 'कर्ण कीर्ति' जो कि संस्थान के इतिहास में उच्चतम दुग्ध उत्पादक है से एक क्लोनड कटड़ी 'पूर्णिमा' का जन्म 6 सितम्बर, 2013 को हुआ। यह कटड़ी 21 दिन तक जीवित रही।

★ एक संतति परीक्षित सांड नं0 4393 से एक क्लोनन् कटड़ा दिनांक 10 अगस्त, 2013 को उत्पन्न हुआ। यह कटड़ा श्रेष्ठ था चूंकि यह एक ऐसे सांड का क्लोन था जिसकी मृत्यु कई वर्ष पूर्व हो चुकी थी। इस सांड के प्रशीतित हिम द्रवित वीर्य से वियोजित सोमैटिक कोशिकाओं का प्रयोग इस बछड़े को उत्पन्न करने में किया गया। यह बछड़ा 12 घंटे तक जीवित रहा।

★ वन्य भैंस अरना (बुबेलस अरनी) से प्रदाता कोशिकाओं तथा घरेलू भैंस (बुबेलस बुबेलिस) से डिम्बाणुजनकोशिकाओं का प्रयोग करके अन्तः प्रजातीय क्लोनड ब्लास्टोसिस्ट उत्पन्न किए गए।

★ भैंस के एन.ए.एन.ओ.जी., एल.आई.एफ तथा एफ.जी.एफ. 2 जीन कन्सट्रक्ट उनकी अति–अभिव्यंजना के लिए भैंस की एम्ब्रयोनिक स्टैम कोशिकाओं में ट्रांसफैक्शन के लिए विकसित किए गए।

★ मनव इन्सुलिन जीन ट्रांसजीनिक कोशिकाओं में उत्पादन के लिए भैंस के स्तनीय एपीथीलिल कोशिकाओं में अभिव्यंजित किए गए।

★ बकरी के एम्ब्रयोनिक स्टैम कोशिकाओं से डिम्बाणुजन कोशिकाएं उत्पन्न की गई।

★ प्रौढ़ बकरी के फाइबरोब्लास्ट कोशिकाओं से प्रवृत्त बहुप्रजननक्षम स्टैम कोशिकाएं उत्पन्न की गई।

★ भैंस के क्रियात्मक आर.आई.जी.आई. तथा एम.डी.ए.5 जीन डोमेन संगठन के पैटर्न का अनुसंरण करते पाए गए जो कि अन्य स्तनधारियों में पाए जाने वाले जीन के समान हैं। आर. आई.जी.आई तथा एन.डी.ए.5 अभिग्राहक डी.एस.आर.एन.ए की ओर विभिन्न सदृश्यता प्रदर्शित करते पाए गए।

★ भैंस के आर.एल.जीन इम्यून अवयवों के रूप में ऊतक के कार्य का ध्यान किए बिना, विभिन्न ऊतकों में सर्वव्यापक रूप से अभिव्यंजित पाए गए।

★ विभिन्न इम्यून अवयवों (रक्त, स्पीलीन तथा टान्सिल) में विभिन्न एन.एल.आर. जीनों की प्रारंभिक अभिव्यंजना का अध्ययन किया गया। भारतीय गोपशुओं तथा भैंसों से बाह्य रक्त मोनों नाभिकीय कोशिकाओं को विभिन्न विशिष्ट पी. आर.आर. की विद्यमानता के साथ तथा बिना एन.एल.आर तथा इन्टरल्यूकिन अभिव्यंजना को मापने के लिए परखनली में सवंर्धित किया गया।

★ दुग्ध–उत्पादन तथा दुग्ध स्त्रवण अवस्थिति के साथ सम्बन्ध दुग्धस्त्रवण प्रदर्शित संभाव्य मार्ग की विभिन्न अवस्थाओं के दौरान स्तनीय एपिथीलिअल कोशिकाओं में प्रोटीन सकेंतों की पहचान की गई।

★ दुग्धस्त्रवण के तीन संभावित बायोमार्करस की पहचान की गई।

★ विभिन्न प्रकार से अभिव्यंजित सोलह प्रोटीनों की पहचान की गई जिनकी कि भैंसों की स्तनीय एपिथीलिल कोशिकाओं के क्रियात्मक विभेदी करण में भूमिका हो सकती है।

★ भैंसों की गर्भाधान से संबंधित प्रोटीनों के 11 विभिन्न आइसोफार्म अनुक्रमित किए गए।

★ भैंस का पुनर्संयोजी ल्यूकेमिया निरोधक तत्व उत्पन्न किया गया तथा एक स्तनीय कोशिका लाइन से परिशुद्ध किया गया।

★ भैंस का पुनर्संयोजी स्पर्म एक्रोसोम सम्बन्धित 3 (एस.पी.ए. सी.ए.3) प्रोटीन उत्पन्न किया गया तथा डिम्बाणुजनकोशिकाओं पर इसकी बाध्यता निर्धारित की गई।

★ पुनर्संयोन कालेगन बांइडिंग प्रोटीन (सी.बी.पी.) तथा फाइब्रोनोक्टिन बांइडिंग प्रोटीन (एफ.बी.पी.ई.) कोलि में उत्पन्न की गई।

★ पुनर्संयोजक भैंस तथा बकरी की लेक्टोफेरिनस (रेक–एल. एफ.) खमीर में उत्पन्न किए गए। रेक–एल.एफ. की लौह बांइडिंग डाइनामिक्स दूध से वियोजित देशी लेक्टोफेरिन के समान पाई गई।

★ नियोजित मैथुन के लिए श्रेष्ठ गायों के रूप में कुल 68 करन फ्रीज गायों (29.56%) का चयन किया गया। इनका औसत 305 दिन का औसत दुग्ध उत्पादन 4841 कि.ग्रा. तथा औसत ई.पी.ए. 4620 कि.ग्रा. था जो कि पशु औसत (4250 कि.ग्रा.) तथा औसत ई.पी.ए.(4114 कि.ग्रा.) की अपेक्षा 13.90% तथा 12.29% अधिक था। श्रेष्ठ 305 दिन का औसत दुग्ध उत्पादन 4158 तथा 8648 कि.ग्रा. के बीच था तथा औसत 5528 कि.ग्रा. था।

★ भविष्य में प्रजनन के लिए युवा बछड़ों के चयन के लिए डैम के श्रेष्ठ 305 दिन के दुग्ध उत्पादन, प्रजनन विशेषताओं एवं शारीरिक अनुरूपता तथा ई.पी.डी. के आधार पर कुल 18 करन फ्रीज बछड़ों को आरक्षित रखा गया। आरक्षित करन फ्रीज बछड़ों का डेम श्रेष्ठ 305 दिन के दुग्ध उत्पादन 4348–6861 कि.ग्रा. के बीच था। चयनित बछड़ों का ई.पी.डी. 5.03 तथा 12.28% के बीच था।

★ करन फ्रीज गायों में दिसम्बर 2012 तक क्षेत्रीय परिस्थितियों में 3562 कृत्रिम गर्भाधान में से 47.04% गर्भाधान दर प्राप्त की गई तथा कृषकों के पशु समूहों में 1167 (622 बछड़े तथा 545 बछड़ियां) उत्पन्न हुई।

★ क्षेत्र में आनुवांशिकी सुधार के लिए विभिन्न एजेन्सियों/कृषकों को प्रशीतित वीर्य की कुल 215 डोज बेची गई।

★ साहीवाल तथा कर्ण फ्रीज गोपशुओं में फोस्ब्रेन एम्ब्रयोनिक जिंक फिंगर (एफ.ई.जेड.एल.) जैसे जीनसव क्रमशः 3.772 के.बी. तथा 3.789 के.बी. तक विस्तारित पाए गए। कर्ण फ्रीज (114) गोपशुओं में 13 जी/13 जी तथा 12 जी/13 जी जीनोटाइप की बारम्बारता क्रमशः 0.965 तथा 0.035 थी जबकि सभी साहीवाल (111) गोपशु 13 जी/13 जी होमोजाइगोटस के रूप में जीनोटाइपडड थे।

★ साहीवाल तथा करन फ्रीज गोपशुओं में सम्पूर्ण कोर्डिंग तथा 100 ए 8 (केलग्रेनुलिन) जीन के 5′ फलेंकिंग क्षेत्रों में क्रमशः 2.036 के बी तथा 2.080 के.बी.विद्यमान थे।

★ गोपशुओं में एस.एन.पी. जीनोटाइपिंग के लिए एच.पी.वाई. सी.एच.वी का प्रयोग कर एस 100 ए 8 के लिए पी.सी. आर–आर.एफ.एल.पी.एस्सैं विकसित की गई। साहीवाल गोपशुओं में 2 (ए./जी.) एस.एन.पी.लोकर पर जी.जी.,जी.ए. तथा ए.ए.जीनोटाइप की सम्पूर्ण बारम्बारता क्रमशः 0.884, 0.0102 तथा 0.013 पाई गई जबकि कर्ण फ्रीज गोपशुओं में यह क्रमशः 0.973, 0.02 तथा 0.007 थी। गोपशुओं में एस 100 ए 8 जीनोटाइप तथा नैदानिक थनैला की घटना में कोई महत्वपूर्ण सम्बन्ध नहीं पाया गया।

★ लेक्टोफेरिन जीन के ए.ए.सी सी जी.जी. संयुकत जीनोटाइप वाली मुर्राह भैंसों में थनैला रोग की कम संभावना थी तथा ए.ए.सी.सी.एच.एच.जीनोटाइप पशुओं में अधिक संभावना थी।

