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FRONT COVER PHOTO



*8<sup>th</sup> Convocation of NDRI,  
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BACK COVER PHOTO



*World's second buffalo calf  
'Garima' produced through  
Hand-guided cloning*



राष्ट्रीय डेरी अनुसंधान संस्थान की वर्ष 2009-10 की वार्षिक रिपोर्ट एक विस्तृत अनुसंधान उपलब्धियों के रूप में प्रस्तुत की जा रही है, इसमें संस्थान की विगत एक वर्ष की डेरी अनुसंधान, शिक्षण, विस्तार एवं संरचनात्मक विकास संबंधी महत्वपूर्ण उपलब्धियां प्रस्तुत की गई हैं।

वर्ष 2009-10 के दौरान, राष्ट्रीय डेरी अनुसंधान संस्थान के अनुसंधान एवं विकास कार्यक्रमों को अधिदेशानुकूल तथा सुव्यवस्थित अनुसंधान कार्यक्रमों के द्वारा और अधिक गति मिली है इन अनुसंधान कार्यक्रमों में 90 अन्तः संस्थानिक एवं 38 बाह्य वित्तीय सहायता प्राप्त अनुसंधान परियोजनाएं सम्मिलित हैं जिनमें 19 एन. ए. आई. पी. परियोजनाओं के द्वारा 33 करोड़ की वित्तीय सहायता प्राप्त कर ली है। प्रत्येक एन. ए. आई. पी. परियोजना को संघ मानीटरिंग 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. ए. सी. की नियमित बैठकें थी।

Annual Report 2009-10 of National Dairy Research Institute (NDRI) is being presented as a comprehensive treatise highlighting 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 holistic view of this premier dairy Institute of the country and its functioning.

During the year 2009-10, the research and development programme of NDRI got further momentum through mandate oriented and very well-structured research programmes comprising 90 in-house and 38 externally funded research projects, which included 19 NAIP projects in consortium mode having the financial outlay of Rs. 33 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.

वर्ष 2009 के दौरान 'हैंड गाइडिड क्लोनिंग तकनीक' नामक नवविकसित तकनीकी द्वारा राष्ट्रीय डेरी अनुसंधान संस्थान में विश्व की प्रथम क्लोन्ड कटड़ी का जन्म होना संस्थान की सबसे विशेष उपलब्धि है। इस तकनीक द्वारा संस्थान पर दो कटड़ियां उत्पन्न हुईं। जीवित क्लोन्ड कटड़ी 'गरिमा' का जन्म 6 जून 2009 को हुआ तथा वह अच्छी प्रकार से बढ़ रही है। संस्थान में निकट भविष्य में ऐसी और अधिक क्लोन्ड कटड़ियों के पैदा होने की आशा है। इस अकेली अनुसंधान उपलब्धि ने पुनः संस्थान को विश्व के मानचित्र पर स्थापित कर दिया है। मदचक्रीय पशुओं को आवृत्त में ला कर भैंसों में जनन क्षमता में वृद्धि करने के लिए एक आसिन्ध विधि विकसित की गई। अपेक्षित प्रजनन मानकों पर आधिरत दो साहीवाल तथा तीन मुराह सांडों को सन्तति सांड घोषित किया गया। दैनिक, साप्ताहिक तथा वार्षिक परीक्षण दिवस दुग्ध उत्पादन का प्रयोग कर परीक्षण दिवस ब्याँत वक्र माडल विकसित किए गए तथा क्षेत्रीय परिस्थितियों के अन्तर्गत संगठित पशुसमूहों में मुराह भैंसों के मासिक तथा कुल ब्याँत दुग्ध उत्पादन के पूर्वानुमान के लिए आंशिक ब्याँत रिकार्ड किए गए। विकसित होते भैंस के डिम्बाणुजन कोशिका के जीनोमिक विश्लेषण तथा भ्रूणों के पूर्वारोपण से एक अभिव्यंजना आधारित मार्कर की पहचान करने में मदद की जिसमें कि डिम्बाणुजत कोशिका को सक्षम बनाने की विशेषता थी। भैंस के भ्रूण को विकसित करने में एम्ब्रयोनिक परिवर्तन से मातृक निर्धारण करने में ट्रांसक्रिपशन प्रवर्तन संबधित जीनों की अभिव्यंजना में सहायक है। गोपशुओं एवं भैंसों के दूध में संयुग्मित लिनोलिक अम्ल (सी. एल. ए.) में वृद्धि के लिए आहार नीतियों को कार्यान्वित किया गया।

डेरी प्रसंस्करण के क्षेत्र में, भैंस, गाय, बकरी तथा ऊँट से लेक्टोफेरिन के प्रोटीन-प्रोटीन पारस्परिक क्रिया सामान्य जठरीय पी. एच. पर लौह-निर्मुक्त क्षमता के लिए भैंस के लेक्टोफेरिन के विभिन्न लाभ सुझाए गए। इसके औषधीय गुणों के कारण भैंस के लेक्टोफेरिन की जाँच के लिए यह अत्यावश्यक संकेत प्रदान करता

The most remarkable breakthrough during 2009 was the birth of world's first cloned buffalo calf at NDRI through development of a new technique called 'Hand-guided cloning' technique. Through this technology, two calves were produced at NDRI. The surviving cloned calf born on 6th June 2009, named 'Garima' is very well growing. The Institute is expecting more such cloned buffaloes in near future. This single research achievement has again put NDRI on world map. An Ovsynch Protocol was developed for augmenting fertility in buffaloes by bringing anoestrous animals into cyclicity. Based on expected breeding values, two Sahiwal and three Murrah bulls were declared as proven bulls. The test day lactation curve models were developed using daily, weekly and monthly test day milk yields and part lactation records for predicting monthly and total lactation milk yields of Murrah buffaloes in organized herd and under field conditions. Genomic analysis of developing buffalo oocytes and pre-implantation of embryos helped in identifying an expression based marker that could define the oocyte competence. Expression profiling of genes related with transcription initiation helped in defining the Maternal to Embryonic transition event in developing Buffalo embryos. Feeding strategies to enhance conjugated linoleic acid (CLA) in bovine and buffalo milk were worked out.

In the area of Dairy Processing, Protein-protein interaction of lactoferrins from buffalo, cow, goat and camel suggested distinct advantage of buffalo lactoferrin for iron release capacity at normal gastric pH. This provides vital clue for exploring buffalo lactoferrin for its therapeutic attributes. The two types of Probiotic Dahi, developed at NDRI were found beneficial against gastrointestinal tract

है। राष्ट्रीय डेरी अनुसंधान पर विकसित दो प्रकार की प्रोबायोटिक दही जठरीय आन्त्रीय क्षेत्र में लाभकारी सिद्ध हुई है तथा प्रयोगात्मक पशुओं में कैंसर उपचार में भी प्रभावकारी पाई गई। अधिक उपनिवेशन संभाव्यता के साथ नवीन प्रोबायोटिक लेक्टोबेसिल की जाँच के लिए पी. सी. आर. विधियां विकसित की गईं। दूध से जैव-एथेनॉल के उत्पादन के लिए चार थर्मो-टोलरेंट, अल्कोहल टोलरेंट तथा ओस्मो टोलरेंट यीस्ट प्रजातियां, डेरी उत्पादों तथा फलों के जूस से वियोजित की गईं। विटामिन बी<sub>12</sub> से भरपूर 'प्रोपासोनि योघर्ट' तैयार करने की तकनीक विकसित की गई जिससे विटामिन की कमी तथा संबंधित रोगों की समस्या का पता लगता है। उच्च प्रतिआक्सीकारक आधारित फल दूध पेय पदार्थों के लिए भी तकनीकी विकसित की गईं। 'फोलेट से भरपूर क्रियात्मक दही' जिसमें उच्च फोलेट उत्पन्न करने वाले प्रतिजैवी विद्यमान हैं। एक क्रियात्मक डेरी आहार के रूप में विकसित की गईं। इसी प्रकार, अल्प वसा तथा उच्च रेशे के अंश तथा ओमेगा-3 भरपूर दूध युक्त एक कुर्ग किस्म की ताजी चीज विकसित की गईं। जैवपरिरक्षकों का प्रयोग करके सोरगम-माल्ट (सोरगम - लस्सी नमकीन) अथवा पर्ल मिलेट माल्ट (बाजरा-लस्सी नमकीन) का प्रयोग करके रबड़ी जैसे: किण्वित दूध पेय की शेल्फ लाइफ बढ़ाने की विधियां मानकित की गईं हैं। स्प्रे ड्राइंग विधि को अपना कर तथा भैंस के दूध, गाय के दूध एवं बटरमिल्क से किण्वित दुग्ध पेय पर आधारित पुनः संरचना के लिए तैयार सोरगम पर्ल मिलेट तैयार करने की विधियां मानकित की गईं। दक्षिण क्षेत्रीय केन्द्र पर काशी हलवा तैयार करने की विधि मानकित की गईं। दूध में प्रतिजैविकी (एन्टीबायोटिकस) के बीटा-लेक्टम वर्ग की विशेष जांच के लिए एक नवीनसूक्ष्मजैविक विधि विकसित की गईं। नैनो प्रौद्योगिकी के क्षेत्र में पारिष्कृत प्रवाह में उनके संभावित प्रयोगों के लिए नवीन कारकों का प्रयोग कर गोल्ड नैनो कणों को सफलतापूर्वक तैयार किया गया। दुग्ध उत्पादों के यन्त्रीकरण उत्पादन के क्षेत्र में मलाई-लच्छा बनाने की विधि विकसित की गईं।

carcinogenesis and efficacious in cancer treatment in experimental animals. PCR assays were developed for screening of new probiotic lactobacilli with strong colonization potentials. Four thermo-tolerant, alcohol-tolerant and osmo-tolerant yeast strains for the production of bio-ethanol from whey were isolated from dairy products and fruit juices. The technology for the preparation of Vitamin B<sub>12</sub> rich 'Propioni Yoghurt' was developed to address the problem of Vitamin deficiency and related diseases. Technology was also developed for high antioxidant based fruit whey beverages. A "folate rich functional dahi" containing a high folate producing probiotic strain was developed as a functional dairy food. Likewise, a Quarg type Fresh Cheese was developed with low fat and high fiber content and omega 3- enriched milk.

Protocols were also standardized to extend the shelf life of raabadi-like fermented beverages using sorghum malt (Sorghum Lassi- Salted) or pearl millet malt (Bajra Lassi - Salted) using biopreservatives. Technologies/ protocols were standardized to produce ready-to-reconstitute sorghum/pearl millet based fermented milk beverage by adopting spray drying method and dairy whitener from buffalo milk, cow milk and buttermilk. Technology for production of Kashi Halwa was standardized at Southern Regional Station, Bangalore. A new microbiological assay for specific detection of  $\beta$ -lactam group of antibiotics in milk was developed. In the field of nanotechnology, gold nanoparticles using new reducing agent for their potential applications in lateral flow have been successfully prepared. In the area of mechanized production of milk products, the mechanization of malai lachha manufacture was accomplished.

संस्थान चतुर्थ डीन समिति रिपोर्ट में दिए गए दिशा निर्देशों के अनुसार बी. टैक. (डेरी प्रौद्योगिकी) के लिए नए पाठ्यक्रम को क्रियान्वित करने वाला प्रथम संस्थान बन गया है। शैक्षणिक वर्ष 2009-10 से संस्थान में भारतीय कृषि अनुसंधान परिषद् द्वारा गठित कत्याल समिति की सिफारिशों के अनुसार मास्टर एवं डाक्टरेट कार्यक्रमों के नए स्नातकोत्तर पाठ्यक्रम क्रियान्वित किए गए। शैक्षणिक नियमों को भी पुनः बनाया गया जिनमें परीक्षा प्रणाली, उपाधियां देने के लिए ग्रेडिंग प्रणाली, तथा पी. एच. डी. छात्रों के लिए परिज्ञान परीक्षा प्रारम्भ करना सम्मिलित थे। शैक्षणिक वर्ष 2009-10 के दौरान राष्ट्रीय डेरी अनुसंधान संस्थान में नेपाल, बंगलादेश, भूटान, रवांडा, ईरान, श्रीलंका, वियतनाम, इथोपिया तथा मिस्त्र से 24 अन्तरराष्ट्रीय छात्र अध्ययन कर रहे हैं।

राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्व-विद्यालय की शैक्षणिक उपलब्धियों को केन्द्रित तथा पुनरावलोकन करने के लिए दिनांक 9-13 मार्च, 2010 तक शैक्षिक सप्ताह मनाया गया। दीक्षान्त समारोह वार्षिक शैक्षणिक कैलेंडर का एक भाग था। तदनुसार, राष्ट्रीय डेरी अनुसंधान संस्थान का आठवां दीक्षान्त समारोह दिनांक 13 मार्च 2010 को संपन्न हुआ। भारत के भूतपूर्व राष्ट्रपति डा. ए. पी. जे. अब्दुल कलाम ने दीक्षान्त अभिभाषण दिया तथा माननीय डा. एस. अय्यप्पन, महानिदेशक, भारतीय कृषि अनुसंधान परिषद् ने समारोह की अध्यक्षता की। अनुसंधान कार्य की गुणवत्ता में सुधार एवं प्रतिस्पर्द्धा की भावना को प्रोत्साहित करने के लिए मास्टर एवं डाक्टरेट छात्रों के लिए सर्वश्रेष्ठ थीसिस पुरस्कार प्रारम्भ किया गया। दीक्षान्त समारोह में मास्टर एवं डाक्टरेट के लिए उत्पादन, प्रसंस्करण एवं प्रबन्धन तीनों वर्गों के लिए प्रत्येक को एक-एक पुरस्कार से पुरस्कृत किया गया। संस्थान में प्रथम बार राष्ट्रीय डेरी अनुसंधान संस्थान के महान निदेशक डा. डी. सुन्दरेसन की स्मृति में डा. डी. सुन्दरेसन व्याख्यान प्रारम्भ किया गया। कृषि एवं संबंधित विज्ञानों के क्षेत्र में वैज्ञानिकों एवं शिक्षाविदों को उनके जीवनपर्यन्त

NDRI became the first institution to implement new course-curricula for B. Tech in Dairy Technology as per the guidelines laid out in Fourth Dean's Committee Report. From the academic session 2009-10, new PG Course Curriculum as per recommendations of Katyal Committee constituted by ICAR has been introduced for Masters and Doctoral programmes. Academic Regulations have also been revised, which include the Examination system, grading system for award of degree and introduction of comprehensive exam for Ph.D. students. During academic session 2009-10, NDRI had 24 no. of International students from Nepal, Bangladesh, Bhutan, Rawanda, Iran, Sri Lanka, Vietnam, Ethiopia and Egypt.

Academic Week was celebrated from 9<sup>th</sup> to 13<sup>th</sup> March 2010, to revisit and review the academic achievements of NDRI Deemed University. Convocation was made a part of the Annual Academic Calendar. Accordingly, the 8<sup>th</sup> Convocation of NDRI was held on 13<sup>th</sup> March 2010. Hon'ble Dr. A. P. J. Abdul Kalam, former president of India delivered the Convocation Address and Hon'ble Dr. S. Ayyappan, Director General, ICAR presided over the function. "Best Thesis Award" was instituted for Masters and "Doctoral" theses to encourage spirit of competition and motivation for quality research work. One award each for Masters and Doctoral theses in Production, Processing and Management groups was given at the Convocation. For the first time, Dr. D. Sundaresan Memorial Lecture Award was instituted at NDRI in memory of legendary Director of NDRI, Dr. D. Sundaresan. The award is bestowed on the basis of life time achievements of scientists & educationists for significant achievements in the field of agriculture and allied sciences. First Dr. D. Sundaresan Memorial Lecture was

उपलब्धियों के आधार पर पुरस्कार दिया जाएगा। प्रथम डा. डी. सुन्दरेसन स्मारक व्याख्यान डा. एस. एल. मेहता, भूतपूर्व कुलपति एम. पी. यू. ए. टी., उदयपुर द्वारा दिनांक 11 मार्च 2010 को 'डेरी शिक्षण : संभावनाएं एवं चुनौतियां' विषय पर प्रस्तुत किया गया।

संस्थान में काफी संख्या में (40 से भी अधिक) सेमिनार, कार्यशालाएं एवं लघु पाठ्यक्रम आयोजित किए गए जिनमें देश एवं विदेशों के प्रतिभागियों ने भाग लिया। वर्ष 2009-10 की महान उपलब्धि दिनांक 07-08 दिसम्बर 2009 को आई. ए. यू. ए. के कुलपतियों के 34वें सम्मेलन का आयोजन था। इस सम्मेलन में राज्य कृषि विश्वविद्यालयों एवं पशुचिकित्सा विश्वविद्यालयों के 35 कुलपतियों एवं भारतीय कृषि अनुसंधान परिषद् के संस्थानों के 15 निदेशकों ने भाग लिया। संस्थान में 'कृषि एवं पशुविज्ञान में जैव-नैनों प्राद्योगिकी के अनुप्रयोग' पर एक राष्ट्रीय संगोष्ठी भी आयोजित की गई। इस अवसर पर आशाजनक एवं राष्ट्रीय महत्व के तेजी से उभरते इस क्षेत्र पर विचार विर्मश किए गए एवं भविष्य के लिए इस दिशा में रूपरेखा तैयार की गई। इस सम्मेलन का उद्घाटन श्री एन. एन. वोहरा, आई. ए. एस., महामहिम राज्यपाल, जम्मू एवं कश्मीर द्वारा किया गया।

राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य-विश्वविद्यालय में विज्ञान दिवस के अवसर पर छात्रों में नवप्रवर्तन की भावना एवं सृजनात्मक विचारधारा को उनके मनो में जागृत करने के लिए एक नई 'माई आइडिया' प्रतियोगिता प्रारम्भ की गई। छात्र समुदाय में सदाचार एवं नैतिक मूल्यों को मन में बैठाने तथा महत्त्वपूर्ण सामाजिक मामलों के प्रति संवेदनशील बनाने के लिए राष्ट्रीय शिक्षा दिवस एवं अन्तर्राष्ट्रीय अहिंसा दिवस मनाए गए।

एग्रोवेब पर एन. ए. आई. पी. परियोजना के अन्तर्गत राष्ट्रीय डेरी अनुसंधान संस्थान की नई वेबसाइट विकसित की गई। नई वेबसाइट भारतीय कृषि अनुसंधान परिषद् के सभी पशुविज्ञान संस्थानों के लिए एक माडल

delivered by Dr. S. L. Mehta, former Vice Chancellor, MPUAT, Udaipur, on the topic "Dairy Education: Prospects and Challenges" on 11<sup>th</sup> March, 2010.

The Institute hosted quite a good number of Seminars, Workshops and Short Courses (over 40 no.) with the participation of delegates from India and abroad. The remarkable feature of the year 2009-10 was the organization of 34<sup>th</sup> IAUA Vice Chancellor's Convention on 7<sup>th</sup>-8<sup>th</sup> December 2009. The Convention was participated by 35 Vice Chancellors from SAUs and SVUs, and 15 Directors from ICAR Institutes. A National Seminar on "Application of Bio-Nano Technology in Agriculture and Animal Sciences" was also organized on this occasion to deliberate on this promising and fast emerging area of national importance and chalk out the future road map in this direction. The Convention was inaugurated by Sh. N.N. Vohra, IAS, His Excellency the Governor of J&K state.

A new concept of "My Idea" competition was introduced amongst students of NDRI Deemed University on National Science Day to inculcate the spirit of innovation and creative thinking. National Education Day and International Non-violence Day were celebrated to inculcate moral and ethical values in the student community and make them sensitive towards important social issues.

New website of NDRI was developed under the NAIP project on AGROWEB. The new website is to serve as a model for all the Animal Science Institutes of ICAR and has been designed as per uniform guidelines of ICAR to give the desired look and feel apart from the contents and databases on dairy starter cultures, semen bank, performance of herd animals

के रूप में कार्य करेगी तथा यह वैबसाइट भा. कृ. अनु. प. के समरूप दिशानिर्देशों के अनुसार डिजाइन की गई है तथा डेरी स्टार्टर कल्चरों, वीर्य बैंक, रा. डे. अनु. सं. के पशुधन फार्म पर पशुसमूह की प्रदर्शन क्षमता पर डेटाबेस तथा विषय वस्तु से अलग प्रतीत होती है। Wi-Fi (वाई-फाई) प्रणाली संस्थापित करके रा. डे. अनु. सं. के छात्रावासों को इंटरनेट सुविधा से जोड़ने का प्रावधान रखा गया है। इसके लिए ग्याहरवी पंचवर्षीय योजना के अन्तर्गत 55.00 लाख रुपए का फंड अलग से रखा गया है तथा टेंडर को अंतिम रूप दिए जाने की प्रक्रिया प्रगति पर है।

राष्ट्रीय डेरी अनुसंधान संस्थान पर दिनांक 24-26 फरवरी 2010 को डेरी मेला 2010 का आयोजन किया गया जिसमें 10,000 से भी अधिक कृषकों ने भाग लिया डेरी मेला के दौरान लगाई गई प्रदर्शनी में भारतीय कृषि अनुसंधान परिषद के विभिन्न संस्थानों, आहार कंपनियों, पशुचिकित्सा औषधियों, डेरी प्रौद्योगिकी एवं इंजीनियरिंग फर्मों की लगभग 75 स्टालें लगाई गईं। इस तीन-दिवसीय मेले में किसान संगोष्ठियां, दुग्ध उत्पादन प्रतियोगिताएं, पनीर बनाने की प्रतियोगिता, दुग्ध-दोहन क्षमता प्रतियोगिता एवं पशुओं की नस्ल सौन्दर्य प्रतियोगिताएं भी आयोजित की गईं।

विस्तार, शिक्षण कार्यक्रम 'कृषकों के द्वार पर डेरी शिक्षण' चल रहा है जिसमें वैज्ञानिक गाँवों में जा कर किसानों को मिल कर उन्हें परामर्श देते हैं एवं उनके परिसर पर उनकी समस्याओं का समाधान करने का प्रयास करते हैं। इस कार्यक्रम ने कृषक समुदाय में डेरी उत्पादन एवं प्रसंस्करण प्रौद्योगिकियों के प्रभावी प्रचार-प्रसार को सुदृढ़ किया है। संस्थान द्वारा विकसित प्रौद्योगिकियों को हस्तांतरित करने के लिए अपनाए गए गाँवों में कुल 37 किसान संगोष्ठियां आयोजित की गईं। किसानों को प्रजनन प्रबन्धन तकनीकियों थैना नियंत्रण, रोगों से बचाव के तरीकों तथा चारा उत्पादन के प्रति जागरूक बनाया। कृषि विज्ञान केन्द्र। डेरी प्रशिक्षण केन्द्र ने (परिसर के अन्दर तथा बाहर दानों) 209 प्रशिक्षण कार्यक्रम आयोजित

at NDRI livestock farm. Provision has been made for internet connectivity in NDRI hostels through Installation of Wi-Fi system. Funds to the tune of Rs. 55.00 lakhs have been earmarked for the same under XI Plan and tender finalization process is under progress.

Dairy Mela 2010 participated by more than 10,000 farmers was organized at NDRI from 24<sup>th</sup> to 26<sup>th</sup> February 2010. Exhibitions were organized during the Dairy Mela in which 75 stalls were put up by various ICAR Institutes, feed companies, veterinary pharmaceuticals, dairy technology and engineering firms. During this three-day event, Kissan Sangosthies, milk yield competitions, Competitions in paneer making and milking efficiency, and breed beauty were also organized.

The Extension Education Programme "Dairy Education at Farmers' Door" was continued wherein scientists visit villages, meet farmers, advise them and try to solve their problems at their premises. This programme has strengthened the effective dissemination of dairy production and processing technologies among farming community. A total no. of 37 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 209 training programmes (both on and off campus) participated by 5990 trainees on different aspects of Dairy Production, Dairy Processing, Agriculture, Vermicompost, Bee-keeping, Fisheries and Home Science. During the period under report, 17460 farmers visited Agriculture Technology Centre (ATIC)

किए। यह कार्यक्रम डेरी उत्पादन, डेरी प्रसंस्करण, कृषि, कृमिसंवर्धन, मधुमक्खी पालन मत्स्यपालन एवं गृहविज्ञान के विभिन्न पहलुओं पर आधारित थे इन प्रशिक्षण कार्यक्रमों में कुल 5990 प्रशिक्षणार्थियों ने भाग लिया। रिपोर्टाधीन अवधि के दौरान तकनीकी जानकारी एवं परामर्श सेवा प्राप्त करने के लिए 17460 कृषक एटिक (कृषि प्रौद्योगिकी सूचना केन्द्र) में आए।

संरचनात्मक विकास एवं नवीन सुविधाएँ जो सृजित की गईं उनमें प्रमुख उपलब्धियों में सम्मिलित हैं—खेल के मैदान (स्टेडियम) का नवीकरण, चार दिवारी एवं स्काई लाइटें लगवाना; छात्रों को प्रयोग करके सीखने के लिए प्रयोगात्मक डेरी की संरचनात्मक सुविधाओं का प्रसार; पशु जैव प्रौद्योगिकी केन्द्र, डेरी प्रौद्योगिकी विभाग, डेरी सूक्ष्म जीव विज्ञान प्रभाग तथा डेरी पशुपोषण प्रभाग की प्रयोगशालाओं को सुसज्जित एवं नवीकरण करना, प्रौद्योगिकी व्यवसाय संवर्धक कार्यक्रम टी. बी. आई. के लिए प्रयोगशालाओं का नवीकरण; बच्चों के नवनिर्मित पार्क की संरक्षात्मक घेराबन्दी; संस्थान के डा. डी. सुन्दरेसन सभाभवन में सी. सी. टी. वी. आधारित सुरक्षा निगरानी प्रणाली संस्थापित, फार्म अनुभाग की चारदीवारी का निर्माण, पशु प्रजनन परिसर में रोगी पशुओं के शैडों/ कार-पार्किंग का निर्माण तथा मौजूदा पुस्तकालय सुविधाओं में सुधार एवं नवीकरण।

संस्थान के गीत की संकल्पना की गई एवं राष्ट्रीय डेरी अनुसंधान संस्थान में बन्धुत्व की भावना को सुदृढ़ करने तथा देश में डेरी विकास के सामान्य उद्देश्यों की ओर अभिप्रेरणा वचनबद्धता, एवं समर्पण की भावना को सुदृढ़ीकरण के लिए प्रोत्साहित करने हेतु प्रारम्भ किया गया। संस्थान के नाम को लिखने के लिए एक समान ढंग अपना कर राष्ट्रीय डेरी अनुसंधान संस्थान को एक विशेष पहचान देने के लिए रा. डे. अनु. स. के हस्ताक्षर का एक विशेष पैटर्न की संकल्पना कर इसे अन्तिम रूप देकर स्वीकार किया गया। राष्ट्रीय डेरी अनुसंधान संस्थान के चहुँमुखी विकास के लिए वर्ष 1970-1981 के दौरान स्वर्गीय डा. डी. सुन्दरेसन के बहुमूल्य योगदान की स्मृति में तथा इस दूरदर्शी पूर्व

for obtaining technical information and advisory services.

Some of the major activities undertaken towards creation of new facilities and infrastructure development included: Renovation of Sports Stadium including boundary wall and installation of Sky Lights; Expansion of infrastructure at Experimental Dairy for experiential learning of students; Furnishing and upgradation of Labs in Animal Biotechnology Centre, Dairy Technology Division, Dairy Microbiology Division and Dairy Cattle Nutrition Division; Renovation of laboratories for Technology Business Incubator Programme; Protective fencing of newly developed Children Park; Installation of CCTV based Security surveillance system in Dr. D. Sundaresan Auditorium of NDRI; Construction of Boundary of Farm Section; Construction of Sick Animal Shed/Car Parking in AB Complex; and Improvement and upgradation in existing library facilities.

The Institute Song was conceptualized and introduced to foster stronger bondage in NDRI fraternity and strengthen the sense of motivation, commitment, dedication and sense of belongingness towards the common cause of dairy development in the country. For giving a specific identity to NDRI by adopting a uniform style of encrypting and writing the Institutional name, the specific pattern of signature of NDRI was conceptualized, finalized and adopted. In memory of the valuable contributions of Late Dr. D. Sundaresan made during 1970-1981 for all round development of NDRI, and to rekindle the legacy of the Former legendary Director, the main Auditorium of the NDRI was rechristened as Dr. D. Sundaresan Auditorium.

निदेशक की धरोहर को पुनः जीवन्त बनाए रखने के लिए संस्थान के मुख्य सभाभवन का नाम डा. डी. सुन्दरेसन सभाभवन के नाम से पुनर्नामित किया गया।

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

यह मेरा परम सौभाग्य है कि मैं इस कार्य से जुड़े संयुक्त निदेशकों, प्रभागाध्यक्षों, संकाय, अधिकारियों एवं 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 चरम सीमा तक पहुंच सके।

I sincerely hope that this publication 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 the Joint Directors, Heads of Divisions, faculty, Officers and the Staff. I am sure that with their persistent support and efforts, I 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.

  
(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, 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 and security are under the administrative control of the Chief Administrative Officer. The Institute presently has strength of 147 scientists, 315 technicians, 179 administrative and 711 supporting staff.

### BUDGET OUTLAY

The total budget of the Institute in terms of actual expenditure for Plan and Non-plan for the year 2008-2009 was Rs. 6410.86 lakhs and budget sanctioned for the year 2009-2010 was Rs. 7871.23 lakhs, respectively. These figures include the financial outlays for the two Regional Stations also.

### RESEARCH

A total number of 90 in-house research projects were in operation during the year 2009. In order to strengthen basic and strategic research, World Bank through NAIP has agreed to fund several research projects in consortium mode wherein NDRI is either the Lead Institute or consortium Partner. Under NAIP nineteen projects with an outlay of Rs. 33 crores approximately were continuing during the year 2009-10. 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-UNFCCC), 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:

- 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 proven in this set.
- The test day lactation curve models were developed using daily, weekly and monthly test day milk yields and part lactation records for predicting monthly and total lactation milk yields of Murrah buffaloes in organized herd and under field conditions.
- A total of 2755 AI were performed in KF and as a result 49.0 % conception rate was obtained under field conditions upto December, 2009. A total of 925 (479 males and 446 females) KF calves were born in the farmers' herds and performance data on 802 Karan Fries were recorded for evaluation of bulls under field conditions.
- The accuracy of prediction of 305-day milk yield for individual fortnightly (FTDYs),

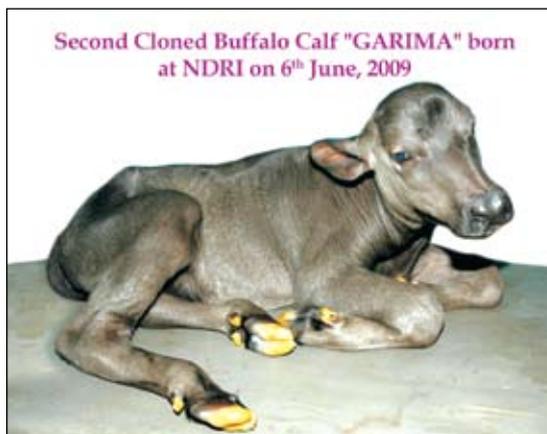
monthly (MTDYs) and bimonthly (BTDYs) test day milk yields were observed to be highest (60-61%) for FTDY-11, MTDY-6 and BTDY-4 in Karan Fries cattle.

- Best prediction equations were derived for prediction of 305-day milk yield and sire evaluation was done using best combinations of test day milk yields by using stepwise backward regression method in Karan Fries cattle. Rank correlations between EBVs by LSQ and SRLS were the highest followed by SRLS with BLUP based on actual and predicted 305-day milk yield. LSQ was found to be relatively more efficient than other methods but was almost similar in stability based on actual 305-day milk yield. BLUP was found more efficient than the other methods based on predicted 305-day milk yield but was almost similar in stability.
- The growth curves were prepared by plotting average weekly body weights from birth to 26 weeks against age (in weeks), separately for male and female Sahiwal calves maintained at NDRI, Karnal. The growth curve was linear in nature in both male and female calves. Average daily weight gain from birth to twenty six weeks (6 months) of age was 339.11g/day in female and 333.50 g/day in male calves.
- The growth bands were constructed for male and female calves using 26 weeks body weight in Sahiwal calves. The growth bands were narrow at the birth for both male and female calves, but it widened with the advancement of age. These growth bands can be used as a criterion of selection of young calves at an early age.
- Selection indices were constructed using various combinations of seven body weights and five first lactation traits in Sahiwal cattle. The optimum selection index incorporated body weights at eighteen months, twenty four months, thirty months and weight at first calving.
- For prediction of first lactation 305-day milk yield in Sahiwal cattle, Multiple Linear Regression (MLR) and Artificial Neural Network (ANN) models were developed using body weights at different ages as independent variables and FL305DMY as dependent variable and the accuracy of fitting both models was compared. The accuracy of prediction from both the models was observed to be very low. However, the accuracy of prediction was comparatively higher from ANN model than MLR model for test set of data. As the ANN predictions gave higher R<sup>2</sup> values with lower RMSE and SD ratio in comparison to MRA in test data set, it can be interpreted that ANN was comparatively more accurate to predict FL305DMY using body weights in Sahiwal cattle.
- Cytogenetical investigation revealed gross anomalies of sex chromosomes in reproductively deficient animals and twin born calves.
- A case of male sexual behaviour was found in an intersex-crossbred goat.
- Studies were carried out on identification of genetic polymorphism in mastitis genes related with *S. aureus*.
- Sahiwal Cattle exhibited two genotypes of IL-8 gene (578 bp fragment from 3205-3783 nt containing exon 4 and 3'UTR) by PCR-RFLP using *Dra 1* restriction enzyme with frequencies of C and D alleles as 0.846 and 0.154, respectively.
- PCR-RFLP analysis using *Dra 1* restriction enzyme of exon 4 of IL 8 gene in Murrah buffaloes exhibited three (AA, AB and BB) genotypes. However, these genotypes indicated non-significant association with incidence of mastitis in Murrah buffaloes.
- AA, AB and BB genotypes of TLR 4 gene were identified in Murrah buffaloes by PCR-RFLP analysis of TLR 4 gene using *BsiHKA I* restriction enzyme.
- Characterization of BoLA DRB 3.2 alleles under bovine MHC locus was carried out in Hallikar and Deoni native breeds of cattle at Southern Regional Station, Bangalore. DNA was isolated from whole blood using high salt method.
- About 72 lactating Deoni cows and 62 HF cows were screened for PCR- RFLP patterns for Prolactin gene.
- *Butyrivibrio fibrisolvens* could produce conjugated linoleic acid on supplementation of dietary oil as a source of linoleic acid.
- A method was standardised for dietary supplementation of fibrolytic enzymes for improving nutrient utilization. It was recommended to supplement the crop residues based diets with fibrolytic enzymes @ 1.5g/kg DM.
- Addition of fumaric and malic acids (65mM) singly and in conjunction with anthroquinone (4ppm) decreased methane release in a synergistic manner.

- *In vitro* studies revealed the possibility of feeding ruminants with mustard, white clover and chicory as green legumes, mustard cake and pearl millets as concentrate ingredients for reducing methane production.
- Lymphocyte proliferation decreased and SOD expression increased with increased dosage of lead and cadmium under *in vitro* studies indicating increased oxidative stress due to heavy metals.
- Babul pods can replace 80% of energy supplied through grains (barley or sorghum) in the diet of lactating cows. Metabolites of tannins detected in the milk of babul pods supplemented cows improved the nutraceutical value of their milk.
- Addition of sulphur @ 0.22% in the diet of buffalo calves fed wheat straw based complete feed blocks containing fungal zoospores of *Neocallimastix sp.* GR-1 improved the growth rate, digestibility of proximate principles and rumen fermentation.
- *In vitro* experiments showed that addition of organic acids had the potential to divert hydrogen for propionate production, which in turn decreases the methane production.
- Cereal grains/byproducts were found to be higher in total gas production and OM digestibility, whereas moderate in methane production and lower in NH<sub>3</sub>-N production.
- Administration of 50 ppm Pb to goat kids did not cause any significant adverse effect on blood parameters; however, the growth rate was reduced. Supplementation of Zn had beneficial effect in lowering the adverse effects of Pb.
- Heatsynch protocol for induction of ovulation followed by A.I. resulted in 52% pregnancies in anestrus and repeat breeding buffaloes under field conditions.
- Phagocytic ability of the milk neutrophils was lowest during early lactation, followed by late and mid lactation.
- Measurement of Lymphocyte activity such as lymphocyte proliferation and NO production could be used to indicate functional status of cell mediated immunity in the Murrah buffaloes.
- Body condition of the cows should be maintained between 3.0 and 3.5 during dry

period and calving and vitamin E @ 1000 I.U. / day should be supplemented during dry period for improved production of cows.

