ndri

# वार्षिक प्रतिवेदन
# Annual Report

2010-11

## 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

भाकृअनुप
ICAR

# MILESTONES

| | |
|---|---|
| 1923 | Established in Bangalore as Imperial Institute of Animal Husbandry and Dairying. |
| 1936 | Renamed "Imperial Dairy Institute". |
| 1955 | National Dairy Research Institute came into existence at Karnal, at the former Central Cattle Breeding Farm. |
| | Bangalore facilities became Southern Regional Station of the Institute. |
| 1961 | B.Sc. Dairying bifurcated into two branches, namely B.Sc. (Dairy Technology) and B.Sc. (Dairy Husbandry); M.Sc. Dairying courses commenced at Karnal. |
| 1962 | Western Regional Station established at Bombay. |
| 1964 | Eastern Regional Station established at Kalyani (W.B.). |
| 1966 | Institute brought under the aegis of ICAR. |
| 1975 | Operational Research Project initiated. |
| 1976 | Department of Human Nutrition and Dietetics established at NDRI, Karnal. |
| 1979 | M.Sc., Ph.D. Programme in Dairy Engineering commenced at Karnal. |
| 1983 | IDD (DH) started at Bangalore. |
| 1985 | "Farm Advisory Bureau" and "Industrial Consultancy Cell" set up. The Institute recognised as Centre of Excellence in Animal Biotechnology. |
| 1987 | Embryo Biotechnology Centre established. |
| 1989 | The Institute granted "Deemed to be University" status. |
| | M.Sc. in Biotechnology started. |
| 1990 | Birth of Pratham, first IVF buffalo calf of the world. |
| 1991 | 20 bedded Hospital Complex set up and made functional. |
| | National Agricultural Research Project (NARP) funded through World Bank. |
| 1994 | The Institute got recognition as Centre of Advanced Studies in Dairy Technology and Dairy Cattle Breeding. |
| 1996 | A two-year National Dairy Diploma (NDD) course introduced at Southern Regional Station of NDRI at Bangalore. |
| | The ICAR award (1993-94) for outstanding KVK conferred on the KVK located at NDRI. |
| 1997 | A state-of-the-art Auditorium having seating capacity of 950 and 2 conference rooms and 2 meeting rooms made functional. |
| | A commercial Model Dairy Plant with a capacity of 60,000 lit./ day commissioned for providing practical training to the students of NDRI University and to serve as an interface between Institute and Industry. |
| 1998 | A Modern Cafeteria with a seating capacity of 150 constructed in front of the Institute Hostels at the cost of 29 lakhs. |
| 1999 | Total no. of 9 NATP Projects with financial outlay of 266.25 lakhs initiated. |
| 2000 | NDRI bagged the Best Annual Report Award second time in succession for the years 1996-97 and 1997-98 in the category of large ICAR Institutes. |
| | A Guest House with two suites named as "Kamdhenu" was constructed at SRS, Bangalore. |
| | Platinum Jubilee of the Institute celebrated on 7th - 8th April 2000 at SRS, Bangalore. |
| | Web-site of NDRI was created and launched by the Hon'ble Union Minister for Agriculture on 23rd December 2000. |
| 2001 | Foundation stone of the Agricultural Technology Information Centre laid on 1st August, 2001 under NATP project at NDRI, Karnal. |
| 2002 | International Students' Hostel equipped with modern facilities and amenities constructed at NDRI, Karnal. |
| | Feed Quality Control Lab. set up to help keep-strict quality check on feeds being fed to bovine livestock. |
| 2003 | State-of-the-art milking parlour system introduced in cattle section. |
| 2004 | First IVF goat kid born at NDRI. |
| | ATIC centre at NDRI made functional. |
| 2006 | New Animal Biotechnology Centre commissioned. |
| 2007 | Creation of Video Conferencing Lab and Mini Auditorium. |
| 2009 | World First Cloned Buffalo Calf and second cloned calf "Garima" produced by hand-guided cloning technique at NDRI. |
| | DST supported Technology Business Incubator (TBI) facility made functional. |
| | New Course Curricula for B.Tech in Dairy Technology and Masters and Doctoral Programmes introduced. |
| | Reforms in Examination System, grading system and introduction of comprehensive exam. for Ph.D. programme introduced. |
| 2010 | 8th Convocation of NDRI, Deemed University held in presence of Dr. A. P. J. Abdul Kalam, Former President of India. |
| 2011 | M.Sc. in Forage Production introduced at NDRI, Karnal. |
| | National Academy of Dairy Sciences launched at NDRI, Karnal. |
| | NDRI recognised as Centre of Advanced Faculty Training (CAFT) in the disciplines of Dairy Production and Dairy Processing. |

## THE 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.

## THE MANDATE

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

# CONTENTS

# CREDIT LINE


| | |
|---|---|
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FRONT COVER PHOTO

*Institute Admn. Block*

BACK COVER PHOTO

*Composite Dairy Foods developed at NDRI*

# प्राक्कथन

# PREFACE

राष्ट्रीय डेरी अनुसंधान संस्थान के वर्ष 2010–11 अवधि की वार्षिक प्रतिवेदन आपके समक्ष प्रस्तुत करते हुए मुझे अपार प्रसन्नता का अनुभव हो रहा है। इस रिपोर्ट में संस्थान की विगत एक वर्ष के दौरान डेरी अनुसंधान, शिक्षण, विस्तार एवं संरचनात्मक विकास के क्षेत्र की महत्वपूर्ण उपलब्धियों को प्रस्तुत किया गया है। इसमें सूचनाओं को इस प्रकार व्यवस्थित किया गया है, यह देश के इस प्रमुख डेरी संस्थान एवं इसकी कार्य प्रणाली का व्यापक चित्रण प्रस्तुत करती है।

वर्ष 2010–11 के दौरान, राष्ट्रीय डेरी अनुसंधान संस्थान के अनुसंधान एवं विकास कार्यक्रम को अधिदेशानुकूल तथा सुव्यवस्थित अनुसंधान कार्यक्रमों के द्वारा और अधिक गति मिली है। इन अनुसंधान कार्यक्रमों में 82. अन्तःसंस्थानिक एवं 50 बाह्य वित्तीय सहायता प्राप्त अनुसंधान परियोजनाएं सम्मिलित है। जिसमें 20 एन.ए.आई.पी. परियोजनाओं के द्वारा ₹34 करोड़ की वित्तीय सहायता प्राप्त कर ली है। प्रत्येक एन.ए.आई.पी. परियोजना को संघ मॉनीटरिंग यूनिट (सी.एम.यू.) संघ क्रियान्वयन समिति (सी.आई.सी.) तथा संघ परामर्श समिति (सी.ए.सी.) द्वारा मार्गदर्शन, मानीटर एवं मूल्यांकित किया गया जिसका नेतृत्व भारतीय कृषि अनुसंधान परिषद से बाहर के एक प्रतिष्ठित वैज्ञानिक ने किया। रिपोर्टाधीन अवधि के दौरान एन.ए.आई.पी. परियोजनाओं की प्रमुख उपलब्धि सी.एम.यू.सी.आई.सी. तथा सी.आई.सी. की नियमित बैठकें थी।

राष्ट्रीय डेरी अनुसंधान संस्थान में जून, 2009 में विश्व के प्रथम भैंस की क्लोनड कटड़ी 'गरिमा' के जन्म का

It gives me immense pleasure to present before you the Annual Report of NDRI for the period 2010-11. This report chronicles the significant achievements of the Institute in the areas of Dairy Research, Education, Extension and Infrastructure development during the last one year. The information has been so arranged that it provides a comprehensive portrayal of this premier dairy Institute of the country and its functioning.

During the year 2010-11, the research and development programme of NDRI got further momentum through mandate oriented and well-structured research programmes comprising 82 in-house and 50 externally funded research projects, which included 20 NAIP projects in consortium mode having the financial outlay of Rs. 34 crores. Each NAIP project was guided, monitored and evaluated by Consortium Monitoring Unit (CMU), Consortium Implementation Committee (CIC) and Consortium Advisory Committee (CAC) headed by a renowned scientist outside the ICAR system. Regular meetings of CMU, CIC and CAC were distinct features of NAIP projects during the period under report.

After the breakthrough in the history of NDRI i.e. the production of the world's first cloned buffalo calf 'Garima' in June 2009, the Institute made further headway in the

ऐतिहासिक रिकार्ड तोड़ने के बाद संस्थान ने क्लोनिंग तकनीकी में आगे और प्रगति की तथा इस तकनीक से भ्रूणीय स्टेम कोशिकाओं से 22 अगस्त 2010 को भैंस की दूसरी क्लोन्ड़ कटड़ी 'गरिमा–II' का जन्म हुआ तथा 28 अगस्त 2010 को एक क्लोन्ड कटड़े 'श्रेष्ठ' का जन्म हुआ जिसमें दो सप्ताह के भैंस के कटड़े के कान से कायिका कोशिका (सोमेटिक सैल) लेकर उत्पन्न किया गया। एक अन्य परियोजना में हृदय पेशी कोशिकाओं के उत्पादन के लिए बकरी के भ्रूणीय स्टेम कोशिकाओं का प्रयोग किया गया। भैंस के डिम्बाणुजन कोशिका में महत्वपूर्ण अभिनवजीनों की पहचान की गई जो कि उनकी कार्यात्मक क्षमता को निर्धारित करने के लिए महत्वपूर्ण हो सकता था। श्रेष्ठ प्रजनन क्षमता वाले पशुओं के चयन के लिए इन में से कुछ उपयोगी मार्कर सिद्ध हो सकते है। आर.एन.ए. व्यतिकरण तकनीकी का प्रयोग करके माडल कोशिका संवर्धन प्रणाली में भैंस के एरोमटेज ज़ीन निर्धारण का अध्ययन किया गया। प्रतिऑक्सीकारक पुष्टीकरण, गोपशुओं, भैंसों तथा बकरियों के वीर्य को प्रशीतित करने, प्रशीतित नाभिकन के लिए संशोधित करने, प्रशीतन की दर को नियंत्रित किया एवं उत्प्रेरित प्रशीतित नाभिकन के लिए संशोधित विधियां विकसित की गई।

दूध में आक्सीटोसिन के आकलन के लिए एक संवेदी एवं विशिष्ट एन्जाइम इम्यूनो विधि विकसित की गई। हार्मोन दूध में छुपे होते हैं जबकि दुग्ध उत्पादन के लिए संस्तुत डोज की अपेक्षा आक्सीटोसिन की 250–500 गुना अधिक डोज दी गई। उसी रूप में दुग्ध उपभोक्ताओं के लिए महत्व नहीं रखता। डेरी पशुओं में मीथेन कम करने के लिए विभिन्न जैविक अम्लों/औषधीय (हर्बल) उत्पादों की सम्पूरण मात्रा दिखाई गई। गायों के प्रसव पश्चात् मिल्क फीवर को नियंत्रित करने के लिए एक ऐनिआनिक खनिज मिश्रण विकसित किया गया। अध्ययनों से प्रकट होता है कि प्रसव से पूर्व अवधि के दौरान गायों तथा भैंसों को विटामिन–ई की सम्पूरित मात्रा देने से थनैला रोग को नियंत्रित करने में सहायता मिलती है।

एक करन फ्रीज गाय ने अपने दूसरे दुग्ध स्त्रवण के दौरान 415 दिन की दुग्ध–स्त्रवण अवधि में 8216 कि0ग्रा0 दूध दिया।एक साहीवाल गाय ने अपने प्रथम ब्याँत के दौरान 490 दिन की दुग्ध स्त्रवण अवधि में 4339 कि0ग्रा0 दूध उत्पन्न किया। 'करनकीर्ति नामक भैंस ने एक दिन में 23.3 कि0ग्रा0 का श्रेष्ठ दुग्ध उत्पादन किया तथा अपने प्रथम ब्यॉत के दौरान 427 दिन की दुग्ध–स्त्रवण

cloning technique by producing 'Garima-II' - cloned buffalo calf originated from embryonic stem cells on **August 22, 2010** and 'Shresth'-cloned buffalo calf produced from ear somatic cells of two week old buffalo calf on **August 26, 2010**. In another project, goat embryonic stem cells were used for production of heart muscle cells. Important novel genes were identified in buffalo oocytes, which could be important for defining their functional ability. Some of these would be useful markers for selecting animals with better fertility. The regulation of buffalo aromatase gene was studied in model cell culture system using RNA interference technique. Improved protocols for freezing cattle, buffalo and goat semen with antioxidant fortification, controlled rate of freezing and induced ice nucleation were also developed.

A sensitive and specific enzyme -immunoassay for estimation of oxytocin in milk was developed. The hormone is negatively secreted in milk even when animals are administered 250-500 fold higher dose of oxytocin than the recommended dose for eliciting milk let down. As such it is not a cause of concern to milk consumers. Supplementation of various organic acids/herbal products was shown to mitigate methane in dairy animals. An anionic mineral mixture was developed for prepartum cows to control incidence of milk fever. Studies revealed that supplementation of vitamin E to cows and buffaloes during periparturient period helps control the incidence of mastitis.

A Karan Fries cow produced 8216 kg of milk in a lactation period of 415 days during her second lactation. A Sahiwal cow produced 4339 kg of milk in a lactation period of 490 days during her first lactation. Buffalo named **Karankeerti** produced a peak yield of 23.3 kg in a day and produced 4428 kg of milk in a lactation period of 427 days during her first lactation. A total of 16 Murrah bulls of VI set were evaluated and Bull No. 4506 of NDRI center achieved second rank (Sire Index – 1972 kg) with 8.90 % superiority over the herd average out of three bulls declared

अवधि में 4428 कि0ग्रा0 दूध दिया। VI सैट के कुल 16 मुर्राह सांडों का मूल्यांकन किया गया तथा राष्ट्रीय डेरी अनुसंधान संस्थान केन्द्र के सांड संख्या 4506 ने (प्रजनक सूचकांक–1972 कि0ग्रा0) दूसरा स्थान प्राप्त किया। इस सैट में से तीन सांड 8.90% श्रेष्ठता के साथ प्रजनक घोषित किये गये। गर्म तथा गर्म आर्द्र परिस्थितियों तथा प्रक्रिया के विभिन्न मापदंड़ों के अन्तर्गत उच्च उत्पादन वाली संकर गायों, भैंसों तथा बकरियों के लिए प्रबन्धन प्रक्रियाएं भी विकसित की गई।

डेरी प्रसंस्करण के क्षेत्र में इस संस्थान पर एसिडो–बिफिडस प्रोबायोटिक दही विकसित की जो कि (i) एजिंग प्रक्रिया को धीमा करती है (ii) जठरीय आन्त्रीय क्षेत्र के कैंसर से बचाती है तथा (iii) पशु माडलों में इम्यून कार्यों में संशोधन करती है। दूध में अफलाटॉक्सिन एम I की जांच के लिए एक बीजाणु अवरोध आधारित परीक्षण विकसित किया गया। संवेदी एवं विशिष्ट प्रोबस का प्रयोग करके ई0 कोलि 0157( एच 7, एल मोनो साइटोजीनस तथा सलमोनीला टाइफी जैसे अतिजोखिम वाले खाद्य रोगाणुओं की जांच के लिए यूनीप्लेक्स तथा मल्टीप्लेक्स रीयल टाइम पी.सी.आर. आधारित विधियां विकसित की गई। दूध में अपमार्जक की जांच के लिए एक नई परीक्षण विधि विकसित की गई।

एक बांइडर के रूप में केसीन का प्रयोग करते हुए एक बेक्टीरिओसिन आधारित प्रतिसूक्ष्मजीवी पैकेजिंग (ए.एम.पी.) प्रणाली विकसित की गई। इस प्रतिसूक्ष्म जीवी पैकेजिंग प्रणाली का प्रयोग करके खोआ तथा पनीर की शेल्फ लाइफ में वृद्धि की जा सकी। प्रोबायोटिक लेक्टोबेसिलि की कई स्वदेशी जातियां जिन्होंने इम्यूनो मोडुलेटरी एवं रक्त कॉलस्ट्रोल कम करने वाले गुण प्रदर्शित किए हैं वियोजित किए जा चुके हैं। यह संस्थापित किया गया कि व्हे प्रोटीन जलघटनी तथा स्ट्राबरी ने उच्च प्रतिआक्सीकारक कार्यकलाप प्रदर्शित करते हैं तथा इन्हें स्वास्थ्य लाभ के लिए स्किम मिल्क अथवा दही में मिलाया जा सकता है। (i) दुग्ध–प्रोटीन आधारित पौषणिक अम्लरोधी टिकिया (ii) दुग्ध–अनाज–मिश्रित लौह–पुष्टीकारक बिस्किट (iii) बाजरा तथा व्हे प्रोटीन सान्द्रण पर आधारित प्रोटीन से भरपूर स्नैक (iv) क्रियात्मक डोडा बरफी तथा (v) भैंस के दूध से तैयार फैटा चीज़ बनाने की प्रक्रियाएं भी विकसित की गई।

मानव संसाधन विकास में संस्थान में चालू बारह विभिन्न विषयों में मास्टर एवं डाक्टरेट पाठ्यक्रमों एवं बी.टैक (डेरी प्रौद्योगिकी) के अतिरिक्त संस्थान ने शैक्षिक वर्ष

proven in this set. Packages of management practices for high yielding crossbred cows, buffaloes and goats for hot and hot-humid conditions and under different scales of operation were also developed.

In the area of Dairy Processing, Acido-bifidus Probiotic Dahi developed at this Institute was shown to (i) retard process of ageing, (ii) protect against G.I tract cancer and (iii) improve immune functions in animal models. A spore inhibition based test for detection of aflatoxin M1 in milk was developed. Uniplex and multiplex Real Time PCR based assays were developed for detection of high risk food pathogens such as *E. coli* 0157:H7, *L. monocytogenes* and *Salmonella typhi* using sensitive and specific probes. A new test for detection of detergent in milk was developed.

A bacteriocin based antimicrobial packaging (AMP) system was developed using casein as a binder. Extension in shelf life of khoa and paneer has been achieved using this antimicrobial packaging system. A number of indigenous strains of probiotic lactobacilli, exhibiting immunomodulatory and blood cholesterol lowering properties have been isolated. It was established that whey protein hydrolysate and strawberry exhibit high antioxidant activity, and these can be incorporated in skim milk or dahi for deriving health benefits. Processes for (i) milk-protein based nutritive antacid tablets, (ii) Iron-fortified biscuits, based on a composite dairy-cereal mix, (iii) Protein-enriched puffed snack, based on pearl millet and whey-protein concentrate, (iv) functional *Doda burfi*, and *(v)* buffalo-milk Feta cheese were also developed.

In human resource development, in addition to ongoing Masters and Doctoral programmes in twelve different disciplines and B. Tech. (Dairy Technology), the Institute also started **M.Sc. in Forage Production** from the academic year 2010-2011. The academic session 2010-11 also attracted several international students for training and education in Dairying. A total no. of **21 foreign students** is currently on rolls in different programmes being

2010–11 से चारा उत्पादन में एम.एससी. भी प्रारम्भ की है। शैक्षणिक सत्र 2010–11 ने डेयरिंग के क्षेत्र में शिक्षण एवं प्रशिक्षण के लिए कई अन्तर्राष्ट्रीय छात्रों को भी आकर्षित किया है। इस समय राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय द्वारा चलाए जा रहे विभिन्न पाठयक्रमों में कुल 21 विदेशी छात्र अध्ययन कर रहे हैं। क्षेत्रीय केन्द्रों की गतिविधियों को सुदृढ़ करने के लिए तथा केन्द्रों पर उपलब्ध विशेषज्ञों/ अनुसंधान एवं शिक्षण सुविधाओं का उपयोग करने के लिए छात्रों को क्षेत्रीय केन्द्रों पर अपने शोध निबन्ध पूरे करने के लिए प्रतिनियुक्त किया गया। रिपोर्टाधीन अवधि के दौरान शैक्षिक विनियम भी संशोधित किए गए जिसमें सबसे महत्वपूर्ण एम.एससी./एम.वी.एससी. छात्रों के लिए परिज्ञान परीक्षा प्रारम्भ करना था। पीएच.डी के लिए प्रवेश प्रक्रिया में सुधार किए गए। वर्ष 2011–12 से पीएच.डी. पाठ्यक्रमों में सेवारत अभ्यर्थियों के प्रवेश हेतु लिखित प्रवेश परीक्षा तथा काऊंसलिंग रखी गई।

राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय की शैक्षिक उपलब्धियों को केन्द्रित तथा पुनरावलोकन करने के लिए दिनांक 14–19 फरवरी 2011 तक शैक्षिक सप्ताह मनाया गया। दीक्षांत समारोह वार्षिक शैक्षिक कैलेन्डर का हिस्सा बनाया गया। तदनुसार राष्ट्रीय डेरी अनुसंधान संस्थान का नवम् दीक्षान्त समारोह 19 फरवरी, 2011 को आयोजित किया गया। पदमभूषण डा0 रामबदन सिंह, अध्यक्ष, राष्ट्रीय कृषि विज्ञान अकादमी (एन.ए.ए.एस.) ने दीक्षान्त भाषण दिया तथा श्री अशोक सिन्हा, सचिव, खाद्य प्रसंस्करण मंत्रालय, भारत सरकार ने समारोह की अध्यक्षता की। अनुसंधान कार्य की गुणवत्ता में सुधार एवं प्रतिस्पर्धा की भावना को प्रोत्साहित करने के लिए मास्टर एवं डाक्टरेट छात्रों के लिए 'सर्वश्रेष्ठ थीसिस पुरस्कार' प्रदान किया गया। राष्ट्रीय डेरी अनुसंधान संस्थान के चहुंमुखी विकास के लिए स्वर्गीय डा0 डी0 सुन्दरेसन के बहुमूल्य योगदान की स्मृति में डा0 डी0 सुन्दरेसन स्मारक व्याख्यान पुरस्कार डा0 मंगलाराय, भूतपूर्व सचिव, डेयर एवं महानिदेशक भारतीय कृषि अनुसंधान परिषद् को दिनांक 17 फरवरी 2011 को दिया गया।

राष्ट्रीय डेरी अनुसंधान संस्थान में पहली बार एक नई एन.सी.सी. बटालियन संस्थापित की गई। बी.टैक प्रथम वर्ष के छात्रों के लिए एन.सी.सी. अनिवार्य की गई। इस योजना के अन्तर्गत, छात्र बी. प्रमाणपत्र परीक्षा के लिए बैठे, उन्होंने एन.सी.सी. ड्रिल में नियमित रूप से भाग

offered by NDRI Deemed University. In order to strengthen the activities of the Regional Stations and use the research and teaching facilities/expertise available at the stations, students were deputed to carry out their Dissertations at the regional stations. In the period under report, academic Regulations were also revised, which include most importantly the introduction of comprehensive examination for MSc/MVSc students. Reforms in the Admission Process for Ph. D. have been introduced. From the year 2011-2012, admission for the in-service candidates in Ph.D. Courses would be done through written Entrance examination as well as counseling.

Academic Week was celebrated from 14th -19th February 2011, to revisit and review the academic achievements of NDRI Deemed University. **Convocation** was made a part of the Annual Academic Calendar. Accordingly, the 9th Convocation of NDRI was held on 19th February 2011. Padam Bhushan Dr Ram Badan Singh, President National Academy of Agricultural Sciences (NAAS) delivered the convocation address and Sh Ashok Sinha, Secretary Ministry of Food Processing Industries, Govt. of India presided over the convocation. **"Best Thesis Awards"** were given to Master's and Doctoral students to encourage the spirit of competition and motivation for quality research work. **Dr D. Sundaresan Memorial Lecture Award** to commemorate the valuable contributions of Late Dr D. Sundaresan for all round development of NDRI was given to Dr Mangala Rai, Former Secretary DARE and Director General ICAR, on 17th February 2011.

For the first time, a new NCC Battalion was established at NDRI. NCC was made compulsory for the B. Tech. first year students. Under this scheme, students appeared for B Certificate exam, attended NCC drills regularly and also participated in NCC camp held at Haryana Police Commando Complex, Navel, Karnal. Research scholars at NDRI were encouraged to apply for INSPIRE fellowship instituted for Topper students by Dept. of Science and Technology. Five

लिया तथा हरियाणा पुलिस कमांडो परिसर, नेवल, करनाल पर आयोजित एन.सी.सी. कैम्प में भी भाग लिया। राष्ट्रीय डेरी अनुसंधान संस्थान के शोध छात्रों को विज्ञान एवं प्रौद्योगिकी विभाग द्वारा सर्वश्रेष्ठ छात्रों के लिए प्रारम्भ की गई 'इन्सपायर' छात्रवृति हेतु आवेदन करने के लिए प्रोत्साहित किया गया। वर्ष 2010–11 के दौरान पांच छात्रों ने यह छात्रवृति प्राप्त की। रिपोर्टाधीन अवधि के अन्तर्गत राष्ट्रीय डेरी अनुसंधान संस्थान, राष्ट्रीय ज्ञान नैटवर्क, भारत सरकार के लिए एक प्रमुख केन्द्र (नोड) के रूप में मान्य हुआ। इंटरनेट सम्पर्कता (कनैक्टिविटी)। जी.बी.गति इस योजना के अन्तर्गत प्रदान की गई। शोधछात्रों में ज्ञान संचार/सूचना प्रसारण के उद्देश्य से छात्रों के छात्रावास मे डब्ल्यू आई–एफ आई इन्टरनेट सम्पर्कता संस्थापित करने के कार्यालय आदेश जारी किए गए हैं। मान्य विश्वविद्यालय की अतिरिक्त छात्राओं को आवास देने हेतु 'ए' टाइप के खाली आवासों को 'अल्कनन्दा सदन' छात्रा छात्रावास में परिवर्तित किया गया। संस्थान परिसर में छात्रों के छात्रावास तथा लड़कों के छात्रावास निर्माण हेतु 1 करोड़ 90 लाख के एक अन्य प्रस्ताव को अन्तिम रूप दिया गया है।

'कृत्रिम प्रजनन अनुसंधान केन्द्र' (ए.बी.आर.सी.) पर जननद्रव्य ज्ञान प्रयोगशाला, गुणवत्ता नियंत्रण प्रयोगशाला, लांग रेंज ओपन बुल व्यायाम क्षेत्र तथा मिस्ट कूलिंग प्रणाली जैसी नवीन सुविधाओं का सृजन प्रजनन सांडों में ऊर्जा दाब को कम करने के लिए किया गया है। इसी प्रकार सन्तति परीक्षण, नर पशुओं का वैज्ञानिक प्रबन्धन, जननद्रव्य का संग्रहण एवं क्रायोसंरक्षण (वीर्य प्रसंस्करण) गोपशुओं तथा भैंसों के श्रेष्ठ जनन द्रव्य का प्रसारण तथा पशु प्रजनन, पुनरूपादन प्रबन्धन एवं प्रशीतित वीर्य प्रौद्योगिकी पर उन्नत प्रशिक्षण प्रदान करना, द्वारा डेरी पशुओं तथा झोटों के आनुवांशिक मूल्यांकन के लिए सुविधाओं को सुदृढ़ किया गया। कृषि वैज्ञानिक भर्ती मंडल के तत्वाधान में छात्रों को प्रवेश परीक्षा के लिए राष्ट्रीय डेरी अनुसंधान संस्थान मान्य विश्वविद्यालय पर आन–लाइन परीक्षा प्रणाली के लिए संरचनात्मक सुविधा सृजित की गई है। नई सुविधाओं तथा संरचनात्मक विकास के कुछ प्रमुख क्रियाकलाप में खेल के स्टेडियम की मरम्मत, प्रशासनिक ब्लाक तथा निदेशक सम्मेलन कक्ष की मरम्मत, पुस्तकालय की मरम्मत एवं नवीकरण सतलुज एवं कृष्णा छात्रावासों का नवीकरण, पशुजैवप्रौद्योगिकी केन्द्र, डेरी प्रौद्योगिकी प्रभाग, डेरी सूक्ष्मजीव विज्ञान प्रभाग तथा डेरी

students of NDRI availed this fellowship during 2010-2011. During the period under report, NDRI was recognized as a node for National Knowledge Network, Govt. of India. Internet connectivity of 1 GB speed has been provided under this scheme. Work order has been placed for installation of Wi- Fi internet connectivity in the Students hostels to facilitate information/knowledge sharing amongst the scholars. Girls' Hostel "Alakhnanda Sadan" was created by converting vacant 'A' Type Residences to a hostel to accommodate additional strength of girl students at Deemed University. Another proposal of Rs. 1 crore 90 lakhs has been finalized for construction of Girls Hostel and a Boys hostel at the Institute premises.

New facilities such as Germplasm Information Laboratory, Semen Quality Control Laboratory, Long range Open Bull Exercising Zone and Mist cooling system for reducing heat stress to breeding bulls were created at "Artificial Breeding Research Centre" (ABRC). Likewise, facilities were strengthened for genetic evaluation of dairy cattle and buffalo bulls through progeny testing, scientific management of male animals, cryopreservation and storage of germplasm; semen processing; dissemination of superior germplasm of cattle and buffaloes, and providing advance training on animal breeding, reproduction management and frozen semen technology. Under the aegis of Agricultural Scientists Recruitment Board, infrastructure has also been created at NDRI Deemed University for on-line examination system for the admission of students. Some of the major activities undertaken towards creation of new facilities and infrastructure development included: Renovation of Sports Stadium, renovation of administrative block and director's conference room, renovation and upgradation of library, renovation of Satluj and Krishna hostels, furnishing and upgradation of labs in animal biotechnology centre, and of divisions of dairy technology, dairy microbiology and dairy cattle nutrition, fencing of the premises of international hostel, and carpeting of approach roads to campus and farm section.

पशु पोषण प्रभाग की प्रयोगशालाओं का आधुनिकीकरण, अन्तर्राष्ट्रीय छात्रावास के परिसर की चारदिवारी तथा परिसर एवं फार्म अनुभाग को जाने वाली सड़क का निर्माण कार्य आदि सम्मिलित हैं।

प्रसार शिक्षण कार्यक्रम 'कृषकों के द्वार पर डेरी शिक्षण' जारी रहा जबकि वैज्ञानिकों ने गाँवों का दौरा किया, वे कृषकों से मिले, उन्हें परामर्श दिया तथा उनके परिसर पर ही उनकी समस्याओं का समाधान करने का प्रयास किया। इस कार्यक्रम ने कृषक समुदाय में डेरी उत्पादन एवं डेरी प्रसंस्करण क्षेत्र की प्रौद्योगिकियों को प्रभावी ढंग से प्रसारित किया है। संस्थान द्वारा विकसित विभिन्न प्रौद्योगिकियों को हस्तान्तरित करने के लिए अपनाए गए गाँवों में कुल 53 किसान संगोष्ठियां आयोजित की गई। कृषकों को प्रजनन प्रबन्धन तकनीकियों, थनैला नियंत्रण, रोगों से बचाव के तरीकों तथा चारा उत्पादन के बारे में जागरूक बनाया। कृषि विज्ञान केन्द्र/डेरी प्रशिक्षण केन्द्र ने 282 प्रशिक्षण कार्यक्रम (परिसर के अन्दर तथा बाहर दोनों) आयोजित किए गए। यह कार्यक्रम डेरी उत्पादन, डेरी प्रसंस्करण, कृषि, कृमि संवर्धन, मधुमक्खी पालन, मत्स्यपालन तथा गृहविज्ञान के विभिन्न पहलुओं पर आधारित थे। इनमें कुल 786 प्रशिक्षणार्थियों ने भाग लिया। रिपोर्टाधीन अवधि के दौरान तकनीकी जानकारी एवं परामर्श सेवा प्राप्त करने के लिए 21040 कृषक, कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक) में आए।

वर्ष 2010–11 की अन्य उल्लेखनीय उपलब्धियाँ संस्थान के संकाय के लिए अनुसंधान, शिक्षण एवं संस्थान निर्माण क्रियाकलापों के क्षेत्र में उनके बहुमूल्य योगदान के लिए डा0 डी0 सुन्दरेसन पुरस्कार, डा0 एन.एन.दस्तूर पुरस्कार, डा0 के.के.अय्या पुरस्कार, डा0 पी.जी.नैय्यर पुरस्कार जैसे कई छात्र पुरस्कारों प्रदान करना था। राष्ट्रीय डेरी अनुसंधान संस्थान पर डेरी शिक्षण एवं अनुसंधान संबंधित विभिन्न मामलों पर नीति संबंधी पत्र (पोलिसी पेपर) विकसित करने के लिए तथा एक 'थिंक टैंक' के रूप में कार्य करने के लिए 'राष्ट्रीय डेरी विज्ञान अकादमी' की संस्थापना 1 जून 2010 को की गई। इस अकादमी का उद्देश्य डेयरिंग संबंधित मामलों पर वैज्ञानिक समुदाय के विचार प्रस्तुत करना तथा वैज्ञानिक एवं प्रौद्योगिकीय प्रतिभा को उन्नत एवं प्रोत्साहित करना तथा राष्ट्रीय अर्थव्यवस्था के विकास के लिए डेरी उद्योग संबंधित ज्ञान को विकसित करने में शक्तिशाली साधन बनाना है। संस्थान की एक नई वीडियो फिल्म 'रा0डे0अनु0सं0–एक झलक' की संकल्पना एवं प्रदर्शन किया गया। उसी तरह, विगत 88 शानदार वर्षों की

The Extension Education Programme "Dairy Education at Farmers' Door" was continued wherein scientists visited villages, met farmers, advised them and tried to solve their problems at their premises. This programme has strengthened the effective dissemination of technologies of dairy production and processing among farming community. A total no. of 53 Kisan Sangoshties were organised in the adopted villages for transfer of technologies, developed by the Institute. Farmers were made aware about the reproductive management practices, mastitis control, disease preventive measures and fodder production. KVK/DTC organized 282 training programmes (both on and off campus) participated by 7861 trainees on different aspects of Dairy Production, Dairy Processing, Agriculture, Vermicompost, Bee-keeping, Fisheries and Home Science. During the period under report, 21040 farmers visited Agriculture Technology Centre (ATIC) for obtaining technical information and advisory services.

Another notable feature of the year 2010-11 was the conferment of several Alumni Awards such as Dr D. Sundaresan Award, Dr. N. N Dastur Award, Dr. K. K. Iya Award, Dr. P G. Nair Award to the faculty for their outstanding contribution in the field of research, education and Institute building activities. National Academy of Dairy Sciences was launched on 1st June 2010 at NDRI to work as a "Think Tank" and develop policy papers on different issues related to dairy education & research. The mission of the Academy is to provide views of the scientific community on dairying related issues, and to encourage and promote scientific and technological talent, making it a powerful instrument in fostering knowledge based vibrant dairy industry for the growth of national economy. A new Video Film of the Institute "NDRI at a Glance" was conceptualized and produced. Likewise, a landmark publication chronicling the achievements of NDRI during the past 88 glorious years was published.

संस्थान की उपलब्धियों को एक ऐतिहासिक प्रकाशन के रूप में प्रकाशित किया गया।

मैं आशा करता हूँ कि यह प्रकाशन वैज्ञानिक/शैक्षणिक संस्थानों के विद्वानों तथा डेरी विकास संगठनों से जुड़ें व्यवसायियों के लिए सूचना का अमूल्य स्त्रोत होगा।

यह मेरा परम सौभाग्य है कि मैं इस कार्य से जुड़े संयुक्त निदेशकों, प्रभागाध्यक्षों, संकाय अधिकारियोंएंव कर्मचारियों 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।

I sincerely hope that this report would serve as a source of valuable information to the professionals of the Scientific/Academic Institutions and other Dairy Development Organisations in the country. Here I feel privileged to acknowledge and place on record the contributions made by Joint Directors, Heads of Divisions, faculty, Officers and the Staff. I am sure that with their persistent support and efforts, we would be able to march ahead in fulfilling the mandate and objectives of NDRI with earnest zeal and responsibility and bring success and glory to the Institute in the years to come.

Srivastava

**(A. K. Srivastava)**

# EXECUTIVE SUMMARY

National Dairy Research Institute is the premier research organization of the Nation dedicated for providing Research & 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&D activities viz. i) Dairy Production, ii) Dairy Processing and iii) Dairy Extension / Management. All the R&D activities are managed through twelve Research Divisions/ Sections, namely, Dairy Cattle Breeding, Livestock Production and Management, Dairy Cattle Nutrition, 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 & Dairy Training Centre and Animal Breeding Research Centre. The Institute has infrastructure consisting of central facilities such as Livestock Farm, Fodder Farm, 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. finance, purchase, stores, establishment, official language and security are under the administrative control of the Joint Director (Admn.) & Registrar. The Institute presently has strength of 149 scientists, 313 technicians, 142 administrative and 662 skilled supporting staff.

## BUDGET OUTLAY

The total budget of the Institute in terms of actual expenditure for Plan and Non-plan for the year 2010-2011 was Rs. 11265.69 lakhs and budget sanctioned for the year 2010-2011 was Rs. 11283.88 lakhs, respectively. These figures include the financial outlays for the strengthening of Deemed University and KVK also.

## RESEARCH

A total number of 82 in-house research projects were in operation during the year 2010. In order to strengthen basic and strategic research, World Bank through NAIP has funded several research projects in consortium mode wherein NDRI is either the Lead Institute or consortium Partner. Under NAIP, twenty projects with an outlay of approximately Rs. 34 crores continued during the year 2010-11. Many of the research programmes have Inter-institutional linkages with Dept. of Biotechnology (DBT), National Bureau of Agriculturally Important Microorganisms (NBAIM), National Communication to United Nations Framework Convention on Climate Change (NATCOM-UNFCC), Indo-US-Agricultural Knowledge Initiative (AKI), Ministry of Food Processing Industries, State Agricultural Universities (SAUs) and State Development Departments at the National level.

**Some of the salient achievements of research during the period under report are as under:**

- After the breakthrough in the history of NDRI i.e. the production of world's first cloned buffalo calf 'Garima' in June 2009 through development of the land mark indigenous technique called Hand guided cloning technique, the Institute made further advancements in the cloning technique by producing Garima – II cloned buffalo calf originated from embryonic stem

*Cloned buffalo calf 'Garima-II' born on August 22, 2010*

cell on August 22, 2010 and a male cloned buffalo calf named 'Shreshtha' produced from ear somatic cells of two week old buffalo calf on August 26, 2010.

- A system, which included supplementation of the culture medium with bFGF and LIF, was developed for the culture of buffalo embryonic stem cells.
- Interspecies blastocyst stage embryos were produced by Hand guided cloning using buffalo cytoplasts and differentiated somatic cells from cattle and goat.
- Zona-free buffalo oocytes were successfully activated for parthenogenetic development for producing blastocyst stage embryos using chemical or electrical stimulation.
- Cloning efficiency was improved by increasing cytoplasm volume or by treatment of embryos with an epigenetic modifier scriptaid.
- Some developmentally important genes viz. Bcl-xl, Bax, Glut-1 and HSP 70.1 were found to be differentially expressed in cloned and IVF-derived embryos.
- Cardiomyocytes exhibiting rhythmic beating were generated from IVF goat ES cells.
- More than 30 oocyte specific novel genes identified in buffalo, some of them could have important role in imparting competence to oocytes.
- Single blastomere sexing of goat embryos carried out by PCR amplification of the SRY gene.
- Epigenetic changes in H19 DMR of sperm DNA was found to be significantly related to fertility of breeding bulls in crossbred cattle.
- Five Y chromosomal genes were cloned and sequencing is in process.
- Bovine Y chromosomal haplotyping method was developed based on Y chromosome based SNPs and indel markers.
- Fragile-X chromosomes were found in reproductively deficient animals. Different TC media were tested for revelation of Fragile-X. DNA primers confirmed the presence of fragile-X chromosomes.
- A total of 253 Sahiwal and 200 KF cattle of NDRI revealed single band of 244 bp of Factor XI gene (Exon 12) indicating that the herds are Monomorphic for FXI gene. Only one non synonymous nucleotide change from G to A at position in 105 was observed resulting into a change of amino acid in second codon from Arginine (R) in *Bos taurus* to Glutamine (Q) in Sahiwal and Karan Fries cattle.
- The 382 bp fragments of exon 3 of TLR 4 gene revealed genetic polymorphism in 190 lactating Sahiwal cattle by PCR-RFLP using *Alu* I restroiction enzyme. The genotypic frequencies for AA, AB and BB were 0.01, 0.61 and 0.37, respectively. T-C Single Nucleotide Polymorphism was identified at nucleotide 2335 bp in exon 3 of TLR 4 gene of AB genotyped animals.
- A total of 16 Murrah male calves were reserved during 2010-11 on the basis of Expected Predicted Difference (EPD) and dam's best days lactation yield, breed characteristics and physical conformity for selection of young male calves for future breeding. The dam's best 305 days lactation milk yield of reserved males ranged from 2542 to 3862 kg. The EPD and superiority of reserved Murrah male calves ranged from 34 to 402 kg and 1.85 to 18.63 %, respectively.
- About 34.40 % elite Murrah buffaloes were identified for the establishment of nucleus-breeding herd.
- The optimum models for prediction of breeding efficiency of Murrah buffaloes were developed with accuracy of prediction ranging from 70.21 to 85.09 %. Indices of breeding efficiency of Murrah buffaloes were also developed for retaining and disposal of buffaloes in the herd.
- Bull No. 4915 of NDRI Center having sire index of 2116 kg and dam's best lactation 305 days milk yield of 3437 kg was declared as best proven bull with 17.26 % superiority out of twelve bulls progeny tested in the VII set under Network Project on Buffalo Improvement.
- A total of 2810 AIs were performed in Murrah Buffaloes under field conditions and as a result 41.53 % conception rate was obtained. A total of 1045 (566 male and 479 female) Murrah buffalo calves were born in the farmers' herds and performance data on 782 buffaloes were recorded for evaluation of bulls. The total herd strength of registered females and the breedable females at different centers was 5664 and 4380, respectively. As many as 13 breeding bulls belonging to the 11$^{th}$ set were used for AI during the year.

- Twenty nine 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 between 4549-8338 kg. The EPD of selected male calves ranged between 1.57 and 18.44 %.

- A total of 3070 A.I were performed in KF and as a result 47.9 % conception rate was obtained under field conditions up to December, 2010. A total of 1086 (560 males and 526 females) KF calves were born in the farmers' herds and performance data on 863 Karan Fries were recorded for evaluation of bulls under field conditions.

- Seventeen Sahiwal 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 Sahiwal males ranged from 2425 (1$^{st}$ lactation) - 3811 kg.

- Higher accuracy of prediction (>92%) of FL305DMY from the optimum equation incorporating test day milk yields (35$^{th}$, 65$^{th}$, 125$^{th}$, 185$^{th}$ and 275$^{th}$ day) revealed that these test day milk yields can be used to predict FL305DMY with higher degree of accuracy in Sahiwal cattle.

- The relative efficiency of selection on the basis of part lactation milk yields over FL305DMY was though lesser, yet comparable, in Sahiwal cattle. Selection on the basis of individual third month milk yield and cumulative 90 days milk yield was 89% and 79% as effective as on the basis of FL305DMY.

- The multiple regression analysis was considered as the best method for prediction of FL305DMY with higher accuracy of prediction on the basis of individual monthly milk yields and cumulative monthly milk yields up to 6$^{th}$ months as compared to other methods namely ratio method, simple regression and modified regression method in Sahiwal cattle.

- The DFREML method was adjudged as the most efficient and accurate method of sire evaluation among the four methods (least squares, simple regressed least squares and BLUP) used in Sahiwal cattle. The single trait DFREML was more efficient than multi trait DFREML for estimating the breeding value of Sahiwal sires for FL305DMY, individual third month milk yield and cumulative 90 days milk yield.

- Molecular characterization of BoLA-DRB3.2 alleles in 107 DNA samples were screened in Malnad gidda cattle. The 2 new BoLA DRB3.2 alleles identified namely DRB3.2*a*aa (*5702) and DRB3*u*bi (*2503) were observed with a frequency of 9.346% and 2.04% respectively. Four novel alleles namely DBR3*caf, *eaf, *abb, *pad with each having the frequency of 0.7% were observed in Deoni breed.

- The study on production performance of graded HF and HF crosses belonging to sixty dairy farmers including five commercial dairy farmers from Bangalore, Kolar and adjoining districts was carried out. The study also included evaluation of performances of graded HFs in 14 commercial herds of Punjab where better housing and feeding inputs were provided.

- Use of *Acacia nilotica* pods in cattle ration revealed that considerable improvement in nutritive value of ration could be obtained in term of nutrients intake, utilisation and performance of the animals. The uptake of total amino acids in the body enhanced significantly which, in turn, increased the overall performance of the animals.

- The use of babul pods or extracted tannins from babul pods in the ration of rats indicated reduction in body weight, blood glucose, serum cholesterol, triglycerides. It increased the concentration of insulin and immunity status.

- Combinations like garlic + fumaric acid and garlic + myristic showed up to 38% reduction in methane in wheat straw based complete diets under *in vivo* conditions.

- The practical application of the heatsynch protocol for fertility improvement in buffaloes suffering from ovarian reproductive disorders was successfully demonstrated.

- Exfoliated milk epithelial cells were successfully isolated and cultured for 30 days from the milk of Murrah buffaloes.

- Neutrophilic and lymphocyte proliferation activity was high in Vitamin E, Copper and Zinc supplemented Sahiwal cows as compared to control cows around calving.

- Feeding of Vitamin E reduced the effect of thermal stress in Murrah buffaloes.

- Supplementing *Saccharomyces cervisie* probiotic to post weaned growing KF calves with low

body weight exhibited improvement in growth performance and health status.

- Using experimental models, it was established that 'probiotic dahi' improves immune functions and slows down the process of ageing.
- The antioxidant status, immune function and expressions of ageing biomarker genes were studied in 4, 12 and 16 months old mice for understanding changes linked to ageing.
- Acido-bifidus probiotic Dahi developed reversed age-induced immune and other biochemical deregulation in experimental mouse. It decreased oxidative damage (TBARS and carbonyl proteins) and expression of heme oxygenase-1. It improved tissue antioxidant status (catalase and superoxide dismutase), macrophage functions (reactive oxygen species, interleukin IL-6 and phagocytic activity and decrease in $PGE_2$ production).
- Caseinophosphopeptides isolated from cow and buffalo milk, enhanced both systemic as well as mucosal immunity and exhibited protective effect against ovalbumin induced IgE mediated allergy in experimental mouse. The osteogenic potential of casein hydrolysate was also established.
- Comparative studies on hyperimmune properties of milk in mouse model revealed 1.8 fold higher ($P \leq 0.05$) titer of anti-cow β-Lactoglobulin (LG) IgE as compared to anti- buffalo β-LG .
- Protective role of feeding diets supplemented with beta-glucan (prebiotic) / milk fermented with *L. casei* (probiotic) was demonstrated through total fecal bacterial counts and histopathological changes in intestinal tissue in ovalbumin induced mice allergy model.
- A significant difference in body weights and cumulative body weight gains was observed by supplementation of high fat diet (HFD) with prebiotic fibers (inulin and β-glucan) as compared to control animals (HFD mice). β-Glucan feeding exhibited lower neuronal activation in different appetite centers of brain in comparison to inulin suggesting a higher satiating effect of β-glucan consumption.
- A new method was developed to prepare stable gold nanoparticles (GMPs). As compared GMPs prepared by citrate reduction method, GMP prepared by new method provided nearly 5 fold more stability towards NaCl.
- Scanning electron microscopy of buffalo spermatozoa loaded with Europium oxide nanoparticles revealed their attachment to membrane surface as well as their entry in the head and tail of spermatozoa. Dose dependent increase in DNA damage with nanoparticles was also observed by sperm chromatin dispersion test.
- The fertility of cryopreserved buffalo spermatozoa was improved in presence of additives like Taurine, Trehalose as assessed by *in vitro* capacitation & *in vitro* fertilization methods. The apoptotic changes in buffalo spermatozoa contributed significantly towards cell death in addition to necrotic cell death.
- The Serine/Threonine protein phosphatase PP-1 alpha catalytic subunit and membrane metallo endopeptidase like $1^C$ were identified as tyrosine phosphorylated substrates for the first time during *in vitro* capacitation of mammalian spermatozoa.
- *Cyp19* gene was differentially expressed and regulated in promoter specific manner in large follicle, follicular cyst and luteal cyst in buffalo. A novel single nucleotide polymorphism (SNP) in proximal promoter region, at position -135 from translation start site was identified and its association in late maturity studied.
- Tissue specific proximal promoter (PII) in ovary was identified, amplified, cloned and sequenced. Involvement of this promoter in the regulation of ovary during folliculogenesis and luteinization was established. PII was found to be epigenetic (hypermethylation), switched off during luteinization. While distal promoter (PI.1) was found to be the major promoter responsible for *Cyp19* gene expression in buffalo placenta and differences in the methylation status of PI.1 coincided with *Cyp19* gene expression in buffalo placenta of different stages of gestation.
- A process was standardized to increase the stability of probiotic organisms by co-microencapsulation with matrix material and prebiotics.
- Processes were developed for health/nutraceutical foods such as nutritive antacid tablets, functional Doda-burfi, Iron-fortified dairy-and-cereal based biscuits, whey protein-and-pearl millet based extruder snack, dietary supplement for diabetics, etc.
- The antihyperlipidemic effects of Arjuna herbal ghee were tested, in animal model.
- Suitability of incorporation of Vidarikand (*Pueraria tuberose*) herb extract in milk was examined.

- A rural milk processing unit (Anmol Mahila Dugdh Samiti, Amritpurkalan) was established under the ownership of Women Self-Help-Group (SHG) to enrich rural livelihood with dairying.
- A process for whey drink was developed from both protein and lactose hydrolyzed whey with 8% sugar, 1% starch and 4% mango pulp, which was acceptable for the consumers. Thermization of whey drinks at $65^0$C for 10 min showed an increased shelf life of the product.
- A method was standardized for the preparation of ready to reconstitute payasam dry mix incorporating ground green gram dal and poppy seeds and skim milk powder at SRS, Bangalore.
- Extracts of some of the vegetables and fruits were used in the preparation of buttermilk drinks for enhanced health benefits. Thermization and carbonation of buttermilk drinks helped to extend the shelf-life of the buttermilk drinks.
- The kinetics of colour changes in *gulabjamun* during deep-fat frying, including order of reaction, reaction rate constants and temperature dependence was found to be important for maximizing quality and minimizing losses.
- The incorporation of WPHs in the skim milk (1 to 2%) raised its antioxidant activity by four fold and ACE inhibitory activity by 35 times as compared to skim milk.
- The incorporation of WPHs in the ice-cream (@1 percent raised its antioxidant activity by 55% and over-run was 26.6% times higher than that of control.
- The antioxidant activity of strawberry fortified dahi was enhanced three fold as compared to control.
- The whey fraction of fermented skimmed milk showed radical scavenging activity 0.12 to 0.49 mMol $L^{-1}$ Trolox equivalent antioxidant capacity (TEAC).
- A method was standardized for isolation of GMP from buffalo milk, with the yield corresponding to 103 mg/L of cheese whey.
- Toned milk was fortified with calcium, iron and vitamin A individually.
- Technology was developed for buffalo skimmed colostrum powder based on freeze drying.
- A simple colour test was developed for detection of melamine in milk using gold nanoparticle with the detection limit in milk 100-200 ppm.
- A bacteriocin based antimicrobial packaging (AMP) system was developed using casein as a binder. Shelf life extension of khoa and paneer was achieved using such an AMP system.
- Indigenous *lactobacillus* isolates significantly ($P<0.001$) upregulated the expression of GPx-1 ranging from 3.310 to 10.083 folds under oxidative stress conditions.
- Cholesterol assimilation from the broth by different indigenous putative probiotic lactobacillus cultures ranged from $7.6 \pm 0.84$ to $69.27 \pm 0.38$ µg/ml.
- Two of putative indigenous lactobacillus strains Lp9 and Lp91 triggered a strong immuno-modulating response on pre treating HT-29 cells with probiotics followed by LPS challenge.
- Cost effective whey based broth media, yielding equivalent growth of *Lactobacillus casei* NCDC 17, 298 to MRS broth, was formulated. The media can be used for production of lactobacilli biomass.
- Antimicrobial Bioactive peptides (<10 kDa) were produced from whey protein and casein by fermentation with proteolytic Lactobacilli. These AMPs had bactericidal activity against Gram positive (*B. cereus*) and Gram negative (*Salmonella typhi, Shigella dysantriae* and *E. coli*) bacteria.
- A novel reduced calorie naturally carbonated fermented milk beverage using a native strain of *Leuconostoc* spp. was developed.
- A cost effective technology was developed for mannitol production from whey using a mutant strain of *Leuconostoc* spp.
- A real time process (Patent Reg#3064/DEL/2010) for monitoring Aflatoxin M1 in milk using Spore Inhibition Based - Enzyme Substrate Assay (SIB-ESA) was developed for its application as quality control test at collection points, chilling centre, manufacturing units as well as R &D institutions.
- ESA (Enzyme Substrate Assay) developed was found to be capable of detecting 2.67, 3.50, 4.25 and 4.8 log counts of enterococci within incubation period of 12, 7½, 6½ and 5 hr, respectively.

- Diversity studies on rumen methanogens in Murrah buffaloes using 16S rRNA gene indicated the dominance of *Methanobrevibacter* spp., followed by *Methanomicrobium mobile* in northern India.

- Anaerobic rumen fungi, *Orpinomyces joyonii* was found to produce maximum p-coumeryl and feruloyl esterases, suggesting towards their lingo-cellulolytic activity in rumen.

- One of the isolates namely *Lactobacillus rhamnosus* D7 was found to be the most potent soy isoflavone bio-transformer.

- Technologies for the production of probiotic dahi with enhanced shelf life, direct vat set probiotic cultures, synbiotic misti dahi and yoghurt were developed. The mixed probiotic culture formulation exhibited antimicrobial activity against food spoilage and pathogenic organisms.

- Cumulative SUM (CUSUM) analysis of the actual energy consumption data against the computed baseline energy use for the selected dairy plant established that the plant presented a case for implementation of energy monitoring and targeting system. The system support required for developing the targets during onsite monitoring was also developed on MS Excel Sheets. Preliminary testing of the same was completed and was being updated as real time data were recorded.

- A survey study revealed that cost per litre of milk production in Ahmednagar District of Maharashtra from crossbred milch cattle was Rs.12.49, Rs.12.58 and Rs.11.48 for small, medium and large farms respectively. The net returns over cost per litre of cow milk were Rs.2.08. Of the total milk produced marketed surplus constituted 94.48, 94.81 and 96.96% for small, medium and large commercial farms.

- The economic analysis of rural and peri-urban dairy farms in Ludhiana District of Punjab found that annual daily net maintenance cost per milking buffalo on rural and peri-urban dairy farms was Rs.141.10 and Rs.151.06, respectively. The annual daily net maintenance cost per milking crossbred cattle on rural and peri-urban dairy farms were Rs.145.18 and Rs.155.61, respectively. The average employment generated from dairying on rural and peri-urban dairy farms was 313.22 and 1450.88 man days per year, respectively.

- The quantities of green fodder, dry fodder and concentrates consumed per day by buffalo in Dharampuri and Thruvannamalai Districts of Tamil Nadu were found to be 11.12, 5.98, 5.24 kg. The overall maintenance cost of dairy herd was Rs.392.5 per day. The overall maintenance cost per crossbred cow per day was Rs.51.29.

- Economic analysis of institutional credit for dairy farming in Shimoga milk zone of Karnataka found that Commercial Banks (CBs) contributed 81% of the dairy credit, followed by Regional Rural Banks (RRBs) 14% and Cooperative Banks 5%. On an average only 36% of the credit was utilised for purchasing animals and the rest was diverted for other uses.

- Study on value chain analysis of milk in high hills temperate Wet Zone of Himachal Pradesh found that the cost of milk collection, transportation and chilling at Milk Chilling Centre, Sarahan (Nahan) was Rs.1.58, Rs.2.03 and Rs.0.43 per litre, respectively. The total variable cost of manufacturing standard milk, toned milk and double toned milk was Rs.20.19, Rs.18.76 and Rs.18.95 per litre, respectively.

- The impact study of policy reforms on livelihoods in dairy value chains revealed that during the period from 1960-61 to 2002-03, the marginal categories of household operational holdings raised from 58% to 79%. It was also found that in the first phase of 'Operation Flood' (1970-1980) growth rate of value added products was 0.93% per annum, while in the third phase (1985-1996), it increased to 9.10% per annum. During the period from 1994-95 to 2000-01 in the unorganised sector, newer value added dairy products like cheese, curd and ice cream manufacturing registered a positive growth while that of highly traditional products, *viz.*, Butter, Cream, Ghee and Butter milk registered a negative growth.

- The study on analysis of performance appraisal of dairy products manufacturing enterprises in India revealed that the number of unorganised dairy manufacturing units declined from 1,40,836 in 1994-95 to 1,27,069 in 2005-06, while that of organised units increased from 563 to 1049 during the same period. The unorganised rural enterprises were highly concentrated in West Bengal, Uttar Pradesh (U.P.) and Gujarat, while the unorganised urban enterprises were concentrated in U.P., Rajasthan and Andhra Pradesh. During the period from 1998-99 to 2007-08 the organised dairy industry registered a growth rate of 5% in real value of output.

- The comparative assessment between connectionist and conventional models for prediction of economic traits in Murrah buffaloes found that connectionist models were relatively better predicting 305-day and total lactation milk yield in Murrah buffaloes.
- A new website of the institute 'Agroweb Digital Dissemination System' containing faculty profile database, Division/Section profiles, M.Sc./Ph.D thesis from 2003-2009, Research project database, Research papers published, ATIC information, Alumni database, Information for farmers etc was developed under the NAIP project.
- Three web-enabled information systems on 'Availability and sources of superior germplasm of cattle and buffaloes, 'Decision Support System for farm management by monitoring the Herd Strength and Expected Productivity of cattle and Buffaloes' and National collection of dairy cultures were also developed.
- The milk products used in the traditional systems, Ayurveda, Unani, Siddha and homeopathy include curd, buttermilk, butter, ghee, cream, whey and paneer. A valuable treasure of indigenous knowledge is available regarding the use of milk products as nutraceutical and therapeutic formulations.
- Orientation programmes were organised by ERS, Kalyani at regular intervals for the farmers of Dairy Cooperative Societies and NGOs on request.

## EDUCATION

- M.Sc. in Forage Production was introduced during the current Academic Session 2010-11 at NDRI Deemed University, Karnal.
- Academic regulations were revised which included examination system, grading system for award of degree and introduction of comprehensive exam for Ph.D. students.
- During the year 2010-11, NDRI attracted a large number of International students from Rawanda, Iran, Ethiopia, Sri Lanka etc. A total no. of 21 foreign students is currently on rolls in different programmes being offered by NDRI Deemed University.
- Best Thesis Award for Master's and Doctoral students was continued to encourage spirit of competition and motivation for quality research work.
- In the period under report, NDRI was recognized as Centre of Advanced Faculty Training (CAFT) in the disciplines of Dairy Production and Dairy Processing.
- Ninth Convocation of NDRI Deemed University was held on February 19, 2011. Padam Bhushan Dr. Ram Badan Singh, President, National Academy of Agricultural Sciences (NAAS) delivered the convocation address and gave away the degrees, gold medals, merit certificates and awards to the students. Sh. Ashok Sinha, Secretary, Ministry of Food Processing, Govt. of India presided over the convocation.
- Dr. D. Sundaresan Memorial Lecture Award to commemorate the valuable contributions of Late Dr. D. Sundaresan for all round development of NDRI was given to Dr. Mangala Rai, Former Secretary DARE and Director General ICAR on 17th February 2011.
- National Academy of Dairy Sciences was launched was 1st June 2010 to serve as a think tank and develop policy papers on different issues related to dairy education and research.
- NDRI was recognized as a Node for National Knowledge Network, Govt. of India. Internet Connectivity 1GB speed has been provided under this scheme.
- For the first time, new NCC Battalion was established at NDRI. NCC was made compulsory for B.Tech. first year students.
- Research scholars of NDRI were encouraged to apply for INSPIRE fellowship instituted for topper students by Dept. of science and technology. As many as 5 students availed this fellowship during 2010-2011.
- To inculcate the spirit of innovation and creative thinking amongst the students, **"My Idea"** competition was organised for the students of NDRI Deemed University on **National Science Day** organised on 28th February 2011. Presentations of the best ideas were made by the award winning students.
- In 2010-11, under the aegis of Agricultural Scientists Recruitment Board, infrastructure has also been created at NDRI Deemed University for on-line examination.
- Academic Week was celebrated from 14th to 19th February 2011 to lay focus and review the academic achievements of NDRI Deemed University.

- NDRI signed memorandum of understanding with SAUs such as Shere-e-Kashmir University of Agriculture and Technology, Jammu; Banaras Hindu University, Varanasi; Thapar University, Patiala; Manav Bharti University, Solan and Indira Gandhi National Open University, New Delhi for collaboration in the areas of mutual interest.

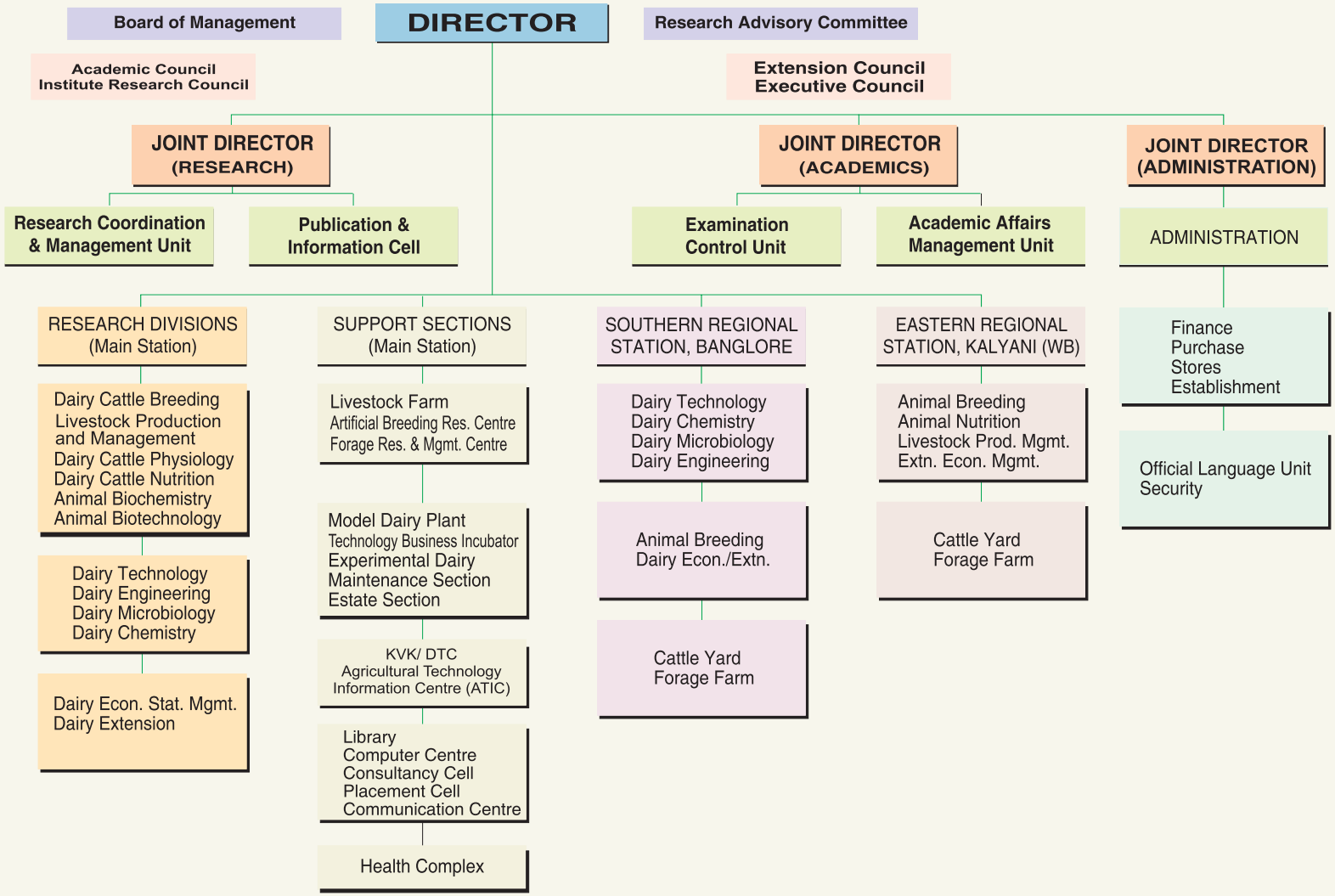
## EXTENSION

- A total no. of 53 Kisan Sangoshties were organised in the adopted villages for transfer of technologies developed by the Institute. A total no. of 856 farmers were made aware about the reproductive management practices, mastitis control, disease preventive measures and fodder production.
- Cross breeding programme was continued in cows and selective breeding in local buffaloes through AI. The conception rate of AI was observed as 46.20 % in Cows and 35 % in buffaloes.
- Monthly infertility and veterinary aid campaigns were organized in adopted villages. A total of 2309 no. animals were diagnosed with late maturity, anestrous and repeat breeding and were given adequate treatment.
- The Extension Education Programme "Dairy Education at Farmers' Door" was continued to strengthen the effective dissemination of dairy production and processing technologies among farming community.
- During the year, KVK/DTC organised 282 training programmes (both on and off campus) participated by 7861 trainees on different aspects of Dairy Production, Dairy Processing, Agriculture, Vermicompost, Bee-keeping, Fisheries and Home Science. During these training programmes, total mandays trained were 20189.
- Agriculture Technology Centre (ATIC) was further strengthened. During the period under report, 21040 farmers visited ATIC for obtaining technical information and advisory services. ATIC was involved in providing helpline services, sale of publications, sale of seeds, biofertilizers & vermicompost, exhibition, filmshows and face to face interactions.
- A total of 73 Foreign delegates from Bhutan, Denmark, Nepal, USA, Iran, Hungary, UK visited ATIC. They were explained about the objectives, working, linkages with other research and development agencies/institutes, role of information and transfer of technologies and impact of single window system approach adopted by ATIC to enhance productivity and income of stakeholders.

## INFRASTRUCTURE

- Renovation of Sports Stadium.
- Renovation of Administrative Block.
- Protective fencing of newly developed Children Park.
- Renovation and upgradation of Library.
- Complete Repair & Renovation of Small Animal House.
- Furnishing and upgradation of labs in Dairy Microbiology Division, Dairy Cattle Breeding Division, Dairy Cattle Physiology Division, Dairy Technology Division, Animal Biotechnology Centre, Animal Biochemistry Division, Dairy Chemistry Division, Dairy Cattle Nutrition Division, and Dairy Extension Division.
- Construction of Power House Building of NDRI, Karnal.
- Renovation of Satluj, Kaveri and Krishna Hostels at NDRI, Karnal.
- Renovation of electrical wiring, fittings and switches in the Hostels of NDRI.
- Renovation of Scientist Home of NDRI, Karmal.
- Fixing of Chain link Fencing with Brick Wall of Dairy Mela Ground.
- Renovation of Director's Office, Conference Hall and Scientists Home.
- Fencing of Premises of International Hostel.
- Renovation of Electrical Works in Dairy Microbiology Division and Dairy Chemistry Division.
- Physiotherapy Unit was established at Human Health Complex, NDRI Karnal.
- Centre of Excellence in Milk Safety was established at NDRI Karnal.
- Carpeting of Approach Roads to Campus and Farm Section.

# 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 it 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<br>Director, NDRI |
| Member | Dr. S. L. Goswami<br>Joint Director<br>(Research), NDRI |
| Member | Dr. G. R. Patil<br>Joint Director (A), NDRI |
| Members<br>(Head of Divisions/<br>Principal Scientists | Dr. B. S. Prakash<br>Dr. S. Kulkarni<br>Dr. A. A. Patel |
| nominated By<br>President of ICAR) | Dr. (Mrs.) B. K. Wadhwa<br>Dr. S. S. Kundu<br>Dr. A. K. Chakravorty<br>Dr. Rameshwar Singh<br>Dr. V. K. Kansal<br>Dr. Jancy Gupta |
| Members (Two<br>Nimbkar Members<br>of Body<br>Nominated by the<br>President, ICAR) | Dr. (Ms.) Chanda<br>(NARI, Phaltan,<br>Maharashtra)<br>Dr. P. Raghava Reddy<br>(VC, ANGAU,<br>Hyderabad) |
| Member<br>(VC of Agril. University<br>Nominated by the<br>President, ICAR) | Dr. K. M. Bujarbaruah<br>VC, AAU, Imphal |
| Member<br>(Nominee of the DG,<br>ICAR) | Dr. K. M. L. Pathak<br>DDG (AS), ICAR |
| Member<br>(Director IVRI/IARI) | Dr. M. C. Sharma<br>Director, IVRI |
| Member<br>(Animal Husbandry<br>Commissioner, Ministry<br>of Agriculture) | Animal Husbandry<br>Commissioner<br>DAH&D, Govt. of India |
| Member (One Eminent<br>Scientist in the Field of<br>Research done in Institute<br>but not employed by ICAR,<br>Nominated by President,<br>ICAR) | Dr. M. P. Yadav,<br>Ex-VC<br>SVPUAT, Meerut |
| Member<br>(One Eminent Agril.<br>Educationist Concerned<br>with the Research work<br>of the Institute but not<br>employed by ICAR,<br>Nominated by President,<br>ICAR) | Dr. B. B. Mallik,<br>Ex-VC<br>WBUAFS, Kolkata |
| Member<br>(One Official Persons<br>Representing Agriculture<br>Interest Nominated by<br>President, ICAR) | Shri. Rajvir Jeeta Ram<br>Shri Dhiraj N. Chauhan |
| Member<br>(FA, ICAR or his Nominee) | D.D. (F-I), ICAR |
| Member<br>(Development<br>Commissioner Rohilkhand<br>Division) | Commissioner, Karnal<br>Division |
| Member Secretary<br>Joint Director (Admn. &<br>Registrar) | Sh. J. K. Kewalramani |

## Academic Council

| | |
|---|---|
| Chairman | Dr. A. K. Srivastava<br>Director, NDRI |
| Vice-Chairman | Dr. G. R. Patil<br>Joint Director (A) |
| Member | Dr. S. L. Goswami<br>Joint Director (Research) |

| | |
|---|---|
| Members | Dr. P. K. Joshi |
| (Four Eminent Scientists from outside the NDRI) | Director, NAARM, Hyderabad |
| | Dr. Sushil Kumar |
| | Former Director NDRI |
| | Dr. S. R. Singh, Director, Institute of Agriculture Banaras Hiudu niversity Varanasi - 221005 |
| | Dr. B. Mishra, Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu |
| Member (Representative from the UGC) | UGC Nominee |
| Member (DDG Education or his nominee) | DDG (Edn.), ICAR |
| Members (One Senior Scientist from each Division) | Dr. Shiv Prasad<br>Dr. B. S. Prakash<br>Dr. A. K. Dodeja<br>Dr. K. K. Datta<br>Dr. Rameshwar Singh<br>Dr. Jancy Gupta<br>Dr. A. A. Patel<br>Dr. R. S. Manik<br>Dr. (Mrs.) B. K. Wadhwa<br>Dr. Y. S. Rajput<br>Dr. S. S. Kundu<br>Dr. Satish Kulkarni<br>Dr. I. K. Sawhney<br>Dr. R. S. Gandhi<br>Dr. A. S. Harika<br>Joint Director (Admn. & Registrar) |
| (Two Representatives from PG Faculty) | Dr. R. K. Malik<br>Dr. S. N. Rai |
| Students Member | Mr. Manoj M.<br>Mr. Pankaj Kumar |
| Member-Secretary | Registrar (Academic), NDRI Deemed University |

## Research Advisory Committee

| | |
|---|---|
| Chairman (An Eminent Scientist from outside ICAR system, nominated by DG, ICAR | Dr. K. Pradhan Vice-Chancellor, OUA&T, Bhubneshwar, Orissa |
| Members (External experts, nominated by Director General, ICAR) | Dr. N. Balaraman, Ex-Vice-Chancellor, TNVASU, Plot No. 27, Rajalakshmi Nagar, Madipakkam, Chennai - 600091 |
| | Dr. B.S. Bisht, Vice-Chancellor, GBPUA&T, Pantnagar |
| | Dr. H.N. Mishra, Head, Post Harvest Technology Centre, IIT, Kharagpur – 721302 |
| | Dr. Narpinder Singh, Dean, Applied Sciences and Prof. of Food Sciences, Dept. of Food Sciences & Technology, Guru Nanak Dev University, Amritsar |
| | Dr. Suresh Pal, Head, Deptt. of Agril, Economics,IARI, Pusa, New Delhi |
| Member | Dy. Director General (AS), ICAR |
| Member | Director, NDRI |
| Member Secretary | Joint Director (Res.), NDRI |

## Extension Council

| | |
|---|---|
| Chairman Director, NDRI | Dr. A. K. Srivastava |
| Members | Dr. S. L. Goswami Joint Director (Res.), NDRI |
| | Dr. G. R. Patil Joint Director (A), NDRI |
| Member | Dr. K. D. Kokate DDG (Extn. Edu.), ICAR |
| Members (NDRI, Karnal) | Dr. S. S. Kundu<br>Dr. S. K. Kanawjia<br>Dr (Mrs.) Smita Sirohi<br>Dr. R. S. Gandhi<br>Dr. B.S. Prakash<br>Dr. A. K. Chakravorty<br>Dr. Shiv Prasad<br>Dr. A. K. Singh |
| Members (Regional Stations) | Head, ERS |
| Members | Dr. Gurbachan Singh Agril. Commissioner to Govt. of India Ministry of Agriculture Department of Agriculture & Cooperation Krishi Bhawan, New Delhi |
| | Dr. H. S. Sandha Director Animal Husbandry Govt. of Punjab Sector- 17 Chandigarh |
| | Director (Farm Information) Directorate of Extn., Govt. of India, New Delhi |
| Member Secretary | Head, Dairy Extn. Division |

# FINANCE

The financial outlays in terms of actual expenditure for Plan and Non-plan for the year 2010-2011 was Rs. 11265.69 lakhs and the sanctioned budget for Plan and Non-plan in 2010-2011 was Rs. 11283.88 lakhs. These figures include the financial outlays for strengthening of Deemed University/KVK and Regional Stations.

| Financial Outlays & Expenditure during 2010-11 (Rs. in lakhs) | | |
|---|---|---|
| **Head** | **Budget** | **Expenditure** |
| Non-Plan | 10230.00 | 10211.81 |
| Plan | 757.15 | 756.87 |
| Strengthening of Deemed University | 230.00 | 230.00 |
| KVK/DTC | 66.73 | 67.01 |
| Total | 11283.88 | 11265.69 |

*The Revenue Receipts of the Institute and the Regional Stations for the year 2010-2011 were Rs. 472.55 lakhs.*

**Revenue Generation (2010-2011)**

| Items | Actual Receipts (Rs. in Lakhs) |
|---|---|
| Sale of Milk | 229.62 |
| Interest on STD | 21.32 |
| Misc. Receipt | 221.61 |
| Total | 472.55 |

# CADRE STRENGTH

| Cadre Strength of NDRI and its Regional Stations as on 31st March, 2011 | | | |
|---|---|---|---|
| | **Sanctioned** | **Filled** | **Vacant** |
| Scientific | 201 | 149 | 52 |
| Technical | 370 | 313 | 57 |
| Administrative | 127 | 142* | 20 |
| Supporting | 782 | 662 | 120 |

**Due to restructuring of Cadre Strength by the ICAR, presently filled positions of UDC in excess will stand abolished on their vacancy.*

# 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

#### Integrated Genetic Improvement of Dairy Cattle and Buffaloes under Open Nucleus Breeding System (ONBS)

**Performance evaluation and multiplication of Sahiwal cattle under open nucleus breeding system:** A total of 17 Sahiwal 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 Sahiwal males ranged from 2425 (1st lactation) - 3811 kg. The EPD of selected male calves ranged between 2.03 and 12.97%. A total of 42 Sahiwal cows (23.73 %) were identified as elite cows for nominated mating with the proven bulls during the period 2010-11. The overall average 305-day lactation milk yield of these elite Sahiwal cows was 2574 kg which was about 30.26% higher than the herd average (1976 kg). The best lactation milk yield of elite Sahiwal cows ranged between 2175 and 3354 kg.

The estimates of heritability of various test day yields ranged from almost zero for 6$^{th}$ day to 0.36 ± 0.14 for 245$^{th}$ day. All the heritability estimates were statistically highly significant (P<0.01) except for 6$^{th}$ and 125$^{th}$ day test yields. The heritability estimate of FL305DMY was higher (0.3581 ± 0.1282) and statistically highly significant (P<0.01). Higher estimates of genetic and phenotypic correlations amongst test day milk yields and their higher association with first lactation 305-day milk yield as well as higher estimates of heritability of all these traits revealed that all the milk yields (test days and FL305DMY) can be used to evolve multi trait selection criteria for cow/sire evaluation in Sahiwal cattle.

Higher accuracy of prediction (>92%) of FL305DMY from the optimum equation incorporating test day milk yields (35$^{th}$, 65$^{th}$, 125$^{th}$, 185$^{th}$ and 275$^{th}$ day) revealed that these test day milk yields can be used to predict FL305DMY with higher degree of accuracy in Sahiwal cattle. Further, it was concluded that the test day milk yields from all the three phases of lactation curve (ascending, persistent and descending) were important for prediction of FL305DMY with higher accuracy.

The relative efficiency of selection on the basis of part lactation milk yields over FL305DMY was though lesser, yet comparable, in Sahiwal cattle. Selection on the basis of individual third month milk yield and cumulative 90 days milk yield was at least 89% and 79% as effective as on the basis of FL305DMY.

The multiple regression analysis was considered as the best method for prediction of FL305DMY with higher accuracy of prediction on the basis of individual monthly milk yields and cumulative monthly milk yields up to 6$^{th}$ months as compared to other methods namely ratio method, simple regression and modified regression method in Sahiwal cattle.

The DFREML method was adjudged as the most efficient and accurate method of sire evaluation among the four methods (least squares, simple regressed least squares and BLUP) used in Sahiwal cattle. The single trait DFREML was more efficient than multi trait DFREML for estimating the breeding value of Sahiwal sires for FL305DMY, individual third month milk yield and cumulative 90 days milk yield.

Sire evaluation based on individual third month and cumulative 90 days milk yield required additional number of daughters to prove a sire with same accuracy of proof based on fixed number of daughters with complete FL305DMY records.

**Genetic evaluation and improvement of Friesian crossbred cattle under organized farms and field conditions:** A total of 109 KF (37 %) were identified as elite cows for nominated mating with the proven bulls. The average 305-day lactation milk yield of these elite KF cows was 5348 kg which was about 28.5 percent higher than the herd average (4160 kg). The best lactation 305-day milk yield of elite KF cows ranged between 4024 and 8648 kg. The average EPA of elite herd was 4830 kg. A total of 29 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 4549-8338 kg. The EPD of selected male calves ranged between 1.57 and 18.44 %. Information is being compiled on VIII – XI sets

of bulls. The progeny testing of XII set of 7 young bulls with dam's best yield ranging between 4645 and 7061 kg (EPD 4.16 – 13.15%) is in progress.

A total of 3070 A.I were performed in KF and as a result 47.91 % conception rate was obtained under field conditions up to December, 2010. A total of 1086 (560 male and 526 female) KF calves were born in the farmers' herds and performance data on 863 Karan Fries had been recorded for evaluation of bulls under field conditions.

**Centre-wise AI and PD done and calves born during 2010 under Friesian Crossbred Project (Field Unit)**

| | | Name of the Centre | | | | |
|---|---|---|---|---|---|---|
| | | **Darar** | **Kheriman Singh** | **Rindal** | **Shekhpura** | **Total** |
| AI | | 683 | 342 | 1025 | 1020 | 3070 |
| PD | | 403 | 154 | 414 | 500 | 1471 |
| CR % | | 59.00 | 45.02 | 40.39 | 49.01 | 47.91 |
| Calves born | Male | 215 | 54 | 94 | 197 | 560 |
| | Female | 167 | 71 | 98 | 190 | 526 |
| | **Total** | **382** | **125** | **192** | **387** | **1086** |

The lactation curve parameters of Quadratic cum log model (QCLM), Gamma function (GF), Cobby Le Du model (CLDM), Polynomial regression function (PRF) and Multiphasic logistic function (MLF) were estimated using 57233 WTDMY of first lactation in Karan Fries cows for developing the best model of lactation curve. The average weekly test day milk yield was predicted with high degree of accuracy ($R^2$ > 85%) by all the models with the maximum accuracy ($R^2$ = 99.50%) obtained by polynomial regression function (PRF) and the least fit ($R^2$ = 87.90%) was obtained with Gamma function (GF). However, Quadratic cum log model ($R^2$ = 99.20%) was almost equal to polynomial regression function and was better than Cobby Le Du model ($R^2$ = 92.80%). It was observed that the errors in prediction of WTDMY using PRF were lowest from actual WTDMY in comparison to other models and ranged from -0.21 kg in week 15 to 0.16 kg in week 6 in Karan Fries cows. The average root mean square error (RMSE) was found to be minimum with PRF (0.0121 kg) followed by MLF (Triphasic) and maximum (0.5321 kg) with MLF (Diphasic). The average RMSE with QCLM, GF, CLDM, and MLF (Monophasic) were 0.0876 kg, 0.3324 kg, 0.3338 kg and 0.5213 kg, respectively. Thus the best fit model was polynomial regression function, which was better than other functions for prediction of first lactation WTDMY.

First lactation monthly test day milk yields were used to predict 305-day or less milk yield using different sampling methods viz., centering date method (CDM), test interval method (TIM) and sample day production method (SPM). There were non-significant differences in lactation yield estimated by various sampling methods with the actual lactation yield. It was further observed that SPM gave the least error (234 kg) followed by CDM (309 kg) and TIM (313 kg) methods. Thus the best method was sample day production method to predict 305-day or less milk yield in Karan Fries cattle.

The monthly test day milk yields were used to predict 305-day milk yield by regression method. The regression coefficients of 305-day milk yield on monthly test day milk yield were highly significant (P≤0.01). The regression coefficients ranged from 92.05 (MTDY-1) to 192.03 (MTDY-6). The regression coefficients showed a consistently increasing trend up to MTDY-6 and thereafter consistently declining trend up to 10$^{th}$ monthly test day milk yield was noticed. The accuracy of prediction ($R^2$) of 305-day milk yield based on individual monthly test day milk yields varied between 18% (MTDY-1) and 62% (MTDY-6). However, the accuracy of prediction of 305-day milk yield was the highest for MTDY-6 (62%) followed by MTDY-5 and MTDY-7 (56%).

**Performance evaluation and multiplication of Murrah buffaloes under ONBS:** A total of 16 Murrah male calves were reserved during the period (2010-11) on the basis of Expected Predicted Difference (EPD) and dam's best days lactation yield, breed characteristics and physical conformity for selection of young male calves for future breeding. The dam's best 305 days lactation milk yield of reserved males ranged from 2542 to 3862 kg. The EPD and superiority of reserved Murrah male calves ranged from 34 to 402 kg and 1.85 to 18.63 %, respectively.

For the establishment of nucleus-breeding herd, a total of 75 Murrah (34.40%) were identified as elite animals. The elite buffaloes were used for

nominated mating with the proven bulls under the breeding programme. The average lactational milk yield of these elite Murrah buffaloes was 2878 kg which was 29.29% higher than the herd average. The best lactational milk yield of elite Murrah buffaloes ranged between 2504 to 4341 kg. Test mating of Murrah breeding bulls of XII Set continued up to the end of March, 2011. The information on growth, reproduction and production performance of Murrah buffaloes from various sets (IX – XII) was collected, compiled and updated during the reporting period.

The weight at birth, 6, 12,18, 24 and 30 months of Murrah buffaloes were estimated as 32.63, 103.03, 162.67, 254.92, 344.49 and 418.17 kg, respectively. The optimum models for prediction of breeding efficiency of Murrah buffaloes were developed with the fitted accuracy of 70.21 to 85.09 %. Indices of breeding efficiency of Murrah buffaloes were also developed.

### Cytogenetic and Molecular Evaluation and Mapping of QTLs of Milk Production and Fertility Traits in Cattle and Buffaloes

Genetic deviations are the main cause for reduced fertility. Chromosomed structural aberrations, particularly fragile sites (FS) lead to other deviations. Chromosome structure aberrations particulary fragile sites (FS) lead to other deviations. Chromosome preparations were made from a total of 72 animals including 37 Sahiwal cattle and 35 Murrah buffaloes. Among these, 52 (27 and 25 animals of Sahiwal cattle and Murrah buffalo, respectively) were reproductively deficient animals. The remaining 20 were control, normal animals. Chromosomes were studied with three different culture media: RPMI-1640 with Aphidicolin (APH), TC-199 without folic acid and Hams-F-10.

Molecular confirmation for the presence of fragile sites was done with PCR amplification using seven pairs of primers: IDVGA82, F9, XIST, DMD, IL1RAPL1, FMR1 and HPRT1. In Sahiwal cattle, Aphidicolin (APH) revealed fragile sites in 29.65% and 7.89% metaphases of abnormal and control animals, respectively. In media TC-199 without folic acid fragile site revelation was 25.17% in abnormal and 10.18% in control animals' metaphases. Routinely used medium Ham's F-10 revealed fragile sites in 17.43% and 10.76% metaphase plates of abnormal animals and controls, respectively.

Analysis showed that fragile sites on X-chromosome were significantly shown by APH and TC 199 without folic acid in reproductively problematic animals compared to Ham's F-10. Effect of medium was significant on fragile sites on X-chromosome of abnormal animals. Pair-wise comparison of effect of different media showed that RPMI 1640 was significantly different from Ham's F 10. Rest two combinations of media were not different from each other. In Murrah buffalo, Aphidicolin (APH) revealed fragile sites in 54.89% and 8.59% metaphases of abnormal and control animals, respectively. In media TC-199 without folic acid fragile site revelation was 50.60% in abnormal and 8.55% in control animals' metaphases. Media Ham's F-10 showed fragile sites in 33.43% and 6.77% plates of abnormal animals and controls, respectively.

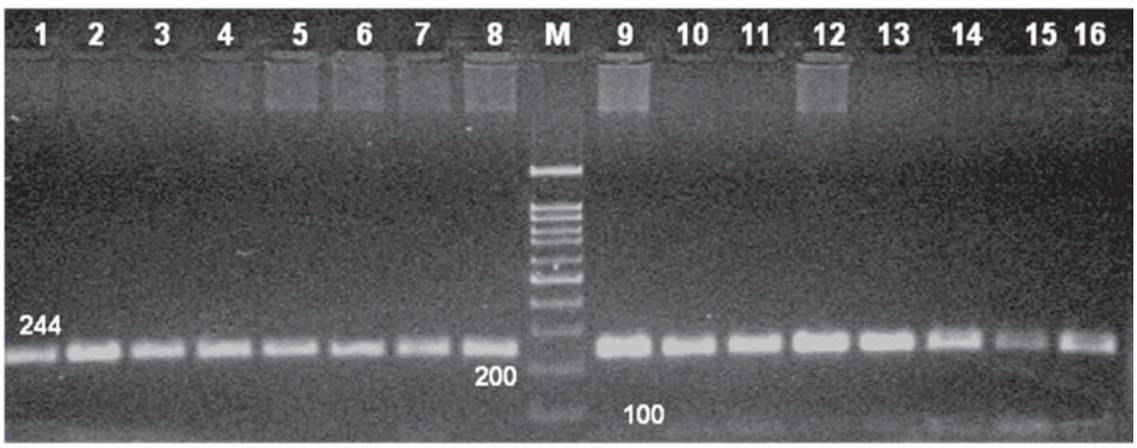
Fragile sites on X-chromosome were significantly revealed by RPMI 1640, TC 199 and Ham's F 10 in reproductively problematic animals. Pair wise comparison of effect of different media showed that RPMI 1640 and TC-199 were significantly different from Ham's F-10. There was no significant difference between RPMI 1640 and TC-199.