★ अन्य जीनोटाइप की तुलना में सी.डी.14 जीन के एच.पी.वाई 1881–आर.एफ.एल.पी. के साथ ए.बी. जीनोटाइपड मुर्राह भैंसों में थनैला की कम संभावना थी।

★ भ्रूण प्रत्यारोपण ये जन्में पांच बछड़ों की साइटोजेनेटिकल सक्रीनिंग स्थानान्तरण संवाहक पाए गए।

★ अपेक्षित पूर्व पूर्वानुमानित अन्तर (ई.पी.डी.) तथा डैम श्रेष्ठ 305 दिन अथवा कम दुग्ध–स्त्रवण काल दुग्ध उत्पादन (2747–4090 कि.ग्रा. के बीच) के आधार पर कुल दस श्रेष्ठ मुर्राह कटड़ों को भविष्य में प्रजनन हेतु आरक्षित रखा गया।

★ भैंस सुधार पर नेटवर्क परियोजना के अन्तर्गत परीक्षण मैथुन के लिए पांच मुर्राह झोटों को चयनित किया गया।

★ श्रेष्ठ मुर्राह भैसों का औसत दुग्ध स्त्रवण दुग्ध उत्पादन 3151.29 कि.ग्रा. तक बढ़ गया जो कि पशु समूह के औसत की अपेक्षा 47.60 अधिक था।

★ राष्ट्रीय डेरी अनुसंधान संस्थान केन्द्र ने कृषकों तथा डेरी विकास संगठनों को प्रशीतित वीर्य की 62,054 डोज़ की आपूर्ति की।

★ मुर्राह भैंसों में जननक्षमता विशेषकों के लिए थ्रेसहोलड़ टी.एच.आई.75 आंकी गई।उपोष्णीय जीलवायुवीय परिस्थितियों के अन्तर्गत मुर्राह भैंसों में जननक्षमता विशेषकों की श्रेष्ठ निष्पादन क्षमता के लिए टी.एच.आई < 75 होनी चाहिए।

★ मलनाद गिदा एक श्रेष्ठ बौनी गोपशु है जो कि अधिकतर चराई पर फलती–फूलती है तथा कर्नाटक के तटीय क्षेत्रों एवं भारी वर्षा वाले मलनाद की क्षेत्रीय प्रणाली में महत्वपूर्ण भूमिका निभाती हैं।गायें प्रतिवर्ष एक बछड़े को जन्म देने वाली है तथा नौं मास तक दूध देती है तथा यह वर्षागंधी के नाम से लोकप्रिय है। क्षेत्रीय परिस्थितियों के अन्तर्गत श्रेष्ठ गायों में औसत दुग्धस्त्रवण दुग्ध उत्पादन, दैनिक दुग्ध उत्पादन, श्रेष्ठ उत्पादन तथा अन्तः–ब्याँत अवधि क्रमशः 522.33+69.40 लीटर, 2.17+0.29 लीटर, 3.42+0.39 लीटर तथा 14.91+0.93 मास था। काफी संख्या में गायों ने अपने पूरे जीवनकाल में 15 बछड़े उत्पन्न किए।मलनाद गिदा गोपशुओं के दूध में लेक्टोफेरिन की मात्रा उच्चतर (48.98 से 157.10 मि.ग्रा./एम.एल.के बीच) पाई गई।

★ दक्षिण भारत के विभिन्न भागों में स्थित नौ व्यावसायिक वीर्य केन्द्रों पर 21 शैडों में रखे गए 627 प्रजनक सांडों का मूल्यांकन किया गया।

★ किण्वन गति के आधार पर डिजाइन सान्द्रण सम्पूर्ण पर कोशिकीय भित्ती की पाच्य पोषक अन्तर्ग्रहण तथा सेल्यूलोस संशोधित किए गए। पेलइट आहार की तुलना में सूक्ष्मजैवीय प्रोटीन उत्पादन लगभग 15% (सम्पूर्ण औसत वृद्धि 13 से 17%) संशोधन हुआ। किण्वन गतिजी के आधार पर डिजाइनड सान्द्रण सम्पूरकों (सी.एस) के साथ एस.एन.एफ. में सुधार पाया गया।

★ उपनैदानिक थनैला (एस.सी.एम.) डेरी कृषकों को उच्च आर्थिक क्षति का एक प्रमुख तथा विशिष्ट कारण हैं यदि उपनैदानिक थनैला, थनैला की नैदानिक रूप में स्थानान्तरित होता है तो यह उत्पादकता में कमी करता है तथा उपचार लागत में इससे वृद्धि होती है जिससे डेरी कृषकों को भारी आर्थिक हानि उठानी पड़ती है। उपनैदानिक थनैला (एस.सी.

एम.) विभिन्न आनुवांशिक एंव गैर–आनुवांशिक तत्वों जैसे आवास, सममूल्यता, ऋतुओं आदि पर निर्भर करता है।

★ डिओनि एक मध्यम आकार का, दोहरे उद्देश्य वाला स्वदेशी गोपशु है तथा ए.एफ.सी. एवं सी.आई. के दिनों को कम करने की आवश्यकता है तथा श्रेष्ठ पोषणिक एवं प्रजनन प्रबन्धन गतिविधियों के माध्यम से डिओनि गोपशु में प्रजनन प्रदर्शन वृद्धि करने का व्यापक अवसर है।

★ भैंस के त्वचीय फाइब्रोब्लास्ट पर ऊष्मा दाब के प्रभाव का मात्रात्मक पी.सी.आर. तकनीक का प्रयोग करके मूल्यांकन किया गया।

★ गोपशु नसलों में परखनली फाइब्रोब्लास्ट कोशिका लाइनों में एच.एस.एफ एस–1,2,4 एच.एस.पी–79 तथा 90 जीनों की अभिव्यंजना पैटर्न अनुक्रमित की गई।

★ भैंस में ट्रांसक्रिपटोम तथा प्रोटीओम द्वारा ऊष्मा दाब के संबंध में जीनों तथा प्रोटीनों की पहचान।

★ थारपारकर (टी.पी.) तथा करन फ्रीज (के.एम.) ओसरों दोनों में ग्रीष्म ऋतु की अपेक्षा शीत ऋतु के दौरान त्वचा रंजकता (एम.सी.आर. तथा पी.एम.ई.एल.) के लिए उत्तरदायी जीनों ने उच्च (पीढ 0.01अभिव्यंजना की। विशेषकर शीत ऋतु में करन फ्रीज गोपशुओं की अपेक्षा थारपारकर गोपशुओं की श्रेष्ठ स्वीकार्यता इंगित करती है।

★ साहीवाल बछड़ों में क्रोमियम प्रोपायोनेट का सम्पूरण स्वास्थ्य स्तर, असंक्राम्यता तथा आहार अन्त:ग्रहण में सुधार करता है तथा चरम जलवायुवीय परिस्थितियों के दौरान मुक्त रेडिकल उत्पादन तथा कोर्टिसोल स्तरों को कम करता है।

★ थर्मोन्यूट्रल परिस्थितियों की तुलना में ग्रीष्म ऋतु के दौरान पूर्वब्यांत तथा पश्चब्याँत दोनों के दौरान साहीवाल तथा करन फ्रीज गायों में बी.ए.एकस./बी.सी.एल.–2 अनुपात अधिकतम थे। संधिकाल के दौरान साहीवाल तथा करन फ्रीज गायों दोनों में ग्रीष्म ऋतु के दौरान पी–53 का अपरेगुलेशन था।

★ साहीवाल तथा करनफ्रीज गायों में कासपेज–3 एम.आर. एन.ए. अभिव्यंजना ब्याँने के 0 दिन की तुलना में थर्मोन्यूट्रल परिस्थितियों तथा ग्रीष्म ऋतु के दौरान प्रसवपूर्व तथा प्रसव पश्चात 15 दिन पर महत्वपूर्ण ढंग से कम हुई। थर्मोन्यूट्रल परिस्थितियों की तुलना में सभी अवधियों पर ग्रीष्म ऋतु के दौरान अभिव्यंजना का महत्व भी अधिक था।

★ विटामिन ई. तथा ए. एवं जिंक जब डेरी पशुओं के परिपारटय में विवों सम्पूरित किया जाता है तो उनकी असंक्राम्यता एवं उत्पादकता में सुधार होता है जबकि तांबें का उनकी उत्पादकता पर प्रतिकूल प्रभाव पड़ता है। विटामिन ए जिसके बारे में यह सोचा जाता है कि यह हरे चारे से पर्याप्त मात्रा में उपलब्ध होता है, की अनुकूलतम उत्पादकता बनाए रखने के लिए परिपारटम अवधि के दौरान अतिरिक्त मात्रा में अपेक्षित है।

★ परखनली में सूक्ष्मपोषक तत्वों का अत्याधिक सम्पूरण रक्त न्यूट्रोफिलस की फेगोसाइटिक क्रिया कलाप को महत्वपूर्ण ढंग से (पीढ0.01) कम करता है।

★ ब्याँने पर न्यूट्रोफिलिक जीनसः टी.एल.आर–2, टी.एल. आर–4, टी.एन.एफ.–अल्फा, आई.एल.–8 में पर्याप्त (पीढ 0.01) न्यूनतम अभिव्यंजना पाई गई। दुग्ध न्यूट्रोफिलस बनाने के लिए स्तनीय ग्रन्थियों को स्थानान्तरित करने के बाद रक्त न्यूट्रोफिलस के पी.ए. तथा आकार, जीवनक्षमता में पर्याप्त परिवर्तन (पीढ 0.01) पाए गए।