- World's second cloned buffalo calf named 'Garima' was produced using Handmade cloning technique.



- Buffalo embryonic stem cells were found to express surface markers CD9 and CD90 and transcription-based markers like OCT4, SOX2, FOXD3, *REX-1* and *NUCLEOSTEMIN*. These markers are also expressed by buffalo embryos at 2-cell, 4-cell, morula and blastocyst stages.
- Embryoid bodies formed by spontaneous differentiation of putative buffalo ES cells contained cells from all three germ layers i.e., ectoderm, mesoderm and endoderm, as confirmed by expression of markers specific to these cell types.
- In the presence of DMSO, ES cells could be directed to form muscle cell-like cells, the identity of which was confirmed by expression of  $\alpha$ -actinin, *MYF-5*, *MYOD* and *MYOGENIN* genes. ES cells were directed to differentiate in the presence of retinoic acid to neuron cells, as confirmed by expression of NF68 gene.
- Mammary epithelial cells were isolated from milk by immune affinity purification technique and characterized.
- Proteome profile of milk mammary epithelial cells was identified by shotgun proteomics technique using ESI-MS.
- Various eukaryotic expression constructs of MGP-40 were prepared for its over expression and functional assay.
- Transfection assay of GFP based expression constructs was standardized in COS7 mammalian expression host.

- Expression profiling of genes related with transcription initiation helped in defining the Maternal to Embryonic transition event in developing Buffalo embryos to take place at 8 cell stage.
- New polymorphic alleles were isolated for buffalo  $\beta$ -casein Gene. Buffalo  $\beta$ -casein exists in two different polymorphic forms. Type B was found to be a predominant (85%) allele over A (15%).
- Protein-protein interaction of lactoferrins from buffalo, cow, goat and camel suggested distinct advantage of buffalo lactoferrin for iron release capacity at normal gastric pH. This provides vital clue for exploring buffalo lactoferrin for its therapeutic attributes.
- The two types of Probiotic Dahi, i.e. *Acidobifidus* Dahi and *Acido-plantarum* Dahi, evaluated for anticancer properties were found to decrease progression of DMH induced gastrointestinal tract carcinogenesis, also increased the efficacy of cancer treatment with piroxicam.
- Dietary conjugated linoleic acid (CLA) reduces body fat mass, and the effect is furthered by including skim milk powder (SMP) in the diet. The body slimming effect of CLA involves decreased biosynthesis of fatty acid in adipose tissue and skeletal muscles.
- Dietary calcium was found to decrease serum cholesterol, and dairy calcium was also found to be more effectual.
- Excessive dietary intake of CLA was found to cause fatty liver and spleen enlargement, and it could be countered by non-fat milk ingredients.
- Addition of 50 mM Taurine and 100mM Trehalose in the semen extender significantly protected buffalo sperm cryodamage as evaluated in terms of post thaw motility, sperm viability, membrane integrity, total antioxidant status and sperm capacitation.
- During *in vitro* capacitation of buffalo spermatozoa, proteins like glutathione s-transferase, mu 3, pyruvate dehydrogenase, E I component subunit- $\beta$ , glycerol -3- phosphate dehydrogenase & voltage dependent anion selective channel protein-2 as tyrosine phosphorylated proteins, were identified.
- DNA fragmentation in fresh and cryopreserved buffalo spermatozoa was found to be directly correlated with the total antioxidant status of the semen.
- A common mechanism altering cell membrane was found to be responsible for the development of cross-resistance to pediocin against alamethicin resistant *Enterococcus faecalis* and *B. cereus*.
- Pediocins produced by *P. acidilactici* NCDC 252 and *P. pentosaceus* NCDC273 were found to be identical to pediocin PA-1.
- Artificial Neural Network could be used as a reliable modeling method for predicting *in vitro* response given the composition of the colorimetric biosensing nanosomes.
- Processes to manufacture dairy whitener from buffalo milk, cow milk and buttermilk were standardized.
- A Quarg type Fresh Cheese was developed with low fat and high fiber content and omega 3- enriched milk.
- A process was standardized to increase the stability of probiotic organisms by co-microencapsulation with matrix material and prebiotics.
- Protocols were standardized to extend the shelf life of raabadi-like fermented beverages using sorghum malt (Sorghum Lassi- Salted) or pearl millet malt (Bajra Lassi - Salted) using biopreservatives.
- Technologies/ protocols were standardized to produce ready-to-reconstitute sorghum/ pearl millet based fermented milk beverage by adopting spray drying method.
- Technology for production of kashi halwa was standardized at Southern Regional Station, Bangalore.
- Study was conducted for the production of foxtail millet and concentrated whey based health food product.
- Modifications were made on the earlier reported method of preparation of Ragi – milk drink to reduce the processing time, to simplify the procedure and to improve the organoleptic properties of the final product.
- Technology for dietetic chhana podo production was standardized.
- Oxygen absorber coupled with high-barrier EVOH and PET laminates extended the shelf-

life of Chhana podo to more than 45 days and that of Kunda to more than 80 days without the appreciable loss of sensory and textural characteristics.

- Methods were standardized to incorporate certain spices such as ginger, pepper, cumin, cardamom, turmeric into butter milk to prepare spiced butter milk drinks. Attempt was made to develop buttermilk drinks incorporated with *tulsi* and *pudina* extracts and having satisfactory organoleptic properties.
- The use of whey protein as well as horse serum resulted in higher cryoprotective effect at 10% concentration. Among the cryoprotective agents examined, whey proteins was selected due to the restriction on use of ingredients from animal sources. Freeze dried cultures were packaged in two packaging materials viz. EVOH and polythene, The results revealed that DVSculture stored at 8°C even up to seven months could be used for preparation of *dahi* with good organoleptic properties.
- The mechanization of malai lachha manufacture was accomplished.
- A technology was developed for continuous manufacture of burfi using three stage SSHE.
- Paneer making gadget was developed with built in mechanism for heating, coagulating and pressing for domestic application to handle around 3 lt. batch of milk.
- Two simple colour based methods were developed for ascertaining the heat treatment of milk around 80° C.
- A technology was developed for the preparation of artificially sweetened whey lemon beverage. Methods were standardized for the estimation of artificial sweeteners and their degradation products (if any) in whey lemon beverage during storage. HPLC analysis revealed that the artificial sweeteners in the product were stable during storage.
- Buffalo milk osteopontin was purified and characterized.
- Twelve peptides were identified from the whey protein hydrolysates optimized for max. ACE Inhibitory activity, out of which eight peptides are known ACE Inhibitory peptides.
- Pyruvate, lactate and ammonia content coupled with the titratable acidity could be used as innovative and reliable tools for knowing the freshness of milk.
- A technology was developed for the preparation of Vitamin B<sub>12</sub> rich 'Propioni Yoghurt' containing *Propionibacterium freudenreichii* subsp. *freudenreichii* PrSo, a Vitamin B<sub>12</sub> producing native and novel strain with a potential to address the problem of vitamin deficiency and related diseases.
- A "folate rich functional dahi" containing a high folate producing and probiotic strain (*S. thermophilus* RD104) bioprospected from indigenous fermented milk products was developed to be used as a functional dairy food.
- A "carb down" naturally carbonated fermented milk product characterized by low calorie content and typical sensory attributes (effervescence, fizz, tinginess) was developed using *Leuconostoc mesenteroides* FD27, an indigenous strain isolated from dahi.
- The role of bsh in reducing the plasma total cholesterol, LDL-cholesterol and triglycerides by 18, 27 and 27%, respectively was observed in high cholesterol fed SD rats after treatment with bsh positive *L. plantarum* 91.
- The expression of atpD, bsh and mub genes was significantly upregulated in *L. plantarum* 91 when exposed to pH 2.5, 1-3 % bile salt, and 0.05% mucin, respectively both under *in vitro* and *in vivo* conditions.
- Relative expression of IL-10 was upregulated to 11.97 and 70.64% in HT-29 and colitis induced mice, respectively when challenged with Lp91, which was much higher than obtained with standard probiotic strain.
- "Scheme on Dairy Microbes" was initiated in the XIth plan with NDRI as cooperating centre and the following three coordinating centres namely: GBPUAT, Pantnagar, SMC College of Dairy Science, AAU, Anand and Dairy Science College, Hebbal, Bangalore. The scheme aims at sourcing of important dairy organisms from indigenous fermented foods in different parts of the country characterize them and deposit in the repository for further distribution to the users.
- "Scheme on Veterinary Microbes" was also sanctioned in the XI Plan with NDRI as one of the cooperating centres and National Institute of Animal Nutrition and Physiology, Bangalore as the coordinating centre.

- A study was conducted on human resource development of rural youth for dairy-based enterprises. It was inferred that dairy-based enterprises gave employment and increased income (96%), as against 42% before intervention, prestige in society (80%), security for the family (92%) and ability to take independent decisions (66%).
- A study was conducted on strategic nutrient supplementation for enhancing milk & reproductive performance in dairy animals under field conditions. The peak yield of cow and buffalo was increased approximately 4.00 and 3.00 litres, respectively. Similarly, service period was also reduced up to 30 days per lactation. The average weight of newly calf born was increased up to 3.66 kg per calf due to feeding of by-pass fat and mineral supplementation to pregnant dairy animals.
- A study was conducted to observe the impact of self help groups (SHGs) on growth of dairy farming in Haryana. It revealed that member farmers possessed high level of knowledge (35.00%) and adoption (37.00%) whereas among non-members it was very low i.e. 11% and 1%, respectively. The mean difference in knowledge and adoption between members and non-members was statistically significant. The SHGs formed by NGOs had more knowledge and adoption than the SHGs formed by DRDA's.
- A study was conducted on retrospect and prospects of commercial dairy farming in Maharashtra. Higher price for milk in urban market, timely payment by dairy cooperatives, remunerative price for milk by dairy cooperatives, adoption of improved dairy farming practices, timely extension support were regarded as major factors influencing commercial dairy farming.
- A study was conducted on mixed farming amongst resource-poor farm families in West Bengal from gender perspective. Results showed that majority of crop cultivation activities were predominantly performed by men. Women were mostly involved in post-harvest operations and seed treatment. Most of the dairy farming activities were predominantly performed by women. Men were mainly involved in taking animal for grazing and cutting and carrying of grasses; chopping of straw; selling of milk and milk products; taking animal for treatment and service; purchase of concentrates and selling and purchase of animal(s).
- Analytical study on milk market innovation system in West Bengal revealed that the Krishi Projukti Sahayak played a very crucial role to transfer information to dairy farmers regarding marketing of milk as well as about the different aspects of agriculture in almost all zones of West Bengal. Private milk collection agents played much more important role in laterite and red soil zone compared to other zones.



*His Excellency Sh. N. N. Vohra Hon'ble Governor J&K inaugurating the 34<sup>th</sup> IAUA VC Convention*

## EDUCATION

- New PG Course Curriculum as per the recommendations of Katyal Committee constituted by ICAR was implemented for Masters and Doctoral programme.
- 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 2009-10, NDRI attracted a large number of International students from Rawanda, Iran, Ethiopia, Sri Lanka etc. A total no. of 23 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 introduced to encourage spirit of competition and motivation for quality research work.
- An International Training Programme was organized in the Division on Sensory Evaluation of Milk and Milk Products for officers of M/s Fan Milk International A/S, Denmark from 18<sup>th</sup>-31<sup>st</sup> May, 2009.
- An International Training Programme on "Milk Collection, Processing and Marketing" was organised for personnel of Afganistan during 18<sup>th</sup> - 31<sup>st</sup> March, 2010.
- International Seminar on "French Genetics & Technologies" for improvement of milk production was organised under Indo-French Collaborative programme on NDRI on 20<sup>th</sup> April, 2009.
- International Training programme on "Sensory Evaluation of Milk and Milk Products" was organised under consultancy programme during 18<sup>th</sup> - 31<sup>st</sup> May, 2009.
- A summer school on "Recent Advances in Analytical Techniques and Innovative Approaches for Quality Assurance and Safety of Dairy Foods" was organised at NDRI during 7<sup>th</sup> - 27<sup>th</sup> July, 2009.
- A Vocation programme on "Natural Resources VPNR - 2009" was organised at NDRI on 18<sup>th</sup> May, 2009.
- 34<sup>th</sup> Annual convention participated by 35 Vice-Chancellors of State Agricultural and Veterinary Universities and 15 Directors from ICAR Institute was organised on 7<sup>th</sup> December, 2009.
- National Symposium on "Application of Bio-Nano Technology in Agricultural and Animal Sciences for Food Security" was also organised.
- A National Seminar on "Need of the Dairy Industry-Initiative, Innovation, Improvisation was conducted by NDRI Graduates & NDRI during 11<sup>th</sup> - 12<sup>th</sup> Sept., 2009.
- Launch Workshop of NAIP Project on Development of e-courses for B.Tech. (Dairy



*A student receiving degree from Hon'ble Dr. A. P. J. Abdul Kalam during Convocation*

Technology) degree programme was organised on 27<sup>th</sup> June, 2009.

- A winter school on “Recent Advances in Dairy Nutraceuticals and Bio-informatics Applications” was organised at NDRI during 1<sup>st</sup> - 21<sup>st</sup> Feb., 2010
- A short course on “Technological Development in Cheese and Fermented Dairy Foods” was conducted at NDRI during 2<sup>nd</sup> - 22<sup>th</sup> June, 2009.
- Eight Convocation of NDRI, Deemed University was held on 13<sup>th</sup> March, 2010. Dr. A. P. J. Abdul Kalam, Former President of India delivered the convocation address and gave away the Degrees, Gold Medals, Merit Certificate and Awards to the students. Dr. S. Ayyappan, DDG, ICAR and Secretary, DARE presided over the function.
- Celebrated Academic Week from 9<sup>th</sup> to 13<sup>th</sup> March 2010 to lay focus and review the academic achievements of NDRI Deemed University.
- Dr. D. Sundaresan Lecture Award was instituted in memory of Legendary Director of NDRI, Dr. D. Sundaresan. Dr. S. L. Mehta, Former Vice Chancellor, MPUAT, Udaipur and Former DDG (Education) ICAR delivered the First Memorial Lecture on “Dairy Education: Prospects and Challenges”.
- National Science Day was celebrated on 28<sup>th</sup> Feb. 2010 by organizing “My Idea Competition” for students of B. Tech. Masters and Doctoral Programme.
- National Education Day and International Non-Violence Day were celebrated to inculcate moral and ethical values in the student community and to make them sensitive towards important social issues.

#### EXTENSION

- A total no. of 37 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.
- Cross breeding programme was continued in cows and selective breeding in local buffaloes through AI. The conception rate of AI was observed as 49.20 % in Cows and 45.0 % in buffaloes.
- Monthly infertility and veterinary aid campaigns were organized in adopted villages. A total of 826 no. animals were diagnosed with late maturity, anestrus and repeat breeding and

were given adequate treatment.

- High yielding varieties of fodder crops (Berseem and Oats) were demonstrated at farmer’s field in collaboration with IGFRI, Jhansi. The wardaan, JHB-146 variety of berseem and JHO-822, JHO-851 and kent variety of oats were demonstrated in adopted villages viz., Kulwehri, and Subri. These varieties had about 12 % higher performance than the local varieties.
- Dairy Mela was organized on 24<sup>th</sup> to 26<sup>th</sup> February, 2010 at Institute level. The various events in the Mela included breed beauty competition, milk yield competition, milking efficiency competition for women, etc., Exhibitions by NDRI and other



ICAR Institutes as well as private organizations were organised. Kisan sangoshti cum question answer session was organized in which experts from NDRI provided solutions to the problems of dairy farmers.



*Dr. Mangala Rai, Former DG, ICAR with prize winning animal*

- A new Extension Education Programme “Dairy Education at Farmers’ Door” was 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 regularly organized

Dairy Education at Farmers' Door in various villages on 2<sup>nd</sup> Saturday of every Month.

- During the year, KVK/DTC organised 209 training programmes (both on and off campus) participated by 5990 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 21537.
- Agriculture Technology Centre (ATIC) was further strengthened. During the period under report, 17460 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.

#### INFRASTRUCTURE

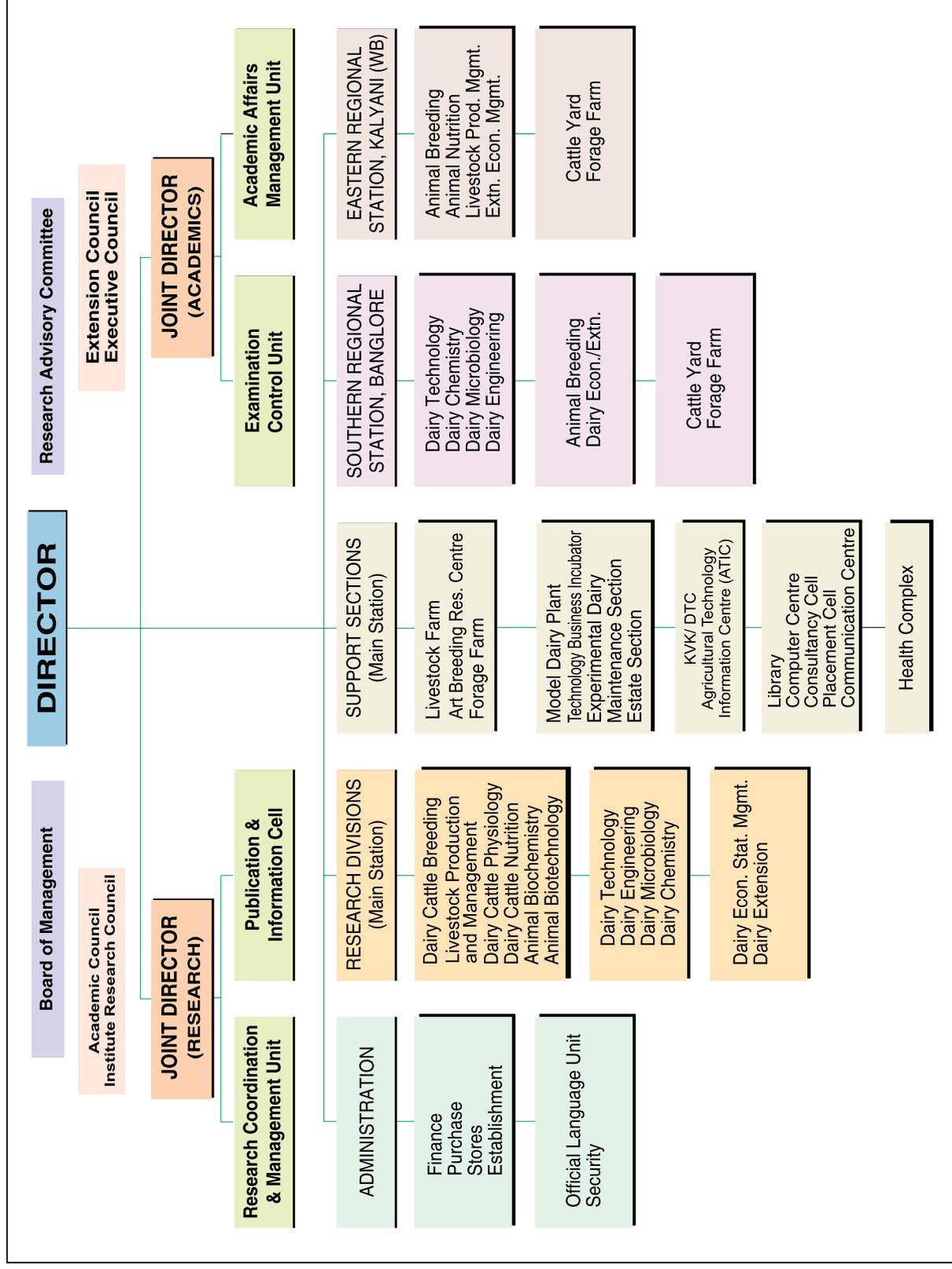
- Renovation of Sports Stadium including boundary wall and installation of sky lights.
- Expansion of infrastructure at Experimental Dairy for experiential learning of students.
- Protective fencing of newly developed Children Park.
- Renovation and upgradation of Library.

- Renovation of Small Animal House.
- Furnishing and upgradation of labs in Dairy Chemistry Division, Dairy Animal Biochemistry Division, Dairy Cattle Physiology Division, Dairy Technology Division and Animal Biotechnology Centre.
- Repair of Feeding Mangers of the Animal Paddocks of Cattle Yard.
- Renovation of Embryo Biotechnology Building/ Central Store/ Artificial Breeding Research Centre/ Director's Office/ Scientists Home.
- Renovation of feeding Mangers of Sick Animals Shed/ Car Parking at Animal Breeding Research Complex.
- CCTV based security surveillance system installed in Dr. D. Sundaresan Auditorium of NDRI.
- Renovation of Residential C, D, E, & F type quarters.
- Renovation of International Hostel, Kaveri Hostel and Krishna Hostel.
- Construction of P/L Sewer line from Milking Byre No.1 to Main sewer line of Cattle Yard.
- Construction of Rain Water Harvesting system.
- Construction of boundary wall of Farm Section.



*Rechristening of Auditorium as Dr. D. Sundaresan Auditorium by Hon'ble DG ICAR*

# 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 of Advanced Studies" in Animal Genetics and Breeding and Dairy Technology disciplines to further strengthen the research and training components.

## ORGANISATIONAL SETUP

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

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

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

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

The Research, Education and Extension activities of the Institute are managed by the Director and the Joint Directors through Scientific, Technical, Administrative and Supporting staff. The Director is overall Administrative Head of the Institute and its Regional Stations. The Joint Directors in addition to extending support to the Director in the area of Research, Academics and Administration are responsible to co-ordinate research and educational activities of various Divisions and Regional Stations, respectively. Each of the Regional Stations is administered through the Head located at the station. The scientific and teaching work at the main station is conducted through 12 subject-matter Divisions/Sections.

### BOARD OF MANAGEMENT

Chairman	Dr. A. K. Srivastava Director, NDRI
Member	Dr. S. L. Goswami Joint Director (Research), NDRI
Member	Dr. G. R. Patil Joint Director (A), NDRI
Member	Dr. (Mrs.) Jancy Gupta Head, Dairy Extension Division NDRI, Karnal
Member (Nominee, Governing Body ICAR, Nominated by President, ICAR)	Dr. (Ms.) Chanda Nimbkar Phaltan
Member (Nominee, DG, ICAR)	Dr. K. M. L. Pathak DDG (AS) ICAR
Member (Director IVRI/IARI)	Dr. M. C. Sharma Director, IVRI
Member (FA, DARE/ICAR or his nominee)	Financial Advisor, ICAR
Member Secretary	Sh. J. K. Kewalramani CAO, NDRI

### ACADEMIC COUNCIL

Chairman	Dr. A. K. Srivastava Director, NDRI
Vice-Chairman	Dr. G. R. Patil Joint Director (A)
Member	Dr. S. L. Goswami Joint Director (Research)
Members (Four Eminent Scientists from outside the NDRI)	Dr. Kirti Singh Former Vice Chancellor and Ex-Member ASRB  Dr. R. Nagarcenkar Former DDG (AS), ICAR  Dr. S. R. Singh, Director, Institute of Agriculture Banaras Hiudu University Varanasi - 221005  Dr. B. Mishra, Vice Chancellor Sher-e-Kashmir University of Agricultural Sciences & Technology, Jammu

### STAFF POSITION (As on 31.03.2010)

Director	1
Joint Directors	2
Scientific	147
Technical	315
Administrative/Ministerial	179
Supporting Staff	711

Member (Representative from the UGC)	Dr. Prakash Khandekar Principal Scientist National Institute of Animal Nutrition and Physiology Adugodi, Bangalore DDG (Edn.), ICAR
Member (DDG Education or his nominee)	
Members (One Senior Scientist from each Division)	Dr. Shiv Prasad Dr. B. S. Prakash Dr. A. K. Dodeja Dr. K. K. Datta Dr. Rameshwar Singh Dr. Jancy Gupta Dr. A. A. Patel Dr. R. S. Manik Dr. (Mrs.) B. K. Wadhwa Dr. V. K. Kansal Dr. S. S. Kundu Dr. Satish Kulkarni Dr. I. K. Sawhney Dr. G. K. Sachdeva Dr. Darshan Lal Chief Admn. Officer
Students Member	Mr. Saidur Rohwan Mr. Yathish. H.M.
Member-Secretary	Registrar, 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, 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 Sci. 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	Dr. A. K. Srivastava Director, NDRI
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 Dr. A. A. Patel Dr. J. P. Dhaka Dr. (Mrs.) B. K. Wadhwa Dr. R. C. Upadhayay Dr. A. K. Chakravarty Dr. T. K. Mohanty Dr. A. K. Singh
Members (Regional Stations)	Dr. Satish Kulkarni
Members	Director (Crop) Govt. of India Ministry of Agriculture Department of Agriculture & Cooperation Krishi Bhawan, New Delhi  Dr. K. S. Dangi DG Dept. of (AH&D) Govt. of Haryana Panchkula Director (Farm Information) Directorate of Extn., Govt. of India, New Delhi
Member Secretary	Dr. Jancy Gupta Head, Dairy Extn. Division

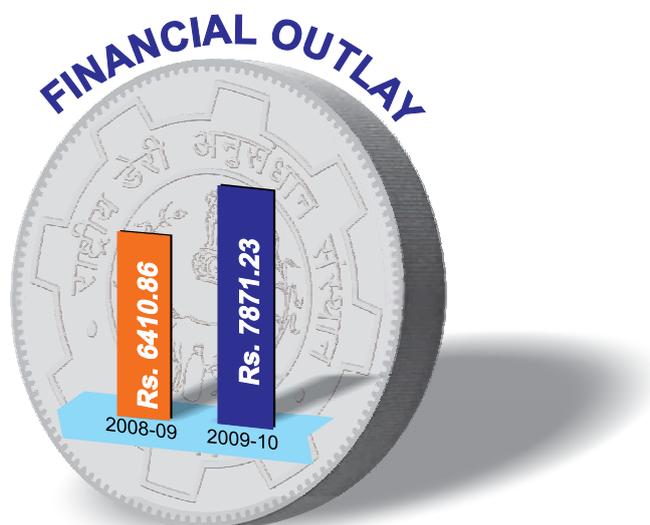
## FINANCE

The financial outlays in terms of actual expenditure for the year 2008-2009 and sanctioned budget for the year 2009-2010 are given below. The total budget of the Institute in terms of sanctioned

budget for Plan and Non-plan in 2009-2010 was Rs. 7871.23 lakhs. These figures include the financial outlays for the two Regional Stations also.

Financial Outlays (Rs. in lakhs)						
Particulars	2008-2009			2009-2010		
	Non-plan	Plan	Total	Non-plan	Plan	Total
	Actual Expenditure			Sanctioned Budget		
NDRI, Karnal, DSC, Karnal and ERS, Kalyani	4867.93	561.73	5429.50	6058.33	542.00	6600.83
SRS, Bangalore	746.77	76.53	823.23	984.80	108.00	1092.80
Deemed University	-	103.74	103.74	-	100.00	100.00
KVK/TTC	-	54.39	54.39	-	77.60	77.60
<b>Total</b>	<b>5614.47</b>	<b>796.39</b>	<b>6410.86</b>	<b>7043.63</b>	<b>827.60</b>	<b>7871.23</b>

*The Revenue Receipts of the Institute and the Regional Stations for the year 2009-2010 were Rs. 399.82 lakhs.*



### Revenue Generation (2009-2010)

Items	Actual Receipts (Rs. in Lakhs)
Sale of Milk	155.77
Interest on STD	22.01
Misc. Receipt	222.04
<b>Total</b>	<b>399.82</b>

## 2 RESEARCH ACHIEVEMENTS

### DAIRY CATTLE BREEDING

#### GENETIC IMPROVEMENT OF MILCH ANIMALS THROUGH IDENTIFICATION AND DISSEMINATION OF SUPERIOR GERMPLASMBYAPPLICATIONOFEMERGING REPRODUCTIVE AND MOLECULAR TECHNOLOGIES

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

**Performance evaluation and multiplication of Sahiwal cattle under open nucleus breeding system:** A total of 22 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 1906 (1st lactation) - 3557 kg. The EPD of selected male calves ranged between 0.24 and 13.14%. A total of 36 Sahiwal cows (23.2 %) were identified as elite cows for nominated mating with the proven bulls during the period 2009-10. The overall average 305-day lactation milk yield of these elite Sahiwal cows was 2773 kg which was about 35.53% higher than the herd average (2046 kg). The best lactation milk yield of elite Sahiwal cows ranged between 2380 and 3595 kg.

The growth curves were prepared by plotting average weekly body weights (from birth to 26 weeks) against age (in weeks), separately for male and female Sahiwal calves maintained at NDRI herd. The growth curve was linear in both male and female calves. Average daily weight gain from birth to twenty six weeks (6 months) of age was 339.11g/day in female calves and 333.50 g/day in male calves. The growth bands were constructed for male and female calves using 26 weeks body weight in Sahiwal calves. The growth band was narrow at the birth for both male and female calves, but it widened with the advancement of age. These growth bands can be used as a criterion of selection of young calves at an early age.

Selection indices were constructed using various combinations of seven body weights and five first lactation traits. The optimum selection index incorporated body weights at eighteen months, twenty four months, thirty months and weight at first calving. The optimum index based on first lactation traits incorporated first lactation 305 days or less milk yield, first lactation length and first

calving. The optimum selection index combining body weights and first lactation traits incorporated body weights at eighteen, twenty four and thirty months age alongwith first lactation 305 days or less milk yield, first lactation length and first calving interval.

For prediction of first lactation 305-day milk yield, Multiple Linear Regression (MLR) and Artificial Neural Network (ANN) models were developed using body weights at different ages as independent variables and FL305DMY as dependent variable and the accuracy of fitting both models was compared. The accuracy of prediction from both the models was observed to be very low. However, the accuracy of prediction was comparatively higher from ANN model than MLR model for test set of data. As the ANN predictions gave higher  $R_2$  values with lower RMSE and SD ratio in comparison to MRA in test data set, it can be interpreted that ANN was comparatively more accurate to predict FL305DMY using body weights in Sahiwal cattle.

**Performance evaluation and multiplication of Murrah buffaloes:** A total of 19 Murrah male calves were reserved during the period (2009-10) on the basis of Expected Predicted Difference (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 lactation yield of reserved males ranged from 2330 (1<sup>st</sup> lactation) to 3862 kg. The EPD of reserved Murrah male calves ranged from 2.47 to 10.68 %. For the establishment of nucleus-breeding herd, a total of 61 Murrah buffaloes (32.97 %) were identified as elite animals for nominated matings with the proven bulls. The average lactation milk yield of these elite Murrah buffaloes was 2937 kg, which was 33.07% higher than the herd average. The best lactation milk yield of elite Murrah buffaloes ranged between 2504 to 4496 kg. Test mating of Murrah breeding bulls of XI Set is being continued. The test bulls of VI set were evaluated and Bull No. 4506 of NDRI center achieved second rank (Sire Index - 1972 kg) with 8.90 % superiority out of three bulls declared proven in the VI set.

The performance recording including information on daily, weekly and monthly test day milk yields and part lactation records of the daughters of various Murrah bulls was done. The test day lactation curve models were developed using daily, weekly and monthly test day milk yields

and part lactation records for predicting monthly and total lactation milk yield of Murrah buffaloes in organized herd and under field conditions.

**Genetic evaluation and improvement of Friesian crossbred cattle under organized farms and field conditions:** A total of 21 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 5056-6657 kg. The EPD of selected male calves ranged between 3.13 and 15.44 %. The progeny testing of XI set of 8 young bulls with dam's best yield ranging between 5306 and 7168 kg (EPD 5.92 - 17.10%) is in progress.

A total of 99 KF (41 %) 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 5334 kg which was about 24.1% higher than the herd average (4298 kg). The best lactation 305-day milk yield of elite KF cows ranged between 5042 and 8648 kg. The average EPA of elite herd was 4449 kg.

A total of 2755 A.I were performed in KF and as a result 48.9% conception rate was obtained under field conditions. A total of 925 (479 males and 446 females) KF calves were born in the farmers' herds and performance data on 802 Karan Fries was recorded for evaluation of bulls under field conditions.

**Centre-wise AI and PD done and calves born during 2009 under Friesian Crossbred Project**

	Name of the Centre				Total
	Darar	Kheriman Singh	Rindal	Shekhapura	
AI	631	426	860	838	2755
PD	383	211	331	424	1349
C.R %	60.7	49.5	38.4	50.6	48.9
Calves Born	344	143	174	264	925
Male	193	67	82	137	479
Female	151	76	92	127	446

Investigations on fortnightly, monthly and bimonthly test day milk yields in Karan Fries cattle revealed that the heritability was found to be lowest ( $0.11 \pm 0.16$ ) for FTDY-1 and highest ( $0.37 \pm 0.08$ ) for FTDY-11 in fortnightly; lowest ( $0.11 \pm 0.16$ ) for MTDY-1 and highest ( $0.37 \pm 0.08$ ) for MTDY-6 in monthly, lowest ( $0.11 \pm 0.16$ ) for BTDY-1, highest ( $0.31 \pm 0.09$ ) for BTDY-4 in bimonthly test day milk yields and  $0.39 \pm 0.09$  for actual 305-day milk yield. The phenotypic and genetic correlations among all the test day milk yields (fortnightly, monthly and bimonthly) and with 305-day milk yield were highly significant. The genetic correlations of mid portion of lactation with 305-day milk yield were found to be higher compared to early and late lactation. Different measures of error of prediction showed a continuously declining trend up to FTDY-10 in fortnightly, up to MTDY-6 in monthly and up to BTDY-3 in bimonthly test milk yields by ratio method. Similarly, continual declining trend of error of prediction in all the test day milk yields was observed by regression method. The accuracy of prediction of 305-day milk yield for individual fortnightly (FTDYs), monthly (MTDYs) and bimonthly (BTDYs) test day milk

yields were observed to be highest (60-61%) for FTDY-11, MTDY-6 and BTDY-4. Best prediction equations were derived for prediction of 305-day milk yield and sire evaluation was done using best combinations of test day milk yields by using stepwise backward regression method. Rank correlations between EBVs by LSQ and SRLS were the highest followed by SRLS with BLUP based on actual and predicted 305-day milk yield. LSQ was found to be relatively more efficient than other methods but was almost similar in stability based on actual 305-day milk yield. BLUP was found more efficient than the other methods based on predicted 305-day milk yield but was almost similar in stability.

Based on the present investigation on fortnightly, monthly and bimonthly test day milk yields, it was concluded that the following prediction equations:

$$279.90 + 51.42 X_2 + 91.49 X_8 + 58.95 X_{13} + 67.31 X_{18}$$

for fortnightly test day milk yields,  $278.93 + 50.37 X_2 + 60.00 X_4 + 72.38 X_6 + 82.96 X_9$  for monthly test day milk yields and  $363.33 + 75.89 X_2 + 185.78 X_3 + 58.65 X_4 + 42.15 X_5$  for bimonthly test day

milk yields could be used for prediction of 305-day milk yield due to higher accuracy (>85%) and low percent error. The highest accuracy (86.9%) of prediction of 305-day milk yield was however, observed in the best equation given by FTDYs combination. Further, either of the three sire evaluation methods viz. LSQ, SRLS and BLUP except CC can be used for genetic evaluation of Karan Fries sires based on test day milk yields due to their high rank correlations and comparable efficiency and accuracy.

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

**Cytogenetic investigations:** Lymphocytes were cultured from the whole blood of 27 reproductively deficient cattle. Chromosomal preparation from the cultured lymphocyte were examined using conventional staining and banding patterns (G, C, R and T) to identify normal and abnormal chromosomes. Various chromosomal anomalies observed included XX-intersex goats expressing male sexual behaviour, XX /XY rare example of horned intersex goat, XX/ XY chimaerism in cattle calves, a fragile X-chromosome detected in a sub-fertile buffalo and the phenomenon was further explored in other animals.