Molecular analysis with PCR amplification using primers IDVGA82, F9, XIST, DMD, IL1RAPL1, FMR1 and HPRT1 confirmed that out of 27 reproductively problematic animals 18.5%, 51.9%, 48.2%, 40.7%, 0.0%, 22.2% and 40.7%, respectively were positive for fragile sites in Sahiwal. While in Murrah buffalo, out of 25 reproductively problematic animals 48%, 52%, 80%, 60%, 44%, 20% and 72% showed the presence of fragile sites with IDVGA82, F9, XIST, DMD, IL1RAPL1, FMR1 and HPRT1 primers, respectively.

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

**PCR patterns of FXI gene exon 12 of Sahiwal & Karan Fries cattle to detect factor XI gene deficiency:** Genotyping of 253 Sahiwal and 200 KF cattle of NDRI was carried out. All the animals of sahiwal and KF breeds revealed single band of 244 bp of Factor XI gene (Exon 12) indicating that the herds are free from FXI gene deficiency. Only one non synonymous nucleotide change from G to A at position in 105 was observed resulting into a change of amino acid in second codon from Arginine (R) in *Bos taurus* to Glutamine (Q) in Sahiwal and Karan Fries cattle.

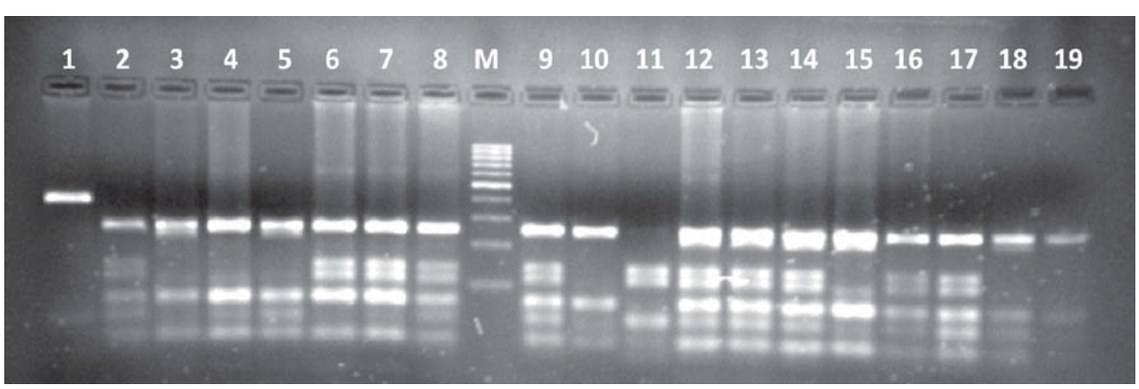
*PCR Patterns of FxI gene exom 12 of Sahiwal Cattle*




*Lane 1-16: 244 bp monomorphic; Lane M: 100 bp ladder*

**Detection of Genetic Polymorphism of TLR 4 Gene by PCR-RFLP in Sahiwal Cattle:** The 382 bp fragments of exon 3 were amplified by PCR and genetic polymorphism was detected by RFLP using I restroiction enzyme (0.07 µl of 10 U/ µl) in 190 lactating Sahiwal cattle. The genotypic frequencies for AA, AB and BB were 0.01, 0.61 and 0.37, respectively and allelic frequencies of A and B alleles were 0.32 and 0.68, respectively. T-C Single Nucleotide Polymorphism was identified at nucleotide 2335 bp in exon 3 of TLR 4 gene of AB genotyped animals.

**PCR-RFLP of Exon 3 of TLR-4 gene using *Alu* I RE in Sahiwal cattle**




*Lane 1 : PCR Product (382 bp)*

*Lane 2, 6-9, 12-14, 16-17 : AB Genotype (260, 142, 118, 77 and 32 bp)*

*Lane M : 100 bp molecular marker*

*Lane 11 : AA Genotype (142, 118, 77 and 32 bp)*

*Lane 3-5, 10-15, 18-19 : BB Genotype (260, 77 and 32 bp)*

## Characterization of CARD15 Gene and its Polymorphism In Murrah Buffalo:

Genomic DNA from 150 lactating Murrah buffaloes was isolated and fifteen sets of the primers were designed to cover complete coding region of CARD 15 gene. The amplicons obtained were 252, 500, 246, 782, 705, 600, 459, 209, 162, 247, 179, 211, 810, 786 and 824 bp long for the respective primers.

The fifteen amplicons were custom sequenced using forward and reverse primers and the final sequences for Murrah were deduced using BioEdit software. For determining the twelve putative exons and coding regions in Murrah, the exons in the sequences in NCBI Accession numbers from AY518738.1 to AY518748.1 for *Bos taurus* were edited and aligned with the deduced sequences from Murrah by ClustalW2 software. The final sequence of 5105 bp obtained for Murrah was compared and aligned with coding sequence of *Bos taurus*. A total of 118 changes were found out of which 87 were in exonic and rest were in the flanking intronic regions. The notable findings were the detection of deletions and insertions. The sequence deletions and insertion were observed in amplicons 12.1 and

12.2. The sequence CTCTACATCT was found to be inserted in amplicon 12.1. Further, there were insertion and deletion of the sequences CAAAAAC and CTAACCTAGGCCAGAA in amplicon 12.1. Eighteen amino acid changes: 3 in exon 2; 13 in exon 4 and one each in exons 11 and 12 have been observed in Bubaline CARD 15 gene.

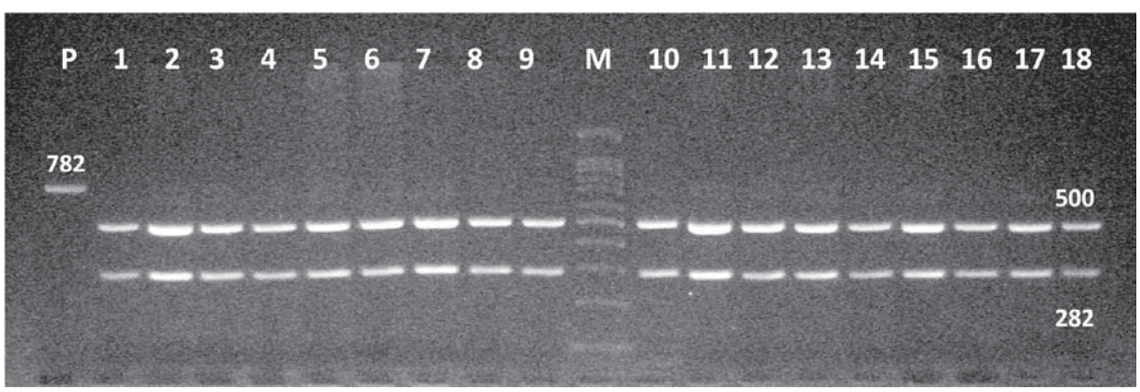
### PCR-RFLP analysis of CARD 15 gene in Murrah Buffalo:

PCR-RFLP analysis of each PCR products of CARD 15 gene was carried out using PvuII, BsaHI and *SacI* restriction enzymes.

### CARD15- *BsaHI RFLP* analysis:

With *BsaHI* cutting sites were observed in three primers, namely, Primer 2, Primer 4.1 and Primer12.3. In Primer 2, monomorphic pattern with fragment sizes 240 and 260 could be seen. For Primer 4.1 the pattern was again monomorphic with restriction fragment sizes of 500 and 282 bp. The polymorphism exhibited by Primer 12.3, where BB was the predominant genotype (84%) with fragment sizes 500 and 324 bp. The heterozygote was the least frequent with fragments 782, 600, 500 and 324 bp. The allelic frequencies for A and B were 14% and 86%, respectively. No cutting sites were exhibited by *BsaHI* in all other primers.

### PCR-RFLP of Primer 4.1 of CARD15 gene using *BsaHI* Restriction Enzyme in Murrah buffaloes




*Lane 1-9, 10-18 : Monomorphic (500, 282 bp)*
*Lane M : 100 bp DNA ladder*
*Lane P : PCR product (782 bp)*

### CARD15- *PvuII RFLP* analysis:

*PvuII* had cutting sites with six primers. With Primer 2 the fragments were 196, 184 and 120 showing monomorphism. Primer 4.1-*PvuII* pattern was polymorphic showing AB (360,422 bp) and BB (360 bp) genotypes and homozygote occurring with a higher frequency. The B allele was the predominant type. Primer 4.2-*PvuII* combination again exhibited polymorphism having AB (705, 395 and 310 bp) and BB (395 and 310 bp) genotype. Furthermore, the homozygote occurred with frequency 64% and the heterozygote had 36% frequency. For primer 5.6-*PvuII*, the AB genotype (459, 350 and 109 bp) had the frequency 22% whereas, BB genotype (350 and 109 bp) had much higher frequency (78%). In case of Primer 12.3-*PvuII* three types of genotypes were differentiated. It was the only primer in which heterozygote had the highest frequency (54%). Also the A allele had the higher frequency (64%) than B allele (36%). No cutting sites were exhibited by *PvuII* in all other primers.

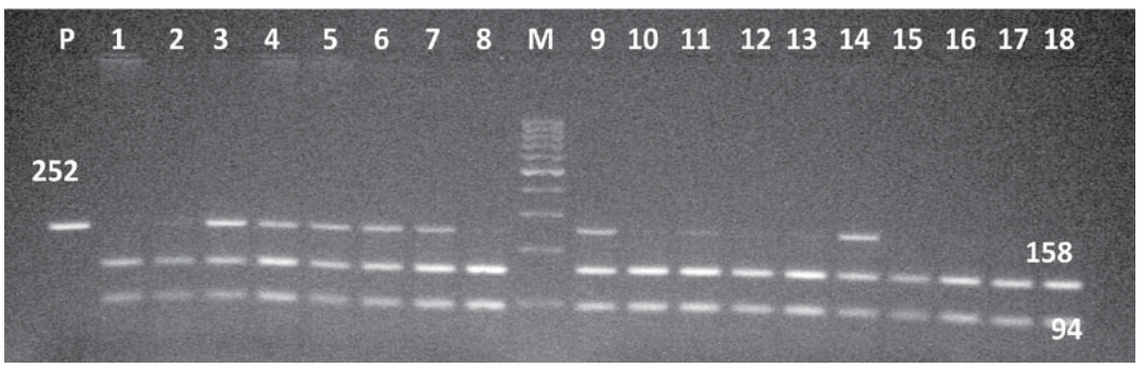
### PCR-RFLP of Primer 4.2 CARD 15 gene using *PvuII* Restriction Enzyme in Murrah buffaloes


*Lane 13-18 : AB Genotype (705, 395,310 bp)*
*Lane 1-4, 6, 8, 9, 10-12 : BB Genotype (395, 310 bp)*
*Lane M : 100 bp DNA Ladder*
*Lane P : PCR Product (705 bp)*

### CARD15-*SacI* RFLP analysis:

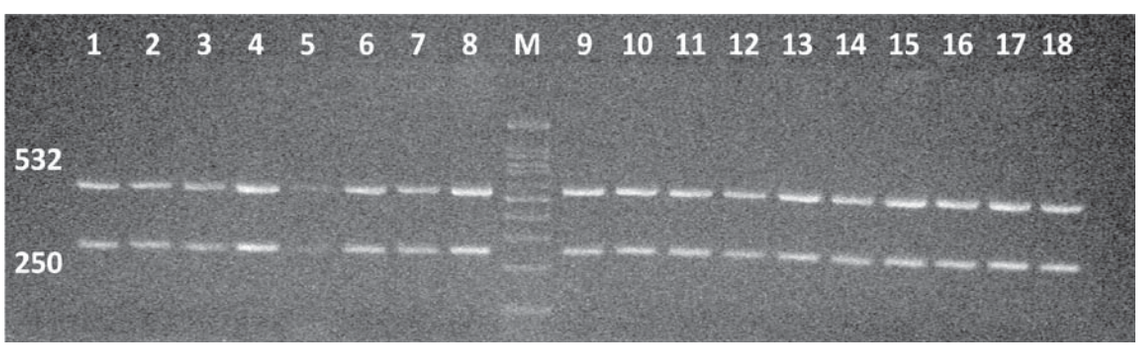
*SacI* gave cutting sites in Primer 1, Primer 4.1, and Primer 12.1.In Primer 1 fragment sizes obtained were 252, 158 and 94 bp for AB genotype. For BB genotype the fragments were of 158 and 94 bp sizes. The BB genotype proportioned 69% and AB genotype had the frequency 31 %. In Primer 4.1 the pattern was monomorphic with fragments 532 and 250 bp. Primer 12.1-*SacI* exhibited polymorphism like Primer 1-*SacI* with the same pattern. With Primer 12.1 polymorphic patterns were two genotypes AB (810, 455 and 355 bp) and BB (455 and 355 bp). B allele has been found to be more prevalent in the population under study. *SacI* did not have cutting sites with rest of the primers.

### PCR-RFLP of Primer 1 CARD 15 gene using *sacI* Restriction Enzyme in Murrah buffaloes




*Lane 2-7, 9, 11, 14 : AB Genotype (252,158, 94 bp)*
*Lane 1, 8, 10, 12, 13, 15-18 : BB Genotype (158, 94 bp)*
*Lane M : 100 bp DNA Ladder*
*Lane P : PCR Product (252 bp)*

### PCR-RFLP of Primer 4.1 CARD 15 gene using *sacI* Restriction Enzyme in Murrah buffaloes




*Lane 1-8, 9-18 : BB Genotype (532, 250 bp)*
*Lane M : 100 bp DNA Ladder*
*Lane P : PCR Product (782 bp)*

### Association of Genotypes with Incidence of Mastitis:

Chi-square analysis of 150 Murrah buffaloes indicated that Primer12.3-*PvuII* RFLP patterns were significantly associated with the incidence of mastitis. Animals with AA genotypes have been found to be more resistant to mastitis as compared to the animals with AB and BB genotypes.

### Network Project on Buffalo Improvement

The breeding programme in the Murrah herd was followed for nominated mating using semen of two proven Murrah bulls of VI Set and of one proven Murrah bull of VII Set. Test mating using semen of eleven test bulls of XII set at the Institute herd is continued. The dams' best lactation 305 day or less milk yield of the test bulls ranged from 2631 to 5192 kg. The Murrah buffalo herd strength was increased during the reporting period. The average lactation milk yield of elite Murrah buffaloes was 2878 kg which was 29.29% higher than the herd average. The best lactation milk yield of elite Murrah buffaloes ranged between 2504 to 4341 kg. Sixty more daughters including 10 elite daughters and 11 elite out of 59 male calves were born during the period in the herd. The overall mortality was 6.01 % in female buffaloes and 13.66 % in male buffaloes and the female calf (0-3

months ) mortality was 13.84 %. Pneumonia, chronic debility, septicemia and toxemia were the major reasons of calf mortality. The overall calving abnormality was 15.12 % of which the retention of placenta was 7.56 % in the herd. During the period, a total of 408 A.Is were done and the overall conception rate was estimated as 29.74 % and the average conception rate of elite mating was 40.90 % in the herd. The conception rate was estimated based on 280 A.Is and pregnancy of buffaloes up to December, 2010.

Average age at first service of buffaloes was 32.86 months and average age at first calving of buffaloes was 41.26 months, which were almost within the target specified in the project. Average age for initiating training of the young bulls and age at first collection were estimated as 26.21 and 33.02 months. The average service period of buffaloes was observed as 140.05 days. The average dry period and calving interval were estimated as 119.36 and 442.40 days. The wet and herd average was 6.83 and 3.75 kg of buffaloes in the herd. The averages of milk constituent traits viz., fat %, SNF % and total solids % were estimated as 8.03 %, 9.76 % and 17.79 %, respectively.

**Progeny test evaluation – Set-wise:** Genetic evaluation of VII set of Murrah bulls using Contemporary Comparison Method was completed and Bull No. MU 4915 having sire index of 2116 kg and dam's best lactation 305 days milk yield of 3437 kg was declared top ranking proven bull with about 17.26 % superiority over contemporary daughters out of twelve bulls in the VII set. The information on 305 days milk yield of daughters was completed for evaluation of VIII set of bulls.

**Germplasm dissemination in the field:** During the period, the NDRI center produced about 8800 doses of frozen semen from three Murrah test bulls. The center supplied 1875 doses of frozen semen to other centers, 4545 doses to NDRI field unit and 22,405 doses of frozen semen to farmers and other dairy development organizations.

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

## Network Project on Buffaloes (Field Unit)

A total of 2810 AIs were performed in Murrah buffaloes under field conditions and as a result 50.64% conception rate was obtained. The highest conception rate was observed in the month of May (53.08 %) and the lowest was in the month of Aug (48.01%). Across the villages, the highest conception rate was observed in Darar (60.53%) and lowest was observed in the village Kheriman Singh (43.53%). A total of 1045 (566 male and 479 female) Murrah buffalo calves were born in the farmers' herds and performance data on 782 buffaloes was recorded for evaluation of bulls under field conditions. The total herd strength of registered females and the breedable females at different centers was 5634 and 4380, respectively. As many as 13 breeding bulls belonging to the 11$^{th}$ set were used for AI during the year.

**Centre-wise AI and PD done and calves born during 2010 under Network Project on Buffalo Improvement (Field Unit)**

| | Name of the Centre | | | | |
|---|---|---|---|---|---|
| | **Darar** | **Kheriman Singh** | **Rindal** | **Shekhpura** | **Total** |
| AI | 598 | 487 | 606 | 1119 | 2810 |
| PD | 362 | 212 | 281 | 568 | 1423 |
| CR % | 60.53 | 43.53 | 46.36 | 50.75 | 50.64 |
| | **Calves born** | | | | |
| Male | 154 | 80 | 73 | 259 | 566 |
| Female | 114 | 89 | 69 | 207 | 479 |
| **Total** | **268** | **169** | **142** | **466** | **1045** |

*An elite Murrah buffalo from a village under the field progeny testing program*

*Performance recorded buffalo alongwith a calf under village conditions*

## Livestock Production And Management

### Modernized Dairy Production System in Dairy Cattle and Buffaloes for Augmenting Productive and Reproductive Performance

**Calving body condition of KF and SW cows in relation to their productive, reproductive and health performance:** Comparison of KF and SW cows calving in low (BCS ≤ 3.0), medium (BCS >3.0 and ≤4.5) or high (BCS > 4.5) body conditions revealed that animals calving in high body condition (H) both in KF and SW lost more body condition & body weight compared to groups M and L during early postpartum. Cows in medium condition (M) recorded higher ($P<0.05$) DMI during prepartum experimental period compared to groups H and L. However, the respective DMI for SW cows did not differ significantly among the BC groups. The comparison of DMI (%BW basis) during postpartum period indicated that the BC group H for KF cows consumed significantly less DM during the first 45d postpartum as well as over overall postpartum experimental period as compared to groups M and L. Similarly, the overall DMI (%BW) for SW cows revealed significant ($P<0.05$) variation among body condition classes and group L consumed higher DM compared to groups M and H. Group M for KF cows produced significantly higher FCM and SCM compared to groups H and L. However, in SW cows, the yields of FCM and SCM did not differ significantly among the groups. The overall fat contents in KF cows in group H had significantly higher ($P<0.05$) milk fat content than group M and L. The content (%) of milk protein, SNF and lactose for both KF and SW cows, however, was not affected due to the body condition of the animals. Cows in group M required less no. of days to first postpartum oestrus, first service, and fewer number of services/conception, lower service period and higher conception rate than groups H and L both in KF and SW cows. Similarly, the incidence of sub clinical mastitis for both KF and SW cows was found to be more severe in BC group H than group M and L. Cows in group M for both KF and SW revealed relatively better health performance compared to other two groups. In KF cows, the overall blood biochemical profiles viz., blood glucose, insulin concentrations in plasma, plasma total immunoglobulin (Ig) were significantly lower in BC group H compared to groups M and L during postpartum experimental period. Plasma NEFA concentration, however, was significantly higher in BC group H for both KF and SW during postpartum experimental period. It was concluded that cows with medium body condition at calving, both the KF and SW, performed better in terms of milk production, reproduction and health performance at farm level.

**Study of vocalization patterns in Murrah buffaloes:** Voice samples were recorded from experimental Murrah buffaloes in different conditions and acoustic features were extracted from voice sample by using MFCC technique. The MFCCs coefficients were able to distinguish one animal from the other based on energy variations. The Vocal signals from different Murrah buffaloes in different conditions differed significantly ($p<0.001$) for various acoustic features viz. amplitude (minimum and maximum), total energy, pitch (minimum, range and mean), intensity (mean, minimum and maximum), formants (F1, F2, F3 and F5), number of pulse, number of periods, mean period, unvoiced frames and mean noise/harmonic ratio. The rate of recognition for ten Murrah buffaloes were 76.09, 78.04, 72.46,

58.69, 73.60, 45.53, 71.45, 72.64, 86.69 and 69.16%, respectively, with an overall efficiency of 74.21% (k = 70.37%). Machine learning algorithm was able to distinguish the isolation, delayed milking and oestrus conditions automatically with an overall efficiency of 75.71, 77.91 and 77.45%, respectively for Murrah buffaloes. Acoustic features like amplitude variation, total energy, pitch (Q50%, mean and range), mean intensity, F1, F2, F3 formants, number of periodic pulses, mean noise to harmonic ratio proved to be best for speaker dependent context identification while pitch spreading, F4 formant, shimmer and mean harmonic/noise ratio proved to be best for context independent speaker identification in dairy animals.

**Effect of Satavari on milk production and composition in Murrah buffaloes:** The study was undertaken to evaluate the efficacy of feeding Satavari root powder (*Asparagus racemosus*) on the productive performance of Murrah buffaloes. Fifteen advanced pregnant buffaloes were selected at random and divided into 3 groups of 5 animals each viz., T1 (control), T2 and T3. The T2 animals were fed with Satavari root powder at the rate of 100 mg and T3 at the rate of 150 mg per kg body weight from 60 days pre-partum to parturition and from parturition to 90 day postpartum the dose of Satavari was doubled in both the groups of buffaloes. The average daily milk yield (kg) was significantly higher during supplementation and post supplementation period in both supplemented groups T2 and T3 compared to T1, respectively. The apparent digestibility of nutrients (CP & CF) increased significantly in both supplemented groups but the other nutrients were not significantly observed in both Satavari supplemented groups. Somatic cell count in colostrum and milk was significantly lower in both T2 & T3 during supplementation period. Colostrum and milk composition was not significantly observed, except milk SNF% and TS%. Blood plasma glucose in buffaloes (mg/dl) was significantly higher during supplementation and post supplementation period in both T2 & T3 groups compared to T1, respectively. The total immunoglobulin level in buffalo blood plasma was significantly higher during supplementation period in T2 & T3 but it was not significantly different in post supplementation period. The average body weight of calves (kg) significantly increased in both Satavari supplemented groups over control. Blood glucose level in calves at calving and 7th days after calving was significantly higher in both T2 & T3 in herbal feed Satavari supplementation groups over control (T1). The reproductive performance of buffalo (birth weight of calves, placenta weight, time taken for expulsion of placenta, first postpartum estrus, days open, service per conception, conception rate, etc.) was not significantly different in both herbal feed supplemented groups compared to control.

**Polyherbal immunomodulator supplementation in relation to productive performance of crossbred cows and goats:** Supplementation (200-250 mg/kg BW) of polyherbal immunomodulator containing, *Withenia somnifera* (Ashwagandha), *Asparagus racemosus* (Satavari), *Emblica officinalis* (Amla), *Ocimum sanctum* (Tulsi), *Tinospora cordifolia* (Giloy), *Trebulus terrestris* (Gokhru) and *Nigella sativa* (Klonji) during peripartum period in Karan-Fries cows improved immunity and antioxidant status and reduced periparturient stress and associated health problems, which in turn optimized production and reproduction performance and consequently improved economics of milk production. Supplementation of polyherbal preparation (including Satawari, Kolonji, Jeera, Jivanti and Vidarikand) @ 125 (T1) and 250 (T2) mg/kg body weight in crossbred dairy goats was not effective in improving the FCM yield, but T1 (2.14 ± 0.12) produced slightly higher FCM as compared to T2 (1.84 ± 0.12) and Control (1.98 ± 0.12). Polyherbal supplementation was effective in decreasing the incidence of kidding disorders; and improved litter weight and pregnancy rate as compared to control. Milk SCC as well as blood Glucose and plasma IgG concentration among treatment groups, however, were not affected significantly.

**Effect of fence-line feeding on behaviour and performance of lactating crossbred cows:** The aim of the present study was to find out the effect of fence-line feeding using post and rail with partition and without partition on the behaviour and productive performance of lactating crossbred cows. For this purpose, 18 Karan Fries (KF) cows with similar parity, milk yield and body weight were selected and grouped into three categories eg. Control (C), Treatment 1 (T1) and Treatment 2 (T2) at random. The cows in C were fed using elevated manger as had existed at the institute farm, the T1 cows were fed at ground level using a fence-line with post and rail and the T2 cows were fed on a fence-line consisting of post and rail with partitions for individual cows for a period of 5 months from early to mid lactation. The overall mean milk yield in C, T1 and T2 was significantly ($P < 0.05$) higher in T2 than that in T1 and C group of animals. There was significant ($P<0.05$)

increase in total daily DMI in T1and T2 groups of animals as compared to the control animals. The differences in the mean wastage of feed among the 3 groups of cows were significant (P<0.05) being highest in C, followed by T1 and T2 Aggressive behaviour measured in terms of aggressive index (AI) was found significantly higher (P<0.05) in C (31%) and T1 (40%) as compared to T2 (18%) and displacement index (DI) was also found significantly higher (P<0.05) in C (40%) and T1 (36%) as compared to T2 (28%). However, no significant differences were observed in eating time, rumination time, and rumination rate, chew rate, standing time and sitting time among the three groups of animals. It was concluded that the fence-line system of feeding consisting of post and rail with partitions for individual cows was found to be better as compared to existing manger system of feeding and a simple fence-line consisting of post and rail only without partition in view of increased DMI, lower feed wastage, improved milk yield and lower level of aggression amongst the cows. The fence-line system of feeding consisting of only post and rail without partitions was found to be marginally better as compared to the existing manger system of feeding in view of increased dry matter intake and reduced feed wastage.

**Hematological and blood parameters of KF cows during transition period:** Hematological and milk parameters associated with immunity were estimated in high vs low yielder and mastitis affected Karan Fries (KF) cows during early lactation. Hemoglobin concentration, Eosinophil count in blood DLC, TEC, Phagocytic Activity (PA) of blood neutrophils, plasma concentrations of TNF-α and IL-6, milk lymphocyte count and milk fat percentage were significantly (P<0.01) higher in low yielding cows when compared to high yielding cows. These values also differed significantly (P<0.01) during different weeks postpartum. Whereas, MCV, SCC and milk macrophage counts were significantly (P<0.01) higher for high yielding cows as compared with low yielding cows, no significant difference were found for other parameters under study i.e. PCV, TLC, blood DLC (except eosinophils), MCH, MCHC, milk neutrophil counts and milk constituents under study. In mastitic group, SCC, TLC, plasma concentration of TNF-α and IL-6 were significantly (P<0.01) higher on first day of mastitis and tended to normalize later, whereas PA of blood neutrophils, milk fat, lactose and SNF contents were significantly (P<0.01) lower on first day of mastitis. Day of mastitis had no bearing on Hb, PCVand TEC. A strong positive correlation (P<0.05) was found among SCC, plasma concentration of TNF-α and IL-6 in mastitic animals, whereas, their correlation with PA of blood neutrophils (P<0.05) was negative. PA was lower in high yielding cows as compared to low yielding cows thus making them more vulnerable for infection. Cytokines such as TNF-α, IL-6 can be used as an effective indicator for mastitis.

**Herd health monitoring in different physiological stages of Karan Fries female:** The present study was conducted to observe the mineral profile in feeds and fodders in different seasons and to observe the metabolic profiles (Blood Glucose, BUN, Cholesterol and NEFA) and mineral profiles (Ca, P, Zn, Cu and Mn) in different physiological stages(Calf, Heifer, Heifer pregnant, Lactating cows and Dry pregnant cows) of KF cattle in different seasons. There was no significant difference in forages for Ca, Zn, Cu and Mn in different seasons but Zn level observed below the critical level in winter season. In dry roughages Zn and Mn were below the critical level in all the seasons & P level was highest in summer season. There was no significant difference observed in concentrate mixture across the seasons. There was significant variation in blood glucose level (P<0.05) among different seasons in different groups. BUN level was high in lactating cows. Urea concentration is an indicator of protein energy balance and raise in BUN level may denote imbalance of protein. Plasma cholesterol considered as an indicator of good hepatic lipoprotein production. Cholesterol level varied significantly among all the seasons (P<0.05). The NEFA level values were higher in lactating cows. Increase in concentration of plasma NEFA resulted from mobilization of lipids, which increased gradually in the prepartum transition period but rapidly last 3 days of gestation. In disease conditions all blood biochemical profile altered and there was significant difference (P<0.05) among the seasons. There was significant difference (P<0.05) serum IgG level in calves higher in winter season and in diseased calves, the level was lower in autumn season. The significant difference (P<0.01) was observed in Lymphocyte proliferation response in different abnormal conditions except laminitis and summer season shows lower value compare to other seasons. This study indicated that the transition period is very critical period of lactation cycle and proper care and management of the animal is necessary during this period to ensure better health.

**Development of organic milk production system:** In this study, 12 freshly calved Murrah buffaloes of the same body weight and parity were selected for the study out of which six buffaloes were converted to Organic Production Management System

(OPMS) and the other group of six buffaloes was maintained under Conventional Production Management System (CPMS). Under OPMS group, the buffaloes were managed as per the National Standards of Organic Production (NSOP, 2000) and the buffaloes under CPMS were managed as per the existing routine management practice followed at the Institute. The productive, reproductive and health performance of the buffaloes under organic management and the control group of buffaloes was studied. The 305 day milk yield was higher in organically managed buffaloes as compared to

*Buffaloes under organic management Organic*

conventionally managed buffaloes. The mean daily milk yield was significantly higher in organically managed buffaloes (7.94 kg) as compared to control (7.29 kg). The mean interval from calving to first AI was similar in both the systems of management whereas the average service period and number of services per conception were lower in organically managed buffaloes as compared to control. The average milk composition in terms of percent fat, protein, lactose and SNF and milk quality in terms of SCC was not statistically different under the two production systems.

The yields of organically produced maize, jowar and berseem crops were comparable with the yields under conventional production system. There was no difference between the mineral content of organically produced fodders, wheat straw and concentrate mixture and conventionally grown fodders, wheat straw and concentrate mixture. The Ca and P levels were higher than the critical dietary levels except in case of wheat straw and Fe levels were detected in excess of the critical dietary levels in both the systems of production. Cu was deficient except in berseem and concentrate mixture, Zn was also deficient except in concentrate mixture and Mn levels were as per the requirements in both the organic and conventional systems of production. The level of pesticides residues in organic and conventional concentrate mixture were not significantly different; though the prevalence of most of the pesticides was lower in organically made concentrate mixture. Among the 10 pesticides compared in various organically and conventionally grown fodder crops, the concentration of 9 pesticides was lower in organic fodders. The levels of pesticide residues in organic and conventionally produced milk were not statistically different. However, these levels were below the MRL except in case of endosulphan. The levels of Cd and Pb were well below the MRL in milk as well as in concentrate and fodders in both organic and conventional production system. Out of 18 milk samples collected, 4 from

*Berseem+Chinese cabbage*

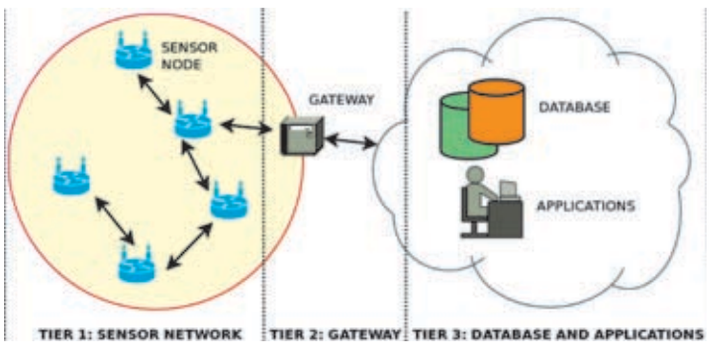
the conventional group and one from the organic group tested positive for antibiotic residues. In summary, the productive, reproductive and health performance was comparable and the quality of organically produced milk was better in view of lower levels of contamination by pesticides, antibiotic and heavy metal residues in organically produced milk as compared to conventionally produced milk

## Development of Wireless Sensor Network for Animal Management

Tier 1: This tier consists of the sensor nodes and the associated systems for monitoring one or more of the target parameters. Broadly, the following three systems are in place:

1. A micro-climate control system consisting of a set of ambient temperature and humidity measurement sensor nodes and a misting system driven by another set of sensor nodes was developed and deployed in the cattle yard.

The sensor nodes can be commanded using a Tier 3 application running in the central cattle yard office to (a) send temperature and humidity readings at user defined intervals back to the it and also (b) turn the misting fan and pump on or off depending on the ambient temperature and humidity conditions.



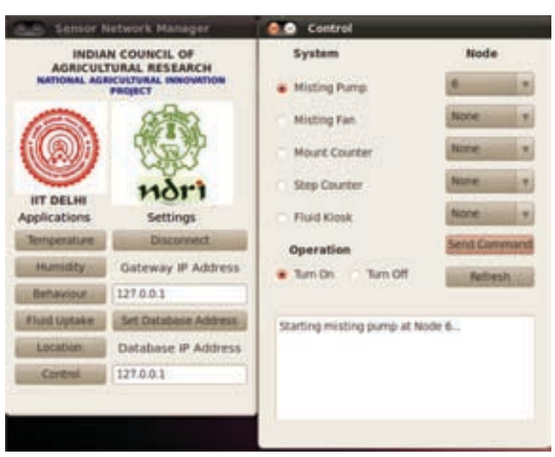

2. A behaviour monitoring system consisting of nodes for step detection and mount detection, respectively was developed and integrated with the application discussed earlier to ease the acquisition of data for analysis and necessary action.

3. A sensor controlled fluid kiosk was indigenously developed for (a) automatic recognition of animal (b) recording its fluid intake and (c) determining the time the animal spent in fluid intake and centrally logging this information in the database running in tier 3.

Tier 2: This tier consists of the Gateway present at a secure location near the deployed Tier 1 systems in the cattle yard. It logs events received from the sensor network in a database residing at Tier 3. Gateway acts as a protocol translator between Tier 1 systems on the sensor network and end-user applications residing in Tier 3 on legacy networks.

Tier 3: This tier has the end-user application that processes events received from the sensor network and sends commands to control the sensor enabled devices. The database into which the gateway in Tier 2 pours data from the sensor network also resides in this tier. New requirements are continuously being incorporated in the application to make it feature-rich. An Application Package Interface (API) is also under enhancement in order to ease development of third-party custom applications.

**Timing of ovulation in relation to estrus symptoms and periestrus hormone levels in Sahiwal cows:** The present study was carried out with the aim to predict the ovulation timing based on the peri-estrual hormonal changes and expression and intensity of estrus behaviour in Sahiwal cattle. To study the temporal pattern of estrus expression and to correlate the signs and symptoms with ovulation, sixty pluriparous and primiparous cows




*Sensor Network Manager*

*Micro-climate control area*

were observed, round the clock, for expression and intensity of estrus behaviour from the onset of estrus till ovulation and the events were recorded in the pre-tested score card. From a separate group of 20 cows (synchronized and natural 10 each) blood samples were collected at 2h interval to study the peripheral changes in progesterone and LH from onset of estrus till ovulation. In 76.47% of the cows onset of estrus was either at the early morning (0000-0600h) or at the later part of the morning (0600-1200h). Initial symptoms observed were discharge of mucus and swelling of vulva followed by the tumefaction of mucous membrane, followed by sniffing and licking of the vulva region, chins resting, mounting other herdmates and then lastly standing to be mounted. Based on the total score, 52% of the cows were observed with moderate and 34% with weak intensity of estrus. The mounting and standing to be mounted behaviours were late in appearance in relation to the ovulation time and they persisted only for 6.17 ± 2.17h and 5.15 ± 2.05h, respectively. Again 56.37% of the standing to be mounted behaviour was of weak intensity. Mucus discharge, swelling of vulva and tumefaction of mucous membrane appeared early before the ovulation and persisted for 12.89 ± 1.79h, 20.55 ± 2.14 and 20.25 ± 1.63h, respectively. Their expression intensity was also higher in the estrous periods. Therefore these cardinal signs are of more importance in predicting the ovulation time in Sahiwal cattle. Low progesterone values were observed with typical arborisation pattern while atypical and nil patterns highly correlated ($P < 0.05$) with high progesterone levels. The average pH, conductivity and spinnbarkeit value of the mucus were 7.59 ± 0.06, 15.21 ± 0.15 mS/cm and 11.06 ± 1.06 cm, respectively at AI. The mean duration from estrus to LH peak and LH peak to ovulation was 3.3 ± 0.67h and 29.45 ± 1.73h in natural estrus and synchronized estrus was 2.2 ± 1.62h and 32.75 ± 3.62h, respectively. The mean peak value was higher in synchronized group than natural estrus. The estrus to ovulation duration was higher when the progesterone concentration was >1 ng/ml on the day of estrus than when it was below <1ng/ml.

**Prediction of subclinical mastitis based on milk electro-conductivity, pH, and Acute Phase Proteins in different dairy animals in sub-tropical climate:** To establish pH and electro-conductivity of milk as reliable markers for early detection of mastitis in sub-tropical climate, pH and electro-conductivity of milk and their correlation with the plasma Acute Phase Proteins i.e. Serum Amyloid A (SAA) and Haptoglobin (Hp) were measured in 200 cows of each breed of Sahiwal, HF Crossbred and Murrah buffaloes. The correlation coefficient between Hp and Electroconductivity was 0.87 and 0.94; SAA and electro-conductivity was 0.73 and 0.91 in subclinical and clinical cases, respectively. Hp and SAA were very good predictor of clinical mastitis; however, in subclinical mastitis Hp proved to be better and highly correlated with EC. Higher Hp level in subclinical mastitis may be due to the chronic nature of the subclinical cases. Electroconductivity, highly correlated with APPs, and other variables can be easily put into algorithm for accurate prediction of subclinical mastitis by fuzzy logic soft computing tools.

## Dairy Cattle Nutrition

### RAISING PRODUCTIVITY OF DAIRY ANIMALS THROUGH IMPROVED FEEDING STRATEGIES, EFFIEICNT NUTRIENT UTILIZATION AND USE OF NON – CONVENTIONAL FEED RESOURCES

#### Effect of Feeding Bypass Fat on the Performance of Lactating Buffaloes

Bypass fat @ 2.5% of DM with concentrate mixture containing formaldehyde treated mustard and ground nut oil cake (1.2 g HCHO/100 g CP) replacing of normal oil cakes were supplemented in buffaloes. The body condition score (BCS) was higher in treatment group. Average birth weights of the calves and total immunoglobulin content of colostrum were also higher. Milk fat content was higher and milk urea nitrogen was lower. Supplementation of bypass fat and protein in ration increased the proportion of unsaturated and long chain fatty acids of milk fat whereas, supplementation of saturated fatty acids decreased the same. The time required for expulsion of foetus membranes decreased. Buffaloes in treatment group required 11.23 days less for complete involution of uterus and less number of cases of retention foetus membranes (RFM) and metritis were observed. The time required for onset of oestrus cycle was also reduced by 8.56 days; service period and AI per conception were also reduced.

### Effect of added Selenium with or without Arsenic on Rumen Fermentation Parameters under *In Vitro* System

Out of different levels (0, 2, 4, 8, 10, 12 and 14 µg) of added selenium (Se), the inhibitory effect on true organic matter digestibility (TOMD), microbial biomass production (MBP), in vitro gas production (IVGP) and total volatile fatty acids (TVFA) was observed at 12 µg level. Arsenic (As), an antagonist of Se, was used as a possible ameliorant at 0, 10, 20, 40, 80 and 100 µg levels added to the substrate (200 mg) containing 12 µg Se (control). Added arsenic at 10 and 20 µg levels increased TOMD, MBP and IVGP, TVFA significantly and the values were at par with negative control (200 mg substrate; concentrate: roughage, 40: 60). However, further addition of arsenic (40 µg onwards) resulted in significant decrease in the values of these parameters. Molar proportion of acetate (mM/100ml) was not affected by addition of arsenic, however, that of butyrate increased probably at the cost of decreased proportion of propionate resulting in an increased A/P ratio. Therefore, addition of arsenic at 10 or 20 µg level to the substrate (200 mg) containing 12 µg Se improved rumen fermentation parameters under *in vitro* system, however, further addition of As (40, 80 or 100 µg) showed negative effects.

### Identification of Acetogens and Methanotrophs in Buffalo Rumen

The study was conducted to identify the presence of reductive acetogens and methanotrophs in buffalo rumen using the molecular markers. The partial nucleotide sequence encoding formyltetrahydrofolatesynthetase (FTHFS) and 16S rDNA gene were amplified in PCR, to identify the acetogen and methanotrophs, respectively. The specific PCR primers used to amplify the partial FTHFS gene sequence and amplification of 16S rDNA were done in two steps. The PCR primers used for first amplification, which amplified almost full-length bacterial 16S rDNA fragments and the nested PCR carried out in second steps by using type I and type II methanotrophs specific primers. The PCR product of an expected DNA length (about 1.1 kbp of FTHFS, 696bp of Type l and 547bp of Type ll) were observed in the 1% gel, and purified. Cloning was done and different gene clones were screened for inserts using the respective PCR primers. Recombinant plasmid DNA isolated from positive clones (bn1410 for FTHFS, om10 for type I and nj10 for type II) and sequenced. The nucleotide sequence after removal of the primer regions were obtained as; 1056bp, 592bp and 486bp which have been deposited in the GenBank database under the accession number HQ699780, HQ699778 and HQ699779 for bn1410, om10 and nj10, respectively. The obtained FTHFS sequence was close and showing 80 to 90% similarity to the uncultured rumen bacterium. Since there was no identical sequence for known acetogenic bacteria, the known acetogen could not be detected in present study, and it can be said that the acetogen with FTHFS gene similar to uncultured rumen bacterium was identified in the Murrah buffalo rumen. The PCR product, amplified with the type I primer set was found to be ≤83% sequence similarity with known type I methanotrophs and most closely (96 to 99%) related to the 16S rRNA gene of uncultured rumen bacteria. The sequence also demonstrated high (98%) identity to the uncultured bacterium and uncultured alpha proteobacterium (90 to 91%). The obtained 16S rDNA gene sequence of type II primer set showed 83% sequence similarity with known type II methanotrophs and sequence clustered with uncultured rumen bacterium and uncultured bacterium (97-98%). The sequence also showed the high level of identities (96% similarity) with 16S rDNA sequence amplified from human fecal sample.The findings of the present study suggested that methane oxidizing uncultured bacteria were present in the Murrah buffalo rumen.

### Methane Production of Different Feed Ingredients and Rations under *In Vitro* System

The study was conducted to estimate *in vitro* methane production from feed ingredients, different rations, and rations with and without feed adjuncts. Forty three feed ingredients were divided into five groups (green and dry roughages, protein and energy sources and agro industrial by-products) and screened for their potential to generate methane in first *in vitro* experiments. Methane production differed significantly (P≥0.05) in the groups indicating that the methane generating potential is an individual characteristics of feed ingredients. On the basis of lowest methane production potential ($CH_4$ g/kg OM digested), 45 different types of rations were prepared from the combinations of selected ingredients (five green roughages, three energy sources and three protein sources) and screened for their methane generating potential and reductive acetogenesis in second *in vitro* experiments. The study indicated that the combination of feed ingredients in a ration influenced the digestibility as well as rumen fermentation parameters specially methane production. Therefore, the selection of feed ingredients to prepare the ration is important from methane mitigation point of view. Three feed

adjuncts (Sodium sulphate-1, 2 and 3g/kg ration, Saccharomyces cereviceae- 1, 2 and 3g/kg ration and 9,10, anthraquinone–2, 4 and 6ppm in total fluid) were added in the three rations during third *in vitro* trial. The positive effects on digestibility and methane production were observed in 1st and 2nd level of sodium sulphate and 1st level of *Saccharomyces cereviceae.* Reduced methane production alongwith digestibility was observed in all anthraquinone added rations.

**Conjugated Linoleic Acid (CLA) in milk by adding suitable herbs/herbal extracts in the feed:** A tentative list of 10 commonly available weeds was prepared and *in-vitro* studies carried out to evaluate their effect on rumen fermentation parameters and CLA production. Analysis of rumen fermentation parameters for hot water plant extracts of *A. conyozoides*, *A. aspera*, *S. nigrum, J. palak* and *F. indica* indicated that total gas production increased substantially in case of *S. nigrum* and *J. palak* supplementation. A 57% increase in total gas production in case of 6% *J. palak* supplementation was reported. Study also indicated positive effect on carbohydrate fermentation in the rumen. Effect of plant extracts supplementation on production of individual gases $H_2$, $CO_2$ and $CH_4$ were carried out using GC and no significant effect was observed on production of $CO_2$ and $H_2$. Methane production in case of 4% *J. palak* decreased to some extent, however, in all other cases, it was not affected. Increase in molar proportion of acetic, propionic and butyric acid was observed in general and in case of *S. nigrum* specifically (as compared to control). *J. palak* (4-6%) slightly decreased acetate to propionate ratio by slightly increasing propionate production. However, there was not much change in all other cases. Increase in propionate production was associated with decrease in methane production. A 360% increase in CLA production was observed in case of supplementation with 4% of *J. palak* plant extract.

## Effect of Micronutrient Supplementation on Induced Oxidative Stress with Toxic Heavy Metals in Relation to Immune Response and Gene Expression Profile in Lactating Goats

Research was conducted on eighteen Cd exposed lactating goats to study the protective effect of Zn. Results of 120 d of experimental feeding indicated significant reduction in Hb and increase in AST activity due to Cd feeding. There was reduction in lymphocyte proliferation. However, Zn supplemented group showed partial amelioration of adverse effect of Cd supplementation. Cd content in milk was 6.05, 9.76 and 7.92 ppb in the three respective groups, thus, suggesting that very small proportion (0.15% in experimental group1 and 0.08% in group 2) was secreted through milk. Similarly, Zn concentration in Zn supplemented group was higher as compared to control and group 2.

## Effect of Feeding *Acacia Nilotica* Pods on Dietary Protein and Amino Acids Availability, Nutrient Utilization and Milk Production in Cows

The research work was carried out in three phases to evaluate the effect of *Acacia nilotica* pods as a source of tannins on UDP and amino acids availability, nutrient utilization, nitrogen balance, microbial protein synthesis and milk production performance in cows. Different protein supplements (GNC, SBM, MSC, CSC) with addition of graded levels (0, 1, 2, 3, 4 and 5% w/w) of Acacia tannins reduced the *in vitro* and *in sacco* protein degradability and increased UDP contents. Considering protection of protein degradability, optimum UDP content, and microbial biomass production, the groundnut cake and soybean meal were selected based on response as protein sources with 3% tannins equivalent Acacia pods in total mixed rations (TMR) for in vivo trials. In TMR, addition of 3% tannins equivalent of Acacia pods reduced the IVTCPD and in sacco ECPD and increased the UDP content. However, SBM groups showed lower protein degradation in the rumen than GNC protein source. But the coefficient of total dietary amino acid digestibility was higher in concentrate containing GNC with pods and SBM without pods. The protein precipitable phenolic compounds of *Acacia nilotica* pods were found to be 17.57 % of total phenolics. In case of leguminous fodder silages, there was no dose dependant effect on protection of protein degradation, MBP and ADIN contents.

In another trial on crossbred heifers, feeding *Acacia nilotica* pods at the rate of 34% in concentrate mixture or 3% Acacia tannin equivalent in total mixed ration with groundnut cake or soybean meal did not affect the dry matter intake, TDN intake, body weight and the feed conversion efficiency. However, the crude protein digestibility, nitrogen balance, net protein utilization and DCP content of diet were significantly lower in GNC+AP (T2) than other treatments due to lower crude protein content of diet. However, digestible coefficient and intake of crude fibre improved in pods fed groups. The microbial protein synthesis was higher in GNC fed than SBM fed. However, the total amino acid intakes and apparent digestibility of total amino

acids were found to be higher in T2 (GNC group) but lower in T4 (SBM group).

In lactating crossbred cows, feeding *Acacia nilotica* pods at the rate of 26% in concentrate mixture or 3% *Acacia tannin* equivalent in total mixed ration with groundnut cake or soybean meal significantly improved the DMI in terms of % BW and feed conversion efficiency for milk yield without affecting milk composition and sensory characteristics of milk especially with GNC. There was improved digestible coefficient of EE and ADF and decreased digestible coefficient of NFE in pods fed groups. However, TDN intake was lower in T4 but both controls did not differ significantly with respective pods fed groups. Intestinal flow of microbial protein and plasma amino acid influx was increased in pods fed groups. The amino acid intake was high in T2 & T3 and apparent digestibility of TAA was low in pods fed groups. First time in whey, the tannin bioactive compounds such as the phloroglucinol, gallic acid, resorcinol, catechin and catechingallate were identified and quantified. The total antioxidant activities of urine, dahi, and whey were lower in SBM+AP group (T4) than other groups. Hence, 3% Acacia tannin supplementation improved the UDP content of diet, microbial protein synthesis, DMI and feed conversion efficiency for milk production of cows especially with groundnut cake.

### Studies on *Acacia nilotica* Pods Extracted Tannins on Rumen Fermentation and its Supplementation Compared to Designer Milk Powder on Neutraceutical Effects in Rats

The study was carried out on *Acacia nilotica* extracted tannins on rumen fermentation and its supplementation compared to designer milk powder on neutraceutical effects in Rats. Two levels of tannins of pure tannic acid, extracted tannin through cold water process and babul pods were compared with different substrates such as GNC alone, concentrate mixture and TMR using 50:50 of roughage and concentrate. The in vitro nutrient digestibility (IVDMD and IVOMD) and rumen fermentation ($NH_3$ and $CH_4$) were reduced in tannin supplemented groups as compared to control. However, total gas production was found higher in treated groups over control. *In Sacco* effective degradability of TMR was decreased in both pure tannic acid and extracted tannin powder where as babul pods did not alter the degradability. In phase II, Nutrients digestibility especially of CP, EE and CF were significantly reduced in both treated groups as compared to control. Similarly, the glucose concentration, total cholesterol, triglycerides and hemoglobin levels were also reduced by tannin supplementation in rats whereas LDL concentrations remained similar to each other. There was no change in catalase, glutathione peroxidase and total antioxidant activity. However, significant improvement in SOD activity of treated group in rats was noticed. There was inverse relationship between the concentration of glucose and insulin levels that means the concentrations of insulin was enhanced by supplementation of tannin, which reduced the glucose concentration as compared to control.

In another experiment feeding of designer milk powder (produced from milk cows fed with *Acacia nilotica* Pods) was compared with plain milk powder and the results indicated significant increase with designer milk powder as compared to control in terms nutrient intake and nutrients utilization in rats. SOD activity was significantly improved in treatment group. The designer milk powder was found better than plain milk powder in terms of dry matter intake, digestibility of different nutrients, haemoglobin and SOD activity.

### Fortification of Low Grade Roughage Based Complete Feed Blocks with Ruminal Fungal Zoospores

Twenty rumen fungi were isolated with the objective to develop spores of superior fungi isolated from cattle, goat and buffaloes to study their persistence/germination *in vitro* on different substrates i.e. wheat straw, paddy straw, total mixed ration/complete feed blocks on these two roughages and also to evaluate complete feed blocks/ total mixed ration containing zoospores for feed intake, nutrient digestibility, rumen fermentation, growth and milk production in buffaloes. Based on the microscopic observations like thallus type, shape of sporangium and number of flagella in zoospore, the cultures were tentatively assigned to their respective genera. The cultures were showing both monocentric and polycentric growth patterns. All the isolates were assayed for various enzymatic activities like CMCase, Xylanase, avicelase and β-glucosidase. Overall maximum enzymatic activity and fibre degrading potential was observed with isolate no. C-2 and hence, possibilities of exploiting it as a direct-fed microbials. But, the paucity of morphological features presents a big challenge for the taxonomy of anaerobic fungi. Some strains of polycentric fungi fail to produce sporangia while other may show altered growth patterns in presence of different culture conditions and thus, only molecular approaches can give exact

taxonomic status. Therefore, the isolate C-2 was also characterized by molecular techniques. Clearly revealed that the isolate C-2 belongs to Genus Orpinomyces based on the sequenced ITS region and was found to share maximum identity (89%) with Orpinomyces spp. NIANP99 (Accession no. EU150189.1). The zoospores of Orpinomyces will be developed and incorporated in the ration of buffaloes for enhancing milk production.

### Supplementation of Herbal Mixture for Immunity and Mitigation of Methane

Anifeed supplement had reasonable nutritional value and pleasant aroma. It contained about 1% tannins, mainly condensed tannins. Taking concentrate mixture and maize fodder alongwith different levels of Anifeed in an *in vitro* study indicated that 1000 ppm level of feed supplement was better than higher levels of same as far as methane emission and truly digestible DM and organic matter are concerned, however, variation among the levels was not significant. In an *in vivo* study, twelve multiparous crossbred cows of similar milk yield and stage of lactation were divided in two groups of 6 each. Both the groups of cows were housed in well ventilated byre having an arrangement for individual feeding. Both groups were fed concentrate mixture and maize fodder according to the nutritional requirement, however, group II (experimental group) ration was supplemented with Anifeed (a herbal feed additive) @ 10g/ day while group I acted as control group. Daily feed intake and milk yield were recorded during 70 days of feeding experiment. After 4 weeks of adaptation period on experimental rations, a digestion trial was conducted alongwith the methane emission measurement using sulphur hexafluoride technique. Feed intake was similar in both groups however, nutrients digestibility was higher ($P>0.05$) in experimental group. Milk yield and milk composition were not affected by the dietary supplementation of Anifeed. Methane emission per day as well as methane emission/kg DM intake in Anifeed supplemented group was 20% lower than in control group and the variation between the groups was significant ($P<0.01$). It was concluded that supplementation of Anifeed @ 10g/ day to the lactating crossbred cows reduced the methane emission significantly and it may help in mitigating the methane emission from the dairy animals.

### Effect of Various Compounds on Methane Production

*In vitro* studies were conducted using different compounds i.e monensin sodium, salinomycin, nisin, 9-10, anthraquinone to see effect on methane production and other rumen fermentation parameters in different wheat straw based diets. Salinomycin showed the maximum effect on methane reduction than monensin sodium, nisin and 9,10-anthraquinone in different diets. Maximum methane reduction was noticed in high fibre wheat straw containing diet than low fibre diets. Acetate: Propionate ratio significantly decreases in different diets by these compounds which clearly indicates that hydrogen utilization pattern shifted towards propionate production. Different aqueous, aqueous methanol and aqueous acetone plant extracts (16 products) and organic acids were also screened for their efficacy to reduce methane in wheat straw based diets. Garlic and Eucalyptus extracts emerged as potent methane inhibitors in wheat straw based rations. Among the organic acids the fumaric and malic acids gave the best results without affecting the dry matter digestibility. Garlic oil and garlic powder were further evaluated under *in vivo* conditions in adult buffalo male calves and lactating buffaloes. Significant methane reduction was observed in case of male calves and the reduction in methane was up to 58% over control diet. Similarly in lactating buffaloes, the methane was reduced up to 70 % in wheat straw based diets without affecting digestibility of other nutrients. Maximum reduction was found in case of garlic oil than garlic powder supplementation. On the basis of 16s DNA phylogenetic study of methanogens (102 clones library) five groups were identified in Murrah buffaloes. These mainly matched with uncultured group, *Methanomicrobium* mobile group, *Ethanococcus vannielii, Methanobrevibacter* and *Methanobrevibacter ruminantium*. Results indicated that dominant group of methanogen present in buffaloes was *Methanomicrobium* mobile on wheat straw based diet. However, on the basis of mcr-A gene ( 104 clones library) based phylogenetic study, one more group was identified which matched with *Methanobrevibacter gottschalkii*.

### Fungal Biodiversity in Ruminants

A total of 20 fungal isolates were isolated from rumen of cattle. All the isolates belong to polycentric rumen fungi including 7 from genus Orpinomyces and 13 from Anaeromyces (Fig 1&2). From the enzyme assay results, it was observed that CMCase enzyme activity increased gradually and at 96 h, the highest activity was observed, further the activity decreased. Isolate 15, 17 and 18 were found to be better CMCase producers showing activity 8.686, 8.453 and 9.034, respectively. Maximum xylanase activity was obtained with the isolates number 1, 12 and 14 i.e. 11.009, 9.880 and 10.085, respectively after 96 h incubation.

Maximum avicellase activity was obtained after 120 h. Isolate 4, 7 and 14 were found to produce the highest avicellase activity as 2.534, 2.418 and 2.491, respectively. Gradual increase in enzyme activity was observed upto 96 h and the activity then decreased in both CMCase and Xylanase, whereas the highest avicellase was obtained after 120 h. In terms of enzyme activity, Xylanase activity was found to be more followed by CMCase and avicellase. A 4.5 to 15.25% increased in IVDMD was observed. The percentage IVDMD was found to be the highest with isolate 17 followed by 3 and 13 showing 60.98, 60.44 and 60.71 % digestibility. A total of 21.84 to 48.31% increase in partition factor value was observed. Microbial biomass (MBM) synthesis increased significantly. Significant increase in acetate, propionate was observed whereas butyrate neither increased nor decreased significantly. In both cases Orpinomyces spp. were found to be potential fibre degraders.

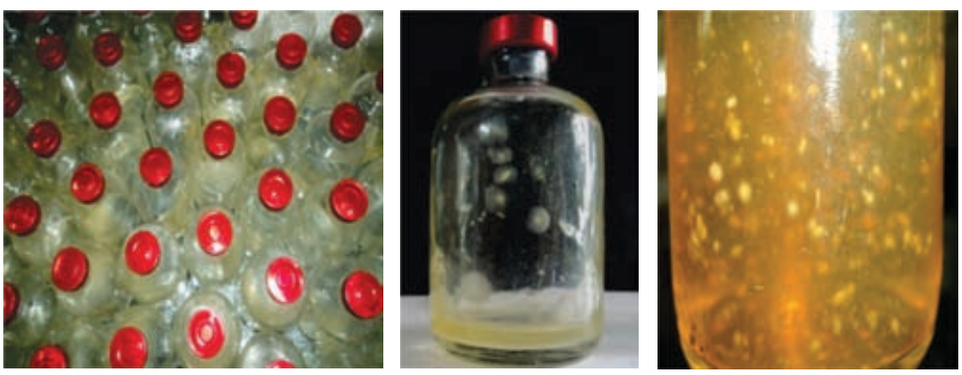
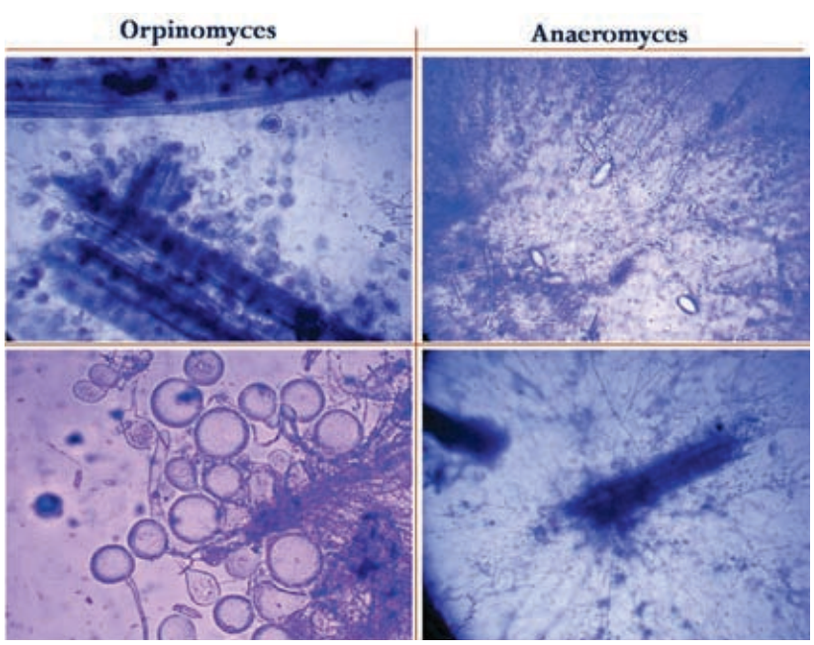


*Fig.1 Serum bottle showing anaerobic fungal colonies*




Four set of species-specific primers were selected to amplify 16Sr DNA of *Fibrobacter succinogenes, Ruminococcusalbus, Ruminococcusflavefaciens* and *Butyriovibriofibriosolvens* bacteria phylotypes using species specific primers. Good quality of genomic DNA was obtained from the rumen sample. All the primers for *F. succinogenes, R. albusand R. flavefaciens* showed bands of 445bp, 175bp and 835bp molecular size, respectively. The DNA fragments obtained from each primer set were cloned into *E. coli* and three clone libraries were constructed to confirm specificity of each primer set. The cloned fragments were then sequenced and analyzed; in each clone library, a total of 28 sequences were analyzed for *F. succinogenes*, 12 for *R. albus* and 19 for *R.flavefaciens*. Dendrogram constructed from the data of cloned sequences specific for *F. succinogenes, R. albusand R. flavefaciens* showed that the sequences are very close to the deposited sequences of respective species. At 2% cut off value dendrogram of *F. succinogenes* showed 4 different clusters whereas 2 clusters were found in *R. flavefaciens* and single cluster was obtained with *R. albus* sequences. The results revealed that

strain specific differentiation was more in the *F. succinogenes* followed by *R. flavefaciens* and *R. albus*. *R. albus* sequences were distantly related to *R. flavefaciens* and *B. fibrosolvens* sequences. The major fibrolytic bacteria *F. succinogenes*, *R. albus* and *R. flavefaciens* were present in the rumen sample of Karan-fries cattle and strain differentiation was more in case of F. succinogenes species.

### Quantification Techniques for Different Rumen Microbes (Fungi, Fibrolytic Bacteria, Methanogens and their Specific Orders) were Standardized Using Specific Set of Primers

Comparison results of different rumen microbes in cattle and buffaloes indicated that some of the specific groups of microbes like *Rumnicoccus albus, Butyriovibro fibrisolvens, Fibrobacter succinogens, Methanomicrobiales* were less in number in cattle than buffaloes. However, the rumen microbial groups like *Rumincoccus flavefaciens* and Methanobacteriales were higher in buffaloes than cattle. After the detailed screening of different plant powders in wheat straw based diets garlic, dalchini and jaiphal emerged to be potent methane inhibitors. These products studied in detail by supplementing at different concentrations i.e 3, 6 and 9% of dry matter in total mixed diets. Results showed that methane reduction was up to 73.96% in different complete diets formulated using wheat straw, concentrate and sorghum or berseem fodder. These powders were further evaluated in combinations with other compounds like fumaric acid and myristic acids, which showed promising results without affecting the digestibility of the diet. Some of the combinations like Garlic + Fumaric and Garlic+Myristic showed up to 38 percent methane reduction in wheat straw based complete diets under *in vivo* conditions.

### Effect of Synchronization of Release of Energy and Nitrogen on Utilization of Feeds

In the present study, four oilseed cakes, four cereals/by-products and five roughages were incubated for different periods in the rumen of fistulated animals using nylon bags. The degradability of DM/OM and N for respective incubation time was obtained and the data was subjected to the first order exponential model to achieve the degradation kinetic parameters. The effective degradability in 24 h was calculated by assuming 5% passage rate/hr. Six diets (Roughage : Concentrate, 50:50) were formulated and their synchrony indices were calculated using nylon bag degradation kinetics data. These diets were classified as high, medium and low synchronous according to their synchrony indices with two diets in each group. These diets were then evaluated for rumen fermentation parameters using *in vitro* gas production technique. There was considerable variation among feed stuffs in nylon bag degradation kinetic parameters. Fodders were having very low rate of degradation and effective degradability while cakes and cereals were having higher instantly soluble and potentially degradable fractions. The diets formulated were isonitrogenous and isocaloric. The total gas production was significantly higher in high and medium synchronous diets. Methane production as proportion of total gas was similar in all diets but absolute methane production followed similar trend like total gas. Methane production per gram of digestible OM was significantly higher in high and medium synchronous diets. True OM and OM degradability was also significantly higher in high and medium synchronous diets than low synchronous. In vitro $NH_3$-N content was slightly higher in high synchronous diets than medium and low synchronous diets. Partitioning factor and microbial biomass production was significantly higher in high and medium synchronous diets than low synchronous diets. Thus, it can be concluded from these observations that in high and medium synchronous diets, the dietary energy and nitrogen were utilized more efficiently than low synchronous diets.

## Dairy Cattle Physiology



### Studies on Immune Competence in Dairy Animals

**Effects of supplementation of *Tinospora cordifolia* to crossbred cows peripartum on various reproductive parameters:** Studies were carried out to explore the possibility of enhancing the reproductive performance of crossbred cows by peripartum guduchi (*Tinospora cordifolia*) supplementation.

Incidence of retention of fetal membranes, endometritis and pyometra were higher in control group of cows in comparison to those recorded in

treated group. The guduchi supplemented cows exhibited faster uterine involution (28 days vs. 42 days) and early commencement of cyclicity (37 days vs. 58 days based on plasma progesterone profiles) in comparison to control group of cows. Mean birth weight of calves from treatment group of cows was significantly higher than that of control group (33.14 kg vs. 29.13 kg). Calves born from control group of cows exhibited high mortality (3 out of 7) within 3-4 weeks in comparison to none among the treatment group. There was an improvement in the innate and adaptive immunity in guduchi supplemented cows in terms of higher total leukocyte, lymphocyte and neutrophil counts alongwith increased neutrophil lymphocyte ratio in comparison to untreated cows. Peripartum plasma total antioxidant activity was similar between the two groups. Supplementation of guduchi significantly reduced plasma progesterone concentration prepartum, although, there was no significant difference in peripartum plasma total estrogen and PGFM levels. It was concluded from the study that guduchi supplementation improved the reproductive performance of cows by enhancing the immunity and lowering the prepartum progesterone secretion.

*Tinospora cordifolia, dried stem and its powder*

## Studies on Physiology of Lactation in Dairy Animals

**Isolation and culture of exfoliated mammary epithelial cells from milk in Murrah buffaloes:** The procedure for isolation and culture of exfoliated mammary epithelial cells was standardized. The cells appeared to be inert for the first two days of culture, after which both small and large cells were able to adhere to plastic dishes making it possible to distinguish them from lymphocytes and granulocytes which remained in suspension. Presence of mammary epithelial cells in the culture was confirmed by immunostaining for the presence of cytokeratin 8. On day 30, three different cell colonies of epithelial cells were seen i.e. tightly joined elongated cells, tightly joined cuboidal cell colonies and contiguous cells were observed.

**Molecular basis for modulation of immune-competence of neutrophilic function *in vivo* and *in vitro* of high producing cows and buffaloes peripartum:** To study the effect of various micronutrient supplementation on the neutrophilic and lymphocytic activity of pregnant Sahiwal cows, thirty Sahiwal cows in their last trimester of pregnancy were selected from the institute's herd and divided into 5 groups. Group 1, 2, 3, and 4 were supplemented with Vitamin E (2000 IU/animal/day + control diet), Zinc (80 ppm+ control diet), Copper (20 ppm + control diet) and combination of all the above vitamins and minerals from 30 days prepartum to 45 days postpartum. Group 5 served as control. Blood samples were collected at weekly intervals during the experimental period. Neutrophilic and lymphocyte proliferation activity was found to be significantly lower ($P<0.01$) around parturition in all the groups. Suppression of neutrophilic and lymphocytic proliferation activity was less in micro-nutrient supplemented Sahiwal cows as compared to control cows.

**Effect of micronutrients supplementation on hormones, milk yield, udder health and immunity in crossbred and indigenous cow:** To study the effect of micronutrients supplementation on hormones, milk yield, udder health and immunity in crossbred and indigenous cows two experiments were conducted.

Crossbred Karan Fries cows (second and third parity) with confirmed pregnancy with similar body weight and body condition score were selected two month before expected date of calving. The cows were divided in two groups based on milk yield as low (< 10 kg/day) and high yielding (> 15 kg/day) groups. The level of

oxidative stress was found to be higher (p<0.01) in high yielding cows as compared to low yielding cows. Lymphocyte proliferation index was higher (1.32 vs 1.29) in high yielding cows as compared to low yielding cows from -60 to 60 days after calving.

Twenty four crossbred cows were selected 60 days before expected date of calving. The cows were divided in 4 groups based on their parity and previous milk production. Group 1 cows were fed a control diet, Group 2 (control diet + 60 ppm Zn), Group 3 (control diet + 1000 IU vitamin E/day) and Group 4 (control diet + 60 ppm Zn + 1000 IU vitamin E/day). The feeding of micronutrients was continued upto 90 days after calving. Collection of blood samples was completed pre and postpartum. (Superoxide dismutase) SOD and catalse enzymes were estimated in blood samples. SOD activity was found to be 1910.99 units/gm hb/min at 60 days before calving which increased to 3831.32 units/gm hb/min. on day of calving. After calving, the SOD actively decreased to 2066.27 unit/gm hb/20 days.

Catalase activity was found to be 143.92 µmole of $H_2O_2$ consumed/min/mg on day 60 before calving and increased around calving to 163.77 µ mole of $H_2O_2$ consumed/min/mg hb. After calving the catalase activity declined to 142.14 µ mole of H2O2 consumed/min./mg hb. In cows supplemented with micronutrients, the SOD and catalase actively was found to be significantly (P<0.01) lower indicating decrease in oxidative stress in supplemented cows.

**Hormone release and behaviour during milking in Murrah buffaloes:** For correlating the hormone release with behaviour during milking, studies were carried out on release of hormones during hand and machine milking operations in buffaloes having different milking temperaments. Blood samples were collected before milking, after concentrate intake, after teat stimulus, during milking at 1 min interval and 20 min post milking. Milking behaviour significantly influenced milk yield (P<0.01), plasma NEFA and SCC but milk composition-(fat, protein, lactose, SNF) was not affected. Milking behaviour significantly influenced (P<0.05) plasma PRL, cortisol and GH release. In hand milking buffaloes, plasma prolactin levels were more (P<0.01) than the machine milking buffaloes (P<0.05) and declined at the end of milking. Milk composition, plasma glucose and NEFA, except SCC were not significantly different in hand and machine milked buffaloes. Circulatory plasma GH was higher (P<0.05) and prolactin levels were lower (P<0.05) in machine milking buffaloes in comparison to hand milked buffaloes. Plasma GH, PRL and cortisol concentration increased (P<0.01) during the milking and basal levels were attained 20 minute post milking. Milking stimulus of machine significantly released (P<0.05) plasma cortisol hormone (P<0.01) before, during and after milking. It was concluded that method of milking (hand or machine) and behaviour at milking influenced release of hormones in Murrah buffaloes.

**Influence of feeding *Tinospora cordifolia* peripartum on lactation parameters in crossbred cows:** For studying the effect of dietary supplementation of guduchi (Tinospora cordifolia) peripartum on lactation an investigation was conducted on 15 pregnant Karan Fries crossbred cows which were divided into two groups: treatment group of 8 cows which were supplemented with guduchi @ 60 gm/day for 45 days prepartum and 120 gm/day for 45 days postpartum; control group of seven pregnant cows which were not supplemented with guduchi. The increase of milk production over 305 days of lactation due to guduchi supplementation was significant (P<0.05). A significant (P<0.01) reduction in somatic cell count was also observed during the experimental period. Plasma non esterified fatty acid (NEFA) concentrations were significantly higher (P<0.01) in cows supplemented with guduchi throughout the course of study. Plasma concentration of growth hormone in the treated cows was also significantly higher beginning on the day of parturition up to 3 weeks postpartum (P<0.05) in comparison to unsupplemented group. It was concluded that peripartum feeding of guduchi improved udder health and milk production through enhanced immunity and higher GH and NEFA levels.

## Augmentation of Fertility

**Evaluation of plasma IGF I and other biomarkers for monitoring growth and reproductive health in female KF calves with probiotic supplementation:** To study postweaning stress effects, fifteen 6 month old KF calves were selected. They were provided with wheat straw and concentrate in the ratio of 1:1. They were also supplemented with green fodder @ 2kg/animal. Their body weights were recorded for four successive months (122 days) and blood samples were collected weekly for analyses of plasma parameters namely IGF-I, Lactoferrin, Haptoglobin and expression of Toll 4 receptor gene in leukocytes except neutrophils. On attaining ten months of age, they were divided into two groups-normal and low body weight group animals. The

range for the body weight for normal (HBW) and low body weight (LBW) group was observed to be 108-124 kg and 68-98 kg, respectively. The LBW group was supplemented with yeast probiotic, *Saccharomyces cerevisiae* for four consecutive months, till they attained 14 months of age or for consecutive 110 days post grouping of animals. During pre and post supplementation period weekly blood samples were collected and body weights were recorded every month. The plasma parameters IGF-I, lactoferrin and haptoglobin were analysed by enzyme immunoassay. The expression of toll 4 receptor gene was analysed by Real Time PCR technique.

The body weight of six LBW animals was significantly lower (P<0.001) during the pre supplementation period (122 days) , when compared to HBW group. During the post supplementation period also, for the first sixty days, the difference between the body weights of two groups was observed to be significant. There was no significant difference in DMI, feed conversion efficiency or daily weight gain between the two groups during the pre supplementation period, or post supplementation period. The parameters DMI/100 kg BW, metabolic body weight, average body weight were significantly high (P<0.01) in HBW group in comparison to LBW group calves during pre and post supplementation periods, respectively.

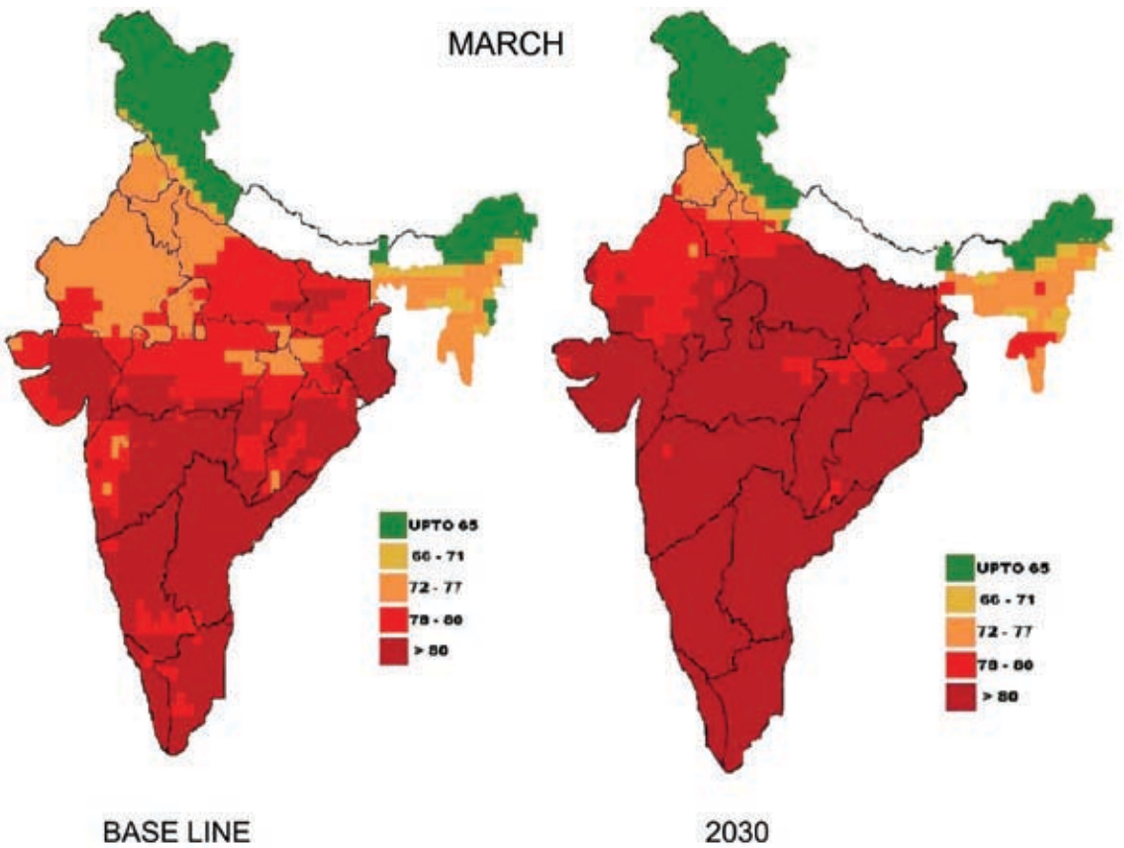
The circulatory level of plasma IGF-I was significantly high (P<0.01) in HBW group in comparison to LBW group. The increase in the plasma concentration of IGF- I with respect to the body weights was earlier in HBW group than in LBW group, further the increase in the plasma IGF- I level in LBW group occurred only after supplementation of probiotic and was positively correlated with the body weight. The level of plasma lactoferrin was significantly high (p<0.01) during the first 91 days of experiment above basal level in both the groups. In LBW group, it was observed that the plasma concentration of lactoferrin significantly decreased in comparison to HBW group with respect to their respective body weights during pre supplementation period. During the post supplementation period the concentration of lactoferrin in both the groups was not significantly different. Plasma levels of haptoglobin was significantly high (P<0.001) in LBW group during pre supplementation in comparison to HBW group. The Hp level was significantly higher than basal level (500 ± 20ng/ml vs. 150 ± 22ng/ml) in both the groups during the 91 days of early pre supplementation period. The levels were negatively correlated with body weight of the animals. During the post supplementation period, though the plasma Hp level decreased to basal levels, the probiotic supplementation further reduced the plasma haptoglobin level (P<0.01) in LBW group when compared with that of HBW group. Toll 4 receptor expression was 12 times more at 60 days post weaning when compared with the expression level observed at 150-220 days post weaning for HBW group, whereas in LBW group expression for the same was observed to be down regulated throughout the post weaning period and could be expressed only at 90 days of post supplementation. Thus, probiotic supplementation had improved the body weight gain, plasma IGF-I level and health status in LBW group animals, in comparison to HBW group calves.

**Impact, adaptation and vulnerability of India livestock to climate change:** The Temperature humidity Index (THI) map based on average temperature and humidity observed at different places of India has been developed. The THI scenario indicates that majority of places in India observe THI > 75 More than 85% places in India experience moderate to high heat stress during April, May and June with THI ranging between 75-85 at 2.00 PM. At about 25% places in India during May and June the THI exceed 85 i.e. severe stress levels. The night temperatures remain high and are unable to relieve heat from heat stress as indicated by morning high THI levels. On an average THI exceed 75 at 75-80% places in India throughout the year. The THI more than 75 affects milk production of high producing European, crossbreds and buffaloes. THI > 80 severely impacts health and productivity. As can be seen from data the congenial THI for production i.e. 70 is during Jan and Feb at most places in India and only about 10-15 % places have optimum THI for livestock productivity during summer and hot humid season.

In the northern parts of the country the THI remains in comfortable range from November to February. THI starts increasing from March and reach peak stress level during May. In general, May to September are stressful due to dry heat or hot humid conditions or at more than 70% places in northern India and THI is more than 75 in afternoon. In the evening hours the stress level increases and more than 70% places experience THI above 80. From April to July more than 40% places experience THI > 85 that severely impacts livestock health and productivity.

In the western parts of the country, THI remains in comfortable zone during December & January only and it start increasing in evening hours of February. From May to September the entire western region experiences THI more than 75 during the day. The level of thermal stress increases in evening hours during the months of May and remain high till July; all places in western India experience THI > 80 and more than 35% places experience THI > 85 in May and June.

The THI analysis of southern region of the country revealed that most places are not comfortable throughout the year and only few places experience THI less than 70 during night/morning from November to February. During the months of April-September THI remain > 75 in morning at more than 55% places and in the afternoon THI exceed 75 from February to October at more than 75% locations. THI greater than 80 is observed at more than 55% locations studied from April to June in southern India.




The eastern region of India also experiences THI less than 75 during the months of November to February at almost all the places, but from April to October THI remains more than 75 during the day at more than 70% locations in East.

All India Temperature Humidity Index (THI) maps for baseline and 2030 indicates a temperature rise and change in THI in Uttar Pradesh, Madhya Pradesh, Gujarat, Rajasthan and other states of India based on the regional climate model PRECIS A1B scenario (Figure 1).

**Quantitation of discomfort level under thermal, exercise and nutritional stresses in goats:** Twelve kids of Alpine X Beetle cross of approximately four months of age were divided in two groups of six animals each based on their body weights. The animals of group-I were subjected to thermal stress in a climatic chamber and made to walk on the treadmill for one hour. The kids of group II served as control. The animals of both groups were given berseem ad libitum and concentrate @ 400 g per animal per day. Water was made available freely all the time. Feed intake was recorded for both groups throughout the experiment. For the first 21 days both groups were kept at similar environmental conditions in the animal shed. The environmental temperature in the shed varied from 20-24°C. After 21 days, the animals of group-I were exposed to thermal stress in a climatic chamber for 2 hours daily for a period of 5 days at each exposure temperature of 40°C, 42°C and 44°C with one day gap at each exposure temperature.

The animals of this group were also made to walk on the treadmill for one hour between days 22-42, while the animals of group-II were kept in the animal shed. Subsequently, the animals of group-I and group-II were kept in the animal shed between days 43-63. The body weights of all the animals were recorded at the beginning 0, 21, 42 and 63 days. Feed intake was recorded daily.

Physiological observations, respiration rate (RR), pulse rate(PR), rectal temperature(RT) and surface temperature(ST) were recorded at 7.00 AM before start of the exposure and at the end of exposure on alternate day during exposure period (22-42days) for group I and at the same time for group II. The initial(0 day) body weights for group I and group II were 14.67 ± 1.11 and 14.58 ± 1.36 kg, respectively. The body weights of group I and group II increased significantly on days 21, 42 and 63 of the experiment. The difference in DMI between group I and group II were non-significant throughout the experiment. The difference in body weight gain per day between group I and group II throughout the experiment were non-significant.

The RR increased significantly in group I after exposure to thermal stress at 40°C and subsequently, there was significant increase at thermal exposure of 42°C and 44°C. The deviations in RR was significantly higher in group I compared to group II and within group I the deviations were higher and statistically significant at temperatures 40, 42 and 44°C. PR of group I increased significantly after exposure to thermal stress and the increase was significantly higher at 42°C compared to 40°C and subsequently the increase at 44°C was significantly higher compared to 40 and 42°C. RT of group I increased significantly after exposure at different exposure temperatures (40, 42 and 44°C) compared to before exposure. ST of group I increased after exposure to thermal stress and the increase was higher and statistically significant at 42°C compared to 40°C and subsequently, it was higher at 44°C compared to 42 and 40°C. ST in group I and group II in the morning were comparable but it was significantly different and higher after exposure in group I and Group II.

**Impact of thermal stress and Vitamin- E supplementation on heat shock protein-72 and antioxidant enzymes in Murrah buffaloes:** The studies were carried out to find out the relationship of HSP72 mRNA expression in lymphocytes with antioxidant enzymes (Superoxide dismutase and catalase), blood profile (TEC, TLC, DLC and N: L ratio), physiological responses (RR, PR, Tre , Tskin and heat storage) and the effect of vitamin E supplementation (summer and winter) on different parameters in different physiological stages of Murrah buffaloes. The results of study showed that in all stages of Murrah buffaloes, the HSP72 mRNA expression and antioxidant enzymes (SOD and CAT) decreased significantly ($P<0.05$) in experimental group of buffaloes compared to control group during both the seasons. Overall values of α-tocopherol was significantly ($P<0.01$) higher in experimental groups as compared to control group. From the results of the study, it can be concluded that thermal stress (climatic chamber and stress seasons) had a significant negative impact on buffalo physiology by increasing the levels of HSP72 mRNA expression in lymphocytes, antioxidant enzymes (SOD and CAT), physiological responses (RR, R, Tre, T skin and heat storage) and deviating the normal picture of TEC,TLC, DLC and N:L ratio.

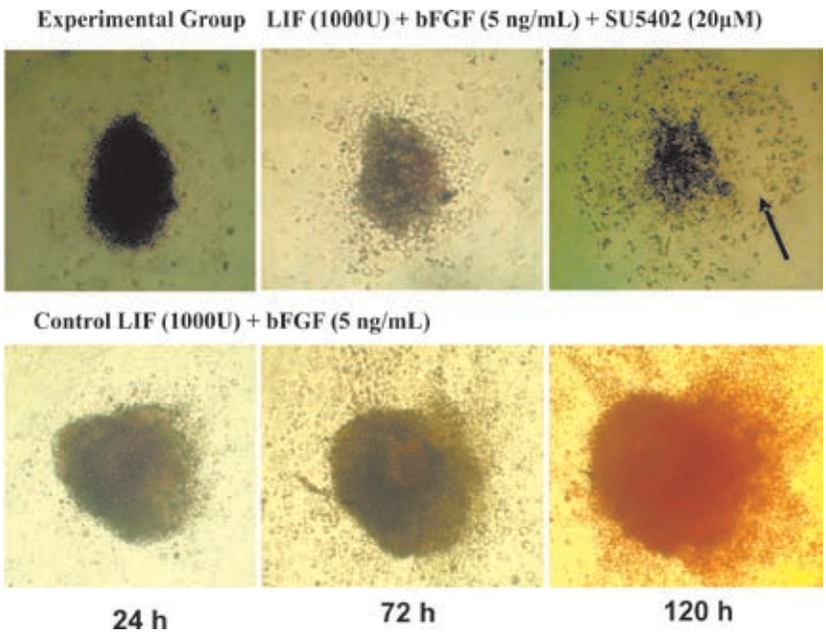
The feeding of vitamin E to the treatment group of buffaloes showed a positive impact by lowering the levels of thermal stress markers viz., HSP72 mRNA expression in lymphocytes, antioxidant enzymes (SOD and CAT), N:L ratio, increased counts of TEC and TLC, reduced number of neutrophils, increased number of lymphocytes, monocytes and eosinophils. It also improved the levels of α- tocopherol in blood plasma of all categories of Murrah buffaloes and even increased milk yield in lactating group during summer and winter season.

## Animal Biotechnology



### Faster Multiplication of Superior Germplasm for Development of National Milch Herds

**Production of embryonic stem cells:** For examining the effects of FGF on the self-renewal of buffalo ES cells, these were cultured on buffalo fetal fibroblast (BFF) feeder layer in ES culture medium (Knockout-DMEM + 15% Knockout Serum Replacer + 1000 IU/ml murine LIF) containing FGF (0, 5 or 10 ng/ml). Supplementation of the ES culture medium with FGF (5 ng/ml) significantly ($P<0.05$) increased the rate of primary colony formation and improved the self-renewal. To confirm that the beneficial effects were indeed because of bFGF supplementation, FGF signaling was blocked by supplementing the culture medium with 20 µM of SU5402, a FGF receptor blocker. This led to differentiation and death of ES cell




colonies, confirming the indispensable need of bFGF for survival and maintenance of buffalo ES cells. In another study, effects of supplementation of ES culture medium with 5 ng/ml bFGF were examined alone or in combination with 1000 IU/ml LIF. It was found that besides the primary colony formation rate, the maximum passage number for which ES cells survived was also the highest in the presence of both bFGF and LIF.