★ ब्याने के समय रक्त न्यूट्रोफिलस का एपोपटोसिस पर्याप्त रूप से उच्चतम (पीढ 0.01) था।

★ प्लाज़्मा आई.जी.एफ. 1 मुर्राह भैंसों के कटड़ों तथा कटड़ियों में विकास तथा प्रजनन प्रदर्शन से निश्चय ही संबंधित था तथा किण्वित खमीर संवर्धन के सम्पूरण मुर्राह भैंसों के कटड़े/कटड़ियों के अल्प शरीर भार के प्रजनन प्रदर्शन वृद्धि के लिए एक आर्थिक नानइनवेसिव जैवप्रौद्योगिकीय साधन के रूप में सिद्ध हुआ।

★ केपराइन हेप्टोसाइटस को जब हाइपरथर्मिक परिस्थितियों में प्रदर्शित किया गया तो वह दाब के अधीन प्रदर्शित जिसके परिणामस्वरूप हेप्टोसाइटस के महत्वपूर्ण क्रियात्मक मार्करों में पर्याप्त कमी पाई गई। कुछ प्रति आक्सीकर किण्वकों की गतिविधि तथा टी.जी.एफ β स्त्रवण परखनली में वृद्धि पाई गई। हाइपरथर्मिक परिस्थितियों के अन्तर्गत मैनन आलिगोसेकेराइड के साथ हेप्टोसाइट संवर्धनों के उपचार से प्रभाव प्रतिकूल पड़ा।

★ प्लाज़्मा विकास कारकों, इन्सुलिन जैसे विकास कारक–1 तथा तंत्रिका विकास कारक का स्तर मुर्राह भैंसों के झोटों के जननक्षमता स्तर तथा शुक्राणु क्रियात्मक पैरामीटरों के साथ सकारात्मक रूप से संबंधित थे। विकास कारक इनविट्रो सम्पूरण किए गए सम्पूरण के बाद शुक्राणु कार्य अपरिवर्तित रहे। आई.जी.एफ.–1 तथा एन.जी.एक विकास कारक इम्यूनोफ्लोरोसैंस तकनीक द्वारा शुक्राणुओं पर सीमित किए जा सकते है।

★ दुग्ध उत्पादन की सम्पूर्ण क्षमता तथा पोषणिक उपयोग में संक्रमित भैंसों के राशन में 1.0 तथा 1.5 पी.पी.एम. स्तर पर क्रोमियम सम्पूरण पर महत्वपूर्ण सुधार हुआ।

★ रूमेन संरक्षित मीथिओनाइन (6 ग्रा.), लाइसिन (60 ग्रा.) तथा कोलाइन (60 ग्रा.) के सम्पूरण से नियंत्रण वर्ग की तुलना में संकर गायों की असंक्राम्यता तथा दुग्ध उत्पादन में वृद्धि हुई।

★ रूमेन संरक्षित कोलाइन (आर.पी.सी) 27 ग्रा./दिन) के सम्पूरण से संकर बछड़ों में आहार क्षमता एवं औसत दैनिक

लाभ में सुधार हुआ तथा रक्त यूरिया नाइट्रोजन, एन.ई. एफ.ए. कम करने में लाभप्रद प्रभाव हुआ तथा जिगर किण्वन कार्यों में सुधार हुआ।

★ ब्यूट्रीविबरिओ फाइबरिसोलवनस के प्रयोग से अवशोषित वसीय अम्लों के अधिमिश्रण से रूमेन चयापचय पाथवे में सुधार हुआ तथापि माँस एवं दूध में सी.एल.ए. संचयन के लिए उत्तरदायी विनियामक प्रक्रिया को अप्रत्यक्ष रूप से परिवर्तित किया गया।

★ करन फ्रीज बछड़ियों में प्रति कि.ग्रा. शरीर भार प्राप्त करने की लागत को 15 भाग बिनौले की खली अथवा एक सान्द्रित मिश्रण में छिलका उतरे हुए बिनौले की खली विलायक सत्व में से 10 भाग सोयाबीन प्रतिस्थापित करके किया जा सकता है।

★ 16 एसआर आर एन ए जीन की तुलना में ओ.टी.यू गोपशुओं में रूमेन में थमोजनस विविधता की श्रेष्ठ पूरी जानकारी प्रदान करने के लिए तीन क्रमों में जमा होती है। परिणाम बताते हैं कि मीथेनोब्रविबेक्टर फाइलोटाइप गेहूँ की भूसी युक्त उच्च रेशे वाले आहार तथा आर. फलेव फेसिनस स्ट्रेन एफ.डी.–1 के जीवाण्विक संर्वधन पर आहारित करन फ्रीज संकर गोपशुओं में प्रमुख रूप से मौजूद हैं। उच्च रेशे वाले आहार पर रखे गए स्थायी रूप से नाड़ी वर्णित भैंसों के रूमेन द्रव से वियोजित ने शरीर भार प्राप्त करने, दैनिक दुग्ध उत्पादन तथा लिग्नोसेल्युलोसिक आहारों से पोषक तत्वों के उपयोग से आहार संयोजक के रूप में प्रयोग करने की संभाव्यता प्रदर्शित की।

★ इन विट्रो अध्ययन के आधार पर ब्रोमोक्लोरोमीथेन की 4एन एन डोज अन्य रूमेन किण्वन पैरामीटरों को प्रभावित किए बिना मिथेन को कम करने में प्रभावी पाया गया। यह पाया गया कि डी.एन. आधार पर 3 प्रतिशत केल्सियम नाइट्रेट मीथेन उत्पादन में सम्पूर्ण कमी के साथ सस्ते किण्वन योग्य नाइट्रोजन स्त्रोत के रूप में जुगाली करने वाले पशुओं के राशन में प्रयोग किया जा सकता है।

★ मध्यम एवं उच्च आर.एफ.आई. वर्गों की तुलना में साहीवाल बछड़ों में निम्न अपशिष्ट आहार अन्तर्ग्रहण (आर.एफ.आई.) युक्त आहार से उच्च आहार क्षमता तथा अल्प मिथेन उत्पादन था।

★ पी.सी.आर. विधि का प्रयोग द्वारा आंशिक न्यूक्लोटाइड अनुक्रमित इनकोडिंग एफ.टी.एफ.एस. जीनस (ऐसीटोजेनस) तथा 16 एसआर आर एन ए जीनस (मीथेनो थ्रोफस तथा मीथेनोजेनस) विस्तारित किए गए। न्यूक्लोटाइड अनुक्रम प्राप्त किए गए तथा क्रमशः एफ टी. एच. एफ एस, टाइप I तथा टाइप II मीथेनोट्राफस के लिए क्लोन नाम अनुक्रम 1, कुण्डू, राधा, बाला तथा बेनकिट संख्या 1570827, 1571273, 1571282 तथा 1571285 के अन्तर्गत जीन बैंक डैटाबेस में जमा किए गए।

★ इम्यूनोसेनेऐस असंक्रमित रोगों तथा प्रदाहक विकारों वाले प्रौढ़ों में रूग्णता तथा मर्त्यता को बढ़ाने का प्रमुख कारण है। कोशिकीय मध्यस्थ असंक्राम्य प्रतिक्रिया, चिकालिक प्रदाहक तथा त्रिदोष–विर्षयक असंक्राम्यता की वृद्धि में कमी प्रौढ़ चूहों में सुस्पष्ट है जो कि निष्कर्शतः प्रौढ़ावस्था के दौरान एक स्कीवड टी एच2 पैथवे सुझाता है।

★ दूध एवं दुग्ध उत्पादों की शेल्फ लाइफ बढ़ाने में प्रयोग के लिए औद्योगिक चीज् व्हे से प्रभावकारी पाऊडर युक्त पीडिओसिन तैयार करने की प्रक्रिया विकसित की गई। एंट्रोकोकस फेकेलिस द्वारा पीडिओसिन के प्रतिकूल प्रतिरोध शक्ति के आण्विक आधार पर प्रकाश डाला गया।

★ भैंस केसिन से निकाले गए 7 अमीनों एसिड का बना पैप्टाइड ओस्टियोब्लास्ट कोशिकाओं को बढ़ाता है और उनका विभेदन भी करता है, जिसका पता विभदेन चिन्हों कोलजन टाइप–1 एलकाइन फास्फेटस तथा ओस्टियोकैलसिन की अधिक मात्रा से होता है। पैप्टाइड सी ओस्टियोक्लास्ट की क्रियाशीलता को टारटरेट रिसिसटनट, एसिड फास्फेटस की सख्या को कम करके तथा ओस्टियोक्लास्ट विभदेन चिन्हों जैसेः टारटरेट रिसिसटनट एसिड तथा कैथपसिन की मात्रा कोकम करके बाधित करता है। पेप्टाइड सी जो कि एक ऐटींआक्सीडेंट है तथा जिसमें ए. सी. इ. को बाधित करने की क्षमता है मज्ज (बोन) कोशिकाओं को बढ़ाता है।

★ एक सात अमीनो अम्ल युक्त पेप्टाइड (पेप्टाइड सी) β केसीन से वियोजित की गई।

★ β केसीन के ए 1 'लाइक' परिवर्तियों (ए1 ए1 तथा ए1 ए2) के आहार चूहों के गट इम्यून प्रतिक्रिया को ए2 'लाइक' दूध की तुलना में टी.एच2 पैथवे के द्वारा अधिमिश्रित किया। व्यावसायिक रूप में संश्लेषित बी.सी.एम. 5 तथा बी.सी.एम. 7 को ओरल इन्टयूबेशन ने आगे पुष्टि की कि ये पेप्टाइड गट प्रदहन को अभिप्रेरित करने में प्रत्यक्ष रूप से लगे हुए हैं।