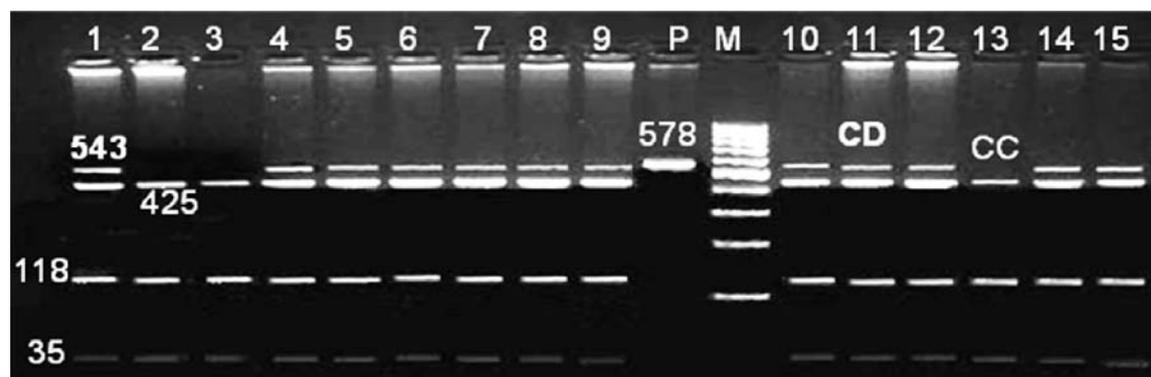
**Mastitis causative organisms:** A total of 126 *S. aureus* isolates from mastitic milk samples were screened for *in vitro* susceptibility to antimicrobial agents (37 antibiotics) by discs diffusion method. Subsequently, all the strains were studied for the detection of antibiotic resistance genes by PCR methods. The phenotypic antibiotic patterns in 126 *S. aureus* isolates were as penicillin (11%), methicillin, oxacillin and pristinomycin (8%), ampicillin (13%), erythromycin (22%), vancomycin

(22%), kanamycin (46%), trimethoprim (28%), streptomycin (33%) oxytetracyclin and gentamycin (17%) and clindamycin (10%). All the isolates showed resistance for Nalidixic and polymyxin B.

### Identification of Genetic Polymorphism for Performance Traits in Sahiwal Cattle and Murrah Buffaloes

**PCR-RFLP analysis of Interleukin 8 (IL 8) gene in Sahiwal cattle:** The eight sets of primers were used to amplify the eight contig regions including 5'UTR of IL-8 gene in Sahiwal cattle. Restriction fragment length polymorphism (RFLPs) in different 8 contig regions was detected by digestion of PCR- amplified products with the *Dra* I Restriction enzyme and contig five with *Alu* I Restriction enzyme, followed by agarose gel electrophoresis. The contig regions 1, 2, 5 and 7 did not show any cutting sites on digestion with *Dra* I, while contigs 3, 4 and 6 showed monomorphic pattern of 92 bp & 492 bp for contig 3, 140 bp & 285 bp for contig 4 and 54 bp & 444 bp for contig 6 in 3% agarose gel. The contig region 5 after digestion with *Alu* I RE exhibited monomorphic patterns of 60 bp, 125 bp & 323 bp band. RE digestion with *Dra* I of contig region 8 (578 bp) revealed polymorphism and two patterns i.e. CC type with three bands (35, 118 and 425 bp) and CD type with four bands (35, 118, 425 and 543 bp) were observed. Out of 179 Sahiwal cows studied, majority of the animals were CC types (69%). Frequency of allele C was 84.6% and allele D was 15.4%. Sequence analysis of these variants showed single mutation (A to T) at 3629 nt position. CD and CC genotypes of Sahiwal cattle differed significantly regarding mastitis incidence. The animals with CD genotype were found less susceptible to mastitis than animals with CC genotype in Sahiwal cattle of the NDRI herd.

#### PCR-RFLP of contig 8 region of IL-8 gene polymorphism Using *Dra* I Restriction Enzyme in Sahiwal Cattle

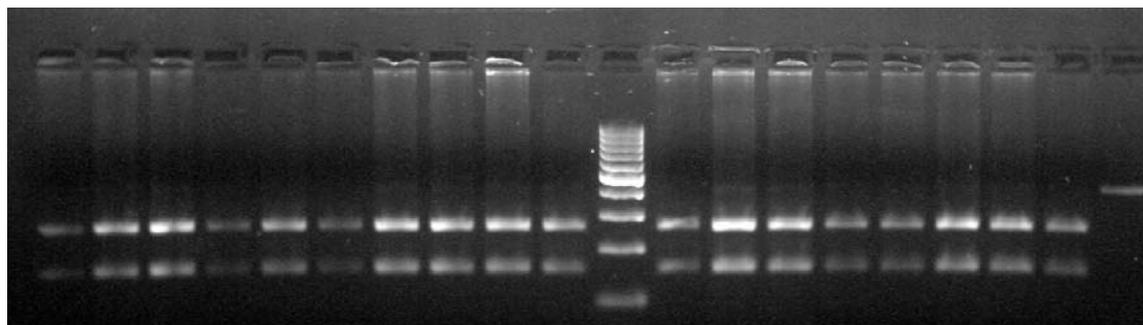


Lane 2, 3, 13 :CC (425,118, 35); Lane 1, 4-12, 14, 15 : CD (543, 425,118, 35); Lane P : PCR product (578 bp); Lane M : 100 bp Ladder

**PCR-RFLP analysis of toll-like receptor 4 (TLR 4) gene in Murrah buffaloes:** Nine sets of primers, one each for exons 1 and 2 and 7 primers to amplify complete exon 3 were designed and respective amplicons of 180, 280, 410, 420, 478, 440, 406, 410, 286 bp sizes were obtained. PCR-

RFLP analysis of amplicons of primer 3 using *BsiHKA I* restriction enzyme generated 234 and 186 bp and primer 7 as 232 and 174 bp fragments exhibiting only BB genotype revealing monomorphism with genotypic as well as allelic (B allele) frequencies of 1.00.

**PCR-RFLP of primer 7 TLR4 gene using *BsiHKA I* Restriction Enzyme in Murrah buffaloes**

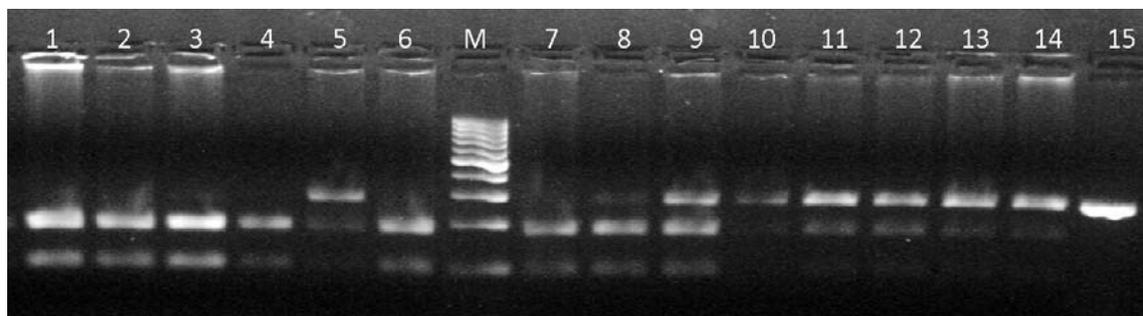


*Lane 1-18 : Monomorphic (232, 174 bp); Lane 19 : PCR Product (406 bp); Lane M : 100 bp DNA Ladder*

For primer 8, genotypes with restriction fragment were identified as AA (410, 308 and 292 bp); AB (308, 292, 200, 136 and 100 bp) and BB (200, 136 and 100 bp) with their respective frequencies of 0.167, 0.078 and 0.755. The allelic frequencies of A and B alleles were 0.206 and 0.794, respectively.

TLR4 Primer 9 also exhibited AA (286 and 186 bp); AB (286, 186 and 100 bp) and BB (186 and 100 bp) genotypes with frequencies of 0.294, 0.118 and 0.588 and allelic frequencies of 0.353 and 0.647, respectively, while primers 1, 2, 4, 5 and 6 of TLR4 gene did not have any cutting site with *BsiHKA I* restriction enzyme.

**PCR-RFLP of primer 9 TLR4 gene using *BsiHKA I* Restriction Enzyme in Murrah buffaloes**



*Lane 1-4, 6, 7 : BB Genotype (186,100 bp); Lane 5, 10-14 : AA Genotype (286, 186,100 bp); Lane 8, 9: AB Genotype (286, 186 bp); Lane 15 : PCR Product (286 bp); Lane M : 100 bp DNA Ladder*

**Network Project on Buffalo Improvement**

The breeding programme in the Murrah herd was followed for nominated mating using semen of three proven Murrah bulls of VI Set and of two proven Murrah bulls of VII Set. Test mating using semen of test bulls of XI set at the institute herd was completed. The dams' best lactation 305 day or less milk yield of the test bulls had ranged from 2489 to 3051 kg. Twelve test bulls were also used in field unit. The center proposed thirteen bulls out of which the following five Murrah breeding bulls were selected for test mating under XII set. The dam's best yield of these bulls ranged from 2711 - 3322 kg. The Murrah buffalo herd strength

increased during the period under report. The average lactation milk yield of elite Murrah buffaloes was 2937 kg which was 33.07% higher than the herd average. The best lactation milk yield of elite Murrah buffaloes ranged between 2504 to 4496 kg. Thirty nine more daughters were born during the period in the herd.

Average age at first service of buffaloes was 30 months and average age at first calving was reduced to 40.60 months which was within the target. Average age for initiating training of the young bulls was estimated as 29.39 months. The average service period of buffaloes was observed as 150.6 days. The overall mortality was as low

as 2.76%, in female buffaloes and 5.69% in male buffaloes and the female calf (0-3 months) mortality was reduced to 8.33%.

The overall female conception rate in the herd was estimated as 39.79 % which was higher than the previous year. However, the average conception rate of elite mating was 40.74 %. The lactation milk yield increased over the previous year due to increase of wet and herd average (7.21 and 4.02 kg) of buffaloes in the herd.

NDRI Center produced about 11,980 doses of frozen semen from four Murrah test bulls. The total doses of frozen semen from test bulls were 26,292. The Center also supplied 2976 doses of frozen semen to field unit and other Centers and 5021 doses of frozen semen to farmers.

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.

**Impact Analysis:** The set wise expected genetic improvement / response per generation and per year in the center was estimated using average daughters first lactation 305 days milk yield of proven bulls and average first lactation 305 days milk yield of all daughters. The set wise expected genetic improvement / response per generation and per year varied from 61.69 kg and 10.29 kg in first set to 138.63 kg and 27.95 kg in seventh set, with overall 102.67 kg / generation and 20.61 kg/year, respectively. The genetic gain under the PT program varied from 0.61 % in first set to 1.56% in seventh set with overall 1.17 % of the herd average.

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.

The superior germplasm of cattle (Karan Fries and Sahiwal) and Murrah buffaloes was multiplied under the project entitled Integrated genetic improvement of dairy cattle and buffaloes under open nucleus breeding system at the NDRI Farm. Under the program, bulls were evaluated on the basis of first lactation 305-day milk yield of their daughters. The salient highlights achieved during the year 2009 are given below:

- A Karan Fries cow produced 8216 kg of milk in a lactation period of 415 days during her second lactation. This excellent cow was produced using imported semen of a Holstein Friesian bull on a Sahiwal dam.

- A Sahiwal cow produced 4339 kg of milk in a lactation period of 490 days during her first lactation. This cow is the daughter of Sahiwal bull no. 1404, which has been progeny tested under VII Set. Two first calver Sahiwal cows have produced >2900 kg, while three first calvers have produced >3000 kg of milk in a lactation during the period under report.
- Highest yielding buffalo namely 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. This record holder buffalo is the daughter of Murrah bull no. 4915, which has been declared proven bull under Set VII.



Sahiwal herd



Karankeerti Murrah buffalo

### Network Project on Buffaloes (Field Unit)

A total of 2563 AIs were carried out in Murrah Buffaloes under field conditions and as a result 49.3 % conception rate was obtained. The highest conception rate was observed in the month of June (52.20%) and the lowest was in the month of May (42.75%). Across the villages, the highest conception rate was observed in Darar (64.9%) and the lowest was observed in the village Rindal

(39.0%). A total of 882 (469 male and 413 female) Murrah buffalo calves were born in the farmers' herds and performance data on 755 buffaloes were recorded for evaluation of bulls under field conditions. The total herd strength of registered females and the breedable females at different centers was 5681 and 4360, respectively. As many as 17 breeding bulls belonging to the 10th – 11th set were used for AI during the year.

### Centre-wise AI and PD done and calves born during 2009 under Network Project on Buffalo (Field Unit)

	Name of the Centre				Total
	Darar	Kheriman Singh	Rindal	Shekhpura	
AI	379	639	586	959	2563
PD	246	284	229	506	1265
C.R %	64.9	44.4	39.0	52.7	49.3
Calves Born	187	223	131	341	882
Male	103	110	72	184	469
Female	84	113	59	157	413



AI being done at Centre Kheri Man Singh



Performance recorded buffalo under village condition

## LIVESTOCK PRODUCTION AND MANAGEMENT

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

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

**Effect of Additives and Cooling Rates on Cryopreservation of Buffalo Semen in Soy Based Extenders:** Studies were conducted on the comparative performance of soy based extender with traditional egg yolk based semen extender

for preservation of Murrah buffalo bull semen. To standardize the process of soy based extender preparation, effect of different osmolality levels on seminal parameters at refrigeration (5°C) and ultra low temperature (-196°C) was also studied. At both the temperatures, the seminal parameters were significantly better in semen samples preserved in extender with osmolality level of 260mOsmol/kg followed by 240, 280 and 300mOsmol/kg, respectively. Pentoxifylline (3.6mM), theophylline (10mM), theobromine (10mM) and n-propyl gallate were used as additives. Seminal parameters were significantly better in egg

yolk based extender fortified with pentoxifylline followed by theobromine and theophylline in egg yolk as well as soy based extenders at refrigerator and ultralow temperature. To evaluate the effect of cholesterol loaded cyclodextrins (CLC) on sperm survival, experiment was conducted wherein CLC was used at three different dose rates i.e. 1mg/ml, 2mg/ml and 3mg/ml in extenders. Use of CLC@2mg/ml in both egg yolk and soy based extenders resulted in significant improvement in seminal parameters at both 5°C and -196°C. Seminal parameters were significantly better in egg yolk extender fortified with CLC@2mg/ml in comparison to other treatment groups. Study was also conducted to evaluate the effect of different cooling rates and freezing methods on cryosurvival of spermatozoa. Cooling of semen from 30°C to 5°C in two hours resulted in better maintenance of seminal parameters in both egg yolk and soy based extenders. Seminal parameters were significantly better in semen sample extended in egg yolk based extender cooled in 2 hours and cryopreserved using programmable freezer than other treatment groups. Overall the results suggested that buffalo semen can be effectively preserved in soy based extender.

**Studies on the Effect of Management and Processing Interventions on Preservability of Sub-Fertile Crossbred Bull Semen:** Studies on the effect of various freezing rates and ice nucleation on cryopreservation of crossbred bull semen, effect of filtration with antioxidant fortification on preservability and to assess the effect of Vitamin E supplementation on ameliorating vaccination stress revealed that the seeding improved the semen quality of spermatozoa, though biological freezer provided no additional benefit to restore the normal characteristics of spermatozoa. Antioxidants significantly improved preservability of semen, but among additives vitamin E had the best effect. Damage to spermatozoa was found to be the least in extender fortified with vitamin E at room, refrigeration and freezing temperature. Filtration system containing sephadex ion-exchange columns effectively removed immotile, dead and abnormal spermatozoa from an extended low quality semen ejaculate specially when it was fortified with vitamin E, at all temperature ranges. Vitamin E supplementation in vaccinated bulls ameliorated vaccination stress partially as it significantly improved overall volume, concentration, dose/ejaculates and other characteristics of spermatozoa. Levamisole treatment in vaccinated bulls ameliorated vaccination stress partially by improving overall concentration, dose/ejaculate and other characteristics of spermatozoa. No significant effect was observed in blood profile

either with Vitamin E supplementation or Levamisole treatment.

**Effect of Taurine and other Additives on Preservability of Bull Semen:** Studies were conducted on Sahiwal bull semen to elicit the effect of additives and antioxidants on the semen quality using plant-based extender. For assessing the effect of antioxidants on characteristics of semen preserved at refrigeration temperature twenty ejaculates were taken from four Sahiwal bulls and three antioxidants i.e. (Taurine @ 20 mM, Catalase @ 100u and Vit.C @ 5 mM) were added to split ejaculates. Incorporation of antioxidants improved seminal parameters like sperm motility, non-eosinophilic count, HOST score, acrosomal integrity and abnormalities in semen preserved at refrigeration temperature (0hr, 24hr and 48 hr), significantly. In experiment on cryopreservation, 12 ejaculates were taken from four Sahiwal bulls and antioxidants were added to study the seminal parameters at (pre-freeze 0day and 7day). Similar results were found as refrigeration temperature. In second experiment semen samples were diluted in plant based extender with three levels of osmolality (240, 260 and 280 mOsmol/kg) and quality was assessed at refrigeration temperature (0, 24 and 48hr) and after cryopreservation (0 and 7 day) on addition of antioxidants. Addition of Taurine, Catalase and Vit.C resulted in significant increase in seminal parameters, both in refrigerated and cryopreserved semen. The significant effect of osmolality was also seen on seminal parameters and the best seminal characteristics were observed at 240 mOsmol/kg. It was inferred that semen samples fortified with Taurine resulted in better preservation of semen both at refrigeration and cryopreservation level in both egg yolk and soya based semen extenders.

**Milk Differential Leukocyte Counts in Cows and Buffaloes as Affected by Physiological and Managemental Practices:** Studies on milk SCC and milk DLC in cows and buffaloes during different physiological stages and reared under different managemental practices revealed that, SCC were higher in the early stage of lactation, decreased in mid-lactation and reached the peak by late stage of lactation both in KF cows and Murrah buffaloes. Milk SCC significantly varied between parity in KF cows. Milk SCC in case of Sahiwal cows and Murrah buffaloes increased non-significantly up to 4<sup>th</sup> parity and then decreased. Milk neutrophils in Murrah buffaloes varied significantly during different parities with significantly higher values being observed in older animals. Increase in body weight was accompanied with the corresponding

rise in milk SCC and milk neutrophils though it was non-significant in KF cows. Milk lymphocyte percentage decreased and milk neutrophils tended to increase with increasing body weight of cows and buffaloes. In KF cows the milk macrophage percentages varied significantly with the changes of body weight. The percentage of neutrophils and lymphocytes varied significantly in the colostrum of cows and buffaloes. Milk SCC was significantly higher in the autumn season whereas milk lymphocytes were significantly higher in winter. Milk SCC was higher in machine milking group though the difference was non-significant. Normal milk contained higher SCC as compared to fore milk and stripping in Sahiwal cows. Similar pattern was also found in Murrah buffalo. In conclusion, maximum change was observed in milk neutrophils and minimum in milk macrophages. Change in milk neutrophils could be a good indicator of milk quality. The milk SCC in conjunction with DLC gave better picture of udder health and milk quality.



**Changes in haematological parameters, Milk cell counts and metabolic status of high yielding dairy cows during transition period:** The study was conducted to observe the changes in the hematological parameters (hemoglobin, PCV, TEC, Erythrocytic Indices, TLC and DLC), milk cell counts (SCC and differential cell counts) and metabolic parameters (blood glucose, BUN, NEFA and cholesterol) of high yielding Sahiwal (SW) and Karan Fries (KF) cows during transition period. The results of the study confirm that the transition period is one of the most stressful and vulnerable periods of the high yielder dairy cows and proper care and management during this period was crucial to ensure health and productivity of high yielder animals.

**Growth Pattern of Sahiwal Animals:** The data on growth of Sahiwal calves available at NDRI herd was analyzed. The overall least squares means for growth rates were  $385.70 \pm 4.81$  g/day for birth to six months,  $296.01 \pm 6.50$  g/day for six to twelve months,  $364.74 \pm 7.66$  g/day for twelve to eighteen

months,  $292.84 \pm 7.42$  g/day for eighteen to twenty four months and  $309.12 \pm 8.57$  g/day for twenty four to thirty months. The  $R^2$  value for prediction of 30 months body weight from early weights at different stages was observed approximately 52%. It indicated that approximately half to the total observed variability in body weight at maturity is due to environmental factors. Two critical growth phases (at 6-12 and 18-24 months) were revealed where growth rate was lower than the expected growth rate (327.19 g/d). Based on these results, two critical age groups ((i) 6-12months and (ii) 18-24 months) were identified for providing extra care.



**Feeding and management interventions for improving the performance of crossbred dairy heifers:** Effect of feeding total mixed ration (TMR) and provision of additional winter protection on the performance and behaviour was studied on crossbred heifers. The results revealed that TMR based feeding was helpful in attaining growth rates in excess of 700 grams per day which is very good for attaining early sexual maturity. Additional winter protection along with TMR feeding, however, had only limited additional benefit in the prevailing environmental conditions of Karnal, where the winter is not severe. The behavioural parameters including eating time, rumination time, and chew rate during eating, chew rate during rumination, idle sitting time, idle standing time and sleeping time however, were not significantly affected by TMR feeding.

**Development of Organic Milk Production System:** The performance of the buffaloes under organic management in the second lactation and the control group of buffaloes was continued to be recorded. The animals are still in lactation and their lactation performance recorded up to 28.2.2010. The mean total lactation yield recorded was 2265.33 kg and 1694.86 kg in organically and control group of buffaloes respectively with the mean lactation length of 258.83 and 201.83 days respectively. The mean daily milk yield of 8.75 and 8.39 kg in organically managed and control group

of buffaloes, respectively whereas the peak daily yield was 17 l and 13.5 kg, respectively.

To feed the experimental buffaloes, the fodder and feed crops were grown organically. In Kharif season the maize and jowar crops were grown. In the winter (Rabi season), Chinese cabbage and berseem were sown as fodder crops and the barley as feed grain and for dry fodder as straw. The fodder, feed and milk samples of organically managed and the control group of buffaloes were collected for the estimation of pesticide, antibiotic, heavy metals residues and vitamin A and vitamin E as well as the estimation of milk composition and milk somatic cell counts.



Group of buffaloes under organic management



Maize fodder crop grown organically

**Effect of Satavari on Milk Production and Composition of Murrah Buffaloes and Crossbred Cows:** The effect of Satavari (*Asparagus recemosum*) supplementation was studied on lactating Murrah buffaloes. The experimental buffaloes were randomly divided into 3 groups of 5 each. T<sub>1</sub> served as control, T<sub>2</sub> animals were fed Satavari @ 100 mg/ kg body weight during pre-partum period, whereas, T<sub>3</sub> buffaloes were fed Satavari @ 150 mg/ kg body weight during pre partum and 300 mg/ kg body weight during post partum. The yield of colostrum was significantly higher in T<sub>2</sub> (41.9 kg) and T<sub>3</sub> (50.0 kg) as compared to control (22.0 kg). The milk production during 60d study period averaged 677.4, 749.7 and 860.0 kg in T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively giving additional yields of 10.67 and 26.96 %, respectively in T<sub>2</sub> and T<sub>3</sub> over control. The

weight at birth of calves was significantly higher in the calves born to T<sub>2</sub> (35.4 kg) and T<sub>3</sub> (37.4 kg) buffaloes in comparison to control (28.8 kg). The level of cholesterol in ghee made from the milk of experimental buffaloes did not differ significantly among the 3 groups. It was concluded that feeding of herbal supplement Satavari to buffaloes during pre as well as post partum had positive effect on the milk production and birth weight of calves. In another trial, prepartum supplementation of Satavari @100 mg/kg body weight in crossbred cows from 60 days prepartum upto parturition improved the prepartum body weight gain, post partum milk production. Likewise, postpartum supplementation @200mg/kg live body weight improved the milk production and reduced post partum body weight losses. Supplementation of Satavari in crossbred cows improved body weight, milk production, reproductive performance, udder health and returns from milk.

**Effect of Feeding Fenugreek Seed on Production Performance of Dairy Goats:**

Feeding Fenugreek seed (*Trigonella foenumgraecum*) powder (FSP) @1 g/kg body weight to dairy goats increased milk production; whereas, feeding FSP @ 2 g/ kg body weight resulted in decrease in milk production. Milk composition was not affected by Fenugreek supplementation. Fenugreek seed supplementation had no effect on DM, CP and TDN intake as well as feed conversion efficiency of experimental goats. It also did not have any positive effect on somatic cell count of milk, although supplementation @1g/kg body weight level significantly improved reproductive performance and economics of dairy goat rearing. It was concluded that supplementation of FSP @1g/ kg body weight is beneficial in increasing milk yield maintaining body weight, improving reproductive performance and economics of goat rearing.

**Effect of Polyherbal Feed Supplement on Production Performance and Milk Quality of Crossbred Cows:**

The study was conducted to find out the effect of feeding polyherbal immunomodulator supplement containing, *Withenia somnifera* (Ashwagandha), *Asparagus racemosus* (Satavari), *Embllica officinalis* (Amla), *Ocimum sanctum* (Tulsi), *Tinospora cordifolia* (Giloy), *Trebulus terrestris* (Gokhru) and *Nigella sativa* (Klonji) during peripartum period on subsequent performance of Karan-Fries cows. Forty pregnant Karan-Fries cows were grouped in to 4 groups of 10 cows each. One group served as control. Cows in treatment groups T<sub>1</sub>, T<sub>2</sub> and T<sub>3</sub>, respectively, were given polyherbal supplementation @ of 150, 200 and 250 mg/kg BW/day from 60 days prepartum

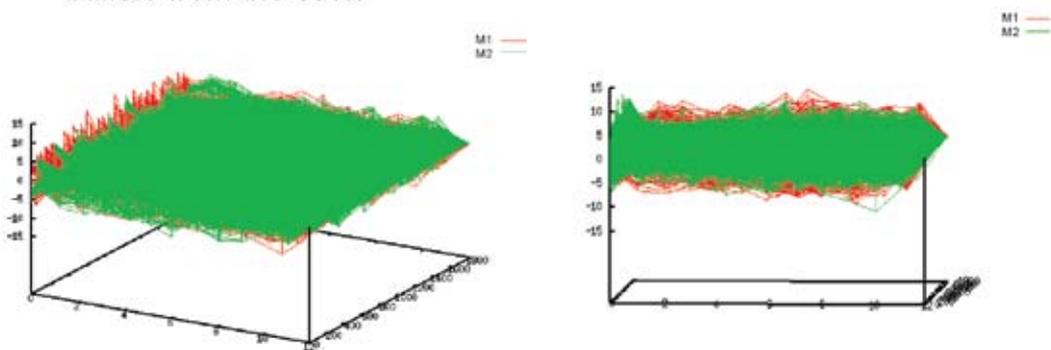
up to 60 days postpartum. Immunity status, in term of TLC, DLC, neutrophil phagocytic activity, plasma micro-minerals (Cu, Fe, Zn and Mn) and IgG concentration, antioxidant status and NEFA during calving, was significantly better in T<sub>2</sub> and T<sub>3</sub> than control and T<sub>1</sub>. Production of milk, fat, protein, lactose and SNF in T<sub>2</sub> and T<sub>3</sub>, was significantly higher than control and T<sub>1</sub>. Likewise, the milk quality, as indicated by lower milk somatic cell and standard plate count was also better in T<sub>2</sub> and T<sub>3</sub> than control and T<sub>1</sub>. This was attributed to lesser severity and incidence of sub-clinical and clinical mastitis in T<sub>2</sub> and T<sub>3</sub> treatment groups. Reproduction performance was also better in T<sub>2</sub> and T<sub>3</sub> than control and T<sub>1</sub> groups. Additional net returns from sale of milk were highest in T<sub>3</sub> followed by T<sub>2</sub> control and T<sub>1</sub>. Based on these results, it was inferred that polyherbal supplementation @ of 200-250 mg/kg BW improved immunity and antioxidant status and

thus reduced periparturient stress and associated health problems. This optimized production and reproduction performance and consequently improved economics of milk production.

**Vocalization Patterns of Murrah Buffaloes:** The MFCCs (Mel Frequency Cepstral Coefficients) technique for feature extraction was used for analysis of voice samples. The MFCCs coefficients were able to distinguish one animal from the other based on energy variations. The large number of voice samples from different categories of cows and buffaloes in different conditions were recorded and edited for further analysis for making accurate individual identification of animals in the herd. The analysis of recorded large number of animal voice samples by using advance software programme at IBM, Research Lab. New Delhi is in progress.

## Comparative analysis

- The MFCC coefficients are (even visually) able to distinguish one buffalo from the other



- As is clearly seen in the plot on the left, there is distinctively high energy in the 0-th coefficient for M1, as compared to M2 buffalo.
- Plot on the right is the same, but viewed from a different angle (with colors swapped). This shows that the energy-variation in middle coefficients in M1 buffalo is extremely high.

**Development of Wireless Sensor Network for Animal management (C4/C2008):** Algorithm developed using Fuzzy logic technique for heat detection in Sahiwal Cow was from continuous and three time observation data of 100 heat cycle. Data on Milk conductivity, pH, somatic cell count(SCC) in different stage of lactation in Crossbred Karan Fries Cow has been collected in normal and oncoming Mastitis animals and under evaluation with sensitive enzymatic confirmation of status of mastitis for developing algorithm by using artificial neural Network

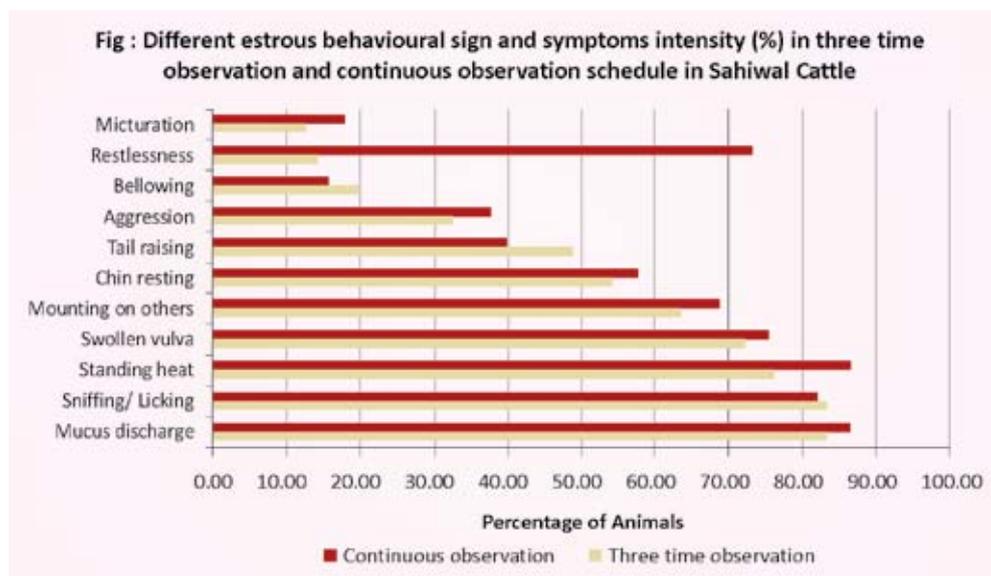
technique for different stages of lactation in Karan Fries cow.

Herd health monitoring data on mineral profile and metabolic profile in Karan Fries Cattle is completed and it was found that 15 to 20 % animals are sub-clinically suffering from metabolic diseases and under stress which can be diagnosed with sensor behavioral data. Ruminal acidosis and lameness study was under progress for corroborating accelerometer sensor reading for development prediction of lameness in dairy cattle. Database

collecting different sensor data is completed and Production data database is under update in the institutional herd. Survey of Nomadic sheep herd was completed in November in Jaipur, Jaisalmer and CSWRI Avikanagar.

**Estrous Behaviour, Cervical Mucus Characteristics and Fertility in Sahiwal Cows:** Studies were undertaken on the estrous behaviour, diurnal pattern of estrus, duration of estrus and time of AI of Sahiwal cows. The estrus symptoms were recorded visually thrice daily v/s continuously for all animals observed in heat. In addition, 13 animals were induced for heat using PGF2 $\alpha$  and time of ovulation was observed. In thrice daily and continuous observation respectively, the standing heat (76.36 & 86.66%), mounting on others (63.63 & 68.89%), sniffing/licking (83.63 & 82.22%) and restlessness (26.84 & 73.33%) were observed. The average estrous symptom score was 12.32  $\pm$  0.74. Onset of estrus during day and night time was in 54 and 46% of the estruses, respectively. Duration of estrus was <12 h in 39% cases and 12-18 h in 45%

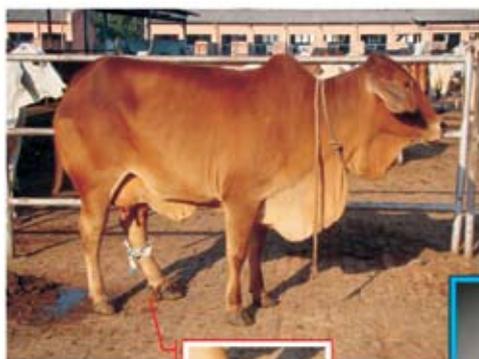
cases(average 13.35  $\pm$  0.53 h). Inter-estrus interval was subnormal, normal and abnormal in 13.49, 43.82 and 42.69% of cycles. The uterine tone was weak, moderate, and intense in 27, 41 and 32% cases of estrus, with conception rates of 23.80, 54.54 and 81.25% respectively, which differ significantly. Pattern observed in the majority of mucus samples showed; clear discharge (53%), thin (45%), 7.5-8.0 pH (41%), typical fern pattern (62%) and 14-16ms conductivity (42.67%) at the time of AI. The average pH and conductivity were 7.62  $\pm$  0.04 (range of 6.67 to 8.54) and 15.20  $\pm$  0.16 ms (range of 12.57 to 17.85) respectively. There was significant difference in conception rates between different groups in respect of duration of estrus, intensity of estrus, degree of uterine tone and conductivity of cervical mucus in Sahiwal cattle. The conception rates for different time of insemination 6-12 h, 12.5-18 h and > 18 h after onset of estrus were 52.94, 59.25 and 14.28%. In induction of estrus 92 % of animals showed response to treatment, with mean interval from treatment to onset of estrus as 64.23  $\pm$  6.76 h. The time of ovulation after start of estrus was 25.69  $\pm$  0.79 h.



*Heat Detection in Sahiwal cows*

Sl. No.	Time of insemination	No of insemination	Pregnant	Non Pregnant	Conception Rate (%)	$\chi^2$ Value
1	6-12 h	51	27	24	52.94	4.57
2	12.5-18 h	27	16	11	59.25	
3	> 18 h	7	1	6	14.28	

*Relationship between time of insemination after onset of estrus and conception in Sahiwal cattle*



Limp event detected remotely at Monitoring Centre, flagged for action (actual logged data)

### Limp Detection in Cattle

Sensor Node developed at IIT Delhi (Prof. S.Kar/ Dept. of Electrical Engg.) attached to infected hind leg of Sahiwal (slight limp,

## DAIRY CATTLE NUTRITION

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

#### Evaluation of Babul Pods as Barley and Sorghum Energy Replacer on Milk Production in Crossbred Cows

Eighty per cent of the energy supplied through barley (T2) and sorghum (T3) was replaced by babul pods (*Acacia nilotica*) in TMRs fed to lactating cows. Feed intake, digestibility of various nutrients, milk yield and its composition remained similar in all the three dietary treatment groups. Microbial protein synthesis increased resulting in energetic efficiency by 10.86 and 10.28% in T2 and T3 where barley and sorghum were replaced with babul pods giving 3% tannin in the whole diet. *In vitro* experiments showed that even 100% replacement of barley and sorghum grains with babul pods had no adverse effect. This shows potential of babul pods to be used as a source of energy in lactating cows. The presence of tannin monomers like phloroglucinol, epicatechin and EGCG on feeding babul pods to cows resulted in value addition to "Milk powder" and "Khoa". Khoa contained 4.15 mg phloroglucinol, 0.012 mg EGCG and 0.156 mg epicatechin/g DM while milk powder contained 2.91 mg phloroglucinol and 0.02 mg epicatechin/g DM. Khoa also contained gallic acid. Sensory evaluation score for both the products was comparable to normal products. Feeding of tannin monomer enriched milk powder to rats improved their blood antioxidative status.