Buffalo ES cells between passage 41 and 64 that had been characterized by expression of transcription-based markers OCT-4, NANOG, SOX-2, FOXD-3, REX-1, STAT and NUCLEOSTAMIN and surface markers alkaline phosphatase, SSEA-1, SSEA-3,SSEA-4, TRA-1-60 and TRA-1-81 were cultured on BFF feeder layer in ES culture medium (Knockout-DMEM + 15% Knockout Serum Replacer + 5 ng/ml bFGF + 1000 IU/ml murine LIF) containing TGF-β1 (0, 0.1, 1.0 or 10 ng/ml) or its inhibitor SB431542 (0, 10, 25 or 50 µM) for 144 h. The medium containing TGF-β1 or SB431542 at respective concentrations was changed every 24 h and the colonies were passaged after being split mechanically every 5-6 days in the spilt ratio of 1:3 to 1:4. BFF feeder layer were found to express TGF-β1at passage-3, 5 and 7, as detected by RT-PCR. Supplementation of ES culture medium with TGF-β1 (1.0 ng/ml) significantly increased ($P<0.05$) the percentage of ES cell colonies found to be morphologically normal and the colony size although the effect on colony size was lost beyond 72 h of culture. Moreover, inhibition of TGF-β1 by SB-431542 (50µM) significantly decreased ($P<0.05$) the percentage of ES cell colonies found to be morphologically normal and the colony size compared to the controls. The results of this study indicated that buffalo fetal fibroblast feeder layer expressed TGF-β1 and that supplementation of the ES culture medium with TGF-β did not improve the self-renewal of buffalo ES cells at least in the presence of FGF and LIF.

Buffalo ES cells produced were used as donor cell for the production of cloned embryos through the new and advanced 'Hand-guided Cloning Technique'. GARIMA-II, the first cloned buffalo calf, in which the donor cell was an ES cell, was born on August 22, 2010. The donor ES cell was derived from 8 day old blastocyst and cultured for 29-passages (117 days).

**Production of cloned embryos:** The possibility of producing interspecies handmade cloned (iHMC) embryos by nuclear transfer from donor cells of cattle, goat and rat using buffalo oocytes as recipient cytoplasts was explored in view of the lack of availability of cattle oocytes in India and the potential of interspecies cloning in conservation of wild-life. Zona-free buffalo oocytes were enucleated by protrusion cone-guided bisection with microblade. After electrofusion with somatic cells, reconstructed oocytes were activated by calcimycin-A23187, treated with 6-dimethylaminopurine and were cultured in K-RVCL-50® medium for 8 days. Although the cleavage rate was not significantly different when buffalo, cattle, goat or rat cells were used as donor nuclei (74.6 ± 3.8, 82.8 ± 5.3, 86.0 ± 4.9 and 82.3 ± 3.6%, respectively), the blastocyst rate was significantly higher ($P<0.01$) for buffalo (51.4 ± 2.6) than that for cattle (3.5 ± 1.0) or goat (2.2 ± 0.9) whereas none of the embryos crossed the 32-cell

stage when rat cells were used. However, the total cell number was similar for buffalo-buffalo (175.0 ± 5.07) and cattle-buffalo embryos (178.0 ± 11.84). Following transfer of 3 buffalo-buffalo embryos each to 6 recipients, 3 were found to be pregnant, though the pregnancies were not carried to full term. These results indicated that interspecies blastocyst stage embryos could be produced by iHMC using buffalo cytoplasts and differentiated somatic cells from cattle and goat and that the source of donor nucleus affected the developmental competence of interspecies embryos.

Parthenogenetic activation using zona-free oocytes offers an alternative model to develop protocols for activation of reconstructed embryos for cloning. The aim of this study was to compare the efficacy of different methods for the activation of zona-free buffalo oocytes in terms of their effects on the developmental competence of parthenogenetic embryos. The effects of zona removal on parthenogenetic activation and in vitro developmental competence of metaphase II oocytes were also examined. All activation methods were followed by incubation of 2mM 6-dimethylaminopurine (6-DMAP) for 4 h. Out of three different pulse strengths (1.2, 2.1 or 3.3 kVcm-1) used, 2.1 kVcm-1 resulted in the highest blastocysts rate (25.3%). On comparing different chemical agents and electric pulse, the highest blastocysts rate was observed for calcium ionophore (CaI) (28.6%) followed by ethanol (25.0%), electric pulse (22.5%) and combined CaI and ethanol treatment (16.7%) though difference among them were not significant. Furthermore, a significantly reduced developmental potential was observed in zona-free oocytes as compared to zona-intact ones up to the blastocyst stage (44.3% vs 27.1%). Zona-free buffalo oocytes could be successfully activated for parthenogenetic development using chemical or electrical stimulation. Out of different agents examined, CaI followed by 6-DMAP resulted in the highest blastocyst rate.

In a study focused on determining the effects of cytoplasmic volume on the developmental competence of Handmade cloned buffalo embryos, two different cell types i.e., BFF and buffalo ES cell-like cells were taken as donor cell and fused with one, two or three demi-cytoplasts to generate embryos with decreased, normal (control) and increased cytoplasmic volume. Using BFF as a nuclear donor, the cleavage rate was similar in all the groups ($P>0.05$), but the blastocysts rate was significantly lower ($P<0.05$) for embryos generated with decreased cytoplasmic volume. Using ES cell-like cells, the cleavage and blastocyst rate with increased cytoplasmic volume was significantly higher ($P<0.05$) compared to that with reduced cytoplasmic volume. Blastocysts produced from embryos having increased cytoplasmic volume had significantly higher ($P<0.05$) cell number than normal (control) embryos in both BFF and ES cell-like cells groups. Pregnancies were established in all the groups except for the embryos reconstructed with decreased cytoplasmic volume. The pregnancy rate was almost double for embryos reconstructed using increased cytoplasmic volume compared to that with the controls.

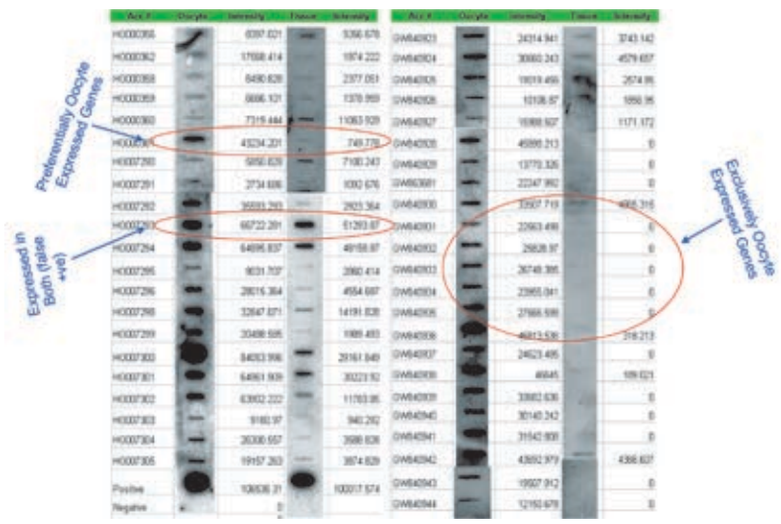
Attempts were made to improve the epigenetic reprogramming of donor somatic cells by the use of an epigenetic modifier scriptaid, which is a HDAC inhibitor. The blastocysts rate in the treatment groups were found to be increased as compared to the control group. Successful pregnancy was established by embryo transfer in one of the treatment group (1000 nM), whereas in rest of the groups (500 nM and control) no pregnancy was established.

The expression pattern of developmentally important genes was determined in immature and mature oocytes, fetal fibroblast cells and in IVF- and HGC-derived embryos at the morula and blastocyst stage. Bcl-xl expression was found to be significantly higher ($P<0.05$) than that of Bax in IVF and HGC embryos indicating that apoptosis level was somewhat low in buffalo IVF and cloned embryos. Bax expression was not seen in matured oocytes. HSP 70.1 expression was significantly higher ($P<0.01$) in IVF compared to that in HGC embryos at both morula and blastocyst stages. Bcl-xl expression was significantly higher ($P<0.01$) in HGC embryos than that IVF-derived ones at the morula but not the blastocyst stage whereas Bax expression was not significantly different between HGC and IVF-derived embryos at both morula and blastocyst stages. Glut-1 expression significantly higher ($P<0.01$) in HGC than that in IVF embryos at the blastocyst but not morula stage. This study suggested that developmentally important genes were differentially expressed at various embryonic stages in HGC and IVF-derived embryos.

### Reproduction Genomics

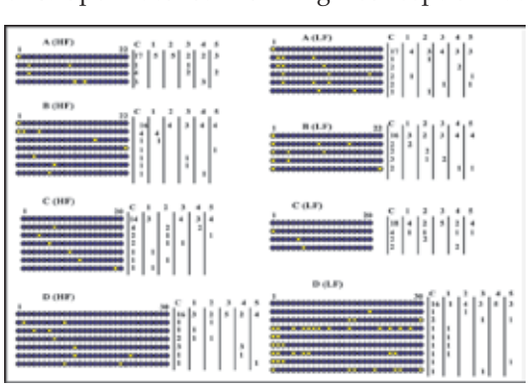
Work was taken up for discovery of novel oocyte specific genes which could be responsible for oocyte competence. An oocyte specific cDNA library was generated where the oocyte expressed genes irrespective of its quality and state of development was subtracted from a variety of somatic cells representing all germ cell origins. Sequencing of more than 1700 SSH clones and its exhaustive bioinformatic analysis revealed at least 62 sequences as novel. The reverse northern analysis further validated the exclusiveness of

identified sequences as oocyte expressed which confirmed 12 of these sequences as exclusively oocyte expressed and another 35 as preferentially oocyte expressed with 15 sequences being expressed at more than 10 fold higher intensity in oocytes. Apart from these novel sequences, another 39 sequences were identified as oocyte exclusive belonging to the category of uncharacterized genes. All of these sequences have been reported in GenBank public domain in internationally acceptable formats. These sequences will fortify buffalo genome sequence databases as well work as invaluable resource for understanding the oocyte biology in mammalian species.



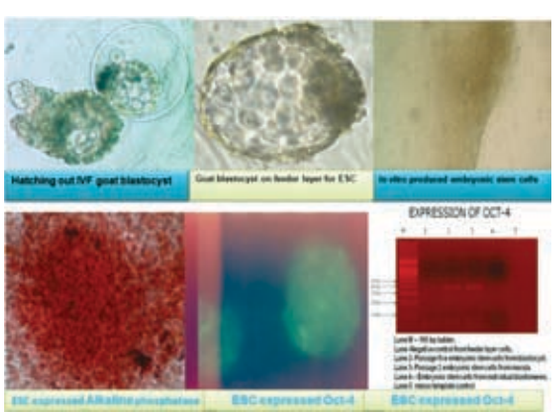

*Exclusively and preferentially expressed oocyte specific novel genes identified in buffalo*

Epigenetic alteration of H19 gene was studied in relation to suboptimal fertility status of crosbred (Karan Fries) bulls. Indigenous cattle H19 DMR sequence was deciphered and was found to be in or total alignment with the same sequence from Bos Taurus. A simplified and effective bisulphite treatment procedure was optimized. Sperm genomic DNA was subjected to bisulphite treatment and sequenced. Methylation data obtained was analysed and correlated with functional parameters of spermatozoa. Rate of methylation at H19 DMR was found to be significantly low in low fertility bulls. Spermatozoa from high conception rate bulls were found to have higher number of live and acrosome intact spermatozoa. Spermatozoa with optimum membrane integrity and displaying rapid velocity were also high in high conception rate bulls. It appears that hypomethylation of the H19 DMR could be responsible for affecting the sperm functional attributes resulting into low fertility of crossbred bulls.

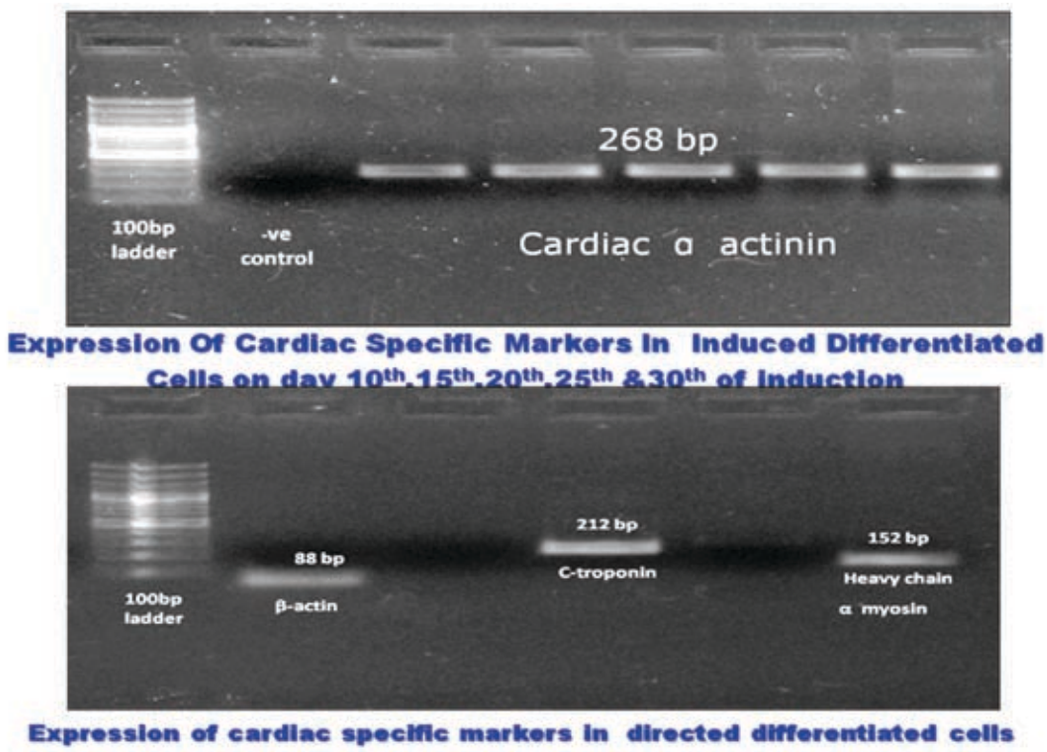


*H19 DMR methylation pattern in high (HF) Vs low fertile (LF) bulls. Each circle represent individual CpG sites within the DMR fragment. Blue circles: Methylated CpG's, Yellow circles: unmethylated CpG's C: Number of clone identified with similar methylation pattern. Number (1-5): Number of clones identified with similar methylation pattern for individual bulls, 5 each under HF & LF groups*

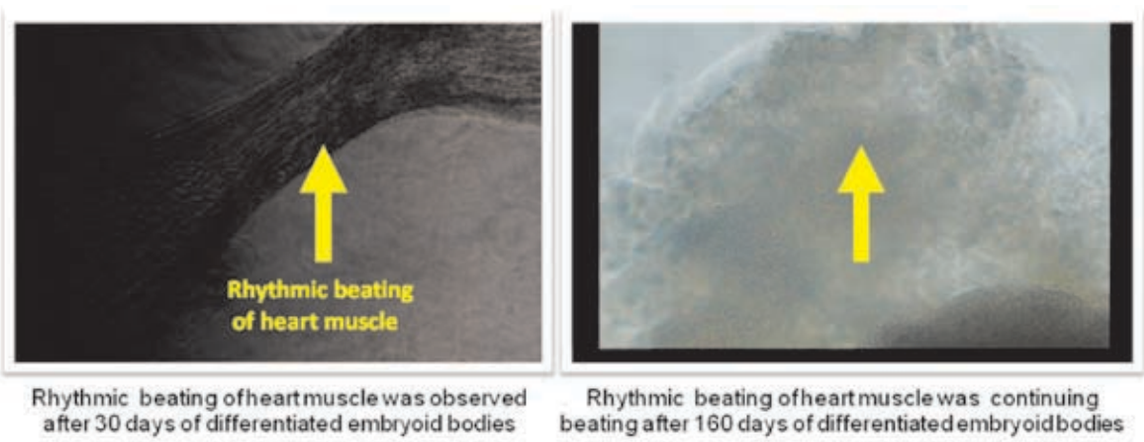
**Rhythmic beating of cardiomyocytes generated from IVF goat ES cells continued up to 160 days:** Goat blastocysts were produced in vitro by combining the techniques of in vitro maturation, fertilization and culture. The inner cell masses (ICMs) isolated from blastocysts were cultured




*In vitro produced goat blastocysts, embryonic stem cells and their characterization by expression of alkaline phosphatase and Oct-4*



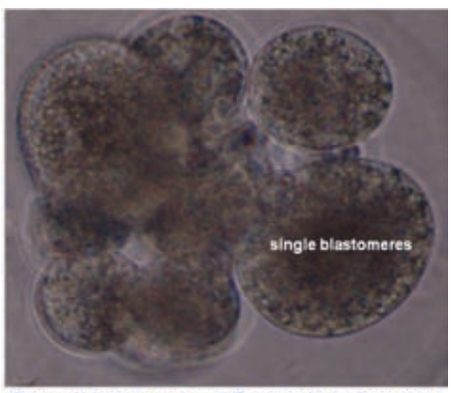

*Expression of cardiac specific markers in induced differentiation of goat ES cells with RT-PCR*




*Rhythmic beating of heart muscles was observed following induced differentiation of goat ES cells*

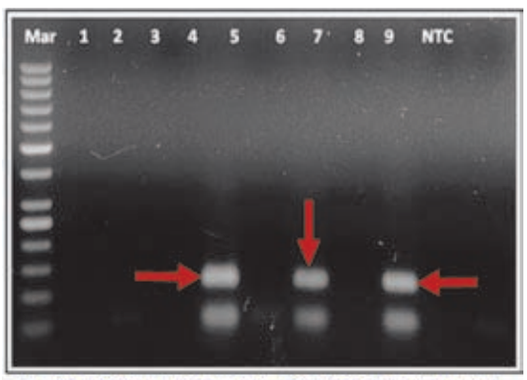
on mitomycin-C inactivated fetal fibroblast feeder layer in the presence of LIF. The ES cells were successfully subcultured up to 22 passages on feeder layer and up to 12 passages without feeder layer with LIF only. Colonies of putative ES were characterized for surface markers like alkaline phosphatase, TRA-1-60, TRA-1-81, SSEA-1, SSEA-3 and SSEA-4 by immunofluorescence, and for intracellular markers like Oct4, Sox2 and Nanog by RT-PCR. Embryoid bodies were generated from ES cells and were characertized by expression of Gata, BMP4 and Nestin. These were cultured in medium containing 100 ng/ml Activin–A, 10 ng/ml FGF-2 and 100 ng/ml BMP-4 to induce differentiation. The rhythmic beating of cardiomyocytes was observed 30 days post culture and the beating is still continuing after 160 days of culture. Similarly, cardiomyocytes in which rhythmic beating went on beyond 75 days, were also produced from 2nd and 3rd batches of embryoid bodies. The cells that exhibited beating were observed to be positive for the expression of cardiac specific markers like α-actinin, troponin and α-myosin heavy chain. Histological studies also revealed a morphology similar to that of cardiomyocytes.

**Sexing of single blastomere of goat embryos by PCR amplification of the SRY gene:** The objective of this study was to amplify goat Y chromosome-specific SRY gene by PCR in order to sex biopsied blastomeres derived from IVF goat embryos. Single cell PCR is a powerful tool in preimplantation diagnosis, using blastomere biopsy of goat embryos at the 4– to 8-cell stage. Based on the SRY gene located on the conserved region of Y-chromosome, a pair of primers were utilized (SRY gene specific primer SRY-F 5'CGA



Group of blastomeres from IVF goat embryos for sexing

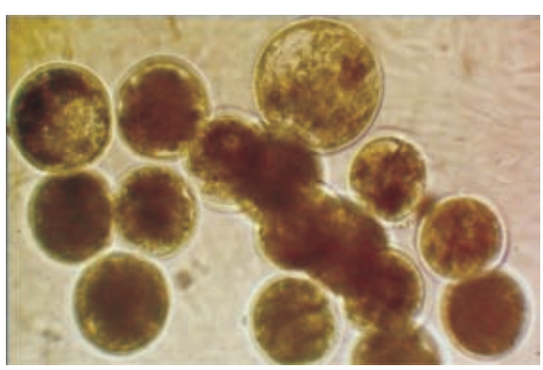
AGA CGA AAG ATG GCT CT3' SRY-R 5'TGT GCC TCC TCA AAG AAT GG3'and PCR was established to amplify a 122 bp fragment specific to the Y-chromosome in male goats. The *in vitro*

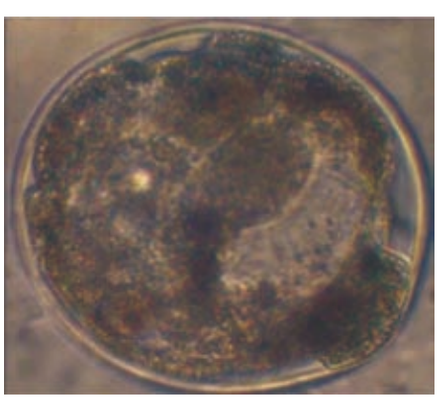


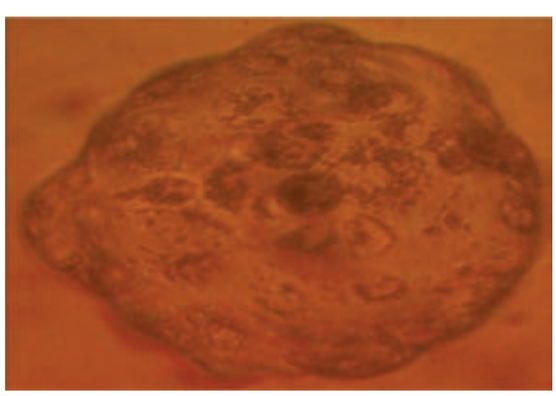
Amplified SRY gene (122bp) Mar: 50 bp DNA ladder, Lane 1, 2, 3, 5, 7 and 9 negative (female goat Embryos) Lane – 4, 6 and 8 positive (male goat embryos), NTC- no template control.

produced goat embryos were made zona free by treating with pronase. The cell number in each embryo was counted before sexing. Single blastomere was taken and SRY gene was amplified by using PCR. Biopsied embryos (n=32) were used for sexing. Out of these, 12 (37.5%) were confirmed to be male and 20 (62.5%) to be female.

**Development of goat parthenogenetic hatched blastocysts with Ca ionophore:** The effects of different serum concentrations on the production of parthenogenetic goat embryos were investigated. Oocytes were isolated from slaughterhouse goat ovaries and were cultured in maturation medium containing TCM-199, 0.5 µg/


*A group of parthenogenetic goat blastocysts*


*Parthenogenetic goat blastocysts*


*Parthenogenetic hatched goat blastocysts*

ml FSH, 10 µg/ml LH, 1 µg/ml estradiol-17β, 3% BSA and 10% FBS in 5% CO2 in air at 38.5°C for 24 h. Parthenogenetic activation was performed with Ca ionophore, reconstituted by dissolving Ca ionophore (20 µl/ml) in embryo development medium without any serum. Oocytes were incubated in 6-DMAP for 4 h. After activation, the oocytes were washed thrice with fibroblast medium containing 5% FBS followed by one washing with RVCL medium. Following culture of oocytes in RVCL medium containing 1% BSA and different concentrations of serum (0, 1, 2.5, 4, 6, 7.5 or 10%), the cleavage rate obtained was 22, 24, 40, 76, 63, 55 and 40%, respectively, whereas the blastocyst rate was 9, 12, 20, 37, 27, 20 and 11%, respectively, indicating that the growth of parthenogenetic goat embryos up to the blastocyst was better in culture medium containing 4% serum. Interestingly, medium without any serum supplementation also supported growth of parthenogenetic embryos.

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

A polymerase chain reaction, amplifying a fragment of the mitochondrial DNA D loop region was developed for species specific detection of cattle and buffalo milk. The method was simultaneously extended for detection of HTST pasteurized milk samples and cheese of bovine and buffalo origin. A common forward primer was used with two different species specific reverse primers that resulted amplification of a 126 bp and 226 bp products for cattle and buffalo, respectively, in simplex as well as in multiplex polymerase chain reaction. The primers successfully amplified DNA extracted by conventional protocol from minimal amount of raw milk, heat treated milk and cheese of either bovine or buffalo origin. The primers showed a high degree of specificity. The sensitivity of the assay was excellent with detection level of 0.1% adulteration of cow and buffalo milk or cheese (0.15 ng buffalo and 0.04 ng cattle DNA). The assay represents a sensitive and simple method for identification of adulteration in milk and cheese.

The iron-desaturated lactoferrin was used for determining the thermal stability by using differential scanning calorimtery. A single major denaturation endotherm was observed in case of cattle and buffalo apo-lactoferrins at around 50-66°C. In case of camel, sheep and goat apo-lactoferrin, in addition to major transition at lower temperature (Td ~ 50-66°C), a minor endotherm was also followed at higher temperature, with Tm ~ 77-80°C for sheep and goat and Tm > 86°C for camel at acidic pH values. In case of camel, the enthalpy of denaturation of second peak was appreciably higher than those of sheep and goat. On the other hand, iron saturated lactoferrins showed several transitions between 50°C and 80-90°C, the area under the peaks (enthalpy of denaturation), was higher in comparison to transition at lower temperatures. These results clearly indicated that

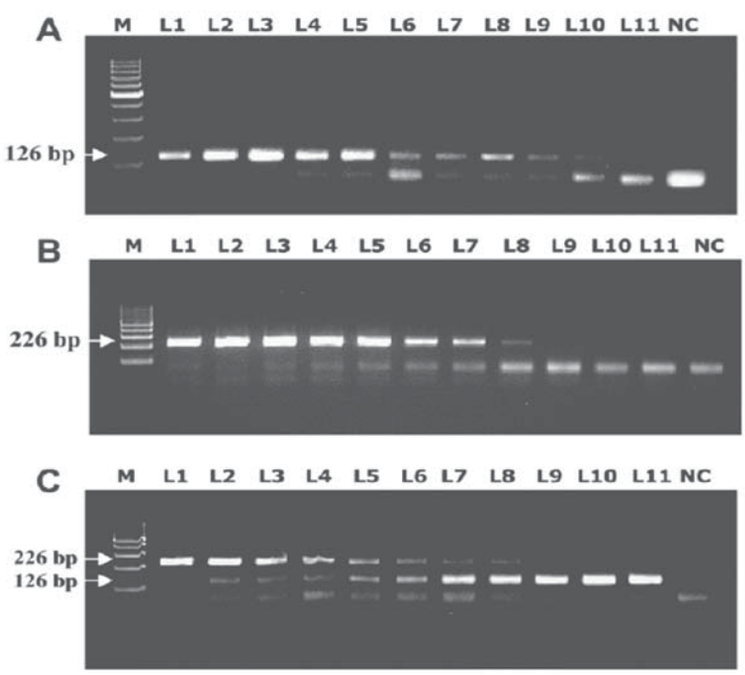



*Figure: Amplification result of mtDNA D loop in simplex PCR with cow specific primers: (Description of DNA samples in the lanes: Marker [M], serially diluted cattle DNA (20, 10, 5, 2.5, 1.25, 0.62, 0.31, 0.15, 0.08, 0.04 and 0 ng) and reverse dilution of buffalo DNA (0, 0.04, 0.08, 0.15, 0.31, 0.62, 1.25, 2.5, 5, 10 and 20 ng) respectively [L1-L11], and negative control [NC].) (A); buffalo specific primers: (Description of DNA samples in the lanes: Marker [M], serially diluted buffalo DNA (20, 10, 5, 2.5, 1.25, 0.62, 0.31, 0.15, 0.08, 0.04 and 0 ng) and reverse dilution of cattle DNA (0, 0.04, 0.08, 0.15, 0.31, 0.62, 1.25, 2.5, 5, 10 and 20 ng), respectively [L1-L11], and negative control [NC].) (B) and duplex PCR with all three primers: (Description of DNA samples in the lanes: Marker [M], serially diluted buffalo DNA (20, 10, 5, 2.5, 1.25, 0.62, 0.31, 0.15, 0.08, 0.04 and 0 ng) and reverse dilution of cattle DNA (0, 0.04, 0.08, 0.15, 0.31, 0.62, 1.25, 2.5, 5, 10 and 20 ng), respectively [L1-L11], and negative control [NC].)(C) in serially diluted mixed DNA samples of cow and buffalo*

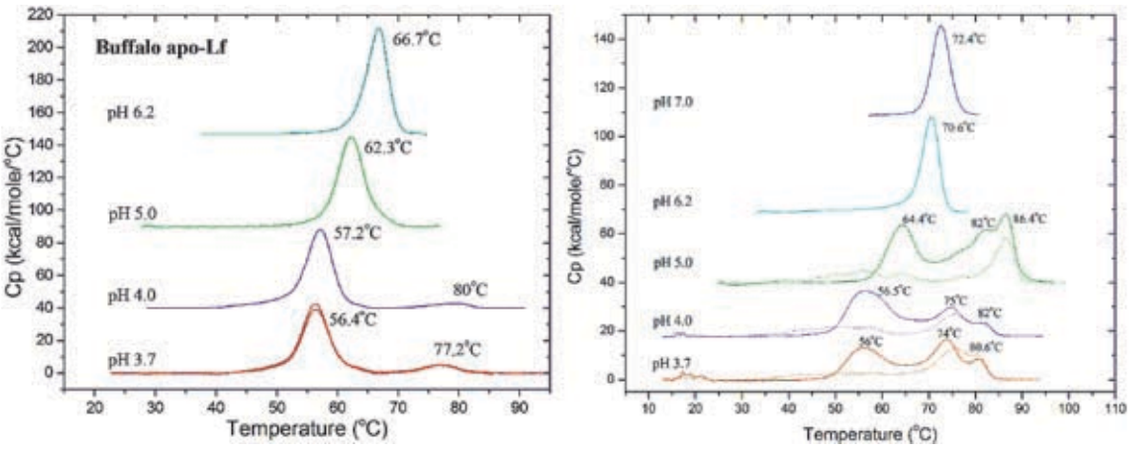
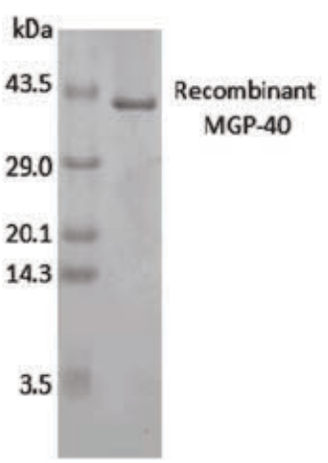



*Figure: Thermal denaturation profile of buffalo lactoferrin. Panel on left side shows thermal denaturation of iron-desaturated lactoferrin (apolactoferrin), while the panel on right side shows for denaturation of iron-saturated lactoferrin at various solution pHs*

the lower transition originated from lactoferrin population lacking iron, while the transition at higher temperature originated from iron bound lactoferrin. The transitions at lower as well as at higher temperatures were accompanied with several overlapping denaturation reactions. The results indicated that iron binding increased the stability of lactoferrin by as high as 25-30°C. The study has important technological implication with respect to heat processing of milk and milk proteins. It may be suggested that lactoferrin can be protected against irreversible heat denaturation by saturating them with iron before processing.

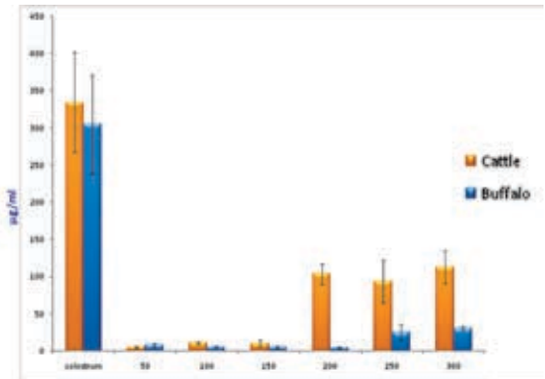
## Genetic Improvement of Milch Animals through Identification and Dissemination of Superior Germplasm by Application of Emerging Reproductive and Molecular Technologies

The recombinant expression of MGP-40 protein was carried out in pET22b+ bacterial expression vector. Technique for purification of MGP-40 by heparin affinity chromatography was standardized and the purified protein was used in cell biology studies. MGP-40 protein was determined during different stages of lactation in cows and buffaloes, in short lactating animals and animals suffering from sub-clinical and clinical mastitis using antibody of human origin YKL-40, which is orthologue of MGP-40, as a control. During peak lactation, the expression of MGP-40 was almost non-detectable suggesting that in an actively proliferating state, the expression of MGP-40 is less. During late lactation the level of MGP-40 started increasing and during involution the level was very high. An over expression of MGP-40 was observed during both sub-clinical and clinical mastitis. A major problem in Sahiwal cows was found to be the inconsistent lactation (short/truncated lactation).




It was also observed that the level of MGP-40 was comparatively higher in short lactating animals in comparison to that in normal lactating animals. As compared to high producing animals, MGP-40 expression was more in low producing animals.

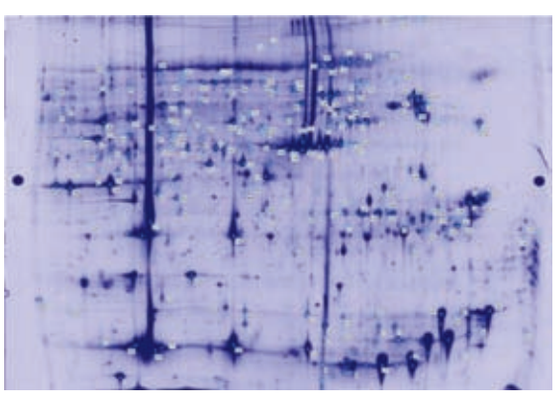
Insulin-like growth factor binding protein-5 (IGFBP-5) is a 29-kDa proapoptotic protein, which is expressed in the mammary gland epithelial cells during involution process and has been associated with apoptosis of secretory mammary epithelial cells thereby causing impaired mammary gland development and cessation of milking. It was hypothesized that proapoptotic factors like IGFBP-5 may be getting expressed in alveolar epithelial cells of mammary gland in animals showing short/truncated lactation thereby causing programmed cell death of the mammary epithelial cells leading to decrease in milk yield. This study was taken up to generate full length sequence information of IGFBP-5, heterogenous expression of recombinant IGFBP-5 and assay of IGFBP-5 in milk of cattle and buffaloes during lactation in normal lactating and in animals showing inconsistent lactation (short/truncated lactation).




*Comparative assay of IGFBP-5 in cows and buffaloes throughout lactation period*

Buffalo IGFBP-5 cDNA was synthesized by using the RNA isolated from buffalo mammary gland and sequenced. Open reading frame of buffalo IGFBP-5 consisted of 813 nucleic acids. Translation of buffalo IGFBP-5 cDNA to amino acid sequences gave rise to the protein sequence which consisted of 271 amino acids. Nucleic acid sequence of buffalo IGFBP-5 was compared with available IGFBP-5 nucleic acid sequences of other mammalian species. The 5'and 3' non-translated region of buffalo IGFBP-5 was also determined. For heterologous expression, buffalo IGFBP-5 was cloned and expressed in E. coli and was partially purified. Expression analysis of IGFBP-5 was performed in milk of cattle and buffaloes during lactation by RT-PCR and ELISA. The RT-PCR data on IGFBP-5 showed 69.1 ± 14.16 and 23.27 ± 6.21 fold expression during involution and colostrums, respectively, than peak lactation. In ELISA, the expression of IGFBP-5 (µg/ml) during lactation was observed to be 420.00 ± 127.01 (colostrum); 5.32 ± 1.36 (50 days), 25.02 ± 6.21 (100 days), 15.17 ± 3.94 (150 days), 173.91 ± 23.35 (200 days), 131.35 ± 48.8 (250 days), 164.03 ± 25.85 (300 days), 2675 ± 158.77(involution), 58.41 ± 10.00 (less persistent lactations), 417.95 ± 123.42 (sub-clinical mastitis) and 946.43±55.02 (clinical mastitis). Expression level of IGFBP-5 during involution was observed to be 7.7, 19.7, 129.5 and 608.9 times higher in comparison to colostrum, late, peak and early lactation, respectively. The expression of IGFBP-5 in subclinical and clinical mastitis was observed to be 16.7 and 37.82 fold higher in comparison to that in peak lactation. Similarly in buffaloes, the expression of IGFBP-5 (µg/ml) during lactation was observed to be 370 ± 105.98 (colostrum); 8.73 ± 3.94 (50 days), 5.96 ± 0.73 (100 days), 5.90 ± 2.38 (150 days), 4.7 ± 0.97 (200 days), 30.73 ± 25.63 (250 days), 30.16 ± 3.84 (300 days), 1093.33 ± 72.18 (involution), 76 ± 7.54 (truncated or less persistent lactations). Expression level of IGFBP-5 during involution was observed to be 3, 5, 180 and 128 times higher in comparison to colostrum, late, peak and early lactation, respectively.

Isolated mammary epithelial cells from milk were identified and characterized by real time PCR by observing the expression of genes such as cytokeratin-8, α-lactalbumin and EMA and absence of SMA and western blot analysis using primary antibodies such as cytokeratin 8 and casein. Proteome analysis of bovine mammary epithelial cells at peak stage of lactation was done by shotgun proteomics method as well as 2D-SDS-PAGE method. 2DE reference map of bovine MECs was made using 18 cm IPG strips and 12.5% SDS-PAGE within the range of pH 4 to 7, to resolve the maximum proteins which are commonly present at physiological range. The 2DE reference map was made taking 4 biological replicates and three technical replicates. Out of the 689 protein spots picked up from the 2D-gel, 430 proteins have so far been identified by MALDI-TOF-TOF. Out of 430 proteins, 178 proteins were unique. This will explain the role of various proteins which help in milk secretion and synthesis. To understand the comprehensive proteome profile of the bovine mammary epithelial cells, bovine mammary epithelial cell lysate was subjected to SDS-PAGE and was cut into small pieces. These were digested by trypsin to peptides and were subjected to LC-ESI-MS. The peptide spectrum was subjected to Mascot search and by following this approach 503 proteins have been identified till date. These proteins were found to play an important role in protein, carbohydrate and lipid

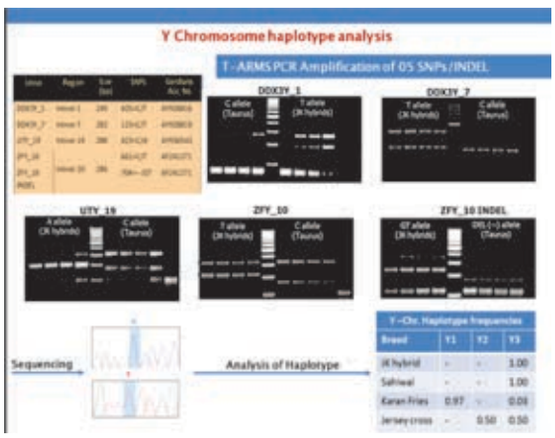


*2D reference map of functionally differentiated bovine mammary epithelial cells during peak lactation*

metabolism. Many of the proteins were involved in signaling pathways. Also, 19 novel proteins and 84 predicted proteins were identified about which no information is available. Extensive bioinformatics analysis was carried out of the identified proteins and the various metabolic pathways existing in the functionally differentiated mammary epithelial

cells and protein-protein interactions were established. Attempts were made to examine the differentially expressed proteins at different stages of lactation such as early, peak and late lactation in cow using DIGE and 90 differentially expressed proteins were identified. The data generated is being currently anslyzed in greater details.

**Xanthine oxidoreductase (XOR):** The molecular properties of buffalo XOR were studied with respect to its physiochemical and biochemical properties as well as sequence variation, which could help understand the biology of this important enzyme in the physiology of animal. Partial sequence of XOR cDNA (2 kbp) corresponding to Molydopterin domain was cloned and sequenced. Sequencing analysis showed 95% similarity with cattle XOR, 93.7% with goat XOR, 88% with human XOR and 81.5% with mouse XOR. Native XOR was purified to homogeneity from buffalo milk by solvent extraction, ammonium sulphate precipitation, heparin affinity chromatography and anion exchange chromatography. The typical yield of 17 ± 0.35 mg/lit of milk was obtained. Buffalo XOR showed an oxidase activity (XO) of 0.65 ± 0.07 U/mg and dehydrogenase activity (XDH) of 0.26 ± 0.03 U/mg. Absorption spectrum and circular dichroism (CD) analysis in the near UV (250-320 nm) and visible region (320-750 nm) suggested the similarity of 3o structure and content of FAD (1 FAD/XOR) and occupancy of Fe/S centres similar to cattle XOR. The Mo content in buffalo XOR was found to be 40% as compared to bovine XOR that has been reported around 55-60%, which could be responsible for the lower XO activity of buffalo XOR. The active fraction of buffalo XOR was only 35% of the Mo content, which translated in to a 14% of the XOR in the active form as compared to 23-27% of cattle XOR in the active form and thus




explaining the difference of 2X between the XO activities of XOR from these species.

Under the NAIP project "Genetic basis of inferior sperm quality and fertility of crossbred bulls" bovine Y chromosomal haplotyping method was developed based on Y chromosome based SNPs and indel markers. Y chromosome microsatellites (STRs) were used to distinguish between B. taurus and B. indicus ancestry. These markers were found to be useful to detect introgression and to distinguish between Bos taurus and Bos indicus patrilines. Characterization and conservation of domestic animal genetic resources is a priority, and efforts are being made to take into account information from nuclear, mitochondrial, and Y chromosome markers to define conservation priorities. The analysis of Y chromosome haplotypes can thus provide additional information for inferring the origins and genetic relationships of our cattle in India and help in classifying Indian cattle into different haplogroups and also establishment of a reference database on the likes of those available for humans or Bos taurus cattle.

## Animal Biochemistry

### Effect of Probiotic Dahi on Immune Functions and Ageing

Using experimental models, it was established that 'probiotic dahi' improves immune functions and slows down the process of ageing.

**Antioxidant status:** The antioxidant status (catalase and glutathione peroxidase activities) declined, and the accumulation of tissue oxidation products, thiobarbituric acid reactive substances (TBARS) and protein carbonyls, significantly increased in RBCs, liver, kidney and heart tissue of aged mice (12 and 16 month old). Superoxide dismutase (SOD) activity in aged mice increased in liver and erythrocytes, while in kidney and heart no change was observed. The antioxidant enzyme ratio (SOD/Catalase+glutathione peroxidase) increased significantly in all the tissues of aged mice.

**Macrophage functions:** The production of reactive oxygen intermediates (hydrogen peroxide, intracellular and extra cellular superoxide ions) declined in peritoneal macrophages in aged mice. In splenic macrophages, the production of hydrogen peroxide and extracellular superoxide ions increased in aged mice, while intracellular superoxide ion production was not affected.

The LPS or LPS+IFN-γ stimulated macrophages (peritoneal as well as splenic) from aged mice produced lower nitric oxide and cytokines IL-6 and TNF-α. Further, the LPS stimulated macrophages (peritoneal and splenic) from aged mice also produced more prostaglandin E2 (that suppresses lymphocyte proliferation and function) than did macrophages from young mice. The adherence and phagocytic indices of peritoneal macrophages declined in aged mice.

**Lymphocyte functions:** The proliferation of splenocytes in response to mitogens (LPS or ConA) declined in aged mice. The in vitro production of IL-2 by T lymphocytes diminished and that of IL-6 and TNF-α increased in aged mice. The significantly increased production of IgG and IgM was observed (by B-splenocytes) in aged mice, while the difference in IgA production was not significant in three age groups.

**Biomarkers of ageing:** The expression of cyclooxygenase-2 (COX-2) (biomarker of inflammageing) mRNA was not detectable in young mice, but observed in liver and kidney tissue of aged mice. The inducible nitric oxide synthase (iNOS) mRNA expression in liver and kidney tissue increased 10-15 folds in aged mice. Further, the aged mice registered decreased expression of peroxisome proliferators-activated receptor-α (PPAR-α) that down regulates COX-2 and iNOS expression. The expression of heme oxygenase-1 (regulates breakdown of hemoglobin) and cyclin-dependent kinase inhibitor-2 (p16ink4a) mRNA was significantly increased in liver and kidney tissue of aged mice. On the other hand, the expression of klotho, (maintains calcium and phosphorus homeostasis) and senescence marker protein-30 (regulates cell survival) mRNA decreased in liver and kidney tissue of aged mice.

## Molecular and Biochemical Changes Associated with Ageing

The antioxidant status, immune function and expressions of ageing biomarker genes were studied in 4, 12 and 16 months old mice for understanding changes linked to ageing.



**Health benefits of Probiotic Dahi:** Seven groups of 12 months old male mice were fed with supplements (5g/day) of buffalo milk (3% fat), regular Dahi and probiotic Dahi (P-Dahi containing L. plantarum; A-Dahi containing L. acidophilus; AP-Dahi containing L. acidophilus and L. plantarum ; AB_dahi containing L. acidophilus and B. Bifidum) or no supplements (control) followed by basal diet ad libitum for four months. Feed intake, body weight and organ indices were comparable in six dietary groups.

**Tissue Antioxidant status:** The age related decline in catalase activity in erythrocytes, liver, kidney and heart tissues was reversed by feeding any of the four probiotic Dahi preparations, while milk and regular Dahi had no significant effect. The age related decline in glutathione peroxidase was reversed in liver and RBCs by feeding probiotic A-Dahi, AP-Dahi or AB-Dahi, while in other tissues, the effect was not significant. Superoxide dismutase activity was not affected in any tissue by feeding aged mice with probiotic Dahi. The antioxidant enzyme ratio declined significantly in liver and erythrocytes by feeding any of the four probiotic Dahi to aged mice, and the effect was not extended to heart and kidney tissue. The accumulation of TBARS significantly decreased in liver, kidney and plasma by feeding any of the four probiotic Dahi to aged mice. The significant decline in protein carbonyls in response to feeding probiotic Dahi preparations was observed only in plasma.

**Production of reactive oxygen species by immune cells:** The age related decline in production of reactive oxygen intermediates (hydrogen peroxide, extracellular and intracellular superoxide ions) by peritoneal macrophages was reversed by feeding mice with any of the four probiotic Dahi preparations. However, the effect was not extended to the splenic macrophages. Feeding probiotic Dahi to aged mice also reversed age induced decline in nitric oxide production by LPS+IFN-γ stimulated peritoneal macrophages. Again the effect was not extended to splenic macrophages (stimulated with LPS or LPS+IFN-γ).

**Interleukin production by immune cells:** Feeding any of the four probiotic Dahi or regular Dahi to aged mice significantly enhanced the production of IL-6 by LPS stimulated peritoneal macrophages, however, the production of TNF-α by peritoneal macrophages (stimulated with LPS or LPS+IFN-γ) was not significantly affected. Also, the splenic macrophages (stimulated with LPS or LPS+IFN-γ) registered no significant change in IL-6 or TNF-α production by feeding aged mice with milk, regular Dahi or the four probiotic Dahi preparations. The reversal age induced decline in IL-2 production by cultured splenocytes was observed in probiotic Dahi fed mice, while regular Dahi had no effect. The production of IL-6 or TNF-α by splenocytes was not significantly affected by feeding mice with probiotic Dahi, regular Dahi or milk.

**Prostaglandin E2 production by immune cells:** Feeding any of the four probiotic Dahi or regular Dahi to mice reversed age related increase in prostaglandin E2 production by peritoneal macrophages, while the effect was not extended to splenic macrophages.

**Phagocytosis by peritoneal macrophages:** Feeding any of the four probiotic Dahi or regular Dahi to aged mice reversed age induced decline in adherence and phagocytic indices of peritoneal macrophages, while milk and regular Dahi had no significant effect.

**Lymphocyte proliferation:** The proliferation of B lymphocytes was stimulated by feeding aged mice with A-Dahi, AP-Dahi or AB-Dahi, while milk, regular Dahi or P-Dahi had no significant effect. The stimulation of T cell proliferation was observed in aged mice fed with P-Dahi, AP-Dahi or AB-Dahi, while A-Dahi, regular Dahi or milk had no effect.

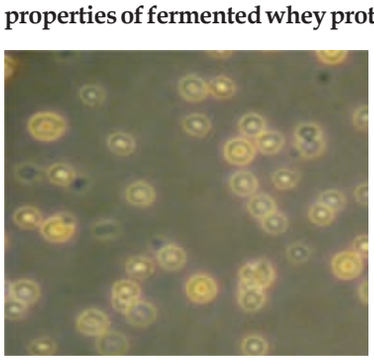
**Ageing biomarkers:** The age induced increase in expressions of heme oxygenase-1 mRNA in liver and kidney tissues was reversed by feeding mice with any of the four probiotic Dahi. Probiotic Dahi or regular Dahi up- regulated PPAR-α mRNA expression in liver but not in kidney. The expression level of klotho mRNA was increased in liver and kidney tissue of aged mice fed with any of four probiotic Dahi preparations. The expression of senescence marker protein-30 mRNA increased in the liver but not in kidney tissue of aged mice fed with any of the four probiotic Dahi. The expression of COX-2 , iNOS and cyclin-dependent kinase inhibitor-2 (p16ink4a) mRNA in liver and kidney tissue of aged mice were not affected by feeding any of the four probiotic Dahi or regular Dahi.

## Immunological Properties of Milk Protein and its Hydrolysate

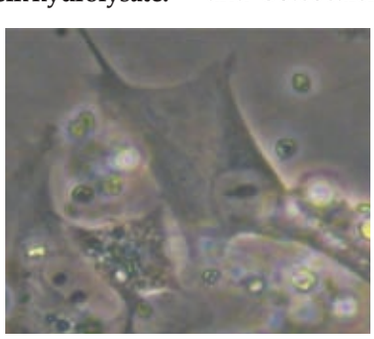
**ACE-Inhibitory and immunomodulatory properties of fermented whey protein hydrolysate:** Whey protein hydrolysate showed ACE-inhibitory and immunomodulatory activity under in vitro conditions. Feeding of fermented whey products resulted in significant decrease in total IgE and ova-specific IgE levels in allergy induced mice by increasing the production of Th-1 cytokines (IL-2) and decreasing Th-2 cytokines (IL-4) levels. It suggests that fermented whey hydrolysates controls ovalbumin induced allergy in mice.

**Antioxidative and immunomodulatory potential of Caseinophosphopeptides (CPPs):** Phagocytic activity, mitogenic and humoral response of cow CPP and buffalo CPP were evaluated in experimental mouse model. Both cow and buffalo CPPs exhibited increased phagocytic activity when animals were fed diet containing CPPs. Mitogenic and phagocytic activity of cow CPPs were relatively more. Total IgG levels in blood and IgA levels in the intestine were also significantly more in the animals fed with CPPs in comparison to animals maintained on diet lacking CPPs. Also, there was significant increase in diphtheria specific IgG and IgA levels and significant decline in OVA/ Diphtheria specific IgE levels in CPPs fed mouse group in comparison to control. The results clearly exhibit that CPPs enhance both systemic as well as mucosal immunity. On the other hand, CPPs has protective effect against OVA and diphtheria induced IgE levels.

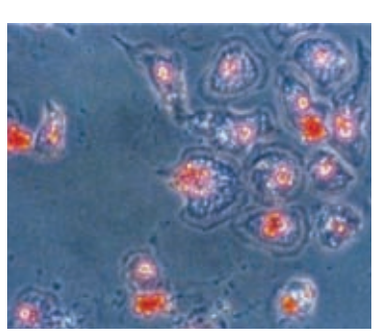
**Osteogenic potential of casein hydrolysate:** Culturing conditions for osteoclasts and osteoblasts from bone marrow cells were optimized. The differentiation of bone marrow cells into osteoblasts requires presence of β-glycerophophate and ascorbate in medium. The differentiation of osteoprogenitor cells to pre-osteoblasts started on 6-7th day of culture and completed in 21 days with mineralization. The differentiation of osteoprogenitor cells to osteoblasts was confirmed by the expression of osteoblast specific gene markers viz. Alkaline phosphatase, Osteoprotegrin and Osteocalcin. Osteoblasts were stained with



*Bone marrow cells (BMC) (0 day)*



*BMC derived osteoblasts (21 days)*



*Calicium deposits in BMC derived osteoblasts (Alizarin red stain)*

alizarin red-S to show the calcium deposits. The treatment of bone marrow cells with casein hydrolysates depicting to be ACE inhibitory peptides enhanced osteoblast gene expression in favour of bone formation and increased mineralization. So, these peptides were found to be anabolic to bone, an effect that is consequent upon their potent proliferative and differentiated actions in osteoblasts.

## Comparative Evaluation of Hyperimmune Properties of Milk Proteins

**Humoral response:** Humoral response against milk proteins in mouse model revealed that the groups of animals sensitized with ova-albumin (positive control), cow β-LG, goat βLG, and cow casein have remarkably higher ($P< 0.05$) total IgE levels as compared to negative control group of animals. However, the levels of total IgE were significantly less in buffalo βLG, cow casein, buffalo casein and goat casein groups as compared to positive control. Ovalbumin and β-LG (cow and goat) sensitized animals also elicited remarkably higher protein specific IgE antibodies titer as compared to buffalo milk proteins. The maximum titer of protein specific IgE was observed in positive control group followed by cow β-LG group. In case of IgG response to milk proteins, levels increased significantly ($P< 0.05$) on immunization with βLG of cow, buffalo and goat but non significant increase was observed with casein proteins as compared to negative control group.

**Cell mediated response:** Visualization of cell mediated immune response was determined by lymphocyte proliferation index (LPI). Splenocytes obtained from negative control, positive (Ovalbumin) and milk protein sensitized groups were cultured in presence of isolated milk proteins (caseins and β-LG) and mitogens (LPS and ConA). Addition of isolated milk proteins and mitogens in splenocytes harvested from naïve animals (negative control group) showed statistically insignificant variations in LPI values. However, presence of LPS significantly increased ($P< 0.05$) the proliferation of lymphocytes in animal groups sanitized with Cow, Buffalo and Goat β-LG and cow casein groups as compared to negative control groups.

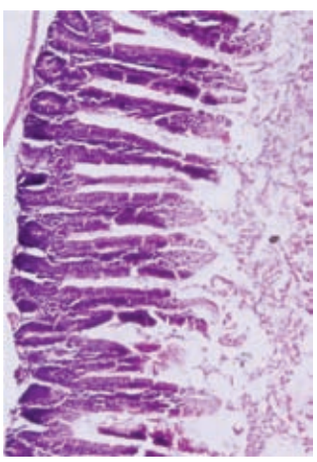
## Pediocin Combats Bacterial Resistance

The pediocin activity from the three cultures was purified and confirmed for their molecular weight using SDS-PAGE and inhibitory activity on SDS-PAGE gel. The purified pediocin produced by Pediococcus acidilactici NCDC 252 was used to ascertain the % colorimetric response (CR) for interactions with biosensing nanosomes, prepared from pure phospholipids (PLs), in vitro. Distearoyl phosphatidyl ethananolamine (DSPE) nanosomes showed maximum % CR followed by Dipalmitoyl phosphatidyl glycerol (DPPG) and Dimyristoyl phosphatidyl glycerol (DMPG). The combinations of these displayed linear relationship for % CR and various ratios of PLs. Purified pediocin was also used to select spontaneous resistant mutants of *Staphylococcus aureus* and *Bacillus cereus*. There was no difference in growth of sensitive and resistant *S. aureus* both in the absence and presence of lysozyme. The Mg++ ions were found to increase the resistance against pediocin among resistant S. aureus. The number of surviving cells increased linearly when resistant *S. aureus* was treated with pediocin in the presence of increasing concentration of Mg++. In contrast, there was no effect of Mg++ for sensitive S. aureus against pediocin. The protective effect of Mg++ against pediocin for resistant *S. aureus* disappeared in the presence of EDTA. The cell surface hydrophobicity was twice for resistant *S.aureus* as compared to sensitive *S.aureus*. One amino-group containing (ACP) PL and one amino-group lacking PL appeared upon acquisition of resistance by *B. cereus* against pediocin in addition to one ACP present in sensitive *B.cereus*. Percent CR for interactions with biosensing nanosomes prepared from cellular lipid extracts of resistant *B. cereus* was more than sensitive *B. cereus.*

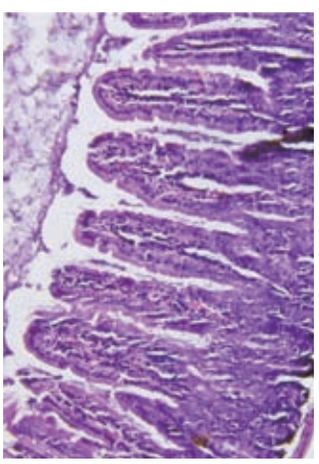
The target gene for pediocin from the cloned sequence was selected for design of PCR primers with included restriction sites for cloning in an expression vector. Pediocin gene was ligated in two expression vectors viz. pET28b+ and pET22b+. The recombinant construct was used for transformation of E. coli TOP10 cells. The recombinant plasmid was isolated and confirmed for the presence of insert using PCR. Then the recombinant vector was used for transformation of BL21 cells. Sequencing of recombinant pediocin gene insert was carried out to confirm the presence of pediocin gene insert in the expression vector. Expression of pediocin with induction using lactose, IPTG, different time intervals and temperatures was also carried out. Expression of the pediocin with a signal peptide was carried out. A QSAR model for curvacin A was developed using feed forward neural network with back propagation learning.

## Prebiotic

**β-glucan with *L. casei* fermented milk modulates gut microflora and immune system:** Effects of a prebiotic (barley beta-glucan), milk fermented with a potential probiotic (L.casei) and a combination of both of these (synbiotic) on the gut microflora and the immune system of mice were investigated in ovalbumin induced allergy model. The study revealed that there was significant decrease in the total bacterial counts (as determined by DAPI) in faeces of mice on induction of allergy. The feeding of diets supplemented with prebiotic/ milk fermented with probiotic or synbiotic were found to resist the decrease in bacterial counts. A significant increase in the Lactobacilli and Bifidobacteria counts in the feces of mice fed different functional food ingredients (barley beta-glucan, milk fermented with probiotic and synbiotic) was observed. Induction of allergy led to different pathological changes like increase in total IgE level in serum, histopathological changes in intestinal tissue. A protective effect of feeding of different functional food ingredients was observed.



*Histopathological section showing ileum with goblet cell hyperplasia, denudation of villi with H.E. staining in Control Ova +ve group*



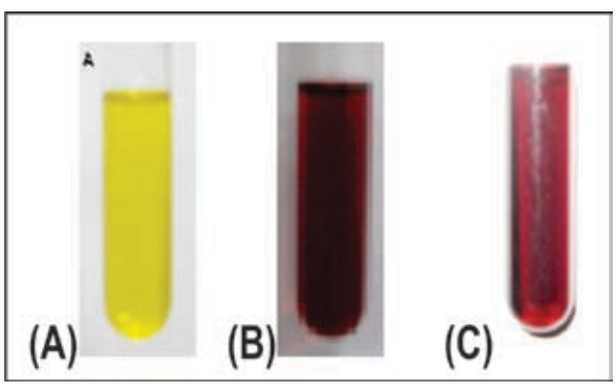
*Histopathological section showing less denudation of villi with H.E. staining in Pre+Pro (synbiotic) Ova +ve group*

**Inulin and β-glucan act in anti-obesity:** The anti-obesity potential of barley β-glucan and inulin in C57/BL6 mice under high fat dietary conditions (HFD) was investigated. A significant difference in body weights and cumulative body weight gains by dietary supplementation of the prebiotic fibers i.e. inulin (HFD-INU) and β-glucan (HFD-BG) was found as compared to control (HFD) animals. A significant difference was observed in cumulative food intake in HFD-BG as compared to HFD. Both Lactobacilli and Bifidobacteria counts (determined by Fluorescent in situ Hybridization technique using fluorescently (cy-3) labeled probes) were observed to increase significantly with feeding of prebiotics in faeces as well as caecal contents. MRI/S study revealed whole body adiposity to be significantly different between HFD and HFD-INU, adipocyte size was also lowest in HFD-INU. However, no change in lipid levels of liver and muscle was observed by prebiotic supplementation of HFD. The Manganese enhanced MRI (MEMRI) patterns displayed lower neuronal activation in all the major appetite centers of brain (arcuate nucleus, ventromedial nucleus, paraventricular, periventricular nucleus and nucleus of tractus solitarius) and revealed the highest satiated state in mice fed diet supplemented with β-glucan. It revealed that both prebiotic fibers (inulin and β-glucan) had anti-obesity potential but they worked through different routes which could be ascribed to their chemical composition and physical characteristics.

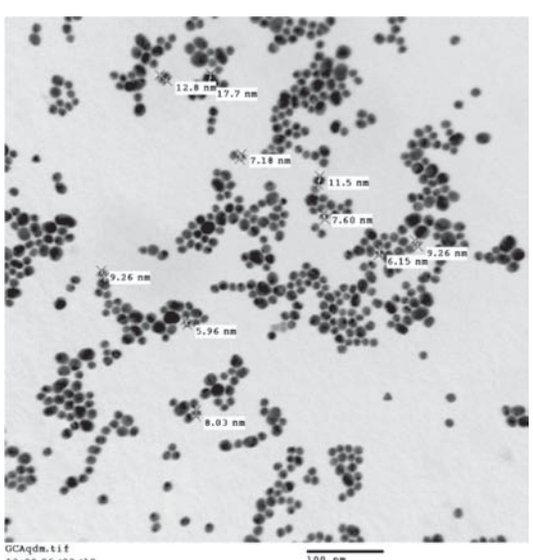
## Gold Nanoparticles with Improved Stability

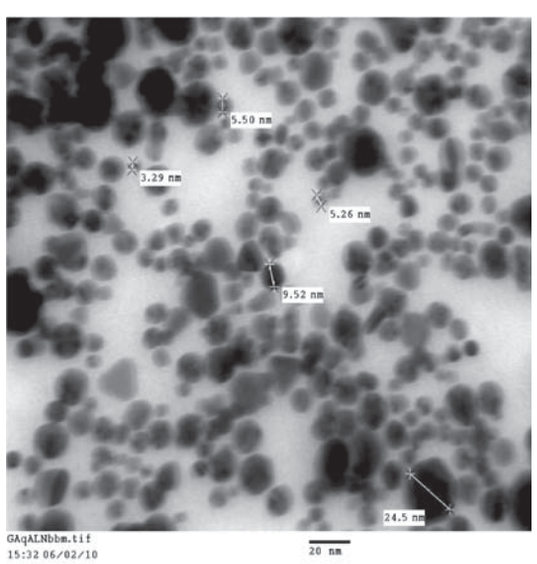
Nanoparticles are essentially required for lateral flow system employed in diagnostics and further, gold nanoparticles (GNPS) are coloured, GNPs are widely exploited for their commercial use. Since, GNPs in experimental design come in contact with biological samples differing in ionic strength, pH and polarity; efforts were made to improve stability of GNPs over the existing method. The most common method used for GNPs is through use of citrate which acts as reducing and stabilizing agent. The size, size uniformity and shape of nanoparticles control physical and optical properties of GNPs. A number of reducing agents viz., oxalic acid, succinic acid, malic acid, maleic acid, glutaric acid, 1-amino 2-naphthol 4-sulphonic acid (ANSA) and sodium borohydride were attempted to prepare GNPs in aqueous system and preparations were characterized with respective size, shape,

plasmon resonance peak and stability. For comparative purposes, GNPs were prepared by citrate reduction method. Out of the above mentioned reducing agents, GNPs prepared with ANSA (as reducing agent) were distinctly more stable. ANSA-GNPs showed plasmon resonance peak at 532 nm with an absorbance value of 3.06. The average size of particles was 10.1 ± 2.68 nm and the shape of particles was largely spherical. In comparison to 13% decrease in absorbance of citrate GNPs during storage at room temperature for 22 days, there was only 1% decrease in absorbance of ANSA-GNPs. Also, ANSA-GNPs exhibited at least five fold higher stability against NaCl when compared with GNPS prepared by citrate reduction method. ANSA acted as both reducing as well as stabilizing agent. ANSA can be used in both aqueous and non-polar solvent.




Change in colour of gold chloride solution on its conversion to nanoparticles (A) Pale yellow solution of gold chloride (B) deep red colour of GNP suspension using citrate as reducing agent (C) deep red colour of GNP suspension using ANSA as reducing agent.




*A* *B*

*TEM of GNP prepared from gold chloride using reducing agent (A) citrate (B) ANSA*

## Augmentation of Reproduction in Farm Animals

**Gene silencing of aromatase expression in buffalo granulosa cells using RNA interference:** Silencing of specific gene using RNAi is a valuable tool for functional analysis of a target gene. The interfering effects of siRNA have been validated on expression of Cyp19 gene and hormone (estradiol-17β) production in cultured buffalo granulosa cells. Qualitative gene knockdown was validated using fluorescent vector (EGFP) and fluorescently labeled siRNA (Cy3) duplex. While, siRNA targeted to luciferase and Cyp19 gene were attempted for quantitative measurements of siRNA knockdown after optimizing siRNA concentrations for transfection. Significant suppressive effect on the mRNA levels of Cyp19 gene at 100 nM siRNA concentration was observed after 24hrs of treatment of transfected cells with FSH. Significant decline in the estradiol levels was also observed in comparison to control. Present study validated the gene silencing using RNAi and hormone production in buffalo granulosa cells.

***Cyp19* (aromatase) gene regulation in buffalo:** *Cyp19* gene is involved in estradiol production. RT-PCR analysis showed the differential expression of *Cyp19* gene in follicular development and differentiation, placenta and different brain tissue in buffalo. Isolation and analysis of tissue-specific transcripts by 5'RACE and RT-PCR showed that the promoter II was the major promoter responsible for aromatase expression in the preovulatory stages and promoter I.1 in postovulatory stages in buffalo. Proximal promoter II (650 bp) and promoter I.1 (734 bp) region were isolated and cloned in pCRII vector using PCR techniques. In silico analysis showed that there was a single base pair deletion in the cAMP- like sequence (CLS) element present in the promoter II region of the buffalo *Cyp19* gene as compared to human. To understand molecular mechanism of estrogen biosynthesis in ovarian cysts, expression and its probable mode of regulation of *Cyp19* gene in ovarian cysts was studied. Results showed that *Cyp19* gene is differently expressed and regulated in promoter specific manner in large follicle, follicular cyst and luteal cyst in buffalo. To elucidate epigenetic regulation of *Cyp19* gene expression in different stages gestation, methylation analysis of the CpG dinucleotides of two major promoters of *Cyp19* gene was carried out. Methylation analysis of individual CpG residues was done by bisulfite direct sequencing method that enables the methylation analysis of all CpG dinucleotides within a given genomic region. The present investigation reported for the first time, a correlation of low methylation and high expression at different stages of gestation. The placenta of early gestation and post parturition period possessing high concentrations of Cyp19 gene transcripts were found to have their Cyp19 gene promoters almost completely hypomethylated. On the other hand, the placental cotyledons of mid gestation stage possessing low levels of Cyp19 gene transcripts had hypermethylated promoters. In conclusion, the data of present study demonstrated that PI.1 was the major promoter responsible for Cyp19 gene expression in buffalo placenta and differences in the methylation status of PI.1 coincided with Cyp19 gene expression in buffalo placenta of different stages of gestation. In addition, the relative expression of Cyp19 mRNA in cotyledons of normal and retained term placenta was studied. Interestingly, results showed that the expression of Cyp19 gene was significantly ($p<0.05$) lower in retained placenta as compared to normal term placenta. Real-time PCR data supports the conventional-PCR and nested PCR results and retained placenta was found to have 2.5 fold lower expressions than the normal term placenta. In ovary, region I.1 and region II of Cyp19 gene showed tissue-specific differences in their methylation status. Both the regions were found to be almost unmethylated in granulosa cells of small follicle and large follicle, but highly methylated in corpus luteum. The inverse correlation between percentage of methylation and expression of Cyp19 gene in ovary was found to be mainly due to the change in methylation status of ovary specific promoter PII with little effect of methylation on PI.1, which was found to be highly methylated even in CL. Promoters were involved in initiating transcription and were important cis-acting elements that regulated gene expression and might harbour functionally relevant polymorphisms. However, they differed from most regulatory elements in that their locations were fixed relative to the positions of their respective genes, and therefore, promoter sequences were an ideal choice for undertaking large scale analysis and functional annotation. The Single Strand Conformation Polymorphism (SSCP) followed by sequencing was used to screen the SNP in isolated tissue specific promoter. Analysis of promoter II sequences of normal cyclic animals and late matured animals from individual group, suggested the presence of a novel single nucleotide polymorphism (SNP) at position -135 from translation start site in buffalo. The presence of this polymorphism resulted in three different allelic variants i.e. TT homozygous, CC homozygous and T/C heterozygous. The -135 position was a putative methylation site, as observed in our methylation study too, which could be responsible for varying expression level of Cyp19 gene in differentiated fertility performance animals.

**Biochemical changes during cryopreservation of buffalo semen:** Freshly collected buffalo semen of more than +3.0 mass activity was split for analysis as fresh and as cryopreserved semen in Egg yolk Tris Extender. The samples were processed in sp-TALP medium and in vitro capacitated in 0.5 ml columns (25 million cells) in presence of Heparin (10µg / ml) for 6 hr to compare with the cryopreserved sample. The cryopreserved spermatozoa were found to be in a capacitation state (15-25%) compared to fresh spermatozoa where it was observed to be 2 to 3% and in vitro capacitated cells (50-60%). The cryopreserved spermatozoa showed lipid peroxidation higher than the fresh spermatozoa and lesser than the in vitro capacitated cells. The total antioxidant status of spermatozoa and seminal plasma decreased and rate of hydrogen peroxide and superoxide

anion increased in cryopreserved spermatozoa. The membrane phospholipids like phosphatidyl choline and phosphatidyl inositol were hydrolyzed to generate lysophosphatidyl choline and 1.2-diacylglycerol in the cryopreserved spermatozoa. The cryopreserved spermatozoa showed lesser cholesterol/ phospholipids ratio and increased intracellular calcium compared to the capacitated cells. The number of tyrosine Phosphorylated protein (p20, p32, p49, p55, p72, p86, p95 and p100) were more in cryopreserved spermatozoa as compared to fresh spermatozoa where only few tyrosine phosphorylated protein could be detected (p45 & p55).

The additives like Taurine (50 mM); Trehalose (100 mM), p- bromophenacyl bromide (200 µM); Catalase (100 units/ml); Zncl2 (5 mM); Quinacrine Hcl (200 µM); Seminal plasma (20% v/v); Cholestrol loaded cyclodextrins (1.5 mg/108 cells) were added to the extender prior to cryopreservation for the prevention of capacitation like changes in the cryopreserved spermatozoa. Taurine, Trehalose, Catalase & p-bromophenacyl bromide effectively prevented the capacitation like changes while others did not show the positive results. The post thaw motility, Plasma membrane integrity and sperm viability were improved to the extent of 25-30%; 15% and 10-15% in the presence of additives compared to their absence. The extent of capacitation in cryopreserved spermatozoa was improved by 30-40% by inclusion of additives. The inclusion of additives improved the in vitro capacitation of the cryopreserved spermatozoa compared to fresh spermatozoa in the presence of heparin (10 µg/ml) upto 6 hrs. Total antioxidant status of spermatozoa as nmoles/109 cells was improved by Taurine (28 ± 1.15 vs 36.33 ± 1.76) & Trehalose (28 ± 1.15 vs 31.74 ± 0.98). The respective value of seminal plasma as µM were (381.7 ± 23.13 vs 518 ± 27.49) for Taurine and 381.7 ± 7.23 vs 500 ± 32.14 for Trehalose. Taurine, Trehalose, Catalase and p-bromophenacyl bromide reduced the intracellular Ca++ in the cryopreserved spermatozoa compared to the control. In vitro fertilization experiments by cryopreserved spermatozoa in presence and absence of additives viz Taurine, Trehalose, Catalase and p-bromophenacyl bromide showed improved cleavage rates in presence of additives compared to the control. The growth upto blastocyst formation was more in Trehalose followed by Catalase and Taurine.

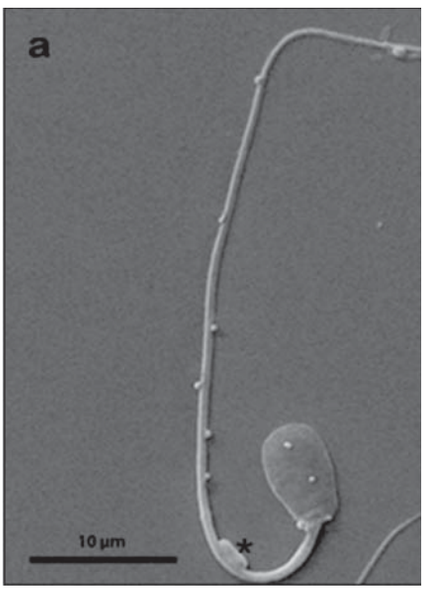
2D gel electrophoresis and Immunoblotting technique was standardized for identification of Tyrosine Phosphorylated proteins. Using this technique followed by MALDI MS/MS, 11 proteins were identified during in vitro capacitation of buffalo and 8 in Karan Fries spermatozoa in presence of heparin (10 µg/ml) as capacitating agent. Proteins namely Glutothione-s transferase mu3 Glyceraldehyde-3-Po4 dehydrogenase 2 and outer dense fibre-2 were common in physiological and cryopreservation induced capacitation of buffalo spermatozoa. The cattle spermatozoa was found to have Serine/Threonine phosphatase PP1α subunit while β-subunit was present in buffalo spermatozoa. The former protein alongwith the Membrane metalloendopeptidase like 1c were the two new proteins reported for the first time in Karan Fries spermatozoa.

The apoptotic and necrotic cells increased during cryopreservation and were differentially identified using Annexin V and Propidium Iodide binding Assay Kit.

The composition of soyabased new extender without egg yolk was standardized. The extender containing 25% soyamilk maintained comparable post thaw motility (30-35%) on cryopreservation in comparison to egg yolk extender. The liquid semen preservation upto 72 hrs was also comparable to the egg yolk extender. Further trails are in progress to modify the new extender for minimal use of concentrated soyamilk.

**Nanoparticles affect buffalo spermatozoa functionality:** With the growth of nanotechnology, there is tremendous increase in the applications of nanoparticles (NPs) and nanomaterials in various products and appliances, which concomitantly increases the risk of exposure to these nanomaterials through various routes leading to appreciable levels of nanotoxicity which would be detrimental. Moreover, the unique physico-chemical properties of nanomaterials due to the high surface to volume ratio of these particles could produce unpredictable effects. The effect of different concentrations (1 µg ml-1, 10 µg ml-1 and 100 µg ml-1) of titanium oxide (TiO2) nanoparticles (NPs) (<100nm) was examined on viability, membrane integrity, capacitation status and DNA integrity of buffalo spermatozoa. Sperm chromatin dispersion (SCD) test and acridine orange test (AOT) were employed to detect DNA fragmentation in sperm treated with NPs. It was found that there was significant ($P<0.05$) decrease in cell viability and membrane integrity (assessed by enzyme leakage) at 6 hr incubation with NPs. However, significant ($P<0.05$) increase in sperm capacitation was observed for TiO2 NP albeit at

lower concentrations. For 1 µg ml-1 of TiO2 NPs there was no significant difference in capacitation whereas at 10 µg ml-1 and 100 µg ml-1 of TiO2 NPs, there was about 9% and 17% decrease in capacitation status, respectively. In DNA fragmentation assay, there was dose dependent increase in the DNA fragmentation (r=0.96). There was increase in DNA fragmentation with respect to increase in doses of TiO2 NP. At 10 and 100 µg ml-1 of TiO2 NPs shows highly significant ($P<0.001$) damaged in DNA when compared with control. Ultra thin cross sections revealed TiO2 NPs inside head and plasma membrane of the buffalo spermatozoa as assessed by transmission electron microscopy (TEM). These studies suggested that TiO2 NPs could have cytotoxic effect on buffalo spermatozoa by affecting sperm functionality and causing high amount of DNA fragmentations.




*Interaction of sperm with TiO2 nanoparticles*

## Dairy Technology

### Incorporation of Selected Probiotic Bacteria in Infant Formula

A probiotic strain of *Lactobacillus acidophilus* NCDC 15 was microencapsulated with and without prebiotics using a suitable encapsulant. Cell viability was assessed during heat treatment, homogenization, low pH and high bile salt concentration. The findings suggested that encapsulation had no effect on survival of cells during homogenization. Microencapsulation offered protection during thermal processing and simulated conditions of gastro-intestinal transit. The addition of prebiotics to the encapsulating material improved the protective ability. Encapsulated biomass was added to the infant formula mix just before spray-drying. The control infant formula (CIF – with free cells) and experimental infant formula (EIF - with microencapsulated cells) were similar in gross composition, physico-chemical characteristics and general microbial profile. During drying, probiotic count in CIF and EIF decreased by ~ 3 and 1.5 log cycles, respectively and decreased further during storage at ambient temperatures. To assess spray drying as a method of micro-encapsulation, the cell mass was spray dried along with encapsulant and skim milk concentrate to a moisture content of 6%. The survival was 86.7%. There was no cell loss during storage under refrigeration, but at ambient temperatures, the cell count reduced to 7.6 log after one month. Therefore, spray drying could be a better alternative to produce dried cell concentrate for dry mixing in products.

### Network Project on R & D Support for Process Up-gradation of Indigenous Milk Products for Industrial Application

**Technology of Channa murki:** Chhana-murki, a traditional popular sweetmeat considered a delicacy remained hitherto undocumented traditional dairy product of northern and eastern India with little or almost negligible information available about the product composition or its characteristics. Therefore after characterizing the product through widespread market survey, optimization of technology for the manufacture of a standard product was taken up during the period under report. The critical parameters studied were fat level in milk (3.5-5.5%), coagulation temperature of milk (70°C-90°C) and sugar-to-cube ratio (0.6-0.9) and these were optimized based on the sensory response of the final product as a function of these variables. The combined effects of these variables were also studied on instrumental texture, colour parameters and water activity values. A total of 20 experiments were carried out in accordance to central composite rotatable design (CCRD). The obtained data was modelled using quadratic multiple regression technique. The optimum product had a composition of moisture content, 15.77% fat 15.10%, protein 14.12%, reducing and total sugar 1.41 and 52.42%, ash 1.10 % with coat-to paneer ratio 0.59 and yield 132% in fresh sample. The product was found acceptable and comparable to market samples even in terms of instrumental textural and colour values and had a much better microbiological quality.

***Functional Channa murki:*** Considering the rising demand for functional and dietetic sweets in the country, attempts were made to develop Chhana-murki added with sugar substitutes and dietary fiber. The study was designed using CCRD approach of Response Surface Methodology with four variables: Polyol (lactitol-isomalt, 1:1), fiber (MCC-Inulin, 1:1), gum acacia and sucralose, selected on the basis of preliminary studies. The design matrix representing thirty combinations of the four factors was obtained by using the software. The criteria for selecting the responses were sensory attributes (colour and appearance, texture, sweetness, flavour and overall acceptability) of the finished product. Statistical analysis showed that the formulation with 737.94 ppm sucralose, fiber blend 10%, polyol blend 15% and gum arabic 1.10% recorded the highest sensory scores. The proximate composition of the optimized product was estimated to be: moisture 17.7%, fat 15.43%, protein 34.1%, lactose 1.3%, fiber 29.5% and ash 1.97%. The caloric value of the functional Chhana-murki was calculated to be 280.5 Kcal/kg which was much lower than conventional product having the caloric value of 431.9 Kcal/kg.

**Pesticide residues and heavy metals:** Raw milk samples (52 No) were collected from Amritsar, Nawanshahar, Ludhiana (summer and winter) and Jalandhar for analysis of pesticide (Organophosphate- acephate chlorpyrifos, chlorpyrifos-methyl, diazinon, dichlorvos, dicrotophos, dimethoate, fenitrothion, malaoxon, malathion, monocrotophos, paraoxon-ethyl, parathion-methyl, phorate, phosphamidon, profenophos, quinalphos, tetrachlorvinphos and Organochlorine- aldrin, dieldrin, endosulfan, endrin, heptachlor, DDT) residues and heavy metals (lead and cadmium). From each district, 2 villages were selected and minimum of 6 samples were collected from each district. The levels of lead and cadmium averaged 0.037 (0.014 to 0.126) and 0.002 (0.001 to 0.009) ppm, respectively which were below the maximum residue limits (MRL values: lead=50-200 ppb; cadmium-5-10 ppb; Codex Alimentarius Commission, 2009). Further these samples were extracted and dried for simultaneous analysis on High Performance Liquid Chromatography (HPLC). Some of the milk samples showed above MRL values for dimethoate (ND-0.348), monocrotophos (ND-0.162), dichlorvos (ND-0.142) and fenitrothion (ND-3.883). The MRL values for dimethoate, monocrotophos, dichlorvos and fenitrothion were 0.05, 0.02, 0.02 and 0.002 (CAC, 2009). The values for majority of other pesticides were below MRL levels.

**Incidence of Antibiotics and Aflatoxins M1 residues in raw milk:** Survey on forty four (44) raw milk samples collected from Delhi and villages near Delhi namely Narela, Singhu, Khampur, Bhalswa, Tikri were carried out. These samples were collected in the month of December 2010 and analyzed for antibiotics residues at codex MRL limit using microbial receptor assay Charm 6602 system and microbial inhibition based assay i.e. NDRI broad spectrum kit. The incidence of β-lactam group was 11.36% at ≥ 4.0 ppb in five samples of raw milk. Streptomycin was detected at ≥ 200 ppb in one sample (2.27%). One sample of raw milk was found positive for sulpha group ≥ 100 ppb as well as for β-lactam group. Gentamycin, tetracycline and erythromycin group could not be detected in any of the sample tested. The overall incidence of antibiotics residues was 13.63%. Samples were also analyzed using MDR test kit developed at NDRI and results obtained followed the same pattern as observed with charm 6602 assay.

**Validation of withdrawal time of different antibiotics from diseased animals:** In NDRI cattle yard for diseased animals (mastitis, metritis, general health problems) the most frequent treatment is with tetracycline, gentamycin, penicillin and streptomycin either through intramammary or intramuscular route. Samples from these animals were collected through out the month. Animals treated with tetracycline were monitored by collecting samples upto 96 hrs after last dose of antibiotic. Residue of tetracycline was detected at ≥100 ppb upto withdrawal period i.e. 48 hrs by Charm 6602 as well as by MDR test kit developed at NDRI. Residues of gentamycin and penicillin were detected after 48 hrs.

**Production and supply of antibiotic kit for industrial application:** During the period under report, eighteen batches of 100 test kits of patented (Patent Reg # IPR/4.9.1.4/05074/1479/del/2006) broad spectrum antibiotic kits developed at Dairy Microbiology Division were sold to different dairy units directly or indirectly through M/S Neugen India Diagnostic Pvt. Ltd @ 1200/- + CST @ 12.36% with total revenue generation of 23, 845/-. Working performance of the kit in terms of colour development, shelf-life, antibiotic sensitivity and comparative performance evaluation with other AOAC approved system like charm 6602 was also carried out.

## Novel Approaches for Production of Nutraceuticals from Milk and Indian Herbs for Potential use in Functional Dairy Foods

**Production of antioxidant and antimicrobial peptides from milk:** Lactobacilli strains (25) were assessed for proteolytic activity and subgrouped based on proteolytic activity as low (18-39 µg/ml), medium (40-52 µg/ml) and high (56-86 µg/ml) with corresponding antioxidant activity as 8-12%, 14-20% and 22-28%. Seven strains showing high proteolytic and antioxidant activity (L. *casei* spp. *casei* (NCDC 17); *L.delbrueckii* ssp *bulgaricus* (NCDC 08); *L.fermentum* (NCDC 141) ; *L. paracasei* ssp. *paracasei* (NCDC 63); *L. acidophilus* (NCDC 15); *L. rhamnosus* (NCDC 24); *L.helveticus* (NCDC 288) were selected and evaluated for extra cellular proteinase activity, with the highest Cell Envelope Proteinase (CEP) activity, corresponding to *L.helveticus* (NCDC 288) 446 U/mg and *L. casei* spp. *casei* (NCDC 17) 488 U/mg, respectively. Chromatographic protocols were standardized for separation of biopeptides and homogenous preparation of individual peptidases for mass finger printing were obtained. Further assay system for various proteolytic enzymes were standardized, their physico-chemical characterization, bioinformatic analysis to identify the enzymes based on physicochemical properties and identification of proteases by mass fingerprinting were accomplished. Further, standardization of hydrolysis conditions and assessment for hydrolysate activity for antimicrobial or antioxidant activity was also carried out.

**Production of galactooligosaccharides (GOS) from whey:** Eighty isolates of *S. thermophilus* were isolated, screened for β-galactosidase enzyme activity and characterized biochemically and molecularly by targeting lac-Z gene with expected product size of 968 base pair (bp) for further transferase acitivity which is related to GOS production. 30 isolates of Kluyveromyces species were isolated, screened for β-galactosidase enzyme activity and characterized biochemically and molecularly by targeting targeting ITS (internal transcribed spacer) with expected product size of 750 bp for further GOS production. 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). Mechanical method using Microfluidizer (Microfluidics M-110P) was standardized and found to be efficient to rapture the cells of *S. thermophilus* at 15,000 psi with single pass. Various parameters such as mobile phase, flow rate, run time and oven temperature for GOS detection through HPLC were standardized. Study of transgalactosylation reaction for GOS production using β-galactosidase isolated from strains of Streptococcus thermophilus and Kluyveromyces spp is under progress.

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

Under this project, operating in collaboration with SVVU-Tirupati and AAU-Anand, 20 teachers underwent training in e-Content development and Multimedia application. Nearly 75% of the textual component of 48 Dairy Technology/ Dairy Engineering/Dairy Microbiology/Dairy Chemistry has been done. For supplementing this text, about one thousand graphics/animations have been got prepared. Contents of nearly 10 courses have been completed for review. The rest of the courses will be completed for peer review before finalizing their contents. The complete course content will be hosted on the Internet.

## A Value Chain on Composite Dairy Foods with Enhanced Health Attributes

Milk solids (whey) along with pearl millet and barley was utilized for the manufacture of composite foods like complementary foods, biscuits, pasta and extruded snacks in combination with milks solids such as whey, whey powder, whey protein concentrate (WPC) and milk powder. This is altogether an innovative approach for enhancing the nutritional and therapeutic profile of products. Another approach applied for development of nutritious composite dairy foods through microbial interventions resulted in certain promising lactobacilli with amylolytic, phytase and proteolytic activity and technology for Bajra and Barley lassi. The four isolates of lactobacilli and 18 isolates of dairy yeast i.e. Kluveromyces sp. with probiotic attributes were isolated. The millet & corse cereal based lassi may assist in diversifying the product profile in dairy industry. Large scale consumer survey conducted in different cities and also among consumers of different demographic pattern indicated acceptance of newly developed products.

## Development of Functional Whey Protein Hydrolysate through Enzymatic Hydrolysis

Hydrolysis of whey proteins release high levels of bioactive peptides as antihypertensive, anticancer, immunomodulatory, opioid, mineral binding etc. The antihypertensive effect is attributed to the inhibition of the angiotensin-I-converting-enzyme (ACE). To obtain maximum antioxidant activity and inhibition of ACE in the whey protein (WPC-70) hydrolysate, the present study was carried out with twenty combinations for hydrolysis at different pH, temperature and time, obtained using the Central Composite Rotatable Design model through the Response Surface Methodology approach of Design-Expert®. ACE inhibition was registered by standard method of using hippuryl-l-histidyl-l-leucine (HHL), antioxidant activity by radical scavenging power (ARP); using 2,2-diphenyl-1-picrylhhdrazyl (DDPH) and degree of hydrolysis (DH) by pH stat method. The responses i.e. % ACE inhibition, ARP and DH, were, registered against each run, subjected to statistical analysis and different solutions obtained and the one with maximum numerical value for desirability was selected for further hydrolysis and verification. The predicted and the observed values (ACE – 76 – 80%, ARP – 50 – 52% and DH – close to 13%) for all the responses were subjected to t-test and the differences were found to be non significant (P>0.01). It can be concluded that hydrolysis when carried out under different combinations of pH, temperature and time, result differently with respect to the release of bioactive peptides.