★ बी.एस.एम–7 β केसीन के ए 1 'लाइक' परिवर्तियों (ए1 ए1 तथा ए1 ए2) से निर्मुक्त हैं न कि ए2 'लाइक' (ए ए2) परिवर्तकों से ए1ए1 जीनोटाइपड करन फ्रीज के दूध से बी. सी.एम.–7 की निर्मुक्ति ए1 ए दूध की अपेक्षा तीन गुना अधिक (0.2 एम.जी./जी β केसीन) थी।

★ β केसीन को दोनों ए1 तथा ए2 अलेल स्वदेशी संकर गोपशु करन फ्रीज (के.एफ.) तथा करन स्विस (के.एफ.) में पाए गए लेकिन ए1 स्वदेशी नस्लों के गोपशुओं (साहीवाल तथा थारपारकर) के सीमित संख्या के नमूनों में अनुपस्थित पाए गए।

★ एप्टामरस द्वारा ए1 दूध से उत्पन्न एक टुकड़े, बीटाकासोमार्फिन–7 के स्वीकरण सिद्धांत के प्रमाण सृजित किए गए। बीटाकोसोमार्फिन–7 के लिए 15 एप्टामर्स की पहचान की गई। एप्टामर्स के विघटन नियतांक 7.0–156 एम

एम के बीच थे। विधि में एप्टामर्स के साथ स्वर्ण सूक्ष्मकणों की परत की आवश्यकता होती है तथा इसकी मान्यता स्वर्णसूक्ष्मकणों में रंग के परिवर्तन से जांची जाती है।

★ चयनित एप्टामर्स द्वारा अफलाटाक्सिन एम1 के स्वीकरण सिद्धान्त के प्रमाण सृजित किए गए। विधि में एप्टामर्स के साथ स्वर्ण सूक्ष्मकणों की परत की आवश्यकता होती है तथा इसकी मान्यता सूक्ष्मकणों में रंग के परिवर्तन लाल से बैंगनी अथवा नीला से जांची जाती है।

★ चुम्बकीय नैनोसामग्री को प्रयोगशाला में तैयार किया गया। इन सामग्रियों की उनके विश्लेषण के लिए अल्प सान्द्रण में मौजूद एनेलाइटस के सान्द्रण में गहरा अनुप्रयोग हैं

★ विभिन्न जातियों से दुग्ध उपभोग (3% वसा) प्लाज़्मा क्लोस्ट्रोल स्तर में वृद्धि को रोकता है जब कोलस्ट्रोल से भरपूर आहार के साथ दिया जाता है। विभिन्न जातियों से दुग्ध आहार मल से उत्सर्जित कोलस्ट्रोल के स्तर में वृद्धि करता है। दूध के साथ (3%) आहारित सभी वर्गों में जिगर में एथ्रोजेनिक सूचकांक एवं कोलस्ट्रोल निक्षेपण्ध को कम करता है। अन्य वर्गों की तुलना में बकरी तथा ऊँट के दूध के लिए प्रतिआक्सीकारक क्षमता उच्चतर है तथा बकरी के दूध का मान नियंत्रित वर्ग के तुल्य है।

★ प्रोबायोटिक (प्रतिजैवीय) (एल.टैमनोसस/एल.प्लानेटरम) किण्वित दूध तथा औषधीय अवयवों के आहारीय सम्पूरण अच्च वसा आहार चूहों में स्थूलता की वृद्धि को रोकने में प्रतिजैवीयों (विशेषकर एल.रैमनोसस) की संभाव्यता को इंगित करता है। तथापि, औषधीय अवयवीस पाऊडरों (अध्ययन में प्रयुक्त एलोवीरा तथा जिमेनेमा सिलवेस्टर की व्यावसायिक तैयारी) की आहारीय समावेशन से संयोजी प्रभाव नहीं पाए गए।

★ प्रतिजैवीय (प्रोबायोटिक) एल. केसी. युक्त किण्वित दूध के आहारीय सम्पूरण से चूहों में उच्च वसीय आहार परिस्थितियों में आन्त्र क्रियाशीलता पर सकारात्मक प्रभाव देखे गए।

★ पेरीफेरल रक्त ल्यूकोसाइटस ट्रांसक्रिपटोमिक संकेत के विश्लेषण ने जेबू गोपशुओं में ऊर्जा दाब द्वारा परिवर्तित चयापचय मार्ग पर प्रकाश डाला।

★ गर्भाश्य माइक्रोबायोटा के मेटाजीनोमिक विश्लेषण प्रसव पश्चात सामान्य तथा ऐडोमेट्रिटिक जल भैंसों (बुबलस बुबेलिस) के बीच विशिष्ट जीवाण्विक संख्या की जांच की गई।

★ ताजे एवं क्रायोपरिरक्षित शुक्राणुओं में एपोपटोटिक पहलुओं के तुलनात्मक विश्लेषण कासपेज़ निर्भर एवं कासपेज़ स्वतंत्र पाथवे के द्वारा भैंसों के शुक्राणुओं के क्रायोसंरक्षण के दौरान सक्रिय एपोपटोसिस के आक्रमण को स्पष्ट रूप से चित्रित करते हैं।

★ ग्रामीण स्तर पर सान्द्रित रूप में तुरन्त प्रयोग हेतु तैयार नरवीन फाइटो आधारित सोया दूध विस्तारक विकसित किया गया तथा परम्परागत रूप से प्रयुक्त अंडपीतक युक्त विस्तारक पर भैंस तथा करनफ्रीज गायों के शुक्राणुओं को क्रायोपरिरक्षित करनके के लिए रेफरीजरेटर तापमान पर 30 दिन तक सुरक्षित रखा जा सकता है।

★ बहुभित्तीय (मल्टीवाल्ड) कार्बन नेनोट्यूबस (डब्ल्यू.सी.एन.टी.) मेसोपोरस सूक्ष्मकणों (नेनोपार्टिकलस एन.एस.एन) की तुलना में तीन गुना से भी अधिक विषाक्त था। सूक्ष्मविषाक्तता (नेनोटाक्सीसिटी) के कारण कोशिका क्षति के सक्षम संकेतक विभिन्न जिंगर किण्वक जैवमार्कर है।

★ दूध में मिश्रित यूरिया एवं तटस्थीकारकों की जांच के लिए स्ट्रिप आधारित परीक्षण विकसित किए गए।

★ आर.पी.–एच.पी.टी.एल.सी का प्रयोग कर घी में वनस्पति तेल की जांच के लिए एक विधि विकसित की गई।

★ पुष्टिकर टोन्ड दूध में विटामिन डी2 के आकलन के लिए एक विश्लेषणात्मक विधि विकसित की गई।

★ शारीरिक–रासायनिक गुणों के आधार पर में भैंस के शरीर की वसा तथा सोयाबीन तेल की जांच के लिए, विभिन्न विधियां निर्धारित की गई।

★ चयनित प्रोटिओलाइटिक लेक्टोबेसिलस जातियों एस एस1–सीएन. (24–34), β–सी.एन (197–209) β–सी.एन (199–209) β–सी.एन (193–207) का प्रयोग कर किण्वन द्वारा स्किम मिल्क पाऊडर से प्रतिसूक्ष्मजैवी पेप्टाइडों की जांच की गई।

★ अपने प्रतिआक्सीकारक क्रियाकलापों के लिए भैंस के as–केसीन जल अपघटन का मूल्यांकन किया गया।

★ दुग्ध प्रोटीनों का प्रयोग करके हल्दी नेनोमिश्रण की तैयारी के लिए एक प्रक्रिया तैयार की गई तथा पशु माडल प्रणाली में प्रतिआक्सीकर गतिविधि के लिए मूल्यांकित की गई।

★ दूध में प्रक्षालक (डिटर्जेंट) की तीव्र जांच के लिए नवीन रंग आधारित परीक्षण को राजस्थान सहकारी डेरी फेडरेशन (आर.सी.डी.एफ) लिमिटेड, एक पंजीकृत समिति को हस्तांतरित की गई। इस समिति का कार्यालय 'सारस सांकुल, जे.एल.एन.मार्ग, जयपुर–302017, राजस्थान में है। यह प्रौद्योगिकी नान–इक्सक्लूसिव आधार पर रू. 6,00,000 (रूपए छह लाख केवल) एक बार की लाइसैंस शुल्क एवं 12.36: की दर से सर्विस टैक्स पर हस्तांतरित की गई। राष्ट्रीय डेरी अनुसंधान संस्थान एवं आर.सी.डी.एफ. के बीच एम.ओ पर दिनांक 19 मार्च, 2014 को हस्ताक्षर किए गए।

★ इन्यूलिन एवं प्रतिरोधी स्टार्च युक्त चीज़ दोनों की ढांचा एवं सरंचना निम्न थी।

★ यह भी नोट किया गया कि मीठी चाशनी में 100% चीनी प्रतिस्थापित करने पर, तैयार खोआ जलेबी वसा, प्रोटीन तथा लेक्टोज़ संघटकों एवं पी.एच. थोड़ी सी कम थी। सोर्बिटोल आधारित एवं क्साइलटोल आधारित चाशनी से तैयार जलेबी के आर्द्रता अंश में भी थोड़ा सा परिवर्तन था।