#### Conjugated Linoleic Acid (CLA) Production Potential of *Butyrivibrio Fibrisolvens* on Supplementation of Dietary Oils

*Butyrivibrio fibrisolvens* isolated from rumen was subjected to morphological and biochemical characterization followed by PCR-based identification. Isolated bacteria was used in *in-vitro* experiment with pure linoleic acid (LA) and linolenic acids (LNA) at 50, 100, 150, 200 and 250  $\mu\text{g mL}^{-1}$  and three dietary oils i.e. sunflower, soybean and mustard (rich in LA) at 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3  $\text{g L}^{-1}$  of media concentration to study the growth of bacteria and CLA production. The growth of the *B. fibrisolvens* was found inversely related to polyunsaturated fatty acid (PUFA) concentration and decreased linearly on increasing the concentrations of LA, LNA and three oils. Bacterial growth decreased most at 250  $\mu\text{g}$  level of LA and LNA. Similarly, bacterial growth decreased most at 0.3 g level of three dietary oils. Highest CLA production was observed at 200  $\mu\text{g}$  LA and 0.25 g of three dietary oils (65.52, 51.96, 42.08 and 25.60  $\mu\text{g mL}^{-1}$ ) which decreased (55.63, 48.19, 39.35 and 23.41  $\mu\text{g mL}^{-1}$ ) at 250  $\mu\text{g}$  LA and 0.3 g dietary oils, respectively. CLA production was recorded highest at 0.25 g/l level with the sunflower oil followed by soybean and mustard oil, positively correlated with their LA concentration of three dietary oils. Growth of the bacteria and CLA decreased at higher concentration of oil (0.3 g/l) due to the antimicrobial effect of LA. Results indicated that *B. fibrisolvens* produced CLA on supplementation of dietary oil as a source of linoleic acid.

### Development of Complete Feed Blocks Based on Low Grade Roughages Fortified with Potential Anaerobic Fungal Zoospores and Their Evaluation in Buffaloes

The elite anaerobic fungal cultures *Neocallimastix sp.* (GR1), *Piromyces sp.* (WNG12) and *Orpinomyces sp.* (C14), isolated from grazing and browsing goat, cattle and wild blue bull were grown under anaerobic conditions. The cultures were inoculated into roll tubes and the differences in the size and the branching of the thalli developed was as per their parent culture. Fungal zoospores from these cultures were developed to study the *in vitro* DM, NDF and ADF digestibility of WS and WS based TMR. The *Neocallimastix sp.* GR-1 and *Piromyces sp.* WNG-12 produced more zoospores than *Orpinomyces sp.* C-14. Based on *in vitro* digestibility of DM, NDF and ADF and enzymatic activities of CMCase, FPase and xylanase, *Neocallimastix sp.* (GR-1) was selected for *in vivo* study. Murrah buffalo calves were fed complete feed blocks incorporated with or without fungal zoospores @ 140x10<sup>6</sup> zoospores/block with 2 kg green maize/animal/day. An increase of 16% body weight gain in experimental group over the control group was observed with similar feed intake resulting in 28.7% more feed efficiency. The digestible energy (DE) value in terms of % TDN also increased. It was concluded that feeding of wheat straw based complete feed blocks incorporated with fungal zoospores of *Neocallimastix sp.* GR-1 resulted in increased nutritive value of wheat straw.

In another study, Murrah buffalo calves were fed on a complete feed block (concentrate mixture 50%, wheat straw 43%, 6% molasses and 1% urea) alongwith 2 kg of green oats for group 1. Complete feed block with purified fungal zoospores of *Neocallimastix sp.* GR-1 for group 2 and 1% wheat straw of group replaced by 1% sodium sulphate in group 3. The average daily gain was significantly higher in group 3 (650.6 gm/day). The digestibility coefficient (%) of DM, OM, CP, NFE, ADF, NDF and cellulose were significantly higher in group 3 (sulphur group) resulting in higher DCP and TDN value. The TVFA's, Total-N was significantly higher ( $p < 0.05$ ) and ammonia nitrogen was significantly ( $p < 0.05$ ) lower in group 3. The TCA perceptible nitrogen was significantly higher ( $p < 0.05$ ) in group 3. It was inferred that incorporation of zoospores of *Neocallimastix sp.* GR1 with additional sulphur @ 0.22% improved the growth rate, digestibility of proximate principles and rumen fermentation in female buffalo calves fed complete feed blocks.

### Rumen Microbial Manipulations for Mitigation of Methane Emission and Productivity Enhancement in Dairy Animals

Seven organic acids and three sodium salts of organic acids i.e Aspartic acid, Citric acid, Fumaric acid, Lactic acid, Malic acid, Propionic acid, Tartric acid, Disodium fumarate, Disodium malate and Disodium tartrate dehydrate were added in incubation medium to achieve final concentration of 10 mM. In *sorghum* based diet, the highest decrease of CH<sub>4</sub> (mM/g digestible dry matter) was found with fumaric acid (44.52%) and malic acid (38.87%), respectively. Maximum propionate concentration increased with disodium fumarate (146%) and propionic acid (159.33%). The maximum reduction of methane (mM/gm digestible dry matter) in berseem based diet was observed with propionic acid (40.51%). Effect of addition of organic acids in berseem based diet on dry matter digestibility was negative in most of the treatment combination as a result digestibility of DM reduced significantly. However, with sorghum based diet, digestibility of DM remained more or less similar in all organic acid treatment combinations. The results of the present study indicated that organic acids have potential to divert hydrogen for propionate production which in turn decreases the methane production.

Four cereal grains/byproducts (sorghum grain, broken rice, wheat bran and deoiled rice bran), four protein sources (soybean meal, mustard cake, sunflower cake and guar meal) and four roughages (oat, maize, berseem fodder and wheat straw) were evaluated individually for rumen fermentation parameters by *in vitro* gas production technique. Due to high amount of non-structural carbohydrates, cereal grains produced higher amount of total gas in 24 h incubation with highest value for sorghum grain and the lowest for wheat bran (70.30 vs. 34.03 ml/200 mg). Total gas production from protein sources ranged from 29.86 (sunflower cake) to 42.86 ml. Among fodders, total gas production was the lowest with wheat straw (24.20 ml) and the highest with oat fodder (35.86 ml). Methane production as percent of total gas ranged from 16.35 to 17.78% for cereal grains/byproducts, from 17.65 to 21.58% for protein sources with the highest value for soybean meal and from 11.99 to 18.09% for fodders with the lowest value for oat fodder. It was inferred that the cereal grains/byproducts were high in total gas production, moderate in methane production, high in OM digestibility and lower in NH<sub>3</sub>-N production. The protein sources were low

in total gas production, high in methane production, OM digestibility and ammonia-nitrogen production while the fodders were low in total gas and methane production but low in OM digestibility and ammonia-nitrogen production.

#### **Evaluation of Cellulase and Xylanase (exogenous fibrolytic enzymes) as Feed Additives for Growth and Milk Production in Ruminants**

Effect of addition of different levels of cellulase (4000  $\mu$ M glucose/g/h) and xylanase (7990  $\mu$ M xylose/g/min) to different concentrate: roughage ratios on *in vitro* DM degradability (IVDMD) and Neutral Detergent Fiber degradability (IVNDFD) was seen. The optimum level of cellulase and xylanase supplementation in 50:50 (w/w) ratio was found to be 1.5 & 3.0 g/kg DM, added in concentrate portion of TMR. There was no effect of heating temperature (40°, 50°, 60° and 80°C) and its duration (2, 5 and 10 min.) on the enzyme activity, IVDMD, IVNDFD and IVADFD of the three TMRs. There was no adverse effect on enzyme activity on storage of cellulase and xylanase mixture up to 60 days. Similarly, there was no effect of storage on IVDMD, INDFD and IVADFD of three TMRs' containing these concentrates up to 60 days.

Feeding of Murrah buffalo heifers on TMR comprising of concentrate : wheat straw : maize green fodder in 40:45:15 (control group), the same TMR plus cellulase (4050  $\mu$ M glucose/g/h) and xylanase (8600  $\mu$ M xylose/g/min) mixed in 50:50 ratio on w/w basis and fortified @ 1.5 g/kg DM of TMR (T-1) and @ 3.0 g/kg DM of TMR (T-2), revealed that average daily gain was 692.35 and 693.33g in control and T-2 and the same was higher ( $P < 0.05$ ) by 15.66 and 15.50% in T-1 over that of control and T-2 due to higher ( $P < 0.05$ ) digestibility of NDF, cellulose and hemicellulose and higher ( $P < 0.05$ ) TDNI.

Another study on lactating Murrah buffaloes with similar treatments revealed that milk yield (kg/d) was 12.99 & 8.10 % higher in group T-1 and T-2 over that of control, respectively. Average fat corrected milk (4% FCM) yield over the entire experimental period was higher by 15.17% in T-1 over that of control. Average TDN intakes kg/d were also significantly higher ( $P < 0.05$ ) by 12.53% in T-1. There was no effect of feeding fibrolytic enzymes on the milk constituents. Improvement in the digestibility of CF, NDF, ADF, Cellulose and Hemicellulose by 10.65, 7.68, 10.86, 8.90, and 6.72% in buffaloes of T-1 was observed against control group.

#### **Use of Dietary Cation Anion based Mineral Mixture**

Initiation of lactation places one of the greatest stresses on Ca homeostasis and is associated with milk fever among high producing dairy cows and buffaloes. Hypocalcemia also increases the incidence of dystocia, retained placenta, metritis, prolapsed uterus and delays uterine involution. Hypocalcaemia prevents the teat sphincter from closing both before and after milking and allows greater access to bacteria in the mammary gland which results in mastitis. During dry period, Ca req. is 10-12 g/d (fetal and endogenous Ca), hence mechanism for replenishing plasma Ca is relatively inactive. Upon parturition, Ca requirements are 10 times more than the supply in bloodstream. An anionic mineral mixture was prepared which was fed to pregnant cows few days before parturition so as to create metabolic acidosis and initiate Ca resorption immediately after calving. This anionic diet (-12 meq/100g DM) resulted in zero incidence of mastitis and milk fever as compared to 14.3 % in cationic diet (15 meq/100g DM) fed cows. The incidence of metritis was also zero against 71.43% cationic diet fed cows. Above all, there was increase of 1.13 kg milk on 4% FCM basis during 90 days postpartum period in anionic diet fed cows resulting in great economic gains. This mineral mixture was provided to dairy farmers and they also reported similar improvement in dairy animals. Hence, it is advisable to feed anionic mineral mixture to high producing animals at least 10 days prepartum for early onset of the mechanism of Ca resorption upon calving.

#### **Evaluation of Certain Binding Agents/Nutrients to Counteract Heavy Metal Toxicity in Crossbred Goat Kids**

A study was conducted to examine the protective effect of 50 ppm Zn in crossbred kids exposed to 50 ppm lead containing diet. No clinical signs of lead toxicity were observed during 190 days feeding. There was no effect on nutrient digestibility in the animals exposed to lead feeding. Serum GOT, GPT activities, Pb concentration in lead exposed groups were higher and Hb concentration was lower than those of control group, showing the adverse effect of lead. The m-RNA transcription of SOD showed a decreasing trend (showing oxidative stress) in experimental groups which was recovered to some extent in Zn supplemented kids. Similarly, another indicator of increased oxidative stress i.e TBARS values was also higher in both the experimental groups. The results indicated that 50 ppm Pb did

not cause any significant adverse effect on various parameters studied. However, the growth rate was the lowest in Pb supplemented group followed by Pb plus Zn group. Therefore, it was concluded that the levels of lead were not high enough to cause any clinically adverse effect during six months feeding.

#### **Effect of Selenium Supplementation on Rumen Fermentation *in vitro***

The effect of different levels of added Se (0, 2, 4, 8, 10, 12 and 14 µg) on rumen fermentation

parameters was studied *in vitro*. There seemed to be no differences in true organic matter digestibility (TOMD) up to addition of 10 µg Se, however, TOMD decreased thereafter. Microbial biomass production also showed a decreasing trend with addition of Se, however, the effect was more prominent at 12 µg supplementary level. *In vitro* gas production (IVGP) was not affected by the level of added Se when measurements were made upto 24 h of incubation, however, when the time of incubation was extended up to 48h, there was decrease in IVGP values after supplementary level of 12 µg. Total volatile acid production showed the similar trend.

## **DAIRY CATTLE PHYSIOLOGY**

#### **Studies on Immune Competence in Dairy Animals**

Studies were taken up in buffaloes to evaluate mitogen stimulated lymphocyte functions during different stages of gestation. Effects of different immunomodulators on immune cell activity were also evaluated *in vitro* during different stages of gestation. Results depicted that physical and metabolic stresses of pregnancy decreased mitogen stimulated immune parameters like LPR ( $P < 0.05$ ) or NO ( $P < 0.01$ ). However, milk production upto 9 kg level had no influence on immune cell activity. But when these lactating buffaloes (production level-9 kg) were exposed to short term heat stress, immune cell activity was found to decline significantly ( $P < 0.05$ ). The study also revealed immunosuppressive effects of nitric oxide donor on lymphocyte functions *in vitro*. These effects were NO dependent. The inhibitory effects of NO inhibitors were mediated via IL-2. Inhibitory effects of high cortisol levels were mediated through NO.

#### **Studies on Physiology of Lactation in Dairy Animals**

**Evaluation and augmentation of *in vitro* phagocytic activity (PA) of bovine milk neutrophils:** To assess milk DLC and *in vitro* phagocytic activity of milk neutrophils during early, mid and late lactation, milk samples were collected throughout lactation. Milk SCC was the lowest in primiparous buffaloes and the highest in multiparous buffaloes. Milk neutrophils were significantly lower in all the buffaloes during early lactation, but increased significantly ( $P < 0.01$ ) by the end of lactation. A non-significant increase was seen in milk macrophages during mid and late lactation. Irrespective of parity, maximum PA and phagocytic index was

observed during mid-lactation, indicating less mammary stress during this period.

To determine enhancement of immunological competence, crossbred cows were supplemented 1000 I.U. of vitamin E beginning 60 days before calving until parturition. After calving milk yield of the experimental animals was recorded till 90 days. There was a decline of 18 and 28 % in body condition score (BCS) between 20 days before and 20 days after calving in control group in medium and high BCS and cows. The treatment group cows showed a decrease of 13 and 18 % in body condition between 20 days before and 20 days after calving in medium and high BCS cows. SOD activity increased up to day of calving and after calving, SOD activity decreased. SOD activity was higher in high BCS cows indicating more oxidative stress in high BCS cows. There was a positive correlation between SOD and catalase activity. Cows with higher BCS and greater BCS loss had increased concentration of NEFA and were particularly sensitive to oxidative stress. Decreased level of total Immunoglobulin was more in high BCS cows as compared to medium BCS cows. TNF  $\alpha$  levels were significantly ( $P < 0.01$ ) higher in high BCS cows as compared to medium BCS cows. However, there was no significant difference between groups. During periparturient period, the control group cows were under more oxidative stress than the treatment group cows in both the seasons of study. SOD, catalase and TNF- $\alpha$  was positively correlated. The decline in  $\alpha$ -tocopherol and retinol concentration on the day of calving was highest in control group of cows during summer. There was a decline of 29 and 37 % in alpha-tocopherol level towards calving period in control group in medium and high BCS cows. The treatment group cows showed a decrease of 9 and 23 % in alpha-tocopherol level towards calving

period in medium and high BCS cows. The decline in total immunoglobulin concentration towards 20 days after calving was more in summer control group cows as compared to winter control group cows. The glucose concentration increased from 20 days before calving to day of calving, then the levels declined towards 20 days after calving. Milk yield was negatively correlated with SOD, catalase and TNF- $\alpha$  levels and was positively correlated with  $\alpha$ -tocopherol levels. The levels of antioxidant enzymes were significantly decreased by supplementation of  $\alpha$ -tocopherol acetate indicating improvement in oxidative status of cows. Vitamin E and A and total immunoglobulin levels were significantly higher in cows supplemented with  $\alpha$ -tocopherol acetate indicating improvement in antioxidant status and immunity of cows. HSP 70 level was higher in high BCS cows as compared to medium BCS cows ( $68.30 \pm 5.49$  vs.  $48.46 \pm 1.93$  ng/ml). Milk yield was significantly higher in medium BCS cows than high BCS cows and also in  $\alpha$ -tocopherol supplemented group during both the seasons. The study revealed that cows of medium body condition are under less metabolic and oxidative stress and have significantly higher milk production and better reproductive performance than cows of high body condition. Supplementation of vitamin E during dry period for 60 days before calving reduces metabolic and oxidative stress and results in improved milk production of cows.

### Augmentation of Fertility

To study the feasibility of heatsynch protocol application for fertility improvement in buffaloes belonging to farmers' herds, trials were conducted on anestrus buffaloes in villages of Karnal district. The buffaloes were selected on the basis of being at least six months anestrus (anestrus period ranging from 6 months to 2 years). The animals were treated as per the protocol (GnRH-PGF2a-Estradiol benzoate) and inseminated twice. The complete results obtained till date are as under:

Application of Heatsynch in Farmers Buffalo Herds ( till October, 2009)

	TRIAL I	II	III	IV	V	Overall No.(%)
No. of Animals treated	25	25	19	23	25	117
No. of animals pregnant at fixed time A.I	10	8	7	6	9	40 (34)
No. of Animals re-inseminated and found pregnant	6	7	3	1	4	21 (18)
No. of Animals re-inseminated and found non pregnant	9	10	9	16	12	56 (48)
Overall success rate in terms of pregnancies	16	15	10	7	13	61 (52)

The protocol has advantage over the earlier protocol viz. the ovsynch protocol in terms of being more economical (Rs.350/- Vs Rs.520/-), better expression of heat symptoms in buffaloes and easier implementation.



Buffalo of Mr. Ramchander S/o Kesi Ram pregnant after 14 months of calving at the village Samorafollowing heatsynchtreatment

### Impact, Adaptation and Vulnerability of Indian Livestock to Climate Change

Animal stress level due to temperature rise was worked out using Temperature Humidity Index (THI) in India. Analysis of stress level revealed that for 160-165 days during the year average THI was less than 65 in northern India and for about 50 days the THI ranged between 66 and 70. THI remained more than 70 for 40-42 days and THI ranged between 75 and 80 for 95-100 days during the year. Temperature rise of more than 4°C is likely to increase uncomfortable days (THI>80) from existing 40 days (10.9%) to 104 days (28.5%) for HADCM3-A2 scenario and 89 days for B2 scenario for time slices 2080-2100. This change in THI has a negative impact on the livestock production both directly and indirectly.

One of the direct impact of climate change is on the milk yield production. A temperature rise of 1.0 or 1.2°C with minor change in precipitation during March -August for India (Region 23- HADCM3 A2/ B2 scenario) will marginally affect milk production and during other months productivity will remain relatively unaffected. The estimated annual loss at present due to heat stress at the all-India level is 1.8 million tonnes, that is, nearly 2 percent of the total milk production in the country. In value terms this amounts to a whopping Rs. 2661.62 crores (at current prices). The economic losses were observed to be highest in UP (>Rs.350 crores) followed by Tamil Nadu, Rajasthan and W. Bengal.

The negative impact of global warming on total milk production for India has been estimated to be about 1.6 million tonnes in 2020 and more

than 15 million tonnes in 2050. The partitioning of milk production impact indicates that high producing crossbred cows and buffaloes will be affected more, accounting for 0.4 million and 0.89 million respective annual decline in 2020. Warming will also negatively impact the productivity of indigenous cows. Productivity loss will be about 0.33 million tonnes milk in 2020. Northern India is likely to experience more negative impact of climate change on milk production in both cattle and buffaloes due to rise in temperature during 2040-2069 and 2070-2099. The decline in milk production will be higher in crossbreds (0.63%) followed by buffalo (0.5%) and indigenous cattle (0.4%). The stress as a result of increased thermal load days due to global warming in 2020 will cause an additional loss in milk production (1.6 million tonnes) accounting about Rs 2365.8 crores at current price rate. The annual loss in milk production of cattle and buffaloes due to thermal stress in 2020 will be about 3.4 million tonnes milk costing more than 5000 crores at current price rates. The increase in stress days on account of global warming due to rise of more than 4°C from March to October by 2100 will accentuate the magnitude of economic losses.

The rise in temperature due to global warming will negatively impact growth and time to attain puberty of livestock species. In addition to this, the reproductive efficiency of livestock is also negatively influenced by high ambient temperatures. The negative impact of THI rise on animals growing at higher rates (500g/day or more) will be more than slow growing (300-400 g/day) cattle.

Assessment of the potential direct impacts of climate change on livestock reproduction indicated that a temperature rise of 2-5°C for time slices 2040- 2069 and 2070-2099 are likely to increase incidence of silent estrus, short estrus and decline in reproduction efficiency of buffaloes. The reproductive rhythm of buffaloes may have impacts of temperature rise and variability as number of buffaloes in silent estrus has been observed to increase with increase in THI, and conception rate declined with an increase in THI above comfortable levels.

Recent estimation of livestock methane production using IPCC methodology indicate that the total methane emitted due to enteric fermentation and manure management of 485 million heads of livestock was 9.37 Tg/annum for the year 2003. The major contributors to methane emission were indigenous, crossbred cattle, buffalo and sheep and

goat accounting 40, 8, 40, and 10%, respectively. The other livestock with minor population consisting of equines (horses, ponies, mules and donkeys), pigs, yak, mithun and camels contributed only 2% (0.15Tg) of total emission from livestock sector. The ruminants, both small and large, were the main contributors (98%) to the enteric methane emission in India. Lactating animals comprising of buffaloes and cattle contributed 3.42 Tg with a major share of 2.04 Tg from lactating buffaloes.

The indigenous female cattle (82.9 million) contributed 2.2 Tg and 77.53 million indigenous males emitted 1.55Tg methane. Crossbred females though in small number compared to indigenous cattle, emitted more methane per animal (0.63Tg methane from 19.74 million heads) indicating that crossbreds produce more methane than indigenous animals. The emission from buffalo females was also higher and 80 million females produced 3.42Tg in 2003. The contribution of buffalo females was about 36.5% to total methane emission from livestock sector. The contribution of milch buffaloes, crossbred cows and indigenous cows was 59.6%, 11.4 and 28.9%, respectively to the total emissions from dairy animals.

### **Impact of Stress on Immune Responses, Antioxidant Status, Stress hormone and Milk Production**

Physiological responses in terms of the respiration rate (RR), pulse rate (PR), rectal temperature (RT) and surface body temperature (ST) of lactating Karan Fries (KF) cows were monitored in exposed and protected group (inside the shed, under fan and fan cum mist system) during winter, hot humid and summer season respectively. Physiological responses were significantly ( $P<0.01$ ) higher during summer and hot humid seasons as compared to winter season. The physiological responses were lower in experimental cows as compared to control animals during afternoon hours in summer and hot humid season. Blood samples from lactating animals were collected at early and peak stage of lactation, whereas from mastitic and hoove wounded animals at identification, 5th day and around 20th day after treatment during summer, hot humid and winter seasons. Neutrophil to lymphocyte (N: L) ratio was found to be significantly ( $P<0.01$ ) higher in mastitic and injured animals at detection compared to at 20th day after treatment. The N:L ratio did not show any significant difference in normal lactating KF cows during different seasons. Antioxidant enzymes (SOD and catalase) activity in erythrocytes decreased at peak stage as compared to early

stage of lactation in KF cows in all the seasons. The superoxide dismutase (SOD) and catalase activity in the RBC's of mastitic and wounded animals were significantly ( $P < 0.01$ ) higher at day of identification compared to after treatment and around one month after complete recovery during summer, hot humid and winter seasons.

The levels of  $T_3$  and  $T_4$  were not statistically significant in control and experimental groups of KF cows. However, the  $T_3$  and  $T_4$  levels were significantly ( $P < 0.05$ ) higher during winter season as compared to summer and hot humid season in normal lactating KF cows. The levels of these metabolic hormones were also significantly ( $P < 0.05$ ) higher during winter in mastitic and wounded cows compared to levels during summer and hot humid season. The cortisol hormone levels decreased as the stage of lactation advanced from early to peak stage in all the seasons. The total immunoglobulin (Ig) levels were found to be significantly ( $P < 0.05$ ) higher during winter (25.80-28.38 mg/ml) than summer (18.68-22.00 mg/ml) season. Similarly, the levels of total Ig was significantly lower ( $P < 0.01$ ) in mastitic and wounded animals during the day of detection compared to after treatment during all the seasons. The Ig fractions i.e. IgM and IgG were significantly ( $P < 0.05$ ) higher during winter as compared to hot humid and summer seasons. The levels of Ig fractions were significantly different between normal and wounded/mastitic cows.

#### **Circadian Variations in Heat Production and Heat Load in Cattle and Buffaloes**

A variety of biological variables oscillate in organisms including behaviour, physiological function and biochemical factors. Rhythmicity in physiological parameters is an important process both as a convenient and reliable marker of operation of the biological clock and as an indicator of general health of an animal. In order to find out the circadian variations on physiological responses, heat production, heat loss, oxygen consumption and head load, experiment was conducted on Murrah buffaloes and KF cattle.

Physiological responses (RR, RT, ST and PR) increased significantly ( $p < 0.01$ ) in themoneutral and summer season. The circadian rhythmic variations in core temperature during summer were 1.0 and 1.4°C, respectively for adult and growing KF cattle. During summer season average oxygen consumption in adult Murrah buffaloes and adult KF cattle was found to be maximum at 2 pm. and minimum at 2 am. and these differed

significantly with seasonal variations ( $p < 0.01$ ) between species. Respiration rate and pulse rate were positively correlated with dry bulb temperature. Heat storage differed significantly ( $p < 0.01$ ) in KF and Murrah adults and growing calves in thermoneutral and summer seasons. Heat loss through skin and pulmonary system was maximum in Murrah and KF adults during summer. Maximum heat production and heat load were observed in Murrah buffaloes and KF cattle during summer at 2 pm. and the values differed significantly between species ( $p < 0.05$ ) as compared to growing KF and Murrah Buffaloes.

#### **Influence of Thermal Stress on Immune Responses in Periparturient and Lactating Cattle and Buffaloes**

Thermal stress during high Temperature-Humidity Index (THI) in various periods of the year, especially in the tropical countries poses immense stress on livestock affecting their productivity. Studies were carried out on periparturient Murrah buffaloes (a month prepartum to a month post partum) and lactating Murrah buffaloes and KF cows in different periods of the year, when the THI of microenvironment was significantly ( $p < 0.01$ ) different i.e., spring ( $< 72$ ), hot dry ( $> 75$ ), hot-humid ( $> 80$ ). Physiological reactions, skin surface temperatures, dry matter intake and milk yield were recorded to evaluate the stress responses; and total plasma cortisol, immunoglobulin-G, interleukin-8 and nitric oxide were estimated as measures of immune responses. The study revealed that thermal stress significantly ( $p < 0.05$ ) increased the physiological reactions and skin surface temperature. These attributes were not significantly affected by different level of production in lactating animals. Heat storage was significantly higher in the animals exposed to high THI and had high significant correlation with THI and Benezra's coefficient of adaptability ( $r > 0.70$ ). The immune responses indicated influence of stress in high THI periods, wherein total cortisol and immunoglobulin-G (IgG) had negative correlation with THI. Cortisol levels were significantly higher on the day of parturition than at a month pre/post partum. The IgG levels were the lowest during the period near parturition and did not return to the day 30 prepartum levels even after a month. Total cortisol and Ig-G levels were lower in low producers and in hot-humid season. Plasma Interleukin-8 and nitric oxide had a weak positive correlation with THI. The circulatory IL-8 levels remained significantly ( $p < 0.05$ ) lower till parturition and increased thereafter. Nitric oxide declined significantly ( $p < 0.05$ ) on a day prior to parturition and did not increase significantly thereafter. Interleukin-8 was significantly higher

( $p < 0.05$ ) in high producing buffaloes in hot-dry season. Nitric oxide was significantly high ( $p < 0.05$ ) in hot-dry and hot-humid seasons as compared to spring season in low producing buffaloes. Variations in immune responses due to the differential milk production in cows and buffaloes were not significant, though the levels were higher in high THI periods. A heat shock to peripheral blood mononuclear cells significantly reduced NO production ( $P < 0.01$ ) in culture supernatants. NO production by PBMCs of periparturient buffaloes did not vary between the various days peripartum. In conclusion, thermal stress significantly affected various stress and immune responses in periparturient and lactating cattle and buffaloes.

### Quantitation of Discomfort Level under Thermal, Exercise and Nutritional Stresses in goats

Alpine x Beetal crossbred goats (3-4 months of age) were exposed at 40, 42 and 44°C each for 2 hours daily for a period of 5 days continuously with a relief of 1 day between each temperature treatment. The body weights increased significantly with age but heat exposure did not influence overall growth of the kids. However, the increase in weight during thermal exposure was lower in goats subjected to heat exposure. Further, the weight gain per kg feed intake was similar in goats exposed to thermal exposure before and after thermal exposure but significant during exposure to heat stress.

## ANIMAL BIOTECHNOLOGY

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

**Production of embryonic stem cells:** The characterization of the putative buffalo ES cells was carried out at different passages by examining the expression of intracellular markers like OCT4, FOXD3, SOX2, *REX-1* and *NUCLEOSTEMIN* and surface markers like CD9 and CD90 through immunofluorescence or RT-PCR. The ES cells were found to exhibit a weak expression of CD9 and CD90. Among transcription-based markers, the expression was examined by immunofluorescence staining, buffalo ES cells expressed OCT4, FOXD3 and SOX2 strongly. Besides these, the ES cells expressed *REX-1* and *NUCLEOSTEMIN* as confirmed by RT-PCR.

The efficacy of different media and media supplements in supporting the growth and maintenance of putative buffalo ES cells in culture was compared based on parameters that included the proportion of ICMs attached, time required for primary colony formation, primary colony formation rate, proportion of colonies that survived after subculture, time interval between passages and the maximum number of passage for which the putative buffalo ES cells survived in culture. Among various combinations of media (DMEM and Knockout-DMEM) and supplements (serum, Knockout-serum replacer and bFGF) examined, that of Knockout-DMEM + 20% Knockout-serum replacer + 4 ng/ml bFGF gave the best results.

For the formation of embryoid bodies, colonies of ES cells were separated from the feeder layer and were mechanically split into small clumps which were cultured for 2-3 days in hanging drops in ES cell culture medium without LIF.

The harvested embryoid bodies were transferred to bacteriological dishes for further culture in suspension for additional 3 days. The embryoid bodies were characterized by examining lineage-specific gene expression by RT-PCR. When these EBs cultured further on gelatin coated dishes, they differentiated spontaneously to several types of cells such as epithelial cell-like cells, neuron-like cells etc. The cells obtained from harvested embryoid bodies were found to express *NF-68* and *NESTIN* specific for ectodermal lineage; BMP-4 and  $\alpha$ -skeletal actin, specific for mesodermal lineage and  $\alpha$ -fetoprotein, *GATA-4* and hepatocyte nuclear factor-4 specific for endodermal lineage further confirming that the ES cells produced were indeed pluripotent.

For carrying out directed differentiation, embryoid bodies were cultured in medium containing dimethylsulfoxide they assumed muscle cell-like morphology and were found to express  $\alpha$ -actinin, a marker for cardiac and skeletal muscles. In addition, these cells expressed *MYF-5*, *MYOD* and *MYOGENIN*, which are markers for skeletal muscles. When cultured in the presence of retinoic acid, embryoid bodies differentiated to neurons, as confirmed by the expression of *NF68* gene.

**Production of cloned embryos:** Studies were conducted to examine the efficiency of different methods for synchronization of cell cycle in G1/G0 phase of cultured buffalo fibroblasts. Among various treatments examined, the best results were obtained following treatment with 30  $\mu$ M roscovitine after which 96% of cells were found to be synchronized in G0-G1 phase, but the viability was very low. Cell confluence and serum starvation with confluence was as efficient as

chemical roscovitine for inducing arrest in the G0/G1 phase of the cell cycle in buffalo fibroblast cells. In studies on the effect of reprogramming time on

developmental competence of handmade cloned buffalo embryos, 6 h was found to be optimum reprogramming time.



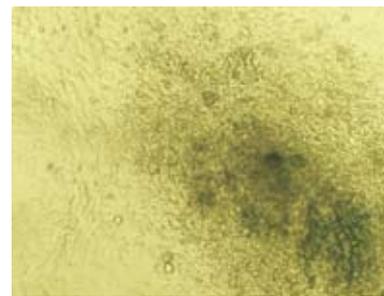
*World's second buffalo calf 'Garima' produced through Hand-guided cloning*

**Isolation and characterization of goat embryonic stem cell like cells:** The present study was carried out to isolate, culture and characterize goat embryonic stem cell like cells from *in vitro* produced goat embryos. These were isolated from individual blastomere cells and inner cell mass (ICM) IVF of blastocyst. The ICMs were cultured on mitomycin-C inactivated feeder layer and with LIF system without feeder layer. Embryonic stem cells were cultured and characterized by markers like alkaline phosphatase, OCT-4, SSEA1, SSEA3, and SSEA4. The total cleavage rate was found 60.48%, in which 24.01% morulae, 11.35% blastocyst and 3.4% hatched blastocyst. The success of primary colony formation (80%) was significantly higher when hatched blastocysts were used for ICM seeding than

early and expanded blastocysts (66%), morulae (15%) and single blastomere (10%). Five goat embryonic stem cell lines were produced which were maintained undifferentiated on feeder layer in ESC medium containing LIF (Leukemia inhibitory factor) upto 5<sup>th</sup>, 7<sup>th</sup>, 18<sup>th</sup> and 21<sup>st</sup> passages. Three goat embryonic stem cell lines were produced in ESC medium containing LIF without feeder layer and maintained undifferentiated upto 3<sup>rd</sup>, 5<sup>th</sup> and 12<sup>th</sup> passages. All the cell lines expressed alkaline phosphatase and OCT-4, at 5<sup>th</sup>, 10<sup>th</sup>, 15<sup>th</sup> and 20<sup>th</sup> passages. It could be concluded that goat embryonic stem cells were maintained undifferentiated upto 21<sup>st</sup> passage with feeder layer and 12<sup>th</sup> passages without feeder layer using LIF only.



*Embryod bodies from ESC of goat*



*Confluent monolayer of Embryod bodies after 5 days*



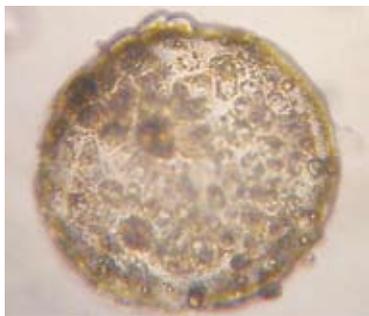
*Expression of OCT-4 in ESC of goat*



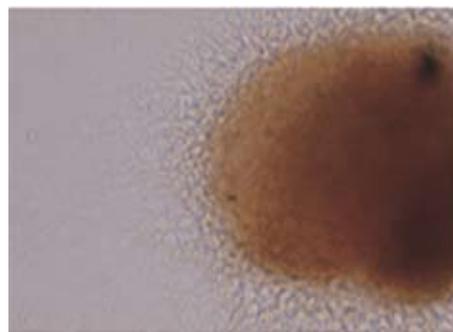
*Expression of OCT-4 in ESC of goat Expression alkaline phosphatase in ESC of goat*

**Parthenogenetic goat blastocysts development and their stem cell characterization:** The present study was carried out to compare between efficiency of chemical and electrical activation in the production of parthenogenetic goat blastocyst and to produce stem cells from them. The parthenogenetic activation of the IVM goat oocytes was carried out by double DC pulse of 2.1 Kv/cm for 5  $\mu$ sec each and in Ca ionophore, reconstituted by dissolving 20  $\mu$ l Ca ionophore in embryo development medium without FBS. The oocytes were incubated in 6-DMAP for 4 h. The oocytes were washed thrice after activation in fibroblast medium containing 5% FBS. Finally, oocytes were cultured in RVCL medium containing 1% BSA and 4% FBS at 5% CO<sub>2</sub> in air at 38.5°C. Cleavage, blastocyst and hatched blastocyst formation rate were found 32.20%, 16.56% and

0.59%, respectively at 2.1 Kv/cm pulse. Similarly cleavage, blastocyst and hatched blastocyst formation rate were obtained 54.58%, 30.82% and 2.34%, respectively in Ca ionophore activation. The blastocyst and hatched blastocyst, thus, obtained were subsequently seeded on a fibroblast feeder layer inactivated with Mitomycin C. The culture was maintained in Embryonic Stem Cell Medium containing Leukemia Inhibitory Factor. Putative stem cells like colonies were obtained after 14 days. The colonies were characterized positively by Alkaline Phosphatase and OCT-4 staining and were maintained upto 5th passage. It could be concluded that chemical activation is better parthenogenetic activation than electrical activation and Alkaline Phosphatase and OCT-4 shows obtained positive result in parthenogenetic stem cells.