## Formulation of Diabetic Dietary Supplement

The current study envisaged to formulate a dietary supplement effective in controlling blood glucose levels, moderate rate of digestion and in addition to impart hypocholesterolemic effect. To optimize the formulation, various ratios of groundnut oil and milk fat; resistant wheat starch and maltodextrin; whey protein concentrate-70, sodium caseinate and skim milk powder were screened and selected through sensory characterization. Response Surface Methodology based on central composite rotatable design (CCRD), using three independent variables (ingredient sources) and five responses comprising of sensory and physico-chemical parameters were used for computation. To exert the beneficial dietary effect, partially hydrolyzed guar gum as soluble dietary fiber (7%) was added to the formulation. Also, to enhance the acceptability of the supplement cocoa powder (4%) and sucralose (20%) were added. The optimized diabetic dietary supplement contained 4.37, 15.93, 10.15, 3.39, 66.15 and 38.5% of moisture, protein, fat, ash, carbohydrate and total dietary fiber, respectively. Moreover percent energy contributed by fat, protein and carbohydrate in the optimized dietary supplement was 21.9, 14.8, and 63.4%, respectively which supply a total of 417.67 kcal per 100 g of the product. An in-vivo feeding studies of 8 weeks revealed that 50% dietary supplementation helped to reduce 16.81% blood glucose, 33.94% blood plasma cholesterol while resulted in 4.16% increase in body weight. The shelf-life of the diabetic dietary formulation remained acceptable for more than 4 months at room temperature. The cost per kg of diabetic dietary supplement was estimated to be Rs 160.69.

## Development of Nutritive Antacid Tablets Based on Milk Proteins

Hyperacidity is a widely prevalent problem. The pharmaceutical antacids generally used to counter the problem often have certain side effects. The nutritive, milk-protein based antacid tablets developed at this institute would serve as a better alternative. Based on the evaluation of buffering capacity of various milk protein products, rennet casein (RC) and whey protein concentrate (WPC) were selected as milk-protein ingredients. Process variables relating to the major ingredients viz., RC-WPC ratio and polyol concentration were optimized based on instrumental hardness and sensory scores using Response Surface Methodology. While a polyol was used for surface treatment of the tablets, the tablet formulation was fortified in its acid-neutralizing capacity employing a calcium salt.

The tablets contained 93.78% TS, 1.37% fat, 36.62% protein, 36.56% ash and 19.23% carbohydrates. The Total Plate Count (cfu/g) of the product was 575 whereas coliform and yeast-and-mold counts were nil in 1:10 and 1:100 dilutions, respectively. The buffering capacity and sensory properties of the milk-protein based antacid tablets were comparable with those of market samples of popular brands of chemical antacids. The production cost of the protein-based tablets was Re. 0.71 per tablet, which was fairly comparable to that of the market samples costing about one rupee per tablet. Thus, a new milk protein-based antacid formulation was developed that was found to be functionally and sensorily comparable to the popular market products but had considerably low chemical content, thereby exhibiting the potential of milk proteins as dairy nutraceuticals.

## RESEARCH ON NUTRACEUTICALS FROM MILK, FUNCTIONAL FOODS WITH PREBIOTICS, PROBIOTICS, MICRONUTRIENTS AND OTHER BIOACTIVE COMPOUNDS FOR IMPROVED HUMAN HEALTH

### Antioxidant Activity of Fermented Skim Milk

Skim milk fermented with nineteen Lactobacillus strains was evaluated for antioxidant activity by 2, 2'- azino-bis (3-ethylbenzo-thiazoline-6-sulphonic acid) (ABTS) decolourization assay. The whey fraction of fermented skimmed milk showed radical scavenging activity to varying extent 0.12 to 0.49 mmol $L^{-1}$ Trolox equivalent antioxidant capacity (TEAC). The proteolytic activity of different strains ranged between 0.40 to 2.25 mmol Leu $L^{-1}$. Seven strains including *L. delbrueckii* subsp. *bulgaricus* NCDC08, *L.plantarum* NCDC25, *L. casei* subsp. casei NCDC17, *L. paracasei* subsp. *paracasei* NCDC63, *L. fermentum* NCDC141 and *L. helveticus* NCDC288 exhibited positive correlation between antioxidant activity and proteolytic activity. On hydrolysis of casein with cell free extracts of these strains, *L. rhamnosus, L.casei* subsp. *casei* and *L.paracasei* subsp. *paracasei* resulted in significant ($P< 0.05$) increase in radical scavenging activity with 60-70% of total radical scavenging activity associated with low molecular weight peptides (< 3kDa). The development of antioxidant activity was strain specific and these Lactobacillus strains can be useful in developing functional foods enriched in dietary antioxidant with a potential to combat oxidative stress in the body.

### Antioxidant capacity of fruit dahi

Dahi was prepared by using NCDC 167 and NCDC 261 in the ratio of 1:1, incorporated with different levels of strawberry pulp / mango pulp (6-12%level). The product was optimized for pulp addition by sensory evaluation using 9 point hedonic scale. Based on sensory evaluation, dahi incorporated with 8% strawberry pulp (corresponding to 17.80 Brix) was adjudged as best for overall acceptability. Similarly, mango dahi showed optimum sensory quality at 8% mango pulp (20.10 Brix) fortification. The products were

*(Strawberry dahi)*

*(Mango dahi)*

evaluated for their compositional parameters, physico-chemical & textural properties. The total solids for strawberry dahi and mango dahi corresponded to 18.42 and 18.39 %, pH 4.44 and 4.50, while firmness as 0.53 and 0.58 N, respectively. For evaluation of antioxidant capacity, FRAP & DPPH methods were used and the total phenolic content was measured by Folin's method. The antioxidant activity measured by FRAP method was found to be 82.75, 173.94 and 255.5µg Trolox equivalent/g for control, mango and strawberry fortified dahi, respectively. High correlation values were observed between different methods of antioxidant capacity and between total phenolic content for different fruit dahi preparations. Further, during storage at refrigeration temperature for three weeks, there was no significant difference ($P>0.05$) in antioxidant potential of mango and strawberry fortified dahi.

### Bioactivity of Whey Protein Hydrolysate Fortified Milk and Ice Cream

The whey protein concentrates (WPCs) with 71.50 % protein contents were hydrolyzed with

commercial enzymes alcalase, flavourzyme, trypsin and corolase PP using optimized conditions. Three main independent variables viz; pH, temperature and time of hydrolysis affecting antioxidant activity and ACE inhibitory activity of the whey protein hydrolysates (WPHs) were optimized by applying response surface methodology (RSM). Most of the bioactivity of WPHs was associated with lower molecular weight fractions. Techno-functional properties were slightly inferior to the unhydrolysed whey protein except over-run, which showed increase in case of pepsin -WPH and papain –WPH. The incorporation of WPHs in the skim milk (1 to 2 percent) raised its antioxidant activity from 21% to 88% and ACE inhibitory activity was 35 times higher than the skim milk. The WPHs prepared using flavourzyme showed better biological activity as well as acceptable sensory properties. The ACE inhibitory and antioxidant peptides were identified using LC/MS. Most of the bioactive peptides present in the flavourzyme WPHs are known for their ACE inhibitory and antioxidant peptides. The incorporation of WPHs in the ice-cream (@1 percent) raised its antioxidant activity by 55% and over-run was 26.6% times higher than that of control. Biofunctional whey protein hydrolysates with optimum antioxidant and ACE inhibitory activities can be used as an ingredient in various promoting foods.

## Isolation and Characterization of Glycomacropeptide from Buffalo Milk Cheese Whey.

Glycomacropeptide (GMP) is the C-terminal part of κ-casein (64 amino acid residue peptide) which is cleaved by chymosin during cheese preparation. During the period, GMP was isolated from buffalo milk cheese whey and was then separated on tricine-SDS-PAGE. GMP isolation was done on the basis of double precipitation method using trichloroacetic acid (TCA). Liquid whey was mixed with TCA solution to a final concentration of 8% TCA to precipitate major whey proteins. The supernatant which mainly contains the GMP was again treated with TCA to a final concentration of 14% to precipitate GMP. These precipitates of GMP were washed with ethanol, dissolved in minimum amount of distilled water and lyophilized. GMP yield was about 103 mg/L of cheese whey from buffalo milk. The SDS-PAGE results indicated that purified GMP is resolved into a major band corresponding to molecular weight 20 kDa. When same amount of GMP (45 µg/ well) was applied on SDS-PAGE, the buffalo GMP was found to stain more intense with CBB as compared to cow milk derived GMP.

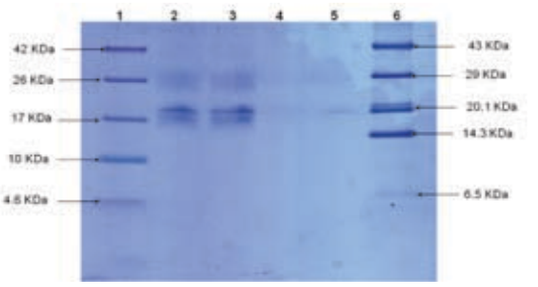



*Figure: Tricine-SDS PAGE of GMP isolated by TCA method*

*Lane 1: Marker (Fermentas); Lane 2: Buffalo GMP (22.5 µg); Lane 3: Buffalo GMP (45 µg); Lane 4: Cow GMP (22.5 µg); Lane 5: Cow GMP (45 µg); Lane 6: Marker (Bangalore Genei)*

## Calcium, Iron and Vitamin A Fortified Toned Milk

Toned milk was fortified with iron and vitamin A individually. Iron salts (ferrous sulphate heptahydrate, microencapsulated ferrous sulphate, ferrous lactate, ferrous gluconate, ferric ammonium citrate, ferric pyrophosphate soluble, ferric chloride hexahydrate and ferric monosodium EDTA) and vitamin A esters (vitamin A palmitate/vitamin A acetate) were selected for sensory analysis. All iron salts except ferric pyrophosphate soluble and ferrous gluconate produced distinguishable/ distinct changes in colour, odour and flavour even below 30 ppm level of addition. However, ferric pyrophosphate soluble and ferrous gluconate (@30 ppm fortified milk gave satisfactory sensory results. Vitamin A palmitate and acetate fortified milk (addition @ 2000 IU, 3000 IU, 4000 IU) passed sensory analysis. Addition of ferric pyrophosphate soluble to milk (≥20ppm) caused slight decrease in pH and restoration of pH with food grade bases (disodium hydrogen phosphate and dipotassium hydrogen phosphate) shifted the HCT-pH maxima on acidic side as compared to that of control.

Selection of calcium salts (calcium gluconate, lactate, hydroxide, oxide, citrate, phosphate bibasic, acetate and chloride) was on the basis of sensory characteristics (color and appearance, odour, taste and mouthfeel and overall acceptability). Levels of fortification tried ranged from 40 to 80 mg/100 ml of milk. Calcium phosphate dibasic and calcium citrate were best upto 70 mg/100 ml of milk.

## Preparation of Protein Rich Powder From Buffalo Colostrums

Heating of buffalo raw colostrum samples at different time temperature combinations viz. 72°C/15s, 68°C/30m, 65°C/30m, resulted in coagulation of the samples. To prevent this, the colostrum was diluted with water (80:20) and heated to 72°C/15 sec without any coagulation.

Buffalo skimmed colostrum and whey colostrum powders were prepared by freeze- drying technique and were analyzed for gross chemical composition.

On SDS-PAGE separation, buffalo skimmed colostrum powder showed eight polypeptides, out of which five were major and three were minor polypeptides. Similarly buffalo colostrum whey powder showed the presence of nine polypeptides, out of which six were major polypeptide and three were minor polypeptides. On comparing the electrophoretic pattern of buffalo skimmed colostrum powder and whey powder with molecular markers, it was found that major polypeptides were in the molecular weight range of 97-20.1 kDa. A low molecular weight peptide (6.5 kDa) was also observed in buffalo colostrum whey powder which might resemble with Insulin like growth factors or Proline rich polypeptides. From these findings, it can be concluded that in case of colostrum whey powders, major polypeptides present were immunoglobulins, lactoferrin, lactoperoxidase and bovine serum albumin.

With a view to have knowledge about the molecular sizes of colostrum protein, freeze dried powder samples prepared from buffalo colostrum were sieved on sephadex G-200 using 0.01M Tris-HCl buffer pH 8.6. Elution profile showed the presence of five peaks of which third peak was a major peak, while others were minor. All the peaks were lyophilized separately and subjected to SDS-PAGE. It was found that majority of buffalo skimmed colostrum powder proteins were eluted in third peak as evident from electrophoretic pattern. Attempts were also made to prepare immunoglobulin concentrate from buffalo whey colostrum powder. Colostrum whey powder samples were subjected to ultrafiltration in amicon ultracentrifugal filter device containing UF membrane (Molecular weight cut off 100 kDa). Retentate was further investigated in order to quantify the concentration of immunoglobulins using ELISA. It was found that immunoglobulin concentration in buffalo colostrum whey powder samples of first milking was increased to 327.52 mg/g while powder samples from second milking showed immunoglobulin concentration as 278.7 mg/g. From above findings, it is evident that level of immunoglobulins can be increased in retentate fraction using UF. Based on these results, it is possible to prepare immunoglobulin rich powder using colostrum whey. Electrophoretic pattern of protein fractions present in retentate and permeate of buffalo colostrum whey powder showed immunoglobulins were concentrated during ultrafiltration and appeared as a thick band. The lymphocyte proliferation index of skimmed colostrum powder was found to be 1.48 while in case of colostrum whey powder, it was found to be 1.69 when compared with standard mitogen (Lps). From these observations, it was revealed that colostrum whey powder had better stimulating effect on cell proliferation than skimmed colostrum powder. Phagocytic activity of Colostrum whey powder was found to be 25 - 30% more when compared with control whereas skim colostrum powder showed an increase of 10 -15 % activity.

## 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

### Physico-chemical Qualities of Market Ghee

Ghee, most widely consumed Indian dairy product, is prepared from cow or buffalo milk or combination thereof. In order to ensure a genuine product to the consumer, the Government of India has prescribed the compositional standards for ghee, under PFA act and Agmark rules. However, unfortunately, the producers or the middle-men involved in the ghee trade tend to adulterate ghee with cheaper oils and fats like vegetable oils, animal body fats, hydrogenated fats, and sometimes even the non edible mineral oils, especially during lean season. Therefore, the present work was undertaken to carry out a survey of collecting limited number of ghee samples from different parts of the country in different seasons and analyze them for physico-chemical parameters.

The present study revealed that the RM value, Polenske value, Saponification value, Iodine value and BR reading of ghee samples of organized dairies collected from different parts (North, South, East and West) in different seasons (Rainy, Winter and Summer) varied (with average) from 6.40 to 34.00 (24.98), 0.5 to 2.5 (1.39), 202.65 to 234.90 (222.88), 26.85 to 76.14 (39.29) and 40.50 to 51.85 (42.47), respectively. The corresponding values of ghee samples collected from unorganized dairies of Karnal city in different seasons (Rainy, Winter and Summer) were from 16.61 to 33.77 (29.57), 0.6 to 1.7 (1.28), 209.00 to 243.90 (228.85), 22.72 to 47.64 (33.02) and 38.80 to 44.60 (41.55), respectively. Similar values for pure ghee of cows and buffaloes of institute herd, collected simultaneously alongwith market ghee samples were also estimated.

It may be concluded from the present limited study that out of the total (66) market ghee samples (36 from organized and 30 from unorganized), 8 samples each of organized and unorganized dairies failed to meet the requirements in terms of either RM value or BR reading or both as specified under PFA rules. Such cases were less in summer and more in rainy and winter seasons. Frequency of such cases was slightly more in unorganized dairy ghee samples of Karnal city than organized dairy ghee samples investigated in the present study.

### Effect of Melamine Addition on Nitrogen Distribution in Milk

Melamine is a chemical used primarily for the production of melamine resins. Because of its high nitrogen level (66% by mass), melamine is illegally added to milk and milk products to enhance the protein content in milk and milk products. Ingestion of melamine at levels above the safe limit can induce renal failure and even death in infants. In the present investigation, melamine addition at different concentration into milk and milk powder showed an increase in the total nitrogen content from 3.80 to 8.13. Higher concentration of melamine i.e. 50 mg onward added into milk remarkably increased non casein nitrogen from 83.12 to 182.63. No significant change was observed in non protein nitrogen content and its component.

Attempts were also made to develop a simple colour test using gold nanoparticle. Absorbance (λ max) of gold nanoparticles at 523 nm revealed the size as 13 nm. Cyanuric Acid derivatized and a stabilized gold nanoparticle through hydrogen bonding was used to detect melamine through optical properties of gold nanoparticles. The change in optical properties was directly reflected by colour change. In present investigation, it was found that instability of Cyanuric acid derivative occurred after storage period of 1- 2 hour. Pale yellow colour change to orange colour and precipitation of Cyanuric acid derivative was observed during the reaction. So alternative method was standardized using melamine strip, a convenient way for its detection. The melamine rapid test strip is based on the specific immune -chemical reactions between antigen and antibody. It relies on the competition between melamine residue in the sample and the melamine immobilized on T line on the membrane for the melamine antibody-dye conjugate. The detection limit in milk for this test is 100-200 ppm.

## Dairy Engineering

### Performance Evaluation of Thin Film SSHE for Continuous Manufacture of Burfi

Three stage thin film SSHE that was designed and developed for continuous manufacture of khoa is used for continuous manufacture of burfi. The sugar-dosing device was designed, fabricated and provided at the inlet of third stage SSHE to blend sugar with khoa. This was designed in the shape of screw conveyor by providing an auger of diameter .025m and length 0.35 m. The drive to auger was given by providing a variable speed drive to obtain speed in the range of 0-100 rpm. The performance evaluation of the system was made for continuous manufacture of burfi using each trial of 160-200 litres milk having 6% fat, 9% SNF. Overall heat transfer coefficient in the first, second and third stage was found 1450-1775, 758-1157 and 376-451 $W/m^2K$, respectively. Specific steam was 1.04-1.19 kg steam/kg consumption water evaporated.

The quality of the product samples obtained was analyzed for sensory evaluation. The sensory characteristics scores of all product sample collected by combination of different rotor speeds of first, second and third stage SSHE indicated that flavour score decreased with increase in scraper speed of all the three stages. The body and texture score increased with increase in rotor speed of first stage and decreased with increase in rotor speed of third stage but it was maximum at 150 rpm in second stage. The colour score also decreased with increase in rotor speed of all the three stages.

A number of trials were taken for large scale production of burfi to evaluate its commercial potential. Concentrated milk (400 litres) having 30 % TS was used. Sugar dosing was made at 3% w/w mixture in ratio of 6.3:1 white crystalline sugar to caramelized sugar into the feed tank. The product obtained was evaluated for sensory attributes and physico-chemical properties. The capacity of the system was estimated around 130 kg/h using concentrated milk and 55 kg/h using buffalo milk.

### Studies on In-Line Production of Indian Dairy Products for Commercial Exploitation

For in-line production of khoa, scraped surface heat exchanger (SSHE) was integrated with Conical Process vat. Three variables at different levels such as steam pressure of SSHE (3, 4 and 5 kg/$cm^2$), scraper speed of SSHE (50, 100 and 150 rpm)

alongwith steam pressure of Conical process vat (2.5,3 ,and 3.5 kg/cm$^2$) were taken. Product obtained was subjected to sensory evaluation and texture profile analysis. On the basis of sensory attributes and texture analysis, the operational parameters were optimized by using response surface methodology (RSM) to locate the true optimal value of multiple variables. Using RSM, optimum parameters for khoa production were predicted 4.32 kg/cm$^2$ steam pressure and 107.26 rpm scraper speed of SSHE alongwith 2.99 kg/cm$^2$ steam pressure of conical process vat giving maximum sensory and textural scores among all combinations. It was observed that khoa produced by using 4.0 kg/cm$^2$ steam pressure and 100 rpm scraper speed of SSHE alongwith 3.0 kg/cm$^2$ steam pressure of conical process vat gave average sensory score like flavour, body and texture, colour and appearance as 43.22, 33.15, and 13.24, respectively, and average textural attributes score like hardness, gumminess, chewiness value as 25.96, 3.680 and 0.557, respectively, which were the highest among all combinations. The predicted score and observed score of all sensory as well as textural attributes were compared, and statistically analysed by Students 't' test. The analysis showed that there was no significant difference (at $p < 0.05$) between predicted and observed value at optimum parameters. It was concluded that, good textural quality khoa can be produced using 4.32 kg/cm$^2$ steam pressure and 107.26 rpm scraper speed of SSHE alongwith 2.99 kg/cm$^2$ steam pressure of conical process vat.

## Dairy Microbiology

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

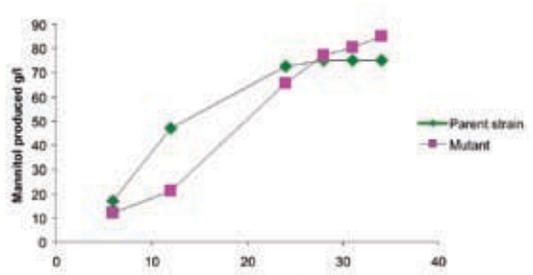
**Formulation of whey based cost effective media for biomass production and preservation of lactobacilli:** *Lactobacillus casei* NCDC 298 was activated (37°C/ 16-18 hrs) and maintained in Chalk litmus milk (7°C) and sub-cultured twice in MRS broth (37°C/ 16-18 hrs) before inoculating in whey and whey based media. Basal whey media were prepared by incorporating basal supplements with minerals, buffering agent, emulsifier and adjusting the pH to 6.4 in paneer whey and reconstituted whey (6% total solids) and were inoculated with NCDC 298 (@ $10^4$ - $10^5$ cfu/ ml) followed by incubation at 37°C for 18 hrs. Incorporation of basal supplements in reconstituted whey (6% total solids) and paneer whey significantly improved the growth of *L. casei* NCDC 298. Total solids @4 & 6% in reconstituted whey yielded the comparable growth of lactobacilli but significantly higher than 2% total solids level with or without basal supplementations. Incorporation of 0.25% yeast extract or 0.50 / 0.1 % casein hydrolysate and 0.1% yeast extract in the reconstituted whey (4% total solids) basal medium yielded maximum growth of *L. casei* NCDC 298 (from ~ 4.5 to ~ 8.3 log cfu/ ml) at 37°C for 18 hrs, which was comparable to the growth in MRS broth.

**Isolation of Kluyveromyces spp. from dairy products and assessment of their potential probiotic attributes:** Out of a total of 110 randomly selected colonies, 60 were identified as *Kluveromyces* spp. after morphological and biochemical characterization. However, 18 were confirmed as *Kluyveromyces* spp., out of which 14 identified as *K. marxianus* and 4 as *K. lactis* by molecular techniques. All the 18 isolates were found to be resistant to selected antibiotics except Nyastatin and Fluconazole. None of the isolates showed antimicrobial activity against Gram negative organisms whereas 90% of the isolates showed antimicrobial activity against *S. aureus*. *K. marxianus* isolates namely PM2, PD14, PD2, PW21 and *K. lactis* isolates viz. PW2 and PL1 showed good acid tolerance, bile tolerance and cell surface hydrophobicity. These strains can be further evaluated for their potential technological applications and further studied for *in vivo* probiotics attributes.

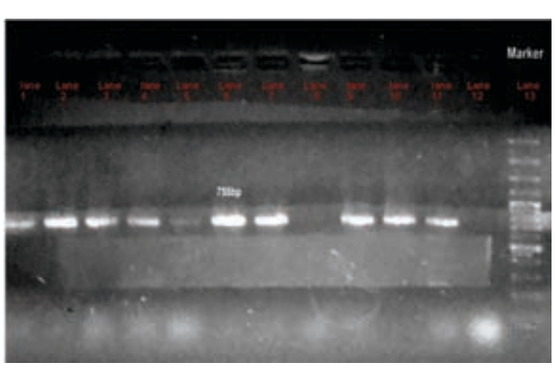
**Mannitol production from *Leuconostoc* spp.:** More than 200 isolates of Leuconostoc spp. recovered from 500 samples of dairy and plant sources were identified phenotypically and genotypically. All the isolates were screened for mannitol production by colorimetric assay and quantified in positive strains by HPLC. During initial screening, fifty per cent of the isolates exhibited ability to produce mannitol to a variable extent. However, only 11.4 % isolates produced mannitol yield above 80% (when fructose used @ 50 g/L). Four high mannitol producers viz. Ln27 (Dahi), Ln92 (Peas), Ln104 (Guava) and Ln206 (Yak Milk) were selected for further study. Ln27, Ln104 and Ln206 were identified as *Ln. mesenteroides* subsp. *mesenteroides* and Ln92 as *Ln. fallax*. The 16 S rRNA gene sequences of the isolates Ln27, Ln92, Ln104, and Ln206 have been submitted to Genbank with Accession Nos. GQ856134, GQ856135, GQ856136 and GQ856137, respectively.

High mannitol production was observed to be favoured by high temperature and high pH. Isolates had high osmotic tolerance as these could use fructose concentration as high as 100 g/L in batch culture. Optimization of mannitol production in whey by RSM culminated into increase in the yield of mannitol by 35.8, 18.1, 31 and 33.51% for Ln27, Ln92, Ln104 and Ln206, respectively. A mutant strain of Ln27 was also generated by 1-methyl-3-nitro-1-nitrosoguanidine and mannitol production increased by 9.7% in flask in MRS. However, in fermenter, the mutant produced mannitol at a slower rate than parent strain but ended up yielding higher amount of mannitol than parent strain. The increase in yield was 13 and 6.6% in whey and MRS, respectively. In fermenter, when fructose was used @ 150g/L (MRS), the increase in yield was 51% more than that in flask. Between 6 to 12 hrs fermentation, the mannitol production rate was the highest with the fructose concentrations i.e., 5.85 g/L/h and 11.24 g/L/h at 100 g/L and 150 g/L, respectively. Mannitol was recovered from fermented broth with a yield of 72%.

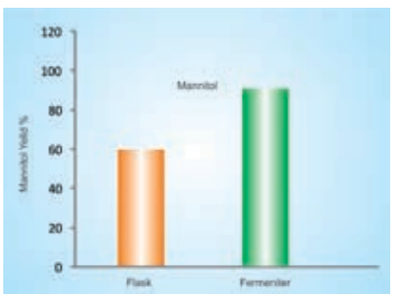
A reduced calorie sweetened naturally carbonated lassi was prepared by co-culturing Ln27 with *Lactococcus lactis* NCDC 90. The product can be satisfactorily stored for 5 days under refrigerated conditions. The calorific value of control product is 106 Kcal/100g whereas the developed product has 78 kcal/100g (35 % reduction in calories).




**Mannitol production pattern of parent strain Ln27 and mutant in fermenter in whey supplemented with fructose (100 g/l)**

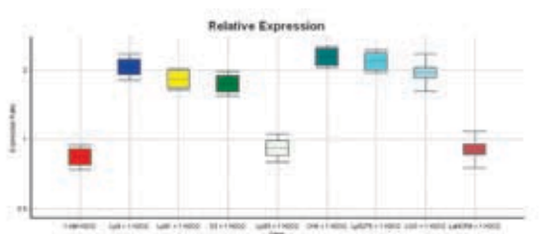



**Electrophoretic profile of *Kluyveromyces* spp. on PCR amplification with primers targeted against ITS-5.8S rDNA-ITS2 region**




**Mannitol yield(% fructose conversion of Ln27 in flask and in fermenter when fructose used@150 g/I**

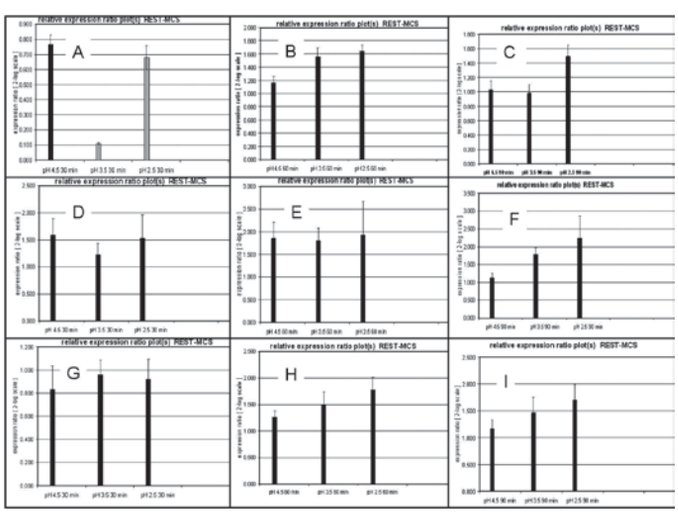
**Antioxidant gene expression profile in human colonic epithelial cells induced by oxidative stress and probiotic interventions :** A total of 39 *Lactobacillus* cultures comprising of 30 indigenous *Lactobacillus* and 9 standard cultures were tested for their resistance against ROS such as $H_2O_2$, hydroxyl ions and superoxide anions. Most of the cultures were found to be moderately to strongly resistant to 0.4 mM $H_2O_2$ with CH4 being the most $H_2O_2$ resistant culture. All the cultures subjected to superoxide anions generated from 10mM paraquat were also found to be quite resistant. Upon testing the cultures for resistance to hydroxyl radicals, majority of the cultures also demonstrated remarkable degree of resistance. Lp21 also showed the highest superoxide dismutase content i.e. 1.15 U/mg protein followed by 1.14 U/mg protein by Lp43. Amongst the 39 cultures, *Lactobacillus* spp. S3 showed the highest total antioxidative activity (TAA) of 77.85 ± 0.13 % followed by Lp55 (56.1 ± 1.2). On subjecting HT-29 cells pre treated with probiotics followed by oxidative stress with $H_2O_2$, Lp91 showed a significant ($p<0.001$) up-regulation of SOD1 both under 0.1 mM (2.079 folds) and 1.0 mM $H_2O_2$ (2.171 folds). In case of $SOD_2$, Lp9 showed significant ($p<0.001$) upregulation by 1.997 folds and 2.058 folds upon 0.1 mM and 1.0 mM $H_2O_2$, respectively. On the other hand, all the indigenous lactobacillus isolates significantly ($P<0.001$) upregulated the expression of GPx-1 ranging from 3.310 to 10.083 at 0.1 mM $H_2O_2$. Lp9 also significantly ($p<0.001$) up-regulated CAT gene expression to 3.717 and 1.370 folds upon 0.1 and 1.0 mM $H_2O_2$ stimulated conditions, respectively. However, none of the cultures showed up regulation of HO-1.




*Relative expression of SOD2 in HT-29 cell lines on challenge with probiotic lactobacillus cultures*

**Evaluation of functional efficacy of indigenous probiotic Lactobacilli based on antithrombotic, anticholesterolemic and pro/anti-inflammatory activities:** Indigenous probiotic *lactobacillus* isolates were tested for antithrombotic, anticholesterolemic and pro/ anti-inflammatory activities. The 24 hr cell lysate from CH4 showed the highest delay in clotting time i.e 218.60s/50 µg protein. The cholesterol assimilation by different indigenous *Lactobacillus* cultures from the broth ranged from 7.6 ± 0.84 to 69.27 ± 0.38 µg/ml. All the test cultures except isolate S3 and the reference strain *L casei* Shirota were able to hydrolyse taurodeoxycholic acid (TDCA). The Lactobacilli cultures showed relatively higher level of co-precipitation with GCA than TCA. The cholesterol precipitation upon deconjugation of GCA varied from 0.75-4.61 µg/ml whereas, it was 0.09-1.87 µg/ml with TCA. Lp65 and S7 were found to down regulate TNF- α expression from 11.917 to -1.83 and 1.125, respectively. Lp77 was found to be the best in terms of inhibiting IL-8 expression from 14.213 to -1.325 in probiotic treated and LPS challenged HT-29 cells. The two most promising indigenous isolates in terms of anti-inflammatory potentials were Lp90 and CH4 which resulted into a high level of 'IL-10' expression as compared to other isolates in the cell line both on LPS stimulation after co-culture and probiotic challenge alone.

**Modulation of gene expression by probiotic lactobacilli under simulated *in vitro* gut environment:** Lp9 and Lp91 showed maximum hydrophobicity and adhesion scores, which were further investigated for relative quantification under *in vitro* simulated gut environmental conditions using RT-qPCR assays. Although, both putative probiotic *L. plantarum* isolates investigated in this study were able to survive acid stress under *in vitro* conditions, amongst the two, Lp91 exhibited relatively greater acid tolerance, as revealed by 4.7-fold up-regulation of the atpD gene as well as higher log counts at pH 2.5 after 90 min. Expression of bsh gene was up-regulated in Lp9, Lp91 and CSCC5276 under different bile concentrations in MRS broth. 'Mub' gene was highly expressed in media containing mucin (0.01%), bile (1%), pancreatin (1%) (pH 6.5): 13.16 ± 0.45 (Lp9), 6.03 ± 0.24 (Lp91) and 9.24 ± 0.29 (Lp5276). mapA gene was highly expressed in media containing mucin (0.05%), bile (1%), pancreatin (1%) (pH 6.5): 30.92 ± 1.51 (Lp9), 6.24 ± 0.24 (Lp91) and 7.30 ± 0.11 (Lp5276). EF-Tu gene was highly expressed in media containing mucin (0.05%) (pH 7.0): 14.04 ± 1.03 (Lp9), 42.84 ± 5.64 (Lp91) and 12.11 ± 0.84 (Lp5276). Anti-inflammatory markers (IL-10, COX1, Hsp70, IFN-α and MUC2) were significantly up-regulated and pro-inflammatory markers (IL-8, TNF-α, COX2 and IL12p35) were significantly down-regulated when Lp9, Lp91 and Lp5276 were pre-incubated on HT-29 before LPS challenge. Both the strains triggered a strong immuno-modulating response on pre treating HT-29 cells with probiotics followed by LPS challenge.




*Expression profile of 'atpD' gene at different acidic conditions. 'A-C: Lp9 at pH 4.5, 3.5 and 2.5 after 30, 60 and 90 min., respectively; D-F; Lp91 at pH 4.5, 3.5 and 2.5 after 30, 60 and 90 min., respectively; G-I: CSCC5276 at pH 4.5, 3.5 and 2.5 after 30, 60 and 90 min., respectively. Black bars: significant up-regulation of 'atpD' gene, p≤ 0.05%; Grey bars: up-regulation of 'atpD' gene not significant (p > 0.1)*

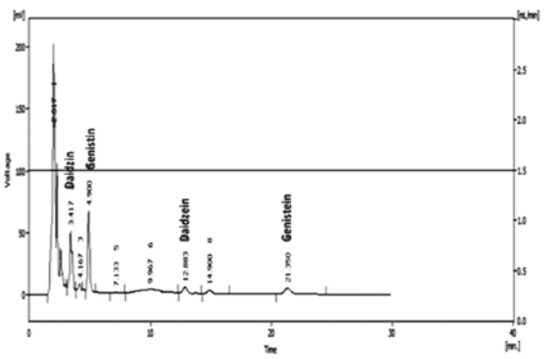
**Development of technology for production of symbiotic Misti Dahi and yoghurt :** Metabolic activities of individual and mixed cultures improved in presence of 14% sucrose. Titratable acidity and proteolytic activities were 1.03% LA and 220 µg tyrosine/ml of synbiotic products. Supplementation

of inulin and maltodextrin upto 10 % increased cell surface hydrophobicity from 63 to 89 and inhibition of spoilage and pathogens (*E. coli* ATCC 25922, *S. aureus* NCDC 110, *Bacillus cereus* ATCC 13061, *Salmonella typhi* NCDC 113, *L. monocytogenes* ATCC 15303). Arginine and glutamine were produced in synbiotic Misti dahi and yoghurt to the tune of 595 and 620µg, whereas, super oxide dismutase activity was 525 nmol of oxygen scavenged/ min/g of product. Prebiotics improved physico-chemical, microbiological, sensory and rheological attributes. The titratable acidity was 1.07 and 1.06% LA with corresponding pH values of 4.35 and 4.34 with inulin and malto-dextrin, respectively. The lactic counts were 11.25 and 10.71 log cfu/ g, respectively. Improvement in sensory quality was corroborated by enhanced rheological parameters like firmness, consistency, viscosity index and sticking force. The values for these parameters were found to be 160.1 g, 687.27 g sec, -52.16 g sec and -75.6 g sec, respectively at 10% malto-dextrin. Increased concentrations of prebiotics in yoghurt were found to reduce syneresis from 12.67 ± 0.33 to 4.33 ± 0.33 per cent. Two stage homogenization at 2500 and 500 PSI and heat treatment of 90°C/20 min resulted in improved quality. Shelf life studies at 4°C suggested marginal increase in acidity and decrease in overall acceptability score, however, product can be consumed safely upto 35 days of storage. Technology for synbiotic Misti dahi and yoghurt with desirable organoleptic, microbiolgical, rheological attributes with enhanced shelf life and food safety could be scaled up for commercial manufacture.

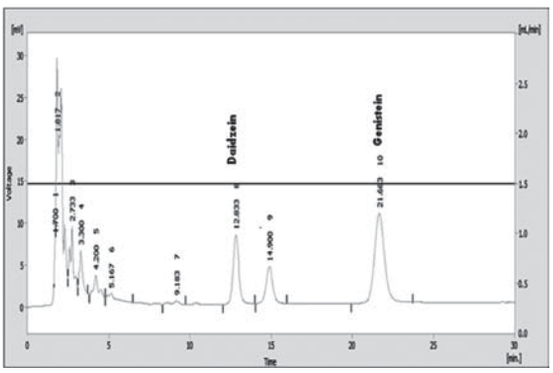
**Production of antimicrobial bioactive peptides from milk proteins by proteolytic *Lactobacillus* spp. :** All the 24 cheese isolates tested were found to be proteolytic. Whey and sodium caseinate fermentate of all cheese isolates showed good antimicrobial effect against *E. coli*, *S. typhi* and *Shigella dysenteriae* and little against *E. faecalis*. Less than 10 kDa peptides of sodium caseinate of all the cheese isolates showed good inhibitory effect against *S. enteritidis* (22 mm) and *S. typhi* (24 mm) while these were less effective against *S. aureus, L. monocytogens* and *E. faecalis*. Among all the test cultures, *S.aureus* was least inhibited. In whey fermentate, <10 kDa peptides from whey of maximum cheese isolates showed inhibition zone against *S. enteritidis* (23 mm) and *E. coli* (15 mm). A few isolates inhibited *E. faecalis* and *S. aureus* and *B. cereus*. Six *Lactobacillus* strains were selected on the basis of their broad spectrum and degree of inhibitory action and the optimum conditions for the maximum production of AMPs for all the selected isolates in whey and casein were 37°C, pH 7.0 and 24 hrs. Molecular weight of all the antimicrobial peptides is <10 kDa. Five isolates were tentatively identified as *L. casei* and one as *L. acidophilus* by PCR. Peptides of <5 kDa of whey and casein fermentate of all the six isolates showed antioxidative and ACE inhibitory activity. The <10 kDa peptides of whey and casein fermentate were stable at refrigeration temperature for one month.

**Probiotic potential of circular bacteriocin producing *Lactobacillus* strains:** Bacteriocin producing *Lactobacillus* strains possessing potential probiotic attributes were isolated and characterized. A total number of 400 randomly selected colonies were isolated from 20 samples of human infant feces (1-6 months age) and 200 isolates were presumptively screened on the basis of morphological examination. Out of which, 34 isolates (17%) were identified as *Lactobacillus reuteri* and 72 (36%) as *Lactobacillus gasseri*. On screening for antibacterial activity, a total of 12 isolates (35.29%) of *L. reuteri* and 25 of (34.72%) *L. gasseri* were found to produce bacteriocin. Among them, the bacteriocins of.5 *L. reuteri* and 10 *L. gasseri* showing relatively higher heat stability also exhibited good antibacterial spectrum of activity against both Gram-positive and Gram-negative pathogenic bacteria and some lactic acid bacterial strains. Out of the 10 isolates of *L. reuteri* and *L. gasseri* LR 19, LG 32 and LG 120 showed good biological barrier tolerance, intestinal adaptability and potential probiotic attributes. These *L. reuteri* and *L. gasseri* isolates can, therefore, be designated as potent probiotic isolates having good antimicrobial spectrum of activity and heat stability. These organisms may further be used in biopreservation of foods and also for further evaluation for biotherapeutic purposes.

**Evaluation of β-glucosidase potential of lactobacilli for biotransformation of soy isoflavones :** A total of 150 randomly selected lactobacillus colonies on BCP-MRS containing 1% cellobiose instead of dextrose were picked-up from human fecal, rumen liquor and dairy products. After phenotypic and genotypic characterization, 90 isolates (30 from each source) were screened for the β-glucosidase activity. Isolates of dairy origin were found to be the most potent enzyme producers with the highest enzyme activity of 3.31IU (nanomole/ ml/ min), followed by rumen (2.85IU) and human isolates (2.00IU). Fifteen best enzyme producers (5 from each source) were subjected to HPLC analysis for isoflavones biotransformation and species specific characterization. Among dairy isolates, D7 was found to be most potent isoflavone bio-




*Chromatogram of unfermented soy milk*




*Chromatogram of soy milk fermented with Lactobacillus rhamnosus D7*

transformer followed by human isolate H9 and R13 of rumen origin. All the selected isolates from dairy sources were identified as *Lactobacillus rhamnosus*. Alternatively, all selected isolates of human origin and three from rumen were identified as *Lactobacillus plantarum*, while rest two from rumen were *Lactobacillus fermentum*.

**Isolation, characterization and genotypic heterogeneity of Streptococcus thermophilus strains :** A total of 158 isolates recovered from 377 samples which included 74/258 plant sources, 70/85 curd, 8/19 milk, 2/6 cheese and 4/9 dosa batter covering 15 states of India, representing a heterogeneous collection were identified as putative *S. thermophilus* isolates based on phenotypic and genotypic tests. The partial 16S rRNA gene sequence analysis of 30 *S. thermophilus* representative strains (accession nos. FJ172679, FJ172680, FJ667758 - 72, FJ982785 – 97) revealed 98-100% similarity in 23 of the isolates and 82-97% in 6 isolates. On subjecting them to functionally important metabolic traits like acid production, 62 isolates (39.2%) showed fast, 81 moderate (51.3%) and 15 (9.5%) slow acidifying activity while proteolytic activity ranged between 0.67 ± 2.1 to 19.82 ± 1.3 µg of leucine/ml. A total of 58 (36.7%) isolates were urease negative and 11 (6.79%) as galactose fermenters. All the isolates produced acetaldehyde and 48 isolates were positive for diacetyl production ranging from 0.57 ± 0.37 to 4.74 ± 0.07 µg/ml. Majority of the isolates (75.3%) produced capsular polysaccharide and none possessed bacteriocin activity. DNA fingerprinting by Rep PCR using GTG5 primers was carried out for all the 158 isolates including four of the reference cultures. Dendrogram comprised of 12 major clusters at a similarity level of 70% and 29 sub clusters at 80% similarity level. Out of the 29 sub clusters, one representative of each genotype was selected for evaluating as starter. These representative isolates of 29 sub clusters of *S. thermophilus* alongwith reference strains were tested for starter activity as single strains and also after pairing with *Lactobacillus delbrueckii* ssp. *bulgaricus* 09 for making dahi and yogurt. Titratable acidity of dahi samples ranged from 0.81 to 0.98% lactic acid, syneresis between 12.78% to 14.24% and acetaldehyde between 8.75 to 29.3 µg/g. From the overall scores of dahi, UKD3 and UHrCb2 strains received higher scores than others including reference cultures ($P<0.05$). Titratable acidity in yogurt ranged from 0.82-0.99% and syneresis recorded at 10.35% to 14.25%. Acetaldehyde production in yogurt ranged from 8.8 to 39.65µg/g. Statistical analysis of overall acceptance of yogurt revealed that isolates UKD6 and USpD1 showed significantly higher acceptance than other cultures including reference cultures ($P<0.05$). *S. thermophilus* strains could be isolated from vegetable samples and they displayed properties similar to those displayed by isolates from dairy sources and reference cultures.

**Phenotypic and Genotypic characterization of *Lactococcus lactis* strains from different sources :** A total of 137 isolates recovered from samples of vegetables, fruits, flowers, silage, fodder, fermented vegetables, fermented grain samples, sprouted seeds, misthi dahi, whey, butter, kefir, dahi, raw milk and cheese covering around 15 states of India representing various geographical regions were identified as *L. lactis* based on phenotypic and genotypic tests. Out of 137 *L. lactis* isolates, 121 belongs to *lactis* subspecies (88.3%), 14 to *diacetylactis* (10.2%) and 2 to *cremoris* subspecies (1.4%). Out of 112 atypical isolates, 2 belonged to *cremoris*, 11 to *diacetylactis* and 99 to *lactis* subspecies. The partial 16S rRNA sequence analysis of 17 *L. lactis* spp. (accession nos. GU992398 to GU992399, GQ267534 to GQ267539, GQ267541 to GQ267543, GU056806, GU056802, HM581651, HM581654, HM581655 and HM581656) showed 98-100% similarity with the sequence of *L. lactis*

retrieved from NCBI GenBank. On subjecting them to functionally important metabolic traits, 19 (13.8%) showed fast, 47 moderate (34.3%) and 69 (50.3%) slow acidifying activity. A total of 19 isolates (13.8%) were found to be proteolytic and 85.9 % as non-proteolytic. The proteolytic activity ranged between 0 to 1.96 ± 0.04 µmoles of leucine/ml. Fourteen isolates (10.3%) were diacetyl producers, whereas twelve were bacteriocin producers (8.8%). The amount of diacetyl produced ranged from 2.02 ± 0.12 to 8.24 ± 0.10 µg/ml, and bacteriocin producers formed zone of inhibition in the range of 16 to 20 mm against *P. acidilactici* LB42. DNA fingerprinting by plasmid profiling and Rep PCR using GTG5 primers was carried out by all the isolates plus three reference strains. Dendogram comprised of 8 and 4 major clusters at the 80% similarity level. Plasmid profiling did not cluster *lactis* and *cremoris* isolates into separate clusters, whereas Rep PCR differentiated *lactis* and *cremoris* subspecies. Twelve strains were not found to have plasmids. No plasmid band and GTG5 PCR band was found to be specific marker to show specificity to dairy and non-dairy origin. Plasmid profiling showed more discrimination among strains than the Rep PCR. Dahi prepared with UKSP2, KCWC1, KCD5 strains received higher score than others, and found as acceptable. The promising isolates used for the production of the dahi were found to be >80% similar by both strain typing techniques, but showed significant difference at 1% and 5% regarding different aspects of sensory analysis.

**Preparation of low-fat lassi by *in-situ* EPS production using *Leuconostoc* strains:** A total of 11 samples both from dairy and plant sources were used for isolating EPS producing *Leuconostoc* spp. Out of 90 isolates, 43 (43%) were identified as *Leuconostoc* phenotypically. All the 43 isolates together with seven reference cultures of *Leuconostoc* spp. were technologically screened for viscosity, syneresis and acidity. The technologically selected isolates BA8, RA101were used for preparing Low-fat lassi by a modified method. The Low-fat lassi by modified process prepared with *Leuconostoc* spp. showed significant improvements in physico-chemical and technological properties over lassi prepared without *Leuconostoc*. The selected isolates BA08 and RA101 were identified as *Leuconostoc mesenteroides* ssp. *mesenteroides/dextranicum* with 99.6 %ID and 99.9% ID, respectively by API CHL 50. Finally, low fat lassi prepared with RA101 showed good consumer acceptance and storage stability up to 7 days. About 73% consumer graded product as excellent and 76% showed their willingness to buy.

The partial sequencing of 16S rRNA gene of RA101 demonstrated 100% similarity with 16S rDNA sequence of *Ln. mesenteroides* subsp *mesenteroides* available in NCBI. This isolate RA101 (3% level) together with *Lactococcus latis* (0.5%) showed 466.34 ± 2.24, 648.45 ± 11.20 and 1188.83 ± 8.66 mg/L EPS production in skim milk medium at 5, 10 and 15% sugar levels, respectively and at 3% level in single culture showed 565.61 ± 8.96, 792.51 ± 16.42, 1253.77 ± 7.46 mg/L EPS at 5, 10 and 15 sugar levels, respectively.

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

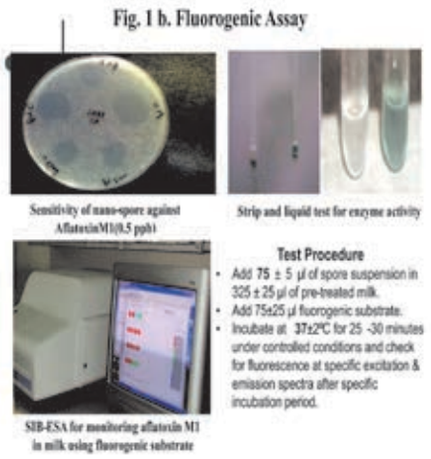
**Development of bacteriocin based antimicrobial packaging system for enhanced food safety :** Bacteriocins of LAB viz. Pediocin 34, Enterocin 99, Nisin and a commercial antimicrobial preparation were used in this study. Pediocin 34, Enterocin 99 and Enterocin 24 were produced from their respective bacteriocinogenic strains *Pediococcus pentosaceus* 34, *Enterococcus faecium* 99 and *Enterococcus faecium* 24 by culturing them in whey based media. Antimicrobial spectrum of activity of bacteriocins were evaluated against some Gram-positive spoilage and pathogenic bacteria. Different concentration of Casein (0.5-2.5%), Whey Powder (5-20%), Maltodextrin (5-20%), Starch (5-20%), and Polyamide (5-20%) were tested for their use as binders of bacteriocins FH 99 and Nisin to select the best concentration. Kinetics of release of the different bacteriocins from the coated membrane in broth medium was also observed. Among the different binders, casein (@ 2.5%) was found to be a relatively better binder. The bacteriocins were quite dispersible in both plate and liquid media and showed antagonistic activity against several pathogenic and spoilage bacteria. The bacteriocin coated films, using casein as a binder, were used as antimicrobial packaging system for shelf-life extension of Paneer and khoa samples. Effect of antimicrobial packaging and direct dipping of paneer in bacteriocin solutions on the growth of Nisin resistant variants of *L. monocytogenes* and *E. faecium* was evaluated. Pediocin 34, in comparison to Enteriocin FH99, showed a better bactericidal effect in case of *L. monocytogenes*. However, not much of difference was observed in the antibacterial activity of the two bacteriocins against *E. faecium*. Though, antimicrobial packaging and direct dipping of paneer in bacteriocin solutions showed significant reduction on the growth of Nisin resistant variants of *L. monocytogenes* and *E. faecium*. Antimicrobial packaging system was quite effective

in increasing the shelf-life of paneer. In comparison to the packaging of khoa in AMP only, addition of the biopreservative preparation (Pediocin 34, Sodium citrate and potassium sorbate) in khoa and its packaging with AMP was more effective in reducing the total bacterial count in khoa after 30 days of storage at refrigeration temperature (7°C) and thus enhancing its shelf life.

## 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 Biosensors and Micro-techniques for Analysis of Pesticide Residues, Aflatoxin, Heavy Metals and Bacterial Contamination in Milk

**Development of on line system for monitoring Aflatoxin M1 in milk using spore inhibition based - enzyme substrate assay (SIB-ESA) :** When an analyte i.e. Aflatoxin M1 is absent in milk system, specific indicator enzyme (s) are produced by active bio-sensing molecules which will act specifically on chromogenic/or fluorogenic substrate resulting in colored reaction/ or fluorescence as end product which is measured semi-quantitatively by either visually/or using optical system at specific excitation/emission spectra as shown in Fig. 1 a & b. The end product response is significantly different in case of milk system containing specific analyte i.e. Aflatoxin M1. SIB-ESA developed at NDRI centre is working on line with novel features like working under natural milk conditions with minimal pre-treatment, reproducible, simplified procedure, exhibited significant correlation with ELISA at Codex MRL Limit i.e.0.5 ppb and the developed assay (Patent


*SIB-ESA for monitoring Aflatoxin M1 in milk*

Reg#3064/DEL/2010) can contribute immensely in dairy industry for routine monitoring of milk for Aflatoxin M1 at collection point, chilling centre, manufacturing unit and R & D institutions. SIB-ESA is working on functionalized sensor disks and storage stability of sensor disks was found up to 30-40 days. Miniaturization of SIB-ESA using EMCCD is under progress. Spores on microfiber sensor disks were immobilized by incubating for 3.30 hrs ± 30 min. SIB-ESA is performing very well with these functionalized sensor disks. Indicator spores were also immobilized in small test tubes by drying in incubator under optimized conditions and chromogenic assay found working within 3 hrs. The storage stability of spores in small test tubes was found up to 2 months.

**Development of ESA on microplate for off line detection of Bacterial contamination on micro plate well:** An Enzyme Substrate Assay (ESA) based on β-D-glucosidase activity was developed for specific detection of Enterococci. In case of *L. monocytogenes*, out of four broths namely University of Vermount medium (UVM), Listeria Enrichment broth (LEB), Brain Heart Infusion broth (BHI) and Fraser Broth (FB) tested, Fraser broth (FB) was selected based on better sensitivity and selectivity when compared with other contaminants. The selective broth can detect a cell level of $10^{6-7}$ in 4-5 hrs with great degree of selectivity. For *E. coli*, out of six broths namely Difco MI, Readicult, E.colite, Rapid high coliform, Chromocult, Colifast screened based on ß-D-glucuronidase activity, Difco MI was selected based on better sensitivity and selectivity when compared with other contaminants. The test protocol for screening was optimized. The selective broth can detect a cell level of $10^{6-7}$ in 1.30 hrs with high degree of selectivity.

PMID agar
+
substrate
+
spore suspension
heated 80°C/ 10min
+
Control milk

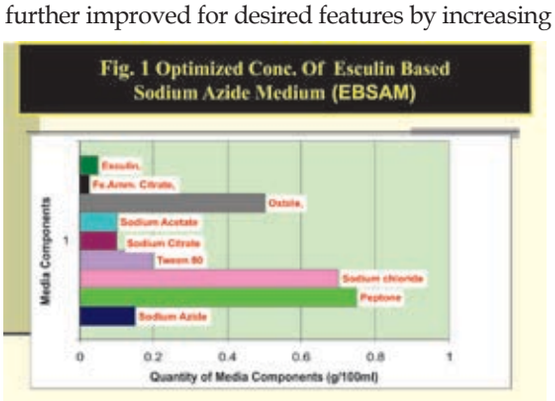
PMID agar
+
substrate
+
spore suspension heated
80°C/10min
+
Antibiotic spiked in
skim milk

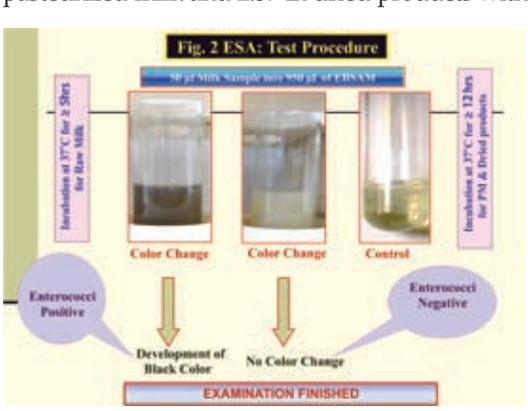
* Colour developed after 3.0 h

## Monitoring of Drug Residues and Environmental Pollutants

**Development of spore inhibition based Chromogenic/fluorogenic substrate assay for detection of broad spectrum antibiotics in buffer/ milk:** The working principle on spore germination based bioassay for broad spectrum antibiotic residues in broth/agar medium was optimized using α-D-Glucosidase activity. PMID broth/agar containing PNPG was seeded with heat treated spores followed by addition of milk with and without antibiotic. The colour changed to yellow in control at 64°C after 3 hrs.

**Development of off-line enzyme based bio-sensing system for enterococci in milk:** Out of the four enrichment broths (commercially available in the market) screened for selective recovery of enterococci based on β-D-glucosidase activity, Chromocult Enterococcus Broth (CEB) showed better performance in terms of selectivity and enzyme activity with partial inhibition of contaminants other than Enterococci. The selected medium was further improved for desired features by increasing the concentration of sodium azide from 0.06 to 0.15g/100 ml which inhibited *L. lactis, L. casei, Leuconostoc mesentoroides* and *L. monocytogenes*. Other media components and supplements were also optimized for enhanced sensitivity and selectivity of *Enterococcus* spp. The optimized selective enrichment medium i. e. Esculin Based Sodium Azide Medium (EBSAM) demonstrated superior features in terms of sensitivity, selectivity, fastness, accuracy etc. and may be a suitable substitute for existing media used for routine monitoring of enterococci in R&D institutions. The ESA developed with pure cells was found to be capable of detecting 7.52 log counts/ml in 1½ hrs with the lowest detection limit of 1.47 log count/ml in 12 hours at 37°C. The impact of milk constituents on Enzyme substrate reaction time was moderate when tested with spiked milk samples and the assay sensitivity was reduced to 2.67 log counts/ ml. Developed assay was screened for enterococci count with 32 samples of raw milk and it could detect 2.67, 3.50, 4.25 and 4.8 log counts within incubation period of 12, 7½, 6½ and 5 hr, respectively. ESA could also detect Enterococci log counts of 2.84 in pasteurized milk and 2.57 in dried products within



12 hrs of incubation; however, assay was insensitive at very low level of 1.13 and 0.915 log counts. As such ESA developed in current investigation may find industrial application as platform test for detection of enterococci in raw milk, pasteurized milk and dried products.

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

**Molecular diversity of rumen methanogens and strategies for methane mitigation *in vitro*:** Methanogens from the rumen of Murrah buffaloes (*Bubalus bubalis*) were isolated using formate and CO2 + H2 mixture as substrate. These isolates (BRM-1, -2 and –3) were found to utilize acetate, but failed to grow on ethanol and methanol. The isolates showed their phylogenetic relation with genus *Methanobrevibacter* and *Methanomicrobium* based on 16S rRNA/ mcrA gene sequence analysis. BRM-1 and -3 showed 100% similarity with *Methanobrevibacter smithii,* while BRM-2 showed 100% similarity with *Methanomicrobium mobile*. McrA protein based phylogeny also showed the similar results of mcrA gene, suggesting no apparent differences in the phylogeny between DNA and amino acid sequences of these isolates. The diversity of rumen methanogens in Murrah buffaloes (*Bubalus bubalis*) was studied using 16S rRNA gene libraries. A total of 241 clones were examined for metagenomic libraries construction. Phylogenetic studies inferred the dominance of *Methanobrevibacter* spp. in buffaloes, followed by *Methanomicrobium mobile* in the northern part of India. Methane production was significantly higher with high roughage diet (6.17 mmol/ 200 mg substrate) in comparison to low roughage diet (4.38 mmol/ 200 mg substrate). Correspondingly, the methanogen counts were also less with low roughage diet. During biological methane mitigation, inclusion of bacteriocins (pediocin and enterocin) or their producers showed a reduction in methane production and number of methanogens. Since, bacteriocinogenic *Pediococcus pantosaceus*-34 was found to increase digestibility, in addition to reduced methane, thus it may offer a possibility to be used as direct-fed microbials for ruminants.

### Scheme on Dairy Microbes

A Scheme on Dairy Microbes under the programme of VTCC (NRCE, Hissar) in Network Mode was initiated during XI Plan by ICAR, New Delhi with Dairy Microbiology Division, National Dairy Research Institute, Karnal as the coordinating centre along with three collaborating institutions - Anand Agricultural University, Anand, Gujarat, GB Pant Univ. of Agril. & Tech., Pantnagar, Uttrakhand and Karnataka Vety. Animal & Fisheries Sci. Univ., Bidar, Karnataka. Different strains of *Streptococcus thermophilus, Lactococcus* spp., and *Leuconostoc* spp. were isolated from different sources such as fermented milks, vegetables, fruits, etc. across India. Thirty strains of *Streptococcus thermophilus* and 17 of *Lactococcus lactis* were identified by genus and species specific PCR and partial sequencing of 16 rRNA gene. The sequences were deposited in NCBI database. Four mannitol producing leuconostocs (Three, *Leuconostoc mesenteroides* ssp. *mesenteroides* and one, *Leuconostoc fallex*) and two EPS producing strains (*Leuconostoc mesenteroides* subsp. *mesenteroides*) were identified, characterized and deposited in NCDC. Further, 179 *Streptococcus thermophilus* strains were isolated and deposited at culture bank (NCDC/VTCC). The genes in the gal operon of five novel strains of *S. thermophilis* showing rare phenotype of galactose fermentation were amplified, sequenced and compared with the reported gene sequences available at NCBI. Besides, five cultures of *Propionibacterium* were procured from the German Culture Collection (DSMZ), Braunschweig (Germany).

## Dairy Economics, Statistics & Management

### Promoting Dairy Enterprises through Transfer of Technogies Improved Farm Financing, Suppy Chain Management and Better Market Access

Recent Economic Survey of India indicated that annual domestic demand for milk is growing at about 6 million tonnes whereas the incremental milk production over the last 10 years has been about 3.5 million tonnes per year. In order to reduce the gap, it is necessary to promote dairy enterprise through improving farm financing, supply Chain management and better market access, different studies were conducted at different locations of the country during 2009-10 to capture the behavior and nature of production and performance, right from the grass root level till it reaches the ultimate consumers.

### Study on Economics of Production and Marketing of Milk in Samastipur District of Bihar

Primary data collected from 100 farm households was analysed and it was found that average milk

yield per day (per milking animal) was about 7 litres for crossbred cows followed by 5 litres from buffaloes and 4 litres from local cows. Maintenance cost per day per milch buffalo ranged from Rs. 65 to Rs. 84. Net return per milch buffalo was the highest (Rs. 5.28) for medium and the lowest for landless (Re.0.54) farm households. Similarly, net maintenance cost per milch local cow was about Rs. 42. The gross return was found to be Rs. 43 with a positive net return. Cost per litre of milk was worked out to be Rs. 17.13, Rs. 12.88 and Rs. 14.05 for buffaloes, crossbred and local cows, respectively. The study revealed that green fodder and concentrate had positive and significant influence on milk yield in buffaloes whereas in case of crossbred cows, green fodder, dry fodder and concentrate had positive and significant effect on milk yield. Out of the total milk produced, marketed surplus accounted for 76% and the rest 24% was retained at home. Milk producers sold about 43% of the milk to cooperative, 30% to milk vendors and 27% to consumers directly realising average price of Rs.15.32 per litre.

### Economics of Milk Production and its Disposal Pattern on Commercial Dairy Farms in Ahmednagar District of Maharashtra

A survey study carried out on 40 Commercial Dairy Farms indicated that the net returns over cost per litre of cow milk were Rs. 2.08 whereas in case of buffalo it was Re. 0.72. Average herd size on small, medium and large commercial farms was 10.55, 14.11 and 34.66 milch animals, respectively. Daily herd average milk yield for crossbred cows was 9.72, 9.58 and 9.49 litres for small, medium and large categories, respectively while the cost of maintenance of milch cows per day was Rs.121.39, Rs.120.52 and Rs.108.94 for small, medium and large categories, respectively. Cost per litre of milk from crossbred milch cattle was estimated to be Rs.12.49, Rs.12.58 and Rs.11.48 for small, medium and large farms, respectively, with an overall average of Rs.12.18 per litre. Out of the total milk produced, marketed surplus constituted 94.48, 94.81 and 96.96% for small, medium and large commercial farms, respectively. Out of total quantity of milk marketed, 33% was disposed of to cooperative dairy, 56% to private dairy and the rest 11% was sold to the vendor.

### Economic Analysis of Rural and Peri-urban Dairy Farms in Ludhiana District of Punjab

Data were collected from 25 dairy farms from rural and 15 dairy farms from the peri-urban areas and it was found that net returns per milking buffalo was about Rs. 53 and Rs.111, respectively in rural and peri-urban areas whereas in case of crossbred cattle, it was Rs. 54 and Rs.137, respectively. The maintenance cost per milking buffalo on rural and peri-urban dairy farms was about Rs.141 and Rs.151, respectively whereas the daily maintenance cost per milking crossbred cattle on rural and peri-urban dairy farms were Rs.145 and Rs.156, respectively. The net returns per milking and milch animal were higher in case of crossbred cattle as compared to buffalo in all seasons. This provides clear indication as to why the Punjab Government is giving more priority to cross bred dairy farming. The average employment generated from dairying on rural and peri-urban dairy farms was 313 and 1451 person days per year, respectively. Green fodder and concentrates were found to have positive and significant effect on milk production on both farms for all the species. Overall, the peri-urban farms were observed to follow better breeding, feeding and health care management practices as compared to rural dairy farms.

### Economic Analysis of Dairy Production Systems in Nanded District of Maharashtra

A study based on a sample of 100 households indicated that the overall maintenance cost of both milking and milch animals was the highest for CB (Cross bred) based system and the lowest for local cow of LC+BF (local cows+ buffalo) based system. The net returns were the highest for CB based system and the lowest in case of LC based system. The estimated milk production function for milking buffaloes revealed that coefficients of green fodder and concentrate were found to be positive and statistically significant; while in crossbred animals, dry fodder, labour and miscellaneous expenses were found to be positive and statistically significant; whereas in local cows, none of the coefficients were found statistically significant. Concentrate and labour were found to be positive and significant indicating that there is a scope to enhance milk productivity by enhancing concentrate and labour. The study concluded that CB based system was found most economical followed by BF based and LC+BF based system.

### Economic Analysis of Dairy Farming in Dry Farming Areas of Dharampuri and Thruvannamalai Districts of Tamil Nadu State

Feed and fodder constitute, an important component in the production of milk and also in the overall expenditure in dairy farming. Deficit feed and fodder for bovine population led to under utilisation of the genetic potential in spite of the breeding

programme and policies. The study revealed that about 78% of the farm families reported high cost of compounded feed and lack of suitable crops for fodder cultivation as the serious constraints faced by them. Green fodder availability and high price in fodder market were considered as constraints for 71% and 68% of farm families, respectively. The average quantities of green fodder, dry fodder and concentrates consumed per crossbred per day were 15.89, 9.61 and 6.29 kg, respectively. In buffalo, these quantities were 11.12, 5.98, 5.24 kg per day green fodder, dry fodder and concentrates, respectively. The overall maintenance cost per crossbred cow per day was about Rs.51. Crossbred cows brought higher cash balances, i.e. about Rs.36 as against Rs.29 for buffalo. There is a need to make available non- conventional feed material at cost effective price and to increase the procurement price of milk to make dairying profitable.

### Economic Analysis of Institutional Credit for Dairy Farming in Shimoga Milk Zone of Karnataka

Without an effective financing system, dairy farmers cannot afford to update or modernise the dairy farming system. In this regard, a study was conducted in Shimoga milk zone of Karnataka. Analysis of credit disbursement in the study area revealed that total credit disbursed in the study area increased at an annual growth rate of 19.34% during the period 2001-07. Credit to Dairy Development (DD) sector also increased at a rate of 17.53% in this period. Within the priority sector credit, the share of agriculture ranged from 64-75% during 2001-07. Dairy sector, which contributed nearly 3% to state's Gross Domestic Product (GDP) received only one per cent of the agriculture credit. On an average, Commercial Banks (CBs) contributed 81% of the dairy credit followed by Regional Rural Banks (RRBs) and Cooperative Banks with 14% and 5%, respectively. The CB borrowers were found to be better endowed with farm resources as compared to borrowers from RRBs or SHGs. The analysis of credit requirement indicated that medium term credit need for the purchase of milch animals was highest for marginal households and the lowest for landless households. However, the credit gap was also found to be higher for marginal farmers followed by landless labourers. Overall medium term credit requirement for purchase of animals was Rs. 12988 and the credit gap was Rs. 980. On an average only 36% of the credit was utilised for purchasing animals and the rest was diverted for other uses. Among other uses about 13% of dairy credit was used for lending to others at higher rate. Discriminant functional analysis indicated that variables such as higher percentage of earning adults in the family and higher per capita income from dairy were associated with higher repayment.

### Value Chain Analysis of Milk in High Hills Temperate Wet Zone of Himachal Pradesh

Value chain reduces cost, minimise losses, add value and share the gains with producers and consumers. The study revealed that the average investment in the dairy enterprise was Rs.91, 170 per household in the study area. The capital investment on animals was 53.05% of the total investment followed by 43.87% investment on buildings and the rest 3.08% on machinery. Per day cost of maintenance of milch crossbred cow, local cow and buffalo were Rs. 42.47, Rs. 28.53 and Rs. 44.35, respectively. The cost of milk production from crossbred cow, local cow and buffalo was worked out to be Rs.9.63, Rs.12.9 and Rs.10.95 per litre, respectively. Milk marketed surplus was found to be 71% of total milk production. Most of milk producers patronised dairy cooperatives to dispose of their surplus milk. Milk price realised from this marketing outlet was observed to be Rs.14.20 per litre. The cost of milk collection, transportation and chilling at Milk Chilling Centre, Sarahan (Nahan) was observed to be Rs.1.58, Rs.2.03 and Rs.0.43 per litre, respectively. The cost of milk procured at Milk Chilling Centre, Sarahan was observed to be Rs.18.07. The total procurement cost of Milk Chilling Centre, Renukaji (Sirmour) was observed to be Rs.6.50 in addition to milk payment made to milk producers at the rate of Rs.14.68 per litre. During the year 2009-10, the plant procured 106.36 lakh litres of milk. The product mix of the plant included table butter, ghee, paneer, curd, sterilised flavoured milk and Khoa. The total variable cost of manufacturing standard milk, toned milk and double toned milk was Rs.20.19, Rs.18.76 and Rs.18.95 per litre, respectively. In all these milk variants, the major cost component was raw material cost followed by processing cost. The plant distributed dairy products through its milk bars and booths, while for fluid milk dealers were appointed. The retail price of ghee was Rs.260 per litre, butter Rs. 220 per kg, paneer Rs.150 per kg, Khoa Rs.140 per kg and Curd Rs.7.50 per cup of 250 g. Standard milk, toned milk and sterilized dairy drink were sold at Rs. 25, Rs. 22 per litre and Rs.12 per 200 ml bottle, respectively.

### Impact of Policy Reforms on Livelihoods in Dairy Value Chains with Special Reference to Smallholder Producers

The study revealed that during the period from 1960-61 to 2002-03, the marginal categories of

household operational holdings has been rising at a very fast rate, i.e., 58% to 79% (risen from 22 million to nearly 70 million). With respect to the number of in-milk bovine stock, marginal category household recorded a significant increase from 20% in 1971-72 to 52% in 2002-03. It was also seen that the marginal and small categories together constituted 58% of all holdings and accounted for as much as 71% of the in-milk bovine stock. As per the choice of selecting livestock for dairying, there was also a growing trend for the use of buffaloes due to their higher returns as compared to cattle. The decadal growth trends of milk production in the last forty years showed that the growth rate of milk production increased from 2.70% during 1966 to 1980 to a maximum of 5.85% during 1981-90 reflecting the possible impact of Operation Flood Programme. It was also found that in the first phase of 'Operation Flood' (1970-1980), growth rate of value added products was 0.93% per annum, while in the third phase (1985-1996), it increased to 9.10% per annum. During the period from 1994-95 to 2000-01 in the unorganised sector, newer value added dairy products like cheese, curd and ice cream manufacturing registered a positive growth while that of highly traditional products, viz., Butter, Cream, Ghee and Butter milk registered a negative growth. The value addition was highest in ice-cream and least in butter. The dominant key actors actively involved in the Dairy Value Chain constitute both the backward linkage and the forward linkages. In the existing scenario with respect to smallholder producers, there are still a number of limiting factors, which hamper the milk production and productivity, viz., shortage of feed and fodder availability, lack of effective transfer of technology (about 70 million dairy farmers, many of whom are illiterate, need to be approached for diffusion of new ideas and technology), genetic improvement and livestock healthcare delivery (Outreach of AI services and quality semen needs to reach the remotest dairy farmer), lack of chilling capacities (bulk milk cooler) at the village level.

### Performance Appraisal of Dairy Products Manufacturing Enterprises in India: Spatio-temporal Analysis

With reference to the structural changes in dairy processing sector and enterprises in India, the study revealed that the number of unorganised dairy manufacturing units declined from 1, 40, 836 in 1994-95 to 1, 27, 069 in 2005-06, while that of organised units increased from 563 to 1049 during the same period. The own-account manufacturing enterprises comprised of 88% of the unorganised manufacturing enterprises but over the years from 1994-95 to 2005-06, there was a decline in small-sized units and increase in large-sized units. The rural-urban ratio of manufacturing units also decreased, perhaps due to better logistic support and higher demand of value added dairy products in the urban areas. The unorganised rural enterprises were highly concentrated in West Bengal, Uttar Pradesh (U.P.) and Gujarat, while the unorganised urban enterprises were concentrated in U.P., Rajasthan and Andhra Pradesh. Examination of the characteristics of the unorganised manufacturing units revealed that these units were mostly unregistered proprietorship firms located within the household premises. About 50% of the enterprise owners undertook other economic activities also, perhaps due to low income generation from dairy enterprises. More than 85% of the enterprises did not receive any financial or technical assistance. Education level of working owners was low, emphasising on HRD requirement for skill development. The performance appraisal of the organised dairy industry revealed 5% growth in real value of output during 1998-99 to 2007-08, but near stagnation in real net value added per factory and real profits per factory. After 2005-06, there was a slowdown in performance of organised dairy industry.

### Prediction of Economic Traits in Murrah Buffaloes – A Comparative Assessment of Connectionist and Conventional Models

In order to study the influence of economic traits on milk yield performance of dairy animal, a study was conducted. The adjusted data were used for developing predictive models based on connectionist paradigm. It was empirically found that the Root Mean Square Error (RMSE) of connectionist models for prediction of 305-day milk yield in all the five lactations as well as for overall prediction of 305-day milk yield were relatively better in comparison with conventional Multiple Linear Regression (MLR) model; and range of RMSE (per cent) in connectionist models varied from 19.28 (fifth lactation) to 51.49 (first lactation) as compared to that in conventional MLR models where it varied from 31.32 (fifth lactation) to 52.49 (first lactation) in Murrah buffaloes. It was empirically found that the RMSE of connectionist models for prediction of total lactation milk yield in all the five lactations as well as for overall prediction of total lactation milk yield were better in comparison with conventional MLR model; and range of RMSE (per cent) in connectionist models varied from 20.54 (fifth lactation) to 33.90 (first lactation) as compared to that in conventional MLR models, 31.16 (fifth lactation) to 34.48 (first

lactation) in Murrah buffaloes. Based on the comparative studies of various developed models, it was suggested that connectionist models were relatively better predicting 305-day and total lactation milk yield in Murrah buffaloes.

### Development and Evaluation of e-Learning Management System (e-LMS) for Dairy Education

As e-Learning has become necessary and important in the present IT based academic setup, a study was carried out as an initiative for providing an e-Learning environment in the institute. For this, a well structured survey questionnaire was developed to assess the requirement of students and scientists to introduce e-learning activities. Response from 72 Scientists and 194 Students were obtained and analysed accordingly. Under this programme, an e-Learning Management System (e-LMS) MOODLE (Modular Object Oriented Dynamic Learning Environment) for initiating e-learning activities and creating e-courses was identified and installed.

### Agroweb Digital Dissemination System

A new website of the institute was developed under the NAIP project for Agriculture Research as per uniform guidelines. The website contains role-based dynamic updating mechanism viz., faculty profile database including regional stations, Division/ Section profiles, M.Sc./Ph.D thesis from 2003-2009, Research project database, Research papers published, ATIC information, Alumni database, Information for farmers etc. Three web-enabled information systems on 'Availability and sources of superior germplasm of cattle and buffaloes, 'Decision Support System for farm management by monitoring the Herd Strength and Expected Productivity of cattle and Buffaloes' and National collection of dairy cultures were also developed.

## Dairy Extension

### Developing Location-Specific 'Package of Practices' for Balanced Feeding: An Action Research on Low-external-Input Dairying with an Extension Perspective

The study revealed that when the dairy farmers treated their locally-available wheat or paddy straw with the "Urea-Ammonia" and fed it to their dairy animals, alongwith an additional supplementation of 'Mineral Mixture', the milk-production among the cows and buffaloes enhanced, approximately, on an average, by 750 and 400 g. per day per animal, respectively, especially during the winter season. Moreover, during the summer season also, when these dairy animals were fed with the afore-said 'Urea-Ammonia treated straw' and 'Mineral Mixture', it was observed that there was no significant increase in the milk-production, yet it helped these dairy animals to maintain their normal level of milk-production as against the loss (to the tune of almost 10%) in production-level, during the summer season of the preceding years, as reported by the same respondents. Further, the respondents also reported that feeding of the 'Common Salt' to their dairy animals helped in prevention of diarrhoea, to a greater extent, as this happened to be a common phenomenon in that area.

### Impact of Extension Activities of NDRI at Pusar and Lalukheri Centres

The study was conducted with 200 beneficiaries dairy farmers belonging to adopted villages Pusar and Laukheri of UP State. The total dairy herd in village Pusar and Lalukheri at the time of initiation (2004) of the project were 6362, which included cattle (Desi :2845, CB : 62) & buffalo (3455) as against in the final year of the project 2010 (Desi cattle : 2844, CB : 150, buffalo : 3692, total : 6686) The finding of the study revealed that there was almost a two and a half times increase in the cross bred cattle in these two adopted villages. As far as milk production in these adopted villages was concerned, the total daily milk production in the village was 133 q at the time of initiation of the project which increased to the tune of 160 q by the end of the project. The data depicted that there was a significant change in the parameter such as economic motivation, risk – taking behaviour, annual dairy income, value of material possession particularly farm materials herd size of cross bred cattle and buffalo, quality of cattle shed, total milk production , their disposal and the entrepreneurial characteristics of dairy farmers who were benefited. The study also revealed that there was significantly higher adoption of scientific dairy farming practices by the dairy farmers.

### Dissemination of Recommended Calf Rearing Practices under Rural Conditions – An Action Research

Majority (53.12%) of the respondents belong to middle age group ranging from 35 to 50 years followed by the old and the young. Respondents were purposively selected from general caste 50 %, OBC 25% and SC/ST 25%. Illiterate were

45.83% followed by others. Family size of 78.12% respondents was medium and main occupation of majority 65.62% was agriculture. Annual income of 43.75% farmers was low up to Rs. 50,000 per annum. Majority (65.62%) of the respondents fed extra ration to their pregnant animals. During winter 39.58% fed desi ghee app. 100 g daily whereas, in summer Dahi +Oil @ 250 ml up to 30 days was given by 43.75% of the respondents. Majority (83.33%) of them provided Kachha floor at the time of calving and same percentage provided Pacca floor at the time of feeding. Majority (78.12%) trim hoof and only (4.16%) cut naval cord by recommended method. 100% fed colostrum to new born calves within 2 hours. Proper housing and bedding was followed by 30.21% and feeding of green fodder after 15-20 days by 22.91%. Nobody was feeding milk replacer to their calves whereas, majority 90.62% were feeding mineral mixture and majority 83.33% tried to provide clean drinking water. Only 11.45% of the dairy farmers gave medicine for deworming as per schedule. Lack of knowledge about scientific management of calves was ranked first with 189 scores followed by timely non-availability of veterinary staff (score 185) second and high cost involved in scientific management of calves (score179) third. Last constraint ranked 11th in the ranking order with score (143) was feeding of colostrums which was mostly delayed till placenta was released.

### Status of Dairying in Manipur

The study revealed that most of the respondents had low level of milk production, milk consumption, utilization of cosmopolite sources. It was revealed that the respondents had great repository of Indigenous Technical Knowledge (ITK) apropos dairying. ITK of healing the diseases affecting digestive disorders, reproductive disorders, disease affecting skin, and naval cavity, infectious diseases and other miscellaneous diseases were delineated. It was also found that the materials used for curing the diseases were of plant, animal and chemical origin. Lack of veterinary hospital at village level was ranked as first constraint by the maximum of the respondents. Majority (62%) of the respondents had medium level of knowledge about overall improved dairy farming practices. Knowledge of breeding, feeding, health care, dairy management had had high and positive significant relationship with overall adoption of improved dairy farming practices. It can be concluded that the status of dairying was poor compounded by less public and private attention.

### Training Needs of Members of Dairy Based Women Self Help Groups (WSHGS) in Bhagalpur District of Bihar

All women SHGs (100 %) had marginal land holding (below one hectare) with medium herd size. About 70% SHGs were having medium level of milk production (25.7 to 87.2 litres/day). Majority of SHGs (60%) had medium level of milk consumption (7.6 to 28.3 litres/day), having medium level of milk sale ranging (16 to 61 litres/day). The study found that 50% of SHGs were having medium level of annual income (Rs 72741 to 171549). A large proportion of women SHGs members had medium level of knowledge about IDFPs with medium level of their adoption. Majority of the respondents had shown high training need in all the four areas of improved dairy farming practices. However, overall training needs of the respondents were reported to be highest in health care practices (97.2%). The most prioritized area of the constraints, as perceived by respondents was regarding the functioning of women SHGs followed by inadequate training given to member of SHGs.

### Prospects of Commercial Dairy Farming in Haryana

Large commercial dairy farmers were most competitive based on socio-economic and communication attributes when compared to medium and small farmers while entrepreneurial behaviour of medium commercial dairy farmers was fairly higher than large and small farmers. The overall adoption index of scientific dairy farming practices was found to be 73.53, 74.72 and 79.62 for small, medium and large commercial farmers, respectively. The net cost of milk production per litre for milking crossbred cattle on small, medium and large farms was estimated to be Rs.10.68, Rs.10.21 and Rs. 9.49, respectively. The net cost of milk production per litre for milking buffalo on small, medium and large farms was estimated to be Rs.15.50, Rs.15.01, Rs.14.96, respectively About 25% of total large farms fell in high technical feasibility category while minimum i.e. 7.14% of total medium farms were found under low technical feasibility. Majority of farms fell under moderate technical feasibility. Average net farm income per year for small, medium and large farms was Rs.151125.78, Rs.525600.34 and Rs.1250758.69, respectively. The major constraints faced by the farmers were identified as non-availability of high quality germplasm, high feed cost, difficulty in getting skilled and efficient labour, low price of milk and lack of organized market for animals and milk.

### Training Needs Assessment of Dairy Farmers Regarding Scientific Calf Rearing Practices in Kurukshetra District of Haryana

In the area of feeding, "Feeding strategies and feeding schedules" was perceived to be the most serious training need. In the area of management, "Care of pregnant animals", "Care at time of calving", "Care of new born calf" were perceived to be the most serious training needs. And in the area of healthcare, "Knowledge and diagnose of common diseases of calves" was perceived to be the most serious training need. The training need index in health care was found high as compared to other areas of scientific calf rearing practices. Maximum respondents fell in the medium category of knowledge level regarding scientific calf rearing practices In the area of feeding, "Lack of knowledge about preparation and feeding of concentrate for calves" was the most felt constraint. In the area of health-care "High cost involved in treatment of calves because of costly medicine" was the most important constraint faced by the respondents. In the area of management, "Limited resources availability for providing scientific housing to calves" was the most important constraint faced. Education and extension contact needs were found to be positively and significantly correlated with knowledge level. Milk production, milk sale and mass media exposure were found to be positively and significantly correlated with the knowledge level. Perceived training need was found to be negatively and significantly related with the knowledge level. Education and milk production, milk sale, land holding and extension contact were found to be negatively and significantly correlated with perceived training needs of dairy farmers regarding scientific calf rearing practices.

### Udder Health-Care Practices Followed by Dairy Farmers: An Exploratory Study in NDRI Adopted Villages

Majority of the respondents followed udder health-care practices upto medium level. Incidence of clinical mastitis in crossbred cows belonging to respondents having large sized milch herd was 30% and the incidence in crossbred cows belonging to respondents having small sized and medium sized milch herd was 12%. Incidence of clinical mastitis in buffaloes belonging to respondents having large sized milch herd was 17% and the incidence in buffaloes belonging to respondents having medium sized milch herd was 14% and for small sized, it was 8%. Majority of the respondents having small sized milch herd had medium level of knowledge about udder health-care practices. Majority of the respondents having medium sized milch herd had medium level of knowledge about udder health-care practices. Majority of the respondents having large sized milch herd had medium level of knowledge about udder health-care practices. The study revealed that about 6% of the crossbred cows belonging to respondents having small sized milch herd were repeat breeders and about 2% of the buffaloes were repeat breeders. "Lack of knowledge about sanitation & hygiene" was the most important perceived constraint in maintaining udder health. The second important perceived constraint was "lack of knowledge regarding prevention of mastitis". "High cost involved in treatment of mastitis because of costly medicine" was perceived as the third important constraint. Incidence of mastitis in crossbred cattle was negatively and significantly related with udder health-care practices. Extension contact and mass media exposure are positively and significantly correlated with knowledge level about udder health practices.

### A Pilot Level Testing of Health Foods Developed at NDRI in Karnal District of Haryana

The study revealed that majority of rural (40%) and urban (58.33%) respondents belonged to the middle age group ranging from 35 to 50 years and (61.67%) rural (65%) urban consumers were having medium level of family education status. Findings with regard to land holding revealed that (40%) rural and (78.33%) urban respondents were found landless. Majority of rural and urban respondents (71.67%) each were having medium level of extension contacts. It was observed that a significant difference existed among the rural and urban respondents with respect to their awareness regarding nutritional aspects of the health foods. Similarly, significant difference was found between rural and urban consumers regarding their knowledge about therapeutic aspects of health foods. The mean score for overall liking of Bajra Lassi was found to be more (7.55) among urban consumers than the rural consumers (6.97), using 9 point hedonic scale. These findings reflected the popularity and willingness of urban consumers for traditional foods in modified form. The over all liking score for mango drink (6.43) was more among urban consumers than (5.70) rural consumers, which showed that it was slightly liked by both rural as well as urban consumers. The over all liking score for Jaljeera drink (8.22) was more among rural consumers than (8.03) urban consumers which indicated that, it was liked very much by both rural as well as urban consumers. Rural consumers (31.67%) reported Bajra Lassi

more acidic as compared to the traditional one. Lower sensory score in case of mango whey drink among rural and urban consumers could be attributed to lower mango content and low intensity of mango flavour as reported by them and Jaljeera Drink perceived slightly sweeter in taste by urban consumers (25%). Regarding choice of the health foods tasted; Jaljeera Drink was most preferred by consumers (50.83%) followed by Bajra Lassi (34.17%) and Mango drink (15%).

### Training Needs of Members Under Manipur Milk Producers Cooperative Union

Majority (73.33%) of the respondents were having medium social participation. Most of the cooperative members i.e. 55% were having small (1-2 ha) land holding. Regarding herd size, 65.83% of members possessed medium herd size (1.25 – 4.14 animals). In case of milk production, majority of the respondents (82.50%) were in the medium category (5 – 18 lit). Regarding milk consumption, 77.50% of members belonged to the medium category (0.47 – 1.41 lit/day) whereas in case of milk sale maximum of the members (82.50%) were in the medium category (3.69 – 17.21lit/day). Most of the respondents (75%) were in middle category (Rs. 58154-139316) of annual income. In case of household, 50.84% respondents had brick wall and tin sheet roof type of house followed by mud wall and thatch (35.83%), concrete house (10%), double storied and above (3.33%) and shed thatch (0.00%). Regarding material possession, most of the respondents (62.50%) belonged to medium category; whereas the low and high category of material possession constituted of 19.17% and 18.33%, respectively. The highest knowledge level was found in areas of breeding (68.10%), followed by the management (57.17%), feeding (57.16%), healthcare (56.75%) and fodder production (35.24%). The overall training needs index of the respondents was found to be 79.90%. The training needs index was highest in case of fodder production (96.38%) followed by healthcare (94.40%), feeding (83%), management (68.60%), breeding (55%), respectively. Among the overall constraints, most serious constraints as perceived by the cooperative members in IDFPs was the high cost involved in purchase of ingredients for preparing concentrate' followed by the non availability of surplus land for fodder cultivation, high cost involved in treatment of animals because of costly medicine, high cost investment in scientific management of dairy animals and importance given to growing food and cash crop than fodder cultivation, etc.