★ संवेदी मूल्यांकन से प्रकट होता है कि दूध को 10% तक प्रतिस्थापित किया जा सकता है जब कि किण्वित व्हे एवं दूध तथा व्हे मिश्रण का किण्वन लस्सी तैयार करने के लिए प्रयोग किया जाता है जबकि ताजा सान्द्रित तथा लेक्टोज जल अपघटित व्हे को लस्सी तैयार करने के लिए 20% दही तक प्रतिस्थापित किया जा सकता है। व्हे तथा दही के उपरोक्त संयोजन के साथ अति वांछनीय लस्सी के उत्पादन के लिए 20% पानी तथा 13% चीनी का प्रयोग अनुकूलतम था।

★ दक्षिण क्षेत्रीय केन्द्र के प्रयोगात्मक डेरी से चीज़ व्हे, पनीर व्हे तथा स्किम मिल्क के नमूने एकत्रित किए गए एवं बेक्टीरिओफेजेस की विद्यमानता की जांच के लिए इनका परीक्षण किया गया।

★ पनीर पर केसीन, व्हे प्रोटीन सान्द्रण एवं कसावा (टपियोका) स्टार्च कोटिंग से परत चढ़ाई गई एवं इसे सुखाया गया। स्टार्च एवं केसीन से परत चढ़ाई गई पनीर को अच्छी प्रकार से संग्रहित किया गया तथा यह समान गुणवत्ता वाली थी। अतः पनीर की शेल्फ लाइफ बढ़ाने के लिए खाद्य कोटिंग की सिफारिश की जा सकती है।

★ फलों का सत्व एवं सब्जियों के उपोत्पादों का प्रयोग करके घी की शेल्फ लाइफ बढ़ाने का कार्य कृत्रिम प्रतिआक्सीकारक बी.एच.ए. को प्राकृतिक प्रतिआक्सकरों के साथ प्रतिस्थापित करने के आशय के साथ प्रारंभ किया गया है।

★ करक्यूमिन पुष्टिकर लस्सी एवं छैना आधारित कम कैलोरी वाला स्प्रेड विकसित किया गया इसमें एलजहेमिर रोग से लड़ने के प्रोफाइलेक्टिक गुण विद्यमान हैं।

★ तुरंत प्रयोग हेतु तैयार स्थायी शेल्फ लाइफ वाली डेरी–फल–अनाज आधारित सम्मिश्रित समूदि निर्मित करने की प्रौद्योगिकी विकसित की गई।

★ सी.एल.ए. तथा फाइटोस्टीरायल के संयोजन द्वारा क्रियात्मक मक्खन विकसित किया गया तथा इसकी क्रियात्मकता पशु बायोएस्सै द्वारा मानकित की गई।

★ गाय के दूध से तैयार 'खीर मोहन' की शेल्फ लाइफ बढ़ाने तथा निर्मित करने की एक प्रक्रिया मानकित की गई।

★ क्रियात्मक डेरी एवं गैर–डेरी संघटकों का प्रयोग करके क्रियात्मक प्रसंस्कृत चीज़ स्प्रेड, मिश्रित वसा चाकलेट स्प्रेड तथा मीठा मृदु चीज़ बनाने की एक प्रौद्योगिकी विकसित की गई है।

★ व्हे स्किम दूध, अंकुरित बाजरा आटा तथा तरल जौं यव्य सत्व से तैयार प्रतिजैवीय किण्वित पेय विकसित किए गए।

★ जैव प्रौद्योगिकीय प्रक्रियाओं का प्रयोग कर अधिक समय तक संग्रहणीय संशोधित संरचना वाली दही तैयार की गई।

★ मधुमेह–पशु माडल में प्रदर्शित ग्लूकोज़ होम्योस्टेसिस को कायम रख कर एक बहुफलकित चयापचय रोग से बचाव के लिए प्रतिजैवीय (प्रोबायोटिक) जातियां सक्षम पाई गई। ग्लूकोज़ सह्य मात्रा तथा इन्सुलिन सुग्राहिता में सुधार वाले उच्च वसीय आहार सी 57 बी.एल/6 जे को खिलाने से लेक्टोबेसिलस फरमैंटम एल.एफ की एक स्वदेशी जाति का प्रयोग चूहों पर प्रदर्शित किया गया।

★ एंडोएंट्रोक्राइन कोशिकाओं के इन विट्रो कोशिका लाइन माडल का प्रयोग कर प्रतिजैवीय लेक्टोबेसिलस की स्वदेशी नसलों द्वारा गट हार्मोन स्त्रवण को अवलोकित किया जा सकता है। इसके अतिरिक्त एल.राहेमनोसिस सी.जी.द्वारा जी.एलत्रपी.–1 अभिव्यंजना में एम.वाई डी.88 की कोई भूमिका नहीं पाई गई। तथापि अभिप्रेरित परितृप्ति के लिए जी.एल.पी.–1 जैसे गट हार्मोनों की अभिव्यंजना में सी.डी.14 तथा जी. प्रोटीन महत्वपूर्ण भूमिका अदा करते हैं।

★ व्यापक स्पैक्ट्रम बेक्टीरिओसिन के सूक्ष्म इनकेप्सुलेशन अपने नियंत्रित त्याग के लिए नवीन मार्ग प्रदान करते हैं तथा अधिक सुरक्षित एवं शेल्फ लाइफ के साथ खाद्य प्रदान करने के लिए एक महत्वपूर्ण तकनीकी सिद्ध हो सकती है।

★ माँ के दूध पीने वाले मानव शिशुओं से वियोजित लेक्टोबेसिलस गसैरी पशु पाडल अध्ययनों में काफी अधिक हाइपोकोलेस्ट्रोलेमिक तथा प्रतिआक्सीकर संभाव्यता प्रदर्शित करते हैं इन्होंने क्रियात्मक डेरी आहारों में प्रयोग के लिए एक होनहार प्रोबायोटिक (प्रतिजैवीय) अवयव सिद्ध हुए हैं।

★ तीव्र अम्लीकृत स्ट्रेपटोकोकस थर्मोफिलस संवर्धनों की आठ जातियां अपनी चीनी सह्य संभाव्यता पर आधारित मिस्टी डोई तैयार करने के लिए चयनित की गई।

★ मिस्टी डोई संवर्धन के डी.वी.एस. उत्पादन के लिए प्रौद्योगिकी मानकित की गई।

★ कुल 26 व्यावसायिक प्रतिजैवीय उत्पादों से 28 पुनः प्राप्त वियोजकों को अभिलक्षित किया गया तथा यूरोपियन कमीशन, 2008 द्वारा दिए गए दिशानिर्देशों को अपनाने वाले 50 विभिन्न प्रतिजीवाणुओं के लिए उनकी प्रतिजीवाणु संवेदी प्रोफाइल के लिए प्रदर्शित किए गए। अधिकतम वियोजकों के लिए एम.आई.सी. यूरोपियन कमीशन द्वारा संस्तुत की अपेक्षा उच्चतम पाए गए जो कि चिन्ता की बात है।

★ मानव उत्पत्ति के लेक्टोबेसिलस जातियां निरन्तर डेरी मूल के लेक्टोबेसिलस की अपेक्षा श्रेष्ठ प्रतिजैवीय गुण प्रदर्शित

करती है तथा निश्चित आनुवांशिक असमानता प्रदर्शित करते हैं।

★ पेथोजन संक्रमण के बचाव, इम्यूनोमोड्यूलेशन तथा हाइपरकोलेस्ट्रालीमिया के उपचार के लिए एल.फ़रमेन्टम आर.एस.2 का प्रयोग किया जा सकता है।

★ पादप जैवसक्रिय संघटक अर्थात् थाइमोल, ट्रांस–सिनेमलडिहाइड, इयूजनोल तथा कारवाक्रोल ने फूड बोर्न पेथोजनस तथा रद्दी सूक्ष्म वनस्पतियों की तुलना में व्यापक स्पेक्ट्रम प्रति सूक्ष्मजैवीय क्रियाकलाप प्रदर्शित करते हैं।

★ मार्कर किण्वकों का प्रयोग कर 96 माइक्रो–बैल प्लेट पर एल.मोनोसवाइटोजेनस की जांच के लिए बीजाणु आधारित एस्सै तथा उनके जर्मीनोजीनिक सबस्ट्रेट तथा मिनिटयुराइज़्ड माइक्रो वेल बायोचिप आधारित जांच प्रणालियां विकसित की गई।

★ क्षेत्रीय स्तर पर दूध में प्रतिजीवाणु अपशिष्टों के लिए बीजाणु–संवदी प्रौद्योगिकी (किण्वक) विकसित की गई।

★ सान्द्रित दुग्ध संचालन के लिए निरन्तर खोआ निर्माण मशीन का स्केल अप डिजाइन तैयार किया गया।

★ रंग मापन पर आधारित डेरी उत्पादों के गुणवत्ता मूल्यांकन के लिए मशीन विज़िन प्रणाली विकसित की गई।

★ निरन्तर गाजरपाक के उत्पादन के लिए थ्री स्टेज स्क्रेप्ड सरफेज ऊष्मा विनिमायक (एस.एस.एच.ई.) संशोधित किया गया।

★ इन लाइन प्रणाली का प्रयोग कर रबड़ी के त्वरित उत्पादन के लिए बलकृत संवहनी विधि डिजाइन एवं विकसित की गई।

★ दूध एवं बाजरे पर आधारित लौह एवं जस्ता पुष्टिकर न्यूट्रीमिक्स (दूध छुड़ाई आहार) की आर्द्रता सोर्पशन विशेषताओं की जांच की गई।

★ थ्री स्टेज एस.एस.एच.ई. में खोआ निर्माण के दौरान ऊर्जा संरक्षण अध्ययन किए गए।

★ यंत्रीकृत एवं हस्तचालित प्रणाली में सान्द्रित दूध की भौतिक–रासायनिक विशेषताओं पर तुलनात्मक अध्ययन किए गए।