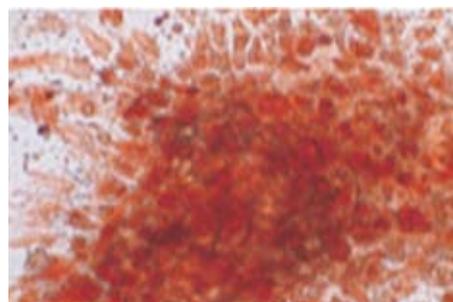
*Parthenogenetic hatched goat blastocysts*



*Stem cells of parthenogenetic goat blastocysts*



*Expression of OCT-4 in parthenogenetic stem cells of goat*



*Expression alkaline phosphatase parthenogenetic in stem cells of goat*

**Production of embryonic stem cells from handmade cloned goat embryos:** Somatic Cell Nuclear Transfer (SCNT) technique when used for the establishment of embryonic stem cell is referred to as therapeutic cloning. The aim of the present study was to produce embryonic stem cells from handmade cloned (HMC) goat embryos. Donor cells were prepared from fetal fibroblast cell in 5th passage obtained from around 2 months old fetus. IVM oocytes were treated with 2% pronase and oocytes bearing protrusion cone were bisected after Cytochalasin B treatment. One demioocyte was coupled with a fetal fibroblast cell and transferred to fusion chamber with another demioocyte. When somatic cell was sandwiched between demioocytes then 2.1 kv/cm DC pulse was

applied for 5  $\mu$ sec. The reconstructed triplets were activated using calcium ionophore and 6-DMAP for 4 h. Then the triplets were cultured in RVCL medium for 7 days. A total of 78 embryos were obtained at a cleavage rate of 84.61% and 39.47% reached the morula stage. The morula were seeded on inactivated fetal fibroblast feeder layer and cultured in embryonic stem cell medium containing DMEM, 5% FBS, 5  $\mu$ l/ml nonessential amino acid, 0.7 $\mu$ l/ml  $\beta$ -mercaptoethanol and 0.5  $\mu$ l/ml LIF. The colonies of embryonic stem cells like cells were obtained after 14 days. The stem cells were characterized by Alkaline Phosphatase and OCT-4 staining. The stem cells were further subcultured upto 6th passages.



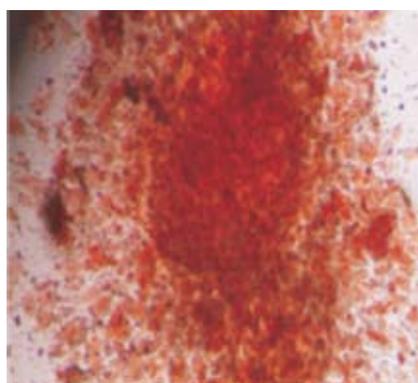
*Handmade cloned goat embryos*



*Stem cells of handmade cloned embryos*



*Expression of OCT-4 in cloned goat embryo stem cells*



*Expression alkaline phosphatase cloned goat embryo stem cells*

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

Lactoferrin from colostrums of five animal species, viz., buffalo, cattle, goat, sheep and camel was purified, iron saturated and used for determining their thermal stability at various pH by differential scanning calorimetry (DSC). The results indicated that structure became progressively less stable when pH was decreased. The interactions of individual lobes as well as in between the lobes diminished sharply at acidic pH values. Distinctly four phases in the denaturation reaction were observed in most of the cases at acidic pH values (3.7-5.0), while at higher pH values only one sharp transition followed by protein aggregation could be observed. Non-two state denaturation model was used to analyse the multiphasic transitions to evaluate the thermodynamic parameters of lactoferrin denaturation. The camel lactoferrin was observed most stable as compared to lactoferrins from other species. The denaturation behavior and stability of lactoferrin from buffalo and cattle were similar, while they differed from goat and sheep, which on the other hand showed similar denaturation reactions. The unfolding

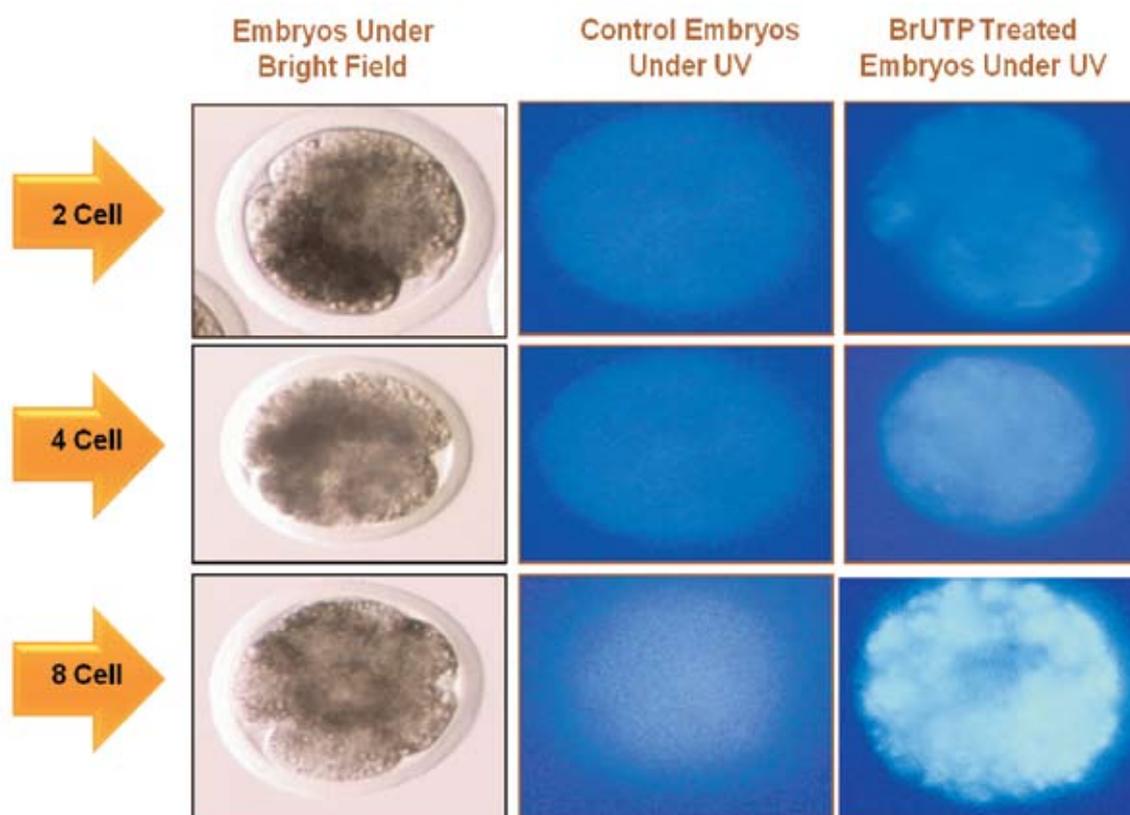
temperature of sheep and goat lactoferrins was lower than that of cattle and buffalo. Lactoferrin showed reversible unfolding reactions in case of all the species.

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

Maternal to Embryonic Transition (MET) event was worked out in buffalo preimplantation embryos following three approaches. In the first approach, the real time expression profile of eIF1A, U2AF and PAP was studied at different embryonic stages. Expression of all of these genes revealed a marked up regulation between 4 and 8 cell stage. The fold change of expression from 4 to 8 cell stage was more than 10, 6.51 and 1.62 for eIF1A, U2AF and PAP, respectively. In the second approach, while culturing the IVF produced embryos a transcription blockage was imposed using alpha amanitin (AA) to observe how long the embryos can grow keeping pending the embryonic transcription initiation. In the presence of AA development rate of embryos was not hindered upto 4 cell stage but no embryos grew beyond 8 cell in the presence of AA. Quantification of eIF1A, U2AF and PAP transcripts in AA treated

embryos also supported de novo appearance of these transcripts at 8 cell stage onwards. Finally the trend of BrUTP incorporation was observed in developing embryos from two cell stage

to morula. Cross linking of gene expression, development block and BrUTP incorporation evidences suggested MZT in buffalo embryos taking place at 8 cell stage.



Gene expression, transcription inhibition and BrUTP incorporation in buffalo preimplantation embryos confirmed MET to take place at 8 cell stage

Studies were carried out to identify oocyte specific novel genes in buffalo. Following a Suppression Subtractive Hybridization (SSH) approach, full length cDNA was prepared from buffalo oocytes of different categories and matured for different time intervals and were subtracted against a variety of somatic tissues like liver, kidney, lung, heart, spleen, intestine and cumulus cells. The unhybridized cDNAs representing oocyte genes were cloned in T/A vector and 1785 positive clones were selected. Further screening and validation of the cDNA library is in progress.

were placed on *Bos taurus* Y specific BAC contigs to work out a marker-based map of the *Bos taurus* Y chromosome to be explored for microdeletion studies in cross bred bulls. From the available genomic database the differentially methylated region (DMR) of H-19 gene was amplified in *Bos indicus* (Sahiwal) genomic DNA. It was confirmed that the sequence of *B. taurus* and *B. indicus* are in consensus for the chosen region. Method was optimized for genomic DNA isolation from frozen thawed crossbred bull semen, bisulphate treatment amplification of bisulphite treated DNA using methylation specific primers followed by re-amplification using nested primers. The optimized protocol would be used for studying epigenetic changes on H19 gene in relation to varying fertility status of cross bred bulls.

**Genetic basis of inferior sperm quality and fertility of crossbred bulls:** Sequences of 6 candidate genes belonging to the corresponding Azoospermic factor (AZF) region of human were retrieved and 34 *Bos taurus* NRY region specific microsatellite and STS markers were identified. By *in silico* analysis, all these markers and genes

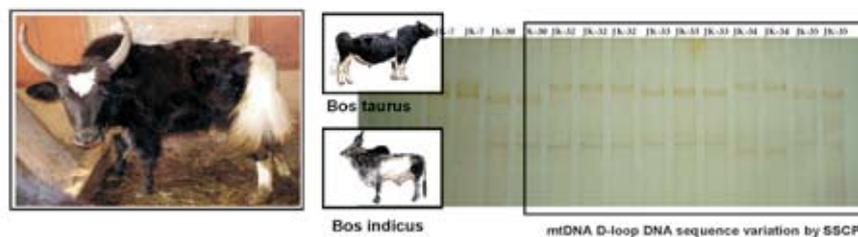
**Niche area of excellence on buffalo production and reproduction genomics:** The study was carried out on elucidation of gene expression profile in maturing buffalo oocytes/ follicular cells, exploring polymorphism in buffalo Casein gene/s, expression of recombinant buffalo IGF Binding Protein and investigating the iron binding capacity

of lactoferrins. Effect of different gonadotropins and growth factors was studied on the expression profile of *Kit Ligand (KL)* gene in buffalo ovarian follicular cells. *KL* gene was found to be expressed in mural granulosa cells only in buffalo ovarian follicles and its expression was restricted during initial stage of culture upto 4 hours. *KL* expression persistence in the granulosa cells during follicular culture was found to be negatively correlated with maturation rate of oocytes. DNA samples from six different breeds of buffalo were analyzed to explore polymorphism in  $\beta$  casein gene at Exon 7 which constituted for majority of coding region of beta casein. Two different SSCP types were identified with pattern B predominant (85%) over pattern A (15%). Nucleotide substitution at three different location of exon7 (codon 68, 151 and 193) were identified. A 382 bp beta casein promoter (-350 upstream to +32 region) was amplified from buffalo genomic DNA and was studied for nucleotide sequence variation following SSCP. Four types of single stranded DNA band patterns were detected in this promoter region. They differed in seven locations within 350 bp 5' UTR region. Pattern-B samples in exon7 (Homozygous wild-type) had three different types of SSCP patterns. These four promoter patterns were sequenced towards upstream region to reveal more nucleotide substitutions, deletions or additions. The complete amino acid coding region of the buffalo beta casein was deduced from cloned, cDNA generated from mammary tissue mRNA. The rare variant coding sequence differed from major variant sequence at codon 10, 39, 41, 68, 151 and 193. Recombinant buffalo IGFBP-5 was expressed

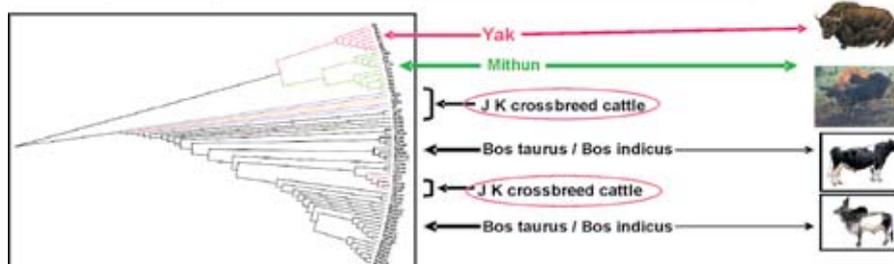
in bacterial expression system and its physico-chemical characteristics analyzed using various bioinformatics tools. Expression of IGFBP-5 was confirmed in milk by western blot. Further analysis of expression of this protein is under progress in milch animals of different physiological states with respect to lactation persistency. Lactoferrin from cow, buffalo, goat, sheep and camel was purified to homogeneity using cation exchange and gel filtration chromatography and its iron binding properties were studied at different pH suggesting that buffalo binds iron most strongly among different species studied.

**Molecular characterization of a semi domestic cattle breed of Jammu and Kashmir:** India is blessed with vast cattle genetic resources in the form of 30 documented breeds besides many populations still undefined. Many local animal populations are unexplored and mostly confined to particular geographical pockets. They are more adapted to the region and resistant to common bacterial and viral diseases. There is a serious risk that most of these breeds will disappear before they are fully identified. Cattle population of Jammu and Kashmir region contains unique gene pool and require attention to protect these animals from extinction. The D-loop is the location of mitochondrial transcription promoters. As a result of the high average mutation rates and the lack of coding or regulatory sequences in the hypervariable regions, they have become a tremendously valuable source of presumably neutral genetic variation. The variation in mtDNA D-loop showed various patterns as presented in the photograph.

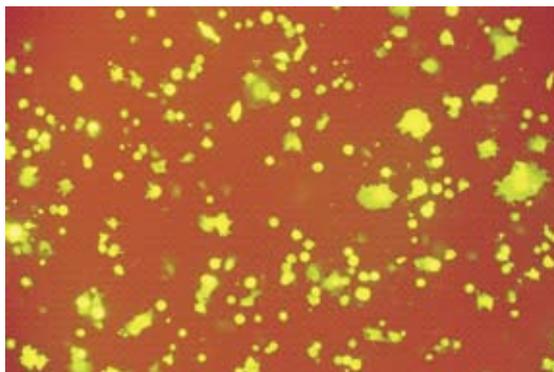
### Molecular characterization of a semi domestic cattle breed of Jammu and Kashmir



### Relationship of JK crossbred cattle with other Indian Bovine members

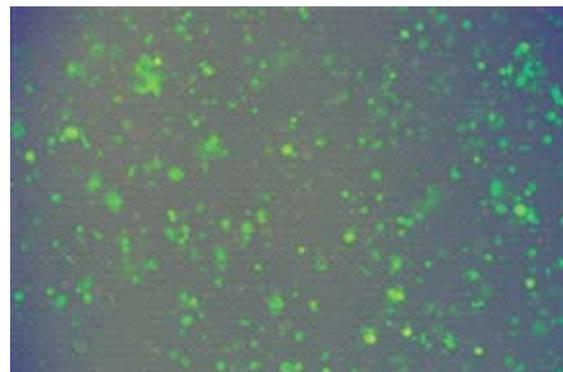


**Prognostic biomarker of lactation persistency:** MGP-40 is a forty kDa glycoprotein, which is expressed in the mammary gland during involution. To explore the potential of MGP-40 as a prognostic biomarker of lactation persistency, an attempt was made to study the functional significance of MGP-40 in the mammary epithelial cells and to explore the expression profile of MGP-40 in milk during lactation. In order to test the expression of MGP-40 in different tissues of buffalo, samples of intestine, liver, lungs, heart, spleen, kidney, ovary and mammary gland were collected from slaughter house and RNA was isolated. Equal quantity of RNA from each sample was used to synthesis cDNA and confirmed the cDNA synthesis by house keeping gene (GAPDH). Expression of MGP 40 in different tissue samples was analyzed by PCR amplification using gene specific primers. The results revealed positive expression of MGP-40 in mammary gland, mammary epithelial cells, intestine and negative in liver, lungs kidney, ovary with less expression in heart and spleen.



*COS 7 cells transfected with pAc GFP vector  
(Fluorescent microscopy -FITC filter)*

For functional characterization of MGP-40, several mammalian expression constructs of MGP-40 were prepared for expression in mammalian host. Open reading frame (ORF) of MGP-40 constituting the active MGP-40 protein was cloned in pCIneo, pcDNA3.1/CT-GFP-TOPO, pAcGFP1N1, pd1EGFP-N1 and pVAX mammalian expression vectors. Mammalian expression vectors such as pAcGFP, pcDNA TOPO CT GFP were transfected to COS7 (P 41) cells using fugene HD transfection reagent. Expression was detected at 24 hrs post transfection and the efficiency was determined from percentage of total cells expressing GFP. The work on the optimization of transfection conditions in buffalo mammary epithelial cells using GFP reporter vectors. Expression of GST\_MGP-40 fusion proteins was monitored by SDS PAGE after induction with IPTG. Experiments are currently underway to determine optimal induction parameters for getting maximum soluble fraction of MGP\_GST fusion protein. MGP\_40 expression from pET22 vector was also monitored by SDS-PAGE.

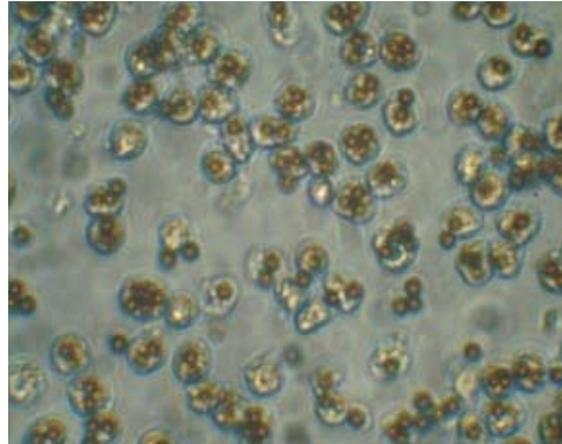


*COS 7 cells transfected with pcDNA3.1 TOPO CT GFP vector  
(Fluorescent microscopy -FITC filter)*

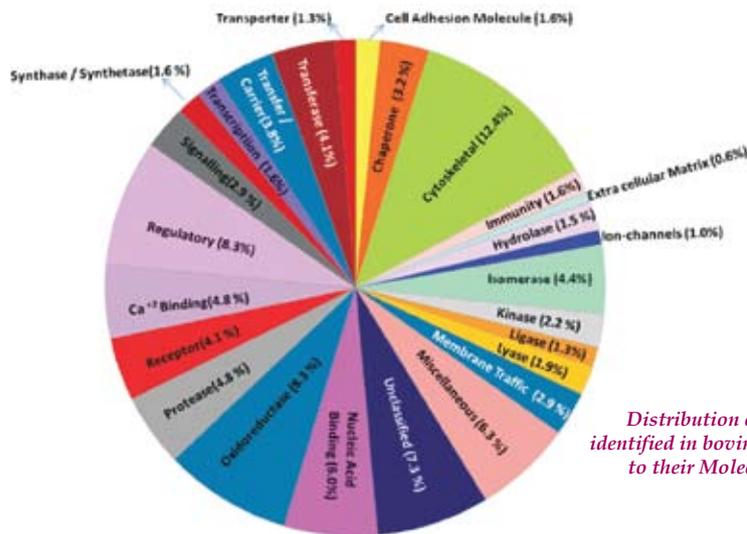
Mammary gland is made up of a branching network of ducts that end with alveoli. Each alveolus consists of epithelial cells surrounding a lumen. These alveolar epithelial cells function by converting nutrients from the blood and transforming them into the molecular components of milk followed by secretion into lumen. Mammary Epithelial Cells (MEC) reflects the milk producing ability of farm animals under selection pressure. To date, a two dimensional (2D) reference map of proteins or shotgun proteome of MECs is not yet available: the aim of study was to characterize the 2D protein map, and to identify proteins of MECs expressed during peak lactation to create a protein database. MECs from milk were purified by using Immunomagnetic separation. The purity of the MECs was confirmed by qRT-PCR and Western blotting using MEC specific marker genes like cytokeratin 8,  $\alpha$ -Lactalbumin ( $\alpha$ -LA), Epithelial Membrane Antigen (EMA). The Cell lysate was

subjected to IEF and SDS-PAGE using 18cm, pH 4-7 range IPG strips. The cell lysate was also subjected to the RP-LC coupled with the ESI-MS for shotgun proteomics and data was analyzed using Sequest and Trans Proteome Pipeline Software. Expression of Cytokeratin 8,  $\alpha$ -LA and EMA in MECs were confirmed by qRT-PCR and the  $\alpha$ -LA expression was 98 times higher in MECs compared to the Somatic cells. Expression of Cytokeratin 8 was further confirmed by western blotting using anti-cytokeratin 8 antibodies. After image analysis of 2D gel. A total of 215 protein spots were observed. The shotgun proteome after data analysis, identified 260 proteins with >90% confidence. This study represents to date the first detailed and reproducible 2D protein map of bovine MECs. The proteins identified in shotgun approach involved in many biological processes including carbohydrate metabolism, fat metabolism, electron transport, protein metabolism and cell structure.

**Xanthine oxidoreductase (XOR):** Xanthine oxidoreductase (XOR) is a ~300 kD homo-dimer enzyme catalyzing the conversion of homoxanthine to xanthine and subsequently to uric acid. It is also involved in production of reactive oxygen and nitrogen species and forms a part of innate immune system. In milk, majority of the XOR is partitioned in the milk fat globule membranes (MFGM). To characterize the buffalo XOR, the MFGM was processed to purify the enzyme by a combination of solvent extraction, ammonium precipitation, ultrafiltration, heparin affinity chromatography, anion exchange and gel filtration chromatography. The partial cDNA of XOR was also synthesized using cattle XOR specific primers. Further characterization of the enzyme is under way.



*Mammary epithelial cells isolated from Milk (transparent) bound to the magnetic beads seen under microscope.*



*Distribution of 260 proteins identified in bovine MECs according to their Molecular Function*



*2-DE map of bovine MECs at peak stage of lactation. Proteins are separated using pH 4-7 and 18 cm IPG strip followed by 10% PAGE*

**Effects of probiotic dahi in prophylaxis and treatment of gastrointestinal tract cancer:** AP-Dahi was prepared by co-culturing *Lactobacillus acidophilus* and *L. plantarum* alongwith Dahi culture (*Lactococcus lactis* ssp *cremoris* and *Lc. lactis* ssp *lactis* biovar *diacetylactis*). AB-Dahi was prepared by co-culturing *Lactobacillus acidophilus* and *Bifidobacterium bifidum* alongwith Dahi culture. The study comprised of 7 groups each consisted of 36 rats. Group I, served as -ve control, received no carcinogen. G I tract carcinogenesis was induced in groups II to VII by injecting 4 doses of dimethylhydrazine (DMH) dihydrochloride given intraperitoneally weekly starting from 4th wk of feeding. The animals were fed purified semi-synthetic diet *ad-libitum*, after they had consumed 20 g supplements of milk or probiotic Dahi, for 32 weeks. Group II, which received milk supplements, served as +ve control. Group III, which received milk supplements plus cancer treatment drug piroxicom (PXC), served as drug treatment control. Groups IV and VI were given AP-Dahi and AB-Dahi, respectively. Groups V and VII were given AP-Dahi and AB-Dahi, respectively alongwith PXC.

The ACF (pre-neoplastic lesions) numbers increased with time in rats challenged with DHM. In rats fed AP-Dahi or AB-Dahi the progression of ACF decreased substantially, and AB-Dahi was more efficacious. PXC treatment also decreased the numbers of ACF. The effect of PXC and two probiotic dahi was additive. Further, the numbers of ACF having multiple aberrant crypts were very few in rats fed probiotic Dahi or treated with PXC compared to DMH treated positive control rats wherein ACF with 3 aberrant crypts increased in a linear manner with time. Therefore, probiotic Dahi decreased the progression of preneoplastic lesions, and improved the efficacy of cancer treatment with PXC.

Preneoplastic lesions MDF also increased progressively with time in rats challenged with DMH. The probiotic Dahi decreased the progression of MDF and AB-Dahi was more efficacious than AP-Dahi. Further PXC treatment also decreased the progression of MDF, and the two probiotic Dahi improved the efficacy of PXC treatment of G.I. tract cancer.

The PCNA index, a marker of carcinogenesis, in G I tract increased progressively in rats challenged with DMH. The treatment with two probiotic Dahi

or with PXC was equally effective in preventing the rise in PCNA index in DMH treated rats. Further, PXC and probiotic Dahi acted synergistically in preventing the rise in PCNA labeling index.

The incidence of tumors in G I tract was 90% in rats treated with DMH, which reduced to 65% in PXC treated group. The treatment with probiotic Dahi also decreased tumor incidence to 60-65%. The synergistic effect of PXC and probiotic Dahi was evident from the fact that tumor incidence reduced to 20-25% in rats treated with probiotic Dahi alongwith PXC.

The tumor load in G I tract was also significantly reduced from 227 mm<sup>2</sup> in DMH treated rats to 78-79 mm<sup>2</sup> in probiotic Dahi treated DMH induced rats and to 71 mm<sup>2</sup> in PXC treated DMH induced rats. In rats treated simultaneously with probiotic Dahi and PXC, the tumor load decreased to 4-9 mm<sup>2</sup>/animal.

**Body slimming effect of conjugated linoleic acid:**

With the rising incidences of obesity and obesity related diseases, these is an urgent need to act against this epidemic. Conjugated linoleic acid (CLA) is the prospective body fat reducing agent present in milk fat at concentration highest in the entire food spectrum. The study was conducted to establish the body fat reducing effect of CLA, and to understand the mechanism of action. Diets containing CLA (1%) with or without skim milk powder (SMP) was fed to 5 wk old male albino mice for 60 d. Adipose depots weight, faecal fat and lipid metabolism enzymes were determined. Body weight gain of mice on CLA and CLA+SMP diets was lower than on control diet despite higher feed intake in former groups. Total fat pad mass was significantly less in CLA group than in control group, and inclusion of SMP in the diet enhanced the fat reducing effect of CLA. Adiposity index was less on CLA than on control diet and the CLA+SMP diet was more efficacious in reducing adiposity index. Excretion of faecal fat was higher on CLA diet than on control diet. The fatty acid synthase (FAS) activity (units/ mg protein) in liver and retroperitoneal adipose tissue was significantly lower on CLA and CLA+SMP diets than on control diet. The activity of carnitine palmitoyltransferase (CPT), the rate limiting enzyme of mitochondrial beta-oxidation, increased 2.5-fold in epididymal fat pad on CLA and CLA+SMP diets, but in skeletal muscle only CLA+SMP diet was effective in stimulating CPT activity (2-fold) in comparison with control diet.

**Effect of dietary CLA on cholesterol metabolism:**

Plasma total cholesterol and VLDL+LDL-cholesterol concentrations were similar in control, CLA and CLA+SMP fed mice. Plasma HDL-cholesterol concentration was significantly higher in CLA fed mice than in control group. There was no difference in cholesterol and triacylglycerol (TAG) contents in aortic tissue among control, CLA and CLA+SMP groups. The cholesterol and TAG contents (mg/g) in liver were greater on CLA and CLA+SMP diets than on control diet. Feeding mice on CLA increased the weight of liver and spleen, which was reverted by SMP.

**Probiotic dahi decreases levels of active carcinogen by modulating xenobiotic metabolism:**

Effects of milk, Dahi and four probiotic Dahi preparations namely *Acidophilus* Dahi (A-Dahi), *Plantarum* Dahi (P-Dahi), *Acidophilus-plantarum* Dahi (AP-Dahi) and *Acidophilus-bifidus* Dahi (AB-Dahi) on carcinogen activating phase I cytochrome P450 (CYP) enzymes namely CYP1A1, CYP1A2, CYP1B1, CYP2B1 and CYP2E1 in liver microsomes and carcinogen detoxifying activities namely  $\gamma$ -glutamyl transpeptidase (GGTP), UDP-glucuronosyl transferase (UDPGT), quinone reductase (QR) and glutathione-S-transferase (GST) activities were studied in Wistar albino rats fed for 8 weeks. Feeding laboratory stock diet, milk or regular Dahi had no effect on phase I activity of carcinogen activation in liver as well as on carcinogen detoxifying activities in liver and colon tissue. Down regulation of CYP P450 activities (CYP1A1, CYP1A2 and CYP1B1) in liver and up regulation of carcinogen detoxifying activities (UDPGT, GST and QR) in liver and colon tissue were observed by feeding probiotic preparations. *Acidophilus-bifidus* Dahi was more efficacious among the four probiotic preparations in down regulation of carcinogen activation in liver and up regulation of carcinogen detoxifying activities in liver and colon tissue.

**Immunomodulatory properties of cow and buffalo casein phospho peptides:**

Casein phospho peptides (CPP) were purified from buffalo and cow milk by isoelectric precipitation followed RP-HPLC. Immunomodulatory property of CPPs was evaluated by carrying out two *in-vivo* trials. In first trial, mice were fed 0.5% CPP for 4 wk, and phagocytic activity of peritoneal macrophages and proliferation index of LPS and CON-A stimulated splenocytes were evaluated. IgG levels in serum and IgA levels in the intestinal fluid were also determined. The second trial was of 8 wk duration wherein mice were immunized with oral ovalbumin and diphtheria toxin at 4 and 6 wk After

8 wk the animals were sacrificed and the systemic and mucosal antibody response was evaluated for total IgG and IgA, respectively. Ovalbumin and diphtheria specific IgG and IgE in serum and IgA in intestine were measured. Phagocytic activity and lymphocyte proliferation index (PI) were also determined.

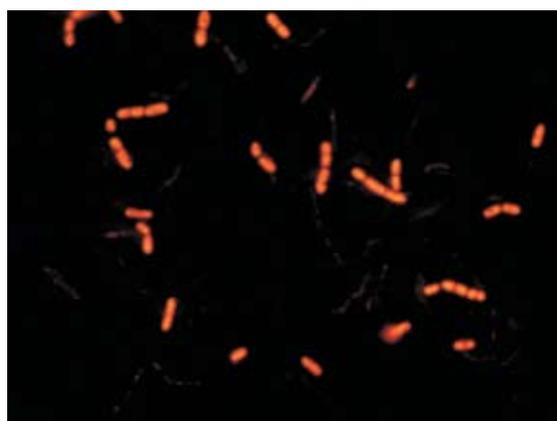
A significant increase in the phagocytic activity was observed in CPP fed animals, and cow CPP was more efficacious. A significant increase in lymphocytic proliferative response to LPS was observed in cow CPP fed rats. In case of CON-A stimulated lymphocyte proliferation similar effect was observed after 4 wk but not after 8 wk. Mitogenic response to buffalo CPP was not pronounced.

The total IgG in serum and IgA in intestinal fluid were significantly more in rats fed buffalo or cow CPP. Antibody generation response to diphtheria toxin was more as compared to ovalbumin. There was significant increase in diphtheria specific IgG and IgA levels. Further, feeding cow or buffalo CPP caused a significant decline in OVA/Diphtheria specific IgE levels. These results show that CPP enhances both systemic and mucosal immunity, and protects against OVA and diphtheria induced IgE levels.

**Prebiotic carbohydrates for stimulation of growth of probiotics:**

Galactooligosaccharides (GOS) and  $\beta$ -glucan preparations were studied for their effectiveness in stimulation of proliferation of two potential probiotics (*L. acidophilus* and *L. casei*) *in vitro*. Carbohydrate free basal medium was supplemented with varying concentrations of commercial preparation of GOS and  $\beta$ -glucan, inoculated with activated probiotic cultures of *L. acidophilus* and *L. casei*, and stimulation of growth was determined by monitoring the changes in pH, OD at different time intervals, and viable cell counts of probiotics. Addition of GOS preparation at 3% level resulted in stimulatory effect on *L. acidophilus* comparable with the effect of 2% GOS at 24 hr. The probiotic was stimulated by  $\beta$ -glucan preparation also. With 2% and 3%  $\beta$ -glucan the viable counts of *L. acidophilus* were found to be 9.40 and 9.76 (log cfu/ml) after 24 hr of incubation. In case of *L. casei*, with 1%  $\beta$ -glucan, a steady increase in viable counts was observed and found to be 8.9 (log cfu/ml) after 24 hr. Addition of  $\beta$ -glucan at the level of 2 to 3% also had a stimulatory effect on growth of organism. By fluorescent *in situ* hybridization (FISH) technique using labeled probes, a significant increase in number of

*Lactobacilli* and *Bifidobacteria* in feces of mice fed high fat diet was observed with  $\beta$ -glucan feeding. Different strains of *S. thermophilus* were compared for galactooligosaccharide formation potential by HPLC analysis using carbohydrate analysis column (amino column) and RI detector. Among the different strains studied,  $\beta$ -galactosidase preparations of two strains of *S. thermophilus* were found to produce maximum oligosaccharides using lactose as substrate.

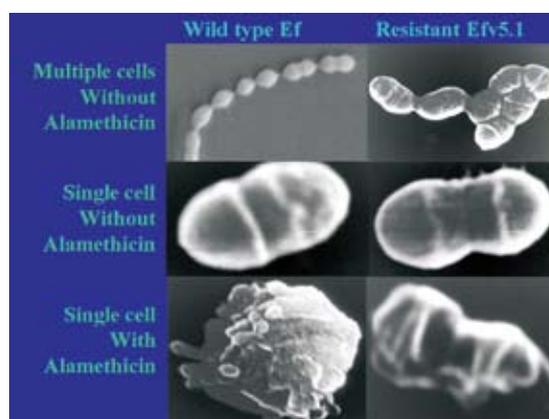


Enumeration of Bacteria by Fluorescent in situ hybridization technique

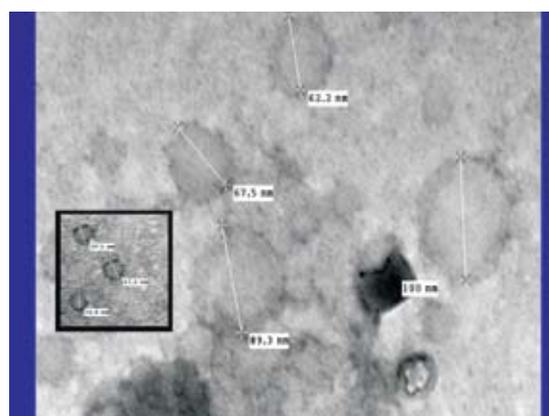
**Purification of allergic proteins from milk:** Whey proteins can act as allergens. Caseins from cow, buffalo and goat milk were removed through isoelectric precipitation and resultant whey was subjected to salt fractionation to isolate  $\beta$ -lactoglobulins and  $\alpha$ -lactoalbumin. The purity of these major allergens was checked on SDS-PAGE. Immunizations of mice were carried by  $\beta$ -lactoglobulins through intra-peritoneal route to check dose response of this isolated allergen on IgG production and lymphocyte proliferation index. Based on this study, 20  $\mu$ g of protein (allergen) can be used for studying allergic reaction.

**Development of cross-resistance to pediocin against alamethicin resistant *Enterococcus faecalis* and *B. cereus* is through a common mechanism altering cell membrane:** Two, 3, 4, and 5-fold spontaneous resistance mutants of *Enterococcus faecalis* against alamethicin were analyzed in detail. A change in cells arrangement forming clumps instead of chains with more round cell ends was observed. Further, in the presence of alamethicin, wild-type cells revealed killing forming a spherical mass whereas resistant cells revealed only contour alteration on the surface. Aggregation of cells was found to be due to increase in the cell surface hydrophobicity. A decrease in growth rate constant upon acquisition of resistance was also observed. However, in the presence of

lysozyme, no difference in growth rate constant was seen. Significant changes in phospholipids and fatty acids composition upon acquisition of resistance indicated changes in cell surface charge and cell membrane fluidity, respectively. The resistance variants were also found to show cross resistance to cell membrane acting class IIa bacteriocin, pediocin. Using an *in vitro* assay, employing colored biosensing nanosomes, it was found that there was a change in AMP-membrane interaction upon acquisition of resistance. Further, this change was collinear for both alamethicin and pediocin. In addition, the *in vivo* inhibition level and *in vitro* membrane interactions level was also collinear. An alamethicin resistant strain of *B. cereus* also showed cross resistance to pediocin.