### Training Needs of Dairy Farmers for Improved Dairy Farming Practices in Bundelkhand Region

Marginal farmers showed maximum perceived training needs in fodder production (77.23%), followed by Small farmers reporting to have highest perceived training in management (76.17%), semi- medium farmers in the area of fodder production (73.10%), however, Medium farmers showed maximum perceived training needs in the area of management (71.68%) and Large farmers had maximum perceived training needs in the area of health-care (78.33%). In the area of having knowledge, farmers had maximum perceived training needs in healthcare, followed by fodder production, management, feeding and breeding, respectively and maximum training needs required by marginal farmers followed by small, large, semi-medium and medium, respectively. Results showed that distant location of veterinary hospital was reported to be the most important perceived constraint in breeding practices. Scarcity of green fodder was the most specified constraint in feeding, distant location of veterinary hospitals/non availability of veterinary hospitals major constraints in health care, lack of knowledge about clean milk production practices was major constraint in management practices, and non-availability of land was major constraint in fodder production practices, respectively. Education was negatively and significantly correlated with perceived training needs at 1 % level of significance, social participation, extension contact, mass media exposure and knowledge of respondents were found to be negative and significantly correlated with perceived training needs at 5% level of significance in relation to improved dairy farming practices.

### Dairy Animal Productivity Enhancement Programme in Ahemednagar District of Maharashtra: An Exploratory Study

Most of the dairy farmers were in middle age group, educated above high school, medium category of family size; having medium social participation, experience in dairying and training obtained. Most of the farmers were having medium herd size and medium land holdings. Milk production, consumption and sale were found at medium level. The values of productive and reproductive parameters from three different respondents were very much similar to each other. Average values for crossbred cattle were observed as follows: Average milk yield (14.8 kg), Lactation milk yield (3692.5 kg), Peak yield (24.41 kg), Days

to attained peak yield 34.8 days, Dry period (71.85 days), Lactation length (255.9 days), Age at first calving (25.02 months), Service period (68.1 days), Conception rate (2.08) and Calving interval (14.2 months). Farmers were coming across some constraints; such as lack of training facilities, lack of communication facilities at farmers' doorstep, low procurement price, etc. Constraints perceived by stockmen were distantly located stockmen centre, lack of appropriate rewards from superiors for doing good job, low education level of farmers, etc. Distortion of information/message flowing downwards and upwards, ambiguity in terms of roles among supervisory staff, lack of training facilities were the serious constraints as perceived by the supervisory staff.

### Design and Validation of Information Dissemination System for Quality Milk Production

To develop the Information Dissemination System (IDS), the secondary data related to clean milk production practices and information needs was collected and organized in view of the IDS. Home page of IDS was designed and the major headings, subheadings and relevant statements were finalized. The design and outline of information dissemination system for quality milk production was planned. The parameters of quality milk production were finalized. The content of information dissemination system was prepared and provided to subject experts for further modifications. A schedule was developed to validate the developed information dissemination system. It measured the overall perception, content component, suggestions for the improvement of the web module and strategies for effective utilization at field level as a tool for transfer of technology. SWOT analysis of the web module was carried out to study the strengths, weaknesses, opportunities, and threats perceived in using the web module/site as a tool for transfer of technology.

## Southern Regional Station, Bangalore

### Faster Multiplication of Superior Germplasm of Region Specific Breed of Cattle and Buffaloes through Intervention

**Characterization of bovine MHC BoLA DRB3.2 alleles employing PCR-RFLP:** Molecular characterization of BoLA-DRB3.2 alleles in 107 DNA samples were screened in Malnad gidda cattle. A total of 37 BoLA-DRB3.2 alleles were identified, the most frequently observed alleles with allele frequencies higher than 5% were DRB3.2*15 (10.28%), DRB3.2*a*aa (*5702) (9.346%), DRB3.2*16 (8.411%), DRB3.2*23 (7.009%) and DRB3.2*09 (5.607%), which cumulatively accounted for 40.65%.

The 2 new BoLA DRB3.2 alleles identified namely DRB3.2*a*aa (*5702) and DRB3*u*bi (*2503) were observed with a frequency of 9.346% and 2.04%, respectively. These new alleles were sequenced on both the strands for conforming their sequence identity. The DRB3*a*aa (*5702) allele sequence showed complete identity with BoLA-DRB3*5072. Whereas DRB3*u*bi (*2503) revealed a 98% identity with BoLA-DRB3*25011 with three nucleotide changes at nucleotide positions 81-C/T, 97-T/A and 130-G/A and protein translation revealed three amino acid changes at amino acid positions 27-H/Y, 32-Y/F and 43-R/Q, respectively. The sequences on conformation were submitted to NCBI Gene bank. The Gene bank accession no HM031388 for BoLA-DRB3.2*a*aa (*5702) and Gene bank accession no HM031389 for BoLA-DRB3.2*u*bi (*2503) was assigned for the two sequences by NCBI Genome bank, respectively.

In all, 73 DNA samples in Hallikar breed were screened and a total of 29 BoLA-DRB3.2 alleles were identified, the most frequently observed alleles (>5%) in Hallikar cattle were DRB3.2*11 (13.014%), DRB3.2*44 (11.644%), DRB3.2*31 (10.274%), DRB3.2*28 (5.479%) and DRB3.2*51 (5.479%) which cumulatively accounted for 45.89%.

Out of the 98 Deoni animals screened, a total of 34 BoLA-DRB3.2 alleles were identified. The most frequently observed BoLA DRB3.2 alleles with frequencies higher than 5% were DRB3.2*11 (18.3%), *9 (9.7%), *47 (8.1%), *20 (6.4%), *34 (5.4%) and *23 (5.3%) cumulatively accounting for 53.2%. Four novel alleles namely DBR3*caf, *eaf, *abb, *pad with each having the frequency of 0.7% were observed in this breed.

**Characterization of Prolactin gene (exon 3 & 4) and its association with production performance in dairy cattle:** Digestion of the PCR product with Rsa I Restriction enzyme revealed three patterns in all the samples signifying that Prolactin gene had Rsa I site in Deoni cattle. In PRL Exon 3 (156

bp), the genotypic frequencies of AA, AB and BB genotypes were 0.097, 0.58 and 0.32, respectively. The estimated allelic frequencies of A & B allele were 0.39 and 0.61, respectively. In PRL Exon 4 (294 bp), the genotypic frequencies observed for allele AA - 0.097, BB - 0.18 and AB - 0.72 and allele frequencies observed for A and B alleles were 0.488 and 0.542, respectively. Multiple regressions analysis revealed that there was no significant difference ($p>0.05$) of PRL exons 3 & 4 with fat yield, milk yield, lactation length and age at first calving in Deoni cattle.

In PRL exon 3 genotypes, the mean production performances in terms of first lactation milk yield (FLMY); first lactation length (FLL), pooled first lactation milk yield (PLMY); pooled lactation length (PLL) were recorded as 968.21 ± 43.19 kg; 219.14 ± 11.25 days ; 994.79 ± 51.08 kg; and 212.88 ± 9.60 days in AB genotype. Whereas, in BB genotype, it was recorded as 1052.43 ± 88.44 kg : 228.90 ± 19.93 days ; 956.86 ± 119.80 kg and 215.5 ± 21.55 days, respectively. Similarly, in AA genotypes, the values were 988.7 ± 10.59 kg; 202.8 ± 17.49 days; 930.8 ± 126.19 kg and 211.8 ± 19.82 days.

The mean pooled daily peak yield in these three genotypes was 5.23 ± 0.22 kg; 4.83 ± 0.36 kg and 5.62 ± 0.278 kg, respectively. The analysis on milk quality parameters depicted that there was a variation among genotypes in terms of fat and protein yield. The values for fat yield were 4.83 ± 0.28; 4.72 ± 0.33 and 5.4 ± 1.0 percent in AB, BB and AA genotypes, respectively. In the case of protein yields, the values were 3.34 ± 0.38; 3.2; and 3.1%, respectively.

Lactating HF animals were screened for PCR-RFLP patterns for prolactin gene Exon3. The PCR product of 156 bp PRL Exon 3 digested with RsaI has separated into two bands of 74 and 82 bp in the B allele, whereas, A allele lacks RsaI site. Thus, 3 genotypes i.e. AA, BB and AB were observed. In HF crossbreds, the frequency of AA, AB, BB genotypes are 0.28, 0.55 and 0.17, respectively. The estimated allelic frequency of A and B alleles are 0.55 and 0.45, respectively. In the present study, 51 HF crossbreed were screened for PCR-RFLP patterns for prolactin gene Exon 4. The PCR product of 294 bp PRL Exon 4 digested with RsaI was cleaved into two bands of 132 and 162 bp in the B allele, whereas B allele lacks RsaI site. Thus, 3 genotypes i.e. AA, BB and AB were observed. In HF breed, the frequency of AA was 29.41%, AB was 70.58% and BB was 0.0% respectively. Thus estimated allelic frequency of A and B alleles are 64.70% and 35.29 %, respectively.

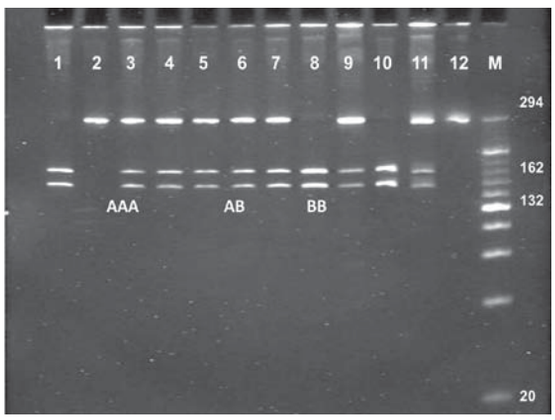



*Fig.1 PCR- RFLP patterns of Prolactin gene Exon 4 (294) using Rsa I inDeoni Cattle Lanes 1 to 6 & 8 to 12: Deoni samples Lane M: 20 to 300 molecular*

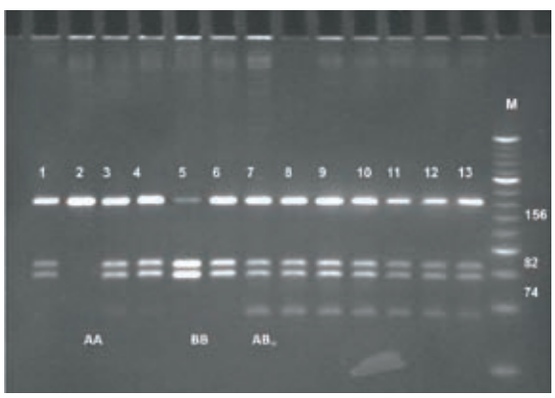



*Fig. 2. PCR- RFLP patterns of Prolactin gene Exon3 (156) using Rsa I in HF Lanes 1 to 6 & 8 to 12:HF samples Lane M: 20 to 300 molecular marker*

## Development of State-of-the-Art Dairy Production Systems using Better Housing and Fertility Practices

**Performance of graded Holstein Friesians and their crosses under field conditions:** The field study was carried out for evaluating production performance of graded HF and HF crosses belonging to sixty dairy farmers including five commercial dairy farmers from Bangalore, Kolar and adjoining districts. The average herd strength, milch animals, dry and young stock female for small holders and commercial dairy farmers were 4, 2, 1, 1 and 45, 28, 9,10, respectively. The overall wet average was the highest (16.3 lit.) during early stage of lactation followed by mid lactation (13.5 lit) and late lactation (10.2 lit). In graded HF, maximum average daily yield (18.17 lit) and peak yield (26.92 lit) was attained during 4th lactation. The overall wet average (15.39 ± 0.76 lit) and peak yield (23.59 ± 0.77) in graded HF were significantly higher than HF crosses. The age at first calving in graded HF was 26 months whereas in HF crosses,

it was 24 months. The quantity of concentrate, green fodder and straw fed per cow were 6.03 ± 0.37, 19.28 ± 1.08 and 5.3 ± 0.48 kg, respectively. Regarding feeding regimes, it was observed that some of the dairy animals were suffering from trace mineral deficiencies, which was reflected in their poor production performance and hoof disorders. Most of the animal sheds had asbestos sheets (40%) as a roofing material followed by thatch (27%) and tiles (14%). The floor space per animal was 2.56 m2, which was found to be inadequate. The stone slabs were predominantly used for flooring of animal sheds.

The study also included evaluation of performances of graded HFs in 14 commercial herds of Punjab where better housing and feeding inputs were provided. The wet average recorded in these herds was (21.11 ± 1.31 lit) with a peak yield of (33.23 ± 1.18 lit).

*Dairy cows affected by hoof damage, hoof disorders, and extreme toe out condition of rear legs*

## Development of Equipment/Processes/Packaging for Upgradation of Technologies for Manufacture of Region Specific Dairy Products

**Characterisation and process standardization for production of Khoa Jalebi:** The market samples of Khoa Jalebi were studied for sensory characteristics like colour and appearance, body and texture, flavour, morphological features, textural characteristics etc.

The ingredients used for khoa jalebi preparation were: Khoa, arrow root powder, tokir (a local product) and sugar (for syrup preparation). Whereas, khoa formed the base material, arrow root powder acted as binding agent and tokir were required for holding sugar syrup inside the jalebi coils. The general method of manufacture of khoa jalebi was almost similar with all the sweet meat makers, but manufacturing parameters varied.

From the survey, it was observed that khoa jalebi possessed coiled appearance as traditional maida jalebi with the number of coils varying from 2 to 4. The morphological features resembled those of maida jalebi, but the individual coils were thicker in case of khoa jalebi, the thickness ranging from 0.4 – 2.3 cm. The weight of individual pieces ranged from 11.6 – 63 gm and the size varied from 4.0 – 10.8 cm. The colour of the jalebi varied from light brown to dark brown depending on the extent of frying. The body of the khoa jalebi was firm, but slightly juicy with the syrup oozing out when chewed, but not to the extent observed in traditional jalebi. The taste is pleasantly sweet, nutty, slightly caramelized and comparable to that of khoa - gulab jamun. The physico-chemical characteristics of the collected samples were : Moisture (15.18 – 34.0%); Fat (9.86 – 21.63%); Ash (0.15 – 1.55%); Protein (1.70 – 9.76%); Lactose (6.72 – 13.9%); Sucrose (12.7 – 63.55%); Water activity (0.7 – 0.87%); pH (4.2 – 6.65%).

**Development of functional whey drinks for health promotion:** Cheese whey was proteolysed to 5 – 7% using 0.01% Flavourzyme at pH 7.0 for 30 min at 50°C . After inactivation of Flavourzyme, pH of whey was adjusted from 7.0 to 5.5 by using citric acid and thereafter further hydrolysis of lactose using β- galactosidase at 30°C was carried out for one hour. The hydrolysate was heated to 85°C for 5-7 min to arrest further hydrolysis. Whey became slightly bitter after hydrolysis of protein. Edible starch of 1% was added to the hydrolysate not only to reduce bitterness but also to increase slightly viscosity of the hydrolysed whey. To improve further, the taste and flavour, 4% mango pulp and 8% sugar were added into the hydrolysed whey. Thus, whey drink was prepared from both protein and lactose hydrolyzed whey with 8% sugar, 1% starch and 4% mango pulp, which was acceptable to the consumers. The drink was packed in polyethylene pouches and kept at room

temperature and refrigerated temperature. Shelf life studies revealed that yeast and mould growth was found within 3- 4 days at room temperature and 10-12 days at refrigerated temperature of storage. Thermization of whey drinks at 65°C for 10 min showed an increased shelf life of the product.

### Development of Fermented Butter Milk Drinks with Enhanced Health Benefits

**Buttermilk drinks:** Extracts of some of the vegetables and fruits were used in the preparation of buttermilk drinks. Boiled and cooled toned milk was fermented with a mixed starter culture (Lb + St) to obtain dahi with an acidity of 1.4 % lactic acid. Dahi, thus, obtained was blended with cucumber juice and water (1:3). To enhance the taste and aroma salt @ 0.7 % and steam distillate of ginger @ 6 % were added to the drink. The product with a pleasant light green colour was accepted well during sensory evaluation. The cucumber – cultured buttermilk drink had 3.12 % total solids, 0.7 % fat, 1.1 % and protein, 1.24 % ash. The product was evaluated for its yeast and mold count and was found to be free from the same. The product packed in glass bottles kept well for 15 days under refrigerated storage.

Dahi, carrot extract and water were blended in a proportion of 1:1:2 and to this salt at a level of 0.6 % was added. The carrot-buttermilk drink with a pleasant colour was accepted well on sensory evaluation. The product had 4.5 % total solids, 0.9 % protein, 0.4 % fat, 1.1 % lactose and 0.4 % ash. Adopting the same procedure, tomato buttermilk drink was prepared which was also accepted well.

Mango pulp (TS, 25 %) diluted with water (100:75) was enzymatically treated using trizyme (a combination of pectinase, amylase and cellulose). Dahi (25 g) was blended with the clarified juice (45 g) with sugar (12 %) and water (30 ml) to obtain a mango buttermilk drink. The product was accepted well on sensory evaluation. Guava extract with 1.5 % total solids was blended with dahi and water (1:1:2) and salt (0.6 %). The guava buttermilk drink thus made was accepted well and had 3.7 % total solids, 0.4 % fat, 0.9 % protein, 1.2 % lactose and 0.9 % ash.

An attempt was made to improve the textural stability of buttermilk drinks through homogenization of the milk used and addition of stabilizers. It was found that thermization and carbonation of buttermilk drinks helped to extend the shelf-life of the buttermilk drinks.

### Value addition to traditional milk products through application of new processes,


*Nutritional and Therapeutic Aspects of Milk and Milk Product*

### biotechnological interventions, packaging and mechanized manufacturing system

**Heat and mass transfer phenomena during manufacture of gulabjamun and pantoa:** During frying, gulabjamun acquires an attractive colour, distinctive mouth feel, fried flavour and unique textural properties. The kinetics of colour changes in gulabjamun during deep-fat frying, including order of reaction, reaction rate constants and temperature dependence is important for maximizing quality and minimizing losses. The kinetic parameters were studied using a computer vision-based approach.

The gulabjamun dough was prepared by blending khoa, maida and baking powder in the ratio of 125:15:1. Balls of 15 g were made and fried for 8 min at oil temperatures of 135, 145 and 155°C in a mini fryer. The images of the gulabjamun during different stages of frying were acquired using a HP flatbed scanner at 1280 x 720 dpi resolution, and were imported into Adobe Photoshop 7.0. The 'L-a-b' values of a user-defined polygonal area of the image were used to compute chroma,

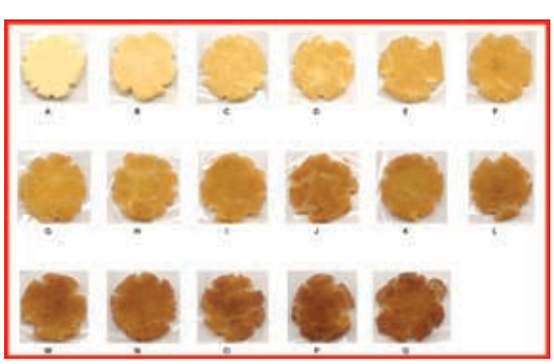


*Fig. Macrograph showing progressive changes in colour during frying of gulabjamun.*

hue and total colour difference. The kinetics and statistical significance of the colour changes also were analyzed.

The lightness and hue values showed a negative trend with frying time and temperature, while, the ch roma values showed an upward trend till 90-120s of frying, thereafter decreasing consistently. Both frying time and temperature had significant influences on total colour difference. The first order reaction kinetics model predicted the colour changes during frying adequately (R2 > 0.90). The temperature dependency of the model was described using Arrhenius relationship. The estimated activation energies for lightness, chroma, hue and total color difference were 87.32, 41.22, 95.04 and 72.82 kJ mol-1, respectively. The corresponding frequency factors were 3x108, 3x103, 2x109 and 5x106 s1.

## Promoting Dairy Enterprising Through Transfer of Technologies, Improved Farm Financing, Supply Chain Management, and Better Market Access

**Application of energy monitoring and targeting (EMT) system in a dairy plant:** Cumulative SUM (CUSUM) analysis of the actual energy consumption data against the computed baseline energy use for the selected dairy plant established that the plant presented a case for implementation of energy monitoring and targeting system. With a view to identify the energy accounting centers (EACs) and assessing the sub-metering requirements, the plant was surveyed with special focus on the steam lines within the plant. A sketch of the same with locations for metering was also prepared. Accordingly, it was decided that for the current year, the energy accounting would be carried out for the vats, namely, peda, mysore pak and rotary type vats. Preliminary work on setting of the initial energy targets for each EAC was also carried out.

The system support required for developing the targets during onsite monitoring was developed on MS Excel Sheets. Preliminary testing of the same was completed and was being updated as real time data is recorded.



**Economic analysis of manufacture of dairy products:** In order to study the economics of production of dairy products & other related aspects from select organized dairies of southern region, Nandini Milk Products Ltd, Bangalore, Revolving funds project, NDRI Bangalore, Srikrishna Milks Pvt Ltd, Kirwatti, Visakha Dairy Visakhapatnam, Pondicherry Milk Union & Ambattore Products Dairy, Chennai were selected. The information pertaining to manufacture of dairy products, various cost components, and marketing were collected by personal visits & observation. The analysis of the collected information is in progress.

**A Profile Study on Nutraceutical and Therapeutic Use of Milk and Milk Products in Traditional Systems in Southern States / Region:** The milk products used in the traditional systems, Ayurveda, Unani, Siddha and Homeopathy include curd, buttermilk, butter, ghee, cream, whey and paneer.

In Ayurveda, Panchghavya, five major substances obtained from cow, which includes milk, ghee, curd, cow's urine and dung, that possess medicinal properties against many disorders and are used for medicinal purpose singly or in combination with other herbs. Milk and milk products find an important role in Panchakarma, in Ayurveda, the five major therapeutic procedures meant to purify the whole body by eliminating the accumulated toxins. Shata-dhauta-ghrita, a unique product of medicated ghee, which is washed hundred times and is used as a vehicle for drugs for external application. Unique milk based medicinal products used in Ayurveda include medicated ghee, ghritham and milk foam. The forms of preparation using milk & milk products in Ayurveda include Arishtam, Kashayam (Liquid) Chyavanprash, Lehyiyam, Ghrithm (Paste) Choornam (Powder) Thailam (Oil) Confections & Ointment, Tablets & Capsules.

The Unani system of medicine drugs was classified according to their uses, which includes, drugs having stimulant action on uterine muscles, cardiac stimulants, blood purifiers, haematonics, purgatives, digestives, appetizers, antacids, flatulence, carminatives, refrigerants, analgesics, demulcents and aphrodisiacs. In Siddha, milk and ghee are used as main drug; butter, curd and buttermilk are used as ancillary drug. The Unani system uses a unique milk product called Paneer Maya and some specific milk based preparations like Jawarish Amla, Majoon Supari Pak and Majoon Zanja beel. Homeopathy system uses a specific product called sugar of milk, which forms the base for most of the medicinal formulations.

The Siddha system of medicine uses specific preparations, Arumuga Sendooram & Navaneeda Paspam and also uses curd, butter, buttermilk and ghee of Goat, Sheep and Camel Milk. In Siddha,

milk and ghee are used as main drug; butter, curd and ghee are used as ancilliary drug. In Siddha, Arumuga Sendooram, Navaneeda paspam and Thayir chundi chooranam. Information on traditional medicines containing milk & milk products was made to know various forms of preparation available in the systems under study.

Milk and milk products play an important and inevitable role in all the three traditional medicinal systems viz, Ayurveda, Unani and Siddha as drug components for therapeutic purposes, nutrient fortifications, preparations meant for external use and medium / carrier for other drugs. Drugs are used for treating wide range of health disorders; actual bioactive component responsible for the demonstrated nutraceutical or therapeutic benefits is yet to be explored, need to focus on potential areas of scientific research based on classical and contemporary sources of traditional knowledge systems need to evolve rationalized formulations to bring safe, standardised products and newer medicines with enhanced effects.

A valuable treasure of indigenous knowledge is available regarding the use of milk products as nutraceutical and therapeutic formulations.

## R & D Support for Process Upgradation of Indigenous Milk Products for Industrial Application

**Green gram dhal payasam:** Green gram dhal payasam is a popular product in the southern region. A method for the preparation of ready to reconstitute payasam dry mix incorporating ground green gram dhal and poppy seeds and skim milk powder was standardized and reported earlier. Further trials were continued on the dry mix preparation and a dry product containing either sucrose (50%) or sucralose 3200 ppm) was prepared. The product with sucrose had 2.7, 7.0, 13.6, 3.0 and 73.7% moisture, fat protein, ash and carbohydrates (by difference), respectively while the corresponding levels for the product with sucralose were 3.0, 13.8, 27.6, 6.0 and 49.6%. Both the products on reconstitution yielded payasams of acceptable sensory quality. The level of sucralose in the reconstituted product was about 570 ppm. The products packed in LDPE pouches and stored at 37°C kept well for four months as observed by sensory evaluation of the reconstituted product and chemical analysis of the dry product. Further assessment is in progress.

**Foxtail millet beverage:** Fox tail millet (100 g) was soaked in water overnight. The water was removed and the soaked millet was ground to a fine paste. Water was added to the paste and the suspension was filtered through muslin cloth. The extraction of the residue left in the cloth was repeated 3-4 times with water (250 ml).

The extract from the millet was boiled to a semisolid consistency. At this stage, cow milk (250 ml) and sugar (20 g) were added and the contents were stirred well. The drink, thus, obtained was observed to have a good taste and acceptability on sensory evaluation.

In another trial, the millet was germinated and sun dried. The dried germinated millet was ground to powder. The powder was sieved to obtain a fine powder.

Millet powder (10 g) was reconstituted in milk (200 ml, TS 12%) and the contents were boiled for 5 minutes. The product was sweetened by adding sugar (10 g). The drink (beverage) was observed to have a good taste and acceptability on sensory evaluation. However, the product had raw millet flavour. Frying of the dried germinated millet alleviated this problem.

The product had a low shelf-life (< 1 day at room temperature). Therefore, the product (100 g) was packed in multi layer aluminum pouches and the pouches were heat treated in a boiling water for 10 minutes. The product on such heat treatment became very thick to a semisolid consistency. Attempts need to be made in this regard to optimize the process.

**Extension of shelf-life of Channa Jhilli:** Channa Jhilli was prepared according to the standardized procedure for storage study. The samples were packed at room temperature with and without preservative and in hot condition at about 70°C in two different packaging materials namely-standby pouch and polypropylene tub. In hot filling, samples were filled with sugar syrup at 70°C and for preservatives, sorbic acid of 1000 ppm was added in the sugar syrup and then filled at room temperature in the packaging materials. Packed channa Jhilli samples were stored at room temperature and in refrigerator to study the shelf-life under different conditions.

Channa Jhilli stored at room temperature without any treatment had shelf –life of 5-6 days when packed in pouch and 4-5 days when packed in tub. Hot filled channa jhilli samples showed a

shelf-life of 10-12 days in pouch and 7-8 days in tub at room temperature. Addition of 1000 ppm sorbic acid extended shelf-life up to 22-25 days at room temperature when packed in pouch and 20-22 days when packed in tub under the same conditions of storage.

Channa jhilli showed a longer shelf-life during refrigerated storage. Jhilli without any heat treatment remained good for about 30 days when packed in pouch and about 25 days when packed in tub. The hot filled samples in both pouch and tub remained in good condition even after 30 days. The samples added with preservatives and packed in pouch and tub also had good acceptability even after a month of storage under refrigeration.

### Colour Measurement of Kunda and Milk Sweet by Reflectance Methods

The suitability of three methods of colour measurement viz. Scanner and Adobe Photoshop; Digital Camera and Adobe Photoshop; and Colour Charts for kunda and milk sweet/kalakand was evaluated. The overall L, R, G and B values for kunda ranged between 124.43 to 127.7; 162.13 to 163.3; 116.24 to 119.94 and 67.51 to 73.71, respectively. The corrosponding values for milk sweet were 225.26 to 237.08; 240.11 to 252.93; 227.08 to 240.67 and 167.44 to 180.7. Similar results were obtained with regard to colour parameters measured under CMYK and Lab mode. Measurement of colour values of kunda / milk sweet could be done at any level of the scanner parameters like resolution, image quality and sharpen level, but the product has to be taken in a specified container - petri dish or cellophane or polythene film. In digital camera and Photoshop method, the sample was taken in a petri dish, images were captured using a digital camera, and the colour parameters were measured in Adobe Photoshop in all three modes. These colour values, at 40 cm distance between sample and camera were significantly less than those obtained at 20 cm distance as indicated by t – test. The results also indicated that distance of 30 cm or 40 cm between the sample and the light source did not matter much with 18 watt compact florescent lights (CFL), however, longer distances might influence the colour parameters significantly. It was also observed that the option of zooming had significant effect for colour measurement purposes. Similar observations were obtained with CMYK and Lab modes. In the third method, colour charts of different RGB values for kunda and milk sweet/ kalakand within the acceptable range were prepared in Adobe Photoshop and printed using HP deskjet printer on casein coated sheets. Colour values of the products could be determined by comparing the sample colour with colour shades in the colour charts.

### Development of Cheese Based Functional Foods Using Oats

Cheese based health promoting food was developed using oats. Cheddar cheese, raw oat flour @ 20%, 30% & 40% on the cheese basis, 3% emulsifying salt and 2.5% common salt were mixed and processed at about 80-85°C to manufacture processed cheese with oats. No significant difference was observed in the cheese made by using three emulsifying salts of tri-Sodium citrate, Sodium hexametaphosphate and di-Potassium hydrogen orthophosphate. The composition of processed cheese with oats was: 43.61, 19.03, 17.10, 3.72 and 16.54 % moisture, fat, protein, ash and carbohydrate (calculated by difference), respectively. The crude fiber and β-glucan were 3.09% and 1.104%, respectively on dry matter basis. During storage, both control processed cheese and processed cheese with oats samples packed in tub and pouch were acceptable till 10 days at room temperature and 20 days in cold store. All the samples showed an increase in pH and tyrosine contents during storage at room temperature and cold store. Free fatty acid content was found to be increased from 0.209% to 0.212% in tub and 0.257% in pouch packed samples of processed cheese with oats during storage in cold store. Yeast and mould counts showed an increase in all the samples irrespective of packaging materials and temperature during storage. Processed cheese with oats degraded chemically as well as microbiologically faster than control processed cheese. Tub was found more suitable than pouch packaging. The average cost of production of processed cheese with oats is Rs. 130/ kg.

### Utilisation of Concentrated Whey in the Preparation of Idli and Dosa

Considering the nutritional and functional virtues of whey and the problems associated with its disposal, attempts have been made for its utilization in the preparation of soups, beverages, coffee drinks, cream yoghurt, bakery products, cereal and millet based health foods, infant food formulations and confectionary products etc. In the present study, an attempt was made for utilization of concentrated whey in the preparation of idli and dosa. Idli and dosa, common breakfast items in the southern part of country, are prepared using fermented batter made from rice (*Oryza sativa*) and black

lentils (*Phaseolus mungo*) in different proportions. Cheese and paneer whey vacuum concentrated to 10, 15 and 25% solids was used in place of water for batter preparation. Addition of concentrated whey up to 15% TS enhanced the degree of fermentation of the batter. The sensory evaluation of the idli and dosa showed that concentrated paneer or cheese whey (up to 15% TS) could be used for the product preparation. However, since paneer whey was available to a greater extent than cheese whey in our country, paneer whey concentrated to 15% TS was used in the present study. Idli and dosa made using concentrated paneer whey were characterized with respect to chemical, microbiological, textural and sensory properties. It was observed that the quality of the products made using concentrated paneer whey (15% TS) compared well with that of the control products. Control idli and product made with concentrated paneer whey had 57.93, 42.07, 0.17, 5.6, 35.61, 0.69% and 56.9, 43.1, 0.19, 5.86, 35.77, 1.28% moisture, TS, fat, protein, total carbohydrates and ash, respectively. The corresponding values for control Dosa and the product made using concentrated paneer whey were 41.72, 57.28, 9.9, 8.48, 37.73, 1.17% and 38.45, 61.55, 10.4, 9.86, 39.03, 2.26%, respectively.

### Utilization of Whey in the Preparation of Rice and Roti

In view of the nutritional value of whey and its role in environmental pollution during its disposal, attempts were made to utilize the whey in preparation of Rice and Roti, the two most popular stable foods. Addition of paneer and cheese whey with 5 and 10% TS was used to replace water at different levels was studied in preparation of Rice. The studies revealed that whey with 5% TS can be successfully used to replace 100% water in Rice preparation. Between the two varieties of whey, paneer whey was better accepted. The rice prepared by using paneer whey containing 10% TS was less accepted due to salty flavour and harder cooked rice grains. The chemical analysis of rice cooked in paneer whey with 5% TS showed that the product contained 55.21% moisture, 41.86% carbohydrates, 3.02% proteins, 0.35% fat and 0.56% ash. Similar attempts were made to utilize whey with 10, 15, and 25% TS in preparation of Roti. The study revealed that the complete volume of water can be replaced with whey containing 25% TS without affecting the sensory and rheological qualities of roti. The chemical analysis of roti showed that, the product contained 41.55% carbohydrates, 11.02% proteins, 1.21% fat, 3.55% ash and 39.12% moisture. The roti had water activity of 0.893.

## Eastern Regional Station, Kalyani

### Studies on Organic Milk Production System in the Plains of West Bengal

The fodder for the experimental cows was grown organically. For this, the plots were prepared with farm yard manure @ 25 tones per hectare. In kharif season, organic fodder like maize, cowpea, sorghum sudan grass hybrid, jowar and rice bean were grown. In rabi season, berseem, chinese cabbage and oats were grown as fodder crops.

The average green fodder productions of maize, berseem, oats & sorghum sudan grass in the organic field was increased in the year 2010 as compared to the previous year. The average yield of berseem (1st & 2nd cut), maize and jowar (single cut) fodder in 2010 was 452, 296 and 395 quintals per hectare under organic management and 520, 310 and 425 quintals per hectare under conventional management.

The mean 305 days lactation yield of cows under organic management was 2340 kg in the year, 2010 as compared to 2596 kg in the previous year. The average service period and average number of AI / conception of these cows were 132 days & 1.2 in 2010 and 125 days & 1.4 in the year 2009, respectively.

Concentration of heavy metals, pesticides and antibiotic residues in milk samples from farm and field was determined. Total 47 milk samples were collected and analyzed covering experimental, non-experimental & village cows' milk. The level of Arsenic (As) and Mercury (Hg) obtained was within the permissible limit. Most of the milk samples had Lead (Pb) values above Maximum residue Limit (0.02 ppm). The Cadmium (Cd) level in all the samples exceeded the permissible limit. The residue concentrations of three pesticides (commonly used in the area i.e., Endosulfan, Chlorpyrifos and Cypermethrin) in milk were also determined. The level of Cypermethrin for all the samples were within the permissible limit and the level of other two pesticides (Endosulfan & Chlorpyrifos) concentration exceeded the permissible limit in few samples. The result

showed that the level of pesticide in the milk samples collected from the experimental cows was within the permissible limit.

Total 58 samples (soil, water, feed and fodder) were collected from farm and field and analyzed for estimation of heavy metals and pesticide residues. The result showed that both Mercury (Hg) and Arsenic (As) were within the permissible limit for all types of samples. The Cadmium (Cd) level in most of the samples exceeded the permissible limit. The lead (Pb) value of soil samples was found to be within the permissible limit. However, the high concentration of lead (Pb) was observed in all types of fodder and water samples. The levels of Endosulfan, Chlorpyrifos and Cypermethrin for all the feed and fodder samples were within the permissible limit.

*Maize fodder grown organically*

*Animals under organic management*

## Studies on the Effect of Oviductal Secretory Proteins for *in vitro* Maturation and Fertilization of Cattle Oocytes

**Purification of cattle oviductal secretory proteins:** Cattle oviductal tissues collected from slaughter house was thoroughly minced and suspended in TBS (pH 7.4) containing 1mM PMSF. After several cycles of freeze/thaw the samples were centrifuged and the supernatant containing oviductal secretory proteins were fractionated by ammonium sulfate precipitation. The protein samples were dialyzed in 50 mM Tris-HCl pH7.0 buffer to remove ammonium sulfate. Dialyzed sample was loaded into SP Sephadex ion exchange column, washed and eluted in 50 mM Tris-HCl pH 7.0 containing 1.5 M NaCl. The eluted protein fractions were dialyzed in normal saline, quantified and lyophilized for further use.

**Biological effect of purified oviductal secretory proteins (cOSP) on IVMFC:** Cattle ovaries were collected from Kolkata slaughterhouse and brought to the laboratory in normal saline supplemented with streptopenicilline at 30-35°C. Oocytes were isolated and washed thoroughly in washing media followed by maturation media (supplemented with cattle oviductal secretory proteins in three different concentrations ie. 10,50, & 100 ug/ml). After washing COCs were placed in the droplet of maturation media, covered with mineral oil and incubated for 24 h at 38.5°C in 5% CO2 incubator with maximum humidity. After 24 h of incubation, COCs drops were inseminated with capacitated sperm suspension and allowed for fertilization in Fert-BO media (supplemented with cOSP), incubated for 24 h at 38.5°C in 5% CO2 incubator with maximum humidity. After 14-18 h, the oocytes were washed and kept in primary culture media (supplemented with cOSP) for cleavage. After 40-42 h of culture cleavage was observed and the cleaved oocytes were put in replacement culture media (supplemented with cattle oviductal secretory proteins in three different concentrations ie. 10,50, & 100 ug/ml) for further development. The media was replaced after every 24 h with fresh replacement media. To evaluate in vitro embryo production in the presence of different concentrations of cOSP, a total of 240 oocytes were subjected to IVMFC in the present study. The cleavage rate was observed as 40.9%, 45.58%, 24.24% and 30.0% at cOSP concentrations of 0, 10, 50 and 100 µg/ml, respectively. The blastocyst stage was developed in the control and 10 µg/ml group with the 3.7% and 12.90%, respectively (Fig.). It was observed that the lower concentration (10 µg/ml) of cOSP increased the cleavage rate, morula and blastocyst yield significantly ($p<0.05$) as compared to higher concentration (50 & 100 µg/ml).

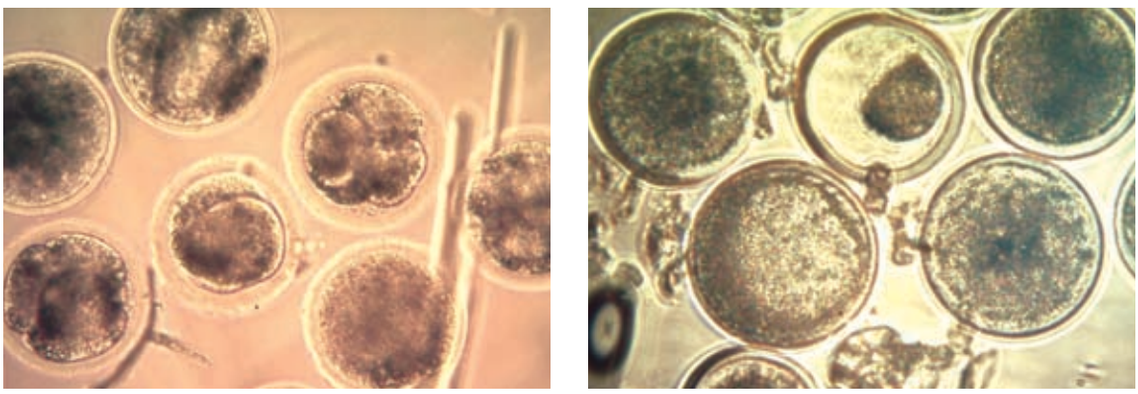


*Fig. Different stages of in vitro produced cattle embryos*

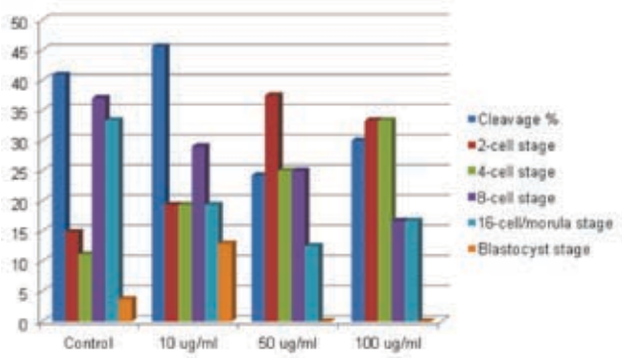



*Fig. Cattle embryos produced in vitro with the supplementation of cOGP in media*

## Nutritional Evaluation of Azolla for Utilization in Ruminant Ration

Fodder cultivation is not a common practice among the dairy farmers of eastern India. Farmers usually utilize their cropping land for food crop cultivation. As a result in many cases, the animals are not offered any sort of green roughages in their ration. Under such circumstance Azola can serve well as it can be grown by minimum input of labour or land throughout the year and can supply at least some amount of green to the dairy animals. The fern Azolla, has a symbiotic blue green algae *Anabaena azollae*, which is responsible for the fixation and assimilation of atmospheric nitrogen. Azolla, in turn, provides the carbon source and favourable environment for the growth and development of the BGA symbiont. Azolla holds the promise as a sustainable feed substitute for livestock. The present study was taken up to nutritionally evaluate azolla for utilization in ruminant ration.

The different methods of azolla cultivation were explored. An experimental azolla production unit was initiated at ERS campus and the cultivation of azolla was being standardized. Fresh yield, DM content and CP content of Azolla were being regularly monitored. The DM content ranged from 4.82 to 7.02 per cent. The CP content (% DM) ranged from 20.27 to 23.18 per cent. The average content ( as % DM) of CP, EE, CF, Total ash, NFE, AIA and OM in Azolla samples analyzed till date were 21.80,5.32, 9.2,17.34, 46.34,1.67 and 82.66, respectively. The average concentration of minerals elements and heavy metals (mg/kg DM) viz. Co, Cu, Mn, Zn, Cr, Pb, As, Hg, Cd in Azolla samples analyzed till date were 1.32, 0.52,56.86, 11.56, BDL, 10.6, 0.289, BDL and 0.66, respectively.

*Experimental Azolla Production units at ERS*

### Feed Resources in Eastern Nothern Eastern States of India

Collection of baseline data on production and reproduction of dairy animals was initiated in some states of eastern and north eastern India. Feeds, fodder and soil samples were collected from different areas of West Bengal. Feeds, fodder and soil samples were collected from Arunachal Pradesh, Nagaland and Meghalaya through ICAR centers of those states. The major feed resources available in Arunachal Pradesh were Maize grit, Maize bran, Millet grain, millet straw, Maize stover, pasture grasses and Tree fodders. In Meghalaya, the major feed resources available were Crushed maize, Concentrate mixture, Rice grit, Wheat grain , Mustard cake, straw, pasture grass, Bamboo leaves and other tree leaves.The common feed resources available in Nagaland were Concentrate mixture, Mustard cake, Rice grit, paddy straw, Pasture grass, Bamboo leaves, Banana leaves and other tree fodder.

### Evaluation and Utilization of Brewer's Spent Grain as Cattle Feed Supplement

Cereal grains are fermented to produce beverage alcohol for centuries. Brewer's spent grain is the by-product after fermentation during the beer making process. These can be fed as such or in dried form to the livestock. There is ample scope for replacing a portion of the cereal grain or oil cake of animal's diet with brewer's spent grain to use it as energy or protein source, respectively for preparation of economic animal ration. Therefore, a study was conducted to assess the effect of brewer's spent grain supplementation on rumen fermentation, methanogenesis, enzyme profile and ciliate protozoal population in paddy straw based diet in vitro. Brewer's spent grain was collected from United Breweries Limited, Kalyani, Nadia, West Bengal and 200 mg substrate e.g. paddy straw was gradually replaced by brewer's spent grain (G1: 00 mg spent grain + 200 mg of paddy straw, G2: 50 mg spent grain + 150 mg paddy straw, G3: 100 mg spent grain + 100 mg paddy straw, G4: 150 mg spent grain + 50 mg paddy straw and G5: 200 mg spent grain + 00 mg paddy straw) under in vitro gas production technique. Brewers spent grain contained 21.4 % DM on fresh basis and 96.8 % OM, 19.7 % CP, 5.7 % ether extract (EE), 72.8 % NDF, 28.4 %. ADF, 22.9 % cellulose and 5.2 % lignin on DM basis. Total ruminal gas as well as methane production per unit truly degraded dry matter as well as organic matter, were significantly reduced ($P<0.01$) due to supplementation of brewer's spent grain in paddy straw based diet. pH of the incubation medium reduced ($P<0.05$) and TVFA concentration increased ($P<0.01$) due to inclusion of spent grain in the incubation medium. Acetic acid production decreased ($P<0.01$) and propionic acid production increased with increasing level of brewer's spent grain. Supplementation of brewer's spent grain had no effect on butyric acid production and total nitrogen concentration in the incubation media. However, ammonia nitrogen concentration decreased with supplementation of brewer's spent grain.

The activities of polysaccharide degrading enzymes e.g., carboxy-methyl cellulase, xylanase and β-glucosidase decreased with supplementation of brewer's spent grain. However, activities of amylase showed the reverse trend. Ciliate protozoa present in the incubation medium was B type population due to presence of Epidinium sp, and the absence of Polyplastron multivesiculatum. Numerically spirotrich protozoa comprised more than 80 % of total rumen protozoal population. The number of total ciliate protozoa as well as holotrich and spirotrich protozoa decreased ($P<0.05$) with increasing level of spent grain. In vitro dry matter and organic matter digestibility of paddy straw also improved with supplementation of spent grain. Microbial biomass production also increased. The study revealed that supplementation of brewers spent grain in paddy straw based diet improved rumen fermentation, microbial biomass, TVFA and propionic acid production in vitro.

### Effect of Natural Plant Extract on Rumen Fermentation, Enzyme Activities, Mehanogenesis and Milk Production in Dairy Animals

Screening of natural plant extract was done for reducing ruminal methanogenesis. Total of 30 different medicinal plants e.g., leaves Kakmachi (*Solanam nigram*), Lalvarenda (*Jatropha gossipifolia*), Gogun (*Comophora mukul*), Satamuli (*Asparagus racemosus*), Keu (*Costus spaciosus*), Dalchini (*Cinnamomum zeylanicum*), Safedmusli (*chlorophytum borivillium*), Aswagandha (*Withania somnifera*), Castor-oil (*Ricinus communis*), Kesuth (*Eclipta alba*), Chattim (*Alstonia scholaris*), Asoka ( *Saraca asoka*), Nagkeshar (*Mesua ferra*), Palas (*Butea monosperma*), Jarul (*Lagerstomia foxregione*), Hijal (*Barringtonia racemosa*), Biksa (*Biksa orellana*), Siuli (*Nyctanthes arborttristis*), Kuchila ( *Strychnos nux-vomica*), Karpur (*Cinnamomum comphorium*), Ulatkambal (*Abroma augusta*), Bamanhati (*Clerodrendron indicum*), Salpani (*Desmodium gangeticum*), Nishinda (*Vitex nigundo*), Pipul (*Piper longum*), Gandhal (*Paederia foetida*), Nagdona (*Artemisia vulgaris*), Ayapan (*Eupatorium ayapana*),

Babchi (*Psoralia corylifolia*) and root of Sweetbasil (*Opilum bassilipum*), were collected from Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal for studying their effect on ruminal methanogenesis in vitro. Plant materials were dried at 45-50°C for 48 h and grounded to pass through 2 mm sieve. Extracts were prepared in three solvents e.g., in Water, ethanol (50 % ethanol in water) and acetone (50 % acetone in water) at the rate of 10 g dried and ground plant material per 100 ml solvent. These plant extracts were tested at three levels e.g., 0 (control), 1.0 and 2.0 ml in four replicates for each treatment. Rumen liquor was collected from cattle. In general, plant extract reduced the *in vitro* true dry matter and organic mater degradability. Out of thirty tested medicinal plants, extract of only eight medicinal plants were effective in reducing ruminal methanogenesis *in vitro*. Addition of water, ethanol and acetone extract of Kakmachi (*Solanam nigram*), Lalvarenda (*Jatropha gossipifolia*), Satamuli (*Asparagus racemosus*), Keu (*Costus spaciosus*), Sweetbasil (*Opilum bassilipum*), Chattim (*Alstonia scholaris*), Siuli (*Nyctanthes arborttristis*), Bamanhati (*Clerodrendron indicum*) in the incubation media resulted in significantly reduction ($P<0.01$) in ruminal methane production. Highest reduction in ruminal methane production was observed due to addition of the extract of *Jatropha gossipifolia*. There was about 80 and 40 % reduction in ruminal methane production due to addition of acetone and ethanol extract of *Jatropha gossipifolia*, respectively. Similarly addition of Solanam nigram extract reduced ruminal methane production by about 40 %. It was inferred that extract of *Jatropha gossipifolia* and *Solanam nigram could be used to manipulate rumen fermentation* for improving the productivity of the ruminant animals.

### Impact Analysis of Women Dairy Cooperatives on the Economy of Rural House Holds in Eastern Region of India

To assess the improvement level of women in the society and in the family, the present study was undertaken in West Bengal, Bihar, Orissa, Jharkhand, Sikkim, and Nagaland of the eastern region. Data related to milking animals, animal productivity, and milk production were collected of the selected states.

The list of women milk unions functioning in the West Bengal was also prepared for section of women milk union in the state. Ichhamati milk Union was selected for study and three women dairy cooperative societies namely; Nutangram, Beri -1 and Beri-2, women dairy cooperative societies were selected for detail survey. In all 25 women members and 10 non members' women dairy farmers were selected from society village.

There were three milk unions in the Nagaland i.e. Kohima Milk Union, Dimapur Milk Union and Mokochung Milk Union. General dairy cooperatives were 71 and women dairy cooperatives were 67 by end of 31 January, 2011. Dimapur milk union had 88 dairy cooperatives, which was the highest number amongst these milk unions. Survey work in other states is in progress.

*Training being given to farm women at ERS, Kalyani*

# 3 TRANSFER OF TECHNOLOGY

## Dairy Extension Division

### Field/Farm Technician (FFT) Laboratory

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

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

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

| Activities | No. of Cases |
|---|---|
| A.I. in Cows | 1236 |
| Conception Rate | 46.20% |
| A.I. in Buffaloes | 1022 |
| Conception Rate | 35.00 % |
| No. of Crossbred Calves Born | 216 |
| No. of Buffalo Calves Born | 204 |
| General Treatment Cases | 325 |

### Infertility and Veterinary aid Campaigns

A total of 41 infertility and veterinary aid campaigns were organized in a cluster of villages i.e. Kulwehri, Budhakhera, Shahpur, Ganjogarhi and Subri in Karnal District. During the campaigns 986 cases were treated for reproductive disorders and various veterinary ailments. Deworming and tick control programmes were also conducted during these campaigns. Special attention was given to infertile, repeat breeding, late maturity and anoestrus animals and 2309 animals were checked, diagnosed and given appropriate treatment.

### Fodder Demonstration

To maintain round the year supply of green fodder at farmers' field, demonstrations of high yielding varieties oats fodder crops were organized. Farmers were also educated about the improved practices of fodder production.

### Kissan Sanghosthies

The Extension Division organized 53 Kissan Sanghosthies in adopted villages to improve the dairy farming practices and to ensure adoption of scientific technologies developed at Institute. A total of 856 farmers participated in these programmes and lectures were organized on Common Cattle Diseases and Preventive Measures, Veterinary Services, Clean Milk Production, Role of Green Fodder in Animal Diet, Role of By-pass Fat and Protein in Animal Production, Balanced Feeding, Silage Making, Role of Dry Cow Therapy, Care of Advance Pregnant Dairy Animals and Value Added Milk Products.

Question/Answer sessions were also arranged in these programmes, which provided excellent opportunities to the farmers. Subject matter specialists of the Institute addressed their day to day problems and also provided the feedback on the extension programmes.

### Dairy Education at Farmers' Door

Extension Education Programme "Dairy Education at- Farmers' Door" continued to strengthen the effective dissemination of dairy production and processing technologies among farming community. Under this programme, a team of NDRI scientists including subject matter specialists from production, processing and management group organized Dairy Education at Farmers' Door in various villages on 2nd Saturday of every Month. Scientists also obtained the feedback from the participating farmers.

### Integrated Dairy Development Programme

Integrated dairy development programme was relaunched by the Institute at Pusar, District Bagpat and Lalukheri, District Muzaffarnagar of Uttar Pradesh to utilize the facilities of Model

Dairy Centre created under Integrated Rural Development Project during 2002-2005 .

For tackling the reproductive disorders in dairy animals, 25 infertility and veterinary aid camps were organized in both villages.

**Off campus Training:** Exposure visits and training programme on "Value added milk and milk products" was organized in Model Dairy Centre in village Pusar, in which more than 90 participants including farm women actively participated. Economics of these value added products were also worked out with trainees. A lecture followed by practical demonstration on Gulab Jamun, Paneer and Khoa was organized as a part of this programme.

### Advisory Services

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

## Krishi Vigyan Kendra & Dairy Training Centre

### Introduction

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.

The philosophy of increasing income and rural jobs lies in integrating the agriculture with other allied activities viz. dairy production, dairy processing and post-harvest technologies for value added products. The allied fields are chosen depending upon the area, climatic conditions, resource pattern, land availability and market potentials.

At KVK, need based training courses are designed for different types of clientele. After training, follow up extension programme is undertaken. The training starts with field units, different farms, live demonstration units, workshops and terminates in discussion assembly. For making training programmes more effective, the KVK has developed close linkages with different Government, Non-Government and voluntary agencies and line Departments.

### Mandate

- To conduct "on farm testing" of identified technologies in terms of location specific sustainable land use systems.
- To organize frontline demonstrations on various crops to generate production data and feedback information.
- To organize short and long term vocational training courses in agriculture and allied vocations for the farmers and rural youths for higher production on farms and generating self employment.
- To organize training to update the extension personnel with emerging advances in agricultural research on regular basis.

### Extension Activities

- The KVK has four stockman centres in the adopted villages, namely: Taprana, Kailash, & Phusgarh and Jundla Gate, Karnal to take care of animal health and artificial insemination in the operational area. In these centres, 9,136 cases were attended, out of which 170 cases were for general treatment, 55 for infertility treatment, 319 for dehorning, 202 for pregnancy diagnosis, 3,490 AI in dairy animals and 4,900 cases were for FMD vaccination. Through Artificial Insemination 2,057 calves were born.

## Training Programmes organized by KVK (January to December, 2010)

| Title of the course | Duration (days) | No. of courses | No. of beneficiaries | Mandays trained |
|---|---|---|---|---|
| **(A) On-Campus Programmes** | | | | |
| Dairy Production | | | | |
| At KVK | 4-5 | 10 | 488 | 3670 |
| Sponsored | 3-5 | 62 | 1667 | 8303 |
| Dairy Processing | 5 | 6 | 107 | 535 |
| Crop Production | | | | |
| At KVK | 3 | 8 | 127 | 257 |
| Sponsored | 3 | 3 | 152 | 456 |
| Vermiculture | 1-3 | 6 | 118 | 324 |
| Bee-keeping | 4 | 3 | 129 | 516 |
| Fish Farming | | | | |
| At KVK | 4 | 2 | 26 | 104 |
| Sponsored | 5 | 2 | 31 | 155 |
| Home Science | 3-5 | 9 | 168 | 587 |
| Short Integrated Training Programmes | 1 | 125 | 3488 | 3488 |
| **Total (A)** | | **236** | **6501** | **18395** |
| **B) Off-Campus Programmes** | | | | |
| Dairy Production | 1 | 6 | 132 | 132 |
| Dairy Processing | 1 | 3 | 56 | 56 |
| Crop Production | 1 | 9 | 253 | 253 |
| Vermiculture | 1 | 2 | 60 | 60 |
| Bee-keeping | 1 | 5 | 93 | 93 |
| Fish Farming | 1 | 5 | 93 | 93 |
| Home Science | 1-40 | 16 | 673 | 1107 |
| **Total (B)** | | **46** | **1360** | **1794** |
| **Grand Total (A) + (B)** | | **282** | **7861** | **20189** |

## Sponsored Courses Conducted (January to December, 2010)

| Title of the Course | Duration (Days) | No. of courses | No. of beneficiaries | Mandays trained |
|---|---|---|---|---|
| Scientific Dairy Farming for farmers sponsored by PCDF Ltd. Lucknow, Uttar Pardesh | 5-10 | 22 | 577 | 2935 |
| Fish Farming for farmers sponsored by DASP Ltd. Lucknow, Uttar Pardesh | 5 | 2 | 31 | 155 |
| Scientific Dairy Farming for farmers sponsored by Agricultural Technology Management Agency (ATMA), Rajasthan | 5 | 7 | 200 | 1000 |
| Scientific Dairy Farming for farmers sponsored by different agencies and deptt. of Himachal Pradesh | 3-5 | 9 | 267 | 921 |
| Scientific Dairy Farming for farmers sponsored by ATMA. Of Bihar | 5 | 5 | 148 | 740 |
| Scientific Dairy Farming for rural youth sponsored by Animal Husbandry, Dept. of Punjab State | 5 | 1 | 25 | 125 |
| Scientific Dairy Farming for dairy farmers sponsored by P.C., KVK, R.S. Pura (J&K) | 5 | 1 | 21 | 105 |
| Scientific Dairy Farming for Extension functionaries sponsored by State Institute for Rural Development (SIRD) Assam | 5 | 4 | 88 | 440 |

| | | | | |
|---|---|---|---|---|
| Scientific Dairy Farming for rural youth sponsored AH Dept. of Sikkim State | 10-15 | 2 | 45 | 550 |
| Scientific Dairy Farming for dairy farmers sponsored by Farmers Training Centre of Jharkhand State. | 5 | 10 | 289 | 1445 |
| Dairy Farming and Dairy Production for Coordinators of Child Fund from UP and Uttarakhand | 6 | 1 | 7 | 42 |
| Training on Agriculture diversification for the farmers sponsored by Nehru Yuva Kendras of Karnal & Panipat | 3-4 | 3 | 152 | 456 |
| **Total** | | **67** | **1850** | **8914** |

(Revenue generated from sponsored courses = Rs. 11,37,544/-)

- Subject Matter Specialists of KVK organized 11 one day camps on fertility, deworming, tick control, general treatment and pregnancy diagnosis and attended 1,511 cases in adopted villages to create awareness among farmers about animal infertility problems and dairy management aspects.
- KVK organized location specific trials on the use of Dahi. Cultures NCDC – 153 and NCDC -323. The four dairy processing owners were provided dahi cultures for making curd.
- Nine On Farm Trials of cauliflower crop were laid in 1.62 hectare area under irrigated conditions on different farmers' fields. The variety Himposh was used for conducting OFTs. The average yield of cauliflower was found 290 qtls/ha.
- Nine On Farm Trials of radish crop were laid in 1.62 hectare area under irrigated conditions on different locations.The variety White Wonder was used for conducting OFTs. The average yield of radish was found 240 qtls/ha.
- Front Line Demonstrations on Mustard RH-30 variety were conducted in 6 hectares area on farmers' field and 15 farmers were selected. In the demonstration plot, an average production was observed 18.4 quintal per hectare. An increase of 26.8% was observed as compared to local check plots. The overall performance of variety Rh-30 was found to be good.
- During the summer season 2010, total five FLDs on fodder crop jowar (multi-cut) were laid in 2.0 hectare area under irrigated conditions. The variety Sudax Char-1 was used for conducting FLDs. The average production was found 642 qtls. fodder per/ha.
- During the Rabi season 2010-11, six hectare area was allotted under oilseed and four hectare area was under pulse crops. This KVK had selected 15 farmers for oilseeds, Mustard and 10 farmers for pulse, gram crops. The total 25 demonstrations were organized in various villages of Karnal district.
- During the Rabi season 2010-11, wheat trials using varieties DBW-17 and HD – 2894 were used on 21 demonstration plots by the KVK covering 8.45 hectare area under irrigated conditions in one acre each in different villages of Karnal district to generate data.
- During the reporting period, 3 On Farm Trials on Berseem in 4.8 ha. area using variety Mescavi, BL-42 and HB-1 and 5 On Farm Trials on wheat in 5.6 ha. Area in association with IARI New Delhi using variety HD-2894, HD-2851, HD-2932, WR-544 and DBW-17 were arranged in different villages of Karnal district.
- KVK in association with State Animal Husbandry Department participated in the calf rally in village Narukheri on 10th Feb., 2010 and village Unchana Samana on 20th Feb., 2010. The expert lectures were delivered to the farmers over around 200 farmers in each.
- International women day was celebrated in village Kailash on 8th March, 2010 in which more than 300 farm/rural women/girls volunteers of NGOs and Women Extension workers from 24 villages of the district participated.
- KVK celebrated World Breast Milk Feeding day on 4th August, 2010 at village Uchani in which 55 farm women participated.
- KVK celebrated "Women in Agriculture" day on 4th Dec., 2010 at village Khera Chhapra of Karnal district in which 70 farm women participated.
- KVK organized 13 exhibitions depicting its activities and achievements:

## Revenue Generated by KVK/DTC

Total revenue generated at KVK through various activities during Jan to Dec., 2010 was Rs 27,20,959/-

# Agricultural Technology Information Centre (ATIC)

Research system has generated vast knowledge on different technological interventions for synthesis of appropriate technologies for the use of stake holders. The end users are not able to use technological interventions/technologies as they lack to access to information about these technologies. In order to bridge this gap, Agricultural Technology Information Centre (ATIC) was established at NDRI. ATIC is a 'single window' delivering, dissemination and support system, for various innovative and farm worthy technologies evolved at different ICAR institutes and SAU's in the pursuit of research and development.

The facility of single window approach through Agricultural Technology Information Center (ATIC) helped the farmers/visitors to provide solution to their problem related to agriculture and allied fields. During interaction farmers/visitors were informed about the methodology to interact in future through help line and electronic media.

*Foreign delegates being introduced with the impact of single window system approach adopted by ATIC*

During the period under report, 73 foreign delegates from eight different countries such as Bhutan, Demark Nepal, USA, Iran, Hungary, UK visited Agriculture Technology Information Center.

## Problem Wise Area Specific Technological Information

A total of 21040 number of farmers visited ATIC to seek solutions to their problems in the areas of feeding, breeding and management in dairying production system. It was observed that out of 21040 framers, 5494 discussed about the problems faced related to productivity of the animals whereas 2304 enquired about the problems faced in the area of management. 1531 farmers sought information about training and education facilities in the institute. Large number of farmers (10548) visited Agricultural Technology Information Centre, NDRI, Karnal to discuss problems related to different area of crop production particularly paddy, wheat and fodder crops cultivation practices. During the visits farmers interacted with the technical staff to seek information related to package practices of various crops cultivated by the farmers.

## Feed Back on Technological Interventions

A total of 5494 farmers from different states interacted about different problems faced by them in Dairy Production System. Maximum Number of farmers came from Haryana (1109) followed by Punjab (647). Significant number of farmers came from UP, Rajasthan, Bihar and Himachal Pradesh to discussion their problems related to different areas of dairy production system. Critical appraisal of the data indicated that out of 5494 farmers 1641 discussed problems related to nutrition whereas 1639 farmers discussed about health problems. Many farmers interacted with the resource persons to solve their problems related to physiology and breeding. Majority of problems were related to animal nutrition, animal breeding, animal physiology and animal health and management problems viz repeat breeding, metritis, anestrous, mastitis, balance feed, formulation of feed, shelter, ecto and endo parasites. Large number of farmers came to discussed about vaccination schedule to be followed in different session during the year.

**Area Specific Feed Back:** To identify the specific technological intervention in specific areas data were collected and analyzed in the areas of Animal Nutrition, Breeding, and Physiology, Health Care, Dairy Economics & Management, Value addition and Crop Production.

It was observed that among animal breeding problems, maximum numbers of problems were related to repeat breeding followed by anestrous. Many farmers discussed about availably and effect of quality semen, care of animals and housing on animal productivity. Data on different aspect Animal Nutrition such as effect of feeding of concentrate mixture, silage making, deficiency of minerals, treatment of roughages, feed blocks, by-pass protein/fat, balance feeding, fodder cultivation

round the year were recorded. Critical appraisal data indicated that maximum number of farmers enquired about effect of feeding of concentrate mixture followed by deficiency of minerals. Significant number of farmers interacted about treatment of roughages, cultivation technology of fodder crops, balance feeding, silage making, and round the year availability of fodder.

**Animal Physiology & Health Care:** It was observed that in animal physiology area of concern was heat detection, infertility problems, summer and winter stress, set time of AI and milk let down. Maximum number of farmers reported problems of heat detection particularly in buffaloes during heat stress. Analysis of data indicated that majority of the problems related to animal health care were mastitis, merits, endow & recto parasite and prolapsed. Many farmers interacted regarding vaccination schedule and also discussed about milk fever, cow pox, diarrhea and timpani etc.

### Management, Economics and Value Addition

Critical appraisal of the data indicated that 417 farmers discussed about the establishment cost of a dairy units different size and 1211 farmers were enquired about the cost of milk production whereas 676 asked about cost of construction of sheds. For value addition, 56 farmers discussed about processing of milk and availability of equipments. Nine entrepreneurs discussed about the establishment of milk plants/ processing units of different capacity.

During period under report, about 10548 farmers visited ATIC to discuss problems related to crop production system. A large number of farmers (7219) came to enquire about availability of seed of different crops whereas 2886 farmers discussed about the improved package of practices to get higher yield. Significant number of farmers (371) discussed about use of bio fertilizers and 72 farmers were guided for soil testing so that optimum dose of fertilizers may be applied to get higher yield and income.

### Problems Referred to Experts

In total 1982 cases were referred for expert opinion to different subject matter specialists working in different research institutes and other agencies located at Karnal. In total 1187 cases were referred to Subject Matter Experts of the institute.

### On-Line Guidance

Regular and frequent interaction between scientists and stake holders is considered most critical component for dissemination of the information. To meet out this requirement, a Toll Free Number **(1800 180 1199)** has been established. A total of 2868 calls were received. On an average, center received six to seven calls daily to get information related to the problem faced by them in the area of dairying and agriculture.

### Sale of Publications

A total of 1938 books were sold through ATIC which generated revenue of Rs. 184766/. Laboratory Manual of Market Milk, Clean Milk Production and Lab manual of cheese & Fermented Milk and the book entitled "Dairy Mela Samarika" 2010 were some of the prominent publications sold through ATIC.

### Sale of Seeds, Biofertilizers and Vermicompost

Under "Revolving Fund Scheme" Seed Production Unit of NDRI, Karnal produces good quality seeds of forage and cereal crops. Moreover, Krishi Vigyan Kendra (KVK) is also engaged to produce good quality wheat seed and vermicompost (Organic Manure). Rhizobium Culture is produced by Division of Microbiology for treatment of berseem seed. To strengthen Single Window Delivery Systems seeds of different crops, vermicompost and culture is sold through Agriculture Technology Information Centre, NDRI, Karnal.

### Film Shows & Face to Face Interaction

Institute activities are displayed through two documentries i.e. "NDRI at a Glance" in English and "Rashtriya Dairy Anusandhan Sansthan – Aek Parichay" in Hindi of 22 minutes each. In addition to this, centre also displayed a film on "Savach dugadh utpadan – Dugadh Padarath Nirman Aur Packaging" of 16 minutes to expose the visitors about the advantages of clean milk production. ATIC has also collected some DVDs on different subjects of agriculture and veterinary science such as Pest Management, Vermicompost, Wheat Production and Animal Diseases.

### Exhibitions

The centre displayed panels to display information on various technologies developed by NDRI, Karnal. Methodology and advantages of these technologies were explained by ATIC staff to the visitors. Panels on monthly activities to be taken during the month both in agriculture and dairying were displayed for the benefit of the visiting farmers. Exhibition Unit exhibited information through posters and pamphlets. Exhibition panels helped the stakeholder to strengthen their knowledge.

# 4 EDUCATION AND TRAINING

NDRI is the premier Institution of International repute in Human Resource Development for the growing dairy industry in India. NDRI conferred with **Deemed to be University Status** vide Govt. of India, Ministry of Human Resource Development, Department of Education, and Notification No. F. 9-15/85-U.3 dated 28.3.1989, is well equipped with modern laboratories and highly qualified faculty to meet emerging needs of the 21st Century of the Dairy Industry. The university offers academic programmes both at under-graduate and post-graduate levels in the field of Dairy Science and Technology. The courses have been so designed as to provide broad based 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.

### Masters and Doctoral Degree Programmes

The Institute offers Masters degree programmes in the following disciplines: i) Dairy Microbiology; ii) Dairy Chemistry; iii) Dairy Technology; iv) Dairy Engineering; v) Animal Biochemistry; vi) Animal Biotechnology; vii) Animal Genetics and Breeding; viii) Livestock Production and Management; ix) Animal Nutrition; x) Animal Physiology; xi) Dairy Economics; xii) Dairy Extension Education, and xiii) Agronomy (Forage Production)

The Institute offers Doctoral programmes in all the above disciplines except Agronomy (Forage Production).

### 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 — Rs. 7560/- P.M. for two years plus Rs. 6000/- per annum as contingency.
- Ph.D. — Rs10,500/- P.M. for three years and Rs. 10,000/- per annum as contingency.
- Ph.D. (In-service) — Rs. 1000/- P.M. for three years and Rs. 10000/- per annum as contingency.

### ICAR Junior Research Fellowship

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

### ICAR Senior Research Fellowship

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

### National Talent Scholarship

The National Talent Scholarship (NTS) @ Rs.1000/- per month is awarded by ICAR on merit to B.Tech. students, 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.

### Inspire Fellowship of DST

Research scholars of NDRI were also encouraged to avail Inspire fellowship Instituted for Topper students by Department of Science and Technology. The following topper students availed this fellowship during 2010-11.

| S. N. | Inspire Fellow | Department |
|---|---|---|
| 1. | Harish Panwar (IF10418) | Dairy Microbiology |
| 2. | Nilufar Haque (IF 10464) | Dairy Cattle Physiology |
| 3. | Bitan Mondal (IF 10539) | Dairy Economics |
| 4. | Anuj Kumar (IF 10556) | Dairy Technology |
| 5. | Siddhartha Shankar Layek (IF 10566) | Livestock Production & Management |

## Career Guidance, Training and Placement Cell

The placement Cell provides career guidance, training and placement services for the passing out students in various disciplines of the Deemed University. B.Tech. (Dairy Technology) and Masters in Dairying students were provided employment in reputed organizations through campus interviews. Passed out students of NDRI are getting employment in Dairy/ Food Industry (Govt./Cooperative/Multinationals). Salary ranges from 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.

## 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, 2010, respectively at NASC Complex, New Delhi.

## Entrance Examination

An All India Competitive Entrance examination for admission to Ph.D. programme for the session 2010-11 was conducted by NDRI on 19.6.2010 at three centers i.e. Karnal, Bangalore and Kalyani.

## Admissions

A total of 47 students joined B.Tech. (Dairy Technology), Programme and 141 students including two foreign nationals, one from Iran and one from Zimbabwe joined for Masters degree and 105 students including two foreign nationals from Sri Lanka and one from Iran joined the Ph.D. Programme.

## Degrees Awarded

During the period under report, 19 B. Tech. (DT), 81 Masters in Dairying and 32 Ph.D. students were awarded degrees.

## Meetings

- 67th and 68th meetings of the Standing Committee on Course Curricula and Academic Affairs were held on 16th Sept. 2010 and 3rd Feb., 2011.
- 46th and 47th meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 6th Sept., 2010 and 11th Feb., 2011.
- 37th and 38th meetings of the Standing Committee on Scholarship, Financial Assistance and Academic Progress were held on 25th May, 2010 and 4th Jan., 2011.
- 29th, 30th and 31st meetings of Academic Council were held on 21st Sept., 2010, 15th Jan., 2011 and 17th Feb., 2011, respectively.

## Ninth Convocation of NDRI Deemed University

Ninth Convocation of NDRI Deemed University was held on 19th February, 2011. Padma Bhushan Dr. R. B. Singh, Presidnt, National Academy of Agricultural Sciences delivered the Convocation Address and Sh. Ashok Sinha (IAS), Secretary, Ministry of Food Processing Industries presided over the function. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI Deemed University presented the Convocation Report. A total of 132 students (including 25 girls) were conferred different degrees i.e. B.Tech. (Dairy Technology) -19, Masters in Dairying -81 and Doctoral – 32. Four topper students were awarded the Director's Gold Medals; Ms. Nisha Saini (B.Tech, Dairy Technology); and Ms. Geetika Thaiur (Processing Group), Mr. Yathish M. (Production Group), Mr. Ata-Ul Munim Tak (Management Group) in the Master's degree programme. Mr. Amit Satyen Ravi (B. Tech. Dairy Technology), Ms. Anupama, M., M. Tech. in Dairy Microbiology (Processing Group), Mr. Sanjoy Datta., M.V. Sc. in Animal Genetics & Breeding (Production Group) and Mr. Nirishj Chandra Sahu, M.V.Sc. in Dairy Extension Education (Management Group) were awarded Merit Certificates for securing second position in B.Tech and different Groups in Master's degree programmes, respectively.

## Best Thesis Awards

Best Thesis Awards for Masters and Doctoral theses (one each in Production, Processing and Management Groups) carrying a citation, a certificate and Rs. 5000 for Best Masters Thesis and

Rs. 10,000 for Best Doctoral Thesis. Two theses in each programme were recommended by committees in each discipline. The students presented their theses before the Award Committee. The three award committees evaluated the theses and gave their recommendations for the Best Thesis Awards in their respective groups as given below:

### Best Doctoral Thesis Awards

- Mr. Yajuvendra Singh, Ph.D.in Livestock Production & Management (Production Group), Major Advisor: Dr. S. S. Lathwal, Sr. Scientist.
- Mr. Raj Kumar Duary, Ph.D. in Dairy Microbiology (Processing Group), Major Advisor: Dr. Sunita Grover, PS.
- Mr. K. B. Vedamurthy, Ph.D. in Dairy Economics (Management Group), Major Advisor: Dr. J. P. Dhaka, PS.

### Best Masters Thesis Awards

- Sandeep Kumar, M.V.Sc. in Animal Biotechnology (Production Group, Major Advisor: Dr. T. K. Datta, PS.
- Ms. Nidhi Yadav, M.Tech. in Dairy Chemistry (Processing Group), Major Advisor: Dr. Bimlesh Mann, PS.
- Mr. Ata-Ul-Munim Tak, M.V.Sc. in Dairy Extension Education (Management Group), Major Advisor: Ms. Ritu Chakravarty, Sr. Scientist.

### Dr. D. Sundaresan Memorial Lecture Award

Dr. D. Sundaresan Memorial Lecture Award has been instituted in the memory of the legendary Director of NDRI Dr. D. Sundaresan who led this institute for 11 long years during 1970- 1981. The award aims at recognising the outstanding contribution in education & research in agriculture and allied sectors. The award carries an amount of Rs. 20,000, a citation, shawl and a certificate.

The second award was bestowed on Agricultural Scientist, Dr. Mangala Rai, Former Secretary, DARE and Director General, Indian Council of Agriculture Research. Dr. Mangala Rai delivered the lecture on 17th February, 2011.

### Presentation of Academic Achievements and Innovations in Teaching

The Different Heads of Divisions presented the innovations and significant achievements of their respective Divisions during Academic Celebrations for the year 2009-10 on 16th February, 2011 before a panel of experts. The panelsits included Dr. J. M. Dave, Dr. R. Sahai and Dr. Raj Vir Singh. The faculty and students participated in the deliberations.

### MOUs Signed

NDRI signed Memorandum of Understanding with the following Universities for Collaboration in Areas of Mutual Interest.

- Shere-e-Kashmir University of Agriculture and Technology, Jammu
- Banaras Hindu University, Varanasi
- Thapar University, Patiala
- Manav Bharti University, Solan
- Indira Gandhi National Open University, New Delhi

### My Idea Programme

National Science Day was celebrated on 28th February, 2011 by organizing "My Idea Competition" for students of B. Tech. (DT), Masters and Doctoral Programmes. It was an intra-college contest of ideas, which encourages the student community to pursue their ideas and innovative solutions to important social problems. The basic goal of this programme is to promote a sustainable culture of innovation and entrepreneurship among student community. Through the contest, students were selected and recognized with certificates and cash prizes. Ideas were evaluated for technical and economic feasibility, innovativeness, social impact and potential for commercialization.

*A View of 9th Convocation held at NDRI*

*Degrees being presented during 9th Convocation 19th February 2011*

# 5 HONOURS / AWARDS

- **Dr. A. K. Singh**, Sr. Scientist, Dairy Technology Division was awarded "**Dr. P. G. Nair Award"** (2005-09) by Alumni Association, NDRI, Karnal on the occasion of 9th Convocation of NDRI Karnal on 19th February, 2011.

- **Dr R. K. Malik**, Principal Scientist, Dairy Microbiology Division was awarded "**Dr. N. N. Dastur Award"** (2005-09) by Alumni Association, NDRI, Karnal on the occasion of 9th Convocation of NDRI Karnal on 19th February, 2011.

- **Dr. (Mrs.) Harjit Kaur,** Principal Scientist, Dairy Cattle Nutrition Division was awarded "**Dr. D. Sundaresan Award"** (2003-07 & 2004-2008) by Alumni Association, NDRI, Karnal on the occasion of 9th Convocation of NDRI Karnal on 19th February, 2011.

- **Dr. Avtar Singh**, Principal Scientist, Dairy Cattle Breeding Division was awarded "**Dr. D. Sundaresan Award"** (2005-09) by Alumni Association, NDRI, Karnal on the occasion of 9th Convocation of NDRI Karnal on 19th February, 2011.

- **Dr. Sumit Arora,** Sr. Scientist, Dairy Chemistry Division was awarded "**Dr. K. K. Iya Award"** (2003-07 & 2004-2008) by Alumni Association, NDRI, Karnal on the occasion of 9th Convocation of NDRI Karnal on 19th Feburary, 2011.

- **Dr. Y. S. Rajput,** Principal Scientist, Animal Biochemistry Division was awarded "**Dr. K. K. Iya Award"** (2005-09) by Alumni Association, NDRI, Karnal on the occasion of 9th Convocation of NDRI Karnal on 19th February, 2011.

- **Dr. Satish Kulkarni, Dr. B. Surendra Nath, Dr. B. V. Balasubramanaym, Dr. B. C. Ghosh** and **Dr. Menon Rekha Ravindra,** SRS, Bangalore got **"ICAR Award for Interdisciplinary Team Research"** for the Biennium – 2007-08.

- **Dr. G. R. Patil, Dr. R. R. B. Singh, Dr. A. A. Patel, Dr. M. J. Solanki, Dr. Sunil Patel, Dr. Satish Kulkarni** and **Dr. B. Surendra Nath** got **"ICAR Award for Interdisciplinary Team Research"** for the year 2010.

- **Dr. K. K. Datta,** Head, Dairy Economics Statistics & Management Division alongwith other team members was awarded **"The ICAR Outstanding Interdisciplinary Team Research Award in Agriculture and Allied Sciences for Biennium 2007-2008"** for their outstanding research contribution in Social Sciences on 16th July, 2010 at NASC, New Delhi on the occasion of ICAR Foundation Day.

- **Dr. B. C. Ghosh,** Principal Scientist, SRS, Bangalore got the "**Best Paper Award"** for the paper entitled **"Preparation and properties of *chhana* sweets"** published in the "Commercial Aspects Area" in the Indian Dairyman for the calendar year 2009. The award was presented at 39th Dairy Industry Conference from 4th -6th Feb., 2011 Kolkata.

- **Dr. Vivek Sharma, Mr. Makwana Tushar, Dr. Sumit Arora, Dr. Amit Kumar, Dr. Darshan Lal, Dr. Raman Seth, Dr. B. K Wadhwa** and **Dr. G. S Sharma** were awarded **"Best Paper Award"** for their paper entitled "**A rapid method of cholesterol estimation in ghee using non - enzymatic diagnostic kit"** published in *Ind. Journal Dairy Sci,* 61 (5): 353- 359 during 38th Dairy Industry Conference from 17th - 19th Feb, 2010 at NIMHANS Convention Centre, Bengaluru, organised by IDA (SZ).

- **Mr. S. Arora, Mr. V. P. Singh, Mr. V. Sharma, Dr. B. K. Wadhwa, Mr. V. George, Dr. A. K Singh**. and **Dr. G. S. Sharma** got "**JFST Best Paper Award"** for their paper entitled **"Analysis of sucralose and its storage stability in *burfi*"** for the year 2009, published in *J. Food Sci. & Technol.* 2009, *46(2): 114–117.* Presented in the Annual Award Ceremony held on 25th January, 2011 at CFTRI, Mysore.

- **Dr. S. K Sood** and **Dr. P. R. Sinha,** Animal Biochemistry Division received **"Best Paper Award"** for their paper entitled **"Acidocin S2 containing powder obtained upon freeze-drying of fermented paneer whey reduces total viable count during storage of processed cheese"** published in *Indian Journal of Dairy Science,* 62 (6) : 486 – 490 : 2009.

- **Dr. V. K. Batish, Dr. Sunita Grover** and **Dr. Raj Kumar Duary** received **"Best Paper Award"** for their paper entitled **"Probiotic - A Magic Bullet"** published in the "Technical Aspects Area" in *Indian Dairyman* for 2008.

- **Dr. K. K. Datta,** Head, Dairy Economics Statistics and Management Division was awarded the **"Best Paper Award"** by the Agricultural Economics Research Association (Dr. D.T. Doshi Research Foundation).

- **Dr. Sumit Arora, Mr. S. Yarrakula, Mr. K. Narendra, Dr. Vivek Sharma, Dr. B. K Wadhwa,**

**Dr. A. K. Singh** and **Dr. G. S. Sharma** were awarded **"Second Best Paper Award"** for their paper entitled "**Analysis of saccharin and acesulfame-k and their storage stability in *kalakand* "** published in *Ind. Journal Dairy Sci.,* 61 (5): 353- 359 during 38th Dairy Industry Conference, 17th - 19th Feb., 2010 at NIMHANS Convention Centre, Bengaluru, organised by IDA (SZ).

- **Dr. K. Ponnysamy** and **Dr. Jancy Gupta** was awarded "**Second Best Paper Award"** for the paper entitled **"An assessment sustainable livelihood parameters in coastal farming systems"** by Indian Dairy Association in the Dairy Economics, Extension and Management area during the 39th Dairy Industry Conference held at Kolkata.

- **Mr. A. A. Awad, Mr. M.A.A. Azzam Ali and Dr. Latha Sabikhi** were awarded the **"Best Poster Award"** for their poster entitled "**Technology of cereal-rich fermented dairy food using barley flour and selected probiotic strains"** at the 11th Egyptian Conference on Milk and Dairy Products for a Healthy Future, Cairo, Egypt. 1st – 3rd Nov., 2010.

- **Dr. Meena Malik** and **Dr. S. L. Goswami** got the "**Best Poster Award"** for the paper entitled **"Innovative technologies developed at NDRI for sustainability in dairy sector"** presented at the 39th Dairy Industry Conference held during 4th – 6th February, 2011 at the Eastern Zonal Cultural Centre, Salt Lake City, Kolkata.

- **Ms. Monica Puniya, Dr. Chander Datt, Dr. Vinod Kumar** and **Dr. S. S. Kundu** got **"Best Poster Award (First Prize)"** for their paper entitled **"Pesticides: occurrence and control measures"** at 3rdNational Conference (Biological and Chemical Sciences) on Recent Advances in Chemical and Environmental Sciences-2011held at Multani Mal Modi College, Patiala, Punjab.

- **Dr. I. K. Sawhney, Mr. A. Shaw** and **Mr. A. R. Gurjar** were awarded **"Best Poster Presentation Award"** for their paper entitled **"Development of mechanized system for continuous cooling of khoa"** at 6th convention of Indian Dairy Engineering Association held at Dairy Science College, Bangalore from 27th-28th August, 2010.

- **Mr. P. S. Minz, Mr. P. Sellam, Dr. R. K. Kohli, and Mr. J. Badshah** were awarded **"Certificate of Appreciation"** for their paper entitled **"Ecolabelling: As a potential marketing tool for Food and Dairy Products"** at 6th convention of Indian Dairy Engineering Association held at Dairy Science College, Bangalore from 27th-28th August, 2010.

- The technology of **Dr. V. K. Kansal,** Principal Scientist, Animal Biochemistry entitled **"A probiotic dahi for cardiovascular health, protection against cancer and improvement of immunity"** presented Regional Fair at IIT Mumbai on 24th September 2010, and than at National Fair 2010 at IIT New Delhi on 22nd November 2010, organized by Confederation of Indian Industries (CII), Department of Science & Technology-Government of India & Agilent Technologies, was awarded as one of the ten best technologies out of 890 presented at National level.

- **Mr. Vyawahare A. S., Mr. Pankaj Madariya and Dr. Jayaraj Rao K.** got "**Second Best Poster Paper Award"** for their paper **"Application of computer vision system in colour evaluation of Kalakand"** presented at 39th Dairy Industry Conference from 4th -6th Feb., 2011 Kolkata.

- **Mr. Prabhakar Padgham, Dr. Bimlesh Mann, Dr. Rajesh Kumar, Mr. Prerna Saini** and **Ms. Anuradha Kumari** got **"Second Best Poster Presentation Award"** for their paper entitled **"Biofunctional properties of traditional Indian lassi prepared from buffalo milk"** presented in the 39th Dairy Industry Conference held at Kolkotta from 4th – 6th Feb. 2011.

- **Dr Avtar Singh,** Principal Scientist, Dairy Cattle Breeding Division received **"Second Poster Presentation Award"** for his paper entitled **"Identification and Prevention of Chronic Spinal Disease in Karan Fries Cattle"** during the Hindi Diwas celebrations on 14th Sept. 2010 at NDRI, Karnal.

- **Dr. Avtar Singh,** Principal Scientist, Dairy Cattle Breeding Division received **"Second Best Paper Award"** for the paper entitled **"Dairy cattle crossbreeding in India"** published in Indian Dairyman 61(6) : 46 - 56 for the year 2009 in the "Technical Category" on 6th February, 2011 at Kolkata.

- **M. L. Kamboj, Dr. Shiv Prasad, Dr. V. S. Raina,** and **Dr. Saroj Rai,** Livestock Production and Management Division were awarded the **"Second Best Paper Award"** by NDRI Karnal for their paper entitled, **"Bharat mein jaivik dhoodh utpadan kee sambhawnayen avam jaivik dairy farm prabandhan paddhtiyan"**

under the "Scheme for the original writing in Hindi of Scientific and technical literature for the year 2008-2009" on 14th Sept., 2010.