★ दक्षिण क्षेत्र के चयनित क्षेत्रों में लघु धारक डेरी उत्पादन प्रणालियों की प्रोफाइल का अध्ययन करने के लिए विशिष्ट उद्देश्यों के साथ दक्षिण क्षेत्र में लघुधारी डेरी उत्पादन पर प्रोफाइल अध्ययन प्रारंभ किए गए। यह अध्ययन दक्षिण क्षेत्र में लघुधारी डेरी उत्पादन प्रणालियों की बाधाओं का अध्ययन करने तथा क्षेत्र के सफल लघु डेरी कृषकों के चयनित केस अध्ययनों का विश्लेषण करने के लिए किए गए। अधिकतम प्रत्यर्थी 2–5 डेरी पशुओं (64–67%) के स्वामी हैं। क्षेत्र में दुग्ध उत्पादन की लागत 17–23 रूपए/लीटर के बीच है। यह प्रदर्शित होता है कि डेरी कृषक बहुत सी बाधाओं का सामना कर रहे है जो कि डेरी विकास को रोक रहे हैं तथा इन्हें प्राथमिकता आधार पर सुधारने की आवश्यकता है।

★ प्रारंभिक प्रवत्तकों की विशेषताओं तथा अभिप्रेरण तत्वों की पहचान की गई। तदनन्तर में डेयरिंग में प्रारंभिक प्रवत्तकों की महत्वपूर्ण भूमिका पर बल देने के लिए नवीन प्रवत्तनों के गुणों पर प्रकाश डाला गया।

★ समूह प्रस्ताव (एस.एच.जी.) आय अर्जित करने तथा सशक्तिकरण का अत्यधिक प्रभावी मार्ग पाया गया।

★ बछड़ों में विकास प्रदर्शन में सुधार के लिए उत्तरी–पूर्वी भारत के पेड़ों के पत्तों का प्रयोग कर रूमेन किण्वन के आहार से काम चलाया गया।

★ परखनली से गोपशुओं के भ्रूणीय स्टैम कोशिकाओं से भ्रूण उत्पन्न किए गए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र, कल्याणी, पश्चिमी बंगाल पर संकर गायों के दुग्ध स्त्रवण विशेषकों के लिए चयनित क्षमता में सुधार के लिए आनुवांशिक माडल का विकास किया गया।

★ डेरी पशु राशन में कुछ नवीनतम आहार संसाधनों का तुलनात्मक पोषणिक मूल्यांकन एवं उपयोग।

★ पूर्वी क्षेत्रीय केन्द्र में जुड़वां संकर बछड़ों–एक केस अध्ययन में लिंग क्रोमोसोम निर्मूल पाया गया।

★ भारत के पूर्वी क्षेत्र में ग्रामीण परिवारों की अर्थव्यवस्था पर महिला डेरी सहकारी समितियों का संघटनात्मक विश्लेषण।

शिक्षण एवं प्रशिक्षण

★ संस्थान में विभिन्न विर्षयों पर चालू मास्टर एवं उपाधि पाठ्यक्रमों तथा बी.टैक (डेरी प्रौद्योगिकी) के अतिरिक्त संस्थान ने वर्ष 2013–14 से दक्षिण क्षेत्रीय केन्द्र, बंगलौर पर डेरी प्रौद्योगिकी में डिप्लोमा पाठ्यक्रम भी प्रारंभ किया है। संस्थान में 837 छात्र हैं जिनमें 645 लड़के एवं 192 लड़कियां हैं इनमें 15 विदेशी छात्र भी सम्मिलित हैं।

★ क्षेत्रीय केन्द्रों पर शिक्षण को सुदृढ़ किया गया है। रिपोर्टाधीन अवधि में, छात्रों को दक्षिण क्षेत्रीय केन्द्र, बंगलौर पर मास्टर उपाधि कार्यक्रम के लिए डेरी रसायन तथा डेरी प्रौद्योगिकी विर्षय में शोध कार्य करने के लिए तथा पशु प्रजनन, डेरी रसायन, डेरी प्रौद्योगिकी तथा डेरी अर्थशास्त्र में डाक्टरेट उपाधि के लिए थीसिस काय्र करने के लिए उत्तरदायित्व सौंपा गया। इसी प्रकार पूर्वी क्षेत्रीय केन्द्र, कल्याणी पर पशु जैव प्रौद्योगिकी, पशुधन उत्पादन एवं प्रबंधन, पशु पोषण तथा डेरी अर्थशास्त्र विषयों में मास्टर उपाधि के शोधकार्य हेतु सुविधाएं प्रदान की गई।

★ एन.ए.आई.पी.संघटक 1 के अन्तर्गत बी.टैक (डेरी प्रौद्योगकी) उपाधि पाठ्यक्रम के लिए ई–पाठ्यक्रम पूरा कर लिया गया है। पूर्वस्नातक कार्यक्रम प्रस्तुत करने वाले अन्य संस्थानों तथा राज्य कृषि विश्वविद्यालयों (एस.ए.यू.) को ऑन लाइन तथा आफ लाइन डिलीवरी के लिए पीर रिव्यूर तथा छात्र पुनरीक्षकों द्वारा इन पाठ्यक्रमों का पुनरीक्षण किया गया तथा इन्हें अन्तिम रूप दिया गया। नियमित फीडबैक को देखते हुए पुनरीक्षण तथा निरन्तर नवीनीकरण के लिए इन पाठ्यक्रमों को क्रियान्वित करने का दूसरा चरण भी पूरा कर लिया गया है।

★ संस्थान का बारहवां दीक्षान्त समारोह 14 फरवरी, 2014 को आयोजित किया गया। श्री अरविन्द आर. कौशल, सचिव भारतीय कृषि अनुसंधान परिषद, नई दिल्ली ने अपना दीक्षान्त उद्‌बोधन प्रस्तुत किया तथा छात्रों को उपाधियां, स्वर्ण पदक, मेरिट प्रमाणपत्र तथा पुरस्कार प्रदान किए। डा. के.एम.एल. पाठक, उपमहानिदेशक (पशु विज्ञान) भारतीय कृषि अनुसंधान परिषद, नई दिल्ली तथा डा. एस.होनापागोल, पशुपालन आयुक्त इस अवसर पर विशिष्ट अतिथि थे।

★ राष्ट्रीय डेरी अनुसंधान संस्थान ने वर्ष 2013–14 में दीक्षान्त समारोह से पूर्व शैक्षिक मास मनाया। इस सप्ताह में स्मारक व्याख्यान तथा शैक्षिक उपलब्धियों की प्रस्तुतीकरण तथा विभिन्न प्रभागाध्यक्षों द्वारा शिक्षण में नवप्रवर्त्तन, श्रेष्ठ मास्टर एवं डाक्टरल शोध–निबंधों के लिए छात्रों का चयन आदि जैसी कई शैक्षणिक गतिविधियों का आयोजन किया गया। शैक्षिक मास जनवरी, 2014 से दूसरे सप्ताह से फरवरी 2014 के दूसरे सप्ताह तक मनाया गया। 'श्रेष्ठ थीसिस पुरस्कार' भी मास्टर एवं डाक्टरल छात्रों को उच्च गुणवत्ता का शोध कार्य करने के लिए प्रतिस्पर्द्धा एवं प्रेरणा की भावना को प्रोत्साहित करने के लिए दिया गया।

★ डा. के.के.अइया स्मारक व्याख्यान दिनांक 28 जनवरी, 2014 को डा. एस.के. बंधोपाध्याय, सदस्य, कृषि वैज्ञानिक चयन मंडल, नई दिल्ली द्वारा दिया गया। डा.एन.एन.दस्तूर स्मारक व्याख्यान इस वर्ष के लिए डा.वी.एस.कटोच, महानिदेशक, भारतीय चिकित्सा अनुसंधान परिषद, नई दिल्ली को दिया गया तथा दिनांक 11 फरवरी, 2014 को पांचवा डा. डी. सुन्दरेसन स्मारक व्याख्यान संपन्न हुआ तथा डा. एस. अय्यप्पन, महानिदेशक, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली द्वारा दिया गया।

★ बी.टैक (डेरी प्रौद्योगिकी) कार्यक्रम के 49 ई. पाठ्यक्रम विकसित किए गए तथा राज्य कृषि विश्वविद्यालयों के सभी डेरी विज्ञान कालेजों को ऑन लाइन तथा आफ लाइन मोड़ पर सफलतापूर्वक सौंपे गए।

विस्तार कार्यकलाप

★ अपनाए गए गॉवों में डेरी कृषकों तथा कृषक महिलाओं के लिए गत एक वर्ष के दौरान विकसित प्रौद्योगिकियों के हस्तांतरण के लिए 53 किसान संगोष्ठियां आयोजित की गई। कृषकों को प्रजनन प्रबंधन प्रक्रियाओं थनैला नियंत्रण, रोग बचाव मापदंड, स्वच्छ दुग्ध उत्पादन प्रक्रियाओं, मूल्य सवंर्धित डेरी उत्पाद तैयार करना, चारा की कमी की अवधि में चारे का प्रबंधन तथा पूरे वर्ष हरे चारे के उत्पादरन के बारे में भी जागरूक किया गया।