**Artificial Neural Network as a reliable modeling method for predicting *in vitro* response given the composition of the colorimetric biosensing nanosomes:** Colorimetric biosensing nanosomes prepared from pure phospholipids were characterized using visible spectroscopy and transmission electron microscopy. The effect of membrane fluidity and surface charge on the interactions of alamethicin was modeled with artificial neural network (ANN). In the modeling, data for interactions between colorimetric biosensing nanosomes, prepared from pure



phospholipids (PLs), and their interactions with alamethicin in terms of percent colorimetric response (%CR), were obtained from *in vitro* studies. The correlation coefficient between observed %CR from *in vitro* studies and predicted %CR using ANN was found to be 0.716.

**Pediocins produced by *P. acidilactici* NCDC 252 and *P. pentosaceus* NCDC273 are identical to pediocin PA-1:** Several strains of lactic acid bacteria from *Lactobacillus*, *Pediococcus*, *Enterococcus* and *Leuconostoc* obtained from NCDC were screened for production of inhibitory activity against *Enterococcus faecalis*, *Bacillus cereus* and *Staphylococcus aureus* using deferred agar spot assay and spot on the lawn assay. *Pediococcus acidilactici* NCDC 252 and *P. pentosaceus* NCDC 273 showed inhibitory activity against all the three indicators. Using PCR, these strains were also found to harbour a 332 bp fragment present on pediocin operon covering small portions both from C-terminal end of mature pediocin and N-terminal end of immunity protein. Since, the strains were +ve for pediocin operon the inhibitory activity was purified using ammonium sulphate precipitation and SP-Sephadex chromatography. The extent of purity was checked by RP-HPLC. The purified preparation revealed a protein band with expected Mr for pediocin at 5.19 kDa on SDS-PAGE and an inhibitory graph at same position on the gel with overlay agar method seeded with *E. faecalis*, confirming the purified protein to be pediocin. Since, PCR amplified 332 bp fragment did not cover the entire mature pediocin sequence, therefore, for sequencing the mature pediocins, a new forward primer was designed to include 74 bp upstream covering the sequence for complete mature pediocin. PCR amplification of this 406 bp fragment was followed by restriction digestion with Hind III to confirm that it was the desired fragment. Consequently, it was cloned and sequenced. The sequence comparison revealed that both show 100% identity with pediocin PA-1. The gene has been transferred to expression vector pET28b+ for use in expression studies.

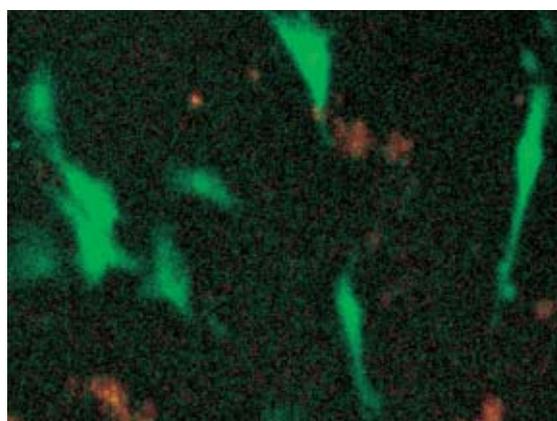
**Pediocin resistant *Staphylococcus aureus* display alterations in its phospholipid head groups:** During the screening of various G+ve pathogenic/spoilage bacteria for pediocin sensitivity, using spot on the lawn assay, a colony of *S. aureus* was found to grow within a spot of pediocin applied. Using this colony as indicator strain, it was found to be highly resistant. Upon comparison of wild-type with resistant mutant for their total cellular lipids, it was found that there was a marked difference in their phospholipid composition.

**Assessment of capacitation like changes during cryopreservation of buffalo spermatozoa:** 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. The samples were processed in sp TALP medium & *in vitro* apacitated in 0.5 ml columns (25 million cells) in presence of heparin (10 µg/ml) for 6 hours to compare with the cryopreserved samples. The Total antioxidant status of cryopreserved extended seminal plasma decreased by 59% compared to fresh seminal plasma each expressed as 390 and 960 n Moles/ ml, respectively. The rate of hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) and superoxide anion (O<sub>2</sub><sup>-</sup>) production by cryopreserved spermatozoa increased by 20 and 79%, respectively compared to fresh spermatozoa. The comparison in the rate of H<sub>2</sub>O<sub>2</sub> and O<sub>2</sub> production by cryopreserved spermatozoa with the *in vitro* capacitated cells revealed capacitation like changes in cryopreserved spermatozoa. Such changes were also observed in terms of sperm plasma membrane integrity (HOST) and sperm viability and Cholesterol /Phospholipid ratio analysis following cryopreservation of buffalo spermatozoa. Major spermatozoal membrane phospholipids phosphatidyl choline (PC) and its hydrolytic product lysophosphatidyl choline (LPC) increased significantly on cryopreservation and *in vitro* capacitation. Phosphatidyl inositol and its hydrolytic product 1, 2 diacyl glycerol showed the similar trend.

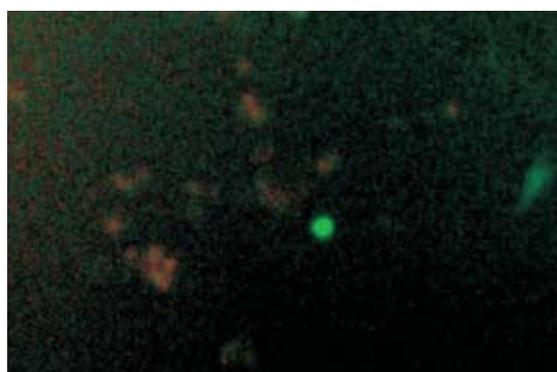
**Molecular basis of capacitation like changes during cryopreservation of buffalo spermatozoa:** Split fresh buffalo semen samples were cryopreserved using tris based egg yolk extender with and without additives like cysteine hydrochloride (5 mM), trehalose (100 mM) and taurine (50 mM). 20-25% post thaw motility was found to be improved in the treated samples compared to the control. Comparison of *in vitro* capacitation of fresh and cryopreserved buffalo spermatozoa showed early capacitation (2-4 hrs) on cryopreservation than the fresh cells which occurred after 6 hrs of incubation. Further, *in vitro* capacitation of cryopreserved spermatozoa in absence (control) and presence of additives exhibited early capacitation, increased dead cells (75%) and lesser motility (45%) in the absence compared to the presence of additives indicating the prevention of capacitation like changes. The phospholipids and cholesterol contents (50 and 24 µg/10<sup>8</sup> cells) and cholesterol/phospholipids ratio (0.49) decreased during *in vitro* capacitation also on cryopreservation (43 and 15 µg/10<sup>8</sup> cells C/P 0.42, respectively) showing early capacitation in cryopreserved spermatozoa.

### Gene silencing of aromatase expression in buffalo granulosa cells using RNA interference:

Aromatase gene silencing is being studied to understand its role in reproduction. The undifferentiated buffalo granulosa cells isolated from ovarian medium sized follicles were used in the study. For siRNA transfection, approximately  $5 \times 10^5$  viable granulosa cells were plated in a 24 well culture plate using 500  $\mu$ l bicarbonate buffered Dulbecco's Modified Eagle's Medium (DMEM, Sigma, Cat. #. D6171) supplemented with antibiotics and 3% FBS to permit cell anchorage. Cells were initially allowed to culture for about 39-43 hrs at 37°C and 5% CO<sub>2</sub> in water-jacketed



(a)



(b)

Transfection of granulosa cells with EGFP-N1 vector (a); Silencing EGFP using EGF silencing vector pEZ-b7SK-shEGFP vector

CO<sub>2</sub> incubator with medium (supplemented with antibiotics and 3% FBS) change after first 24h. At about 39-40 hour of culture, transfection mixes were assembled and cells were changed to serum-free, antibiotic-free DMEM, 10-15 min prior to transfection. Cells were transfected with siRNA (Sense, r(CAACAGAUGUAUGGAGAA)dTdT; Antisense r (UUCUCCAUACAUCUUGUUG)dTdA) targeting buffalo aromatase mRNA sequence (Acc No. DQ407274) (Target, TACAACAAGATGTATGGAGAA; Offset 435). The cells were incubated with transfection medium for

5-6 h. Transient transfection of granulosa cells was performed with siRNA of varying concentrations (50 nM and 100 nM) using lipofectamine as a transfection reagent (siRNA: lipofectamine, 1:3). Following transfection, cells were treated with FSH (20 ng/ml) and IGF-I (50 ng/ml) for 6 and 12 hrs each. Total RNA was extracted using the standard procedure using trizol reagent. For semi quantitative RT-PCR, reverse transcription (cDNA synthesis) was performed with 1 $\mu$ g of total RNA followed by expression analysis using gene specific primers. Estradiol was measured in the conditioned medium in duplicate using ELISA. Preliminary data showed that there was marginal decrease in the expression of aromatase mRNA and estradiol production after 12h of cultured granulosa cells transfected with 100 nM siRNA, which suggest the gene silencing of aromatase.

### Fertility performance and analysis of *Cyp19* gene regulation in buffalo:

In the present study, analysis of aromatase expression in differentiated fertility performance (ovarian cyst) was attempted. The total RNA was isolated from morphologically and hormonally classified ovarian cyst (follicular cysts and luteal cysts). The *CYP 19* gene transcript comprising of 5' UTR of exon II, exon 1.1, exon 1.2, exon 1.3, exon 1.4, and exon 1.5 were determined in large follicle (as control), follicular cyst and luteal cyst of buffalo ovary by RT-PCR. A single factor ANOVA was done using three replicates of *CYP 19* gene transcript variants /G3PDH mRNA ratios. Transcript with 5'UTR of exon II was the major transcript determined in granulosa cells from large follicle. A significant ( $p < .01$ ) decline in amount of this transcript was found in follicular cyst and luteal cyst. Intermediate level of transcript from exon 1.1 was found in the large follicle. Luteal cyst showed significantly higher expression of transcript from exon 1.2. Transcripts with 5'UTR of exon 1.3 was found as the major *CYP19* gene transcripts in follicular cyst. Transcripts comprising of exon 1.4 were present in intermediate concentration in follicular cyst. A significantly less amount was found in large follicle and luteal cyst. Transcripts comprising of exon 1.5 was found in very low concentration in follicular cyst and luteal cyst as compared to large follicles.

### Comparative analysis of epigenetic regulation of the *Cyp19* gene in buffalo and cattle:

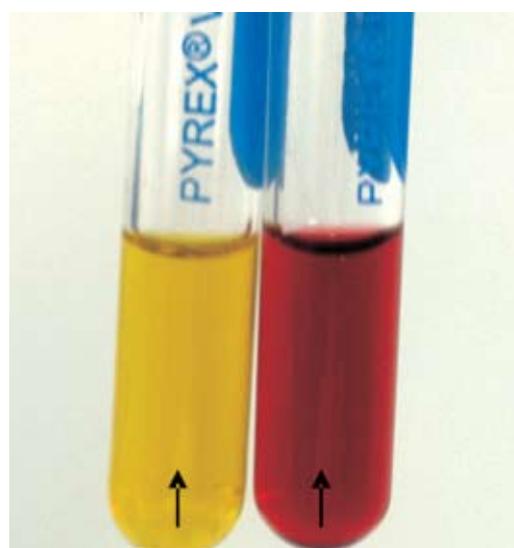
The hormone oestrogen, essential for the development of dominant follicles, is synthesized by rate limiting enzyme cytochrome P450 aromatase, encoded by *Cyp19* gene. The tissue-specific expression of *Cyp19* gene is regulated partly due to alternative transcriptional start sites that arise as a consequence of the tissue-specific promoters. Earlier study showed existence

of tissue-specific regulation *Cyp19* gene 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 structure (corpus luteum) in buffalo. The respective proximal (PII, 625bp) and distal (PI.1, 734bp) promoter regions of buffalo *Cyp19* gene were cloned using PCR technique. In silico analysis identified the CpG dinucleotides. To elucidate if the epigenetic mechanisms as tissue- and differentiation-specific DNA methylation involved in the aromatase gene expression, methylation status of five individual CpG dinucleotide, within each of the promoter II and I.1, was analyzed with bisulfite direct sequencing in granulosa cells of different sized follicles. Analysis demonstrated that region I.1 of buffalo ovarian *Cyp19* gene showed stage specific-differences in its DNA methylation status. Both the regions were found to be hypomethylated at all CpG residues in granulosa cells of small, medium and large sized follicles while in case of small follicles the CpG residues proximal to transcriptional start site in region I.1 were found to be hypermethylated. The methylation data suggested that, in case of tissue specific regulation of *Cyp19* gene expression during folliculogenesis, there could be moderate relation between the percentage of individual CpG, relative to start site of transcription of exon I.1 and its expression in different types of follicles.

**Buffalo spermatozoa functionality as affected by silver nanoparticles:** Effect of silver nanoparticles on buffalo sperm motility, viability, capacitation and acrosome reaction was studied. Viability of the silver nanoparticle loaded buffalo sperm cells ( $10^8$  cells/mL) at concentration of 10  $\mu$ g/ml, 20  $\mu$ g/ml and 50  $\mu$ g/ml at 0h, 3 h, and 6 h incubation was assessed by dye exclusion method. The viability of sperm cells decreased to nearly 3, 4, and 9% points at 10  $\mu$ g/ml, 20  $\mu$ g/ml and 50  $\mu$ g/ml of silver nanoparticles, respectively at 2 h incubation as compared to control. After 3 h incubation, viability of sperm cells decreased by 3, 5 and 10% at 10  $\mu$ g/ml, 20  $\mu$ g/ml and 50  $\mu$ g/ml of silver nanoparticles, respectively. The viability of sperm cells significantly reduced at 50  $\mu$ g/ml concentration of silver nanoparticles at 6h incubation as compared to control. Membrane integrity was determined based on the morphology of sperm cells after treatment with HOST solution for 1h. It was found that the membrane integrity of buffalo sperm cells decreased by 10, 10 and 20% at 10, 20 and 50  $\mu$ g/ml of silver nanoparticles, respectively after 1h incubation as compared to control. It could be inferred that using silver nanoparticles at and above 50  $\mu$ g/ml could affect sperm cell membrane integrity and

normal physiology of sperm cells. Effect of silver nanoparticles at different concentrations on buffalo sperm capacitation and acrosome reaction was assessed by determining the percentage of acrosome reacted cells by dual staining method and also by FITC-PSA. Buffalo spermatozoa were grouped into two aliquots, one aliquot of sample was treated with inducers of capacitation and acrosome reaction; another aliquot without inducers. The extent of capacitation was increased by 7, 8 and 12% at 10, 20 and 50  $\mu$ g/ml concentration of silver nanoparticles at 2h incubation in buffalo spermatozoa induced with inducers of capacitation and acrosome reaction as compared to control. Similarly capacitation was increased by 15, 20 and 25% at 10, 20 and 50  $\mu$ g/ml concentration of silver nanoparticles at 6h incubation. However, no change was observed in buffalo sperm cells (without inducers of capacitation and acrosome reaction) incubated at 50  $\mu$ g/ml of silver nanoparticles for temporal studies.

**Nanoparticles of gold and silver prepared and partially characterized:** Nanoparticles possess unique property of flow and on it ligands can be attached. This makes them very useful in lateral flow system in diagnostic. Nanoparticles of gold were prepared in the laboratory from reduction of gold chloride by citrate. New reducing agent, amino naphthol sulphonic acid was attempted and this reducing agent could also be used for preparation of gold nanoparticles. Gold nanoparticles showed characteristic lambda maximum at about 529 nm. Silver nanoparticles were also being prepared from silver nitrate using sodium borohydride as reducing agent. The method for phase transfer of silver nanoparticles was worked out. Preliminary results showed that stability of silver nanoparticles was poor in toluene when transferred from aqueous phase to toluene.



Gold chloride Nanoparticles of gold

## DAIRY TECHNOLOGY DIVISION

### Incorporation of Selected Probiotic Bacteria in Infant Formula

This investigation was undertaken to protect the viability of probiotic organisms during thermal processing and gastrointestinal transit by co-microencapsulation with a prebiotic. *Lactobacillus acidophilus* NCDC15 with proven probiotic characteristics were microencapsulated using sodium alginate, corn starch and different levels of the prebiotic Sunfiber™. The results obtained suggest that at low pH, the survival of the organism improved in capsules containing Sunfiber™, demonstrating that co-microencapsulation with Sunfiber™ sodium alginate-corn starch matrix may be useful in improving their survival rate in the gastrointestinal environment.

### Studies on the Manufacture of Dairy Whiteners Employing Ultrafiltration Technology

Investigation was undertaken to prepare dairy whitener from buffalo milk, cow milk and buttermilk using ultrafiltration process.

**Buffalo milk dairy whitener:** The buffalo skim milk was concentrated by ultrafiltration. The addition of 0.4% stabilizer improved the heat stability of UF retentate. The standardized middle-fat and full-fat liquid dairy whiteners prepared from buffalo milk were spray dried to about 3% moisture content. But when added in tea and coffee solution, the powdered dairy whitener showed poor stability with respect to protein stabilization and also had poor reconstitutability. So, it was concluded that buffalo milk was not suitable for preparation of dairy whitener employing ultrafiltration process.

**Cow milk dairy whitener:** Standardized Dairy whitener was prepared using cow skim milk ultrafiltered retentate as a base. It was observed that middle-fat and full-fat dairy whitener fetched significantly higher sensory scores on 9-point Hedonic scale as compared to market sample with respect to flavour, mouth-feel, whiteness, feathering resistance, sweetness and overall acceptability. Packed in metalized polyester LDPE-laminates under vacuum condition and stored at  $37 \pm 1^\circ\text{C}$ , full-fat dairy whitener showed stability in coffee up to 2 months of storage and in tea up to 3 months of storage. While middle-fat dairy whitener showed stability in tea and coffee up to 2 months of storage compared to 1 month stability of market sample.

**Buttermilk dairy whitener:** Buffalo skim milk was added partially to sweet buttermilk to improve the flavour and UF concentrated about 5-fold. The developed low fat dairy whitener exhibited significantly ( $p < 0.05$ ) better sensory and whiteness parameters in tea and coffee than market sample.

### Development of Raabdi-like Cereal Based Traditional Fermented Milk Foods with Extended Shelf-life

The study was undertaken with an objective to develop a value added fermented beverage, like *Raabdi* utilizing milk solids and cereals, which possess health attributes. Development of *Bajra* / sorghum *lassi* was based on the selection of milk solids source; selection of level, form & stage of addition of pearl millet solids; fermentation conditions and stabilization of developed product in terms of preventing sedimentation and wheying-off in the product during storage. Fermented beverages made from skim milk and sour buttermilk (*chhachh*) as source of milk solids were equally acceptable on the basis of sensory scores. Although traditional product is prepared from sour buttermilk, yet keeping in view the suitability for industrial production and easy availability, skim milk was selected as source of milk solids for development of proposed beverage. Pearl millet solids/sorghum were added to skim milk in three different forms viz. a) raw flour obtained from milling grains, b) slurry obtained by grinding of soaked grains and c) flour obtained after grinding of 24 h & 48 h germinated and dried pearl millet / sorghum grains (malt). NCDC-167 starter culture was selected on the basis of desirable acidity in the curd. The level of flour and other ingredients were determined using RSM with Central Composite Rotatable Design. Subsequent to the development of above process for the manufacture of salted *lassi* from skim milk, trials were conducted to further improve the quality of the beverage. Skim milk was replaced with standardized milk so as to minimize the sharp acidic and flat taste in the final product. Sorghum and pearl millet based beverages had a shelf life of about seven days at refrigeration storage. The shelf life of *lassi* was enhanced up to 28 and 35 days using MicroGARD and Nisin. There is a great demand of ready -to- reconstitute (RTR) products including dairy products in India. Efforts were, therefore, made to develop a technology for production of ready -to- reconstitute sorghum/pearl millet based fermented milk beverage by adopting spray drying method.

### Development of Quarg type Fresh Cheese with Enhanced Health Attributes and Shelf- life

A study was undertaken with the objective to develop good quality Quarg type fresh cheese with enhanced health attributes and shelf life. Trials were conducted to standardize certain processing parameters viz. fat levels in milk, heat treatments and starter cultures and rennet (Meito) levels. Dietary fiber, especially soluble fibers are associated with carbohydrate and lipid metabolism has shown to have hypercholesterolemic properties. Keeping in view the reported beneficial effect of dietary fiber on cardiac disease, inulin (Raftiline), oat (Vitacel) fiber and soy fiber were assessed using RSM for their suitability. The experimental cheeses were analyzed for physico-chemical properties (pH and titratable acidity), rheological properties (firmness, work of shear and stickiness) and sensory characteristics. Effect of different levels of plant sterol esters on the quality of fiber enriched quarg cheese was studied to explore the enrichment of quarg cheese with plant sterol esters. Adding plant sterol ester had no significant change in sensory quality of fiber enriched quarg cheese.

Quarg cheese has a shelf life of about 2 week under refrigeration storage. The trials were undertaken to extend the shelf life of quarg cheese using MicroGARD™ 100 and Nisin. The study revealed that MicroGARD™ 100 or Nisin could be successfully used to extend the shelf life of the Quarg cheese without adversely affecting the quality of Quarg cheese.

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

**Studies on the technology of Doda Burfi:** Preliminary trials were conducted to narrow down the levels of various ingredients used for optimization study. Thus, range of each of the three factors were employed for standardization process viz. fat, germinated wheat flour and sugar with values ranging from 3-6, 2.5-5.5 and 14-18% in milk, respectively. Seventeen trials were conducted based on the formulations provided by Box-behnken design using response surface methodology (RSM). The optimization was carried out using sensory scores to arrive at optimum product formulation. Based on the responses received and set goals for further optimization of recipe, four different combinations were obtained. The differences between different solutions were so small that it could be neglected and also on practical basis could not be maintained. So, solution number 1 was

tried for the verification purpose. The t-test was applied upon the predicted and observed values of solution number 1 for all the responses obtained against colour and appearance of surface, texture, sweetness, flavour and overall acceptability which showed that there were no significant differences between the predicted and observed scores for the attributes studied. The optimized recipe, thus, obtained and finally made, had quality comparable to market quality in terms of physico-chemical, textural attributes with better microbiological quality compared to market product.

**Studies on the technology of Chhana-murki:** *Chhana-murki*, a popular delicacy of northern and eastern regions of India, is prepared by heat desiccation of paneer cubes in concentrated sugar syrup. The conditions for *Chhana-murki* preparation were optimized with respect to fat percentage in milk, coagulation temperature of milk for the preparation of paneer and cube to sugar ratio for finished product by following CCRD of Response Surface methodology. The effect of different parameters was studied by subjecting the prepared sample for evaluation of sensory and physical properties. Optimization was done based on sensory score (Hedonic rating) done by experts. Fat percentage in milk and cube to sugar ratio had significant effect on flavour. All the sensory attributes were significantly influenced by the process variables studied. Water activity was significantly influenced by cube to sugar ratio. Descriptive analysis was also conducted. Physico-chemical parameters like Moisture content, Cube to Syrup ratio, Bulk density, Textural analysis, Color, Water activity and Yield was done for all experiments. The optimized product parameters were further used for osmotic dehydration studies where the parameters considered was cube to sugar syrup concentration, temperature and time interval for osmotic dehydration studies. Sugar to cube ratio was kept constant. Water activity, moisture content and texture analysis of osmotic dehydrated paneer cubes was performed and the final product after particular time interval was prepared with standardized sugar to cube ratio obtained in the previous optimized product. Descriptive analysis was also done for final product. The optimized product was stored and analyzed at regular intervals for various quality parameters and isotherm studies.

**Development of a process for Functional Chhana-murki:** Having wide ranging beneficial effects on human health, dietary fiber has come to be recognized as an important ingredient of health foods. *Chhana-murki* is an energy-dense Indian

traditional milk product which could benefit a great deal in terms of acceptability in the modern consumer environment if it is fortified with fibre. Hence, Various fibers viz. Polydextrose, Inulin, MCC, Oat and Wheat fiber were screened for their suitability in *Chhana-murki* with respect to sensory and physical properties such as moisture content, texture profile and water activity. MCC and Inulin in combination were found most acceptable. Presence of higher amount of nutritive sweeteners like sucrose restricts consumption of traditional dairy products among diabetics, obese, heart patients and health conscious people. Sugar was, therefore, sought to be replaced by non-nutritive sweeteners in the product. Screening of various low-calorie sweeteners and their blends was carried out along with the selected bulking agent (i.e. lactitol or sorbitol) and selected fiber combination (i.e. MCC-Inulin) in order to replace the sucrose completely in *Chhana-murki*. Aspartame, Acesulfame-K, Saccharin, Stevioside and Sucralose and their blends were used in different concentration ranges selected on the basis of preliminary trials along with the bulking agent to find out the best sweetener/blend in terms of sensory parameters like sweetness intensity, sweetness quality and flavour. It was observed that there was no appreciable difference in the flavour of the product with different sweeteners. However, Sucralose showed the best sweetness intensity as well as quality according to product requirements. In further studies, optimization of the product was carried out by using selected fiber combination (MCC-Inulin), polyol (lactitol/lactitol) and sweetener (sucralose) by CCRD approach of Response Surface Methodology using four variables viz. sweetener level (600-800 ppm), fiber level (5-10%), polyol level (5-15%) and gum arabic (1-2.5%). Optimized product was further standardized for flavour using three flavours i.e. rose white, pineapple and elaichi at three different levels and rose white flavour was finally selected on the basis of sensory evaluation according to suitability in the product.

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

**Complementary food from a composite dairy-cereal mix:** A blend of whey and skim milk in the ratio of 4:1 was standardized as a base for the complementary food. Germinated pearl millet flour, barley malt extract, maltodextrin and corn flour improved the organoleptic and reconstitutive properties. Response Surface Methodology (RSM) based on Central Composite

Rotatable Design (CCRD) was adopted to optimize the composition of the formulation. Optimized product was prepared by mixing the calculated amount of ingredients, heat processing, and drying. The resultant product was analysed for gross composition. The tray dried complementary food contained 1.24, 12.82, 2.02, 0.86, 2.64 and 81.28 % of fat, protein, ash, crude fiber, moisture and carbohydrate by difference respectively and 1.06, 36.86 and 1.51 mg per 100 g of iron, calcium and zinc. The corresponding values in the spray dried product were 0.96, 12.83, 2.09, 0.84, 2.57 and 81.55 % and 2.58, 38.56 and 1.40 mg per 100 g.

**Iron-fortified biscuits from a composite dairy-cereal mix:** Iron deficiency is the most prevalent nutritional deficiency in the world, affecting approximately 2 billion persons. Osteoporosis and osteoarthritis are diseases that result from calcium malnutrition. Fortification of composite wheat-pearl millet flour with iron in combination with valuable dairy ingredients would be a practical approach to address iron and calcium deficiency among the population. The formulation of ingredients for the composite flour based biscuits is being optimised following CCRD of Response Surface methodology using Design Expert Software. The effects of different parameters are under investigation by subjecting the prepared sample to sensory and physico-chemical analysis.

**Barley-based sweetened probiotic beverage:** The technology of a barley-based sweetened beverage fermented by probiotic organisms with improved textural properties is being optimised. Protocols were formulated for the germination of barley seeds, preparation of barley flour, addition of appropriate quantity of flour in beverage, incorporation of optimum quantity of other additives (sugar, starter culture) in the beverage, mode of addition of these additives in the beverage, fermentation time and criteria for the culture and analyses to be carried out on the raw materials as well as the final product. Trials are in progress to formulate the beverage and assess its physico-chemical and sensory attributes.

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

Studies were conducted for production of nutraceuticals like antioxidant and antimicrobial peptides from milk and galacto-oligosaccharides (GOS) from whey through microbial or enzymatic hydrolysis. A number of 25 lactobacilli strains

of various species like *Lactobacillus acidophilus*, *L. helveticus*, *L. casei* and *L. fermentum* were procured, purified and screened for proteolytic activity. Potential *Lactobacillus* strains (13) having good proteolytic activity were selected after preliminary screening of *lactobacilli* cultures. Intracellular and extracellular proteolytic activities of these potential *Lactobacillus* strains were being determined. Fifty strains of *S. thermophilus* and *Kluveromyces* were isolated from dairy products procured from different sources and characterized by biochemical and molecular methods. In response to objective to study the feasibility of using the cattle rumen system to enhance productions of the nutraceutical Conjugated Linoleic Acid (CLA) and herbal nutraceuticals directly in milk by adding suitable herbs/herbal extracts in the feed, extracts of *Acacia concinna*, *Azadirachta indica*, *Ocimum sanctum*, *Spindus minalia Arjuna*, *Terminalia bellerica*, *Terminnalia chebula*, and *Trachyspermum ammi* were prepared, freeze-dried and reconstituted in distilled water and incubated in buffered rumen fluid at three levels (0, 1 and 2 mg/ml) with 200 mg concentrate and berseem (1: 1) as a substrate. In comparison with control, treated cultures showed greater concentration of CLA except *T. bellerica*. Greater responses were observed in VA production than CLA when cultures were supplemented with different extracts. Fourteen more plant varieties were identified to study their effect on inhibiting the *Clostridium proteoclasticum* activity without adversely affecting the *Butyrivibrio fibrosolvans* activity for higher CLA production for isolation and identification of bacteria involved in biohydrogenation of PUFA from different sources, ruminal fluids were collected for isolation of *Butyrivibrio fibrisolvans* and *Clostridium proteoclasticum* and identification of *Butyrivibrio fibrisolvans*.

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

The various courses as outlined by the IV Deans' Committee have been allotted to the concerned teachers with teaching experience in respective areas at the three centres. The content development is in progress, with lessons/modules of digitalized text having been done to different extents in different courses. Simultaneously, equipment procurement for setting up of an e-learning laboratory is in progress, most of the equipment having been already received. Two Review Meetings were conducted, one at Karnal in December 2009 and the other Tirupati in February 2010. Teachers' Training in e-content development has been provided in part by NAARM, Hyderabad and IIT-M, Chennai

and about 30 project participants have benefited from the same.

#### Technological Interventions for Omega-3 and Fiber Supplementation in Milk

The study was designed in such a way that one serving (250 mL) of liquid milk would meet the daily requirement of omega-3 fatty acids, DHA (200 mg) and ALA (2g), using algal oil and flax seed oil, respectively. The milk was also fortified with 1% Sunfibre® which would fulfill 25% of daily requirement of dietary fibre. The product had DHA and ALA at 1.35% and 7.71% of total fatty acids, but exhibited a high degree of fat oxidation on the very day of preparation. This effect diminished by the 3rd day as also corroborated by the sensory scores. The *in vivo* studies using Swiss albino female mice demonstrated that phagocytic activity of omega-3 milk group was 33% and 41% less than that of control group after 4 and 8 weeks of feeding. The lymphocyte proliferation index was 26% and 61% less than that of control when lipopolysaccharide was used as mitogen and 17.8% and 19% when concanavalin A was used after corresponding periods. IgG level in serum reduced after dietary supplementation. IgG in intestine and IgA in serum and intestine did not show any particular trend. The estimated cost of production of the fortified milk was Rs.62.40 per litre.

#### Technology for Long shelf-life Paneer Tikka

Convenience foods are at premium among professional women, singles, elderly, and people with little cooking experience or insufficient time. Paneer is highly rich in proteins, vitamins, minerals, fibre content, sulphur compounds, is laxative in nature, and used as a base material for the preparation of large number of culinary dishes including paneer tikka (a South Asian term meaning marinated barbequed food). Paneer tikka is one such item that requires more than five hours for its preparation. Though, at present paneer tikka is consumed immediately after preparation, but if stored its shelf life is hardly one day. Preservation and packaging of paneer tikka is a major problem, which impedes the organised marketing of the product commercially. Hence, a study was planned to increase its shelf life. 250 g paneer tikka samples were vacuum packed in two high barrier bags, viz. nylon based co-extruded films (P2), metallized polyester films (P3) alongwith polyethylene films as control (P1), and stored at  $3 \pm 1^\circ\text{C}$ . The stored samples were evaluated at regular intervals for changes in physico-chemical, microbial and sensory

characteristics. Amongst the three packaging materials studied  $P2 > P3 > P1$  respectively. The shelf life of vacuum packed paneer tikka increased up to 40 days in packaging materials P2 and P3.

#### **Development of Technology for Manufacture of Feta Cheese with Enhanced Functional Attributes from Buffalo Milk**

Feta cheese is a soft white-brined cheese which is traditionally made from Sheep milk or from mixture of Sheep and Goat milk. To meet the ever increasing demand of Feta cheese throughout the world, cow milk has been used successfully for its production. As such, no study has been reported for the manufacture of Feta Cheese from buffalo milk using microbial rennet. Therefore, the present



*Feta Cheese*

study was taken with the aim of developing a good quality Feta cheese with enhanced functional attributes from buffalo milk. In order to obtain an acceptable quality Feta cheese, various processing parameter such as C/F ratios, heat-treatments, type and level of Starter culture, level of rennet, brine condition, level of rennet and brine concentration were studied. It was also observed that Feta cheese made from buffalo milk by modified technology was quite comparable to that made from cow milk Feta and commercial Feta cheese with advantages of higher yield and without adding additives. Augmentation of starter with starter adjunct like *L. helveticus* and *L. casei* had further improved the quality of buffalo milk Feta cheese. As Feta cheese contained high salt (4 to 5%) this indicated high content of sodium in cheese. Increased intake of sodium not only induces hypertension but also induces osteoporosis and incidence of Kidney stones, whereas increase intake of Potassium via the diet exerts a protective effects in individuals with sodium induced hypertension, reduces urinary Calcium excretion and potentially protects skeletal mass. Therefore, the attempts were also made to reduce the sodium content by replacement of NaCl by KCl. Through this study, an appropriate technology was developed to manufacture good quality Feta cheese with enhanced functional attributes from buffalo milk.

## **DAIRY ENGINEERING**

#### **Development of a Mechanized System for Production of Malai Lachha**

On the basis of feasibility trials the flat plate heat exchanger was fabricated. A feed cylinder was fabricated to provide a reservoir. A gear mechanism was developed to convert one dimensional rotary motion to linear motion. The trial indicated that browning was observed at the bottom most layer. To overcome browning, a cooling mechanism was integrated with the system. The most acceptable product was found in case of 35% TMS concentrated milk at 0.4 kg/m<sup>2</sup> steam pressure and cooling rate of 3500 j/s with a batch of 2.4 kg finished product. Total time including heating and cooling was 55 minutes.

#### **Performance Evaluation of Three Stage SSHE for Continuous Manufacture of Burfi**

Three stage three thin film SSHE designed and developed for continuous manufacture of Khoa

was used for continuous manufacture of burfi. The sugar dosing device was designed, fabricated and provided at the inlet of three stage SSHE to blend sugar with khoa.

The performance evaluation of the system was made for continuous manufacture of burfi using each batch of 60 lt milk having 6% fat, 9% SNF and 0.17% LA. The steam pressures of first, second and third stage was fixed at 4.0, 2.0 and 1.5 kg/m<sup>2</sup>. The rotor speed of first stage was kept at 150, 175, 200 rpm; second stage at 125, 150, 175, 200 rpm and third stage at 15, 20, 25 rpm. The mass flow rate was varied in the range of 150-210 kg/s so as to get the final product of same consistency. Three methods of sugar dosing were used. The quality of products samples obtained was analyzed for sensory evaluation. The sensory score of all product samples indicated that sugar dosing at inlet in third stage SSHE using scraper speed at 200, 175 and 115 rpm in first, second and third stage, respectively gave overall maximum scores.

## DAIRY CHEMISTRY

### 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 simple methods for ascertaining the heat treatment of milk:** Two simple colour based methods for ascertaining the heat treatment of milk around 80°C were developed. These methods are based on the development of colour when substrates of GGTP or LPO added to milk samples. Active enzymes result in formation of pink coloured products in both cases. Absence of pink

colour indicated enzyme was inactivated during heat treatment. For validating the developed colour tests, the tests were applied to raw milk as well as heated milk. Results indicated that at 80°C, there was no formation of pink colour thus indicating the complete destruction of both GGTP and LPO. However, in raw milk as well as in milk heated at other temperatures (65° to 75°C), a distinct pink colour formation was observed which can be distinguished visually. These methods are simple, rapid (5-10 min) and can be adapted by the dairy industry as indicator of heat treatment of milk around 80°C.