- **Dr. S. S. Thakur,** Principal Scientist, Dairy Cattle Breeding Division was conferred the **"Compound Livestock Feed Manufacturers Association (CLFMA) of India Felicitation Award 2010"** at the CLFMA National Symposium held at Chandigarh on 30th August, 2010.
- **Dr. Khajan Singh, Mrs. Ritu Chakravarty, Dr. D. S. Brar,** and **Dr. S. K. Tomar** were conferred **"First Prize"** in original article writing related to dairy science for folder **"Care of Calves/ Newborn Animals (Hindi)"** prepared by Dairy Extension Division, National Dairy Research Institute, Karnal (Haryana). NDRI, Karnal on 19th Oct., 2010.
- **Dr. S. K. Sirohi, Dr. S. S. Kundu, Dr. Sohan Vir Singh, Dr. Praveen Kumar** and **Ms. Poonam Pandey** received **"First Prize"** for book **"Dairy Pashu Poshan Avum Prabandhan (Hindi)"** during Hindi Divas on 14th Sept., 2010
- **Ms. Nidhi Yadav, Mr. Prerna Saini, Dr. Bimlesh Mann** and **Dr. Rajesh Kumar** got "**Best Poster Presentation Award"** for their paper entitled **"Whey protein hydrolysates ki pratioxikark kshmta avam unka Ice cream mein upyog"** on the occasion of Hindi Divas celebrated on 14th September, 2010 at NDRI, Karnal.
- **Dr. A. K. Puniya, Dr. Sanjay Kumar** and **Dr. Kishan Singh,** received **"Tritaya Puruskar"** in October 2010 for 'Dairy Vigyan Sambandhi Mool Hindi Alehkh, 2008-09, entitled – **"Suksham Jevon Kee Adhbhut Duniya"**, at Rashtriya Dairy Anusandhan Sansthan, Karnal.
- **Dr. A. Kumaresan** availed the prestigious Biocon Post Doctoral Fellowship of Govt. of Sweden.
- **Dr. Satish Kulkarni,** Head Southern Regional Station, Bangalore was nominated as an External Expert Member to the Board of Studies of faculty of Dairy Science, Karnataka Veterinary, Animal & Fisheries Sciences University, Bidar for a period of two years.
- **Dr. R. S. Gandhi,** Head DCB was nominated as Member, Editorial Board, Indian Buffalo Journal published by Indian Society for Buffalo Development.
- **Dr. R. S. Gandhi**, Head, Dairy Cattle Breeding Division was nominated as Member, Institute Management Committee, NBAGR Karnal for a term of three years w.e.f. 13.12.10. He was also elected as Vice-chairman of Indian Dairy Association (North Zone) for a period of three years w.e.f. 01.01. 2011.
- **Dr. A. K. Chakravarty**, Principal Scientist, Dairy Cattle Breeding Division was appointed as Member of Veterinary Hospital Planning and Surgical Instruments Sectional Committee, MHR-13 by Bureau of Indian Standards, Govt. of India, New Delhi.
- **Dr. A. K. Puniya,** Principal Scientist, Dairy Microbiology Division, was awarded the 'Honorable Mention', for the **"Moselio Schaechter Distinguished Service Travel Award"** of the "American Society for Microbiology" 2010.

### Popularization, Awareness Programmes and Technology Transfer of Newly Developed Composite Dairy Foods- A Success Story

- Entrepreneurship development campaign was launched for transferring some of the technologies that have been developed in the field of composite dairy foods. A total 150 women were contacted and workshops were organized to promote the entrepreneurship among them with complete techno-economic feasibility and modalities of technology transfer.
- A group of 14 women all resource poor villagers with an average monthly income of Rs. 4500/- only was formed and they were trained in the manufacture of dairy products including the value added dairy products.
- A processing unit has been established at Amritpur Kalan located near Karnal and commercial production of various composite dairy foods has been started since October, 2010.
- These women have earned a monthly turnover of Rs. 55000/- through sale of these products and generated a profit of Rs. 1000 per person monthly.

# 6 RESEARCH COLLABORATIONS

The Institute maintained close liaison with various organisations 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.

### Linkages with International/National Agencies

| Area | Project/PI | Sponsoring Agency |
|---|---|---|
| Reproduction Genomics | Fertility Performance and Analysis of *CYP19* Gene Regulation in Buffalo (Dheer Singh) | DBT |
| Bioactive/Nutraceutical/ Therapeutic Milk Proteins | Energetics and Dynamics of Protein Stability and Iron Binding Properties and their Modulation by Domain-Domain Interactions in Lactoferrins from Various Animal Species (J. K. Kaushik) | DBT |
| Genomics | Cloning, Expression and Functional Characterization of a Mammary Gland Protein MGP-40 Expressed during Mammary Gland Involution and Exploring its Potential as a prognostic Mammary Biomarker in Farm Animals (A. K. Mohanty) | DBT |
| Embryo Production Techniques | Conservation and Multiplication of Germplasm of Yak (Poephagus Grunniens L.) and its Hybrid using *in vitro* Embryo Production Techniques (M. S. Chauhan) | DBT |
| Reproduction Genomics | Comparative Analysis of Epigenic Regulation of the *Cyp19* Gene in Buffalo and Cattle (Dheer Singh) | DST-DFG (Indo-German Project) |
| Environmental Physiology | Research Needs and the Financial, Technological and Capacity Needs and Constraints to Address Climate Change Concerns vis-)-vis Livestock and Dairy Products (R. C. Upadhyay) | NATCOM-SNC, Ministry of Environment & Forest, GOI; UNDP-GEF |
| Climate Change | Enabling Activities for Preparation of India's Second National Communication to UNFCC-UNDP ((R. C. Upadhyay) | Ministry of Environment & Forest |
| Medical and Nutritional Sciences | Mechanisms of Cholesterol Transfer into Milk – A Comprehensive Gene Expression and Metabolism Study in Buffalo and Cattle (B.S. Prakash). | DST-DAAD |
| Nutrition and Immunity | Effect of Micronutrients Supplementation on Hormones, Milk Yield, Udder Health and Immunity in Crossbred and Indigenous Cows (A. Aggarwal) | DBT |
| Embryo Production | Embryo Production by Ovum Pick-up from Live Cattle (M. S. Chauhan). | DBT |
| Stem Cell | Reprogramming of Goat Fibroblast Cells by Introducing Transcription Factor Genes to Produce Induced Pluripotent Stem (ips) Cells (D. Malakar) | DBT |
| Animal Nutrition | Rumen Microbial Manipulations for Mitigation of Methane Emission and Productivity Enhancement in Dairy (S. K. Sirohi). | NFBSFARA |
| Micro-encapsulation | Micro-encapsulation of Bacteriocins for their Controled Release (R. K. Malik) | NFBSFARA |
| Cellular Immunity | Molecular Basis for Modulation of Immuno Competence of Neutrophilic Function *in vivo* and *in vitro* of High Producing Cows and Buffaloes Peripartum (A. K. Dang and Shiv Prasad) | DBT |
| Quality Assurance | Developing & Evaluation of Multiple Micro-nutrient (Mineral & vitamins) Fortified Milk for Consumer Market (Sumit Arora). | DBT |
| Probiotics | Development of Traditional Fermented Dairy Products Enriched with an indigenous Probiotic Strain for Promoting the Health and well being of Consumers (Sunita Grover) | MFPI |

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|---|---|---|
| Quality Assurance | Investigations on High Pressure Induced Effect on Quality Characteristics of Buffalo Milk (A. K. Singh) | NFBSFARA |
| Animal Production | Bovine Sub-clinical Mastitis in Crossbred Dairy Cattle, Early Diagnosis and Control for Enhancement of Milk Production under Field Conditions : An Integrated Approach (D. N. Dass) | NABARD |
| Sire Evaluation | Indigenous Breed Improvement Programme (Sahiwal cattle) (R. S. Gandhi) | PDC, Meerut; Govt. Livestock Farm, Lucknow; Govt. Livestock Farm, Hisar; GADVASU, Ludhiana; Sh. Gaushala Trust, Bhiwani |
| Extension Service | Dairy Extension Education and Services at Farmers' Door through Mobile Extension Unit: Action Research (Jancy Gupta) | NABARD |
| Reproduction | Deciphering the Mechanism of Aberrant Maternal Recognition of Pregnancy Events in Sheep and Buffalo under Heat and Nutritional Stress (T. K. Datta) | NFBSFARA |
| Climate Change | National Initiative on Climate Resilient Agriculture (R. C. Upadhyay) | CRIDA |
| Probiotics | Application of Probiotics in Alleviating Allergic Responses and Immuno-senescence (Rajiv Kapila) | DBT |
| Crossbred Male Infertility | Molecular Characterization of A Semi-domestic Cattle Breed of Jammu and Kashmir (S. De.) | DBT |

## Linkages with State Agricultural Universities/State Departments/Other ICAR Institutes/Industries

| Area | Project/PI | Collaborating Agencies |
|---|---|---|
| Indigenous Milk Product Technologies | Network Project on R&D Support for "Process Upgradation of Indigenous Milk Products for Industrial Application" (G. R. Patil). | SMC College of Dairy Science, GAU, Anand; WBUAFS, Mohanpur (W.B.); SRS, Bangalore; BHU, Varanasi; IIT, Khargpur |
| Organic Farming | Studies on Organic Milk Production System in the Plains of West Bengal (P. K. Roy). | Department of Veterinary Pharmacology & Toxicology, WBUAFS, Kolkata |
| Progeny Testing of Murrah Buffaloes | Network Project on Buffalo Improvement (A. K. Chakravarty and Avtar Singh). | CIRB, Hisar; PAU, Ludhiana and CCS HAU, Hisar; IVRI, Bairelly; NDAUT, Faizabad |
| Sahiwal Sire Evaluation | Performance Evaluation and Multiplication of Sahiwal Cattle under Open Nucleus Breeding System (R. S. Gandhi). | Govt. Livestock Farm, Lucknow; Govt. Cattle Breeding Farm, Durg, Chhattisgarh; College of Veterinary Science and Animal Husbandry, Durg; Shri Gaushala Trust, Bhiwani |
| Environmental Physiology | Impact Adaptation and Vulnerability of Indian Agriculture to Climate Change (R. C. Upadhyay). | ICAR (Network Project) |
| Environmental Physiology | Adaptation of Livestock to Impending Climatic Changes through Shelter Management (R. C. Upadhyay). | ICAR (Network Project) |
| Reproduction Genomics | Buffalo Production and Reproduction Genomics (T. K. Datta). | Niche Area (ICAR) |
| Rumen Manipulation | Rumen Microbial Manipulation for Mitigation of Methane Emission and Productivity Enhancement in Dairy Animals (S. K. Sirohi and A. Santra). | NIANP, Bangalore; IVRI, Izatnagar (NFBSRA) |

| | | |
|---|---|---|
| Reproductive Physiology | Endocrine Profiles and Characterization of Candidate Genes Influencing Prolificacy of Black Bengal Goat (B. S. Prakash). | ICAR Research Complex for NEH Region, Tripura |
| Genomics | Molecular Characterization of Semi Domestic Cattle Breed of Jammu and Kashmir (S. De.). | Doda, SKUAST, Jammu |
| Endocrinology | Development of Plasma Catecholamines Assays for Evaluation of Sympathetic Neuronal Function and Milk Production Performance in Heat Stressed Cows (Mahendra Singh/B.S. Prakash). | RTAC, BRNS, Mumbai |
| Quality Assurance | Monitoring of Drug Residues and other Environmental Pollutants (N. K. Goel). | College of Veterinary Science, Mumbai; Chennai; Kolkatta; Gujrat; Pantnagar; A. P.; M. P.; Ranchi; Guwahati; Patna; NRC on Yak, Dirang; NIANP; Bangalore; Outreach Project (ICAR) |
| Microbiology | Scheme on Dairy Microbes under Network Mode (Remeshwar Singh). | ICAR Network |
| Lactation Physiology | Candidate Gene Analysis and Identification of Allelic Variants Associated with the Incidence of Mastitis in Dairy Cattle and Buffalo (A. K. Dang). | NBAGR |
| Feed Resources | Nutritional Evaluation of Azolla for Utilization in Ruminant Ration (A. Chatterjee). | Regional Station for Forage Production and Development, Kalyani, Govt. of India. |
| Feed Resources | Evaluation and Utiliztion of Brewers Spent Grain as Cattle Feed Supplement (A. Santra). | Dept. of Animal Nutrition, WBUAFS, Kolkata |

## NAIP Projects

| Area | Project/PI | Collaborating Agencies |
|---|---|---|
| **NDRI as Lead Institute** | | |
| Reproduction Augmentation/ Genomics | Elucidating the Physiological and Genomic Regulation Process of Follicular Development, Oocyte Maturation and Embryogenesis in Buffalo (T. K. Datta) | CIRB, Hisar; NIANP, Bangalore and IISC, Bangalore |
| Stem Cells | Characterization and Differentiation of Embryonic and Spermatogonial Stem Cells in Cattle and Buffaloes (M. S. Chauhan) | PDC, Meerut |
| Genomics/ Proteomics | Analysis of Mammary Gland Transcriptome and Proteome during Lactation and Involution in Indigenous Cattle and Buffalo for Identification of Probable mammary Markers (A. K. Mohanty) | NBAGR, Karnal and NCHGS&R, Punjab University, Chandigarh |
| Stem Cells | Characterization and Differentiation of Embryonic and Spermatogonial Stem Cells in Cattle and Buffaloes (M. S. Chauhan) | PDC, Meerut |
| Semen Cryo- preservation | Molecular basis of Capacitation Like Changes in the Assessment and Prevention of Cryodamage during Cryopreservation of Bovine Spermatozoa (Buffalo and Crossbred Bulls) (S. K. Atreja) | SKUAST, Jammu |
| Reproduction Augmentation | Value Chain on Zona Free Cloned Embryos for Quality Animal Production from Elite Buffaloes and Pashmina Goats' (S. K. Singla) | SKUAST, Srinagar |

| | | |
|---|---|---|
| Functional Dairy Products | Novel Approaches for Production of Nutraceuticles from Milk and Indian Herbs for Potential use in Functional Dairy Foods (R. R. B. Singh) | NBRI, Lucknow |
| Value Added Dairy Products | A Value Chain on Composite Dairy Foods with Enhanced Health Attributes (A. K. Singh) | CIPHET, Ludhiana; Arpana, Karnal and M/s New Millennium Health Foods Pvt. Ltd. NOIDA |
| E-education | Development of e-course for B.Tech (Dairy Technology) Degree Programme (A.A. Patel) | SVVU, Triupati; AAU, Anand |
| **NDRI as Consortium Partner** | | |
| Biosensors | Development of Biosensors and Micro-techniques for Analysis of Pesticide Residues, Aflatoxin, Heavy Metals and Bacterial Contamination in Milk (Naresh Goel) | BITS, Pilani, Goa, IIT, Delhi and Punjab University, Patiala |
| Bioinformatics | Development of wireless Sensor Network for Animal Management (T. K. Mohanty) | IIT, Delhi |
| Policy Planning | PME Cell under Visioning, Policy Analysis and Gender (V-PAGE) (Director, NDRI/B. S. Chandel) | NCAP Delhi; IASRI, Delhi; NAARM, Hyderabad; Yes Bank, Agriwatch; NRCWA, PME Cells |
| Networking | Agro-Web-Digital Dissemination System for Indian Agricultural Research (ADDSIAR) (D. K. Jain) | SAUs and ICAR Institutes |
| Animal Nutrition | Rumen Microbial Diversity in Domesticated and Wild Ruminants and Impact of Additives on Methanogenesis and Utilization of Poor Quality Fibrous Feeds (S. K. Sirohi) | IVRI, Izatnagar; GADVASU, Panjab; CIRB, Hisar |
| Nano Particles | Detection and Mitigation of Dairy Pathogens and Detection of Adulterants using Chemical Biology (Y. S. Rajput) | IIT, Roorkee; BITS, Pilani (Goa) |
| Reproduction Augmentation | Genetic basis of Inferior Sperm Quality and Fertility of Crossbred Bulls (S. De) | PDC, Meerut; IVRI, Izatnagar |
| Reproduction Augmentation | Development of Potency of Parthanogenetic Goat Embryos (D. Malakar) | IVRI, Izatnagar; CARI, Izatnagar; CIRG, Makhdoom; JNKVV, Jabalpur |
| Environmental Physiology | Bio-prospecting of Genes and Allele Mining for Abiotic Stress Tolerance (R.C. Upadhyay) | IVRI, Izatnagar; CIRG, Makhdoom; NRC on Camel, Bikaner; VPKAS, Almora; NEHR, Lucknow; IIT, Kanpur; NBAGR, Karnal; CIBA, Chennai; IARI, New Delhi; NBFGR, Lucknow; CIFA, Bhubneshwar; CARI, Cuttak; DRR, Tamil Nadu |
| Animal Reproduction | Application of Reverse Genetics: A Novel Approach to Study the Molecular Basis of Differential Immune Response in Indian Cattle Breed (D. N. Das) | II Sc, Bangalore<br>IVRI, Bangalore |
| Economics | Strengthening Statistical Computing for NARS (R. Malhotra) | IASRI, New Delhi; IVRI, Izatnarar; MPUAT, Udaipur; Water Technology Centre for Eastern Region, Bhubaneshawar; ICAR Res. Complex for NEH Region, Barapani; UAS, Bangalore; NAARM, Hyderabad; CIFE, Mumbai |

# 7 EMPOWERMENT OF WOMEN AND MAINSTREAMING OF GENDER ISSUES

The women empowerment trainings and campaigns in the field of dairying and home-science were organized with the objective to create awareness, impart skills in these areas and mobilize the farmwomen to take up vocation in the field of dairying for generating income and develop healthy atmosphere in the family.

### Training Programmes Organised by Extension Division of NDRI

- Seven training programmes on capacity building of farmwomen on "Clean Milk Production" were organized for 94 farmwomen at villages- Subri, Nasirpur, Nasirpur Tilla, Kulwaheri, Amritkalan on 8th April, 17th and 18th August, 6th October; 21st Dec, 2010 and 8th Jan 2011, respectively.
- Exposure visit and awareness campaign on "Clean Milk Production" for 45 farm women of village Nasirpur Tilla was organised at NDRI, Karnal on 20th May 2010.
- Seven training programmes on Capacity Building of Farm Women in "Value Added Milk Products" were organized for 122 farmwomen at villages- Kulwaheri, Subri, Nasirpur, Subri, Kulwaheri, Vazidpur on 6th August, 21st Oct., 6th Nov., 9th Dec., 2010 & 12th Jan., 30th Jan. and 11th Feb., 2011, respectively.
- Four training programmes on "Capacity Building of Farm Women in Dairying" were organized for 58 farm women at villages- Kulwaheri, Nasirpur& Subri, Vazidpur, on 3rd August, 2010, 7th Jan, 10th March and 17th March, 2011, respectively.
- Four awareness Campaign on "Health and Hygiene" were organized for 65 farmwomen in villages- Nasirpur Tilla, Subri & Kulwaheri on 7th July, 8th August, 19th Oct., 2010 and 9th March, 2011, respectively.
- Three awareness campaigns were organized on "Importance of Sprouted Pulses" for 62 farmwomen at villages – Nasirpur Tilla, Subri on 30th June, 16th July & 12th August 2010, respectively.
- Two training programmes on capacity building of farmwomen in "Preservation of Fruits & Vegetables" for 29 farmwomen at village - Shahpur on 29th April & 4th August 2010, respectively.
- Two awareness campaigns on "Child Care & Nutrition Practices & Balanced Diet" were organized for 30 women in villages- Nasirpur tilla & Ganjogarhi on 28th April, 13th Oct., 2010, respectively.
- Awareness campaign on "Cultivation of Vegetables as an Enterprise" was organised for 20 farmwomen in village Nasirpur tilla on 9th June 2010.
- A new Sadbhawana Self Help Group of 13 members for dairy development was formed in village Shahpur on 26th August 2010 as women empowerment programme.
- Empowerment of farmwomen through Self Help Groups was organised for 20 farmwomen in village Kulwaheri on 29th July, 2010.

### Performance of Satyam Dairy Self Help Group

A Satyam Dairy Self Help group of 16 members was formed in village Subri on 11th July 2007 This group was formed with the objective to increase the milk production of animals and for its value addition. They are contributing Rs. 100/person/month as a contribution to the savings of their group. Till now they have deposited approximately Rs 1 Lakh as group savings, which is being used as inter loaning among their members for purchase of animals & mineral mixture. Now, they are not dependent upon their milk vendor for these loans. The village people are getting good market price of the milk. Two of the group member had taken Rs 30,000 & Rs 25,000 for purchase of buffalo & cow, respectively. They earned good income by sale of milk, which increased their standard of living.

After repeated trainings of Self Help Group members in scientific dairy farming and clean milk production, the ladies reported the increase in milk production & decrease in the incidences of repeat breeding of animals by feeding them with balanced feed and supplemented with mineral mixture & salt. Further, by adoption of clean milk production practices, the shelf life of milk also increased. This group was also trained in Paneer making (10 days vocational training) & market was provided for sale of Paneer, which is a profitable business as compared to sale of milk. This highly mobilized group is further being trained in other milk products for getting more profit.

### Training Programmes Organised by Krishi Vigyan Kendra of NDRI

- Fifteen training programmes were organized for Rural Women and girls in the areas of preservation of fruits & vegetables, preparation

of tomato ketchup, milk based sweets, low cost nutritional recipes, importance of sprouted pulses, kitchen gardening & its importance, child care and nutrition, importance of health and hygiene and storage of food grains participated by 381 women from KVK adopted villages, NDRI, Karnal.

- During sponsored training programmes organized by KVK & DTC, NDRI in Scientific Dairy Farming for farmers and farm women, 210 farm women from Himachal Pardesh were imparted training and they were explained and demonstrated the relevant dairy production and processing technologies.
- KVK celebrated "Women in Agriculture" day on 4th Dec., 2010 at village Khera Chhapra of Karnal district in which 70 farmwomen participated. They were apprised of various scientific technologies in dairy farming, crop production, milk processing and home science.
- More than 350 farm women from KVK adopted villages and other states were mobilized for their participation in Dairy Mela organized on 26th – 28th March 2010 by NDRI Karnal.
- About 125 Farmwomen from KVK adopted villages were taken to Ganna Mela organized by CCS, HAU, RRS, Uchani in Karnal district on 25th Sept., 2010.
- During World Breast Feeding Week, NDRI organized a programme on Child Care & Nutrition on 4th August 2010 in village Uchani about 55 rural women participated. They were explained the importance of breast feeding, nutritional requirements of a child, expecting and lactating mother.
- Two training programmes on "Vermicompost Making & its Importance in Organic Farming" were organized for 50 rural women by NDRI, Karnal.
- A six week training programme on "Embroidery" was organized for 10 women in NDRI adopted village.
- A training programme of five days duration was organized on "Entrepreneurship Development in Block Printing" for 13 women trainees of Karnal district at KVK, NDRI, Karnal.
- Three training programmes on "Clean Milk Production" were organized for 68 rural/ farm-women of Karnal district by KVK, NDRI, Karnal.
- One training programme of two days duration on "Entrepreneurship Development through Value Added Milk Products i.e. Paneer Making and Khoa Making" for self employment generation were organized for 21 farm women of Self Help Groups, Karnal district at KVK, NDRI. Karnal.
- International Women Day was celebrated in village Kailash on 8th March, 2010 in which more than 300 farm/rural women/girls volunteers of NGOs and Women Extension workers from 24 villages of Karnal district participated.
- Two training programmes on "Entrepreneur Development through Preservation of Fruits and Vegetable" were organized for 34 farmwomen of Karnal district at KVK, NDRI, Karnal.
- One day training cum visit on "Cultivation and Importance of Pulse Crop Summer Moong Techniques" was organized for 26 farmwomen of KVK adopted villages at KVK, NDRI, Karnal.

**Training Programmes Organised by Eastern Regional Station, Kalyani**:

- Two six week training programmes on "AI and Veterinary First Aid" were conducted during the year. A total of 23 farmwomen participated from West Bengal and Bihar.
- Two 5 day Capsule courses on "Dairy Cattle Management" were organized. A total number of 19 women beneficiaries attended the training programmes.
- Six Farmers Induction Programmes (FIP) were organized during the year. A total number of and 110 women dairy farmers of Ichhamati Milk Union Limited (North 24 Parganas) were given exposure to dairy cattle management, nutrition, fodder production, and milk production.
- Three village level Motivational Interaction Meetings on "Methods to Ensure Production of Quality Milk for Higher Remuneration" were organized in three women dairy cooperative societies of Ichhamati Milk Union, 24 (N) Parganas.
- Six Fodder Demonstration and seedling distribution Programmes were organized in 24 (N) Parganas, Burdwan and 24 (S) Parganas districts, in which 131 women farmers were distributed root slips of different fodder.

# 8 PUBLICATIONS

### Institute Publications

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Gupta, Jancy, Chakravarty, Ritu, Meena, B. S., Subhash, S., Mohammad, Asif and Kumar, Ram (Ed.) (2010) All India Dairy Husbandry Officers' Workshop (Compendium), Dairy Extension Division, NDRI, Karnal.

Gupta, Jancy *et al* (2010) *Buffalo Dairying Husbandry Practices.* (Technical Bulletin), Publication No. 63/2010, NDRI, Karnal.

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## Dairy Cattle Breeding Division

### Research Papers

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## Books

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## Livestock Production and Management Division

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## Dairy Cattle Physiology Division

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# 9 CONSULTANCY, PATENTS & COMMERCIALISATION OF TECHNOLOGIES

## Industrial Consultancy Services

The consultancy Board facilitates transfer of the technologies developed on the basis of R&D work done in various laboratories for infusion of Science and Technology in areas of Dairy Production, Dairy Processing and Dairy Management on professional basis. For providing assistance to Nation's Dairy Industry, consultancy services are available in areas of (i) Products/Processes/Equipments developed at NDRI, (ii) Engineering design support for scaling up and fabrication of dairy equipments developed at NDRI, (iii) Preparation of techno-economic feasibility reports for dairy projects on milk production and milk processing plants, (iv) R&D assistance in product manufacture and problem solving, and (v) Quality assurance and product testing services to the industry.

Revenue generated from consultancy services is utilized for strengthening the Institute's infrastructure and R&D work and also part of the money is shared among the scientists rendering such service as an incentive. Consultancy services also provide a via media for two-way communication between scientists and industry. Feedback from industry through such interactions helps the scientists to focus and fine tune their research efforts to fulfill the real needs of dairy industry. During April 2010 to March 2011, the Board provided services to 281 organizations and generated a total revenue of Rs.37,90,015/-.

### Contract Research Projects/Consultancy Projects/ Consultancy

- "Visioning and Strategic Planning of Dairy Sector in India" Sponsored by NCAEP, New Delhi (Dr. B. S. Chandel, Principal Scientist, DES&M).

- "Effect of Antifeed on Mitigating the Methane Emission from Dairy Cows" Sponsored by M/s Daglia Agri Vet Limited, Indore (MP) (Dr. A. K. Tyagi, Sr. Scientist, DCN).

- "Research Needs & the Financial Technological & Capacity Needs and Constraints to Address Climate Change Concerns vis-a-vis Livestock and Dairy Products in India" Sponsored by Winrock International India, New Delhi (Dr. R. C. Upadhayay Principal Scientist, DCP).

- "Evaluation of SX 17 and SSG 080 Sudan Sorghum Grass Hybrid in Comparison to other Popular Sorghum Hybrid on Milk Production in Dairy Animals" Sponsored by Devgen Seeds and Corp. Technology Pvt. Ltd., Secunderabad (Dr. S. K. Tomar, Principal Scientist, DCN)

- "Use of Rice Bran Lecithin and Phospholipids in Dairy Cattle Feeding" Sponsored by A. P. Organics Pvt. Ltd., Dhuri (Pb) (Dr. A. K. Tyagi Sr. Scientist, DCN).

- Effect of Feeding of Feed Supplement 'Concentrate Cow' and 'Concentrate Buffalo' on 'Milk Production and Composition in Crossbred Cows and Buffaloes' Sponsored by Godrej Agrovet Ltd. (Dr. J. P. Sehgal, Principal Scientist, DCN)

- Facilities for Utilization of Planetary Mixer and Baking oven were provided to M/s Pr. ARAS Bio-sciences Pvt. Ltd., Bangalore

- Consultancy was offered on "Evaluation of Flavourzyme and Palatase Enyme in Cheese Production" and "Fortification of Omega Fatty Acids in Yoghurt" to strategic Marketing and Research Team, Bangalore.

### Technologies Assessed and Transferred to Farmers

- Location specific feeding technologies
- Low cost feeding module
- Scientific calf rearing practices
- Information system on clean milk production
- Scientific Udder health management practices
- Value added dairy based food products
- An area specific mineral mixture

### Practical Application of the Novel Heatsynch Protocol for Enhancing Fertility in Rural Anestrus/ Repeat Breeding Buffaloes

To study the feasibility of heatsynch protocol application for fertility improvement in buffaloes belonging to farmers' herds, a total of 11 trials were conducted on anestrus buffaloes in villages

## Technology Transferred

### Commercialization of Low Cholesterol Ghee Technology

Low -Cholesterol ghee Control ghee

- NDRI - Karnal has developed a process for preparation of Ghee with reduced level of cholesterol by 75-80%.
- The technology for production of Low Cholesterol Ghee has been transferred to M/s KWALITY DAIRY (India) LIMITED through NRDC, New Delhi.
- The Consideration amount Rs.50 Lac. one time payment and royalty @ 1.5% on the total production/sale of the product for ten years.

of Karnal district in collaboration with the KVK of NDRI. The buffaloes were selected on the basis of being at least six months anestrus or repeat breeders (anestrus or repeat breeding ranging from 6 months to 2 years or more). The animals were treated as per the protocol and inseminated twice. The economics of the protocol was worked out. The cost benefit ratio of the technology was 40 times.

### Institute Technology Management Committee (ITMC)

- Institute Technology Management Committee (ITMC) was constituted as the highest decision making body at the institute level, relating to all issues of IP management and technology transfer, commercialisation. It took various steps to examine and encourage the progress of IPR issues and provided all support to file patent applications and technology transfer. ITMC meetings were held on 10th July, 20th August, 22nd Nov., 2010 and 8th March, 2011.
- Dr. Somenath Ghosh, Chairman & Managing Director, National Research and Development Corporation (NRDC), Delhi delivered lecture on **Intellectual Property Rights**' on 21st December, 2010.
- NDRI and NRDC after prolonged discussion and analysis signed Memorandum of Agreement (MOA) on 21st December, 2010 for facilitating patent filing and technology transfer of IPR generated at NDRI- Karnal.
- One day NDRI-Industry Meet on 1st December, 2010 was organized. In this Meet, more than 25 industries/ Dairy Federations participated. Also, 'NDRI-Britannia Meet' was organized on 16th November, 2010 to discuss possibility of funding from Britannia.

### Patent Applications Approved by ITMC (2010 -11)

The following patentable research was examined by ITMC for their submission to NDRC:

- Development of spore inhibition based enzyme substrate assay (SIB ESA) for monitoring aflatoxin M1 in milk, (Naresh Kumar, Namita Ashish Singh, Vinay Kumar Singh, Sunil Bhand, R. K. Malik).
- Development of Technology for Manufacture of Feta Cheese from Buffalo Milk using Microbial Rennet, (Sanjeev Kumar, S. K. Kanawjia).
- A process of whey utilization for bioethanol production by thermotolerant yeast, (Minakshi Dahiya, Shilpa Vij)
- Method and system for automatic identification and estrus detection in buffaloes based on their vocalization Patterns (Yajuvendra Singh, S. S. Lathwal, T. K. Mohanty, A. P. Ruhil, Shiv Prasad).
- A qualitative and quantitative test for anionic detergent in milk (Amit Kumar Barui, Rajan Sharma and Y. S. Rajput).

# 10 RESEARCH COORDINATION AND MANAGEMENT

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 rew3esearch 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 of research 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 meetings of the Research Advisory Committee of NDRI, Karnal under the chairmanship of Dr. K. Pradhan, Ex-Vice Chancellor, OUA&T, Bhubneshwar and RAU, Bikaner was held on 10th – 11th August, 2010 at NDRI, Karnal. The other Expert members who attended the meetings were Dr. K. M. L. Pathak, DDG (AS) ICAR; Dr. N. Balaraman, Ex-VC, TNVASU, Chennai; Dr. B. S. Bisht, VC, GBPUA&T, Pantnagar; Dr. H. N. Mishra, Head, Post Harvest Technology Centre, IIT, Kharagpur; Dr. Narpinder Singh, Dean, Guru Nanak Dev. University, Amritsar; Dr. A. K. Srivastava, Director, NDRI, Karnal; Dr. S. L. Goswami, Joint Director (Research) and Dr. G. R. Patil, Joint Director (Academic), NDRI, Karnal. All Heads of Divisions also attended the RAC Meeting as special invitees. The committee was apprised of the new initiatives taken during last one year. Action taken report on the recommendations of the previous RAC Meeting was also presented. The Chairman appreciated the growth of NDRI over the years. He pointed out that there is a need to reorient and balance research efforts at the regional stations. The concerted efforts need to be directed on demand driven technology development in a time bound manner.

### 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 16th to 19th August, 7th Sept. and 8th October, 2010 at NDRI, Karnal, SRS, Bangalore and ERS, Kalyani, respectively. The final reports of the completed research projects were discussed at length during the Institute Research Council Meetings held from 24th, 25th, 27th January; 4th March and 10th March, 2011. At these meetings, new proposals for research projects to be initiated from the year 2011 were also considered for approval. Based on the critical reviews at the Divisional level and subsequently at the Institute IRC meetings, certain clear-cut recommendations emerged on each research project, which were documented in the Proceedings of IRC Meetings.

### National Agricultural Innovation Project (NAIP)

National Dairy Research Institute, Karnal is now active centre for executing NAIP projects. There are total **twenty** NAIP projects; for which NDRI is either the lead centre or consortium partner. The total budget outlay is Rs. 34 crore. 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 costs equipments have been procured under this programme. With the availability of sophisticated equipments and budget provisions under recurring head, NDRI has become the preferred place for carrying out basic research. The facilities are being used by scientists and students in purusing 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 are regular features being utilized 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 develop linkages with IITs and CSIR laboratories. During the period under report, CAC Meetings were held on 2nd August, 2010, 24th December, 2010, 22nd January, 2011 and 2nd February, 2011. Also CIC Meetings under NAIP were held on 10th July 2010 and 22nd December, 2010.

## Project Information Management System (PIMS)

The RCM Unit initiated implementation of On-line database/computerization of Research Projects under **PIMS** introduced for the first time in collaboration with IASRI. The unit acted as a nodal agency to facilitate and coordinate with IASRI, New Delhi and PIs of all the On-going and Completed Research Projects at NDRI for taking off and smooth functioning of PIMS activity.

## Database Management

A database of research projects was updated for all the projects in operation during the year 2010. 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 2009-2010** 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 2010 - 2011.** 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 etc. 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 (2010) 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 10 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 no. IV and VIII of 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.

## I. IRC INTERNALLY FUNDED RESEARCH PROJECTS

### A. GENETIC IMPROVEMENT OF MILCH ANIMALS THROUGH IDENTIFICATION AND DISSEMINATION OF SUPERIOR GERMPLASM BY APPLICATION OF EMERGING REPRODUCTIVE AND MOLECULAR TECHNOLOGIES

**A-6 Isolation, culture and characterization of goat embryonic stem cells**. D. Malakar T. K. Mohanty and A. K. Mohanty (2006-2009)

**A-8 Integrated genetic improvement of dairy cattle and buffaloes under open nucleus breeding system.** R. S. Gandhi (2007-2011)

- **Performance evaluation and multiplication of Sahiwal cattle.** R. S. Gandhi, Avtar Singh, A. K. Chakravarty, G. K. Sachdeva, Shiv Prasad and T. K. Mohanty (2007-2011).
- **Performance evaluation and multiplication of Murrah buffaloes**. A. K. Chakravarty, Avtar Singh, R. S. Gandhi, V. S. Raina A. K. Gupta, G. K. Sachdeva and Shiv Prasad (2007-2011).
- **Genetic evaluation and improvement of Friesian crossbred cattle under organized farms and field conditions.** Avtar Singh, R. S. Gandhi, A. K. Chakravarty, V. S. Raina, A. K. Gupta, G. K. Sachdeva, Shiv Prasad, Ashwani Sharma, S. K. Singla and T. K. Mohanty (2007-2011).

**A-9 Cytogenetical and molecular evaluation and mapping of QTLs of milk production and fertility traits in cattle and buffaloes.** B. R. Yadav, Raman Seth, Dheer Singh, A. K. Gupta, T. K. Mohanty, and R. K. Mehla (2007-2010)

**A.18 Structural and functional characterization of IGFBP-5 gene and exploring its role in truncation of lactation in farm animals.** A. K. Mohanty, J. K. Kaushik, T. K. Datta, Dheer Singh and S. K. Das and Sudarshan Kumar (2008-2010)

**A-19 Assessment and prevention of capacitation like changes during cryo-preservation of buffalo spermatozoa.** S. K. Atreja, Dheer Singh and M. S. Chauhan (2008-2010)

**A-20 Gene silencing of aromatase expression in buffalo granulose cells using RNA interference.** Dheer Singh and S. K. Atreja (2008-2010)

**A-21 Characterization of prolactin gene (exon 3 & 4) and its association with production performances in dairy cattle.** D. N. Dass, A. Obi. Reddy and B. Sriniwas (2008-2010)

**A-22 Studies on the effect of oviductal secretary proteins for *in vitro* maturation and fertilization of cattle oocytes.** S. K. Dass, D. K. Sharma, A. K. Mohanty, A. Santra and A. Chatterjee (2008-2010)

**A-23 Evaluation of plasma IGF 1 and other biomarkers for monitoring growth and reproductive health in female KF cattle with probiotic supplementation.** Anand Laxmi, J. P. Sehgal and Shiv Prasad (2009-2011)

**A-24 Buffalo spermatozoa functionality as affected by nanoparticles and carbon nanotubes.** Gautam Kaul, A. K. Gupta, S. K. Tomer and Rajeev Kapila (2009- 2010)

**A-25 Molecular cloning and characterization of buffalo milk xanthine oxidoreductase.** J. K. Kaushik, A. K. Mohanty and D. Malakar (2009-2011)

**A-26 Production of handmade clone transferable goat embryos.** D. Malakar, S. L. Goswami, A. K. Mohanty, S. De and T. K. Mohanty (2009-2011)

**A-27 Molecular characterization and identification of polymorphism in mastitis related genes in Sahiwal, Karan Fries cattle and Murrah buffaloes.** I. D. Gupta, Archana Verma, A. K. Chakravarty and R. S. Gandhi (2010-2014)

**A-28 Molecular cloning and expression of Buffalo Leukemia Inhibitory Factor (LIF) in eukaryotic system.** Sudarshan Kumar, A. K. Mohanty, J. K. Kaushik, D. Malakar and Manoj K. Singh (2010-2012)

**A-29 Expression of apoptosis-related genes in buffalo embryos produced *in vitro* under different oxygen concentrations.** Manoj K. Singh, P. Palta, M. S. Chauhan, R. S. Manik and S. K. Singla (2010-2012)

**A-30 Genetic characterization of HSP70 gene and its association with thermo tolerance and reproductive performance in cattle.** K. P. Ramesha, D. N. Das, Mukund A. Kataktalware, B. Srinivas and A. Obi Reddy (2010 – 2013)

## B. DEVELOPMENT OF STATE-OF-THE-ART DAIRY PRODUCTION SYSTEMS USING BETTER HOUSING AND FERTILITY MANAGEMENT PRACTICES

**B-11 Studies on nutritional, endocrinal and reproductive profiles in lactating Deoni cattle.** B. Sriniwas, A. Obi. Reddy, I. J. Reddy and S. Selva Raju (2007-July, 2010)

**B-12 Modernized dairy production system in dairy cattle and buffaloes for augmenting productive and reproductive performance.** Shiv Prasad, A. K. Tyagi, T. K. Mohanty, M. L. Kamboj, Ravindra Malhotra, and S. S. Lathwal (2006-2010)

- **Development of model dairy unit using state of the art management system for dairy cattle and buffaloes.** Shiv Prasad (2006-2010)
- **Development of feeding management practices for high yielding cattle and buffaloes including automated feed dispensing system.** A. K. Tyagi (2006-2010)
- **Development of computer assisted herd management information system.** T. K. Mohanty (2006-2010)
- **Improved feeding and management of dairy heifers for early sexual maturity and higher productivity.** M. L. Kamboj (2006-2010)

**B-14 Effect of Shatavari on milk production and composition in buffaloes.** R. K. Mehla, Shiv Prasad, S. S. Lathwal, M. L. Kamboj, Mahendra Singh, S. K. Sirohi and R. R. B. Singh (2009-2010)

**B-15 Study of vocalization patterns of Sahiwal cows.** S. S. Lathwal, A. P. Ruhil and T. K. Mohanty (2009-2010)

**B-16 Hormone release and behaviour during milking in Murrah buffaloes** Mahendra Singh, Anjali Agarwal and B. S. Prakash (2009-2010)

**B-17 Quantitation of discomfort level under thermal, exercise and nutritional stresses in goats.** O. K. Hooda, R. C. Upadhyay, S. V. Singh, Ashutosh, S. S. Kundu and Shiv Prasad (2009-2011)

**B-18 Effect of vitamin E supplementation on levels of leptin and insulin hormones and m-RNA transcript expression in indigenous and crossbred cows.** Anjali Aggarwal, Ashutosh, Harjit Kaur, Veena Mani and Neelam Gupta (NBAGR) (2009-2011)

**B-19 Evaluation of Performance of purebred Friesians and their crossbreds under different management conditions**. Mukund A. Kataktalware, A. Obi Reddy and B. Srinivas (2009-2010)

**B-20 Effect of prepartum physiological determinants on the development of fertility disorders in buffaloes.** Sujata Pandita, Madhu Mohihi and Manju Ashutosh (2010-2012)

## C. RAISING PRODUCTIVITY OF DAIRY ANIMALS THROUGH IMPROVED FEEDING STRATEGIES, EFFICIENT NUTRIENT UTILIZATION AND USE OF NON-CONVENTIONAL FEED RESOURCES

**C-3 Yield and quality of Sorghum, Cowpea, Oats and Berseem fodder under organic production system.** A. S. Harika, Harjit Kaur and Chander Datt (2005-2010)

**C-7 Fortification of low-grade roughage based complete feed blocks with ruminal fungal zoospores.** J. P. Sehgal, Aruna Chhabra, Kishan Singh and A. K. Punia (2007-2011)

**C-14 Effect of micronutrients supplementation on immunity, udder health and productive performance of crossbred cows.** Harjit Kaur, Veena Mani, Neelam Kewalramani and A. K. Tyagi (2008-2011)

**C-15 Effect of micronutrient supplementation of induced oxidative stress with toxic heavy metals in relation to immune response and gene expression profile in lactating goats.** Veena Mani, Harjit Kaur, Neelam Kewalramani, Anjali Aggarwal and Neelam Gupta (NBAGR) (2009-2011)

**C-16 Studies on energy and nitrogen release pattern of some commonly available cattle feedstuffs and development of synchrony index.** S. K. Tomer, S. S. Thakur and S. K. Sirohi (2009-2011)

**C-17 Studies on the use of babul pods as natural protein protectant and anti parasitic agent to enhance ruminant productivity.** S. N. Rai and S. S. Chaudhri (CCS, HAU-Karnal) (2009-2011)

**C-18 Evaluation of penta-sulphate and arsenic in alleviating chronic selenosis and the gene expression of seleno-proteins in buffaloes.** Chander Datt, S. S. Kundu and M. Mukesh (NBAGR) (2009-2010)

**C-19 Participatory approach on the effect of various micronutrients on productive performance of dairy animals under field conditions.** Harjit Kaur, S. S. Kundu, A. K. Tyagi, Chander Dutt, D. S. Sohi, Veena Mani and S. V. Singh (2010- 2012)

**C-20 Comparative performance of different fodders sown during post monsoon season.** D. S. Sohi, A. S. Harika and S. K. Tomar (2010-2012)

**C-21 Developing protocol to formulate designer concentrate supplement for synergistic affect on microbial protein production in rumen, nutrient utilization and milk production in cattle.** Bandla Srinivas, Mukund A. Kataktalware and A. Obi Reddy (2010 – 2012)

**C-22 Micro nutrient mapping and their evaluation in improving production and reproductive performance of dairy animals in eastern region of India.** M. K. Ghosh, A. Chatterjee, A. Santra , R. A Dey, Veena Mani and Ajoy Mandal (2010-2012)

**C-23 Evaluation and utilization of brewers spent grain as cattle feed supplement.** A. Santra, M. K. Ghosh, A. Chatterjee, S. K. Dass, A. Mandal and P. Biswas (2010-2012)

**C-24 Nutritional evaluation of some aquatic plants for utilization in ruminant ration.** A. Chatterjee, M. K. Ghosh, A. Santra, P. K. Roy and B. B. Sahu (2010- 2012)

## D. RESEARCH ON NUTRACEUTICALS FROM MILK, FUNCTIONAL FOODS WITH PREBIOTICS, PROBIOTICS, MICRONUTRIENTS, AND OTHER BIOACTIVE COMPOUNDS FOR IMPROVED HUMAN HEALTH

**D-2 Incorporation of selected probiotic bacteria in infant formula.** Latha Sabikhi, D. K. Thompkinson, Suman Kaplia and R. K. Malik (2007-2010)

**D-4 Studies in relation to probiotic effectiveness of certain carbohydrates for development of symbiotic fermented milk product.** R. K. Sharma and A. A. Patel (2007-2010)

**D-5 Development of functional whey drinks for health promotions.** Bikash Chandra Ghosh, Satish Kulkarni and V. Unnikrishnan (2007-2010)

**D-12 Development of functional food ingredients by enzymatic modification of whey proteins.** Bimlesh Mann, R. B. Sangwan, Rajesh Bajaj, Shilpa Vij and Dharm Pal (2007-2010)

**D-13 Immunomodulatory and bone health promoting biofunctional peptides of milk origin.** Suman Kapila, A. K. Dang, Sumit Arora and Rajeev Kapila (2007-2010)

**D-17 Production of antimicrobial bioactive peptides from milk proteins by proteolytic *lactobacillus spp.*** Shilpa Vij, R. K. Malik and Bimlesh Mann (2008-2010)

**D-19 Studies on antioxidant potential of milk-fruit preparations.** Rajesh Kumar, R. B. Sangwan, Bimlesh Mann, Sumit Arora, S. K. Kanawjia and D. S. Sogi (GNDU-Amritsar) (2008-2010)

**D-20 Preparation of protein rich powder from Buffalo colostrums.** Raman Seth, Suman Kapila, Darshan Lal, Vivek Sharma and Y. S. Rajput (2008-2010)

**D-21 Development of fermented buttermilk drinks with enhanced health benefits.** B. Surendra Nath, M. K. Bhavadasan, Chand Ram F. Magdaline Eljeeva Emerald and V. Unnikrishnan (2008-2010)

**D-22 Development of technology for production of symbiotic misti dahi and yoghurt.** Chand Ram, A. K. Singh, Rameshwar Singh and Rajan Sharma (2008-2010)

**D-23 Evaluation of hyper immune properties of milk proteins and their oral tolerance.** Rajeev Kapila, V. K. Kansal, Suman Kapila and Ajay Dang (2009-2011)

**D-24 Formulation of whey based cost effective media for biomass production and preservation of lactobacilli.** Surajit Mandal, Rameshwar Singh, S. K. Tomar, S. K . Kanawjia and Raman Seth (2010-2011)

**D-25 Isolation and characterization of glycomacropeptide from buffalo milk cheese whey.** Rajan Sharma, Y. S. Rajput and Chand Ram (2010-2012)

**D-26 Isolation of antagonistic lactic acid bacteria and their use in extending shelf- life of fermented dairy foods.** S. Varalakshmi, B.V. Balasubramanyam (2010 – 2011)

## E. VALUE ADDITION TO TRADITIONAL MILK PRODUCTS THROUGH APPLICATION OF NEW PROCESSES, BIOTECHNOLOGICAL INERVENTIONS, PACKAGING AND MECHANIZED MANUFACTURING SYSTEM

**E-10 Development of bacteriocin based Anti Microbial Packaging (AMP) system for enhanced food safety.** R. K. Malik, T. Rai, Naresh Kumar and Shilpa Vij (2008-2010)

**E-11 Performance evaluation of thin film SSHE for continuous manufacture of burfi.** A. K. Dodeja, Bikram Kumar and P. S. Minz (2008-2010)

**E-12. Characterization and process standardization for production of Khoa-Jalebi.** C. N. Pagote and K. Jayaraj Rao (2009-2011)

**E-13 Heat and mass transfer phenomena during manufacture of gulabjamun and pantoa.** F. Magdaline Eljeeva Emerald, Menon Rekha Revindra, P. Heartwin Amaladhas, K. Jayaraj Rao and B. Surendera Nath (2009-2011)

**E-14 Quality improvement of set fermented dairy products using ultrafiltration technology.** V. K. Gupta, S. K. Kanawjia, Chand Ram, F. C. Garg and Ganga Sahay Meena (2010-2012)

**E-15 Studies on in-line production of Indian dairy products for commercial exploitation.** P. S. Minz, I. K. Sawhney, Bikram Kumar and R. K. Kohli (2010- 2012)

**E-16 Development, characterization and evaluation of edible films and coatings for selected dairy products.** P. Heartwin Amaladhas, F. Magdaline Eljeeva Emarald, K. Jayaraj Rao, Menon, Rekha Ravindra and B. C.Ghosh (2010 – 2012)

## F. 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

**F-3 A pilot study on development of organic milk production system.** M. L. Kamboj, A. S. Harika, Shiv Prasad, A. K. Tyagi, S. S. Lathwal, Naresh Kumar, Aruna Chhabra and Chander Datt (2007-2011)

**F-10 *In vitro* effects of nitric oxide on peripheral blood lymphocyte functions during lactation in crossbred cattle and its relevance to mastitis.** Manju Ashutosh, Sujata Pandita and Ashutosh (2008-2010)

**F-11 Studies on organic milk production system in the plains of West Bengal.** P. K. Roy, D. K. Sharma, L. Singh, M. Singh, A. Chatterjee and T. K. Mondal (WBUAFS) (2008-2012)

**F-12 Computer aided design and development of pediocin analogs to combat resistance in pathogenic/food spoilage G+ve bacteria.** S. K. Sood, V. K. Kansal and A. K. Mohanty (2009-2010)

**F-13 Isolation, culture and activity of exfoliated mammary epithelial cells from milk of Murrah buffaloes.** A. K. Dang, A. K. Mohanty and Rajeev Kapila **(**Jan**,** 2010 - Dec., 2010)

## G. PROMOTING DAIRY ENTERPRISE THROUGH TRANSFER OF TECHNOLOGIES, IMPROVED FARM FINANCING, SUPPLY CHAIN MANAGEMENT, AND BETTER MARKET ACCESS

**G-7 Prediction of economic traits in Murrah buffaloes – A comparative assessment of connectionist and conventional models.** A. K. Sharma, D. K. Jain, A. K. Chakravarty, Ravinder Malhotra and A. P. Ruhil (2007-2010).

**G-14 Developing location-specific 'package of practices' for balanced feeding: An action research on low-external-input dairying.** S. K. Jha, S. Chinnadurai, Gopal Sankhala, J. P. Sehgal and K. S. Kadian (2007-2010)

**G-17 Value chain analysis of milk in high hills temperate wet zone of Himachal Pradesh.** N. K. Verma, A. K. Chauhan, J. P. Dhaka and B. S. Chandel (2008-2010)

**G-18 Design and validation of information dissemination system for quality milk production.** Jancy Gupta, Shiv Prasad, A. K. Singh, A. P. Ruhil, B. S. Meena and Senttil Kumar R. (2008-2010)

**G-19 Dissemination of recommended calf rearing practices under rural conditions - An action research.** Khazan Singh, Ritu Chakarvarty, D. S. Brar and S. K. Tomer (2008-2010)

**G-21 Economic analysis of manufacrure of dairy products in organized dairies.** P. K. Dixit

B. V. Balasubramanyam, Menon Rekha Ravindra and S. Vijayalakshmi (2008-2010)

**G-22 A profile study on nutraceutical use of milk and milk products in traditional systems in southern states/region.** M. C. A. Devi, S. Vijayalakshmi, K. Jayaraj Rao, Menon Rekha Ravindra and P. Sudheer Babu (KAU Kerala) (2008-2010)

**G-25 Practical application of the novel Heatsynch Protocol for enhancing fertility in rural anestrus/repeat breeding buffaloes.** B. S. Prakash, D. K. Gosain, T. K. Mohanty, Ashutosh and Parveen Kumar (2008-2010)

**G-26 Impact of economic reforms on productivity and viability in a dairy federation.** K. K. Kalra, J. P. Dhaka, B. S. Meena and R. Malhotra (2009-2010)

**G-27 Development and evaluation of e-learning management system (e-LMS) for dairy education.** A. P. Ruhil, D. K. Jain, Rameshwar Singh and R. Malhotra (2009-2010)

**G-28 Farmers' participatory field trials to manage fodder scarcity in rainfed areas.** B. S. Meena, Jancy Gupta, S. S. Kundu, A. S. Harika and Gopal Sankhala (2009-2011)

**G-29 Application of energy monitoring and targeting system in dairy plant.** Menon Rekha Ravindra, Satish Kulkarni, F. Magdaline E. E, P. K. Dixit and Mohan Rao (Rtd. Scientist CSIR) (2009-2011)

**G-30 Performance appraisal of dairy products manufacturing enterprises in India: Spatio-temporal analysis.** Smita Sirohi, A. K. Chauhan, Raka Saxena and J. P. Dhaka (2010-2011)

**G-31 Impact of policy reforms on livelihoods in dairy value chains with special references to small holder producers.** K. K. Datta, Rishikanta Singh Kh, Manoj Ghosh (ERS), Ajoy Mandal (ERS) and P. K. Dixit (SRS) (2010- 2011)

**G-32 Extension strategies for promoting value addition in milk among farming community: An action research.** Gopal Sankhala, A. A. Patel, A. K. Singh, B. S. Meena, K. S. Kadian, Sumit Arora, Ram Kumar and P. N. Raju (2010-2012)

**G-33 Impact of extension activities of NDRI under IRD Project at Pusar and Lalukheri Centre.** Ram Kumar, Khajan Singh, Ritu Chakravarty, K. S. Kadaian, S. K. Jha, Gopal Sankhala, B. S. Meena, R. Senthil Kumar and Jancy Gupta (2010 One year)

**G-34 Feeding resources and their utilization pattern in dairy animals-An explorative study of Karnal District of Haryana.** D. K. Gosain, S. S. Kundu, S. S. Thakur and Gurmeet Singh, Deputy Director (AH) Karnal (2010-2012)

**G-35 Impact analysis of women dairy cooperatives on the economy of rural house holds in Eastern Region of India.** Lotan Singh, R. A. Dey and M. K. Ghosh (2010-2012)

## B. EXTERNALLY FUNDED PROJECTS

### A. GENETIC IMPROVEMENT OF MILCH ANIMALS THROUGH IDENTIFICATION AND DISSEMINATION OF SUPERIOR GERMPLASM BY APPLICATION OF EMERGING REPRODUCTIVE AND MOLECULAR TECHNOLOGIES

1. **Buffalo production and reproduction genomics at NDRI-Karnal (Under Niche Area ICAR)** T. K. Datta (2006-2010)

2. **Network Project on buffalo improvement (CIRB, Hisar-125001 (Haryana) -Network Project** Nodal Officer. R. S. Gandhi (1-4-2007-31-3-2012)

3. **Fertility performance and analysis of *Cyp 19* gene regulation in buffalo) DBT.** Dheer Singh, T. K. Mohanty and M. S. Chauhan (July, 2007 to July, 2010)

4. **Elucidating the physiological and genomic regulation process of follicular development, oocyte maturation and embryogenesis in buffalo – NAIP.** T. K. Datta, S. L. Goswami, Dheer Singh, S. De and T. K. Mohanty (Jan-2008 to March, 2012)

5. **Cloning, expression and functional characterization of a mammary gland protein MGP-40 expressed during mammary gland involution and exploring its potential as a prognostic mammary biomarker in farm animals" DBT.** A. K. Mohanty, J. K. Kaushik, D. Malakar, T. K. Mohanty and A. K. Dang (May, 2008-May, 2011)

6. **Embryo production by ovum pick-up from live cattle – DBT.** M. S. Chauhan, R. S. Manik, Shiv Prasad and M. K. Singh (Sept, 2008-Sept, 2011)

7. **Characterization and differentiation of embryonic, adult and spermatogonial stem cells in cattle and buffaloes-NAIP.** M. S. Chauhan P. Palta, R. S. Manik, S. K. Singla, Dheer Singh, Taruna Anand and S. L. Goswami (July, 2008- March, 2012)

8. **Analysis of mammary gland transcriptome and proteome during lactation and involution in indigenous cattle and buffalo for identification of probable mammary biomarkers-NAIP.** A. K. Mohanty, J. K. Kaushik, D. Malakar, B. S. Prakash, A. K. Dang, V. K. Batish and Sunita Grover (July, 2008- March, 2012)

9. **Molecular basis of capacitation like changes in the assessment and prevention of cryodamage during cryopreservation of bovine spermatozoa (Buffalo and Crossbred Bulls)-NAIP.** S. K. Atreja, Dheer Singh, A. K. Mohanty, V. S. Raina, T. K. Mohanty and Rajiv A. K. Aggarwal (NBAGR) (Jan, 2009- March, 2012)

10. **Genetic basis of inferior sperm quality and fertility of crossbred bulls-NAIP.** S. De, T. K. Datta, A. K. Gupta, T. K. Mohanty and S. K. Das (Jan, 2009- March, 2012)

11. **Developmental potency of parthenogenetic goat embryos- NAIP.** D. Malakar, A. K. Mohanty and J. K. Kaushik (Jan, 2009- March, 2012)

12. **Conservation and multiplication of germplasm of yak (Poephagus grunniens *L.*) and its hybrid using *in vitro* embryo production techniques-DBT.** M. S. Chauhan, R. S. Manik, S. K. Singla and P. Palta (2009-2013)

13. **Bio-prospecting of genes and allele mining for abiotic stress tolerance-NAIP.** R. C. Upadhyay and S. De. (2009-2012)

14. **Value chain on zona free cloned embryos for quality animal production from elite buffaloes and pashmina goats – NAIP.** S. K. Singla, M.S. Chauhan, R. S. Manik, P. Palta, Taruna Anand and Shiv Prasad (2009-2012)

15. **Comparative analysis of epigenetic regulation of the *CYP-19* gene in buffalo and cattle – DST-DFG.** Dheer Singh and M. S. Chauhan (2008-2010)

16. **Molecular characterization of a semi domestic cattle breed of Jammu and Kashmir-SMS, KVK, Doda, SKUAST-Jammu.** S. De (2008-2011)

17. **Application of reverse genetics: A novel approach for studying the molecular basis of immune response in Indian cattle feed-NAIP.** D. N. Dass (2006-2011)

18. **Mechanisms of cholesterol transfer into milk-a comparative gene expression and metabolism study in buffaloes and cattle-DST-DAAD.** B. S. Prakash A. K. Dang and A. K. Mohanty (2009-2011)

## B. DEVELOPMENT OF STATE-OF-THE-ART DAIRY PRODUCTION SYSTEMS USING BETTER HOUSING AND FERTILITY MANAGEMENT PRACTICES

1. **Impact adoption and vulnerability of Indian Agriculture to climate change-Network Project.** R. C. Upadhayay, S. V. Singh, Ashutosh, Harjit Kaur and B. S. Chandel (2004-2012)

2. **Development of wireless sensor network for animal management-NAIP.** T. K. Mohanty, A. P. Ruhil, S. S. Lathwal, D. K. Jain and Shiv Prasad (July, 2008-March, 2012)

3. **Adaption and facilitation of livestock to impending climatic changes through shelter management – Network Project.** R. C. Upadhyay S. V. Singh and Ashutosh, (2009-2012)

4. **Development of plasma catecholamines assays for evaluation of sympathetic neuronal function and milk production performance in heat stressed cows – DAE.** Mahendra Singh and B. S. Prakash (2009-2012)

## C. RAISING PRODUCTIVITY OF DAIRY ANIMALS THROUGH IMPROVED FEEDING STRATEGIES, EFFICIENT NUTRIENT UTILIZATION AND USE OF NON-CONVENTIONAL FEED RESOURCES

1. **Mitigation of methane emission through rumen manipulations for increased productivity in buffaloes-DBT.** S. K. Sirohi, Bhupinder Singh, Madhu Mohini, Dheer Singh and A. K. Punia (Oct., 2006- Oct., 2010)

2. **Rumen microbial manipulations for mitigation of methane emission and productivity enhancement in dairy animals-**

**NFBSRA.** S. K. Sirohi, L. C. Chaudhary (IVRI), M. Chandrasekharaiah (NIANP, Bangalore) and A. Santra (2007- 2012)

3. **Uncertainty reduction in methane and nitrous oxide emission from Indian Livestock- NATCOM.** Madhu Mohini, K. K. Singhal, A. K. Tyagi and K. S. N. Prasad (2008-2010)

4. **Rumen microbial diversity in domesticated and wild ruminants and impact of additives on methanogenesis and utilization of poor quality fibrous feeds- NAIP.** S. K. Sirohi (30th July, 2008 to March, 2012)

## D. RESEARCH ON NUTRACEUTICALS FROM MILK, FUNCTIONAL FOODS WITH PREBIOTICS, PROBIOTICS, MICRONUTRIENTS, AND OTHER BIOACTIVE COMPOUNDS FOR IMPROVED HUMAN HEALTH

1. **Energetics and dynamics of protein stability and iron binding properties and their modulation by domain-domain interactions in lactoferrins from various animal species-DBT.** J. K. Kaushik, A. K. Mohanty and Sunita Grover (2007-2010)

## E. VALUE ADDITION TO TRADITIONAL MILK PRODUCTS THROUGH APPLICATION OF NEW PROCESSES, BIOTECHNOLOGIAL INERVENTIONS, PACKAGING AND MECHANIZED MANUFACTURING SYSTEM

1. **Network project on R&D support for process upgradation of indigenous milk products for industrial application.** G. R Patil (NDRI) and Satish Kulkarni (SRS) A. A. Patel, R. R. B. Singh, I. K. Sawhney, A. K. Dodeja, N. K. Goel, Chander Datt, V. Unnikrishnan, M. K. Bhavadasan, N. N. Balasubramanya, B. Surendranath, B. V. Balasubramanyam, B. C. Ghosh, K. Jayaraj Rao, Rekha R. Menon and R. K. Sharma (1999-2012)

2. **Technology for Plant and Dairy Ingredients based formulated and Functional Foods using Extrusion Technology under Indo-US Agricultural Knowledge Initiative (AKI)** A. K. Singh (2008-2010)

3. **Novel approaches for the production of nutraceuticles from milk and Indian herbs for potential use in functional dairy foods-NAIP.** R. R. B. Singh, A. A. Patel, A. K. Tyagi, S. K. Tomer, Rajesh Kumar, A. K. Singh, J. K. Kaushik, Suman Kapila and Sumit Arora (Jan, 2009- March, 2012)

4. **A value chain on composite dairy foods with enhanced health attributes by ICAR under NAIP.** A. K. Singh and A. A. Patel (2009-2012)

## F. 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

1. **Development of biosensors and micro-techniques for analysis of pesticide residues aflatoxin, heavy metals and bacterial contamination in milk – NAIP.** Naresh K. Goel (NDRI Consortium Partner) and R. K. Malik (Jan. 2008 to March, 2012)

2. **Detection and mitigation of dairy pathogens and detection of adulterants using chemical biology – NAIP.** Y. S. Rajput, Rajan Sharma and Naresh Goel (Jan. 2009 to March, 2012)

3. **Monitoring of drug residues and other environmental pollutants – Out Reach Project.** N. K. Goel and Raghu, H.V. (2008-2012)

## G. PROMOTING DAIRY ENTERPRISE THROUGH TRANSFER OF TECHNOLOGIES, IMPROVED FARM FINANCING, SUPPLY CHAIN MANAGEMENT, AND BETTER MARKET ACCESS

1. **Visioning policy analysis and gender (V-PAGe) under the NAIP.** Director, NDRI-Karnal and B. S. Chandel (Jan. 2008 to March, 2012)

2. **AGROWEB-Digital dissemination system for Indian agricultural research (ADDSIAR)-NAIP.** D. K. Jain, Rameshwar Singh, A. K. Chakravarty, Ravinder Malhotra, A. K. Sharma and A. P. Ruhil (2008-2010)

3. **Development of e-courses for B. Tech (Dairy Technology) degree programme – NAIP.** A. A. Patel and Vijay Kumar (2009-2012)

4. **Enabling activities for preparation of India's second National Communication to UNFCC-UNDP** R. C. Upadhyay, S. V. Singh, Ashutosh and K. K. Datta **(**Dec, 2009-2010)

# 11 HUMAN RESOURCE DEVELOPMENT

## Scientists/Officers/Scholars Trained Abroad

**Dr. A. K. Srivastava,** Director & Vice Chancellor NDRI attended the General Board Meeting of the Erasmus Mundus Masters Programme SE FOTECH. NUT **"Masters of Science in Food Science, Technology and Nutrition"** at KaHo Sint – Lieven, Gebroeders Desmetstraat 1,9000 Gent, Belgium from 18th to 23rd May, 2010.

**Dr. Rajan Sharma**, Senior Scientist, Dairy Chemistry Division was deputed for training on **Lateral Flow Separation of Aptamer Linked Nanostructures** under NAIP Project entitled "**Detection and Mitigation of Dairy Pathogens and Detection of Adulterants using Chemical Biology"** at University of Illinois, Urbana-Champaign, USA from 10th March, 2010 to 8th May, 2010.

**Dr. A. K. Puniya,** Principal Scientist, Dairy Microbiology Division, visited Taiwan, under – Exposure visit to scientific laboratories/ institutions in advanced countries in frame of plan scheme **"National Programme for Training of Scientists and Technologists Working in Government Sector"** of Department of Science and Technology, New Delhi from 29th May to 6th June, 2010.

**Dr. A. K. Singh**, Sr. Scientist, Dairy Technology Division was deputed to avail Eramus Mundus Scholarship on the subject "Food Science Technology and Nutrition" at Belgium, Ireland & Germany from 14th Feb., to 14th May, 2010.

**Dr. J. K. Kaushik,** Sr. Scientist, Animal Biotechnology Centre was deputed for training on "Proteomics under NAIP Project" at USA from 30th March to 12th April, 2010.

**Dr. (Mrs.) Suman Kapila**, Sr. Scientist, Animal Biochemistry Division was deputed for training on "Nutraceuticals under NAIP - HRD Programme" from 31st March to 30th June, 2010 at USA.

**Dr. R. K. Malik,** Principal Scientist, Dairy Microbiology Division visited Federal Research Centre for Nutrition and Food Science, Kalsruhe, Germany for 45 days (1st July to 14th Aug., 2010) under German Academic Exchange Service (DAAD) Re-invitation programme.

**Dr. A. Kumaresan,** Sr. Scientist, Cattle Yard was deputed to avail DST's BOYSCAST fellowship programme in the area "Reproduction Technology" at Swedish University of Agri. Sciences, Sweeden for a period of one year from 6th April to 31st March, 2011.

**Dr. R. R. B. Singh,** Principal Scientist, Dairy Technology Division attended ISEKI Mundus 2 and ISEKI Food 3 projects 2nd overall meeting for 3 days at Wageningen, the Netherlands from 7th – 9th June, 2010.

**Dr. A. K. Mohanty,** Sr. Scientist Animal Biotechnology Centre visited Germany under DST/DAAD Programme from 21st April to 14th May, 2010.

**Dr. A. K. Tyagi,** Principal Scientist, Dairy Cattle Nutrition Division participated in 9th World Buffalo Congress at Argentine from 23rd April to 1st May, 2010.

**Dr. M. S. Chauhan,** Principal Scientist, Animal Biotechnology Centre availed training in "Technique GFP/DNA transfection into stem cells, nuclear transfer cloning and embryo production" at USA from 28th April to 27th May, 2010.

**Dr. Dheer Singh,** Sr. Scientist, Animal Biochemistry Division attended joint Indo German Project entitled "Comparative analysis of epigenetic regulation of the *Cyp 19* gene in buffalo and cattle jointly (by DST-DFG) at Germany from 28th June to 18th July, 2010.

**Dr. Latha Sabikhi,** Sr. Scientist, Dairy Technology Division was deputed to undertake Training in the area of Probiotics under the NAIP from 25th August to 23rd October, 2010 at the South Dakota State University, USA.

**Dr. S. K. Sirohi,** Sr. Scientist, Dairy Cattle Nutrition Division was depulted to participate in 4th International Conference on Animal Nutrition (ICAN 2010) at Malaysia from 21st – 23rd Sept., 2010.

**Dr. B. C. Ghosh,** Principal Scientist, SRS, Bangalore availed Australian Endeavour Executive Award at Victoria University, Melbourne, Australia.

**Dr. Rajesh Kumar**, Sr. Scientist, Dairy Chemistry Division visited Dublin Institute of technology, Ireland as Visiting Professor under Erasmus Mundus programme for teaching and research guidance to the International students of European

Masters Degree in Food Science and Nutrition from 14th Feb. to 25th March, 2011.

**Dr. Sumit Arora,** Sr. Scientist, Dairy Chemistry Division got training in the area of "Application of extrusion technology for composite dairy foods" under NAIP from 25th February to 26th March, 2011 in University of Georgia, Athens, USA.

**Dr. R. R. B. Singh,** Principal Scientist, Dairy Technology Division proceeded to USA for the period 25th Feb., to 26th March, 2011 to avail training in the area of "Complementary food based on whey-cereal blend" under NAIP.

**Dr. Sudhir Kumar Tomar,** Sr. Scientist, Dairy Microbiology Division proceeded to Germany/Ireland/ Belgium for 6 weeks from 7th March to 15th April, 2011 to avail Erasmus Mundus Scholarship as a visiting scholar for teaching and research on topics: Dairy Science and Food Biotechnology.

**Dr. B. S. Prakash,** Head, Dairy Cattle Physiology Division attended the DST DAAD (German Academic Exchange Service) under Joint Research Project entitled "Mechanisms of Cholesterol Transfer into Milk-a Comparative Gene Expression and Metabolism Study in Buffaloes and Cattle" from 22nd – 31st March, 2011 at Germany.

## Training Imparted

**Mr. Anthony Martin Callaghan**, a Ph.D. scholar from Institute of Biological, Environmental and Rural sciences, Aberystwyth University, UK, was imparted a short training of two weeks starting from 26th June to 9th July, 2010 on 'Isolation and Characterization of Rumen Fungi' under the supervision of Dr. A. K. Puniya, Principal Scientist.

*Mr. Anthony M. Callaghan with faculty and students of Dairy Microbiology Division*

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

| Name & Designation | Title of Workshops /Seminars /Conferences Training | Period |
|---|---|---|
| Dr. C. J. Juneja T.O. | Two days Honey Mela-Cum-Seminar on Bee Keeping held at HAIC Agro Research and Development Centre, Murthal, Sonepat. | 2nd -3rd April, 2010 |
| Dr. (Mrs.) Latha Sabikhi, Sr. Sci. | Institute Industry Workshop on "Food Science Education & Research" at BHU, Varanasi. | 7th April, 2010 |
| Sh. I. K. Sawhney, PS | 12th National Science Seminar on "Sustainable Agricultural Production and Preservation" at CSSRI, Karnal. | 22nd -24th April, 2010 |
| Dr. D. K Gosain Sr. Sci.<br>Sh. Kulvir Singh, T.O. | KVKs Interface Meeting at NASC, New Delhi. | 26th -27th April, 2010 |
| Dr.(Ms) Sunita Grover, PS | Symposia on "Recent Developments in Health, Food and Nutrition" by ILSI-India at Hotel Le Meridien, New Delhi. | 30th April, 2010 |
| Dr. Ravinder Malhotra, PS<br>Dr. A. K. Chauhan, PS<br>Dr. Rishi Kanta Singh, Sci. | Orientation Training Programme on "Unit Level Data of NSS" at New Delhi. | 4th – 5th May, 2010 |
| Dr. A.K. Sharma, Sr. Sci. | 2nd International Conference on "Innovative Practices in Management and Information Technology for Excellence – SRIJAN'10" at Jagadhri. | 8th May, 2010 |
| Dr.(Mrs.) Jancy Gupta, Head | National Seminar and Exhibition on "Dairy Farming and Dairy Based Enterprise" at Kozhikode, Kerala. | 15th – 16th May, 2010 |

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| Dr. R. K. Malik, PS<br>Dr. Kaushik Khamrui, Sr. Sci.,<br>Dr. (Ms) Raka Saxena, Sr. Sci.<br>Sh. Asif Mohammad, Sci.<br>Dr. A. Maniamaran, Sci.<br>Sh.G. S. Meena, Sci.<br>Sh.Narender Raju Panjagiri, Sci.<br>Sh. Raghu H.V. Sci.<br>Dr. S. Subhash, Sci.<br>(Ms) Sellam P., Sci.<br>Mrs. Udita Sheokand, Sci.<br>Sh. Yogesh Khetra, Sci. | International Conference on "Dairy Industry: PPP for Inclusive Growth" at New Delhi. | 14th May, 2010 |
| Dr. A. K. Sharma, Sr. Sci. | International Conference on "Upcoming Trade in IT 2010" at PSET, Ludhiana. | 21st May, 2010 |
| Dr. P. Heartwin Amaladhas, Sci. (SS) | Seminar on "Microcalorimetry" organized at TA Instruments, Bangalore. | 23rd June, 2010 |
| Dr. D. K. Gosain, Sr. Sci.<br>Dr. S. K. Gupta, T.O.<br>Mrs. Saroj Mehta, T.O.<br>Sh. R. Dayal, T.O. | Two days training programme on E-extension organized at KVK, NDRI, Karnal by Zonal Coordinator ICAR. | 8th – 9th July, 2010 |
| Dr. R. S. Gandhi, Head<br>Dr. K. K. Datta, Head | Management Development Programme on "Leadership for Innovation in Agriculture" at NAARM, Hyderabad. | 19th – 23rd July, 2010 |
| Dr. C. J. Juneja, T.O. | One day National Seminar on "Scientific Bee Keeping and Quality Management of Honey" at Horticulture Training Institute, Uchani, Karnal. | 24th July, 2010 |
| Mrs. T. R. Thivija Kumari, T.O. | TOLIC Meeting at CPRI, Bangalore. | 28th July, 2010 |
| Sh. Mohar Singh, T.O.<br>Sh. Kulvir Singh, T.O. | "Training cum Workshop on Oil Seed and Pulses" at KVK Sirsa. | 7th -8th August, 2010 |
| Dr. R. S. Gandhi, Head | 9th Scientists meet of AICRP on Cattle and to Present Report of Project at SVV University Tirupati. | 20th – 21st August, 2010 |
| Dr. A. K. Dodeja, Head<br>Sh. I. K. Sawhney, PS<br>Dr. S. Kulkarni, PS<br>Dr. C.N. Pagote, PS<br>Dr. B. Surendranath, PS<br>Dr. B. C. Ghosh, PS<br>Dr. B. V. Balasubramanyam, PS<br>Dr. K. Jayaraj Rao, Sr Sci,<br>Dr. P. Heartwin Amaladhas, Sci. (SS)<br>Ms.. F. Magadaline, E Emerald, Sci. (SS)<br>Dr. Rekha Ravindra Menon, Sci. (SS)<br>Ms. Sellam P. Sci.<br>Mr. P. Aravindakshan, T.O.<br>Sh.. Sarwar, T.O.<br>Ms. M.A. Usha, T.O.<br>Ms. M.K. Vedavathi, T.O.<br>Ms. Vimala, T.O. | National Conference on "Green Technologies in Dairy and Food Processing Industries" organized by IDEA at Bangalore. | 27th – 28th August, 2010 |
| Dr. Mukund A. Kataktalware, Sci. (SS) | DST Sponsored Training Programme on "Climate Change and Carbon Mitigation" at Indian Council of Forestry Research and Education, Dehradun. | 6th – 10th Sept., 2010 |
| Dr. B. S. Chandel, PS | MDP on "PME of Agri. Research and Development Projects" at NIRD, Hyderabad. | 6th – 10th Sept., 2010 |

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| Dr. A.K. Sharma<br>Sr. Sci. | UGC Sponsored Two-Day National Seminar on "Prospects of IT: 2020" at Hindu Girls College, Jagadhri. | 14th – 15th Sept., 2010 |
| Sh. Ganga Sahay Meena, Sci.<br>Sh. Raghu H. Sci. | Summer School on "Food Safety and Quality for Global Competitiveness of Traditional Foods of India" at BHU, Varanasi. | 15th Sept. to 5th Oct., 2010 |
| Dr. S. Subash, Sci. | Workshop on "Rural e-Governance (RReG) for Evolving Citizen – Centric Rural e-Governance Framework" at IIPA, New Delhi. | 16th – 17th Sept., 2010 |
| Dr. Kaushik Khamrui, Sr. Sci. | 7th "National Dairy Product Judging Contest" and 3rd "Dairy & Food Quiz Contest-2010" at AAU, Anand. | 17th – 18th Sept., 2010 |
| Dr. Ashutosh, Sr. Sci. | National Security and Strategic Contexts at NIAS, Bangalore. | 20th – 24th Sept., 2010 |
| Dr. R. C. Upadhyay, PS<br>Dr. Sohan Vir Singh, Sr. Sci.<br>Dr. Ashutosh, Sr. Sci. | NPCC Annual Workshop at Anand Agricultural University, Anand. | 21st– 23rd Sept., 2010 |
| Dr. A. K. Mohanty, Sr. Sci. | Workshop on "Synthetic and Wral Passed System for Gene Slilencing" at Hyderabad. | 23rd - 24th Sept., 2010 |
| Dr. A. K. Sharma, Sr. Sci. | 2nd National Seminar on "Application and Trends in Data Warehousing, Data Mining and Data Modeling" at Patiala. | 24th – 25th Sept., 2010 |
| Sh. Mohar Singh, T.O. | Multi Stake Holder Travelling Seminar on "Direct Seeded Rice" organized by CSISA, Karnal. | 25th Sept., 2010 |
| Dr. Dalip K Gosain, Sr. Sci.<br>Mr. Kulvir Singh, T.O. | Brain storming for New Extension Approaches of KVK at CCS,HAU, Hissar | 29th -30th Sept., 2010 |
| Dr.(Ms) Raka Saxena, Sr. Sci | Meeting of "Technical Committee of Dairying Statistics" at Agartala – Tripura. | 4th – 5th Oct., 2010 |
| Dr. Shiv Prasad, PS | MDP on "Leadership for Innovation in Agriculture" under NAIP at IIM Lucknow. | 4th – 8th Oct., 2010 |
| Dr. R. S. Gandhi, Head<br>Dr. G. K. Sachdeva, PS | National Symposium on "Conventional and Modern Breeding Technologies for Genetic Improvement of Livestock and Poultry in India" at GBPUA&T, Pantnagar. | 22nd – 23rd Oct., 2010 |
| Dr. Menon Rekha Ravindra, Sci. (SS)<br>Ms.. F. Magdaline Eljeeva Emerald, Sci. (SS) | Seminar on "Novel Functional Foods - 2010 at Brindavan College, Bangalore | 29th Oct., 2010 |
| Dr. Dalip K Gosain, Sr. Sci. | Round Table Meet at Library Hall, IARI, Pusa Institute, New Delhi. | 30th Oct., 2010 |
| Dr. Dalip K Gosain, Sr. Sci.<br>Mr. Kulvir Singh. T.O. | Two days National Consultation on "Future Approaches in Agriculture Extension" at NASC Complex, New Delhi. | 1st– 2nd Nov., 2010 |
| Dr. D. K. Jain, I/c<br>Dr. A.K. Sharma, Sr. Sci.<br>Dr. A. P. Ruhil, Sr. Sci. | Interactive Meet on "Information and Communication Technology" at ICAR, New Delhi. | 3rd– 4th Nov., 2010 |
| Dr. Mahender Singh, PS | International Conference on "Physiological Capacity Building in Livestock under Changing Climate Scenario" at IVRI, Barelley. | 11th – 13th Nov., 2010 |
| Dr. S. S. Kundu, Head | National Symposium on "Optimizing Forage Production from Arable and Non-arable Lands for Increasing Livestock Production" at IGFRI, Jhansi. | 12th – 14th Nov., 2010 |
| Dr. A. P. Ruhil, Sr. Sci.<br>Dr. Meena Malik, Asstt. Prof. | Sensitization-cum-Training Workshop for the Nodal Officers of PIMS, ICAR at IASRI, New Delhi. | 15th Nov., 2010 |

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| Dr. K. K. Datta, Head<br>Dr. P. K. Dixit, PS<br>Mrs. Udita Choudhary, Sci. | 18th Annual AERA Conference "Value Chains of Agricultural Commodities and their Role in Food Security and Poverty Alleviation" at NAARM, Hyderabad. | 17th - 21st Nov., 2010 |
| Dr. D. K. Jain, I/c<br>Dr. A. P. Ruhil Sr. Sci.<br>Dr. A.K. Sharma, Sr. Sci. | Partners' Meet for "National Agricultural Bioinformatics Grid" sub-project under the NAIP (Component–I) at NBAGR, Karnal. | 19th Nov., 2010 |
| Dr. Shiv Prasad, PS | Consultation Meeting on "Abiotic Stress Management of Animal Sciences" at Baramati, Maharashtra. | 19th - 20th Nov., 2010 |
| Dr. Shiv Prasad, PS<br>Dr. A. Manimaran, Sci. | 2nd Biennial International Conference on "New Developments in Drug Discovery from Natural Products and Traditional Medicines" at NIPER, Mohalli. | 20th – 24th Nov., 2010 |
| Dr. V. K. Kansal, Head | To present NDRI technology "Probiotic Dahi for Cardiovascular Health, Protection against Cancer and Improvement of Immunity" in i3 National Fair at IIT, New Delhi. | 22nd Nov., 2010 |
| Dr. Rameshwar Singh, Head<br>Dr. R. K. Malik, PS | 4th India Probiotics Symposium on "Health Impact of Probiotics – Vision and Opportunities" at Mumbai. | 27th – 28th Nov., 2010 |
| Dr. Satish Kulkarni, PS<br>Dr. B. Surendra Nath, PS<br>Dr. S. Varalakshmi, Sci. (SS) | National Conference on "Novel Functional Foods 2010" organised by Swedish South Asian Network on Fermented Foods at Bangalore. | 29th Nov., 2010 |
| Dr. K. K. Datta, Head<br>Dr. B. S. Chandel, PS | 70th Annual Conference of ISAE on the theme "Hill Agriculture, Conservation Agriculture, Global Meltdown and its Impact on Agriculture" at Jammu University Jammu. | 29th Nov. to 1st Dec., 2010 |
| Dr. M.C.A. Devi, Sr. Sci.<br>Ms. F. Magadaline, E Emerald, Sci. (SS)<br>Dr. Rekha Ravindra Menon, Sci. (SS)<br>Dr. S. Varalakshmi, Sci. (SS) | Winter School on " Nutraceuticals - Opportunities and Challenges in 21st Century" at University of Agricultural Sciences, Bangalore. | 29th Nov. to 19th Dec., 2010 |
| Dr. Meena Malik, Asstt. Prof. | National Seminar on "Feminism in Indian Literature" at Guru Nanak College, Yamuna Nagar. | 1st – 2nd Dec., 2010 |
| Dr. Narender Raju P., Sci. | International Conference on "Traditional Foods (ICTF-2010) by AFSI" Pondicherry University, Pondicherry. | 1st – 3rd Dec., 2010 |
| Dr. D. K. Jain, PS | National Seminar on "Statistics and Information for Massive Data Sets" at BCKV, Kalyani. | 3rd – 5th Dec., 2010 |
| Sh. A. Goswami, T.O., ERS, Kalyani | Training Programme on "Science & Technology for Rural Societies" at Centre for Disaster Management, LBSNAA, Mussoorie. | 6th – 17th Dec., 2010 |
| Ms. K. Geetha Kumar, T.O.<br>Ms. Janakshi, T-4 | Training Programme on "Research Methodology, Data Management and Biostatistics – using Web Page Statistical Software" at NIANP, Bangalore | 10th – 11th Dec., 2010 |
| Dr. Satish Kulkarni, Head<br>Dr. B. Surendra Nath, PS | The Great Indian Ice cream Contest organisd by Danisco (India) Pvt. Ltd and Indian Dairy Association at New Delhi. | 12th Dec., 2010 |
| Dr. Rameshwar Singh, Head<br>Dr. S. S. Kundu, Head<br>Dr.(Mrs.) Harjit Kaur, PS<br>Dr. J. P. Sehgal, PS<br>Dr.(Mrs.) Veena Mani, PS<br>Dr. S. N. Rai, PS<br>Dr. A. K Tyagi, PS<br>Dr. A. K. Puniya, PS<br>Dr. Dheer Singh, Sr. Sci.<br>Dr. Chander Dutt, Sr. Sci.<br>Dr. M.K. Ghosh, Sr. Sci., ERS<br>Dr. A. Chattarjee, Sr. Sci., ERS<br>Dr. A. Santra, Sr. Sci., ERS | 7th Biennial ANA Conference on "Animal Nutrition for Environment Production and Poverty Alleviations" at Bhubneshwar (Orissa). | 17th – 19th Dec., 2010 |

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| Dr. B. S. Prakash, Head | Regional Conference on "Global Warming and Future of Domestic Animal Wealth of India Ban Islands" at Gosaba Island, Sunder Ban (W. Bengal). | 19th – 21st Dec., 2010 |
| Dr. Dalip K Gosain, Sr. Sci.,<br>Dr. C.J. Juneja, T.O.<br>Mr. Kulvir Singh, T.O. | Fifth National Conference on KVKs held at Maharana Partap University of Agriculture and Technology, Udaipur (Rajasthan). | 22nd - 24th Dec., 2010 |
| Dr. A. K. Sharma, Sr. Sci.,<br>Mr. Jai Pal, T-4 | Sensitization cum Training Workshop for Nodal Officers of National Information System on Agricultural Education Network in India (NISAGENET) IASRI, New Delhi. | 27th – 28th Dec., 2010 |
| Dr. M. C. A. Devi, Sr. Sci. | International Conference on "Ethno Veterinary Practices at Thanjavur, Tamilnadu. | 4th – 6th January, 2011 |
| Dr. P. Heartwin Amaladhas, Sci. (SS)<br>Ms. F. Magdaline Eljeeva Emerald, Sci. (SS) | Workshop on "Research Methodology, Data Management and Biostatistics" at NIANP, Bangalore. | 8th – 9th January, 2011 |
| Dr. S. S. Kundu, Head | Management Development Programme on "Leadership for Innovation in Agriculture" at IIM, Lucknow. | 10th – 14th January, 2011 |
| Dr. R. S. Gandhi, Head<br>Dr. Ajoy Mandal, Sr. Sci, ERS, Kalyani | 11th "Annual Convention of ISAG&B" and National Conference on "New Horizons in Animal Breeding Technologies for Accelerating Livestock Production and Health" at IVRI, Izatnagar. | 20th – 21st January, 2011 |
| Dr. S. Subash, Sci.<br>Dr. R. Santhil Kumar, Sci. | Winter School on "Livestock Business and Market Intelligence" at TANUVAS, Chennai. | 28th January to 17th Feb., 2011 |
| Dr. K. P. Ramesha, PS | Training Programme on "Technology Valorization & Management" at ASCI, Hyderabad. | 31st January to 11th Feb., 2011 |
| Dr. A. K. Sharma, Sr. Sci. | Silver Jubilee Symposium on "BTISNET in India (1986-2011)" Pondicherry University, Pondicherry. | 2nd Feb., 2011 |
| Dr. A. K. Sharma, Sr. Sci. | 22nd Annual BTIS Net Coordinators Meeting Pondicherry University, Pondicherry under the aegis of the Department of Bio-Technology (DBT), Government of India, New Delhi. | 3rd - 4th Feb., 2011 |
| Dr. S.K. Kanowjia, PS<br>Dr. R. K. Malik, PS<br>Dr. Meena Malik, Asstt. Prof.<br>Mr. A. K. Sharma, DS<br>Mr. U. C. Govil | 39th Dairy Industry Conference on "Dairying Path to Sustainability" organized by IDA (EZ) at Kolkatta. | 4th - 6th Feb., 2011 |
| Dr. S. K. Tomar, Sr. Sci | Workshop on "Food Safety of Animal Source Foods" by ILRI at ILRI New Delhi. | 8th Feb., 2011 |
| Dr. Meena Malik, Asstt. Prof. | National Seminar on "Commitment in Post Colonial Literature and Theory" at Dyal Singh College, Karnal. | 11th – 12th Feb., 2011 |
| Dr. Ajoy Mandal, Sr. Sci, ERS, Kalyani | 8th "Annual Convention of SOCDAB" and National Symposium on "Animal Genetic Resources for Sustainable Livestock Sector in India" at Bhubnashwar. | 18th – 19th Feb., 2011 |
| Dr. A. K. Puniya, PS | 3rd Annual Conference on "Recent Advances in Chemical and Environmental Sciences (RACES-2011)" at MMM College, Patiala. | 28th Feb., to 1st March, 2011 |
| Dr. K. S. Kadian, Sr. Sci | International Conference on "Tropical Island Ecosystems: Issues Related to Livestock, Sustainable Development and Climate Change" at CARI, Port Blair. | 23rd – 26th March, 2011 |