★ महिलाओं के लिए परिसर के बाहर गाँवों में 34 महिला सशक्तिकरण प्रशिक्षण एवं शिविर आयोजित किए गए। इससे 511 ग्रामीण महिलाओं ने लाभ उठायां ग्रामीण महिलाएं डेयरिंग से अधिक आय अर्जित कर सकती हैं तथा अपने–अपने परिवारों में स्वस्थ वातावरण कायम रख सकती है। मूल्य सवंर्धित डेरी उत्पादों को लघुस्तर पर उत्पादन करने के लिए संस्थान परिसर पर चार महिला उद्यमिता एवं क्षमता निर्माण कार्यक्रम आयोजित किए गए जिससे 64 ग्रामीण महिलाओं ने लाभ उठाया।

★ करनाल जिले के 6 ब्लॉकों में लिए गए 12 गॉवों में वैज्ञानिक पद्धति द्वारा डेरी पालन, कृत्रिम गर्भाधान, पी.डी. तथा पशुचिकित्सा, प्रारंभिक उपचार में बेरोजगार ग्रामीण युवाओं की क्षमता का निर्माण किया। पशुचिकित्सा सेवाओं को तीव्रता से प्रदान करना तथा कृत्रिम गर्भाधान (ए.आई.) का व्यापक प्रयोग।

★ संस्थान में 104 कालेजों/संस्थानों/विश्वविद्यालयों से कुल 6121 आगन्तुकों (छात्र एवं संकाय) ने भ्रमण किया। इन समूहों ने संस्थान पर हो रहे विभिन्न अनुसंधान, शिक्षण तथा प्रसार उपलब्धियों एवं संस्थान पर उपलब्ध सुविधाओं के बारे में जानकारी प्राप्त की।

★ कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण केन्द्र ने पूरे देश के 6873 कृषकों, ग्रामीण महिलाओं, ग्रामीण युवाओं एवं उद्यमियों के हित के लिए फसल उत्पादन बागवानी, मधुमक्खी पालन, मत्स्य पालन, गृह विज्ञान जैसे कृषि के संबंधित क्षेत्रों एवं डेयरिंग के विभिन्न पहलुओं पर 230 प्रशिक्षण कार्यक्रम (परिसर पर एवं परिसर से बाहर) आयोजित किए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के एटिक केन्द्र ने विभिन्न राज्यों के 1,54,790 व्यक्तियों को वीडियो शो, व्याख्यानों, व्यक्तिगत चर्चाओं, प्रकाशित साहित्व, टोल फ्री फोन कालस तथा ई.मेल के द्वारा 8802 सेवाएं प्रदान की। केन्द्र ने कुल ₹ 6,45,064/– का राजस्व, पुस्तकों की बिक्री द्वारा (₹ 1,62,379/–) तथा बीजों की बिक्री, एफ.वाई.एम., वर्मी कम्पोस्ट (₹ 4,82,685/–) द्वारा अर्जित किया। कृषकों के हित के लिए पहली बार राष्ट्रीय डेरी अनुसंधान संस्थान तथा पंजाब कृषि विश्वविद्यालय लुधियान द्वारा संस्थान के एटिक केन्द्र पर संयुक्त रूप से एक बीज बिक्री केन्द्र प्रारंभ किया गया है।

आधारीय संरचना

★ राष्ट्रीय डेरी अनुसंधान संस्थान पर 'दुग्ध गुणवत्ता एवं सुरक्षा के लिए एक 'रेफरल प्रयोगशाला' सृजित की गई है। यह प्रयोगशाला एफ.एस.एस.ए.आई. के लिए अनुसंधान एवं विकास/मानव संसाधन विकास/मानक विकास कार्य आयोजित करने के लिए काफी उपयोगी होगी।

★ पशु कलेरोमीटर, सी.ओ. 2 पर्यावरण चैम्बर, साइक्रोमीट्रिक चैम्बर, कस्टम डिजाइनड पशु शैल्टर, शरीर क्रियात्मक तथा व्यवहार अभिलेखन प्रणाली की सुविधाओं से युक्त जलवायुवीय परिवर्तनों को कायम रखने वाली पशुधन अनुसंधान केन्द्र स्थापित किया गया। पशुविाान में अग्रणी एवं प्रमुख अनुसंधान के लिए चयापचय फेनोटाइप तथा फीजियो–जिनोमिक प्रयोगशाला स्थापित की गई है।

★ एन.ए.आई.पी. के अन्तर्गत नवीन व्यवसाय नियोजन एवं विकास (बी.पी.डी.) एकक सृजित किया गया है।

★ 'थीरियोजीनोलोजी' प्रयोगशाला: एन.एफ.बी.एस.एफ. ए.आर.ए. परियोजना के अन्तर्गत राष्ट्रीय डेरी अनुसंधान संस्थान पर एक अत्याधुनिक 'थीरियोजीनोलोजी प्रयोगशाला' स्थापित की गई है। सुविधाओं में कोशिका संवर्धन सुविधाएं (जैव सुरक्षा केबिनेट, इन्वरटिड फल्रोसैंट माइक्रोस्कोप, सी. ओ.2 इन्क्यूबेटर आदि) हिस्टोलोजी सुविधाएं, प्रोटिओमिक्स सुविधाएं एवं अन्य मूल अनुसंधान सुविधाएं सम्मिलित हैं।

★ डेरी गायों के आराम एवं प्रभावी पशु कल्याण हेतु तीन अत्याधुनिक आवास प्रणालियों, कंप्यूटरीकृत डिस्पैंसिंग प्रणाली, कंप्यूटरीकृत दुग्ध दोहन प्रणाली तथा पशु क्रियाकलाप अनुश्रवण प्रणाली प्रारंभ एवं मूल्यांकित की गई।

★ वायरलैस संवेदी आधारित जलवायु नियंत्रण कक्ष विकसित एवं सुसज्जित किया गया।

★ आचरणीय अध्ययनों के लिए पशुधन फार्म में व्यवहार मानीटरिंग प्रणाली भी संस्थापित की गई।

★ बी.पी.डी. परियोजना के अन्तर्गत काफी संख्या में नए उपकरण जैसे पास्ता निर्माण मशीन, बोतलें भरने, पैकिंग मशीन, कैनिंग लाइन, साफट सर्व आइसक्रीम फ्रीजर, आइसक्रीम फ्रूट फीडर, प्लेनटरी मिश्रक, बेकरी ओवन, कप फिलिंग मशीन, सब्जी प्रसंस्करण मशीन, स्पेक्ट्रोफोटोमीटर, शिंक–रैप पैकेजिंग मशीन, फलों का गूदा निकालने की मशीन तथा वाल्क इन कोल्ड रूम प्राप्त किए गए।

★ प्रभाग में ई.कंटैन्ट विकास प्रयोगशाला संस्थापित की गई। यह सभी आवश्यक उपकरणों के साथ सुसज्जित है तथा आन लाइन डिलिवरी के लिए ई.कंटैन्ट सृजन, संशोधन एवं ई.कंटैंट अपलोडिंग के लिए संरचित है।

★ डेरी सूक्ष्मजीव विज्ञान प्रभाग की आण्विक जीव विज्ञान एकक को नवीनतम रूप देने के लिए इसे अत्याधुनिक सुविधाओं से सुसज्जित किया गया है तथा इसके अतिरिक्त एक ऊत्तक संवर्धन प्रयोगशाला भी संस्थापित की गई है।

★ कावेरी छात्रावास का नया विंग सृजित किया गया तथा चालू किया गय। कुल 52 कमेर–(एकल कमरे) लड़कियों के लिए बनाए गए। सभी कमरों के साथ बाथरूम भी बने हुए हैं।

★ छात्रों के लिए नया छात्रावास 'नर्मदा छात्रावास' बनाया गया। इस छात्रावास में 150 छात्रों के रहने की व्यवस्था है। सभी कमरे एकल है।

★ राष्ट्रीय डेरी अनुसंधान संस्थान पर लगभग 2 एकड़ भूमि पर चारा संग्रहालय सृजित किया गया।

★ ऑन–लाइन ए.एस.आर.बी. परीक्षा केन्द्र चालू किया गया।

★ सभी छात्रावासों में इन्टरनेट सुविधाएं विकसित की गई।

★ अन्तरराष्ट्रीय छात्रावास में काफी मरम्मत कार्य।

★ अतिरिक्त सम्मेलन हाल/बैठक कक्षों की नवीन सुविधाओं का निर्माण।

★ डेरी इंजीनियरिंग प्रभाग के यूटीलिटी अनुभाग को संस्थान के परीक्षा केन्द्र के रूप में परिवर्तित किया गया।

★ विभिन्न शैड़ों एवं कमरों की मरम्मत एवं नवीकरण तथा फार्म क्षेत्र के ब्लॉक नं. 7 में शैड एवं संग्रहण सुविधा प्रदान करना, मौजूदा फैंस की मरम्मत (8'ऊचाई) तक ब्लॉक नं. 6 में तार लगाना।

★ वर्कशाप तथा कार्यालय परिसर फार्म अनुभाग के सेमीनार कक्ष/समिति कक्ष के कमरों की मरम्मत एवं नवीकरण।

★ डी.सुन्दरेसन स्मारक सभाभवन की मरम्मत एवं नवीकरण।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, बंगलौर के संस्थान मुख्य द्वार पर संस्थान का नाम बोर्ड लगाना एवं संरचना का नवीकरण।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के द.क्षे.के., बंगलौर पर छात्रों के छात्रावास के 'बी तथा ई.' विंग का नवीकरण।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र, कल्याणी पर चारदीवारी की मरम्मत।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र, कल्याणी में मैटल सड़कों की कारपेटिंग एवं नवीकरण।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र, कल्याणी पर पशुशाला कोरीडोर की मरम्मत/नवीकरण।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के पूर्वी क्षेत्रीय केन्द्र, कल्याणी के कंकरीट फर्शों के सुधार एवं भूमि विकास को कार्यान्वित करने का प्रस्ताव।