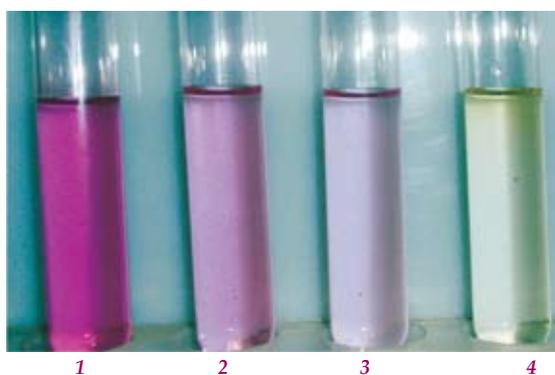


Figure 1. GGTP assay tubes. Sample details : test tubes 1, Raw cow milk; test tube 2, Milk heated at 70°C/15 sec; test tube 3, Milk heated at 75°C/15 sec; test tube 4, Milk heated at 80°C/15 sec.



Figure 2. LPO assay tubes. Sample details : 1, Raw cow milk; 2, Milk heated at 70°C/15 sec; 3, Milk heated at 75°C/15 sec; 4, Milk heated at 80°C/15 sec.

**Quality assessment of raw milk using innovative analytical approaches:** Innovative approaches like estimation of ammonia, pyruvate and lactate, degree of neutralization of milk as well as ash and sodium content, were used to assess quality and freshness of raw milk. These were also studied for the detection of added neutralizers. Fresh cow and buffalo (individual and pooled) milk samples collected from Institute cattle yard were used for the study. Souring of milk was done till it became COB positive. Two neutralizers (sodium hydroxide and sodium bicarbonate) were used to neutralize the developed acidity to original level. Based on the study, it was revealed that electrical conductivity and degree of neutralization are not reliable parameters for knowing the freshness of milk, where as pyruvate, lactate and ammonia content coupled with the titratable acidity could be used as innovative and reliable tools for knowing the freshness of milk. Lactose content could also be useful in this context. As regards detection of neutralizers in milk, sodium and alkalinity of ash were found to be reliable indicators for the detection of neutralizers, while ash content

and pH, electrical conductivity and degree of neutralization of ash were useful to some extent for this purpose. Ammonia, pyruvate and lactate, besides supporting the determination of freshness of milk, were also found to be helpful in detecting neutralized milk even when it showed negative rosolic acid test. Formalin was found to interfere in all the parameters used for assessing the freshness of milk or detecting neutralizers, except lactose which remained unaffected by formalin.

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

**Analysis of sweetener/ sweetener blends (aspartame x acesulfame-k & aspartame x saccharin) and their stability in whey beverage:** Technology for preparation of artificially sweetened *whey lemon beverage* was standardized to obtain the same sweetness as the sucrose sweetened whey lemon beverage (control). Binary sweetener blend aspartame x acesulfame-K (50:50, 0.05%) scored the

highest ( $P < 0.05$ ) in terms of sweetness and overall acceptability based upon comparison with the other optimized binary sweetener blend/sweetener, viz. aspartame x saccharin blend (70:30, 0.0425%) and aspartame (0.07%) in *whey lemon beverage* on the basis of sensory evaluation. A maximum synergy with the best binary blend aspartame x acesulfame-K (50:50, 0.05%) in sweetness intensity and overall acceptability (17.5%, 9.0%) was obtained with respect to single sweetener aspartame. Multiple sweetener approach involving use of binary blend aspartame x acesulfame-K (50:50, 0.05%) resulted in 29% reduction of usage level when compared with single sweetener aspartame (0.07%). There was about 61% reduction

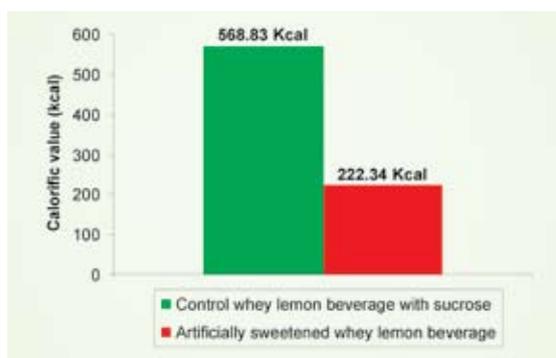


Fig. 1 Reduction in calorific value of artificially sweetened (AS x AK) whey lemon beverage with as compared to control whey lemon beverage with sucrose.

in calorific value of artificially sweetened *whey lemon beverage* when compared with control. Further it was also established that sweeteners did not degrade during storage. Increase in acidity and viscosity and decrease in pH of artificially sweetened whey lemon beverage samples was similar to control during storage. Increase in total plate counts obtained during storage of *whey lemon beverage* was highly influenced by sucrose and was not influenced by the sweetener/sweetener blend used in preparation of artificially sweetened *whey lemon beverage*. There was a significant decrease in ascorbic acid and browning index of artificially sweetened *whey lemon beverage* samples and control during the entire period of storage.

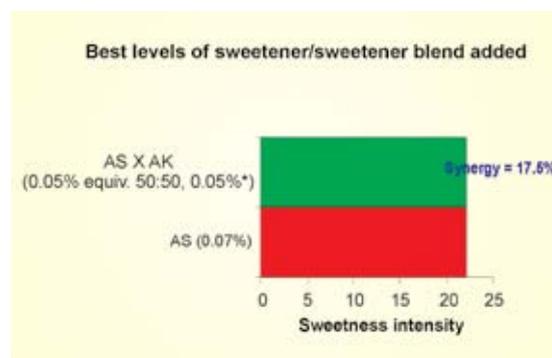


Fig. 2 Synergistic effect of sweetener blend (AS x AK) on sweetness intensity of whey lemon beverage

**Development of functional food ingredients by enzymatic modification of whey proteins:** In the present study, the process for the production of biofunctional whey protein hydrolysates was optimized by hydrolyzing whey protein concentrate (WPC) with different commercial enzymes. The effects of three process parameters i.e. pH, incubation temperature and hydrolysis time on antioxidative activity, antihypertensive activity (ACE inhibitory) and the correlations between molecular and functional characteristics of whey protein hydrolysates (WPHs) was studied systematically. The WPC was hydrolyzed with enzymes alcalase, flavourzyme, trypsin, corolase PP, pepsin and papain. Antioxidant and ACE inhibitory activities were evaluated using standard methods. The hydrolysis conditions viz. pH, temperature and time of hydrolysis were optimized using response surface methodology (RSM). The whey protein hydrolysates (WPHs) prepared using optimized conditions with enzyme alcalase, flavourzyme, trypsin and corolase PP showed very high antioxidant activities i.e.  $1.41 \pm 0.08$ ,  $1.25 \pm 0.06$ ,  $1.37 \pm 0.12$  and  $1.57 \pm 0.09$   $\mu\text{M}$  of trolox/ mg of proteins as compared to that of WPC ( $0.19 \pm 0.07$   $\mu\text{M}$  of trolox/ mg of proteins). The

antioxidant activity of permeates was higher than that of the WPHs after ultrafiltration (MW cut off  $< 3$  kDa). The whey protein hydrolysate for which the conditions viz. pH, temperature and hydrolysis time were optimized for the maximum ACE inhibition using flavourzyme exhibited substantial ACE inhibitory activity i.e.  $289.98 \pm 2.97$   $\mu\text{g}$  proteins ( $\text{IC}_{50}$  value). The techno-functional properties were slightly inferior to the unhydrolysed whey protein except overrun which showed increase. The WPHs were added to the skim milk to observe the sensory and biological properties in the food system. The

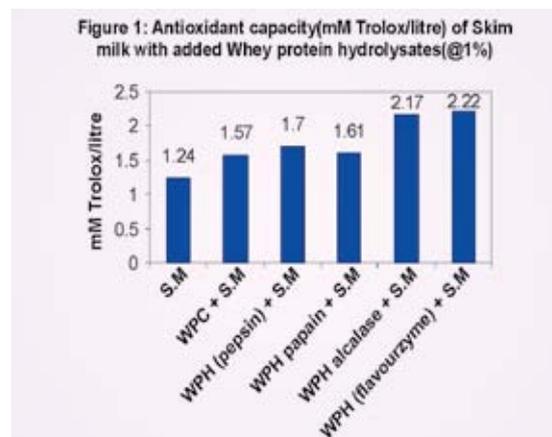


Figure 1: Antioxidant capacity (mM Trolox/litre) of Skim milk with added Whey protein hydrolysates (@1%)

incorporation of WPHs in the skim milk (1 to 2%) 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.

**Antioxidant capacity of fruit whey beverage:** Fruit whey beverage based on mango pulp and strawberry pulp was standardized. The whey beverage based on mango was found organoleptically acceptable at 18% level of pulp and pH 4.24 while that for strawberry, it was 12% and pH 4.18. Both these beverages were evaluated for compositional and

physicochemical parameters. The antioxidant capacity was evaluated by iron reducing method based on TPTZ (2, 4, 6-tris (2pyridyl)-s-triazine), ABTS (2, 2' azinobis 3-ethyl benz thiazoline 6-sulphonic acid) and DPPH (2,2-Diphenyl 1-picryl hydrazyl) using Trolox as standard. Based on ABTS method, the total antioxidant capacity of mango whey beverage was observed to increase 1.67 fold as compared to paneer whey while that for strawberry the antioxidant value enhanced by 8.9 fold. A good correlation coefficient was observed between different methods of measurement for total antioxidant capacity and the total phenolic content was also positively correlated with total antioxidant capacity. During storage of fruit whey beverages at refrigeration temperature for four weeks, there was no significant difference ( $p < 0.05$ ) in total antioxidant capacity.



*Mango whey beverage*



*Strawberry whey beverage*

**Purification and properties of buffalo milk osteopontin:** Osteopontin was isolated and purified by sequential chromatographic steps of ion exchange chromatography on DEAE-sephacel, dual hydrophobic interaction chromatography on phenyl-sepharose-6-fast-flow followed by hydroxyapatite chromatography on HA-ultrogel. The yield of osteopontin was  $9.17 \pm 0.42$  for buffalo milk and 19.14 mg/l liter for buffalo colostrum and that for cow and goat milk was found to be 8.23 and 8.64 mg/l, respectively. The yield of osteopontin from buffalo, cow and goat whey was 8.85, 8.42 and 8.69 mg/l, respectively. No differences in mobility of osteopontin were observed in SDS-PAGE under reducing and non-reducing conditions. The molecular weight of purified buffalo milk osteopontin was 60 kDa. Resolved protein bands were visualized with Alcian blue-silver staining. Poor cross reactivity was observed during dot blot and Western blot of osteopontin on nitrocellulose membrane using anti-osteopontin-mouse (developed in goat). Purified osteopontin had high levels of aspartic acid, glutamic acid and serine, 5.9 mol phosphate/mol osteopontin, 21.79 % total carbohydrate and 7.15 % sialic acid. A 20 kDa

fragment was obtained on trypsin hydrolysis and a 32 kDa on thrombin cleavage. Thrombin cleaved osteopontin fragment was isolated and analyzed for molecular weight, amino acid composition, total carbohydrates and sialic acid.

**Evaluation of diagnostic kits for cholesterol estimation in ghee and development of a method for estimation of adsorbent in low-cholesterol ghee:** A method was standardized for acid hydrolysis of pure standard  $\beta$ -cyclodextrin for its complete conversion into glucose and then its subsequent estimation by using glucose enzymatic diagnostic kit. For efficient acid hydrolysis of  $\beta$ -cyclodextrin, 1.0 ml of concentrated hydrochloric acid, 10 min boiling and 10 min holding gave maximum yield of glucose. The recovery of  $\beta$ -cyclodextrin in the method was 94%. The detection limit of the method was 0.2 mg.

Phenolphthalein - binding method for estimation of  $\beta$ -cyclodextrin was also standardized and the linearity of the method was found to be good in the concentration range of 2.0 to 500.0  $\mu$ g and detection limit of the method was 2.0  $\mu$ g.

High Performance Liquid Chromatography (HPLC) method using Shimpak CLC - NH<sub>2</sub> (M), 25 cm length amino propyl group column, differential refractometer detector and acetonitrile : water (70:30) as solvent system showed a detection limit of 2.0 µg for pure β-cyclodextrin.

During this study, a Reverse Phase Thin Layer Chromatography (RPTLC) method was also developed for estimation of pure standard β-cyclodextrin. For development of the plate Butane-1-ol : Ethyl alcohol : Water in the ratio of 4:3:2 was found to be most suitable solvent system. The development time to reach solvent front was observed to be 30 - 40 min and colour development was done by spraying 15% methanolic H<sub>2</sub>SO<sub>4</sub> followed by heating for 15 - 20 min at 100°C. The RPTLC plates were quantified using Quantity One software. This method showed a very good detection limit of 0.05 µg for visualizing the bands and 0.1 µg for quantifying purpose.

**Preparation of protein rich powder from buffalo colostrums:** Buffalo and cow raw colostrum samples were subjected to heat treatment at different time temperatures combination viz. 72°C/15 sec, 68°C/30 min, 65°C/30 min, 63°C/30 min, 60°C/45 min, 60°C/60 min. The heat treatment selected in this study was 60°C for 45 min, which was below the unfolding temperature of Igs. Also at this temperature, there was minimum loss (2.632%) of immunoglobulins so that minimum amount of immunoglobulins were rendered inactive due to heat treatment. Buffalo skimmed colostrum powder and whey colostrum powder were prepared by freeze-drying technique and were analyzed for gross chemical composition. Fat percentage in buffalo skimmed colostrum powder prepared from first, second and third milking ranged from 1.0-1.68%,

0.89-1.17% and 0.58 - 1.68%, respectively. Protein showed a decreasing trend and varied from 77.49-79.64% in powder prepared from first milking to 72.87-75.49 % in powder obtained from second milking whereas it was in the range of 69.59-72.87% for powder made from third milking. Lactose showed an increasing trend and varied from 13.73-13.83% in powder obtained from first milking to 15.22-16.28 % in powder made from second milking whereas it was in the range of 17.45-23.57% for powder prepared from third milking. The ash content varied from 6.45-6.8% in powder prepared from first milking to 4.09-5.02% in powder prepared from second milking and to 2.43-3.202% in powder prepared from third milking.

In buffalo colostrum whey powder, the moisture level in first, second and third milking ranged from 4.93-5.16%, 3.98-5.12% and 3.88-5.79%, respectively. Buffalo colostrum whey powder of first milking had 0.98-1.045% fat, whereas in powder made from second milking colostrum had 0.69-1.026% fat and powder prepared from third milking had fat content 0.48-0.89%. Protein showed a decreasing trend and varied from 73.82-74.83% in powder obtained from first milking to 70.21-72.14% in powder prepared from second milking whereas powder prepared from third milking had protein content in the range of 67.42-71.52%. On the other hand, lactose showed an increasing trend and varied from 11.81-11.90% in powder prepared from first milking whereas lactose content was in the range of 13.70-14.65% in powder prepared from second milking and it was in the range of 15.88-21.45% for powder prepared from third milking. Ash varied from 3.07-3.57% in powder prepared from first milking to 1.89-2.84% in powder obtained from second milking to 0.92-1.82% in powder obtained from third milking.

## DAIRY MICROBIOLOGY

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

**Protection of intestinal epithelial cells from camptothecin - induced cytotoxicity with bioactive peptides obtained from milk fermented with a probiotic *Lactobacillus*:** The study was undertaken to examine the protective effects of bioactive peptides obtained from milk fermented with *Lactobacillus rhamnosus* GG (LGG). The HPLC fraction obtained from 18 h growth showing highest activity was used as test peptide for

*in vitro* animal cell studies. Primary culture of gastric epithelial cells obtained from newborn rat stomach was maintained in DMEM. There was significant ( $P < 0.01$ ) reduction in caspase-3 and caspase-9 activity in apoptosis induced cells (camptothecin) later treated with bioactive peptides than with non-treated apoptosis induced controls. In the *in vivo* studies, intestinal injury resulted due to the oral intubation of camptothecin in rats. HE staining showed the damage (haemorrhage and apoptosis), partial loss of the mucosa higher in rats fed with camptothecin + control diet as compared to the rats previously fed with LGG milk. Positive cellular staining

for immunohistology was manifested as fine brown cytoplasmic granularity and/ or nuclear expression. Nuclear expression of the antigen (Hsp 27) was observed in the case of intestinal epithelial and liver cells of the rats previously fed with LGG milk. There was a consistent correlation between positive expression levels of Hsp 27 and the feeding of rats with LGG milk. These *in vitro* and *in vivo* results complement each other proving the fact that LGG secretes soluble factors which are anti-apoptotic in nature.

#### Production of antimicrobial bioactive peptides from milk proteins by proteolytic *Lactobacillus* spp. :

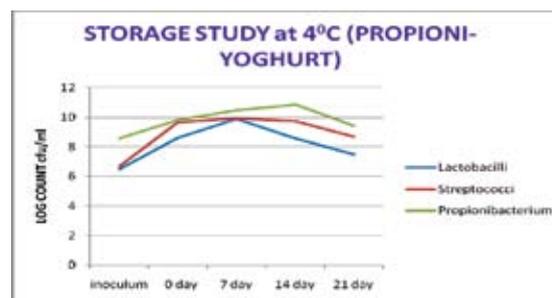
Antimicrobial activity of milk and milk protein fermentate of selected 12 standard proteolytic *Lactobacillus* cultures was tested against *E. coli*, *B. subtilis*, *Saccharomyces cerevisiae* and *R. oryzae*. Maximum activity of milk and sodium caseinate fermentate was observed against *B. subtilis* followed by *E. coli*, yeast and mold by agar well assay, whereas, in case of whey fermentate, maximum antimicrobial activity was found against *E. coli*. The sodium caseinate and whey fermentate, of standard *Lactobacillus* were filtered through a 10 kDa ultra-filtration unit and antimicrobial activity of the permeate as well as the retentate were tested for all the samples. UF (10 kDa), both permeate as well as retentate, of whey fermentate had more inhibitory activity against *E. coli* than other test cultures. Whereas, UF (10 kDa) of sodium caseinate fermentate and permeate had inhibitory activity against *S.aureus* and retentate against *E. coli*.

Out of a total of 37 *Lactobacilli* isolated from milk, Dahi and butter milk samples tested for proteolytic activity by milk agar assay and protease activity, only 3% showed very good, 5% showed good and 30% showed moderate proteolytic activity. Sodium caseinate fermentate of all the 37 *lactobacillus* isolates showed maximum inhibition against *S. aureus* followed by *E. coli*, *E. faecalis*, *B. cereus* whereas, in whey fermentate maximum inhibition was observed against *E. faecalis* followed by *E. coli*. The fermentate of all the isolates had inhibitory mode of action against test cultures.

#### Exploring propionibacteria as a potential source of vitamin B<sub>12</sub> and functional probiotic ingredient in a dairy based nutraceutical formulation

: B<sub>12</sub> producing isolate PrS0 (*P. freudenreichii* subsp. *freudenreichii*) selected out of 32 strains of dairy propionibacteria isolated from dahi and chesse assessed previously by *in vitro* methods (acid resistance, bile tolerance, cell surface hydrophobicity and antibiotic susceptibility) using

*P. freudenreichii* subsp. *freudenreichii* DSMZ 20271 as reference was found to be endowed with promising probiotic attributes and hence was further subjected to *in vivo* study using mice model. The feeding of Propioni-yoghurt to mice for 21 days led to the elevation of vitamin B<sub>12</sub> concentration in serum samples of vitamin deficient mice to the level of 34.571 ± 0.028 ppb at the end of 4 weeks. The count of propionibacteria in faeces and small intestine reached to 10 and 8 log cfu/ml, respectively. The use of *P. freudenreichii* PrS0 as an adjunct starter in development of vitamin B<sub>12</sub> rich propioni-yoghurt resulted in about 50% increase in vitamin B<sub>12</sub> content of yoghurt. The developed product was found to be acceptable on the basis of sensory evaluation and count of B<sub>12</sub> producing probiotic PrS0 strain was observed to be to the extent of 10.8 log cfu/ml even after storage of product for two weeks at 4°C. This is the first ever study of isolation, identification and characterization of strains of *Propionibacterium* spp. from dahi and indigenous vegetables. Bioprospecting of these novel strains paves the way for biobanking and conservation of rich national biodiversity. Besides B<sub>12</sub> production, these strains can be potentially explored for a wide array of functional biomolecules viz. folate, bacteriocin, exopolysaccharide, propionic acid and trehalose. Vitamin B<sub>12</sub> rich propioni-yoghurt developed in this study containing B<sub>12</sub> producing probiotic strain of *P. freudenreichii* PrS0 can be effectively used as a wholesome dairy food to address the problem of Vitamin B<sub>12</sub> deficiency and related diseases.



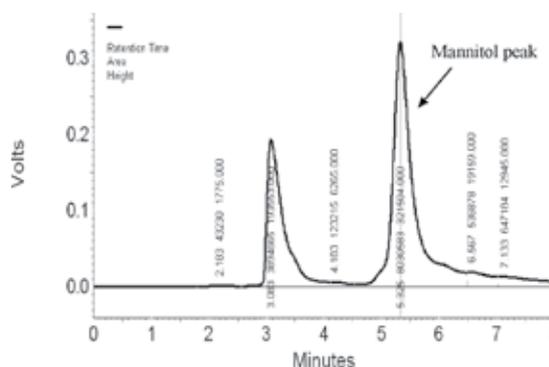
**Folate Production and Potential Probiotic Attributes of *Streptococcus thermophilus*:** Among 18 high folate producing strains (selected from 117 isolates), RD 102 and RD 104 produced highest content of folate i.e. 48.62 µg/l and 46.44 µg/l, respectively and showed appreciable *in vitro* biological barrier tolerance, intestinal adaptability and potential probiotic attributes as compared to other isolates in our previous studies. The folate production by these strains (RD 102 and RD 104) was further optimized by using response surface methodology. Co-culturing study showed that *Lactobacillus* spp. NCDC 09 consumed folate,

*Propionibacterium* spp. DSMZ 20271 produced folate while *Leuconostoc* spp. NCDC 29 had no obvious effect on the final folate level after fermentation. Dahi prepared using RD102 and RD 104 under optimized conditions was found to possess sound sensory scores. The purified PCR product of *lac Z* gene of *S. thermophilus* RD 102 and RD 104 was got sequenced and submitted to Genbank with Accession. No. FJ161697 and FJ16698, respectively. The comparative analysis of folate estimation by MA, ELISA and HPLC, showed a good correlation among the estimated average values of folate by all the three methods showing MA as highly efficient, sensitive and reproducible method for total folate estimation. The process was also filed for obtaining the patent.

#### Mannitol Production by *Leuconostoc* spp. :

In the present study, an attempt was made to isolate novel strains of mannitol+ *Leuconostoc* spp. from different food sources of Indian origin for mannitol production which could be used for industrial production of low calorie mannitol and also can serve as a functional starter for fermented vegetables and 'light' sweetened fermented milk food products with low calorific value. Mannitol producing strains of *Leuconostoc* spp. (210) were isolated from wide array of sources such as milk (cow, buffalo, yak), dahi, cream, butter, cheese, dosa and idli batter, vegetables (chilly, capsicum, cabbage, radish, peas, spinach, ladyfinger, potato, greens), fruits (guava, grapes) and sugarcane juice. Among the mannitol positive isolates, only 11.4 % produced mannitol above 40 gL<sup>-1</sup> (theoretically 80 % conversion with 50 gL<sup>-1</sup> as initial fructose concentration). Cultural and environmental factors affecting growth and mannitol production were studied for four high mannitol producing isolates (FF104, FD27, FV92, FY206). High mannitol production was favoured by high temperature and high pH. All the isolates had high osmotic tolerance as these could use fructose concentration as high as 100 gL<sup>-1</sup> in batch culture. Based on these preliminary studies, the conditions were further optimized by using response surface methodology. *Leuconostoc mesenteroides* subsp *mesenteroides* strain FF104 produced maximum mannitol (72%) in whey under optimized conditions. Sequencing of 16S rDNA genes of the strains revealed that Ln 27, Ln 104 and Ln 206 were *Leuconostoc mesenteroides* and Ln 92 was *Ln. fallax*. Sequence data for the four representative isolates were submitted to GenBank under the accession Nos. GQ856134, GQ856135, GQ856136 and GQ856137. Besides mannitol production, growth of *Leuconostoc* in milk results in production of CO<sub>2</sub> and hence attempts are being

made to standardize the method of development of a novel fermented dairy product "Carb countdown carbonated lassi" characterized by reduced calorific values, typical sensory attributes (effervescence, fizz, tinginess) and extended shelf life.



#### Molecular cloning, sequence analysis and expression of bile salt hydrolase (bsh) gene from a potential indigenous probiotic *Lactobacillus* of human origin :

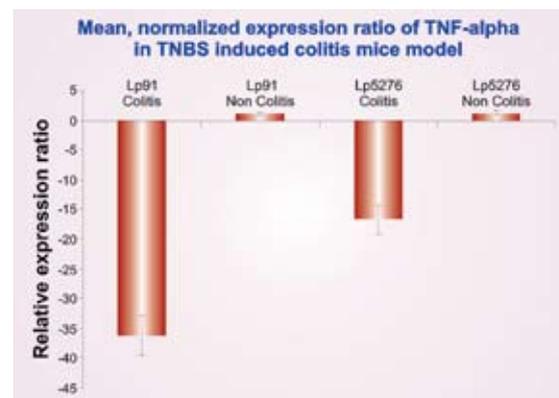
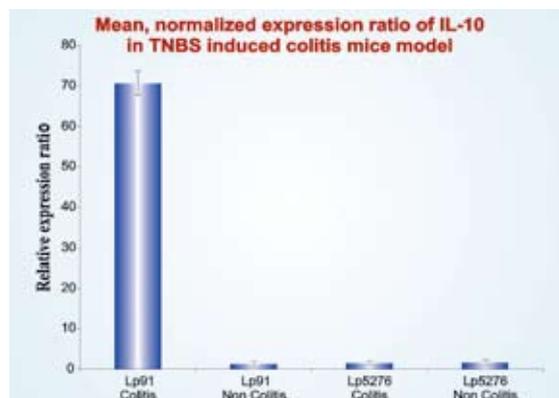
The study was specifically aimed towards exploring the Bile salt hydrolase producing potential of selected *Lactobacillus* isolates, their species and strain level identification by PCR and cloning, sequence analysis and expression of bile salt hydrolase gene. During the course of this study, around 102 cultures of *Lactobacillus* spp. including 68 new isolates and 34 reference *Lactobacillus* strains were screened for Bsh activity by using direct plate assay and ninhydrin assay. Four *Lactobacillus* isolates namely *L. plantarum* MBUL91, 21, 11 and 10 were adjudged as prolific Bsh producers and identity of these strains at species/strain level was further confirmed by species specific PCR and DNA fingerprinting. Specific primers Lp1F/Lp975R targeting bsh gene were used for full length amplification of bsh gene from selected *L. plantarum* cultures. All the *L. plantarum* strains produced an amplicon of 1.0 kb while *L. plantarum* MBUL20 and 77 isolates produced an amplified product of approximate 2.0 kb. The bsh genes of selected *L. plantarum* strains namely *L. plantarum* MBUL91, 21, 11, 10, 90, 77, 20 and *L. fermentum* MBUL69 were cloned into pGEMT/pDrive cloning vectors and sequenced. Nucleotide sequence of 975 bp long bsh gene exhibited high level of sequence similarity to previously published bsh gene of other *L. plantarum* strains, while bsh gene sequence of *L. plantarum* 77 and 20 were found to be disrupted due to insertion of transposon like DNA element. Four amino acid motifs (YFGRN XD, NEXGLXXAGLNF, VXVLTNNPXF, and SXS RFV R XAF) located around the active site (C-2, D-19, N-79, N-172 and R-226), were highly conserved in all Bsh

proteins. The *bsh* gene of *L. plantarum* MBUL91 was subcloned into pET - 23d (+)/pET - 43.1a (+) expression vectors and expressed in *E. coli*, BL-21 (DE3) host. Expression of recombinant Bsh proteins (rBsh and Nus-Bsh) was induced with 0.1 mM IPTG at 25°C for 4 h and SDS-PAGE analysis revealed the appearance of ~37 kDa (rBsh) and ~98 kDa (Nus-Bsh) protein bands in induced fractions of Bsh-active clones. Recombinant Bsh proteins were further purified by ion-exchange (rBsh) and affinity chromatography (Nus-Bsh) and the identity of the expressed enzyme was confirmed by western blotting using anti-*C. perfringens* Bsh antibodies and characterized subsequently for its biochemical attributes.

To establish the role of Bsh in plasma cholesterol reduction and gut colonization, Sprague-Dawley (SD) rats were fed with a cholesterol enriched diet containing *L. plantarum* MBUL91 and 21 as dietary adjunct (>108 cfu/g) for six weeks. Compared with control group, plasma cholesterol, LDL-cholesterol, and triglycerides were significantly reduced by 18, 19 and 27% levels in the group fed *L. plantarum* MBUL91 while noticeable enhancement in HDL-cholesterol (13%) was recorded in same group. Faecal microbial analysis and RAPD banding pattern of faecal lactobacilli isolates after seven days of feeding trial termination clearly confirmed the presence of *L. plantarum* MBUL91 indicating that Bsh could play an important role in gastrointestinal colonization by probiotics. The present investigation suggests that *L. plantarum* MBUL91 has considerable potential to be used as a potential probiotic culture which can be effective to control hypercholesterolemic conditions.

**Expression of Immunomodulating markers in mouse model by probiotic *Lactobacillus plantarum* 91:**

A new probiotic candidate *Lactobacillus plantarum* 91 was used alongwith *L. plantarum* 5276, a reference probiotic culture to study the gene expression of pro-inflammatory and anti-inflammatory cytokines, the mediators of immune response in the host. The *in vivo* study carried out in mouse colitis model with 7 days probiotic treatment with Lp91 using Real Time PCR showed that the expression of TNF- $\alpha$  induced by Lp91 was 36.101 folds as compared to Lp5276 which showed only 16.89 fold decrease. Similarly, the IL-12 was down regulated by 1.14 fold only whereas Lp5276 resulted into an increase in 27.87 fold. The COX 2 gene was down regulated on induction with Lp91 and showed 3.671 fold decrease in the expression as compared to Lp5276 which showed 1.219 fold increase in the level of expression. The anti-inflammatory cytokine IL-4 was expressed 48.48 fold higher with Lp91 in comparison with Lp5276 that contrary to this showed 2.194 fold increase only. IL-6 was up regulated 6.322 fold by Lp91 and Lp5276 showed 4.695 fold increase. IL-10 was up regulated 70.64 and 1.489 folds by Lp91 and Lp5276, respectively. COX 1 was up regulated 2.265 fold with Lp91 but in case of standard Lp5276, it was down regulated by 1.47 fold. Histopathological examination of the sections of colitic and non-colitic gut treatment with probiotic cultures revealed that the thickness of mucous layer remained intact after colitis induction with Lp91 treatment but the control group of mice after colitis induction showed a clearly discernible damage or totally ruptured mucous layer and epithelial cells also got severely affected and showed altered morphology.



**Induction of bacterial and host specific gene expression in mouse model by probiotic *L. plantarum* 91 :** An *in vivo* gene expression study was conducted in Swiss albino mice using *Lactobacillus plantarum* 91 alongwith a *L. plantarum* 5276 (reference culture) to study the expression

of various genes that play a role during the intestinal passage and the host genes due to the interaction of bacteria with the intestinal mucosa by real time quantitative PCR. The *atpD* gene of *Lactobacillus plantarum* 91 was upregulated after probiotic treatment when compared with control

which showed the ability of these bacteria to tolerate acidic pH and transit through gut. The bile salt hydrolase gene of Lp91 was expressed 166.9 fold and this was much higher than that of the reference culture which showed an increase of 15.20 fold only. The *mub* gene of Lp91 and Lp5276 was increased 33.23 and 100.2 fold in the intestinal tract of mice. The expression of *MapA* was not influenced by probiotic treatment whereas the *MUC2* gene of Lp91 and Lp5276 was expressed 1.494 and 2.443 fold, respectively after 7 days of probiotic treatment. The histopathological examination clearly revealed the increase in mucus layer thickness after probiotic administration.

#### **Modulation of gene expression by probiotic lactobacilli under simulated *in vitro* gut environment :**

Expression of genes that play an important role in survivability of probiotic bacteria during their passage through hostile gut environment and colonization in the gut was investigated using quantitative Real Time PCR (RT-qPCR). The expression of *atpD*, part of  $F_1F_0$ -ATPase operon involved in acid stress conditions was studied using total RNA isolated from two putative probiotic *Lactobacillus plantarum* isolates (Lp9 and Lp91) grown in MRS at different pH values. Even at pH 2.5, the expression of *atpD* gene for Lp9 and Lp91 was up-regulated 1.4 and 2.0 folds at 30 min. and 2.8 and 3.4 folds at 60 min. for Lp9 and Lp91, respectively. Expression of '*bsh*' gene in probiotic bacteria helps to overcome the toxic effect of bile salts. In Lp91 '*bsh*' gene was up-regulated to 3.387, 4.253 and 3.426 folds at 1, 2 and 3% bile salts concentration in MRS broth at 37°C after 3 hrs. The expression of surface layer proteins '*Mub*' and '*MapA*' was up-regulated to 44.4 and 10.5 folds in Lp91 in MRS (pH 6.5) consisting of mucin- 0.05% (w/v), bile-1% (w/v) and pancreatin-1% (w/v) at 37°C. EF-Tu expression increased to 2.5 fold in MRS (pH 6.5) consisting mucin -0.05%, (w/v).

Colonization potentiality of *L. plantarum* Lp91 and *L. plantarum* Lp9 was also studied using *in vitro* HT-29 and Caco<sup>2</sup> differentiated colonic adenocarcinoma human intestinal epithelial cell lines. *L. plantarum* Lp91 was found to be the most adhesive strain as the adhesion percentage was  $12.8 \pm 1.56$  and  $10.2 \pm 1.09$  with HT-29 and Caco2 cell lines while *L. plantarum* Lp9 showed  $11.5 \pm 1.21$  and  $7.4 \pm 1.34$  adhesion percentages, respectively.

**Safety evaluation and probiotic potential of bacteriocinogenic strains of *Enterococcus faecium*:** The genus *Enterococcus* like other LAB has also been featured in food and probiotic

industry for decades but at the same time, some enterococcal strains present an emerging pool of opportunistic pathogens for humans. The present study was undertaken to assess the safety and probiotic attributes of 14 previously isolated bacteriocinogenic strains of *E. faecium*. Results showed that 57% of the isolates had sound *in vitro* biological barrier tolerance, bile salt hydrolase activity and ability to assimilate cholesterol from growth media. Further, safety of all these was evaluated in terms of presence of virulence determinants (*agg*, *esp*, *efaAfs*, *efaAfm gelE*, *cylA*, *cylB*, *clyM*, *cpd*, *cob*, *ccf*, *ace*), ability to produce biogenic amines; production of aggregation substance and susceptibility to killing by human immune system. The only virulence gene *efaAfm* was present in all the *E. faecium* strains. Among the different biogenic amines, only tyramine was produced by 9 out of 14 strains. In the clumping assay, none of the isolates produced aggregation substance, while in opsonophagocytic assay, 71% of isolates showed higher susceptibility to killing. Among all *E. faecium* strains, FH 99 was found to be the safest and hence was evaluated for immunomodulatory and hypocholesterolemic attributes through *in vivo* study. Probiotic *E. faecium* FH 99 fed mice group showed significantly increased level of lysosomal enzymes as well as phagocytic activity of peritoneal macrophages ( $p < 0.01$ ) and the number of IgA+ cells ( $p < 0.01$ ) in small intestine as compared to that of the control group. Total cholesterol, triglycerides, LDL-Cholesterol and atherogenic index were significantly reduced ( $p < 0.01$ ) in the blood plasma of probiotic FH 99 fed rats. *E. faecium* FH 99 can be used as a safe probiotic strain having strong immunomodulatory and hypocholesterolemic effect for food and probiotic preparations.