# 12 CONFERENCES/ SEMINARS/ SYMPOSIA/ WORKSHOPS/ TRAINING PROGRAMMES/ FIELD DAYS ORGANISED

During the past one-year (April 2010-March 2011), 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:

| | |
|---|---|
| One Day Sensitization Workshop on "Content Management for E-Learning System using Moodle" under Project Management System | 26th April, 2010 |
| World Veterinary Day, 2010 Celebrations | 27th April, 2010 |
| Second Entrepreneurship Development Programme | 17th - 26th May 2010 |
| Vacation Programme on "Bio-Resources" (VPBR-2010) | 31st May, 2010 |
| World Milk Day | 1st June, 2010. |
| Conference on "Science and Spirituality for Balanced Growth of India" | 17th June 2010 |
| Training Programme for "Online Access of Journal (CeRA)" at NDRI | 9th June, 2010 |
| Short Course on "Technological and Engineering Aspects of Dairy Processing" for 19 professional of M/s Nestle India Ltd. | 21st - 26th June, 2010 |
| Focus Group Discussion on "Manpower Planning in Indian Dairy Sector" | 5th July, 2010 |
| Training cum Workshop on "E-linkage of KVKs" | 8th - 9th July, 2010 |
| Consultancy Training Programme on "Starter Cultures and Fermented Milk Products" | 12th-16th July, 2010. |
| Training Programme on "Manufacturing of Ice-Cream" by TBI | 24th - 29thJuly, 2010 |
| Agropedia Workshop | 31st July, 2010 |
| Training Programme on "SAS: A Comprehensive Overview" | 2nd August to 8th Sept., 2010 |
| Training Programmes for Farmers | 16th - 20th August, 2010 |
| Meeting on "Updation of the Nutrient Requirement for Different Classes of Livestock and Nutritive Value of Indian Feeds" | 11th August, 2010 |
| Invited Lecture Series under the Aegis of Nutrition Scientist Forum | 11th August, 2010 |
| TBI Training Programme on "Commercial Dairy Farming" | 25th August to 3rd September, 2010 |
| Seminar on "Regulatory Status: Issues and Challenges for Food Beverages" at SRS, NDRI | 6th September, 2010 |
| Brainstorming Session on "Haryana Livestock and Dairy Sector: Present Status and Future Road Map" | 9th September, 2010 |
| National Seminar on "Indian Dairy and Food Industry – Future Roadmap for Sustainable Growth" | 25th September 2010 |
| National Symposium on "Climate Change & Livestock Productivity in India" | 7th and 8th October, 2010 |
| Training Programme on "Laboratory Testing and Product Manufacturing" | 11th - 14th October, 2010 |
| National Training by Foreign Experts under NAIP on "Hands on Stem Cell Culture for Quality Animal Production" | 11th - 20th October 2010 |
| Six days training programme on "Data Analysis using SAS" | 25th - 31st October, 2010 |
| National Convention on "Zoonotic Diseases : Present Status and Future Roadmap" | 30th October 2010 |
| Winter School on "Impact, Vulnerability and Adaptation of Indian Livestock to Impending Climatic Changes" | 9th - 29th Nov., 2010 |
| Winter School on "Dairy Entrepreneurship Development" | 10th - 30th Nov., 2010 |
| Second Meeting and Brain Storming of National Core Group on "Probiotics" | 15th Nov., 2010 |
| NDRI - Britannia Industries Meet | 18th Nov., 2010 |
| Winter School on "Advances in Dairy Production Management for Precise Output in Relation to Environment and Trade" | 22nd November to 14th Dec., 2010 |

| | |
|---|---|
| NDRI-Industry Meet | 1st Dec., 2010 |
| All India Dairy Husbandry Officers' Workshop-2010 | 3rd – 4th Dec., 2010 |
| Winter School on "Data Mining Techniques for Farm Animal Management" | 8th-28th Dec., 2010 |
| Invited Lecture on IPR | 21st Dec., 2010 |
| Training programme on "Data Analysis using SAS" | 10th - 15th Jan., 2011 |
| Winter School on "Chemical Analysis of Value Added Dairy Products and their Quality Assurance" | 11th - 31st January, 2011 |
| Brainstorming session "Promotion of Indigenous Dairy Products in International Market" | 22nd January, 2011 |
| Training Programme on "Data Analysis using SAS" | 24th - 31st January, 2011 |
| Annual Workshop for NAIP Component for review of 22 NAIP projects in Frontier Areas of Animal Sciences | 4th February, 2011 |
| International Conference on "Frontiers in Reproductive Biotechnology" | 9th - 11th February 2011 |
| Dr. D. Sundaresan Memorial Lecture | 17th February., 2011 |
| Ninth Convocation of NDRI Deemed University | 19th February., 2011 |
| National Science Day | 28th February, 2011 |
| Refresher's Training on "Procurement and Financial Management" under NAIP | 26th - 28th February, 2011 |
| Winter School on "Technological Advances in Novel Dairy Foods" | 1st - 21st March, 2011 |
| National Training Programme on "Intellectual Property Rights" at SRS, Bangalore | 9th - 18th March, 2011 |
| National Training Program on "Databases and Softwares for Analysis of Animal Genetic and Breeding Data" | 10th-30th March, 2011 |
| National Training Program on "Recent Techniques in Proteome Analysis" | 10th - 30th March, 2011 |
| National Training Programme on "Hands on Training on Stem Cell Research for Quality Animal Production" | 17th - 30th March, 2011 |
| Advanced Course in Faculty Training on "Advances in Processing and Quality Assurance of Dairy Foods" | 22nd March - 11th April 2011 |
| Training Programme on "Data Analysis using SAS" | 22nd - 28th March, 2011 |
| Farmers' Awareness and Sensitization Programme on "Climate Change" at Village Jundla under NICRA Project | 26th March, 2011 |

*Cerenomial Lamp being lighted by His Excellency Governor of Haryana, Sh. Jagannath Pahadia during International conference on 'Frontiers or Reporductive Bioletchnology*


*Dr. Mangla Rai, Former Secretary DARE & DG, ICAR delivering Dr. D. Sundaresan Memorial Lecture*

# 13 DISTINGUISHED VISITORS

| | |
|---|---|
| 15.01.2010 | **Sh.Naveen Jindal**, Hon'ble Member of Parliament, New Delhi. |
| 20.01.2010 | Eight member delegation from Ministry of Agriculture, Royal Govt. of Bhutan. |
| 22.01.2010 | **Dr. M. H. Karim**, Counselor & Director, Science & Education Section, Embassy of the Islamic Republic of Iran. |
| 23.01.2010 | **Mr. Ngoga Eugene Fixer**, First Counselor, Rawanda High Commission, New Delhi. |
| 25.01.2010 | Five member delegation from North Carolina State University, USA. |
| 29-30.01.2010 | **Dr. Jayant Lohakare**, College of Animal Life Sciences, Kangwon National University, KNU Avfe-I, Chunchon, South Korea with five students. |
| 09.02.2010 | Four member delegation from General Mills, Minneapolis, USA. |
| 10.02.2010 | **Mr.Craig Pedley** of Skellerup Industries Ltd., New Zealand. |
| 29-30.03.2010 | Eight Member delegation from Nepal. |
| 03.04.2010 | Fourteen member delegation from Ministry of Agriculture & Forests, Bhutan. |
| 09.04.2010 | Forty member delegation from sixteen countries sponsored by Ministry of Overseas Indian Affairs under Know India Programme. |
| 25.05.2010 | Seventeen member delegation from Dept. of Grain Science & Industry, KANSAS State University, USA. |
| 07.07.2010 | Five member delegation from Hungry. |
| 30.08.2010 | Nine member delegation led by **Dr. Gerd Muller**, Parliamentary State Secretary, Ministry of Food, Agriculture and Consumer Protection, Federal Government of Germany. |
| 11.09.2010 | **Mr. Seyed Mehdi Nabizadeh**, Ambassador, Iranian Embassy, New Delhi and Dr.Mohammad Hossein Karim, Counsellor, Science, Technology & Education India and Sub Continent. |
| 27.09.2010 | **Dr. Ferdinand Schmite**, MD, ADT Project GmbH, A Limited Cop. Germany. |
| 28.10.2010 | **Sh.LalJiTondon** Honorable Member of Parliament from Lucknow. |
| 29-30.10.2010 | **Dr. Richard Ipsen**, Department of Food & Science, University of Copenhagen Denmark. |
| 22.11.2010 | Twenty two member delegation from Germany. |
| 26-27.1.2011 | Six member delegation from Ethiopian, Institute of Agricultural Research, Ethiopia. |
| 16.02.2011 | Eleven Member delegation from Gay Lea Foods Co-operative Limited, Canada. |

*Delegation from Hungry at Animal Breeding Research Centre at NDRI*

*Director, NDRI interacting with German delegation*

# 14 PERSONNEL

## INSTITUTE STAFF

*As on 31st March, 2011*

### General Administration

| | |
|---|---|
| A. K. Srivastava, Ph.D. | Director |
| S. L. Goswami, Ph.D. | Joint Director (Research) |
| G. R. Patil, Ph.D. | Joint Director (Academic) |
| J. K. Kewalramani, B.Sc., M.B.A. | Joint Director (Admn.) & Registrar |
| Rameshwar Singh, Ph.D. | Registrar (Academics) |
| I. K. Sawhney, M. Tech. | Controller of Exams |
| Pushpnayak, M.Sc. | Chief Admn. Officer |
| S. George, M.A., PGDLA. | Chief. Fin. & Account Officer |
| D. K. Arya, M.A. | Fin. & Account Officer |
| Ram Shankar, M.A., P.G.D.T. | Deputy Director (Off. Lang.) |
| Vishal Acharya, MA | Asstt. Fin. & Account Officer |
| Kuna Ram Kisku | Asstt. Admn. Officer (ERS, Kalyani) |
| S. C. Tuli, B.A. | Asstt. Admn. Officer |
| A. G. Barapatre | Asstt. Admn. Officer |
| R. K. Bansal, M.A. | Asstt. Admn. Officer |
| Ram Niwas, B.A. | Asstt. Admn. Officer |
| Ishwar Diyal, B.A. | Asstt. Admn. Officer |
| S. Shashi Kala | Asstt. Admn. Officer (SRS, Bangalore) |
| S. S. Meena, B.A. | Asstt. Admn. Officer |
| Saroj Khurana, M.A. | Asstt. Admn. Officer |
| Saroj Setia | Asstt. Admn. Officer |
| Neelam Bala | Asstt. Admn. Officer |
| N. K. Verma | Asstt. Admn. Officer |
| Deepak Chopra, B.A. | Security Officer |
| Sunita Chaudhary | Private Secretary |
| Khub Chand | 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 |

### RTI Cell

| | |
|---|---|
| S. L. Goswami, Ph.D. | Appellate Authority |
| B.S. Prakash, Ph.D. | Public Information Officer |
| Meena Malik, Ph.D. | Asstt. Pub. Information Officer |
| P. K. Dixit, Ph.D. | Asstt. Pub. Information Officer |
| R. A. Dey, Ph.D. | Asstt. Pub. Information Officer |

### Dairy Cattle Breeding Division

| | |
|---|---|
| R. S. Gandhi, Ph.D. | Head |
| G. K. Sachdeva, Ph.D. | Principal Scientist |
| B. R. Yadav, Ph.D. | Principal Scientist |
| A. K. Gupta, Ph.D. | Principal Scientist |
| 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 |
| A. P. Dabas, B.Sc. | Technical Officer |
| Om Bir Singh | Technical Officer |
| Vinod Kumar, B.Sc. | 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 |
| Shisha Singh | Technical Officer |
| Vikram | Technical Officer |
| Y. P. Singh, B.Sc. | Technical Officer |

### Livestock Production and Management Division

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

### Dairy Cattle Nutrition Division

| | |
|---|---|
| S. S. Kundu, Ph.D. | Head |
| Amarjit Singh, Ph.D. | Principal Scientist |
| S. N. Rai, Ph.D. | Principal Scientist |
| Harjit Kaur, Ph.D. | Principal Scientist |
| J. P. Sehgal, Ph.D. | Principal Scientist |
| D. S. Sohi, Ph.D. | Principal Scientist |
| Neelam J. Kewalramani, Ph.D. | Principal Scientist |
| S. S. Thakur, Ph.D. | Principal Scientist |
| Madhu Mohini, Ph.D. | Principal Scientist |
| Veena Mani, Ph.D. | Principal Scientist |
| S. K. Tomar, Ph.D. | Principal Scientist |
| A. K. Tyagi, Ph.D. | Principal Scientist |
| S. K. Sirohi, Ph.D. | Sr. Scientist |
| Chander Datt, Ph.D. | Sr. Scientist |
| Raj Bahadur, B.Sc. | Technical Officer |
| Karan Singh, M.Sc. | Technical Officer |
| Satnam Kaur, M.Sc. | Technical Officer |
| K. L. Bakshi | Technical Officer |

### Dairy Cattle Physiology Division

| | |
|---|---|
| B. S. Prakash, Ph.D. | Head |
| R. C. Upadhayay, Ph. D. | Principal Scientist |
| 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. | Sr. Scientist |
| A. K. Dang, Ph.D. | Sr. Scientist |
| Anjuli Aggarwal, Ph.D. | Sr. Scientist |
| Manju Ashutosh, Ph.D. | Sr. Scientist |
| Ashutosh, Ph.D. | Sr. Scientist |
| Bhagwat Swroop | Technical Officer |

### Animal Biotechnology Centre

| | |
|---|---|
| S. L. Goswami, Ph.D. | Joint Director (Research) & Officer-in-charge |
| R. S. Manik, Ph.D. | Principal Scientist |
| Prabhat Palta, Ph.D. | Principal Scientist |
| S. K. Singla, Ph.D. | Principal Scientist |
| M. S. Chauhan, Ph.D. | Principal Scientist |

| | |
|---|---|
| T. K. Datta, Ph.D. | Sr. Scientist |
| D. Malakar, Ph.D. | Sr. Scientist |
| S. De, Ph.D. | Sr. Scientist |
| J. K. Kaushik, Ph.D. | Sr. Scientist |
| A. K. Mohanty, Ph.D. | Sr. Scientist |
| Manoj Kumar Singh, Ph.D. | Scientist |
| Sudarshan Kumar, Ph.D. | Scientist |

## Animal Biochemistry Division

| | |
|---|---|
| Y. S. Rajput, Ph.D. | Head |
| V. K. Kansal, Ph.D. | Principal Scientist |
| S. K. Atreja, Ph.D. | Principal Scientist |
| R. K. Sharma, Ph.D. | Principal Scientist |
| Gautam Kaul, Ph.D. | Sr. Scientist |
| S. K. Sood, Ph.D. | Sr. Scientist |
| Dheer Singh, Ph.D. | Sr. Scientist |
| Rajeev Kapila, Ph.D. | Sr. Scientist |
| Suman Kapila Ph.D. | Sr. Scientist |
| Ravi Kant, M.Sc. | Technical Officer |

## Dairy Technology Division

| | |
|---|---|
| A. A. Patel, Ph.D | Head |
| Vijay Kumar, Ph.D | Principal Scientist |
| S. K. Kanawjia, Ph.D | Principal Scientist |
| D. K. Thompkinson, Ph.D | Principal Scientist |
| R. R. B. Singh, Ph.D | Principal Scientist |
| Latha Sabikhi, Ph.D | Sr. 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 |
| Vinod Kumar, B.Sc. | Technical Officer |
| Ram Swarup, M.A. | Technical Officer |
| Lehri Singh, M.Sc. | Technical Officer |
| S. K. Kharb, M.A. | Technical Officer |
| Savitri Jhamb, B.Sc. | Technical Officer |

## Emeritus Scientist

G. K. Goyal, Ph.D.

## Experimental Dairy

| | |
|---|---|
| A. K. Sharma, B.Sc. | Dairy Superintendent |
| U. C. Govil, B.A., IDD | Technical Officer |
| Hari Ram Gupta, M.Sc. | Technical Officer |
| A. K. Kohli, Dip. (Mech. Engg.) | Technical Officer |
| D.P. Verma, Intermediate | Technical Officer |
| T. L. Jaggi, Dip. (Refrigerator) | Technical Officer |
| Probir Mondal, B.Sc. | Technical Officer |
| Subhash Chander, Dip. (Electrical) | Technical Officer |
| Sanjeev Kumar, M.A. | Technical Officer |
| Prathvi Raj | Technical Officer |
| Balvir Singh | Technical Officer |

## Dairy Engineering Division

| | |
|---|---|
| A. K. Dodeja, Ph.D. | Head |
| I. K. Sawhney, M.Tech. | Principal Scientist |
| Bikram Kumar, M.Tech. | Principal Scientist |
| Prashant Saurabh Minz, M.Tech. | Scientist |
| Sunil Kumar, M.Sc. | Technical Officer |
| S. K. Chaudhary, A.M.I.E. | Technical Officer |
| S. S. Bhinder, Diploma (Mech. Engg.) | Technical Officer |
| J. K. Dabas, M.Tech. | Technical Officer |
| Pawan Kumar | Technical Officer |

## Dairy Chemistry Division

| | |
|---|---|
| B. K. Wadhwa, Ph.D. | Head |
| Darshan Lal, Ph.D. | Principal Scientist |
| Raman Seth, Ph.D. | Principal Scientist |
| Bimlesh Mann, Ph.D. | Principal Scientist |
| Sumit Arora, Ph.D. | Sr. Scientist |
| Vivek Sharma, Ph.D. | Sr. Scientist |
| Rajan Sharma, Ph.D. | Sr. Scientist |
| Rajesh Kumar, Ph.D. | Sr. Scientist |
| P. C. Singh, M.Sc. | Technical Officer |

## Dairy Microbiology Division

| | |
|---|---|
| Rameshwar Singh, Ph.D. | Head |
| R. K. Malik, Ph.D. | Principal Scientist |
| Sunita Grover, Ph.D. | Principal Scientist |
| A. K. Puniya, Ph.D. | Principal Scientist |
| S. K. Tomar, Ph.D. | Sr. Scientist |
| Shilpa Vij, Ph.D. | Sr. Scientist |
| Naresh Kumar, Ph.D. | Sr. Scientist |
| Chand Ram, Ph.D. | Sr. Scientist |
| Surjit Mandal, Ph.D. | Scientist |
| Raghu H.V., M.Sc. | Scientist |
| R. P. Singh, Ph.D. | Technical Officer |
| Inder Kumar, B.Sc. | Technical Officer |
| Chamela Ram | Technical Officer |

## Emeritus Scientist

V. K. Batish, Ph.D.

## Dairy Economics, Statistics and Management Division

| | |
|---|---|
| K. K. Datta | Head |
| D. K. Jain, Ph.D. | Principal Scientist |
| K. K. Kalra, Ph.D. | Principal Scientist |
| 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 |
| A. P. Ruhil, Ph.D. | Sr. Scientist |
| Raka Saxena, Ph.D. | Sr. Scientist |
| Uditya Chaudhary, Ph.D. | Scientist |
| Rishi Kanta Singh, M.Sc. | Scientist |
| Tara Chand, B.Sc. | Technical Officer |

## Emeritus Scientist

S. B. Agrawal, Ph.D.

## Dairy Extension Division

| | |
|---|---|
| Ram Kumar, Ph.D. | Head |
| Jancy Gupta, Ph.D. | Principal Scientist |
| Khajan Singh, Ph.D. | Principal Scientist |
| K. S. Kadian, Ph.D. | Sr. Scientist |
| S. K. Jha, Ph.D. | Sr. Scientist |
| Gopal Sankhala, Ph.D. | Sr. Scientist |
| Ritu Chakravarty, M.Sc. | Scientist (SG) |
| B. S. Meena, Ph.D. | Scientist (SS) |
| R. Senthil Kumar, Ph.D. | Scientist |

| | |
|---|---|
| Asif Mohammad, Ph.D. | Scientist |
| S. Subash, Ph.D. | Scientist |
| Sanchita Garai, Ph.D. | Scientist |
| N. S. Sirohi, Ph.D. | Technical Officer |
| Parvinder Sharma, Ph.D. | Technical Officer |
| Mridula Upadhayay, M.A. | Technical Officer |
| Jai Bhawan Sharma, Dip. (AH) | Technical Officer |

## Agricultural Technology Information Centre (ATIC)

| | |
|---|---|
| D. S. Sohi, Ph.D. | Incharge |
| Kumar Bharat, M.A. | Technical Officer |
| Rajpal Sharma, B.A. | Technical Officer |
| Pramod Kumar, M.Sc. | Technical Officer |

## Krishi Vigyan Kendra/Trainers' Training Centre

| | |
|---|---|
| Dalip K. Gosain, Ph.D. | Progam Coordinator |
| C. J. Juneja, Ph.D. | Technical Officer |
| Surender Gupta, Ph.D. | Technical Officer |
| Saroj Mehta, M.Sc., B.Ed. | Technical Officer |
| Satya Pal, M.V.Sc. | Technical Officer |
| Rajeshwar Dayal, B.Sc. | Technical Officer |
| Mohar Singh, M.Sc. | Technical Officer |
| Kulvir Singh, M. Sc. | Technical Officer |
| D. V. Sharma | Technical Officer |
| Prem Singh | Technical Officer |

## Forage Section

| | |
|---|---|
| A. S. Harika, Ph.D. | Incharge |
| D. S. Sohi, Ph.D. | Principal Scientist |
| Satish Kumar, M.Sc. (Horti.) | Technical Officer |
| Om Parkash, Dip.(Agri.Engg.) | Technical Officer |
| Uttam Kumar, Ph.D. | Technical Officer |
| Ramesh Chand, B. Sc. (Agri.) | Technical Officer |
| Anil Kumar Dagar, M.Sc. | Technical Officer |
| Rishi Pal, ITI, (Electrical) | Technical Officer |
| Sohan Lal | Technical Officer |
| Satrughan Mehto | Technical Officer |
| Jagpal Singh, B.Sc. | Technical Officer |
| Sukhdev Singh | Technical Officer |
| Ravi Rawat, M.Sc. (Entomology) | Technical Officer |

## Livestock Farm

| | |
|---|---|
| Shiv Prasad, Ph.D. | Incharge |
| T. K. Mohanty, Ph.D. | Sr. Scientist |
| M. L. Kamboj, Ph.D. | Sr. Scientist |
| Kumaresan, Ph.D. | Scientist |
| Manimaran, M.Sc. | Scientist |
| Nishant Kumar, M.Sc. | Scientist |
| Chaman Lal, Intermediate, Dip. (Motor Mechanic) | Technical Officer |
| S. K. Sharma, B.A. | Technical Officer |
| S. Raju, M.V.Sc. | Technical Officer |

## Animal Health Complex

| | |
|---|---|
| K.P.S. Tomar, M.V.Sc. | Technical Officer |
| M. K. Srivastava, M.V.Sc. | Technical Officer |
| Ramesh Chandra, B.A., PGCAW | Technical Officer |
| Praveen Kumar, M.V.Sc. | Technical Officer |
| Harpal Singh | Technical Officer |
| Sahdev, M.Sc. | Technical Officer |

## Artificial Breeding Research Centre

| | |
|---|---|
| A. K. Chakravarty, Ph.D. | Incharge |
| A. K. Gupta, Ph.D. | Principal Scientist |
| T. K. Mohanty, Ph.D. | Sr. Scientist |
| J. K. Pundir, B.V.Sc. | Technical Officer |
| R. T. Bansode, B.Sc. | Technical Officer |
| Nihal Singh | Technical Officer |
| Jintendra Rana, M.Sc. | Technical Officer |
| Subhash Chand, B.V.Sc. | Technical Officer |
| Amarpal Singh, M.Sc. | Technical Officer |

## University Office

| | |
|---|---|
| G. R. Patil, Ph.D. | Joint Director (Academic) |
| Rameshwar Singh, Ph.D. | Registrar (A) |
| I. K. Sawhney, M. Tech. | Controller of Exams |
| A. K. Tyagi, Ph.D. | Chief Hostel Warden |
| Gopal Sankala, Ph.D. | Hostel Warden |
| S. V. Singh, Ph.D. | Hostel Warden |
| Madhu Mohini, Ph.D. | Hostel Warden |
| Ritu Chakravary, M.Sc. | Hostel Warden |
| A. K. Singh, Ph.D. | Hostel Warden |
| Latha Sabikhi, Ph.D. | I/c Placement Cell |
| S. C. Tuli | Asstt. Admn. Officer |

## Research Coordination and Management Unit

| | |
|---|---|
| S. L. Goswami, Ph.D. | Joint Director (Research) |
| Meena Malik, M.Phil., Ph.D. | Asstt. Prof. (English) |
| Braj Kishor, M.A., B.Lib Sci. | Technical Officer |

## Library Services

| | |
|---|---|
| B. R. Yadav, Ph.D. | Incharge |
| Pushpa Rani, B. Lib. Sci. | Technical Officer |
| B. P. Singh, M.A., M.Lib.& Info. Sci. | Technical Officer |

## Computer Centre

| | |
|---|---|
| D. K. Jain, Ph.D. | Principal Scientist, Incharge |
| A. K. Sharma, Ph.D. | Sr. Scientist |
| A. P. Ruhil, Ph.D. | Sr. Scientist |
| Anirudha Kumar M.Sc., PGDCA, NHT Diploma | Technical Officer |
| Gian Singh, M.Sc. | Technical Officer |

## Communication Centre

| | |
|---|---|
| Gopal Sankhala, Ph.D. | Incharge |
| G. D. Joshi, M.A. | Technical Officer |
| S. K. Talwar, M.A., P.G.D. | Technical Officer |
| Dharmbir, B.A. | Technical Officer |
| Ganpat Rai, Matric, ITI | Technical Officer |
| Gulshan Kumar, B.A. | Technical Officer |

## Vehicle Maintenance Section

| | |
|---|---|
| R. K. Mittal, B. E. (Mechanical) | Incharge |
| Ram Chander | Technical Officer |

## Press Unit

| | |
|---|---|
| Dr. S. K. Kanawjia, Ph.D. | Incharge |
| Bhupinder Kaur, M.Com., B. Lib. Sci. | Technical Officer |
| Mehi Lal | Technical Officer |

## Official Language Unit

| | |
|---|---|
| Ram Shankar, M.A. P.G.D.T. | Deputy Director (Off. Lang.) |
| Kanchan Choudhary, M.A. | 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. | Incharge |
| R. K. Bansal, B.E. (Civil) | Technical Officer |
| Pankaj Chawala, M.Tech. (Electrical) | Technical Officer |
| Sarwan Kumar | Technical Officer |
| S. K. Saini | Technical Officer |
| Tek Chand (ITI Electrical) | Technical Officer |
| Bhagwat Singh (ITI Workshop) | 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 |

## Hospitality Cell

| | |
|---|---|
| D. Sherpa | Technical Officer |

## Health Complex

| | |
|---|---|
| R. K. Malik, Ph.D. | Incharge |
| Rekha Sharma, M.B.B.S. | Sr. Medical Officer |
| Manoj Kumar, M.B.B.S. | Medical Officer |
| Richa Walia, Diploma Nursing | Technical Officer |
| Saroj Kathuria, Diploma Nursing & Mid Wifery | Technical Officer |
| Shishan Pal | Technical Officer |

## Estate Section

| | |
|---|---|
| Sushil Kumar Kamboj, M.Sc. | Incharge |
| Prem Singh, M.A. | Technical Officer |
| P. M. Meena | Technical Officer |

## Southern Regional Station, Bangalore

| | |
|---|---|
| Satish Kulkarni, Ph.D. | Head |
| A. Obi Reddy, Ph.D. | Principal Scientist |
| 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. | Sr. Scientist |
| M. C. Arunmozhi Devi, Ph.D. | Sr. Scientist |
| K. Jayaraja Rao, Ph.D. | Sr. Scientist |
| D. N. Das, Ph.D. | Sr. Scientist |
| P. Heartwin Amala Dhas, Ph.D. | Scientist (SS) |
| Rekha Ravindra Menon, M. Tech. | Scientist (SS) |
| F. Magdaline Eljeeva Emerald, ME (Agri.) | Scientist (SS) |
| Mukund Amritrao Kataktalware, Ph.D. | Scientist (SS) |
| S. Varalakshmi, Ph.D. | Scientist |
| P. Murugananthan, M.Lib. Sci. | Technical Officer |
| M. Nanjundaswamy, M. Lib.Sci. | Technical Officer |
| V.R.V. Surendranath Naik, M.D. | Medical Officer |
| P. S. Shivaprasad, Dip. (Elec.Engg.) (PGDEPA) | Technical Officer |
| M. Sreenath, M.Sc. | Technical Officer |
| Sarwar, M.Sc. | Technical Officer |
| L. Krishna Murthy, M. Sc. | Technical Officer |
| P. Aravindakshan, M.Sc | Technical Officer |
| M.A. Usha, B.Sc. | Technical Officer |
| M. K. Vedavathi, B.Sc. | Technical Officer |
| B. K. Rajeshekaraiah, B.Sc. | Technical Officer |
| J. Nageshwara Rao, Dip.(Mech) | Technical Officer |
| Veeraju, B.E. (Civil) | Technical Officer |
| K. L. Sampath, B.Sc. | Technical Officer |
| P. G. Satisha, B.V.Sc. | Technical Officer |
| K. P. Lakshminarayanappa DME (Mech.) | Technical Officer |
| Meganathan, Dep. (Elect. Engg.) | Technical Officer |
| R. Keshvamurthy, B.Sc. | Technical Officer |
| Gurunath Gouda Patil, B.Sc. | Technical Officer |
| M. S. Nagarajaiah, Dip. (Civil Engg.) | Technical Officer |
| B. R. Srinivasamurthy, B.Sc. | Technical Officer |
| Thivija Kumari, M.A. | Technical Officer |
| Siddaramanna | Technical Officer |
| K. Geetha Kumari | Technical Officer |
| K. Ningaraju, Ph.D. | Technical Officer |
| K. H. Rangappa | Technical Officer |
| A. Louis | Technical Officer |
| Vimala | Technical Officer |

## Eastern Regional Station, Kalyani

| | |
|---|---|
| P. K. Roy, Ph.D. | Acting Head |
| R. A. Dey, Ph.D. | Sr. Scientist |
| Lotan Singh, Ph.D. | Sr. Scientist |
| S. K. Das, Ph.D. | Sr. Scientist |
| A. Santra, Ph.D. | Sr. Scientist |
| Anupam Chatterjee, Ph.D. | Sr. Scientist |
| M. K. Ghosh, Ph.D. | Sr. Scientist |
| Ajoy Mandal, Ph.D. | Sr. Scientist |
| V. P. Verma, M.A., B.Lib.Sci. | Technical Officer |
| Alokesh Goswami, M.Sc. | Technical Officer |
| Amitava Ghosh, M.V.Sc. | Technical Officer |
| Somnath Dutta, M.V.Sc. | Technical Officer |
| Prabir Saha, M.Sc. | Technical Officer |
| H. C. Yadav | Technical Officer |
| N. K. Daihya | Technical Officer |

## PERSONNEL MILESTONES

### Joinings/Appointments

- Mr. Prateek Sharma, Scientist (Dairy Processing) joined at Dairy Technology Division, NDRI, Karnal on 13th April, 2010.
- Mrs. Udita Sheokand, Scientist (Agricultural Statistics) joined at Dairy Economics Statistics & Management Division, NDRI, Karnal on 19th April, 2010.
- Mr. Yogesh Khetra, Scientist (Dairy Processing) joined at Dairy Technology Division, NDRI, Karnal on 21st April, 2010.
- Mr. Raghu H. V., Scientist (QAFS) joined at Dairy Microbiology Division, NDRI, Karnal on 23rd April, 2010.
- Ms. P. Sellam, Scientist (A.S. & P.E.) joined at Dairy Engineering Division NDRI, Karnal on 23rd April, 2010.
- Mr. Raghu Harikyathanahalli, Scientist (Dairy Microbiology) jointed at NDRI, Karnal on 23rd April, 2010.
- Dr. A. Maniamaran, Scientist (Veterinary Pharmacology) joined at Cattle Yard, Mr. Ganga Sahay Meena, Scientist (Dairy Processing) and Dr. Narender Raju Paniagari, Scientist (Food Sci. & Tech.) joined at Dairy Technology Division, NDRI, Karnal on 24th April, 2010.
- Mr. Sunil Kumar, T-6 (Instrumentation workshop) joined at Dairy Engineering Division, NDRI, Karnal on 2nd August, 2010.
- Sh. Sathish Kumar. M. H., Scientist (Dairy Processing) joined at Dairy Technology Division, NDRI, Karnal on 17th Sept., 2010.
- Sh. Devaraja, H. C., Scientist (Dairy Processing) joined at Dairy Technology Division, NDRI, Karnal on 27th Sept., 2010.
- Dr. Nishant Kumar, Scientist (Animal Reproduction Gynecology) joined at Cattle Yard, NDRI, Karnal on 7th January, 2011.
- Mr. Sanchita Garai, Scientist (Veterinary Extension) at Dairy Extension Division NDRI, Karnal on 10th January, 2011.
- Mr. Vishal Acharya, AF&AO joined at NDRI after his transfer from CSSRI, Karnal on 14th March, 2011.

### Promotions

- Dr. P. G. Satish, T-5, SRS, Bangalore promoted as T-6 w.e.f. 22.06.09.
- Sh. K. L. Sampath, T-5, SRS, Bangalore promoted as T-6 w.e.f. 1.7.2009.
- Mrs. Neelam Bala, Assistant promoted to the post of AAO w.e.f. 1.5.2010.
- Sh. T. Nagaraj, Assistant, SRS, Bangalore promoted to the post of AAO w.e.f. 3.6.2010.
- Sh. P. Saha, T-6, ERS, Kalyani promoted as T-7/8 w.e.f. 01.01.09.
- The tenure of Dr. S. L. Goswami, Joint Director (Res.) renewed for the period w.e.f. 02.05.2010 to 28.02.2014.
- Sh. J. K. Kewalramani, Chief Admn. Officer promoted as Joint Director (Admn.) & Registrar w.e.f. 20.07.2010.
- Sh. Pushpnayak, Sr. Admn. Officer promoted as Chief Admn. Officer w.e.f. 07.09.2010.
- Dr. Amrish Tyagi, Sr. Scientist (Animal Nutrition) promoted as Principal Scientist w.e.f. 05.08.2008.
- Dr. R. R. B. Singh, Sr. Scientist (Dairy Processing) promoted as Principal Scientist w.e.f. 05.10.2008.
- Dr. Ravinder Malhotra, Sr. Scientist (Agricultural Statistics) promoted as Principal Scientist w.e.f. 16.10.2008.
- Dr. T. K. Datta, Sr. Scientist (Biotechnology Animal Science) promoted as Principal Scientist w.e.f. 13.11.2008.
- Dr. Sohan Vir Singh, Sr. Scientist (Animal Physiology) promoted as Principal Scientist w.e.f. 13.11.2008.
- Dr. R. K. Mehla, Sr. Scientist (LPM) promoted as Principal Scientist w.e.f. 16.11.2008.

- Dr. K. P. Ramesha, Sr. Scientist (AG&B) promoted as Principal Scientist w.e.f. 03.12.2008.
- Dr. K. S. Kadian, Sr. Scientist (Agricultural Extension) promoted as Principal Scientist w.e.f. 28.12.2008.
- Dr. A. K. Puniya, Sr. Scientist (Dairy Microbiology) promoted as Principal Scientist w.e.f. 29.12.2008.
- Sh. Naresh Kumar Verma, Assistant promoted as Asstt. Admn. Officer w.e.f. 01.07.2010.
- Sh. Khub Chand, P.A. promoted as Private Secretary w.e.f. 01.09. 2010.
- Mrs. Nirmala Kumari, Mrs. Shukla Vermani, Mrs. Prem Kumari, Mrs. Parvesh Lata and Mrs. Simita Roy (ERS-Kalyani) P.A. promoted as Private Secretary w.e.f. 26.10. 2010.
- Dr. M. K. Kataktalware Scientist (LPM) SRS of NDRI, Bangalore, promoted to the post of Scientist (S.S.) w.e.f. 26.02.2008.
- Dr. P. K. Roy, Sr. Scientist (LPM) ERS of NDRI, promoted to the post of Principal Scientist w.e.f.27.07.2008.
- Sh. R. S. Gautam, Asstt Director (L) promoted as Deputy Director (OL) w.e.f. 04.01.2011.
- Dr. Y. S. Rajput, Principal Scientist joined as Head, Animal Biochemistry Division, NDRI, Karnal w.e.f. 21.01.2011
- Mrs. Shakuntla Rani, P.A. promoted as Private Secretary w.e.f.01.03.2011.

## Retirements/Transfers

- Mr. R. C. Nagpal, T-7-8 (F/FT) Computer Centre retired from Council's services on w.e.f. 31.05.2010.
- Mr. P. R. Saini, AAO retired from Council's services on w.e.f. 30.04.2010.
- Dr. Daluar Singh, Principal Scientist (Agricultural Extension) retired from Council's services on w.e.f. 31.05.2010.
- Dr. T. Rai, Principal Scientist (Dairy Chemistry) retired from Council's services on w.e.f. 30.06.2010.
- Mr. T. Nagaraja, AAO (SRS, Bangalore) retired from Council's services on w.e.f. 30.06.2010.
- Mr. J. I. P. Madan, AAO promoted as AO and relieved from NDRI w.e.f. 02.06.2010 to join at NBAGR, Karnal
- Sh. F. C. Garg Scientist (SG) (Dairy Technology) retired from Council's services on w.e.f. 31.08.2010.
- Sh. O. P. Bareja, Private Secretary retired from Council's services on w.e.f. 31.08.2010.
- Sh. Puspendra Kumar, Sr. A. O. promoted as C.A.O. and relieved from NDRI w.e.f. 08.09.2010 to join at IARI, Pusa, New Delhi.
- Ms. Sellam, P. Scientist (AS&PE) relieved from NDRI w.e.f. 27.12.-2010 to join at Directorate of Floriculture Research, New Delhi.
- Dr. R. K. Kohli, Principal Scientist (AS& PE) retired from Council's service on superannuation on 31.01.2011.
- Dr. N. K. Verma, Principal Scientist (Agril. Economics) retired from Council's service on superannuation on 31.01.2011.
- Dr. V. Chandra Sekar, Scientist. (SS) (AS&PE) Compulsory retired from the Council's service on 11.01.2011.
- Dr. J. P. Dhaka, Principal Scientist (Agril. Economics) retired from Council's service on superannuation on 28.02.2011.
- Smt. M. Jaylakshimi Private Secretary (SRS-NDRI) Bangalore retired from Council's service on superannuation on 28.02.2011.
- Sh. Chander Kumar Thakral promoted as Finance Accounts Officer & relieved from NDRI w.e.f. 09.03.2011 to join at NBAGR, Karnal.

## Demise

- Dr. B. G. Ladkhani, Former Faculty Member in the Dairy Technology Division passed away on 13th June, 2010.
- Dr. K. C. Tyagi, Former, Head, Dairy Extension Division expired on 19th June, 2010.
- Mr. Pankaj Davar, alumnus of the Institute (B.Sc Dairy Technology - 1975-79) expired on 12th June, 2010.
- Sh. S. K. Basu, T-4 (FFT), ERS, Kalyani expired on 1st April, 2010.
- Dr. Ashwani Sharma, Principal Scientist (AG&B) Dairy Cattle Breeding Division expired on 11th Feb., 2011.

# 15 MAIN STATION

## Research Divisions

### Dairy Cattle Breeding Division

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 & 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 their association with production/reproduction traits and disease resistance, screening of young males for genetic disorders and assessment of male fertility.

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

The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at the Division imparts 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 27 National Training Programs have so far been organized under the aegis of CAS/CAFT (AG&B) in the Division.

The Division has Animal Breeding Lab., Biometrical Genetics Lab., Sire Evaluation Lab., Animal Genetics Labs, Computer Cell, Livestock Record Cell and Artificial Breeding Research Complex. Besides this, breeding herds of cattle (Karan Fries, Karan Swiss, Sahiwal and Tharparkar) and Murrah buffaloes are also the integral part of the Dairy Cattle Breeding Division.

### Livestock Production Management Section

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: To maintain elite germplasm repository of dairy animals of the identified breeds; Development of state-of-art dairy animal management facilities and infrastructure for high yielding dairy animals; To carry out research in collaboration with different divisions, in the upstream areas of dairy animal production; To standardize the package of management practices and to demonstrate the 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

The major objectives of the Dairy Cattle Nutrition Division are to conduct basic, applied and anticipatory research, to undertake post-graduate programme in Animal Nutrition and to participate in the process of extension education through various training programmes. The contribution of the Division has been widely recognized at National and International level by way of conferring of many coveted awards such as Rafi Ahmed Kidwai Memorial Prize, Jawahar Lal Nehru Award, Rajendra Prasad Award, to the faculty and students of the Division. The Division was accorded the status of Center of Excellence by UNDP/IAEA for conducting post-graduate education and research. The faculty of this Division has been working in the frontline research areas such as mitigation of methane release from rumen of cattle and buffalo, mineral mapping, pesticide, insecticide and mycotoxin contamination of feeds and its amelioration, development of feed additives including herbal ones to enhance animal

productivity, bypass nutrients, technological aspects for the improvement of feed utilization.

The Division has excellent facilities including Central Fine Instrumentation Laboratory, Laboratory for Anaerobic Rumen Microbial Work Post Graduate Teaching Lab, Environmental Laboratory, Quality Control Laboratory and Feed Manufacturing Unit besides the well equipped animal sheds for conducting the animal experiments.

## Dairy Cattle Physiology Division

The discipline of Animal Physiology functioned as a section of Dairy Cattle Nutrition Division till the end of the 6th Five Year Plan. In the year 1984, it received the status of an independent Division. The objectives of the Division are: to conduct basic and applied research and impart training in various aspects of Animal Physiology; to undertake post graduate programmes of education in Animal Physiology at Master's and Doctoral levels and development and application of field level technologies.

The notable salient achievements of the Division include 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, 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; induction of lactation, 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.

The achievements of the Division have been amply recognized at National and International levels and a number of awards, Fellowships and honours have been bestowed on its scientists; these include the coveted Rafi Ahmed Kidwai Award, M. S. Swaminathan Award, Hari Om Ashram Trust Award, Dr. D. Sundaresan Memorial Award, Indian Science Congress Association Young Scientist Award, Nils Lagerlof Memorial Award, ISSAR Young Scientist Award, DAAD Fellowship, Department of Biotechnology Sponsored Overseas Associateship, Dr. D. N. Mullick Memorial Award, PG Nair Award, Harikrishna Shastri Memorial Award of IARI, Fellowship of National Academy of Agricultural Sciences the Dr. Heinrich – Baur Foundation Award of the Technical University of Munich, Germany, Recognition Award of the National Academy of Agricultural Sciences and the Dr. C. R. Sane Oration Lecture. The students have also distinguished themselves by winning the coveted Jawaharlal Nehru Award of ICAR consecutively for three years. Presently, the Division is focusing its research thrust in 3 main areas 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. A Network Project on Impact, adaptation and vulnerability of Indian agriculture to climate change with emphasis on livestock has been initiated and will continue during the current plan period.

## Animal Biotechnology Centre

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-the-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 the M.Sc. and Ph.D. Animal Biotechnology program.

The objectives of the centre 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. Recognizing its strength in Genomics research, ICAR recognized the Centre as

a Niche Area of Excellence in Buffalo Production and Reproduction genomics.

Animal Biotechnology Centre has 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 Animal Genomics, Prokaryotic and Eukaryotic Genome Analysis, Transgenic Animal Production, Proteomics Research etc.

## Animal Biochemistry Division

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 seman; 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 contributions of the Division have been amply recognized by three Ahmed Kidwai Memorial Awards, Dr. P. G. Nair Award, Dr. K. K. Iya award AAAP/CAPI Outstanding Research Award, two Jawahar Lal Nehru Awards, Young Scientist Award, IUIS/FIMSA Travel Bursary Award and several paper presentation awards. In addition Division has filed four patents and developed technologies for different types of probiotic dahi

The Division has the laboratories for Nutrigenomics, Functional foods and therapeutics; Prebiotics and probiotics; Bioactive peptides and immunology; Bioinformatics; Molecular endocrinology, Reproductive biochemistry and Stem cell research. Division manages Small Animal House that caters to the need of students and scientist for laboratory animals viz. rat, mouse, rabbit and hamster etc. The unit possesses all facilities for formulation of feeds for laboratory animals.

## Dairy Technology Division

The Dairy Technology Division is involved in teaching, research, training and consultancy activities. Over the years, the Division has made significant contributions to development of technological know-how for the dairy industry.

The prominent research achievements of the Division include development of technologies and innovative processes for improved traditional dairy products as well as certain western products such as cheese. Convenience formulations such as instant ready-to-reconstitute rasmalai mix, gulab jamun mix, khoa powder, Sorghum-based and bajra-based fermented milk beverages (salted sorghum lassi, salted bajra lassi), Whey-cereal based complimentary food (extended shelf-life

milk-cake), kheer mix, dalia dessert mix, basundi mix, kulfi mix powder are meant to solve the problem of refrigerated storage and transport. Important among formulated products are shelf-stable paneer curry, long-life dalia dessert, misti dahi, fruit-dahi, mango-lassi, ultrafiltered (UF) shrikhand, UF cheese, and low fat cheese. Other products include long-life paneer, low-fat paneer, rasogolla from buffalo milk, diet burfi, sugar-free kulfi and ice-cream; dairy whiteners from cow and buffalo milks, chocolate milk powder, low-lactose condensed milk and milk powder; a variety of table spreads viz., chhana/whey-protein concentrate-based spread, vegetable-fat based spreads, soya-based spread, etc. infant food formulations to suit the requirements of different groups of babies; different varieties of cheese from cow, buffalo and goat milks and their admixtures; formulated foods such as malted milk food, tea-complete and coffee-complete; dairy byproducts such as edible casein, caseinates, co-precipitates, whey protein concentrates, whey powder and lactose; development of ready-to-reconstitute whey-kinnoe juice mix and a range of whey-based formulations such as whey-mango beverage, whey-Jaljeera drink, whey-tomato soup and whey-mushroom soup; egg-less cake mixes, functional dairy foods such as fortified long life paneer, Arjuna herbal ghee, probiotic cheese and infant formula with microencapsulated probiotic organisms; probiotic milk-barley, milk-millet and whey-millet beverages, WPC-millet and WPC-barley biscuits, milk-barley weaning foods, extruded products from cereal-milk base and set yoghurt from a milk-millet base.

Scientific aspects relating to the LP-system for preservation of raw milk have been extensively studied in the Division and a process has been standardized for the preparation of tablets for activation of LP system. Packaging of milk products, and analytical tests/methods for milk and milk products are also an important research area for this Division. Modified Atmosphere Packaging (MAP) of Mozzarella cheese, Pizza and paneer tikka has been studied. Earthen pots as an alternative packaging of dahi is an important contribution toward protecting the environment.

The Division has developed strong expertise in the area of membrane processing and biotechnological applications to utilize modified microorganisms and enzymes for production of cheese and fermented milk with improved sensory, biochemical, textural and probiotic attributes. The current emphasis is on functional dairy-foods using various health related compositional interventions. Recently developed Quarg type fresh cheese with low fat and high fiber content, omega-3-enriched milk, chocolate chhanna murki, triphala ghee and fiber-enriched doda burfi, fiber-fortified milk, kheer, yoghurt and paneer, special dry milk-food formulation for cardio-vascular health, functional ice-cream and high fiber iron fortified biscuits are the examples of efforts in this area. The thrust of R&D work is also on utilization of dairy by-products in the manufacture of beverages, utilization of underutilized minor crops in combination with dairy products in the manufacture of variety of health foods, manufacture of low-fat products e.g. low-fat cheese, processed Mozzarella cheese, improvement of stability of probiotic organisms during processing etc.

The Indian Council of Agricultural Research has, since 1994, recognized the Division as Centre for Advanced Studies (CAS) in Dairy Technology (now, Centre for Advanced Faculty Training (CAFT) in Dairy Processing. Through these efforts a large number of teaching faculty and research scientists of the State Agricultural Universities and other institutions have been exposed to the latest developments in the field of Dairy Processing. The Division has thus far organized 24 training courses under this programme.

The Division spearheads the nation's most prestigious under-graduate programme in Dairy Technology and provides elite human resource for various managerial positions in the industry. The Division of Dairy Technology has received a number of National and International Awards in recognition of the outstanding scientific contributions made by the scientists and students, some of which include Rafi Ahmed Kidwai Awards, Jawaharlal Nehru Awards for P. G. Agricultural Research, Hari Om Ashram Trust Awards, DAAD Fellowships, Humboldt Fellowships, Rishab Shree Award, CSIRO Dairy Research Jubilee Award, Nestle' Young Scientist Award, UGC Research Award, Fellowship of NAAS, Vijay Shree Award, Fellowship Award of the Bioved Research Society, Hari Krishan Shastri Memorial Award for outstanding research in Agriculture, Borlaug Award, International Professional Women Opportunity Award, Dr. P. G. Nair Award, Dr. J. R. Patel Memorial Trust Award for teaching & research in Dairy Processing and ICAR Team Research Award besides several others including Best Research Paper awards.

Physically, the Division comprises the Traditional Dairy Products Cell, Infant and Dietetic Foods Cell, Cheese and Fermented Dairy Products

Cell, Convenience and Health Foods Cell, By-products and Membrane Technology Laboratory, Under-graduate/ Post-graduate Laboratory, Sensory Evaluation Laboratory, Food Technology Laboratory, Packaging Laboratory and Quality Control Laboratory.

## Dairy Engineering Division

Dairy Engineering Division was established as one of the research divisions since the inception of the Institute. It is contributing in teaching, research, training and industrial consultancy. The Division has research laboratory facilities in the areas of 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. The Division has developed prototypes for the manufacture of khoa, paneer, rasgolla, malai laccha etc on the industrial scale and paneer gadget and cream separator attachment for small scale applications.

Recent research achievements include cooling system for viscous dairy products, in-line production of khoa and three stage SSHE. Three stage SSHE is fully automatic state-of-the-art system for continuous manufacture of khoa, basundi, burfi, and rabri.

The contributions of the Division have been recognized by several best research paper awards and outstanding teacher award to the faculty of the Division on several occasions. The Division also conducts specialized training to the graduate engineers during summer.

## Dairy Chemistry Division

The mandate of Division is to conduct fundamental and applied research for understanding chemistry of milk and milk products, to impart educational programmes for undergraduate and postgraduate courses and to provide R&D support towards chemical-quality control related problems of the dairy industry.

The Division has contributed significant knowledge on the chemistry of milk and milk products. The salient achievements are: evaluation of physico-chemical properties of buffalo milk and alteration in its calcium and casein levels and micellar stability enabling manufacture of satisfactory products like cheese, condensed milk and rasogolla; humanization of buffalo milk and glyceride structure of buffalo milk fat; 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.

Technology/methodology has been standardized for the incorporation of whey protein hydrolysates for enhancement of antioxidant activity and ACE inhibitory activity of skim milk and ice cream; high antioxidant based fruit dahi; isolation of GMP from buffalo milk; toned milk fortified with calcium, iron and vitamin A individually; buffalo skimmed colostrum powder based on freeze drying; evaluation of physico-chemical qualities of market ghee and a simple colour test for detection of melamine in milk using gold nanoparticle.

The Division has state-of-the-art Seminar room, Quality control Lab, Undergraduate and Postgraduate labs, Instrument room, Research labs (lipids, proteins, minerals, enzymes, functional foods/ neutraceuticals)

### Dairy Microbiology Division

The Division has been contributing significantly in both basic as well as applied aspects of Dairy Microbiology. The DM faculty has also been extensively involved in developing human resource and imparting educational programmes for both undergraduate 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 conducts research covering 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.

### Dairy Economics, Statistics and Management Division

The Division of Dairy Economics, Statistics and Management was created during the IV Five Year Plan. In the early stage, the focus of research in the Division was on conducting research in Economics of Milk Production and Processing, with thrust on cost-returns studies. During subsequent periods, the research programmes of the Division enveloped more intricate and broader aspects of dairy enterprise encompassing backward and forward linkage factors for facilitating technology evaluation and transfer.

The Division, over the years, has developed good infrastructure in terms of scientific manpower, teaching and training aids, Divisional Library and Computer Unit.

In response to the research demands of the clientele systems, the Division has been orienting its research priorities and conducting the research accordingly. From simple economic analysis of milk production, the Division envisaged to work on advanced aspects of value chain management, implication of economic reforms on dairy sector, climate change and economic impact assessment through the staff research projects and post-graduate research programmes of the scholars.

### Dairy Extension Division

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

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

## Livestock Farm

The total milk production of the herd during the year 2010-11 was 1557469.3 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 11.3 and 12.7 kg per head per day, respectively. The milking average of Sahiwal cows and Murrah buffaloes was 6.8 and 6.2 kg per animal per day, respectively. One Sahiwal cow (SW-1829) produced best milk yield of 22.0 kg in peak lactation. Best yield in Murrah buffalo (MU-5517) was 20.0 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 35.5 kg (KF-6616) and 33.5 kg (KS-4344), respectively.

### Bovine Strength of Cattle and Buffaloes as on 31.12.2010

| Age group | Cattle | | | | | Buffaloes | Total Bovines |
|---|---|---|---|---|---|---|---|
| | Sahiwal | Tharparkar | Karan Swiss | Karan Fries | Total | Murrah | |
| **Calves upto 6 months** | | | | | | | |
| Male | 21 | 06 | 02 | 38 | 67 | 24 | 91 |
| Female | 18 | 07 | 01 | 45 | 71 | 30 | 101 |
| Heifers | 129 | 37 | 17 | 150 | 333 | 128 | 461 |
| Cows | 197 | 43 | 24 | 296 | 560 | 218 | 778 |
| Male stock (young) | 57 | 10 | 04 | 34 | 105 | 65 | 170 |
| Bullocks/ Teaser | - | 02 | - | 01 | 03 | 01 | 04 |
| **Total** | **422** | **105** | **48** | **564** | **1139** | **466** | **1605** |

Three number of cattle were sold on book value for Rs. 44820.00 during the year 2010

### Flock Strength of Goats as on 31.12.2010

| Age Group | Alpine x Beetal | Sannen x Beetal | Total |
|---|---|---|---|
| **Female** | | | |
| Kids upto 6 months | 58 | 10 | 68 |
| 6-12 months | - | - | -- |
| Yearling | 49 | 36 | 85 |
| Goats | 102 | 29 | 131 |
| **Male** | | | |
| Kids upto 6 months | 42 | 08 | 50 |
| Bucks | 68 | 23 | 91 |
| **Total** | **319** | **106** | **425** |

### Performance of Dairy Animals during the Year 2010 (1.1.2010 to 31.12.2010)

| Particulars | Genetic Groups | | | | |
|---|---|---|---|---|---|
| | Sahiwal | Tharparkar | Karan Swiss | Karan Fries | Murrah |
| Average number of animals in milk per day | 93 | 13 | 16 | 210 | 102 |
| Average number of dry animals per day | 84 | 26 | 05 | 69 | 95 |
| Milking average (kg) per day | 6.8 | 5.5 | 11.3 | 12.7 | 6.1 |
| Overall average (kg) per day | 3.6 | 1.8 | 8.6 | 9.5 | 3.2 |
| Best yield (kg) in a day | 22.0 | 18.0 | 33.5 | 35.5 | 20.0 |
| Animal Number | SW-1829 | TP-1122 | KS-4344 | KF-6616 | MI-5517 |

## Flock Performance of Goats during the Year 2010 (1.1.2010 to 31.12.2010)

| Particulars | Genetic Groups | |
|---|---|---|
| | Alpine x Beetal | Sannen x Beetal |
| Average number of animals in milk per day | 45 | 13 |
| Average number of dry animals per day | 29 | 14 |
| Milking average (kg) per day | 1.3 | 1.1 |
| Overall average (kg) per day | 0.8 | 0.6 |
| Best yield (kg) in a day | 4.1 | 3.0 |
| Animal Number | AB-916 | SB-126 |

## Milk Protein and Lactose Percentage of Cattle and Buffaloes (Jan. to Dec. 2010)

**First Lactation**

| Particulars | Cows | | | | Buffaloes Murrah |
|---|---|---|---|---|---|
| | Sahiwal | Tharparkar | Karan Swiss | Karan Fries | |
| No of observations | 280 | 43 | 97 | 966 | 485 |
| Average Protein | 3.11 | 3.11 | 3.07 | 4.10 | 3.75 |
| Range | 2.71-3.39 | 2.79-3.39 | 2.76-3.46 | 2.73-3.76 | 3.22-4.89 |
| Average Lactose | 4.69 | 4.69 | 4.67 | 4.67 | 5.72 |
| Range | 4.47-4.99 | 4.50-4.88 | 4.49-5.17 | 4.11-4.99 | 4.89-6.55 |

**All Lactations**

| Particulars | Cows | | | | Buffaloes Murrah |
|---|---|---|---|---|---|
| | Sahiwal | Tharparkar | Karan Swiss | Karan Fries | |
| No. of Observations | 1104 | 148 | 178 | 2531 | 1184 |
| Average Protein | 3.12 | 3.12 | 3.09 | 3.09 | 3.77 |
| Range | 2.71-3.49 | 2.75-3.42 | 2.73-3.63 | 2.56-3.76 | 3.09-5.32 |
| Average Lactose | 4.69 | 4.68 | 4.68 | 4.67 | 5.73 |
| Range | 4.33-5.36 | 4.48-4.97 | 4.46-5.25 | 4.11-5.53 | 4.89-6.55 |

## Fat and SNF Percentage of Cattle and Buffaloes during the Year-2010 (Jan. to Dec. 2010)

**First Lactation**

| Particulars | Cows | | | | Buffaloes Murrah |
|---|---|---|---|---|---|
| | Sahiwal | Tharparkar | Karan Swiss | Karan Fries | |
| No. of observations | 280 | 43 | 97 | 966 | 485 |
| Average Fat % | 4.56 | 4.51 | 4.31 | 4.33 | 8.04 |
| Range | 3.72-5.90 | 3.99-5.55 | 3.56-5.55 | 3.45-5.43 | 5.45-10.62 |
| Average SNF% | 8.70 | 8.71 | 8.69 | 8.69 | 9.77 |
| Range | 8.36-9.08 | 8.52-8.93 | 8.52-9.09 | 8.40-9.77 | 8.85-10.93 |

**All Lactations**

| Particulars | Cows | | | | Buffaloes Murrah |
|---|---|---|---|---|---|
| | Sahiwal | Tharparkar | Karan Swiss | Karan Fries | |
| No. of observation | 1104 | 148 | 178 | 2531 | 1184 |
| Average Fat % | 4.53 | 4.51 | 4.38 | 4.31 | 8.17 |
| Range | 3.20-5.92 | 3.94-5.55 | 3.56-5.74 | 3.03-5.45 | 4.75-10.62 |
| Average SNF% | 8.70 | 8.70 | 8.69 | 8.68 | 9.76 |
| Range | 8.36-9.08 | 8.50-9.10 | 8.50-9.09 | 8.26-9.77 | 8.85-10.93 |

## Month-wise Milking Average (kg) as Fat Corrected Milk (FCM) of Cows and Buffaloes Maintained at NDRI, Karnal (Jan. to Dec. 2010)

| 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 |
| Jan. | 74 | 8.21 | 7 | 7.21 | 10 | 15.54 | 191 | 14.87 | 113 | 9.81 |
| Feb. | 86 | 7.58 | 8 | 5.52 | 13 | 13.18 | 201 | 13.43 | 94 | 7.96 |
| March | 91 | 9.19 | 9 | 7.87 | 15 | 15.40 | 216 | 15.40 | 105 | 9.32 |
| April | 96 | 8.57 | 8 | 7.37 | 15 | 14.30 | 217 | 14.14 | 111 | 7.75 |
| May | 99 | 8.57 | 13 | 6.49 | 14 | 13.49 | 212 | 14.64 | 108 | 7.51 |
| June | 105 | 8.10 | 18 | 6.68 | 17 | 13.70 | 210 | 15.18 | 103 | 6.97 |
| July | 103 | 7.43 | 17 | 5.25 | 18 | 11.39 | 213 | 12.87 | 99 | 6.65 |
| August | 102 | 6.64 | 19 | 4.81 | 18 | 10.93 | 216 | 11.74 | 96 | 6.51 |
| Sept. | 96 | 5.89 | 17 | 4.94 | 19 | 9.47 | 221 | 10.52 | 93 | 5.94 |
| Oct. | 88 | 6.18 | 16 | 5.77 | 19 | 9.72 | 214 | 11.30 | 89 | 6.91 |
| Nov. | 92 | 6.17 | 15 | 4.76 | 17 | 10.24 | 209 | 12.50 | 96 | 8.69 |
| Dec. | 78 | 6.05 | 11 | 4.85 | 14 | 11.73 | 205 | 12.11 | 97 | 7.64 |
| Average | 93 | 7.38 | 13 | 5.96 | 16 | 12.42 | 210 | 13.23 | 100 | 7.64 |

## Month-wise Milking Average (kg.) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal 2010 (Jan. to Dec. 2010)

| Months | Cows | | | | | | | | Buffaloes | | Goats | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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)/ anima/ day | No of Animals in milk/ day | Milk yield (kg)/ animal/ day | No of Animals in milk/ day | Milk yield (kg)/ animal /day | No of animals in milk/ day | Milk yield (kg)/ animal/ day | No of animals in milk/ day | Milk yield (kg)/ animal/ day |
| Jan. | 74 | 7.4 | 07 | 6.5 | 10 | 13.9 | 191 | 13.6 | 113 | 7.5 | 55 | 1.4 | 21 | 1.3 |
| Feb. | 86 | 7.7 | 08 | 5.7 | 13 | 14.4 | 201 | 14.3 | 111 | 7.0 | 54 | 1.4 | 21 | 1.2 |
| Mar. | 91 | 8.3 | 09 | 7.2 | 15 | 14.2 | 216 | 14.5 | 105 | 7.0 | 54 | 1.4 | 19 | 1.3 |
| Apr. | 96 | 8.2 | 10 | 7.1 | 15 | 13.5 | 217 | 14.1 | 111 | 6.2 | 54 | 1.4 | 19 | 1.1 |
| May | 99 | 7.8 | 13 | 5.9 | 14 | 13.3 | 212 | 13.7 | 108 | 5.9 | 52 | 1.3 | 14 | 1.2 |
| June | 105 | 7.6 | 18 | 6.1 | 17 | 12.7 | 210 | 14.2 | 103 | 6.0 | 46 | 1.2 | 12 | 1.0 |
| July | 103 | 6.7 | 17 | 4.8 | 18 | 11.2 | 213 | 12.6 | 97 | 5.4 | 39 | 0.8 | 08 | 0.7 |
| Aug. | 102 | 6.0 | 19 | 4.1 | 18 | 9.6 | 216 | 11.0 | 96 | 5.1 | 23 | 0.6 | 04 | 0.8 |
| Sep. | 96 | 5.6 | 17 | 4.8 | 19 | 9.2 | 221 | 10.3 | 93 | 4.9 | 09 | 0.7 | 05 | 0.6 |
| Oct. | 88 | 5.8 | 15 | 5.5 | 19 | 8.9 | 213 | 10.7 | 89 | 5.7 | 25 | 1.2 | 06 | 1.0 |
| Nov. | 92 | 5.4 | 15 | 4.3 | 17 | 9.5 | 209 | 11.4 | 96 | 6.2 | 63 | 1.4 | 11 | 1.4 |
| Dec. | 78 | 5.8 | 11 | 4.7 | 14 | 11.2 | 205 | 11.7 | 97 | 6.5 | 70 | 1.5 | 13 | 1.3 |
| Avg. | 93 | 6.8 | 13 | 5.5 | 16 | 11.3 | 210 | 12.7 | 102 | 6.1 | 45 | 1.3 | 13 | 1.1 |

## Artificial Breeding Research Center

The Artificial Breeding Research Center (ABRC), erstwhile known as the Artificial Breeding Complex (ABC), was renamed in 2010. ABRC with an infrastructure and capacity of managing 146 bulls (Sahiwal, Tharparkar, Karan-Fries breeds of cattle and Murrah breed of buffalo), is the Largest Institute Breeding Bull Center in the country.

The centre has a state-of-the-art seminar-cum-class room; Semen Quality Control Laboratory; Germplasm Information Laboratory; Long range Open Bull Exercising Zone; Mist cooling system for reducing heat stress to breeding bulls.

The center has been playing proactive role in providing scientific management of male animals/ dairy bulls, cryopreservation facility

for storage of germplasm, advance training facility on animal breeding / reproduction management and frozen semen technology and dissemination of superior germplasm of cattle and buffaloes.

## Research Achievements

- The center evaluated the best progeny tested bulls of Sahiwal and Karan Fries cattle and Murrah buffalo breed. Murrah bulls of VII th set were evaluated and Bull No. 4519 achieved first rank (Sire Index - 2116) with 17.26 % superiority out of twelve bulls in the VII th set.
- Developed management and processing intervention for improving cryopreserved semen quality and enhancing production of male germplasm.
- Standardized the male reproduction management intervention technique for improving the semen quality (motility of sperms) of bulls during vaccination (Raksha Triovac and FMD).
- Development of extenders, cryopreservation and trans-cervical artificial insemination (AI) technique with high (60%) conception rate in crossbred dairy goat.
- A new collaborative project "*Ex-Situ* Conservation of Important Indigenous Cattle and Buffalo Breeds" was initiated by developing a Memorandum of Understanding (MoU) between NBAGR, Karnal and ABRC, NDRI, Karnal.

## Management of Dairy Bulls

During the period Nine Murrah bulls for XI and XII set under 'Network project on Buffalo improvement', 14 Sahiwal bulls for IX th and Xth set under 'Associated herd progeny testing programme in Sahiwal' and 18 Karan Fries crossbred bulls for XI th and XII set under Progeny Testing of KF bulls were maintained in the center.

## Artificial Insemination and Reproduction Management

The center performed the test and elite mating of breeding bulls and monitored the reproductive health and reproductive efficiency of the NDRI herd.

### Reproductive Status of NDRI Herd for the year 2010

| | Breeds | | | | |
|---|---|---|---|---|---|
| **Particulars** | **Sahiwal** | **Tharparkar** | **Karan Swiss** | **Karan Fries** | **Murrah** |
| Cows/ Buffaloes | | | | | |
| No. of Observations | 127 | 20 | 20 | 134 | 75 |
| Service Period ( days ) | 133 | 139 | 103 | 152 | 142 |
| No. of Service/ Conception | 2.18 | 1.9 | 1.7 | 2.16 | 1.45 |
| Heifers | | | | | |
| No. of Observations | 31 | 7 | 6 | 45 | 20 |
| Age at Maturity ( mo ) | 30.3 | 31.4 | 31.1 | 27.5 | 36.5 |
| Age at Conception (mo) | 33.3 | 33.7 | 33.3 | 29.1 | 42.6 |
| No. of Service/ Conception | 2.16 | 2.14 | 2.10 | 1.75 | 1.80 |
| Conception Rate ( % ) | | | | | |
| Conception rate by 1st service | 37.6 | 25.0 | 50.0 | 33.8 | 35.8 |
| Conception rate by 3rd service | 74.7 | 60.0 | 79.0 | 69.8 | 56.9 |
| Overall Conception rate | 39.7 | 25.0 | 51.9 | 34.3 | 32.5 |



## Production and Dissemination of Superior Germplasm

During the period, the Center produced 62,270 doses of frozen semen and disseminated 59,972 ml doses liquid semen of Sahiwal, KF and Murrah bulls to farmers of different States and 57,927 doses frozen semen of Sahiwal, KF and Murrah bulls to farmers and various dairy development organizations / agencies.

Revenue amounting to Rs.10,45,288 was generated through sale of liquid and frozen semen during the period.

## Forage Research and Management Centre

Economic milk production can only be achieved, if nutritious fodder is made available to the dairy herd. The cost of feeding constitutes about 65% of the total cost of production of milk. Thus, it is essential to economise the feeding cost. It has been established that cost of milk production is the lowest and animal performance is better if adequate green fodder in the form of cereal-legume mixture and high energy silage are made available for feeding to the dairy animals.

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

### Fodder/ Seed/ Feed Production and supply

A total of 1,95,333.75 quintal good quality green fodder was produced from high yielding varieties of fodder crops of maize, sorghum, sorghum x sudan grass hybrids , bajra, makchari and cowpea during *kharif* season and lucerne, berseem + mustard, oats, oats + mustard, mustard, turnip and winter maize in *rabi* season. Similarly, grain crops of oats, wheat and paddy were also grown. During the period under report, a total of 1,95,240.25 q of fodder including 1,81,205.25 q. green fodder, 6339.75 q silage and 7695.25 q. dry fodder was supplied to cattle yard. A total of 552.75 q. green fodder (berseem and oats) was supplied in Dairy Mela- Feb-2010. Total production of grains of wheat, barley and oats was 2219.32 q.

**Allocation of the Farm Land to Different Units**

| Particulars of Units | Area (Acres) | Area (hectare) |
|---|---|---|
| Fodder Production Farm | 741.04 | 300.01 |
| Revolving Fund Scheme/Forage Research Farm | 99.42 | 40.25 |
| Dairy Demonstration Unit (KVK) | 33.39 | 13.52 |
| Dairy Mela Ground | 8.50 | 3.44 |
| Hostel, Power House & Play ground | 7.00 | 2.83 |
| **Total Land** | **882.35** | **357.22** |

**Production and Productivity of Forage Crops in terms of Green Fodder**

| Crop | Area (ha) | Average Yield (q/ha) | Production (q) |
|---|---|---|---|
| Berseem+mustard | 59.80 | 832.19 | 49765.50 |
| Oats/oats+mustard | 103.07 | 297.60 | 30671.00 |
| Turnip | 12.23 | 638.51 | 7809.00 |
| Lucerne | 3.74 | 498.06 | 1862.75 |
| Maize | 176.23 | 281.73 | 49648.50 |
| Mustard | 10.89 | 358.10 | 3899.75 |
| Jowar(multi-cut) | 29.98 | 815.11 | 24437.00 |
| Jowar(single cut) | 41.96 | 558.67 | 23441.75 |
| Cowpea | 7.17 | 201.26 | 1443.00 |
| Bajra | 4.05 | 540.68 | 2189.75 |
| Makchari | 0.40 | 414.38 | 165.75 |
| **Total** | **449.52** | **-** | **1,95,333.75** |

### Production and Productivity of Grain Crops

| Crop | Area (ha) | Average yield (q/ha) | Production (q) |
|---|---|---|---|
| Wheat | 40.10 | 37.52 | 1504.41 |
| Oats | 27.85 | 5.94 | 165.35 |
| Barley | 17.61 | 30.55 | 538.06 |
| Maize | 1.42 | 8.10 | 11.50 |
| **Total** | **86.98** | **-** | **2219.32** |

## Dry Fodder

Sufficient quantity of dry fodder as wheat, barley and oats straw in the form of by-product of these crops (1185.75 q.) 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, wheat, barley and oats straws were supplied.

## Revenue Generation

Through sale of farm produce and providing tractors on lease to the sister Institutes, an amount of Rs. 27,65,510.20 was realized and an amount of Rs. 15,35,253.00 was saved by the use of Farm Produce as Seed/Feed.

### Revenue Generation by the Sale of Farm Produce

| Item sold | Quantity (q) | Rate (Rs./q) | Amount (Rs.) |
|---|---|---|---|
| Wheat grain | 775.85 | 1100 | 8,53,435.00 |
| Wheat seed (DWR) | 301.76 | 1375 | 4,14,920.00 |
| Oats seed | 2.10 | 2800 | 5,880.00 |
| Paddy (Pusa-1121) | 73.23 | 1090 | 79,820.70 |
| Paddy (Pusa-1121) | 102.65 | 1800 | 1,84,770.00 |
| Tractors leasing out | - | - | 1,41,050.00 |
| Farm yard manure | 160.50 | 10 | 1,605.00 |
| Timber wood | | | |
| i) Sheesham wood | 1572.00 | 520 | 8,.17,440.00 |
| ii) Kiker/Eucaliptus wood | 604.15 | 330 | 1, 99,369.50 |
| iii) Misc. wood | 336.10 | 200 | 67,220.00 |
| **Total** | | | **27,65,510.20** |

### Budget Saved by the Use of Farm Produce as Seed/Feed

| Produce | Quantity (q) | Rate (Rs./q) | Amount (Rs.) |
|---|---|---|---|
| Wheat seed | 10.00 | 2400 | 24,000.00 |
| Wheat feed | 383.20 | 1100 | 4,21,520.00 |
| Oats seed | 122.91 | 3500 | 4,30,185.00 |
| Oats feed | 78.25 | 800 | 62,600.00 |
| Oats (DT Divn. ) | 0.10 | 800 | 80.00 |
| Oats (DCN Divn.) | 0.40 | 800 | 320.00 |
| Oats (Dairy Ext. Div.) | 1.20 | 800 | 960.00 |
| Barley seed | 18.46 | 2800 | 51,688.00 |
| Barley feed | 524.00 | 850 | 4,45,400.00 |
| Barley (DT Div.) | 1.60 | 850 | 1,360.00 |
| Paddy (Pusa-1121) feed | 25.25 | 2000 | 50,500.00 |
| Cowpea seed | 5.91 | 4000 | 23,640.00 |
| Maize seed | 11.50 | 2000 | 23,000.00 |
| **Total** | **1182.78** | **-** | **15,35,253.00** |

## Revolving Fund Scheme on Seed Production

Non-availability of good quality seeds of improved varieties of fodder crops is the biggest constraint in increasing the production of fodder crops. Thus, a Revolving Fund Scheme on Seed Production of fodder crops was initiated at NDRI, Karnal in about 40 hectare area to produce the seeds of improved varieties of fodder crops for cultivation at Institute farm and for sale to farmers, ICAR Institutes and other agencies. During the year under the report, 559.125 q seeds of improved varieties of fodder crops, 292.95 q undersized grains and 14,136.50 q green fodder and 2,002 q Dry fodder were produced and a revenue of Rs.20,18,586.50 was generated.

### Revenue Generation by Seed Production (RFS)

| Name of crop | Quantity (q.) | Rate (Rs./q.) | Amount (Rs.) |
|---|---|---|---|
| Maize (V.C.) | a) 105.00 | 2000/- | 2,10,000.00 |
| | b) 150.00 | 3000/- | 4,50,000.00 |
| Jowar (PC-9) | 50.00 | 5000/- | 2,50,000.00 |
| Jowar (HJ-513) | 7.75 | 5000/- | 38,750.00 |
| Oats (OS-6/ Kent) | 65.00 | 3500/- | 2,27,500.00 |
| Mustard (Chinese cabbage) | 2.95 | 4000/- | 11800.00 |
| Berseem (Mascavi) | 0.52 | 5500/- | 2860.00 |
| Paddy (Pusa-44) | 176.40 | 3000/- | 5,29,200.00 |
| Turnip (purple top) | 1.505 | 15000/- | 22,575.00 |
| **Total** | **559.125** | **-** | **17,42,685.00** |

### Revenue Generation by Grain Production under RFS

| Name of crop | Quantity (q.) | Rate (Rs./q) | Amount (Rs.) |
|---|---|---|---|
| Maize | 9.00 | 900.00 | 8100.00 |
| Mustard | 8.00 | 1500.00 | 12000.00 |
| Paddy grains | 10.50 | 1100.00 | 11550.00 |
| Wheat | 142.20 | 11200.00 | 1,59,264.00 |
| Jowar | 0.55 | 850.00 | 467.50 |
| Oats | 54.50 | 800.00 | 43,600.00 |
| Paddy (Screen) | 68.20 | 600.00 | 40,920.00 |
| **Total** | **292.95** | **-** | **2,75,901.50** |

### Fodder Supplied to Cattle Yard (q) under RFS

| Particulars of Fodder | Quantity (q) |
|---|---|
| Green Fodder | 14,136.50 |
| Maize Kadbi | 868.50 |
| Jowar Dry | 720.50 |
| Wheat Bhusa | 223.00 |
| Paddy Straw | 190.00 |
| **Total** | **16,138.50** |

## 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, Gulab Jamun Mix, 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 & training facility to students & scientists of the NDRI Deemed University.
- It also provides training facility to outside students of various universities and colleges in the Dairy field. A total no. of 72 students from several institutions were provided training during the year 2010-2011.
- Experimental Dairy is certified under Quality management system I.S/ISO 9001-2008 and food safety (IS-15000-1998) HACCP by BIS Chandigarh.
- Experimental Dairy has been running successfully under Revolving Fund Scheme since 1989-90. Revenue generated through scheme is being utilized for development of infrastructure of Experimental Dairy.
- The revenue generated during the year Jan. to Dec., 2010 was Rs. 3,45,92,973.

**Sale of the Dairy Products (January to December, 2010)**

| Item | Quantity | Amounts (Rs.) |
|---|---|---|
| Cow Ghee (kg) | 25674 | 7954740 |
| Mix Ghee (kg) | 1257 | 367870 |
| Pasteurized Butter (200 gm) (kg) | 6757 | 607085 |
| Paneer (500 gm) (kg) | 17360.5 | 2777680 |
| Paneer (250 gm) (kg) | 11595.05 | 1855200 |
| Paneer (kg) | 15026 | 2300870 |
| Ice-cream (Cup) | 92577 | 1388655 |
| Flavoured Dairy Drink (200 ml) | 274177 | 2741770 |
| Lassi (200 ml) | 145051 | 1450510 |
| Dahi (200 ml) | 13904 | 139040 |
| Kalakand (kg) | 11529.5 | 1844640 |
| Pro. Cheese Slices (200 gm) | 2024 | 216800 |
| Skim Milk Powder (Roller Dried) (kg) | 29106 | 5222740 |
| Gulab Jamun Mix (kg) | 14645 | 2490675 |
| Pizza Cheese 200 gm | 3497.5 | 234745 |
| Carry Bag (No) | 6874 | 58870 |
| Cheddar Cheese (kg) | 3379.7 | 465352 |
| Khoa (kg) | 236 | 42750 |
| Cooking Butter (kg) | 1368 | 25965 |
| Mozzarella Cheese (kg) | 11053.5 | 1435292 |
| Burfi (kg) | 6675.5 | 1068080 |
| Table Cream (kg) | 68.5 | 3425 |
| Skim Milk Powder (Spray Dried) (kg) | 11.5 | 1725 |
| Jaljeera (200 ml) | 760 | 6080 |
| Skim Milk (kg) | 50 | 750 |
| Tomato Soup (Cup) | 3062 | 27664 |
| **Total** | | **3,45,92,973** |

## Computer Centre

The Computer Centre is engaged in academic and service providing activities such as teaching Computer Science courses to under-graduate and post-graduate students in Dairying, scientific data processing, monitoring management information, maintenance of databases, software development and imparting training to staff and sponsored students from other academic institutions. The centre is also providing services for data analysis, pay bill processing, LAN Management, DTP and graphic applications to staff and students, Coordinating Maintenance of Computers, Printers and UPS and Maintenance of EPABX Unit.

The Computer Centre is equipped with a multi-user Pentium/UnixWare computer system alongwith a heavy duty line matrix printer for scientific data analysis. A number of latest state-of-the-art Pentium-IV processor based multimedia/ Internet ready computer systems (networked through LAN) are available for students and staff training. There is a campus wide LAN established to provide e-mail/Internet connectivity through three leased lines and a National Knowledge Network node with 1Gbps connectivity. Various licensed sophisticated software such as language compilers, application software packages and operating software are available.

### Agricultural Research Information System

The Agricultural Research Information System (ARIS) Cell worked effectively during the year with regard to LAN management in order to provide network services. The bio-data of staff of the Institute is being regularly updated as part of PERMISNET. The data is also being maintained online about Academic and related information under NISAGENET. Intelligent Reporting System (IRS) of ICAR is also operational for about two years in which information is being uploaded quarterly.

A Statistical Cell is also functioning in the Centre, which maintains information on students and faculty as per the requirement of UGC, State Department of Higher Education and the like.

### Distributed Information Sub-Centre

The Distributed Information Sub-Centre on Animal Biotechnology funded by the Department of Biotechnology, Govt. of India, New Delhi continued to function effectively.

Advanced training on sophisticated software tools was provided under the BTIS Project, on the following topics:

- Prediction of Helical Transmembrane Region Using Adaptive Neuro-Fuzzy Inference System.
- Prediction of Helical Transmembrane Region Using Connectionist Model.

### NAIP Project on AGROWEB (ADDSIAR)

New Website of NDRI Karnal was developed and launched on the occasion of the World Milk Day 2010. Salient features of the new Website include role based security for instant updating of the information.

## Library

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. The Institute Library is currently involved in project "Strengthening of Digital Library and Information Management under NAIP-NARS (E-Granth)". More than 200 periodicals are subscribed to keep track of the current scientific / technical developments. Currently, there are 94,400 volumes, which includes 50,095 books 31,210 bound journals, 8,200 bulletins, 3,327 theses, 268 microfiches and 1,300 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 also provides Internet, Email, Documentation, Reference, Current Awareness Services and CD-ROM Literature scanning services. Library has various CD-ROM Databases i.e. CAB Abstract, Food Science Technology Abstract, AGRIS, Derwent Biotechnology Abstract, Indian Standards on CD-ROM and ISO Standards of milk and dairy products on CD-ROM. The Library also provides Photocopying, Document Scanning and Printing facility. Computerized Issue-Return and reservation of books is done by using LIBSYS Library software Packages with Web OPAC.

## Communication Centre

**Photo Lab:** Photo Lab of the Institute covered research activities of scientists and students, National and International Seminars, Workshops, Conferences, Cultural programmes, Extension, KVK Activities, Visit of Dignitaries and Student Activities etc. held at the Institute. A sum of Rs.15206/- was received through supply of photographs to various organization in the country.

**Video Lab:** The facilities of video recording, audio video editing, dubbing, mixing of audio & video images on DVD/VCD were provided to the staff, scientists & students for their research work. Video coverage of 54 events of the Institute consisting of National & International seminars, workshops, meetings, conferences, convocations, women day, kisan sangosthies, exhibitions, veterinary camps, scientists at farmers door, calf rallies and other functions of the Institute were carried out. Two new video films namely **NDRI at a Glance** in Engilsh & **Rasshtriya Dairy Anusandhan Sansthan- Ek Jhalak** in Hindi were produced and to disseminate technology of clean milk production in Hindi & English, 219 nos. of DVD /VCD were supplied to various prestigious organizations, ICAR Institutes/SAUs during the current year.

**Audio & Projection Unit:** Audio & projection unit provided sound & projector system for different National, International Seminars held at NDRI and also arranged sound systems for students activities, in hostel and play ground etc.

**Exhibition Unit:** Exhibition Unit organised a total of 19 exhibitions in and around Karnal. Exhibitions were also arranged from 23rd to 25th March, 2011 at Kisan Mela, SKAUST, Jammu and IIFF Pragati Maidan, New Delhi from 14th to 27th November, 2010.

## Maintenance Section

Since 1979, Maintenance Section has been providing the services to the Institute in the fields of civil, electrical, mechanical, refrigeration & Air Conditioning etc. ; Carrying out various new works / additions & alterations required in the various labs / buildings of the Institute; Maintenance of Institute Buildings w.r.t all masonry, carpentry, painting & plumbing works; Maintenance of Sub-Station, overhead lines, street lights, service connections, maintenance of the electric supply to

the office as well as residential area of the Institute; providing generator supply to the office area in case of power failures; maintenance of water supply & sewage disposal system of the Institute; planning & inspection of various works / new Buildings of the Institute; operation & maintenance of the Effluent Treatment Plant; Liaison works with the CPWD, UHBVN, Haryana State Pollution Control Board & local authorities for various civil, electrical & other misc. works of the Institute.

## Human Health Complex

The Human Health Complex was established in 1991. It is a 20 bedded hospital catering to the health needs of the employees at NDRI as well as other sister ICAR Institutes i.e., IARI, NBAGR & DWR, in addition to the students of NDRI Deemed University and the retired ICAR employees settled in Karnal. Physio- theropy unit was established during 2010-11 for the benefit of patients suffering from various orthopedic diseases, obesity and cardio vascular diseases. Doctors render medical aid in Allopathy, Ayurveda & Homoeopathy. Qualified nurses, laboratory technicians and pharmacists assist the medical officers in providing medical facilities.

## Technology Business Incubator

Technology Business Incubator (TBI) is a grant-in-aid project of Department of Science & Technology, Government of India, promoted by Society for Innovation and Entrepreneurship in Dairying (SINED) & hosted by National Dairy Research Institute, Karnal.

### Services Offered

#### 1. Incubation Process

SINED-TBI is designed to provide a launch pad to budding entrepreneurs who wish to launch themselves into the world of technology based business careers. The incubator is designed to provide entrepreneurs all the support to make technology based business ventures successful.

#### 2. Pre-Incubation Process

- Entrepreneurship Awareness Camps
- Entrepreneurship Development Programmes: TBI is conducting Entrepreneurship Development Programmes in the following areas:
  - Commercial Milk Procurement & its Management
  - Commercial Milk Processing
  - Commercial Manufacture of Cattle Feed
  - Organic Dairy Farming
  - Ice Cream, Softy & Frozen Desserts
  - Commercial Honey Production & Processing
  - Indigenous Milk Products
  - Technology Entrepreneurship Training
  - Consultancy & Testing
  - My Idea Programme

Technology Business Incubator conducted the following programmes during the year 2010-11.

- Entrepreneurship Development Programme (EDP) on 'Milk Processing for Market Milk & Related Products' from 17th May'10 – 26th May'10.
- Entrepreneurship Development Programme (EDP) on 'Commercial Dairy Farming' from 25th Aug '10 – 3rd Sep '10.
- Training program on 'Manufacturing & Routine Testing of Milk, Dahi & Paneer' from 11th Oct '10 – 14th Oct '10. NABARD, Una (Shimla) has sponsored the participants for this programme.
- Training program on 'Organized Dairy Farming' from 29th Nov '10 – 1st Dec '10. The program was organized for the Director's & Chairman of Thiruvanthapuram Milk Co-operative Societies.
- Consultancy was provided for setting up of dairy farm.