राजभाषा एककक

राजभाषा कार्यकाल (2013-14)

★ संस्थान राजभाषा कार्यान्वयन समिति की वर्ष में चार अर्थात प्रत्येक तिमाही बैठक आयोजित की गई। इन बैठकों में राजभाषा कार्यान्वयन के क्षेत्र में संस्थान द्वारा किए जा रहे कार्यों की प्रगति का अवलोकन किया जाता है तथा भविष्य में किए जाने वाले कार्यों की रूप रेखा तैयार कर उन्हें क्रियान्वित करने का प्रयास किया जाता है।

★ संस्थान के निदेशक महोदय की अध्यक्षता में नगर राजभाषा कार्यान्वयन समिति की पहली छःमाही समीक्षा बैठक जून मास में संपन्न हुई एवं दूसरी छःमाही बैठक दिसम्बर मास में केन्द्रीय मृदा लवणता अनुसंधान संस्थान में वहां के निदेशक डा. डी.के. शर्मा की अध्यक्षता में आयोजित की गई। इन बैठको में संस्थान की ओर से संयुक्त निदेशक (प्रशासन) उपनिदेशक (राजभाषा)/प्रशासन प्रभारी, राजभाषा एकक, वरि. तक. अधिकारी राजभाषा एकक ने भाग लिया।

★ संस्थान में विगत वर्षों की भांति इस बार भी दिनांक 17 सितम्बर, 2013 से 11 नवम्बर, 2013 तक राजभाषा मास का आयोजन किया गया। इस मास का शुभारंभ वैज्ञानिकों तकनीकी अधिकारियों एवं शोध छात्रों हेतु एक 'शोधपत्र/पोस्टर' प्रदर्शित किए गए। इसके अतिरिक्त टिप्पण तथा मसौदा लेखन एवं भाषण प्रतियोगिता का आयोजन भी किया गया। दैनिक पत्राचार बढ़ाने के उद्देश्य से संस्थान के सभी वर्गों के कार्मिकों हेतु टिप्पण एवं मसौदा लेखन प्रतियोगिता दिनांक 21.9.2013 को संपन्न हुई। नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों हेतु दिनांक 25 सितम्बर, 2013 को गीत–गायन प्रतियोगिता का आयोजन किया गया। इस कार्यक्रम में 18 कार्यालयों के 39 कार्मिकों ने भाग लिया। इसके अतिरिक्त संस्थान के लिपिकों एवं वरिष्ठ लिपिकों हेतु दिनांक 28 सितम्बर, 2013 को राजभाषा प्रशासनिक कार्यशाला आयोजित की गई जिसमें संस्थान के 69 कार्मिकों ने भाग लिया।

★ राजभाषा मुख्य समारोह एवं पुरस्कार वितरण कार्यक्रम 11 नवम्बर, 2013 को आयोजित किया गया जिसमें राजभाषा मास के दौरान आयोजित प्रतियोगिताओं के विजेताओं को नकद पुरस्कार एवं प्रतिभागियों को प्रमाणपत्र वितरित किए गए।

★ मूल रूप से हिंदी में टिप्पण एवं मसौदा लेखन प्रोत्साहन योजना के अन्तर्गत वर्ष 2012–13 के लिए संस्थान के 09 कार्मिकों को पुरस्कृत किया गया।

★ नगर राजभाषा कार्यान्वयन समिति, करनाल द्वारा संस्थान में किए जा रहे राजभाषा कार्यान्वयन संबंधी उल्लेखनीय कार्यकलापों हेतु करनाल स्थित लगभग 66 केन्द्रीय कार्यालयों के मध्य द्वितीय राजभाषा पुरस्कार 2012–13 दिनांक 26.06.2013 को प्रदान किया गया।

★ संस्थान की वार्षिक गृह पत्रिका 'दुग्ध गंगा' के तृतीय अंक का सफल प्रकाशन हुआ। यह प्रकाशन कृषकों एवं पशुपालकों के लिए अत्यन्त उपयोगी है। वैज्ञानिक अपने विषय से संबंधित लेख राजभाषा (हिंदी) में लिख कर इस पत्रिका से प्रकाशित हेतु भेजते है जिससे इसका ज्ञान अधिक से अधिक लोगो तक पहुंच सके।

★ मूल हिंदी वैज्ञानिक लेख लेखन प्रोत्साहन योजना विगत कई वर्षों से संस्थान में चालू है इस प्रोत्साहन योजना के अन्तर्गत वैज्ञानिकों द्वारा विभिन्न पत्रिकाओं में उनके द्वारा मूल रूप से लिखित एवं प्रकाशित लेख/आलेख/शोधपत्रों को मूल्यांकित कर पुरस्कृत किया जाता है ताकि राजभाषा (हिंदी) में काम–काज बढ़े।

★ संस्थान के वैज्ञानिकों से वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, वार्षिक प्रतिवेदन, प्रशासनिक पत्र/परिपत्र/ज्ञापन इत्यादि विभिन्न समारोहों की प्रेस विज्ञप्तियां, भाषण, व्याख्यान एवं अनेक प्रकार का अनुवाद कार्य इस एकक द्वारा किया जाता है।

★ संस्थान में नगर राजभाषा कार्यान्वयन समिति के तत्वाधान में दिनांक 19.7.2013 तक एक पांच दिवसीय संक्षिप्त अनुवाद प्रशिक्षण कार्यक्रम आयोजित किया गया जिसमें विभिन्न कार्यालयों के लगभग 35 कार्मिकों एवं अधिकारियों ने भाग लिया। यह कार्यक्रम केन्द्रीय अनुवाद ब्यूरो, नई दिल्ली के सौजन्य से आयोजित 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

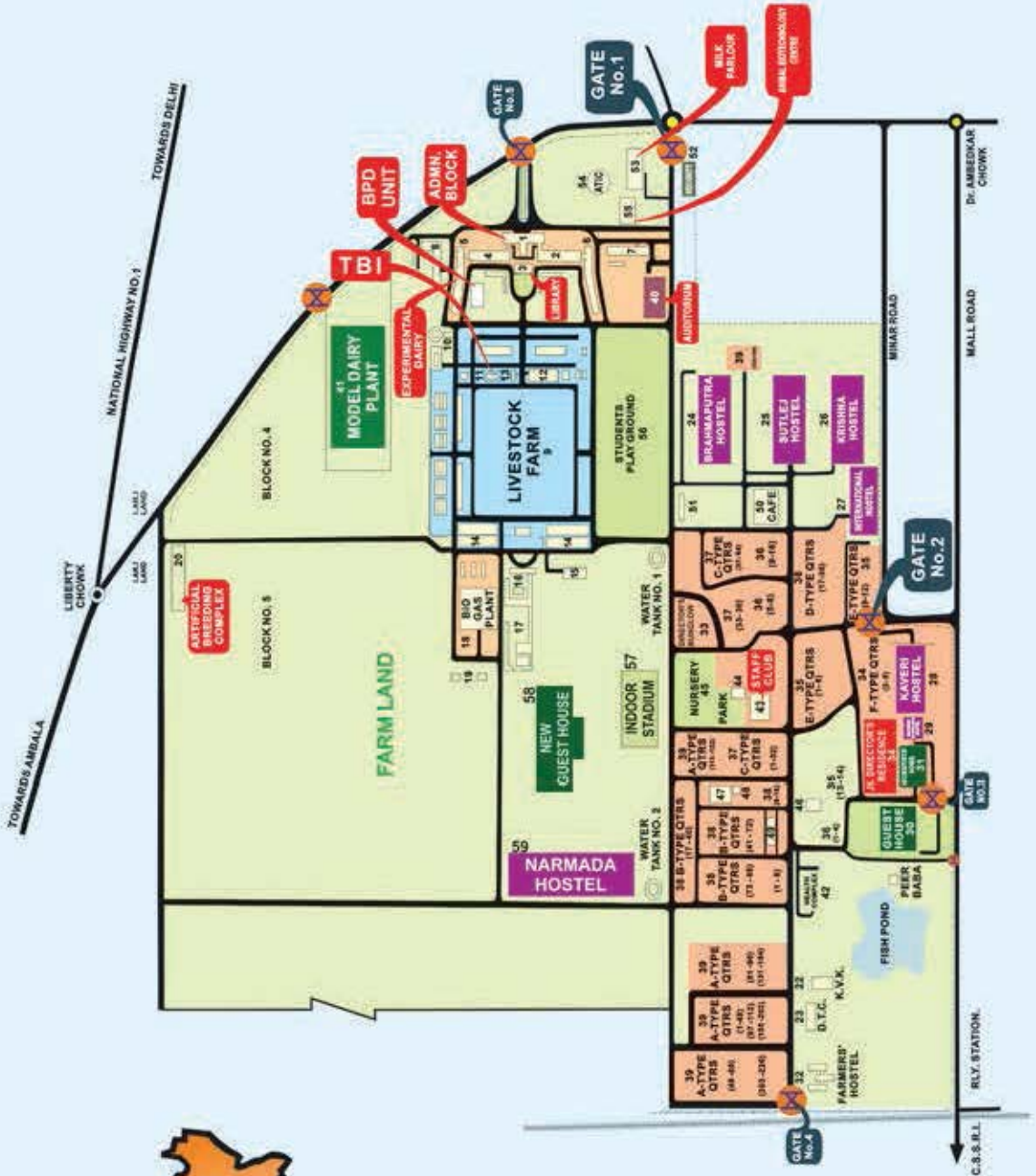
STUDENT HOSTELS

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

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

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