## 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.

## Special Features

- Model Dairy Plant provides six Month In-plant training to the students of B.Tech. (DT) of the N.D.R.I. Deemed University during the 4th year of the course curriculum.
- The students are provided with complete infrastructure for training, which helps them in gaining sufficient experience in managing the modern commercial Dairy Plant and instills confidence in handling real life problems in production management.
- It also provides infrastructure facilities to the scientists of NDRI for scaling up R & D concepts from laboratory scale to industrial scale under commercial environment.

Model Dairy Plant (MDP), an autonomous unit of ICAR, is independently managed by a committee, whose Chairman is the Director of NDRI. The other committee members are: Representative of NDDB, A.D.G., ICAR, Managing Director, Mother Dairy Fruit & Vegetable Pvt. Ltd., Delhi, General Manager (MDP) as Convener and the Head, Dairy Technology Division, NDRI as Coordinator for matters related to Model Dairy Plant.

## Liquid Milk Processing / Packaging (Capacity 60,000 lpd)

MDP is currently engaged in processing and packaging of milk for Mother Dairy in five different variants (Full Cream, Standard, Toned, Double Toned and Skim Milk). MDP is presently processing / packing 70,000 – 75,000 lpd of polypack Milk in all the varieties for Mother Dairy, Delhi. The plant is running in three shifts and the supplies from MDP are dispatched in the evening & morning to Delhi market thereby utilizing the plant to more than its full capacity.

## Ice Cream Manufacture (Capacity 7000 lpd)

MDP is in agreement with Mother Dairy for processing / packing of Ice-cream in Mother Dairy brand on job work to the tune of 7000 liters per day. The production of ice-cream is further enhanced to 12000 lpd during the summer season. The ice cream manufactured at MDP is of different varieties i.e. Vanilla, Strawberry, Mango, Butter Scotch etc. and as per the requirements of Mother Dairy.

## Ghee Manufacturing (Capacity 800 kg per day)

MDP manufactures Cow Ghee from Cow Butter purchased from different State Federations and its production is not taken as per demand. The average production / sale of ghee is 12-15 metric tons per month. All the Ghee manufactured at MDP is being sold through the MDP Sale Counter.

## Cheese and Paneer (Capacity 1500 kg per day)

MDP is also engaged in training students in manufacturing of Cottage Cheese, Processed Cheese, Paneer on trial basis. The section is operated occasionally for the purpose of taking trials and making the students familiar with the manufacturing details.

## Procurement of Milk

MDP does not have its own infrastructure for milk procurement and is receiving milk on behalf of Mother Dairy from the units of Punjab / Rajasthan / Uttar Pradesh State federations on NMG rates. The average milk procurement per day is around 55,000 to 60,000 LPD, which is sufficient to meet day to day demand of different milk variants being packed at MDP.

## Training to the Students

As its primary objective, Model Dairy Plant is providing In-plant training to B.Tech. (DT) students of NDRI (Deemed University). The students are provided with In-plant Training Manual comprising of unit wise operation covering all the sections of the Dairy Plant. Since its inception in 1996, Model Dairy Plant has provided training to fourteen batches of B.Tech. (DT) students. The student trainees are provided Rs.1500/- per month as stipend. A total of 354 no. students have been trained so far.

## Quality Management System

Model Dairy Plant is presently certified under the Food Safety Management System ISO 22000:2005.

## HRD Programmes

MDP has well trained Technical Staff to handle the various operations of the Plant for further upgrading the knowledge and skill of the employees, MDP is continuously taking up HRD programs from external agencies for up-gradation of knowledge and motivation of the employees & student trainees, which has been quite beneficial and helpful both to the employees and the organization.

## Kaizens & SGA's

MDP has started KAIZEN's (improvements) and Small Group Activities (SGA) for its continued improvements by involving all the employees, students and the floor level staff.

# 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. The Institute started at Bangalore 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.

### Objectives

- Faster multiplication of superior germplasm of region specific breeds of cattle and buffaloes through interventions.
- Process upgradation for the industrial production / packaging of region specific dairy products.
- Establishment of the regional referral centre for quality assurance of dairy products.
- Economic analysis of various aspects of dairying and establishment of data bank for strategic development of dairying in the region.
- Establishment of model villages with integrated development focused on dairying.
- Transfer of technologies suitable for the crop-livestock production systems prevalent in agro-climatic conditions of the region.
- Training of farmers and industrial entrepreneurs at technology development centers.
- Undertake advanced HRD programmes to meet the needs of the industry.

### Infrastructure

The Campus is endowed with necessary infrastructure in terms of qualified staff, farmland, dairy herd, laboratories, library, staff dispensary, hostel facilities etc. The Campus envelopes a land area of 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 constitutes 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 has been established and functioning at the campus. A sensory evaluation laboratory for evaluation of dairy products has also been established.

The library is stocked with 12329 books, 10253 bound volumes of journals , 1034 theses and 1295 reprints. Library subscribes to 125 Indian / Foreign Journals relevant to various disciplines of Dairy Science. Library Automation Software procured for facilitating the automation of library functions and 8080 entries of book database have been entered in to the software. 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.

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.

The research, training and transfer of technology programmes at the Campus are carried out through different sections viz., Animal Breeding & Artificial Insemination, Cattle yard & Forage Production, Dairy Technology, Dairy Chemistry & Bacteriology, Dairy Engineering, Dairy Economics & Management, Dairy Extension and Dairy Education. The Campus has staff strength of 197 including 17 Scientific and 45 Technical, 17 Ministerial and 119 Supporting Staff.

## Education and Training

Ph.D. Programmes are being offered in the disciplines of Dairy Technology, Dairy Chemistry, Animal Genetics & Breeding, Livestock Production and Management and Dairy Economics. In addition to conducting M.Tech Programme in Dairy Technology, guidance is being provided to the PG students in the disciplines of Dairy Chemistry, Dairy Engineering, Animal Genetics and Breeding, Livestock Production and Management, Animal Nutrition 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 are given to the UG and PG students of other Colleges/Universities. PG students of other Colleges/Universities also conduct project work in the Campus.

A total revenue of Rs.1,76,100/- was collected towards the training fees for the above training programmes.

## Career Guidance and Placement Cell

Guidance and counseling were imparted to the PG students for their career advancement and Campus recruitment was conducted by the various organizations like M/s Almarai company, Saudi Arabia, GCMMF, Anand, Gujarat and ITC Foods Division, Bangalore.

## Extension Activities

During the period under report, 1286 visitors in 27 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.

Advisory services and technical advice were rendered to forty of the clientele, during their personal visits to the institute and through mail response also.

NDRI SRS, Bangalore participated in the exhibition organised at Indian Institute of Horticultural Research (IIHR), Bangalore for the All India Coordinated Research programme Review meeting on 16th January 2010 for showcase of technologies of regional level ICAR Institutes for the benefit of the participants.

NDRI SRS, Bangalore participated in the Horti Expo. 2010, exhibition organised in view of Swadesh Prem Jagriti Sangosthi 2010 and National Conference on Horticulture Biodiversity for Livelihood, economic development & healthcare organised by Lt. Amit Singh Memorial Foundation and University of Horticultural Sciences (UHS), Bagalkot, Karnataka, in collaboration with biodiversity international, Rome, Italy during 28th to 30th May 2010.

The Institute participated in the exhibition at National Conference on "Green Technologies in Dairy & Food Processing Industries" held in Dairy Science College, University of Agricultural Sciences, Hebbal, Bangalore during 27th – 28th, August 2010.

Extension literature on dairy production and processing aspects was distributed to the visitors and needy clients for dissemination of needed technical information to the needy clientele group. During the period under report, an exclusive extension literature on Indigenous Breeds of Southern India was prepared for the benefit of the clientele groups, especially dairy entrepreneurs / progressive farmers as per their request. A dairy product catalogue was prepared for the benefit of the clientele groups especially in view of participation in various dairy melas / exhibitions.

Regular weekly visits were made to the adopted villages for providing needed technical advice

to clientele groups on scientific dairy farming practices and Veterinary Extension Services to the needy clientele group.

| Type of veterinary service | No. of cases treated in Adopted Villages |
|---|---|
| Artificial Insemination | 707 |
| Re-insemination | 302 |
| Calves born. Male | 214 |
| Female | 192 |
| First-aid Cases | 2701 |
| Infertility Cases | 758 |
| Deworming | 2187 |
| Dehorning | 197 |
| Castration | 272 |
| Tattooing | 241 |
| Pregnant Animals | 336 |
| Sale of Born Calves | 53 |
| Abortion | 38 |

## LIVESTOCK FARM

### Deoni Herd Strength

| Age group | Male | Female | Total |
|---|---|---|---|
| Calves up to 6 months | 18 | 20 | 38 |
| 6 months to 1 year | 22 | 10 | 32 |
| 1 to 2 years | 28 | 21 | 49 |
| Above 2 years | 06 | 47 | 53 |
| Milch Animals | - | 41 | 41 |
| Dry Animals | - | 55 | 55 |
| Breeding Bulls | 04 | - | 04 |
| Bullocks | 08 | - | 08 |
| **Total** | | | 280 |

### Performance of Deoni Animals

| | |
|---|---|
| Average no. of Animals in milk | 38 |
| Average no. of Animals in dry | 47 |
| Milking Average (kg/day) | 4.5 |
| Herd Average (kg/day) | 2.0 |
| No. of calves born (M + F) | 49 (28+21) |
| No. of animals died | 02 |
| Mortality per cent | 0.71 |
| No. of Animals disposed | Nil |

## Fodder Farm

The campus has a fodder farm of about 21 hectares for cultivation of various forage crops for meeting the feeding requirement of the dairy herd.

### Fodder Production During (2010-11)

(Qty in Quintals)

| Month | Napier | Guinea | Para | Maize + legumes | Jowar | Ragi | Total (q) | Daily Av (q) |
|---|---|---|---|---|---|---|---|---|
| Apr. 2010 | 481.2 | 175.0 | 1161.5 | 53.9 | - | - | 1871.6 | 62.4 |
| May 2010 | 645.4 | 557.4 | 1066.1 | - | - | - | 2268.9 | 73.2 |
| June 2010 | 575.4 | 485.5 | 909.9 | 14.5 | 165.3 | - | 2150.6 | 71.7 |
| July 2010 | 571.0 | 652.3 | 737.1 | 154.4 | 253.8 | - | 2368.6 | 76.4 |
| Aug. 2010 | 810.0 | 547.1 | 818.1 | 19.0 | 133.4 | - | 2327.6 | 75.1 |
| Sept. 2010 | 520.5 | 318.7 | 1238 | 180.1 | 96.7 | - | 2354 | 78.5 |
| Oct. 2010 | 631.0 | 365.0 | 691.2 | 279.7 | 416.8 | - | 2383.7 | 76.9 |
| Nov. 2010 | 299.0 | 810.6 | 685.1 | 14.3 | 406.7 | 29.0 | 2244.7 | 74.8 |
| Dec. 2010 | 422.9 | 8.5 | 1529.8 | 135.3 | - | 83.2 | 2179.7 | 70.3 |
| Jan. 2011 | 192.1 | 9.0 | 1597.2 | 43.5 | - | - | 1841.8 | 59.4 |
| Feb. 2011 | 60.0 | 83.8 | 1078.3 | - | - | - | 1222.1 | 43.6 |

## Revolving Fund Scheme

The revolving fund scheme was started to sustain the activities of the experimental dairy without much burden on the institute for the funds. Required amount of milk over and above the milk received from the farm was purchased from Bangalore Dairy - a unit of Karnataka Milk federation. Various products like cheese, milk sweet, flavoured dairy drink, ice cream, chhana podo, cheese puri mix, curds, butter, ghee etc. were prepared for sale under this scheme through the milk parlour.

# 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 ICAR. till then located at Haringhata, West Bengal, was merged with the ERS of NDRI with effect from June 1, 1968. In 1978 the Government of West Bengal granted 100 acres of land at Kalyani where cattle sheds, forage unit, staff quarters etc. were gradually built up. The Station built its own laboratory building and the entire station started functioning within the same campus from May, 1987.

The main objective of the Eastern Regional Station is to identify the major constraints of dairy production in eastern and north eastern India and to offer plausible 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 region 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-economics conditions of dairy farmers of this region.

*ERS of NDRI Kalyani*

The ERS, Kalyani has infrastructure facilities like Research laboratories, Cattle Herd, Fodder Farm, Library, Computer section, Guest House *etc*. The station has staff strength of 51 including 08 Scientific, 16 Technical, 07 Ministerial and 20 Skilled Supporting Staff.

Keeping in view the enormous demand for milk in the eastern region, low milk production potential of the native stock, abundance of natural 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.

### Resource Generation

| Heads | Amount (Rs.) |
|---|---|
| Sale of Milk | 16,14,309 |
| Sale of Green Fodder | 16,990 |
| Sale of Animals | 1,00000 |
| Training Charges | 1,08,020 |
| Others | 1,47,284 |
| **Total** | **19,86,523** |

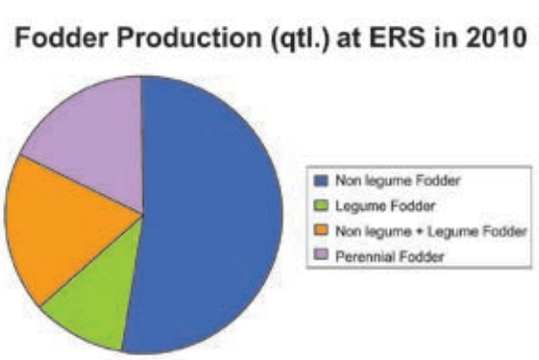
## Support Sections

### Livestock Farm

**Different Breeds:** Jersey cross and Tharparkar

### Fodder Farm

Fodder Farm section is engaged in cultivation of quality fodder crops in about 27 hectare area and manages harvesting and supply of fodder crops either chaffed or unchaffed for farm animals.



## Performance of ERS- NDRI Herd during the year (2010)

| Particulars | Jersey Cross | Tharparkar | Over all |
|---|---|---|---|
| Herd Strength as on 31.12.2010 | 140 | 3 | 143 |
| Total milk production (kg) | 101110 | 1634 | 102744 |
| Av. no. of cow's in milk/day | 45 | 1.2 | 46.2 |
| Av. no. of cow's in dry/day | 15.6 | 2 | 17.6 |
| Wet Average (kg)/day | 6.2 | 2.3 | 6.1 |
| Herd Average (kg)/day | 4.6 | 1.3 | 4.4 |
| Age at First Calving (month) | 39.7 | 0 | 39.7 |
| No. of Inseminated | 87 | 5 | 92 |
| No. of Pregnant | 39 | 2 | 41 |
| Conception Rate (%) | 44.8 | 40.0 | 44.6 |
| Service period (days) | 155 | 189 | 157 |
| Inter calving period (days) | 484 | 555 | 487 |
| Mortality (%) | 5.6 | 0 | 5.6 |

## Milk Production Performance & Fat-SNF% in Milk at ERS-NDRI Herd (Jan. To Dec. 2010)

| Months 2010 | Milk Production (kg) | Wet Average (kg) | Herd Average (kg) | Average FAT % | Average SNF % |
|---|---|---|---|---|---|
| January | 9194.0 | 5.25 | 4.11 | 4.90 | 8.45 |
| February | 7960.0 | 6.10 | 4.64 | 5.13 | 8.72 |
| March | 8387.0 | 5.77 | 4.42 | 5.12 | 8.72 |
| April | 7833.5 | 5.60 | 4.21 | 4.97 | 8.68 |
| May | 8477.0 | 5.77 | 4.29 | 4.93 | 8.67 |
| June | 7871.5 | 5.83 | 4.10 | 4.87 | 8.66 |
| July | 7546.5 | 5.74 | 4.00 | 4.93 | 8.67 |
| August | 8331.5 | 6.37 | 4.20 | 4.87 | 8.68 |
| September | 8212.5 | 6.49 | 4.28 | 4.94 | 8.70 |
| October | 10083.5 | 7.31 | 5.08 | 4.78 | 8.70 |
| November | 9012.0 | 6.80 | 4.80 | 4.66 | 8.42 |
| December | 9835.0 | 6.35 | 5.05 | 4.83 | 8.71 |
| Overall | 102744.0 | - | - | - | - |
| **Average** | | **6.12** | **4.43** | **4.91** | **8.65** |

Besides cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machinery including tractors, chaffcutter etc. There is a small vermicompost unit used for production of vermicompost 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, sissoo, *etc.* around the institute premises. The Forage Section has necessary facilities for the theoretical and practical training in fodder crop production.

**Production of Different Fodder Crops at ERS Fodder Farm during (Jan.-Dec., 2010)**

| Type of fodder | Production (Qtl.) |
|---|---|
| Berseem / Berseem+ Mustard | 2229.45 |
| Maize / Maize+Cowpea | 2439.40 |
| Oats/ Oats + Mustard | 1058.70 |
| Sorghum/ Sorghum + Maize | 3755.15 |
| Sorghum+Ricebean/ RiceBean | 1532.15 |
| Hybrid Napier | 1931.67 |
| Guinea grass | 311.98 |
| Para grass | 146.25 |
| **Total** | **13404.75** |

## Library

The Library has 1503 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 22 journals are subscribed.

## Computer Section

The computer center facilitates the maintenance of database and analysis of experimental data of various research projects. The institute has Internet connectivity through VSAT.

## Extension Activities and Trainings

- Two training programmes on "AI and Veterinary First Aid" of six weeks duration were conducted for 23 participants from West Bengal and Bihar.
- Two 15 days trainings on *Scientific Dairy Farming* were imparted to 33 unemployed rural youth and dairy farmers.
- Two 5 days Capsule courses on *Dairy Cattle management* were organized for 19 women beneficiaries.
- Six Farmars Induction Programmes (FIP) were organized during the year. A total number of 45 men and 110 women dairy farmers of Ichhamati Milk Union Limited (North 24 Parganas) were given exposure to dairy cattle management, nutrition, fodder production, and milk production.
- Thirteen Health and Fertility camps were organized during the year. A total number of 715 animals from 376 beneficiaries were attended and rendered veterinary services and advise on nutrition and management.
- Three village level Motivational Interaction Meetings on "Methods to ensure production of quality milk for higher remuneration" were organized in three women dairy cooperative societies of Ichhamati Milk Union, 24 (N) Parganas.
- A total 8 no. *Awareness Programmes* were conducted at different WMPCS Ichhamati Milk Unions to create awareness among the dairy farmers regarding scientific dairy management practices, nutrition and health management and fodder development.
- Six Fodder Demonstration and seedling distribution Programme were organized in 24 (N) Parganas, Burdwan and 24 (S) Parganas districts.
- The extension team of ERS, NDRI visited Manbhum Dairy Milk Union and delivered lecture on milk production and fodder production under draught prone area, its prospect and remedies. Total 34 beneficiaries from 4 societies attended this programme.
- Three programmes were attended by the experts from ERS in Nadia and 24 (N) Parganas districts on the request of Institute of Cooperative Management, BCKV and Seva Vikas Kendra (NGO).
- The institute participated in three rural Exhibitions held in 24(N) parganas and West Midnapore districts of West Bengal.

★ संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकें नियमित रूप से आयोजित की जाती हैं। इस वर्ष में भी चार तिमाही बैठकें आयोजित की गई तथा बैठकों में लिए गए निर्णयों पर अनुवर्ती कार्रवाई सुनिश्चित की गई।

★ संस्थान द्वारा विगत कई वर्षो से चलाई जा रही प्रोत्साहन योजनाओं के अन्तर्गत मूल हिन्दी वैज्ञानिक/तकनीकी आलेख लेखन पुरस्कार योजना वर्ष 2008–09 के अन्तर्गत 32 वैज्ञानिकों/तकनीकी कार्मिकों को पुरस्कृत किया गया।

★ मूल रूप से हिन्दी में टिप्पण/मसौदा लेखन प्रोत्साहन योजना के अन्तर्गत वर्ष 2008–09 के लिए संस्थान के प्रशासनिक/तकनीशियन तथा चतुर्थ श्रेणी स्टाफ के 10 कार्मिकों को पुरस्कृत किया गया।

★ संस्थान में गत वर्षो की भांति इस वर्ष भी 14 सितम्बर से 30 अक्तूबर 2010 तक राजभाषा मास का आयोजन किया गया। जिसमें तकनीकी वर्ग के कार्मिकों तथा शोध छात्रों हेतु 'शोधपत्र/पोस्टर प्रदर्शन प्रतियोगिता आयोजित की गई। नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों हेतु 'राजभाषा ज्ञान प्रतियोगिता' आयोजित की गई। 19/10/2010 को मुख्य राजभाषा समारोह एवं पुरस्कार वितरण समारोह संपन्न हुआ जिसमें विभिन्न प्रतियोगिताओं के विजेता प्रतिभागियों को नकद पुरस्कार एवं प्रमाणपत्र प्रदान किए गए।

★ संस्थान में राजभाषा क्रियान्वयन को गति देने के उद्देश्य से संस्थान के सहायकों हेतु दिनांक 28/9/2010 को एक प्रशासनिक कार्यशाला का आयोजन किया गया जिसमें 35 सहायकों ने भाग लिया। इस अवसर पर तीन अतिथि वक्ताओं के विशेष व्याख्यान कराने के साथ–साथ प्रतिभागियों को हिन्दी में सरकारी काम–काज करने का अभ्यास भी कराया गया।

★ संस्थान के वैज्ञानिकों के वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, संस्थान की आडिट रिपोर्ट, वार्षिक प्रतिवेदन, प्रशासनिक कार्य, विभिन्न समारोहों की प्रेस विज्ञप्तियां, भाषण, अभिभाषण एवं अनेक प्रकार का अनुवाद कार्य इस एकक द्वारा किया गया।

★ कृषि अनुसंधान तथा शिक्षा विभाग (डेयर) कृषि मंत्रालय, भारत सरकार की श्रीमती उर्मिल हरित, सहा. निदेशक (राजभाषा) द्वारा दिनांक 17/2/2011 को संस्थान में किए जा रहें राजभाषा कार्यकलापों का निरीक्षण तथा समीक्षा कार्य किया गया। उन्होंने संस्थान के प्रशासनिक अधिकारी एवं अनुभाग अधिकारियों की बैठक कर परिषद एवं डेयर की राजभाषा नीति के संबध में चर्चा कर सभी से सरकारी काम–काज राजभाषा हिन्दी में निपटाने का अनुरोध किया।

★ संस्थान के उपनिदेशक (राजभाषा) द्वारा केन्द्रीय मृदा लवणता अनुसंधान संस्थान, करनाल द्वारा आयोजित राष्ट्रीय कृषि विज्ञान संगोष्ठी (22–24/4/2010) तथा राष्ट्रीय कृषि वांनिकी अनुसंधान संस्थान, झांसी तथा बुलेंदखंड विश्वविद्यालय, झांसी द्वारा आयोजित राष्ट्रीय कृषि विज्ञान संगोष्ठी (21–23/1/2011) में भाग लिया तथा एक आलेख प्रस्तुत करते हुए, संगोष्ठी के दो सत्रों में प्रतिवेदक की भूमिका का निर्वाह किया।

## उपलब्धियां/पुरस्कार व सम्मान

★ उच्च विशेषाधिकार प्राप्त संसदीय राजभाषा समिति (कमेटी ऑफ पार्लियामेंट ऑन ओ.एल.) के निर्देशानुसार गठित नगर राजभाषा कार्यान्वयन समिति, करनाल द्वारा संस्थान में किए जा रहें राजभाषा कार्यान्वयन संबंधी उल्लेखनीय कार्यकलापों हेतु करनाल स्थित लगभग 70 केन्द्रीय कार्यालयों के मध्य प्रथम राजभाषा पुरस्कार, 2009–10 के लिए श्री प्रदीप टम्टा, माननीय सांसद एवं सदस्य, संसदीय राजभाषा समिति के करकमलों द्वारा दिनांक 25/11/2010 को प्रदान किया गया। निदेशक के प्रतिनिधि के रूप में यह पुरस्कार श्री आर.एस.गौतम सहा.निदेशक(राजभाषा) तथा राजभाषा एकक के स्टाफ ने प्राप्त किया। संस्थान को यह प्रतिष्ठित पुरस्कार पहले भी 5 बार प्राप्त हो चुका है।

## विशेष सम्मान:

★ इस अवसर पर संस्थान के श्री जे.के.केवलरमानी, सयुंक्त निदेशक (प्रशासन)/कुलसचिव द्वारा विगत कई वर्षो से दिए जा रहे अभूतपूर्व सहयोग के लिए उन्हें लाइफ टाइम एचीवमैंट (जीवन पर्यन्त उपलब्धि) स्वरूप विशेष सम्मान प्रदान किया गया। यह सम्मान उन्हें श्री प्रदीप टम्टा, माननीय सांसद एवं सदस्य, संसदीय राजभाषा समिति गृह मंत्रालय, भारत सरकार के करकमलों द्वारा दिनांक 25/11/2010 को प्रदान किया गया।

# हिन्दी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित अनुसंधान संस्थान है जो कि देश मे डेरी विकास कार्यक्रमों के लिए अनुसंधान एवं विकास तथा मानव संसाधन विकास में सहयोग के लिए पूर्ण रूप से समर्पित रहा है । वर्ष 1923 में स्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में करनाल से स्थानान्तरित कर दिया गया । इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो कि बंगलौर एवं कल्याणी में स्थित है । दक्षिण व पूर्वी क्षेत्रीय केन्द्र स्थानीय क्षेत्र में कृषि वातावरण के अनुरूप डेरी विकास के लिए अनुसंधान एवं सहयोग प्रदान करने में लगे हुए हैं। शैक्षिक कार्यक्रमों के संचालन हेतु संस्थान को मान्य विश्वविद्यालय का दर्जा प्राप्त है ।

## संगठनात्मक स्वरूप

संस्थान की प्रबन्ध प्रणाली भारतीय कृषि अनुसंधान परिषद् के मान्य विश्वविद्यालय की प्रशासनिक पद्धति के अनुरूप ही है। संस्थान के अनुसंधान, शिक्षण, प्रशिक्षण, विस्तार शिक्षा और प्रशासनिक कार्यकलाप के क्षेत्र में नीति–निर्धारण और निर्णय का दायित्व प्रबंध मंडल, अनुसंधान सलाहकार परिषद, विद्या परिषद एवं विस्तार परिषद, समितियों को सौंपा गया है। निदेशक इस संस्थान का कार्यपालक अधिकारी है। दोनों संयुक्तनिदेशक, निदेशक को अनुसंधान, शिक्षण एवं विस्तार कार्यकलापों को संपन्न कराने में सहयोग प्रदान करते है । संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र (1) डेरी उत्पादन (2) डेरी प्रसंस्करण तथा (3) डेरी प्रसार प्रबन्ध है। सभी अनुसंधान एवं विस्तार कार्यक्रम संस्थान के मुख्यालय तथा इसके दो क्षेत्रीय केन्द्रों पर संस्थान के बारह प्रभागों/अनुभागों डेरी पशु प्रजनन, पशुधन उत्पादन एवं प्रबंधन, डेरी पशुपोषण, डेरी पशु शरीर क्रिया विज्ञान, पशु जीवरसायन, पशु जैवप्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी इंजीनियरी, डेरी सूक्ष्मजीव विज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र सांख्यिकी एवं प्रबन्धन प्रभाग के अन्तर्गत संपन्न होते है। संस्थान में एक कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक), कृषि विज्ञान क्रेन्द्र तथा डेरी प्रशिक्षण केन्द्र भी है। संस्थान में पशुधन फार्म, चारा अनुसंधान केन्द्र, पशु प्रजनन अनुसंधान केन्द्र, पशु स्वास्थ्य परिसर, मॉडल डेरी संयंत्र, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय सेवा एंव राष्ट्रीय जैवसूचना केन्द्र, कंप्यूटर केन्द्र, संपदा अनुभाग तथा अनुरक्षण इंजीनियरी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे वित्त, क्रय, भंडार, स्थापना, राजभाषा एकक तथा सुरक्षा के कार्यकलाप संयुक्त निदेशक (प्रशासन) एवं कुलसचिव के नियंत्रण में है। संस्थान में इस समय 149वैज्ञानिक 313 तकनीशियन, 142 प्रशासनिक तथा 662 निपुण सहायक कर्मचारी सेवारत हैं ।

## बजट

वर्ष 2010–2011 में संस्थान में योजना और गैर–योजना शीर्ष में कुल व्यय बजट 11265.69 लाख रूपए था तथा वर्ष 2010–11 के लिए कुल बजट 11265.69 लाख रूपए स्वीकृत किया गया। इसमें मान्य विश्वविद्यालय तथा कृषि विज्ञान केन्द्र का बजट भी सम्मिलित है।

## अनुसंधान

वर्ष 2010 के दौरान कुल 82 अन्तः संस्थान अनुसंधान परियोजनाओं का कार्य चल रहा था। मूल एवं महत्वपूर्ण अनुसंधान कार्यो को सुदृढ़ करने के लिए एन.ए.आई.पी. के द्वारा 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 कृषि नवप्रवर्तन परियोजना (एन.ए.आई.पी.) परियोजना के अन्तर्गत वर्ष 2010–11 के दौरान 20 परियोजनाओं के लगभग 34 करोड़ रूपए की राशि जारी रहेगी। कई अनुसंधान कार्यक्रमों के राष्ट्रीय स्तर पर जैव प्रोद्योगिकी विभाग (डी.बी.टी.), राष्ट्रीय कृषि उपयोगी सूक्ष्मजीव ब्यूरो (एन.बी.ए.आई.एम.) नैशनल कम्यूनिकेशन टू यूनाइटेड नेशन्स फ्रेमवर्क कनैक्शन ऑन क्लाइमेंट चेंज (एन.ए.टी.सी.ओ.एम–यू.एन.एफ.सी.सी.) इंडो–यू.एस–एग्रीकल्चरल नोलेज इनीशिएटिव (ए.के.आई) खाद्य प्रसंस्करण उद्योग मंत्रालय, राज्य कृषि विश्वविद्यालयों तथा राज्य विकास विभागों के साथ अन्तःसंस्थानिक संबंध थे।

इस अवधि की कुछ महत्वपूर्ण अनुसंधन उपलब्धियों का विवरण निम्नवत् है।

- ★ राष्ट्रीय डेरी अनुसंधान संस्थान में हैंड गाइडिड क्लोनिंग तकनीक के द्वारा जून 2009 में विश्व के प्रथम क्लोन्ड भैंस की कटड़ी 'गरिमा' के जन्म का ऐतिहासिक रिकार्ड तोड़ने के बाद संस्थान ने क्लोनिंग तकनीकी में आगे और प्रगति की तथा इस तकनीक से एम्ब्रोयोनिक स्टैम सेल से 22 अगस्त,2010 को भैंस की दूसरी कटड़ी 'गरिमा–II' का जन्म हुआ तथा अगस्त 26, 2010 को एक क्लोन्ड कटड़े 'श्रेष्ठ का जन्म हुआ जिसमें दो सप्ताह के भैंस के कटड़े के कान से स्टैम सैल लेकर उत्पन्न किया गया।
- ★ एक प्रणाली जिसमें बी.एफ.जी.एफ तथा एल.आई.एफ. के साथ कल्चर माध्यम का सम्पूरण सम्मिलित है। भैंस के एम्ब्रोयोनिक स्टैम सैल के कल्चर के लिए विकसित की गई।
- ★ हैंड गाइडिड क्लोनिंग द्वारा अन्तःर्जातीय ब्लास्टोसिस्ट स्टेज भ्रूण उत्पन्न किए गए इसके लिए भैंस के साइटोप्लास्ट तथा गोपशुओं एवं बकरियों से अलग किए सोमोटिक कोशिकाओं का प्रयोग किया गया।
- ★ रासायनिक अथवा विद्युत उत्प्रेरण का प्रयोग करके ब्लास्टोसिस्ट स्टेज भ्रूण उत्पन्न करने के लिए अनिषेक जनन

विकास के लिए जोना–फ्री भैंस के डिम्बाणुजन कोशिकाओं को सफलता पूर्वक सक्रिय किया गया।

★ एक पश्चआनुवांशिक संशोधक स्क्रिपटायड के साथ भ्रूणों के उपचार द्वारा अथवा साइटोप्लाज़्म मात्रा बढ़ाकर क्लोनिंग क्षमता में सुधार किया गया।

★ विकास की दृष्टि से कुछ महत्वपूर्ण जीन्स जैसे– बीसी$^{एल}$–एक्स$^{एल}$, बैक्स, ग्लुट–1 तथा एच.एस.पी. 70.1 क्लोन्ड तथा आई.वी.एफ से उत्पन्न भ्रूणों में विशिष्ट रूप से अभिव्यंजित किए गए।

★ भैंसों में 30 से अधिक डिम्बाणुजन कोशिका विशिष्ट असाधारण जीनों की पहचान की गई, उनमें से कुछ डिम्बाणुजन कोशिका को सक्षम बनाने में महत्वपूर्ण भूमिका निभा सकते हैं।

★ एस.आर.वाई जीन के पी.सी.आर प्रवर्धन द्वारा बकरी के भ्रूणों की सिंगल ब्लास्टोमियर सैक्सिंग की गई।

★ शुक्राणु डी.एन.ए. के एच 19 डी.एम.आर. में पश्चजनन परिवर्तन संकर गोपशुओं में प्रजनित सांडों की जननक्षमता से महत्वपूर्ण ढंग से संबंधित पाए गए।

★ पांच क्रोमोसोमल जीन्स से क्लोन्ड बनाए गए तथा उनकी परवती कार्रवाई प्रक्रिया में है।

★ एस.एन.पीएस तथा इनडेल मार्करस आधारित वाई क्रोमोसोम पर आधारित गोपशु वाई क्रोमोसोमल हैपलोटाइपिंग विधि विकसित की गई।

★ प्रजनन की दृष्टि से अपूर्ण पशुओं में दुर्बल– X (एक्स) क्रोमोसोम पाए गए। दुर्बल– X के प्रकथन के लिए विभिन्न टी.सी.मीडिया का परीक्षण किया गया। डी.एन.ए. प्राइमरों ने दुर्बल– X क्रोमोसोम की विद्यमानता की पुष्टि की।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के कुल 253 साहीवाल तथा 200 करल फ्रीज गोपशुओं ने फैक्टर XI जीन (एक्ज़ोन 12) के 244 बी.पी. के सिंगल बैंड प्रदर्शित किए जो कि यह इंगित करते हैं कि पशु समूह एफ XI जीन के लिए एकरूप है। 105 में जी.से ए. अवस्थिति से केवल एक असमानार्थक न्यूक्लिओटाइड परिवर्तन पाए गए परिणामस्वरूप साहीवाल तथा करन फ्रीज गोपशुओं में ग्लूटामाइन (क्यू.) से बॉस टारस में आर्गिननाइन (आर.) से दूसरे कोडोन में अमीनो अम्ल के परिवर्तन देखे गए।

★ टी.एल.आर. 4 जीन के एक्ज़ोन 3 के 382 बी.पी. विखंड एलू। रिस्ट्रोइक्शन एन्ज़ाइम का प्रयोग करके पी.सी.आर.–आर.एफ.एल.पी. के द्वारा 190 दुधारू साहीवाल गोपशुओं में आनुवांशिक पोलिमार्फिज़्म प्रकट किए गए। ए.ए., ए.बी. तथा बी.बी. के लिए जिनोटाइपिक आवृति क्रमशः 0.01, 0.61 तथा 0.37 थी। ए.बी. जिनोटाइपड पशुओं के टी. एल.आर. 4 जीन के एक्ज़ोन 3 में न्यूक्लिओटाइड 2335 बी.पी. पर पहचान की गई।

★ कुल 16 मुर्राह कटड़ों को वर्ष 2010–11 के दौरान भविष्य में प्रजनन के लिए युवा कटड़ों के चयन के लिए शारीरिक समनुरूपता तथा नसल विशेषताओं, डैम की श्रेष्ठ दिन दुग्ध उत्पादन तथा अपेक्षित भावी अन्तराल (ई.पी.डी.) के आधार पर आरक्षित रखा गया। आरक्षित कटड़ों का डैम का श्रेष्ठ 305 दिन दुग्ध उत्पादन 2542 से 3862 कि०ग्रा० के बीच रहा। आरक्षित मुर्राह कटड़ों की ई.पी.डी. तथा श्रेष्ठता क्रमशः 34 से 402 कि0ग्रा0 तथा 1.85 से 18.63: के बीच रही।

★ लगभग 34.40% श्रेष्ठ मुर्राह भैसों की न्यूक्लिअस ब्रीडिंग पशु समूह की स्थापना के लिए पहचान की गई।

★ मुर्राह भैंसों की प्रजनन क्षमता के पूर्वानुमान के लिए अनुकूलतम माडल 70.21 से 85.09% के बीच पूर्वानुमान की परिशुद्धता के साथ विकसित किए गए थे। मुर्राह भैंसों की प्रजनन क्षमता की इन्डाइसिस पशुसमूह में भैंसों के निपटान तथा प्रतिधारण के लिए भी विकसित किए गए।

★ राष्ट्रीय डेरी अनुसंधान संस्थान केन्द्र के सांड संख्या 4915 जिस का प्रजनक सूचकांक 2116 कि0ग्रा0 तथा 305 दिन के श्रेष्ठ दुग्ध उत्पादन 3437 कि0ग्रा0 था सर्वश्रेष्ठ प्रजनक सांड घोषित किया गया, भैंस सुधार पर नैटवर्क परियोजना के अन्तर्गत सात सैट में सन्तति परीक्षण के 12 सांडों में से 17.26% के श्रेष्ठता पाई गई।

★ मुर्राह भैंसों में क्षेत्रीय परिस्थितियों के अन्तर्गत कुल 2810 कृत्रिम गर्भाधान किए गए जिसके परिणामस्वरूप 41.53% गर्भाधान दर प्राप्त की गई। कृषकों के पशुसमूह में कुल 1045 (566 कटड़े तथा 479 कटड़ियां) उत्पन्न हुई तथा झोटों के मूल्यांकन के लिए 782 भैंसों पर प्रदर्शन आंकड़े रिकार्ड किए गए। विभिन्न केन्द्रों पर रजिस्टर्ड मादा पशुओं तथा प्रजनन योग्य मादा पशुओं की कुल संख्या क्रमशः 5664 तथा 4380 थी। वर्ष के दौरान कृत्रिम गर्भाधान के लिए 11वें सैट के 13 प्रजनित झोटों का प्रयोग किया गया।

★ कुल 29 करन फ्रीज बछड़ों को भविष्य में प्रजनन के लिए युवा बछड़ों के चयन के लिए शारीरिक समनुरूपता तथा नसल विशेषताओं, डैम की श्रेष्ठ 305 दिन दुग्ध उत्पादन तथा अपेक्षित भावी अन्तराल (ई.पी.डी.) के आधार पर आरक्षित रखा गया। आरक्षित करन फ्रीज कटड़ों का डैम का श्रेष्ठ 305 दिन दुग्ध–उत्पादन 4549–8338 कि0ग्रा0 के बीच था। चयनित बछड़ों का ई0पी0डी0 1.57 तथा 18.44% के बीच था।

★ करन फ्रीज गायों में कुल 3070 कृत्रिम गर्भाधान किए गए जिसके परिणामस्वरूप दिसम्बर 2010 तक क्षेत्रीय परिस्थितियों के अन्तर्गत 47.9% गर्भाधान दर प्राप्त की गई। कृषकों के पशुसमूह में कुल 1086 (560 बछड़े तथा 526 बछड़ियां) करन फ्रीज बछड़े–बछड़ियां उत्पन्न हुए तथा

क्षेत्रीय परिस्थितियों के अन्तर्गत सांडों के मूल्यांकन के लिए 863 करन फ्रीज बछड़ों पर प्रदर्शन आंकड़े रिकार्ड किए गए।

★ कुल 17 साहीवाल बछड़ों को भविष्य में प्रजनन के लिए युवा बछड़ों के चयन हेतु शारीरिक समनुरूपता तथा नसल विशेषताओं, डैम की श्रेष्ठ 305 दिन दुग्ध उत्पादन तथा अपेक्षित भावी अन्तराल (ई.पी.डी.) के आधार पर आरक्षित रखा गया। आरक्षित साहीवाल बछड़ों का डैम श्रेष्ठ 305 दिन दुग्ध उत्पादन 2425–3811 कि0ग्रा0 (प्रथत दुग्धस्त्रवण काल) के बीच रहा।

★ परीक्षण दिवस दुग्ध उत्पादन (35वें, 65वें, 125वें, 185वें तथा 275वें दिन) के अनुकूलतन समीकरण समावेशन परीक्षण दिवस से एफ.एल.305 दिन डी.एम.वाई. के (>92%) पूर्वानुमान की उच्चतम यथार्थता प्रकट करती है कि इन परीक्षण दिवसों का दुग्ध उत्पादन साहीवाल गो–पशुओं में यथार्थता की उच्चतर डिग्री के साथ एफ.एल. 305 डी.एम.वाई. पूर्वानुमान के लिए प्रयोग किया जा सकता है। इसके अतिरिक्त, यह निष्कर्ष निकाला गया कि दुग्ध–स्त्रवण वक्र की सभी तीनों अवस्थायें (आरोही, स्थायी तथा अवरोही) उच्चतर यथार्थता के साथ एफ.एल. 305 डी.एम.वाई. के पूर्वानुमान के लिए महत्वपूर्ण थे।

★ साहीवाल गोपशुओं में एफ एल 305 डी.एम.वाई. से अधिक आंशिक दुग्ध उत्पादन के आधार पर चयन की सापेक्षितक क्षमता यद्यपि कम थी तथापि तुलनात्म्क थी। प्रथम तीसरे महीने के दुग्ध उत्पादन तथा सचिंत 90 दिन के दुग्ध उत्पादन के आधार पर चयन 89% तथा 79% था। जो कि उतना ही प्रभावी था जितना कि एफ एल 305 डी.एम.वाई. के आधार पर था।

★ एफ एल 305 डी.एम.वाई. के पूर्वानुमान के लिए बहुगुणा (मल्टीपल) रिग्रेशन विश्लेषण विधि सबसे श्रेष्ठ विधि पाई गई। छह मास तक पृथक मासिक दुग्ध उत्पादन तथा संचित मासिक दुग्ध उत्पादन के आधार पर पूर्वानुमान की उच्चतर यथार्थता पाई गई। साहीवाल गोपशुओं में अनुपात विधि, सरल प्रतिक्रमण विधि जैसी विधियों की तुलना में मल्टीपल (बहुगुणन) प्रतिक्रमण विधि अधिक श्रेष्ठ पाई गई।

★ साहीवाल गोपशुओं में प्रयुक्त चार विधियों (लीस्ट स्कवेयर, सिंपल रिग्रेसड लीस्ट स्कवेयर तथा बी.एल.यू.पी.) में से प्रजनक मूल्यांकन की सबसे अधिक सक्षम एवं सही विधि डी.एफ आर.ई.एम.एल. विधि पाई गई। एफ एल 305 डी.एम.वाई. प्रथम तृतीय मास दुग्ध उत्पादन के लिए साहीवाल प्रजनकों के प्रजनन मान का मूल्यांकन करने के लिए मल्टी ट्रेट डी.एफ.आर.ई.एम.एल. की अपेक्षा सिंगल ट्रेट डी.एफ. आर.ई.एम.एल. अधिक सक्षम थी।

★ मलनाद गिदा गोपशुओं में 107 डी.एन.ए. नमूनों में बीओएलए. – डी.आर.बी. 3.2 एलेल के आण्विक लक्षणों का परीक्षण किया गया। दो नवीन बी.ओ.एल.ए.–डी. आर.बी 3.2 एलेल की पहचान डी.आर बी 3.2*ए.**एए (*5702) तथा डी.आर.बी.3* 4*bi(*2503) के रूप में की गई इसकी आवृति क्रमशः 9.346% तथा 2.04% पाई गई। डी.आर बी 3*सी.ए.एफ., *ई.ए.एफ., *ए.बी.बी., 'पी.ए.डी. नामक चार नवीन एलेल जिनकी प्रत्येक की आवृति 0.7% थी। दियोनी नस्ल में अवलोकन किया गया।

★ बंगलौर, कोलर तथ समीपस्थ जिलों से साठ डेरी कृषकों जिनमें पांच व्यावसायिक डेरी कृषक भी सम्मिलित थे, के श्रेणीकृत होलस्टिन फ्रीजियन तथा संकर होलस्टिन फ्रीजियन की उत्पादन क्षमता पर अध्ययन किया गया। पंजाब के 14 व्यावसायिक पशु समूहों में श्रेणीकृत होलस्टिन फ्रीजियन के प्रदर्शन का मूल्यांकन भी इस अध्ययन में सम्मिलित है जहां अच्छी आवास एवं आहार सुविधाएं प्रदान की गई।

★ गोपशुओं के राशन में ऐकेशिया नीलोटिका फलियों के प्रयोग से प्रकट होता है कि पशुओं के पौषणिक अन्तर्ग्रहण, उपयोग तथा प्रदर्शन के संबंध में राशन के पौषणिक मान में महत्वपूर्ण सुधार हो सकता है। शरीर में कुल अमीनो अम्लों के उद्ग्रहण में महत्वपूर्ण वृद्धि हुई जिसके फलस्वरूप पशुओं की समग्र प्रदर्शन क्षमता में वृद्धि हुई।

★ चूहों के राशन में बबूल की फलियों से तत्व निकाले गए टे. निनस अथवा बबूल की फलियों का प्रयोग शरीर भार, रक्त शर्करा, सीरम कोलस्ट्रोल, ट्रिगलाइसीरायडस में कमी इंगित की गई। यह इन्सुलिन सान्द्रता तथा असंक्राम्यता स्तर को बढ़ाता है।

★ लहसून+फयूमरिक अम्ल तथा लिसुन+माइरिस्टिंक के संयोजन से इन विवो परिस्थितियों के अन्तर्गत गेहूँ की भूसी पर आधारित सम्पूर्ण आहारों में मीथेन में 38 प्रतिशत तक कमी प्रदर्शित की गई।

★ अण्डाशय प्रजनन विकारों से पीड़ित भैंसों में जननक्षमता सुधार के लिए हीटसिन्च विधि के व्यवाहारिक प्रयोग सफलतापूर्वक प्रदर्शित किए गए।

★ छिली हुई दुग्ध एपीथिलियल कोशिकाएं मुर्राह भैंस के दूध से 30 दिन के लिए सफलतापूर्वक वियोजित एवं सवंर्धित किए गए।

★ ब्याने के आस–पास नियंत्रित गायों की तुलना में विटामिन ई०, तांबा तथा जस्ता सम्पूरित साहीवाल गायों में न्यूट्रोफिलिक तथा लसीका–कोशिका (लिम्फोसाइट) प्रचुरउदभवन क्रियाकलाप अधिक थे।

★ विटामिन ई० खिलने से मुर्राह भैंसों मे ऊष्मीय दबाव का प्रभाव कम हो गया।

★ दूध छुड़ाने के बाद बढ़तु हुए अल्प शारीरिक भार वाले करन फ्रीज बछड़ों को सैकेरोमाइसीज सेरेबिसी प्रतिजीवियों के सम्पूर्ण से विकास क्षमता एवं स्वास्थ्य के स्तर में सुधार प्रदर्शित किया।

★ प्रयोगात्मक माडलों का प्रयोग करके, यह संस्थापित किया गया कि 'प्रोबायोटिक दही' असंक्राम्यता कार्यो में सुधार करती है तथा एंजिंग की प्रक्रिया को धीमा करता है।

★ प्रतिआक्सीकर स्तर, असंक्राम्यता कार्य एवं एजिंग बायोमार्कर जीनों की अभिव्यंजना पर 4,12 तथा 16 मास की आयु के चूहों में एजिंग संबंधी परिवर्तनों को समझने के लिए अध्ययन किया गया।

★ प्रयोगात्मक चूहों में एसिडो बिफिडस प्रोबायोटिक (प्रतिजैवी) दही ने प्रतिवर्तित आयुअभिप्रेरित असंक्राम्यता तथा अन्य जैवरासायनिक विकसित किए। इससे आक्सीकर क्षति (टी.बी.ए.आर एस तथा कार्बोनिल प्रोटीन) एवं हीम आक्सीजिनेज –1 की अभिव्यंजना में कमी हुई। इसने ऊत्तक प्रतिआक्सीकर स्तर (कैटालेज़ तथा सुपरआक्साइड डिसमुटेज), मेक्रोफेज कार्यो (प्रतिक्रिया आक्सीजन किसम, इन्टरल्यूकिन आई.एल–6 कमी) में सुधार किया।

★ गाय तथा भैंस के दूध से वियोजित केसीनोफास्फोपेप्टाइड ने प्रयोगात्मक चूहों में दैहिक एवं म्यूकोसल असंक्राम्यता दोनों को बढ़ाया तथा ओवलब्यूमिन प्रवृत आईजीई० मीडियेटिड एलर्जी के प्रतिकूल संरक्षात्मक प्रभाव प्रदर्शित किए।

★ चूहों के माडल में दूध की हाइपर अंसक्राम्यता गुणों पर तुलनात्मक अध्ययनों से प्रकट होता है कि एंटीबफैलो बीटा–ले. क्टोग्लोबुलिन की तुलना में एंटीकाओ बीटा–लेक्टोग्लोबुलिन (एल.जी.) आई.जी.ई. की टाइटर 1.8 गुना (पी.<0.05) अधिक थी।

★ बीटा–ग्लूकेन (प्रोबायोटिक)/एल.केसी.(प्रोबायोटिक) के साथ किण्वित दूध युक्त सम्पूरक आहार खिलाने की संरक्षात्मक भूमिका ओवलब्यूमिन प्रवृत एलर्जी माडल में आन्त्र ऊत्तकों में हिस्टोपैथोलोजिकल परिवर्तनों तथा कुल विष्ठीय जीवाण्विक काऊन्ट के द्वारा प्रदर्शित की गई।

★ पशु (एच.एफ.डी.चूहों) की तुलना में प्रोबायोटिक फाइबर इन्यूलिन एवं बीटा–ग्लूकेन युक्त उच्च वसा आहार के सम्पूर्ण द्वारा शरीर भार एवं संचित शरीर भार वृद्धि में महत्वपूर्ण अन्तर पाया गया।

★ स्थायी गोल्ड नैनोपार्टिकलस (जी.एम.पी.एस) तैयार करने के लिए एक नवीन विधि विकसित की गई। साइट्रेट रिडक्शन विधि द्वारा तैयार किए गए जी.एम.पी. की तुलना में नई विधि द्वारा तैयार जी.एम.पी. ने एन.ए सी एल की ओर पांच गुना अधिक स्थिरता प्रदान की।

★ यूरोपियम आक्साइड के साथ मिला हुआ भैंस के शुक्राणुओं की इलेक्ट्रान माइक्रोस्कोपी द्वारा बारीकी से जांच करने पर उनकी झिल्लीय सतह के साथ सम्पर्क तथा शुक्राणुओं के सिर तथा पूंछ में उनका प्रवेश प्रकट हुआ। शुक्राणु क्रोमोटिम विक्षेपण परीक्षण द्वारा नैनोपार्टिकलस के साथ डी.एन.ए. क्षति में डोज़ आधारित वृद्धि भी अवलोकित की गई।

★ परख नली संधारिता एवं परखनली निषेचन विधियों द्वारा मूल्यांकन करने पर टारिन, ट्रिहलोज जैसे संयोजकों की विद्यमानता में क्रायोपरिरक्षित भैंस के शुक्राणुओं के एपोपटोटिक परिवर्तनों ने नेक्रोटिक सेल डैथ के अतिरिक्त सेल डैथ की ओर महत्वपूर्ण योगदान दिया।

★ स्तनधारियों ने शुक्राणुओं के परखनली निषेचन के दौरान पहली बार टायरोसाइन फास्फोरिलेटिड के रूप में सीराइन/परियोनाइन प्रोटीन फास्फोटेज़ पी.पी.–1 अल्फा कैटाला. इटिक सबयूनिट तथा मेम्ब्रेन मटेलो एंडोपेप्टीडेज़ 1° सें० पहचान की गई।

★ भैंस में विशाल पुटिका, पुटिकीय पुटी तथा ल्यूटिल पुटी में प्रमोटर (प्रवर्तक) विशिष्ट व्यवहार में सी.वाई.पी. जीन 19 विभिन्न प्रकार से तथा भैंसों में ल्युटियल सिस्ट के दिखायी दी। एक नोवेल न्यूकिलिमोटाइड पॉलीमोर फ़िज़्म (एस.एन.पी.) निकटस्थ प्रोत्साहक क्षेत्र में रहें। 135 की स्थिति से पहचान कर यह अध्ययन किया गया कि इसके संबंध से पशुओं में देरी से परिपक्ता आती है।

★ ऊतक विशिष्ट निकटस्थ प्रोत्साहक (पी.11) को डिम्बग्रंथि में पहचाना, प्रवर्धक क्लोन्ड तथा क्रमशः पाया गया। डिम्ब ग्रंथियों को नियमन करने के क्रम में प्रोत्साहक के रूप में फॉलीक्यूलो जीनसिस तथा ल्यूटिनी जेशन का प्रभाव पाया गया, जबकि डिस्टल प्रोत्साहक (पी.1.1) को मुख्य प्रोत्साहक के लिए सीवाईपी–19 जीन को उत्तरदायी देखा गया फिर भी सीवाईपी 19 जीन को भैंसों की अपरा की विभिन्न अवस्थाओं को प्रकट करता है।

★ मैट्रिक्स मैटीरियल तथा प्रोबायोटिक (प्रतिजैवी) के साथ कोमाइक्रोइनकेप्सुलेशन द्वारा प्रोबायोटिक अवयवों की स्थिरता में वृद्धि के लिए एक प्रक्रिया मानकीकृत की गई।

★ मधुमेह के रोगियों के लिए पौषणिक प्रत्याम्ल गोलिया, क्रियात्मक डोडा बरफी, लौह–पुष्ट दुग्ध एवं–अनाज आधारित बिस्किट, व्हेप्रोटीन–तथा बाजरा आधारित निस्त्रावक स्नेक, आहारीय सम्पूरक जैसे स्वास्थ्य/नयूट्रासियुटिकल आहारों के लिए प्रक्रियाएं विकसित की गई।

★ पशु माडल में अर्जुन हर्बल घी के एंटीहाइपरलिपिडैनिक प्रभावों की जांच की गई।

★ दूध में विदारीकंड (प्यूरेरिया टयूबरोज) हर्ब (शाकीय) सत्तव के समावेशन की उपयुक्तता की जांच की गई।

★ डेयरिंग की सहायता से ग्रामीण आजीविका को समृद्ध बनाने के लिए महिला स्वयं–सहायक–समूह (एस.एच.जी.) के स्वामित्व के अन्तर्गत एक ग्रामीण दुग्ध प्रसंस्करण यूनिट

(अनमोल महिला दुग्ध समिति, अमृतपुरकलां) की स्थापना की गई।

★ प्रोटीन तथा लेक्टोज़ हाइड्रोलाइजड व्हे दोनों से व्हे पेय बनाने की प्रक्रिया विकसित की गई इसमें 8% चीनी, 1% स्टार्च तथा 4% आम का गूदा सम्मिलित था जो कि उपभोक्ताओं द्वारा स्वीकार्य था। व्हे पेयों को 65° सेंटीग्रेड पर 10 मिनट के लिए ऊष्मा उपचारित करने से उत्पाद की शेल्फ लाइफ में वृद्धि प्रदर्शित की गई।

★ दक्षिण क्षेत्रीय केन्द्र, बंगलौर पर स्किम मिल्क पाउडर तथा खसखस एवं पिसी हरी मूँग दाल संयोजित प्यासम शुष्क मिश्रण को तुरन्त पुनः संरचना के लिए तैयार करने की विधि मानकित की गई।

★ स्वास्थय की दृष्टि से लाभकारी बटरमिल्क पेय को तैयार करने में कुछ सब्जियों एवं फलों के सत्व का प्रयोग किया गया। बटरमिल्क पेय पदार्थो को ऊष्मित तथा कार्बनीकरण करने से बटरमिल्क पेय पदार्थो की शेल्फ लाइफ बढ़ाने में सहायक होते हैं।

★ डीप फ्राइंग के दौरान गुलाबजामुन में रंग परिवर्तनों की बलगातिकी जिसमें प्रतिक्रिया दर स्थिरता एवं तापमान निर्भरता सम्मिलित हैं। गुणवत्ता को बढ़ाने में तथा क्षति को न्यूनतम करने में महत्वपूर्ण पाए गए। एक कंप्यूटर विज़न आधारित प्रस्ताव का प्रयोग करते हुए बलगतिकी पैरामीटरों का अध्ययन किया गया। डेरी उत्पादों के निर्माण, विभिन्न लागत संघटकों तथा विपणन से संबंधित सूचना व्यक्तिगत रूप से निरीक्षण एवं अवलोकन द्वारा एकत्रित की गई।

★ स्किम मिल्क में डब्ल्यू.पी.एच. (1 से 2%) के समावेशन से इसकी प्रतिआक्सीकर क्रियाकलाप चार गुना तथा स्किम मिल्क की तुलना में ए.सी.ई. निरोधक क्रियाकलाप 35 गुना तक बढ़ गई।

★ आइसक्रीम में 01 प्रतिशत की दर से डब्ल्यू.पी.एच. के समावेशन से इसकी प्रतिआक्सीकर क्रियाकलाप 55% तक तथा ओवररन 26.6% गुना उच्चतर थी।

★ स्ट्राबेरी पुष्टिकारक दही का प्रतिआक्सीकर क्रियाकलाप सामान्य की तुलना में तीन गुना अधिक पाया गया।

★ किण्वित स्किम मिल्क की व्हे फ्रेक्शन को मूलभूत अपमार्जक क्रियाकलाप 0.12 से 0.49 एम.एम.ओ.एल$^{-1}$ ट्रोलक्स समकक्ष प्रतिआक्सीकर क्षमता (टी.ई.ए.सी.) प्रदर्शित करता है।

★ चीज़ व्हे के 103 एमजी./एल. से अनुरूप उत्पादन के साथ भैंस के दूध से जी.एम.पी. के वियोजन के लिए एक विधि मानकित की गई।

★ टोन्ड दूध को केल्सियम, लौह तथा विटामिन ए के साथ अलग–अलग पुष्टीकृत किया गया।

★ फ्रीज–ड्रांइग पर आधारित भैंस के स्किम कोलस्ट्रम पाऊडर के लिए प्रौद्योगिकी विकसित की गई।

★ दूध 100–200 पी.पी.एल. में जांच सीमा के साथ गोल्ड नैनोपार्टिकल का प्रयोग करके दूध में मैलामाइन की जांच के लिए एक सरल रंग परीक्षण विधि विकसित की गई।

★ एक बाइंडर के रूप में केसीन का प्रयोग करते हुए एक बेक्टीरिओसिन आधारित प्रतिसूक्ष्मजीवी पैकेजिंग (ए.एम.पी.) प्रणाली विकसित की गई।

★ स्वदेशी लेक्टोबेसिलस वियोजक महत्वपूर्ण रूप से (पी<0.001) जी.पी.एक्स[1] की अभिव्यंजना को आक्सीकर प्रतिबल परिस्थितियों के अन्तर्गत 3.310 से 10.083 गुना के बीच नियंत्रित करता है।

★ विभिन्न स्वदेशी अनुमानित प्रोबायोटिक लैक्टोबेसिलस कल्चर (प्रवर्तक) के द्वारा शोरबा से कोलस्ट्रोल परिपाचन 7.6±0.84 से 69.27±0.38 ug / एम.एल के बीच रहा।

★ ख्यात स्वदेशी लेक्टोबेसिलस की दो जातियां एल.पी. 9 तथा एल.पी. 91 ने प्रोबायोटिक के साथ एच.टी–29 कोशिकाओं को पूर्व उपचारित करने पर सुदृढ़ इम्यूनो–मोडयूलेटिंग प्रतिक्रिया तथा उसके बाद एल.पी.एस. चैलेंज प्रवर्तित करता है।

★ व्हे आधारित शोरबा मीडिया प्रभावी लागत लेक्टोबेसिलस केसी एन सी डी सी 17,298 से एम.आर.एस.शोरबा के विकास के समान उत्पादन सूत्रीकृत किया गया। लेक्टोबे. सिली बायोमास के उत्पादन के लिए मीडिया का प्रयोग किया जा सकता हैं ।

★ प्रोटियोलाइटिक लेक्टोबेसिली के साथ किण्वन द्वारा व्हे प्रोटीन तथा केसीन के एंटीमाइक्रोबाइल जैवसक्रिय पेप्टाइड (< 10 के डी ए) उत्पन्न किए गए। इन ए एम पी में ग्राम पोजिटिव (बी.सीरस) तथा ग्राम नेगेटिव (सेलमोनीला टाइफी, शिगैला डाइसैनट्राइ तथा ई0 कोलि) जीवाणुओं के प्रतिकूल जीवाण्विक प्रक्रिया थी।

★ ल्यूकोनोस्टक स्पै. की एक प्राकृतिक जाति का प्रयोग करके एक विलक्षण कम कैलोरी वाला प्राकृतिक कार्बोनिटेड किण्वित दुग्ध पेय विकसित किया गया।

★ ल्यूकोनोस्टक स्पै. की एक उत्परिवर्ती किस्म का प्रयोग करके व्हे से मैनीटॉल उत्पादन के लिए एक किफायती प्रौद्योगिकी द्वारा व्हे से मैनीटॉल उत्पादन के लिए एक किफायती प्रौद्योगिकी विकसित की गई।

★ बीजाणु अवरोध आधारित–एन्जाइम तत्व अमापन (एस.आई.बी.–ई.एस.ए.) का प्रयोग करके दूध में अफ्लाटाक्सिन एम। अनुश्रवण के लिए एक रियल टाइम प्रक्रिया (पेटेन्ट रजि०# 3064/डी.ई.एल./2010) विकसित किया गया। इसका विकास संग्रह केन्द्रों, चिलिंग केन्द्र, निर्माण यूनिटों तथा अनु. संधान एवं विकास संस्थानों पर गुणवत्ता नियंत्रण परीक्षण पर इसके प्रयोग के लिए किया गया।

★ विकसित ई.एस.ए.(एन्जाइम तत्व अमापन) क्रमशः 2,7½, 6½ तथा 5 घंटों की उदभवन अवधि के भीतर इन्टरकोकि के 2,6,7 3.50, 4.25 तथा 4.8 लाग काउन्टों का पता लगाने में सक्षम पाए गए।

★ 16 एस.$_{आर.}$आर.एन.ए. जीन का प्रयोग करके मुर्राह भैसों में रूमेन मेथनोजनस पर विविध अध्ययन उत्तरी भारत में मेथनोब्रेविबेक्टर स्पै तथा उसके बाद मेथनोमाइक्रोबियम मोबाइल की प्रभाविता इंगित करते हैं।

★ अवायुजीवी रूमेन रूमेन फफूंद, आर्पिनोमाइसिस जायोनि अधिकतम पी–कामरि 1 तथा फेरूलायेल इस्टरसिस उत्पन्न करते रूमेन में उनकी लिंगों–सेल्युलोलइटिक क्रियाकलाप की ओर पाए गए।

★ लेक्टोबेसिलस रहेमनोसस डी 7 नामक एक वियोजन अधिकतक पोटेन्ट सोय आइसोफ्लेवोन जैव परिवर्तक (बायो–ट्रासंफार्मर) पाए गए।

★ बढ़ती शेल्फ लाइफ के साथ प्रोबायोटिक (प्रतिजैवी) दही के उत्पादन, प्रत्यक्ष वैट सेट प्रतिजैवी कल्चरों, सिनबायोटिक मिस्टी दही तथा योघर्ट के उत्पादन के लिए प्रोद्योगिकियां विकसित की गई। मिश्रित प्रोबायोटिक प्रवर्तक सूत्रीकरण खाद्य का विकृत होना एवं रोगजनक अवयवों के विरूद्ध प्रतिसूक्ष्मजैवी क्रियाकलाप प्रदर्शित हुए।

★ चयनित डेरी संयंत्र के लिए परिकलित (कंप्यूटिड)बेसलीन एनर्जी के विरूद्ध वास्तविक एनर्जी उपभोग आकंड़ों का संचित एस.यू.एम. (सी.सू.एस.यू.एम.) विश्लेषण ने संस्थापित किया कि संयंत्र ने ऊर्जा अनुश्रवण एवं लक्ष्य प्रणाली के क्रियान्वयन के लिए एक मामला प्रस्तुत किया। एम.एस. एक्सेल शीटों पर ऑनसाइट मानीटरिंग के दौरान लक्ष्यों के विकास हेतु अपेक्षित प्रणाली समर्थन भी विकसित किए गए। इसके प्रारम्भिक परीक्षण पूरे किए गए तथा आधुनिक बनाए जा रहे थे जैसा कि रियल टाइम डाटा रिकार्ड किए गए।

★ एक सर्वेक्षण अध्ययन से प्रकट हुआ कि महाराष्ट्र के अहमदनगर जिले में संकर दुधारू गोपशुओं के दुग्ध–उत्पादन की प्रति लीटर लागत लघु, मध्यम एवं विशाल फार्मो के लिए क्रमशः ₹ 12.49 ₹12.58 तथा ₹ 11.48 थे। गाय के दूध से प्रति लीटर लागत पर ₹ 2.08 शुद्ध लाभ हुआ। कुल उत्पादित दूध का अतिरिक्त विपणन लघु,मध्यम एवं विशाल व्यावसायिक फार्मो के लिए 94.48, 94.81 तथा 96. 96 प्रतिशत था।

★ पंजाब के लुधियाना जिले में ग्रामीण एवं पैरी अरबन डेरी फार्मो के आर्थिक विश्लेषण में पाया गया कि ग्रामीण एवं पैरी–अरबन फार्मो पर दुधारू भैंसों की वार्षिक दैनिक शुद्ध अनुरक्षण लागत क्रमशः ₹141.10 तथा ₹151.06 थी। ग्रामीण एवं पैरी–अर्बन डेरी फार्मो पर प्रति दुधारू संकर गाय की वार्षिक दैनिक शुद्ध अनुरक्षण लागत क्रमशः ₹145.18 तथा ₹155.61 थी। ग्रामीण एवं पैरी–अर्बन डेरी फार्मो पर डेयरिंग से उत्पन्न औसत रोजगार क्रमशः 313.22 तथा 1450.88 श्रम दिवस प्रतिवर्ष थी।

★ तमिलनाडु के धर्मपुरी तथा थरूवनामलाई जिलों में भैंस द्वारा प्रतिदिन प्रयुक्त हरे चारे, शुष्क चारे तथा सान्द्रण की मात्रा 11.12, 5.98 तथा 5.24 कि0ग्रा0 पाई गई। डेरी पशु समूह की सम्पूर्ण अनुरक्षण लागत ₹ 39.25 प्रतिदिन थी। सम्पूर्ण अनुरक्षण लागत प्रति संकर गाय प्रतिदिन ₹51.29 थी।

★ कर्नाटक के शिमोगा दुग्ध क्षेत्र में डेरी फार्मिंग के लिए संस्थानिक आकलन के आर्थक विश्लेषण में पाया गया कि व्याव्सायिक बैंकों (सी.बी.एस) ने डेरी व्यवसाय से जमा पूंजी का 81% योगदान रहा। औसतन कुल जमा राशि का केवल 36% पशुओं की खरीद के लिए तथा अन्य प्रयोगों के लिए शेष राशि का व्यय किया गया।

★ हिमाचल प्रदेश के उच्च पहाड़ी शीतोष्ण नम क्षेत्रों में दूध की वैल्यू चेन विश्लेषण पर अध्ययन में पाया गया कि दुग्ध द्रुतशीतन केन्द्र, सराहन (नाहन) पर दुग्ध संग्रहण, परिवहन एवं द्रुतशीतन की लागत क्रमशः ₹1.58, ₹2.03 तथा ₹ 0.43ए प्रतिलीटर थी। स्टैन्डर्ड दूध, टोन्ड दूध तथा डबल टोन्ड दूध उत्पादन की कुल चल लागत क्रमशः ₹20.19, ₹ 18.76 तथा ₹ 18.95 प्रति लीटर था।

★ डेरी वैल्यू चेन में आजीविका पर नीति सुधार के प्रभावी अध्ययन से प्रकट होता है कि वर्ष 1960–61 से 2002–03 की अवधि के दौरान परिवार क्रियात्मक जोत क्षेत्र के सीमान्त वर्ग 58% से 79% तक बढ़ गए। यह भी पाया गया कि 'आपरेशन फ्लड' (1970–1980) के प्रथम चरण में मूल्यवर्धित उत्पादों की विकास दर 0.93% प्रतिवर्ष थी, जबकि तीसरे चरण में (1985–1996) में यह बढ़कर 9.10% प्रतिवर्ष हो गई। वर्ष 1994–95 से 2000–01 की अवधि के दौरान असंगठित सैक्टर में चीज़ दही तथा आइसक्रीम जैसे नवीन मूल्य वर्द्धित डेरी उत्पादों के उत्पादन ने एक सकारात्मक वृद्धि रजिस्टर्ड की जबकि मक्खन, क्रीम, घी तथा बटरमिल्क जैसे अत्यन्त परम्परागत उत्पादों ने नकारात्मक वृद्धि रजिस्टर्ड की।

★ भारत में डेरी उत्पाद निर्माण उद्योगों के प्रदर्शन मूल्यांकन के विश्लेषण पर अध्ययन से यह प्रकट हुआ कि असंगठित डेरी उतपादन यूनिटों की संख्या 1994–95 में 1,40, 836 से कम होकर 2005–06 में 1,27,069 हो गई, जबकि संगठित यूनिटों की संख्या उसी अवधि में 563 से बढ़कर 1049 हो गई। असंगठित ग्रामीण उद्यम पश्चिमी बंगाल, उत्तरप्रदेश तथा गुजरात में अत्यन्त सकेन्द्रित थे, जबकि असंगठित शहरी उद्यम उत्तरप्रदेश, राजस्थान तथा आन्ध्रप्रदेश में सकेन्द्रित थे।वर्ष 1998–99 से 2007–08 की अवधि के दौरान संगठित डेरी उद्योग ने उत्पादन का वास्तवित मान में 5% विकास दर रजिस्टर्ड की।

★ मुर्राह भैंसों में आर्थिक विश्लेषकों के पूर्वानुमान के लिए संयोजक एंव परम्परगत माडलों के बीच तुलनात्मक मूल्यांकन में पाया गया कि मुर्राह भैंसों में कुल दुग्ध स्त्रवण काल के दूध उत्पादन तथा 305 दिन दुग्ध उत्पादन में संयोजक माडल अपेक्षाकृत श्रेष्ट पाए गए।

★ संस्थान की एक नई वैबसाइट 'एग्रोवैब डिजिटल डिससेमिनेशन सिस्टम' एन.ए.आई.पी. परियोजना के अन्तर्गत विकसित की गई जिसमें संकाय सदस्यों के प्रोफाइल डाटाबेस, प्रभाग/अनुभाग प्रोफाइल, वर्ष 2003–2009 से एम.एससी./पीएच.डी, शोध प्रलेखों अनुसंधान परियोजना डैटाबेस, प्रकाशित अनुसंधान पेपर, एटिक सूचना, छात्रों के डाटाबेस, कृषकों के लिए सूचना आदि सम्मिलित है।

★ 'गाय तथा भैंसों के श्रेष्ठ जर्मप्लाज़्म (जनन द्रव्य) के स्त्रोत एवं उपलब्धता', 'गोपशुओं तथा भैंसों अपेक्षित उत्पादकता तथा पशु समूह के अनुश्रवण द्वारा फार्म प्रबन्धन के लिए निर्णय सहायता प्रणाली तथा डेरी प्रवर्तकों के राष्ट्रीय संग्रहण' पर तीन वैब– योग्य सूचना प्रणालियां भी विकसित की गई।

★ आयुर्वेद, यूनानी तथा सिद्वा तथा होम्योंपैथी जैसी परम्प. रागत प्रणालियों में प्रयुक्त दुग्ध उत्पादों में दही, बटरमिल्क, घी, क्रीम, व्हे तथा पनीर सम्मिलित है। न्यूट्रास्युटीकल तथा चिकित्सीय सूत्रीकरण के रूप में दुग्ध–उत्पादों के प्रयोग से संबंधित स्वदेशी ज्ञान का बहुमूल्य खजाना उपलब्ध है।

★ पूर्वी क्षेत्रीय केन्द्र, कल्याणी द्वारा डेरी सरकारी समितियों तथा एन.जी.ओ.एस. के अनुरोध पर कृषकों के लिए नियमित अन्तराल पर अभिविन्यास कार्यक्रम आयोजित किए गए।

## शिक्षा

★ राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय, करनाल पर चालू शैक्षणिक सत्र 2010–11 के दौरान चारा उत्पादन में एम.एससी पाठ्यक्रम प्रारम्भ किया गया।

★ शैक्षिक विनियमों को पुनः बनाया गया जिनमें परीक्षा प्रणाली, उपाधियां देने के लिए ग्रेडिंग प्रणाली तथा पीएच.डी. छात्रों के लिए परिज्ञान परीक्षा प्रारम्भ करना सम्मिलित थे।

★ वर्ष 2010–11 के दौरान राष्ट्रीय डेरी अनुसंधान संस्थान ने खांडा, इरान, इथोपिया, श्रीलंका आदि के अन्तरराष्ट्रीय छात्रों को बड़ी संख्या में अपनी ओर आकर्षित किया है। इस समय राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय द्वारा चलाए जा रहे विभिन्न पाठ्यक्रमों में कुल 21 विदेशी छात्र अध्ययन कर रहे हैं।

★ अनुसंधान कार्य की गुणवत्ता में सुधार एवं प्रतिस्पर्धा की भावना को प्रोत्साहित करने के लिए मास्टर एवं टाक्टरेट छात्रों के लिए छात्रों के लिए सर्वश्रेष्ठ थीसिस पुरस्कार आरम्भ किया गया।

★ रिपोर्टाधीन अवधि में, राष्ट्रीय डेरी अनुसंधान संस्थान डेरी एवं डेरी प्रसंस्करण के क्षेत्र प्रगत संकाय प्रशिक्षण केन्द्र (सी.ए.एफ.टी.) के रूप में मान्य हुआ।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय का नौंवा दीक्षान्त समारोह 19 फरवरी, 2011 को संपन्न हुआ। पदमभूषण डा0 रामबदन सिंह, अध्यक्ष, राष्ट्रीय कृषि विज्ञान अकादमी (एन.ए.ए.एस) ने दीक्षान्त भाषण दिया तथा छात्रों को उपाधियां, स्वर्णपदक, मेरिट प्रमाणपत्र एवं पुरस्कार दिए। श्री अशोक सिन्हा, सचिव, खाद्य प्रसंस्करण मंत्रालय, भारत सरकार ने समारोह की अध्यक्षता की।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के चहुंमुखी विकास के लिए स्वर्गीय डा0 डी0 सुन्दरेसन के बहुमूल्य योगदान की स्मृति में डा0 डी.सुन्दरेसन स्मारक व्याख्यान पुरस्कार डा0 मंगलाराय भूतपूर्व सचिव, डेयर एवं महानिदेशक, भारतीय कृषि अनुसंधान परिषद को दिनांक 17 फरवरी, 2011 को दिया गया।

★ डेरी शिक्षण एवं अनुसंधान से संबंधित मामलों पर नीति पत्र (पोलिसी पेपर) विकसित करने के लिए राष्ट्रीय डेरी विज्ञान अकादमी 01 जून, 2010 को थिंक टैंक के रूप में कार्य करने के लिए प्रारम्भ किया।

★ रिपोर्टाधीन अवधि के दौरान राष्ट्रीय डेरी अनुसंधान संस्थान, राष्ट्रीय ज्ञान नैटवर्क, भारत सरकार के लिए एक कड़ी के रूप में मान्य हुआ। इंटरनेट सम्पर्कता (कनैक्टिविकटी) 1 जी.बी. गति इस योजना के अन्तर्गत प्रदान की गई।

★ राष्ट्रीय डेरी अनुसंधान संस्थान में पहली बार, एक नई एन. सी.सी. बटालियन संस्थापित की गई। बी.टैक प्रथम वर्ष के छात्रों के लिए एन.सी.सी. अनिवार्य की गई।

★ राष्ट्रीय डेरी अनुसंधान संस्थान के शोध छात्रों को विज्ञान एवं प्रौद्योगिकी विभाग द्वारा सर्वश्रेष्ठ छात्रों के लिए प्रारम्भ किए गए 'इन्सपायर' छात्रवृति हेतु आवेदन करने के लिए प्रोत्साहित किया गया। वर्ष 2010–11 के दौरान पांच छात्रों ने यह छात्रवृति प्राप्त की।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय के छात्रों के लिए दिनांक 28 फरवरी 2011 को 'राष्ट्रीय विज्ञान दिवस' के अवसर पर छात्रों में नवप्रवर्तन की भावना एवं सृजनात्मक विचारधारा हेतु 'माई आइडिया' प्रतियोगिता आयोजित की गई। पुरस्कार विजेता छात्रों द्वारा श्रेष्ठ आइडियों (विचारों) की प्रस्तुति दी गई।

★ कृषि वैज्ञानिक चयन मंडल (ए.एस.आर.बी.) के तत्वावधान में 2010–11 में छात्रों के प्रवेश के लिए आन–लाइन परीक्षा प्रणाली के लिए राष्ट्रीय डेरी अनुसंधान संस्थान पर संरचनात्मक सुविधा का भी सृजन किया गया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय की शैक्षिक उपलब्धियों को केन्द्रित तथा पुनरावलोकन करने के लिए दिनांक 14–19 फरवरी, 2011 तक शैक्षिक सप्ताह मनाया गया।

★ राष्ट्रीय डेरी अनुसंधान संस्थान ने पारस्परिक हितों के क्षेत्र में समन्वय के लिए राज्य कृषि विश्वविद्यालयों जैसे शेर–ए–काश्मीर कृषि एवं प्रौद्योगिकी विश्वविद्यालय, जम्मू, बनारस हिन्दू विश्वविद्यालय, वाराणसी, थापर विश्वविद्यालय, पटियाला, मानव भारती विश्वविद्यालय सोलन तथा इन्दिरा गाँधी राष्ट्रीय मुक्त विश्वविद्यालय, नई दिल्ली के साथ आपसी सूझबूझ के ज्ञापन पर हस्ताक्षर किए।

## विस्तार

★ संस्थान द्वारा विकसित विभिन्न प्रौद्योगिकियों को हस्तांतरित करने के लिए अपनाए गए गॉवों में डेरी कृषकों के साथ कुल 53 किसान संगोष्ठियां आयोजित की गई। कुल 856 कृषकों को प्रजनन प्रबन्धन तकनीकियों, थनैला नियंत्रण, रोगों से बचाव के तरीकों तथा चारा उत्पादन के बारे में जागरूक बनाया।

★ कृत्रिम गर्भाधान के द्वारा देशी भैंसों में चयनित प्रजनन तथा गायों में संकरण कार्यक्रम चालू रहे। कृत्रिम गर्भाधान की गर्भस्थापन दर गायों में 46.20% तथा भैंसों में 35% पाई गई।

★ अपनाए गए गाँवों में बांझपन नियन्त्रण तथा पशु चिकित्सा सहायता हेतु मासिक कैंप लगाए गए। देर से परिपक्व होने वाले अमदकाल तथा पुनरावृति प्रजनन के कुल 2309 पशुओं की जांच की गई तथा उनके निदान हेतु पर्याप्त उपचार दिए गए।

★ कृषक समुदाय में डेरी उत्पादन तथा प्रसंस्करण प्रौद्योगिकियों को प्रभारी तथा प्रचार–प्रसार को सुदृढ़ करने के लिए 'कृषकों के द्वार पर डेरी शिक्षण' कार्यक्रम प्रभावी ढंग से चल रहा है।

★ वर्ष के दौरान कृषि विज्ञान केन्द्र/डेरी प्रशिक्षण केन्द्र ने 282 प्रशिक्षण कार्यक्रम (परिसर के अन्दर तथा बाहर दोनों) आयोजित किए गए। यह कार्यक्रम डेरी उत्पादन, डेरी प्रसंस्करण, कृषि, कृमि संवर्धन, मधुमक्खी पालन, मत्स्यपालन तथा गृहविज्ञान में विभिन्न पहलुओं पर आधारित थे। इनमें कुल 7861 प्रशिक्षणार्थियों ने भाग लिया तथा इन प्रशिक्षण कार्यक्रमों के दौरान कुल प्रशिक्षित श्रम दिन 20189 थे।

★ कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक) को और सुदृढ़ किया गया। रिपोर्टाधीन अवधि के दौरान तकनीकी जानकारी एवं परामर्श सेवा प्राप्त करने के लिए 21040 कृषक एटिक में आए। एटिक सहायता सेवा प्रदान करने, प्रकाशनों की बिक्री, बीजों, जैव–उर्वरकों तथा वर्मी कम्पोस्ट की बिक्री, प्रदर्शनी, फिल्म प्रदर्शन तथा आमने–सामने परस्पर सम्पर्क स्थापित कराने के कार्यों में लगा हुआ था।

★ भूटान, डेनमार्क, नेपाल, संयुक्त राज्य अमरीका, ईरान, हंगरी, यू.के. से कुल 73 प्रतिनिधि कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक) में पधारे। उन्हें स्टेक होल्डरों की आय तथा उत्पादकता बढ़ाने में एटिक द्वारा अपनाए गई सिंगल विंडो प्रणाली के प्रभाव तथा प्रौद्योगिकियों के हस्तांतरण एवं सूचना की भूमिका अन्य अनुसंधान एवं विकासात्मक एजेन्सियों/संस्थानों के साथ सम्पर्क, कार्यों तथा उद्देश्यों के बारे में स्पष्ट किया गया।

## आधारीय संरचना

★ खेल के मैदान का नवीकरण।

★ प्रशासनिक खंड का नवीकरण।

★ बच्चों के नवविकसित पार्क में संरक्षात्मक दीवार का चारों तरफ निर्माण कार्य किया गया।

★ पुस्तकालय की मरम्मत एवं नवीकरण।

★ लघु पशुगृह की संपूर्ण मरम्मत एवं नवीकरण का कार्य।

★ डेरी सूक्ष्मजीव विज्ञान प्रभाग, डेरी पशु प्रजनन प्रभाग, डेरी पशु शरीर क्रिया प्रभाग, डेरी प्रौद्योगिकी प्रभाग, पशु जीव प्रौद्योगिकी केन्द्र, पशु जीवरसायन प्रभाग, डेरी रसायन प्रभाग, डेरी पशु पोषण प्रभाग तथा डेरी विस्तार प्रभाग में प्रयोगशालाओं को सुसज्जित एवं नवीकरण करना।

★ संस्थान के पावर हाउस के भवन का निर्माण।

★ संस्थान में सतलुज, कावेरी तथा कृष्णा छात्रावासों का नवीकरण।

★ संस्थान के छात्रावासों को बिजली की तारों, फिटिंग तथा स्विचों का नवीकरण।

★ संस्थान के वैज्ञानिक गृह का नवीकरण।

★ डेरी मेला ग्राऊंड की ईंटों की दीवार के साथ चेन लिंक फेन्सिंग की गई।

★ निदेशक कार्यालय, सम्मेलन कक्ष एवं वैज्ञानिक गृह का नवीकरण।

★ अन्तरराष्ट्रीय छात्रावास के परिसर की फेन्सिंग का कार्य।

★ डेरी सूक्ष्मजीव विज्ञान प्रभाग तथा डेरी रसायन प्रभाग में बिजली के कार्य का नवीकरण।

★ संस्थान के स्वास्थ्य परिसर पर फिजियोथेरैपी एकक की संस्थापना।

★ परिसर से फार्म अनुभाग को जाने वाली सड़कों का नवीकरण।

# GUIDE MAP OF NDRI, KARNAL

## ADMINISTRATIVE BLOCK



## DIVISIONS, SECTIONS AND SUPPORTING UNITS



## RESIDENTIAL



## OTHERS



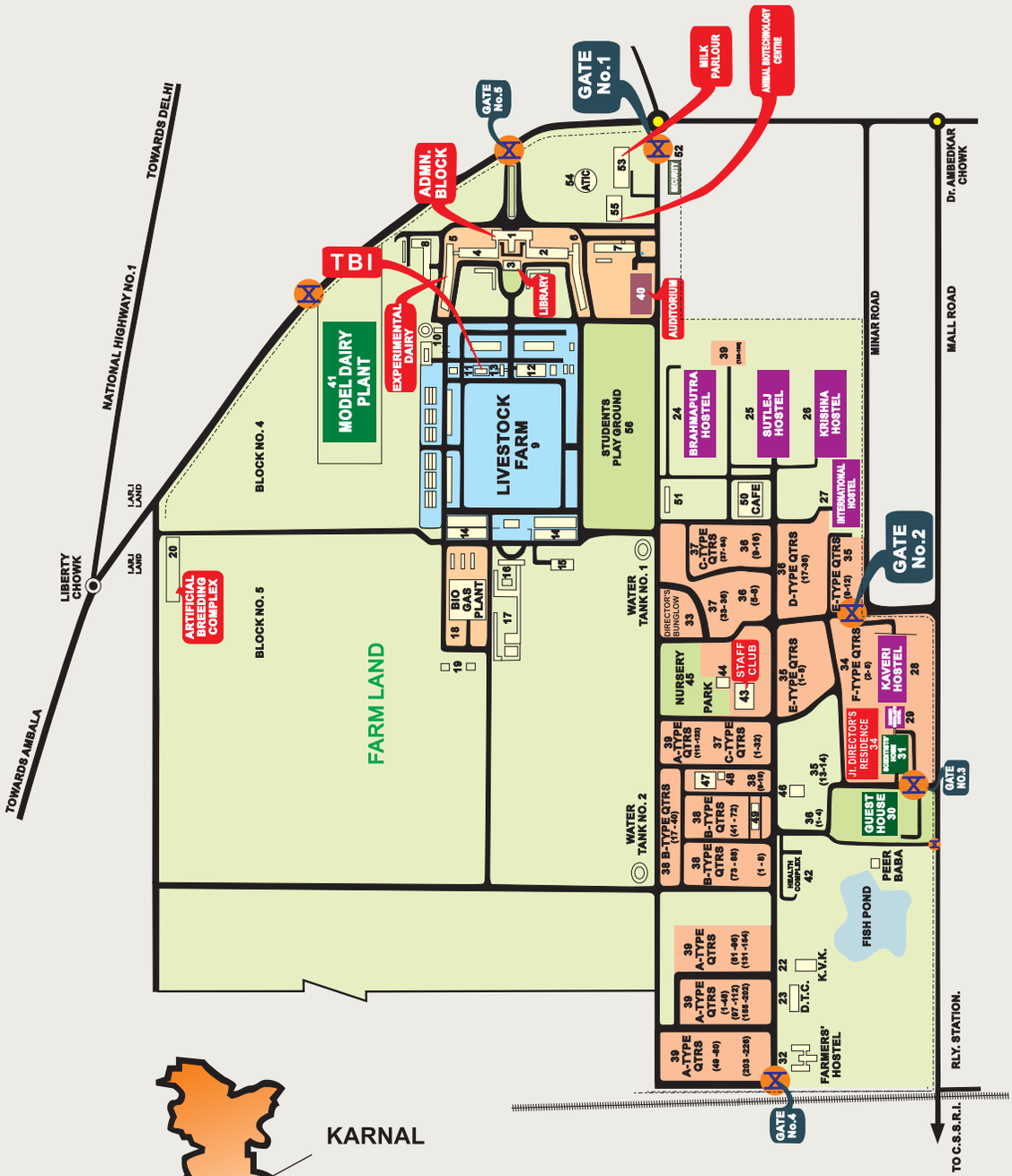
## STUDENT HOSTELS



## GUEST ACCOMMODATION



# 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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