#### **Bacteriocin resistance among dairy pathogens and spoilage bacteria and strategies for its mitigation:**

Bacteriocins of LAB have been widely studied due to their potential use in food preservation as natural preservatives. One of the major concerns regarding the use of bacteriocins in food preservation is the development of highly tolerant and/or resistant strains which decrease the efficiency of bacteriocins as biopreservatives. In foods with a long shelf life, even a small number of these resistant cells can multiply to a very high number and thus, may lead to food-borne outbreaks and food spoilage. Knowledge of the characteristics of bacteriocin resistant variants and the conditions that prevent their emergence will help in determining optimal conditions for applications of bacteriocins in foods and minimize the incidence of resistance. In the present investigation, minimum inhibitory

concentrations (MIC) of different bacteriocins against some common dairy pathogens and spoilage bacteria were determined along with the isolation bacteriocin resistant variants. Effect of mild heat treatment on the susceptibility of resistant variants was determined. The synergistic effect of heat-treatment (45, 50 and 55°C) and Bacteriocins on the resistant cells and the wild type *L. monocytogenes* ATCC 53135 showed that there was no difference in heat resistance between wild type and bacteriocin resistant cells of *L. monocytogenes* at 45, 50 and 55°C when the cells were grown in the absence of bacteriocin. However, bacteriocin resistant variants were found to be more sensitive to heat than the wild type cells. Antibacterial efficiency of three bacteriocins from lactic acid bacteria Nisin, Pediocin 34 (produced by *Pediococcus pentosaceus* 34) and Enterocin FH 99 (produced by *Enterococcus faecium* FH99), was also evaluated individually and in combination against several Gram positive food spoilage and pathogenic bacteria. A greater antibacterial effect was observed when the bacteriocins were combined in pairs, maximal inhibition being reached when nisin was involved indicating that the use of more than one LAB bacteriocins in combination may be effective in inhibiting/ reducing the survival of pathogens.

#### 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:** Pediocin 34, Enterocin 99 and Enterocin 24 were produced from their respective bacteriocinogenic strains *Pediococcus pentosaceus* 34 and *Enterococcus faecium* 99 and 24 by culturing them in whey based media. Three different compounds viz. Starch, Casein and Dextran were tried as binders and different concentration of these binders were mixed with these bacteriocins (10,000 AU/ml) and Nisin. These preparations were then coated onto (15 mm x 15 mm) laminated metallic film, polyethylene film and butter paper followed by drying. The dried membranes were tested for their antimicrobial activity by placing them on the agar plates overlaid with indicator strain *Pediococcus acidilactici* LB 42. Bacteriocin with casein (@ 2.5 %) as binder showed relatively better activity on butter paper and laminated metallic film. Further, bacteriocin coated films were tested for their release kinetics in broth media. AMP films prepared using casein as binder were able to extend the shelf-life of paneer up to about 20 days at refrigeration temperature.

**Development of probiotic direct vat set (DVS) ferment(s) for short- set Dahi:** The present investigation was aimed to develop technology for production of probiotic direct vat set (DVS) ferment for short set dahi. Based on compatibility studies, four probiotic lactic ferments viz., *Lactobacillus bulgaricus* (Lb), *Lactococcus lactis ssp diacetylactis* (Ld), *Lb acidophilus* (Lt) and *Streptococcus thermophilus* (St) were selected. Lb and Lt were grown optimally in MRS while St and Ld in M17 broth. The cell biomass was harvested and suspended in 10% sterilized reconstituted NFDM and was used to select suitable cryo-protective agent and optimization of lyophilisation parameters. Lactose, glucose, glycerol, horse serum (HS) and whey proteins (WP) were added individually to evaluate their cryo-protective effect at varied concentrations of 2.5, 5.0, 7.5 and 10 % w/v. Glucose at 5.0 % level resulted in ~86 % survivability of mixed ferment followed by lactose and glycerol. The DVS obtained from cell suspension reduced to 1/7th of its initial volume and containing 10% (v/v) horse serum was lyophilised at  $-43 \pm 2^\circ\text{C}$  & 0.060 mm Hg for 2-3 hrs showed highest survival and performance. Prolonged time of lyophilisation under above conditions could not improve quality of DVS but marginally reduced water activity to 0.328 from 0.375 after 7 h. The highest cryo-protective effect of HS was confirmed by assessing the metabolic activity, sensory and rheological quality of fermented product prepared by using probiotic DVS. The milk was heated to 90°C/10 min, cooled, inoculated @ 0.5% DVS, incubated at 37°C and 42°C for different time intervals. Results indicated that DVS prepared from HS developed acidity at faster rate at 42°C, thereby, shortened curdling time, enhanced acidity development, improved sensory and rheological quality of probiotic dahi. Storage studies were conducted after packaging in glass vials and EVOH films at refrigeration temperature. The shelf life observations suggested that probiotic DVS ferment can be stored in EVOH packaging material for more than six months at 8°C and -20°C without affecting its performance.

**Development of technology for production of synbiotic Misti Dahi and yoghurt:** Investigations were conducted on compatibility of prebiotics (inulin and malto-dextrin) with probiotic as well as their influence on microbial, chemical, sensory, rheological quality attributes of synbiotic *misti dahi*. Standardized cow milk supplemented with 10 % sucrose and varied concentrations of prebiotics was boiled and cooled to 37°C. This was inoculated @ 1% with mixed probiotic culture and incubated at 37°C/18 h. The observations revealed that prebiotics upto 7.5%

(w/v) did not have any adverse effect on metabolic activities of selected ferment. The titratable acidity was 1.06 and 1.05% LA for malto-dextrin and inulin, respectively with corresponding pH values of 4.36 and 4.54 as well as more lactic counts as compared to control. Overall acceptability sensory score of 8.3 and 7.9 was recorded on 9 point hedonic scale of test synbiotic misti dahi. Improvement in sensory quality was corroborated by increase in rheological parameters like firmness, consistency, viscosity index and sticking force. Rheological attributes were more pronounced in case of inulin; however, this could not be perceived by sensory panel. Arginine, glutamine and super oxide dismutase activity in synbiotic product improved with increased prebiotic concentrations. Super oxide dismutase activity was found to be 520 nmol of oxygen scavenged/ min/g of product. Effect of prebiotics on probiotic attributes enhanced cell surface hydrophobicity and tolerance to ox bile. Similarly, malto-dextrin improved ox bile tolerance of mixed probiotic culture.

### 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 microbial assay for the detection of  $\beta$ -lactam antibiotics in milk using spores as biosensor :** A real time microbial assay based on  $\beta$ -lactamase enzyme using starch iodine as color indicator has been developed. The microbial assay is working on principle of non competitive enzyme action on inducer ( $\beta$ -Lactam) resulting in indirect reduction of starch iodine mixture through penicilloic acid. A comparison of the intensity of the test reaction with that of a control was taken as criteria to determine whether the sample is positive or negative (Patent Regd. #IPR / 4.14 .1/08073). The assay can detect specifically  $\beta$ -lactam groups in spiked milk with in 15-20 min at regulatory codex limits with negligible sensitivity towards non  $\beta$ - lactam groups. The presence of inhibitors other than antibiotic residues in milk did not interfere with the working principle of microbial assays. A significant correlation between microbial assay and receptor based assay (charm 6202) was established in survey work with raw, pasteurized milk and dried products with no false positive/ negative results. Spore suspension was found stable up to 5 months when stored under refrigeration conditions. The microbial assay (Rs 20.54/- test) is cost effective and can find immense application in dairy industry as "ON FARM" milk screening test for  $\beta$ - lactam group.

### Survey work on antibiotic residues and aflatoxin M1 in milk and milk products -Network project:

A survey work on two hundred and thirteen (213) samples which comprised of 152 raw Milk, 54 pasteurized milk and 7 samples of dried milk powder procured from organized and unorganized dairy sector was carried out for the presence of aflatoxin M1 and antibiotics residues using microbial receptor assay. Sixty three samples of raw milk procured from source-I showed the presence of Aflatoxins M1 varying from 0.025 to 4.5 ppb and 12.6% were in the range of 0.5 to 4.5 ppb. In another survey of 28 samples collected from source-II, aflatoxin M1 level was in the range of 0.0 to 0.9 ppb and 10.7% samples showed levels beyond codex limit of 0.5 ppb. M1 in fifty four samples of pasteurized milk procured from two different sources (I&II) varied in the range of 0.12 to 2.37 ppb.

The above 213 samples were also analyzed for the presence of different groups of drug residues namely  $\beta$ -lactam, Tetracycline, Sulpha, Gentamicin, Streptomycin and Erythromycin. Nine samples of raw and pasteurized milk were found to be positive for  $\beta$ -lactam group (4.2%) at codex limit of 4.0 ppb. Tetracycline at 100 ppb was found in 1.4 % samples of raw milk and dried powders. Incidence of sulpha group at 250 ppb level was detected in 3.75% raw and pasteurized milk as well as dried powders. However, gentamicin could not be detected in any of the samples procured in the current survey. Erythromycin at 40 ppb level could be spotted in 3.28% of the samples and streptomycin in 2.81% samples .The overall incidence of antibiotics and drug residues was 15.44%.

Ceftriaxone antibiotic, most frequently used for the treatment of endometritis in dairy animals was administered @ dose 6.72 mg/kg to diseased animals through intravenous (I/V) and intramuscular (I/M) route. The plasma samples were collected at different intervals ranging from 1 min. to 24 hrs. Milk samples were also collected from 12 hrs intervals to 72 hrs. In intravenous study, ceftriaxone concentration was 5.13875  $\mu$ g/ml with in 5 min. followed by decreasing trend up to 6 hrs and low level of 1.94 ppb was detected after 24 hrs. The presence of ceftriaxone could be detected up to 36 hrs in milk samples withdrawn from treated animals with corresponding levels of 191.0, 59.75 and 2.87 ppb. In corresponding intramuscular study, 4.61  $\mu$ g/ml of ceftriaxone was achieved within 30 min of injection followed by gradual reduction up to 0.6 ppb after 24 hr. The milk samples showed the presence of ceftriaxone levels 133.4, 3.9, and 1.05 ppb after 12, 24 and 36 hrs, respectively.

## DAIRY ECONOMICS, STATISTICS & MANAGEMENT

### Sustainable Dairy Farming through Self Help Group

Identifying and appraisal of livelihood opportunities and transfusing these ideas through development functionaries to potential entrepreneurs among the dairy farmers has to be changed through investment credit. The demand for credit in the predominantly inward-looking subsistence dairy economy is not forthcoming easily. For want of market exposure, entrepreneurial ideas and managerial competence, the dairy farm households become risk averse and have sometimes even given up economic opportunities. Credit facilitating self-employment dairy programmes have a significant role in evolving sustainable models for rural livelihood. Two studies were conducted one in Rajasthan and other in Haryana to study impact of dairy financing through self help group (SHG).

Based on 214 sample households from Jaipur district of Rajasthan, comprising of 84 members in *Self Help Groups*, 84 non-members who were predominantly involved in dairy activities and 46 members who were involved in agricultural activities during the year 2007-08 data were collected under the study on "Economics of Dairy Financing through Self Help Groups in Jaipur District of Rajasthan". The overall total transaction cost incurred by the sample SHGs was comparatively higher in (SHGs financed by bankers through NGOs and other agencies) Model-III (Rs.1301.45) as compared to (SHGs formed financed by banks) Model-I (Rs.1111.09) and (SHGs formed by formal agencies but directly financed by banks) Model-II (Rs.791.69). The per cent cost of credit to average loan amount was higher in Model-III (17.23) as compared to Model-I (13.66) and Model-II (11.07). Chow test showed that production functions of milk differed significantly between member and non-member households. The coefficient for the constant dummy was also found to be positive and significant in the milk production functions, which indicated positive impact of finance through SHGs on returns from milk.

Model-II performed better due to higher saving ratio (0.23), higher recovery rate (94.48 per cent) and low outstanding ratio (0.06) as compared to Model-I and Model-III. The estimated repayment capacity for dairy members was found to be higher (Rs. 31383.42) as compared to agriculture members (Rs. 26437.64). The average net income from buffaloes and crossbred cows was significantly

higher in member households (Rs. 3861.70 and Rs. 5153.80) than non-member households (Rs. 2609.75 and Rs. 3062.35), respectively. The overall labour employed per annum per household was significantly higher in the case of member households (387.37 man days) than the non-member households (246.40 man days). The main constraints faced by the members were lack of finance, marketing facility, infrastructure, knowledge of loan procedure, education and mutual understanding among the members. The study clearly indicated the positive impact of dairy financing on rural economy among the sample households, suggesting the need for extending the SHG network in Jaipur district, in particular and Rajasthan, in general.

Another study entitled as "Economic Analysis of Dairy Self Groups in Western Zone of Haryana" investigated the determinants of repayment performance of dairy SHGs and assessed the impact of dairy finance through SHGs on income from dairy farming in Western Zone of Haryana. Primary data were collected from 120 members of SHGs and 60 non-members during 2007-08. The study revealed that on an average each SHG contributed an annual amount of Rs. 14501 per annum towards saving. A group actually saved 74% of the planned saving. It was observed that 88% of the group members actually received internal loans. The magnitude of external loans was 4.34 times the savings of a SHG. Average repayment rates were worked out as 80% and 75% for external and internal loans, respectively. The overall comparative performance of NGO groups was better than the SGSY groups. Peer monitoring, group size and female percentage showed positive and significant effect on repayment performance of the SHGs whereas homogeneity and loan amount showed negative and significant influence. The decision of a household to participate in SHG was positively influenced by annual return from dairy and self-employment in off-farm activity whereas age of respondent and number of dependents had negative influence of dependents. Gross annual returns per household from dairy were significantly higher (Rs. 28256) for member households than non-member households (Rs. 26443). Credit through participation in SHG programme had shown significant positive impact on dairy income; hence, there is a scope for increase in dairy income for the weaker sections of the society through participation in the SHGs.

### Prospects and Scope of Enhancing Milk Production in Eastern India

Poor performance in management may be one of the main causes of least growth of milk production in Eastern India. West-Bengal, being one of the most important states in Eastern India, has been chosen under the study entitled “Economic Efficiency of Milk Production at Farm Level in Old alluvial Zone Of West-Bengal”. Based on 121 sample data collected in 2008-09, the analysis shows that in case of local cows, farmers can increase their milk production by 54% if they follow the techniques followed by best practiced farmers and efficiently allocate their resources. Similarly in case buffalo, the milk production can increase 55% if they follow the best management practices and in case of crossbred cow, their output can increase by 48% if they follow the best management practices. In case of buffalo, herd size and ratio of variable cost to total cost are the factors affecting economic efficiency. In the case of local cow, factors like herd size & farm income were the affecting factors. In crossbred cow, factors like education, farm income and ratio of variable cost to total cost were the factors affecting economic efficiency.

The allocative efficiency among the farmers was found to be low in the study area. Farmers are either overfeeding or underfeeding the inputs. Non availability of green fodder leads to overfeeding of concentrate/feed mixture in the area. The labour charges were high due to general practice of grazing followed by the farmers in study area. These factors ultimately lead to high cost of milk production & low allocative efficiency. Farmers can be encouraged for the cultivation of fodder crops by providing good quality seed of fodder crop and technical guidance. Farmers should be given demonstration on scientific dairy management practices and optimum quantity of inputs for each species of bovines. If farmers go for stall feeding instead of grazing, the economic efficiency may improve with most efficient use of resources. Farmers should be encouraged to rear animals with better genetic potential (e.g. crossbred cow instead of local cow). Imparting knowledge of scientific dairy management and efficient allocation of resources will help the farmers to bring out the best possible output from animal. This will not only increase the average productivity of dairy animals but also result into higher milk production. Keeping these factors in mind, policy implications are suggested to improve both technical and allocative efficiencies. There is a need to increase the availability of green fodder in the region.

### Suggested Tool of Milk Price Fixation

As the cost of milk production is increasing over time, milk producers find that the milk production is a losing enterprise. Prices paid by the union are not enough to cover the cost of milk production. Hence, the present study “Pricing for Cow and Buffalo Milk in Milk-Shed Area of Ajmer District Cooperative Milk Producers’ Union Limited” was undertaken with objectives to work out cost of milk production, to study the existing milk pricing policy, to estimate the bulk line cost and suggest milk procurement pricing for buffalo and cow milk. Bulk line is that level of cost which covered/reflected the cost of 85th percentile of the milk producers. Thus, it covered bulk of the milk produced by the majority of the farmers under study. Bulk line cost per kg. ‘buffalo milk fat’ was considered and proposed for pricing as a suitable base for pricing of buffalo milk. To achieve the above objectives a sample of 104 farm households in each season (summer, rainy, winter) from two villages of two zones in Ajmer district of Rajasthan was selected randomly. Tabular analysis was done. Per litre cost of milk production worked out to be Rs. 12.76, Rs. 9.59 and Rs.11.30 for buffalo, crossbred cow and local cow, respectively. The net returns were found to be positive for milch animals. In the mixed milk rate, average cost of per kg. mixed milk fat was Rs. 211.24 and society offered Rs. 280 per kg mixed milk fat rate, but 71% of the farmers could cover their cost. In the cow milk rate, cost of per kg. mixed milk fat was Rs. 235.05 and society offered Rs. 293.86 per kg cow milk fat rate. About 76.42% farmers covered the cost of per kg fat. It was found that mixed milk pricing fetched less prices to the farmers. Bulk line cost of 85th percentile of the farmers was Rs. 317.12 for mixed milk. If the union is inclined to pay mixed milk pricing rates it is suggested that it should pay Rs. 317.12 per kg fat in place of Rs. 280 per kg fat. Bulk line cost of 85th percentile of the farmers was Rs. 310.56 for buffalo milk. The proposed buffalo milk fat rate is also the same i.e. Rs. 310.56 per kg fat. The above mentioned tool has been considered where proposed rate of ‘buffalo milk fat’ was used as a base to determine two axis pricing for cow milk also. Out of five different fat: SNF weights, 1: 42/58 ratio was selected and proposed for cow milk as it covered cost of milk production of 82% farmers.

### Marketing of Milk and Milk Products in Organized Sector

Compared marketing of milk and milk products by co-operative and private sector dairy plants and

identified the constraints faced by them in Salem District, Tamil Nadu. Data were collected from one selected co-operative and one private dairy plant of Salem district for the financial year 2007-08. The product-mix of both the dairy plants was almost similar comprising of toned milk, standardized milk, full cream milk, butter, ghee and skim milk powder (SMP).

The marketing cost of products namely, Toned Milk, Standardized Milk, Full Cream Milk, Butter, Ghee and SMP was Rs. 3.97/litre, Rs. 5.27/litre, Rs. 4.35/litre, Rs. 32.56/kg, Rs. 50.69/kg and Rs. 52.76/kg, respectively for the co-operative plant and Rs. 3.56/litre, Rs. 4.09/litre, Rs. 4.20/litre, Rs. 34.87/kg, Rs. 52.75/kg and Rs. 45.52/kg, respectively for the private plant indicating that the marketing cost of Toned Milk, Standardized Milk, Full Cream Milk and SMP was lower for private dairy plant and the marketing cost of Butter and Ghee was lower for the co-operative dairy plant.

The marketing margins and marketing efficiency was higher for the private plant in Toned Milk, Standardized Milk and Butter whereas they were higher for the co-operative plant in Full Cream Milk, Ghee and SMP. The marketing efficiency of Toned Milk, Standardized Milk, Full Cream Milk, Butter, Ghee and SMP for the co-operative plant was 0.32, 0.33, 0.59, 0.63, 0.67 and 0.35, respectively while it was 0.56, 0.62, 0.54, 0.75, 0.55, and 0.30, respectively for the private plant.

Underutilization of transport vehicles ranked first position among private milk transporters. Lack of skilled manpower was the important constraint at co-operative chilling centers whereas under-utilization of capacity was found to be the main constraint at private chilling centers. Old milk plant machineries and equipments was the principal constraint during processing at the co-operative plant whereas under utilization of capacity was the most serious constraint at the private plant during processing. Lack of promotional activities posed a serious marketing problem at the co-operative plant level while inadequate retail sales outlets were found to be the principal constraint at the private plant level.

#### **Prediction of Economic Traits**

The data pertaining to various economic traits including reproductive and productive characters of Murrah buffaloes being maintained at Institute Livestock Farm, for the period 1990-2006 were collected and subjected to Least-Squares analysis. The comparison among sub-classes within years, seasons in each lactation and also parities for pooled lactation was completed. Constants for significant effects of non-genetic factors on reproduction and

production parameters were used for adjusting the data. Regression analysis technique was employed on the final dataset with all possible combinations of the different economic traits (lactation wise as well as overall) so as to isolate representative variables affecting the milk production. The datasets comprising of representative variables (for each lactation including overall lactation) were used for developing predictive models based on connectionist paradigms, viz., error back-propagation, radial basis function and generalized regression learning algorithms. Investigations carried out so far point towards the better potential of connectionist models over the conventional multiple linear regression technique. Connectionist models for predicting milk yield in Murrah buffaloes were developed, and exhibited better performance potential as compared to multiple linear regression technique.

#### **Predictive Model for Shelf-Life of Dairy Products**

Ready to reconstitute and ready to eat food products are gaining popularity. The future growth of processed dairy food market will be driven to a significant extent by such products. The loss of quality/shelf life of these shelf stable products is attributed to spoilage resulting from microbial, chemical, biochemical and physical changes that occur during storage of the product. Shelf life prediction models were developed at NDRI to help the manufacturers and also the food quality regulating agencies to critically evaluate the shelf life of such foods in the marketing chain. Shelf life prediction models based on chemical kinetics were product specific and were scarcely amenable to on line applications in the processing and retail environment. Artificial neural network (ANN) emerged as a novel tool to explain in a better manner the predictive aspects related to shelf stability and safety of dairy products.

#### **Statistical Evaluation of Economic Traits**

The data on meteorological parameters i. e; Maximum & Minimum Temperature, Relative Humidity, Rainfall etc. for past five years (2001-2005) alongwith breed wise information on Average Daily Milk Production of NDRI herd and No. of Milch animals (wet+dry) was collected. Temperature Humidity Index (THI) given by Johnson et al.(1963) was calculated for each of the five years data. In order to identify the important factors affecting the daily milk production, the data was subjected to Principal Component Analysis (PCA). The First Principal Component (PC1) showed maximum weight for Temperature Humidity Index (THI) (A.N.) followed by THI

(Mor.) while Wind velocity had the maximum contribution in PC2. Both these components explained 81 percent of the total variation in the data. THI (A.N.) and THI (Mor. ) was found to affect daily milk yield of Karan Fries (K.F.), Karan Swiss (K.S.) and Sahiwal cows adversely during all the years under study. However, its affect on Sahiwal was relatively less as compared to K.S. and K.F.

The data pertaining to various economic traits like age at first calving, monthly milk yield, lactation wise milk production in 305 days or less, lactation length, dry period, calving interval, service period etc. starting from first lactation to sixth lactation on the individual animals spread over a period of 25 years (1981-2005) maintained at

Dairy Cattle Breeding Division, NDRI, Karnal for Karan Fries, Karan Swiss and Sahiwal cows was collected. Stepwise regression analysis revealed that 6th, 5th and 3rd parity significantly affected the life time production in Karan Swiss and Karan Fries cows. In case of Sahiwal cows 5th, 6th, 1st and 4th parity significantly affected the life time production. Average lactation length significantly affected the average life time production in Karan Swiss, Karan Fries and Sahiwal cows. In order to forecast milk production, statistical time series modeling techniques - Double Exponential smoothing and Auto-regressive Integrated Moving Average (ARIMA) techniques were tried. Double exponential smoothing method was found to perform better in all the three breeds, on the basis of minimum root mean square error.

## DAIRY EXTENSION

### Human Resource Development of Rural Youth for Dairy-based Enterprises: An Action Research

Intervening Modules were developed and used for imparting training on various vital aspects of Scientific Dairy Farming Enterprise. The technical information was provided and in the recap sessions, questions, problems were discussed alongwith case studies to improve comprehension and decision making ability of the respondents. The knowledge level increased after training, as, all reported that Scientific Dairy Farming Enterprise was based on improved dairy farming practices (as against 46% before intervention) 78% believed it as a profit earning enterprise and 100% perceived that its success was based on adoption of new and improved technologies. The knowledge about improved feeding of animals, health care and better management, being major areas under scientific dairy farming, besides improved animal breeds, increased considerably. The knowledge on the concept of 'Value-added milk and milk products also broadened. The outlook that increasing shelf-life and adding new market dimensions were also related to value-addition was developed by 82.5 and 66% as against the initial 18% and 32%, of the respondents, respectively. Initially, the respondents opined that one of the most important factors in starting dairy farming, was the experience. However, this view was reversed after training, which led the respondents to believe that training was more important. Before training, 22% of the respondents had started a dairy-based enterprise and after intervention, this increased to 32%. All the respondents agreed that dairy-based enterprises gave employment, increased income

(96%), as against 42% before intervention, prestige in society (80%), security for the family (92%) and ability to take independent decisions (66%). The overall knowledge mean score increased from 16.32 to 29.73 and the overall awareness mean score increased from 21.91 to 32.43.

### Strategic Nutrient Supplementation for Enhancing Milk & Reproductive Performance in Dairy Animals under Field Conditions-An Action Research

Feed and fodder samples from selected farmers were collected and analyzed for chemical constituents such as CP, EE, NDF, ADF, Total ash, Ca, P, Mg, Zn, Cu. The nutrient, intake by each category of cattle & buffaloes were calculated and deficiency in energy intake of buffaloes & cows yielding 10-12 litre milk and more than 15 litre milk was observed. On the basis of the feeding schedule being followed by individual farmers, total 38 high yielding buffaloes and cattle were selected and supplemented 250-300 gms/day bypass fat and 50 gms/day mineral mixture 45 days prepartum. Observations were recorded for reproductive performance and milk yield of these animals. It was observed that milk production of experimental animals was higher than earlier lactation in both the trials besides other benefits. It was also observed that fat percentage in milk was more than earlier lactation. The milk production in early stage of lactation was high in the by-pass fat fed experimental animals as compared to control group. The body condition score of the experiment animals was improved greatly after feeding of by pass fat and mineral mixture. The peak yield of cow

and buffalo was increased approximately 4.00 and 3.00 litres, respectively. Similarly, service period was also reduced up to 30 days per lactation. The average weight of newly born calf was increased up to 3.66 kg per calf due to feeding of by-pass fat and mineral supplementation to pregnant dairy animals. Therefore, it could be inferred that by-pass fat technology is very useful for high yielding dairy animal.

### Impact of Self Help Groups (SHGs) on Growth of Dairy Farming in Haryana

The study revealed that member farmers possessed high level of knowledge (35.00%) and adoption (37.00%) whereas among non-members, it was 11% and 1%, respectively. The mean difference in knowledge and adoption between members and non-members was statistically significant. The SHGs formed by NGOs had more knowledge and adoption than the SHGs formed by DRDA's. The member farmers had positive attitude towards SHGs. Average lactation milk yield was found 1326.66, 1014.28 and 1078.72 litres in crossbred cows, local cows and buffaloes, respectively whereas in case of non-members, it was observed as 1011.11, 743.75 and 882.55 litres, respectively. Age at First Calving (AFC) in crossbred cows,

local cows and buffaloes of member dairy farmers was 32.06, 37.71 and 49.56 months, respectively, whereas in case of non-members, it was 35.55, 39.80 and 51.18 months. The Lactation Length (LL) in crossbred cows, local cows and buffaloes of member dairy farmers was 9.21, 7.78 and 10.05 months, respectively, whereas corresponding figures for non-members were 7.83, 7.1 and 9.39 months. The average Calving Interval (CI) in crossbred cows, local cows and buffaloes of members was 13.14, 13.64 and 16.17 months, respectively. In case of non-members, it was observed to be 14.27, 14.65, and 17.04 months, respectively. The most serious constraints perceived by SHGs members were low return on investment, unorganized market for milk and milk products and inadequate training facilities given to members of SHG. The study clearly reflected the success of SHG programme in relation to dairy farming.

### Retrospect and Prospects of Commercial Dairy Farming in Maharashtra

The present study revealed that majority of the respondents had small herd size upto 20 animals and annual income between Rs. 1.5 to 5 lakh. Most of the respondents had medium level of entrepreneurial behaviour. Well-developed

Mr. Karanvir, Village Subri was rearing a Karan Fries crossbred cow of 5 years age, which was unproductive due to persistent Corpus Leuteum (PCL) on right ovary. This cow was treated with the Estrus Synchronization protocol developed by DCP Division of NDRI and transferred at field level by Dairy Extension Division. As per the protocol, animal was administered PGF2 $\alpha$  followed by GnRH 60 hrs. later. Fixed time artificial insemination (FTAI) (i.e. after 72 hrs. of PGF2 $\alpha$ ) was performed accordingly. This animal which was causing much economic loss to the owner due to its unproductive status could conceive by this technology and delivered a healthy female calf. This cow produced 18 lit. milk per day.



Karanvir, Subri with his KF Cow

A farmer from Village Kulwehri, Mr. Subhash was keeping a buffalo which was not coming in heat for the last 8 months. During the ovarian palpation, a case of Persistent Corpus Leuteum (PCL) was observed. Animal was treated with estrus synchronization protocol giving PGF2 $\alpha$  followed by GnRH 60 hrs. later. Fixed time AI was performed after 12 hrs. of GnRH administration. By this technique, buffalo got conceived in 1st attempt and delivered healthy female calf and milk yield was observed 14 lit. per day. This technology helped the farmer to bring the buffalo in heat and conceive without further delay.



Subhash, Kulwahari with his buffalo

infrastructure for dairy development, efficient input support and services provided by dairy cooperatives were regarded as major strengths in western region than that of eastern region by the experts. High cost of inputs, low emphasis on clean milk production, lack of funds for extension activities were major weaknesses in western region, whereas lack of availability of green fodder, lack of emphasis on hi-tech dairy farming, scarcity of water, poor adoption of improved dairy farming practices were major weaknesses in eastern region as reported by the experts. Regarding use of ICT, most of the respondents used mobile phone followed by radio, TV, dairy information system, automatic milk collection system and information kiosk. Most of the respondents had medium level of adoption of recommended scientific dairy farming practices. Higher price for milk in urban market, timely payment by dairy cooperatives, remunerative price for milk by dairy cooperatives, adoption of improved dairy farming practices, timely extension support were regarded as major factors influencing commercial dairy farming. Remunerative price for milk and procurement by dairy cooperatives, government and private milk plant provided good prospects for commercial dairy farming as an entrepreneurial venture.

#### **Mixed Farming amongst Resource-Poor Farm Families in West Bengal - A Gender Perspective**

The farm families were found possessing an average operational holding of 0.49 ha and an average standard animal unit of 5.07017 (standard score). The average annual income of these families was recorded Rs. 32348/- in which 77.66% was contributed by crop sector and 22.34% was contributed by animal sector. Results showed that majority of crop cultivation activities were predominantly performed by men. Women were mostly involved in post-harvest operations and seed treatment. It was also observed that women devoted 26.66% of total time in rice cultivation. Most of the dairy farming activities were predominantly performed by women. Men were mainly involved in taking animal for grazing and cutting and carrying of grasses; chopping of straw; selling of milk and milk products; taking animal for treatment and service; purchase of concentrates and selling and purchase of animal(s). The data

indicated that women used to devote 72.12 and 57.14% of total time spent in daily and occasional dairy activities, respectively. The majority of the men and women were found having medium level of knowledge in mixed farming. Men were dominant decision maker in crop related activities, whereas women were dominant decision maker in dairy and household related activities. The results showed that men mainly obtained information from progressive/contact farmers, Krishi Prayukti Sahayaka (KPS) and television and women mostly obtained information from family members, KPS and television. The study revealed that farm couples mainly preserved the information by memorizing. Men used to evaluate the information based on experience of others, whereas women evaluated the information by discussion with spouse. 'High cost of inputs' and 'high cost of animal ration' were perceived by resource-poor farm couples as major constraints of crop cultivation and animal rearing, respectively. Women perceived 'difficulty to manage farm and household work together' as major constraint of active participation in farm activities.

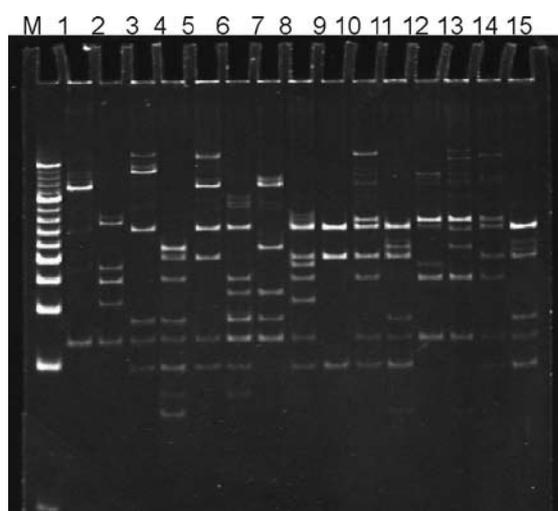
#### **Analytical Study on Milk Market Innovation System in West Bengal: A system Approach**

In West Bengal majority of the respondents (66.67%) fell in the medium level of milk selling as well as medium level of milk production (65.63%) category. A significant variation existed in different zones of West Bengal in case of milk production as well as milk disposal scenario. In West Bengal, 113 respondents made marketing decision after consulting family members. The Krishi Projukti Sahayaka played a very crucial role to transfer information to dairy farmers regarding marketing of milk as well as about the different aspects of agriculture in almost all zones of West Bengal. Private milk collection agents played much more important role in laterite and red soil zone compared to other zones. The major constraints found in West Bengal with respect to milk marketing were: lack of finance, market intelligence and news, low price of liquid milk, malpractices in purchasing methods, delay in payment, distantly located milk collection centers, low level of contact with extension agency, lack of storage facilities, transport facility, regulated market and cooperatives, market facilities and unawareness of clean milk production.

**Faster Multiplication of Superior Germplasm of Region Specific Breeds of Cattle & Buffaloes through Intervention**

**Characterization of bovine MHC BoLA DRB3.2 alleles employing PCR-RFLP:** Characterization of BoLA DRB3.2 alleles under bovine MHC locus was carried out in Hallikar and Deoni breeds of cattle. DNA was isolated from whole blood using high salt method. Primers specific for exon 2 of BoLA-DRB3 gene were used to amplify the region by hemi nested PCR. The 284-bp amplified product was separately digested with restriction enzymes viz., RsaI, HaeIII, and BstYI. The RE digested PCR products were electrophoresed in 8% native polyacrylamide gel electrophoresis, with size standard O' RangeRuler™ 20bp DNA ladder (Fermentas).

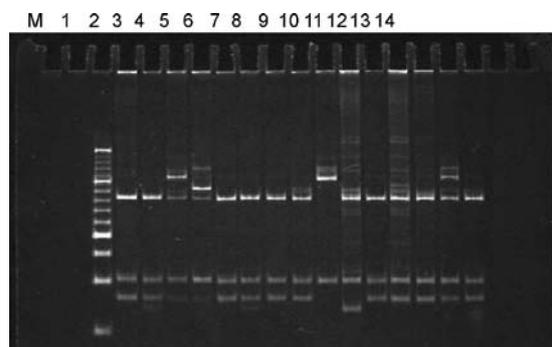
In the present investigation, fifty three DNA samples were screened from Hallikar breed maintained at State Govt. Farm, Kunikanahalli, and farmers' herds surrounding Bangalore. In these animals, a total of 96 BoLA DRB3.2 allelic patterns were observed, of which 26 unique allelic patterns fell under standard BoLA nomenclature. The highest observed allele was DRB3.2\*11 with a frequency of 17.7%. On the contrary nine alleles (DRB3.2\*8, \*10, \*12, \*13, \*18, \*19, \*33, \*42, and \*46) were observed at the lowest frequency of 1.0%. One new allele was also detected with a frequency of 3.1% to the population (Fig 1).



M - 20-300bp DNA Marker, Lanes 1 to 14 - RsaI RE samples  
Fig 1. PCR-RFLP Patterns using RsaI Restriction Enzyme in Hallikar breed

In Deoni cattle from NDRI herd 72 DNA samples were screened for BoLA DRB3.2 polymorphism. A

total number of 132 allelic patterns were observed, of which 28 unique allelic patterns fall under standard BoLA nomenclature. The most frequent allele observed was DRB3.2\*11 with a frequency of 16.6% followed by DRB3.2\*6 and \*9 with the frequencies of 12.8 and 12.1%, respectively. Nine alleles were observed at the lowest frequency of 0.7%. Four new alleles with a frequency of 0.7% and another new allele with a frequency of 1.5% were observed in this breed (Fig 2).



M - 20-300bp DNA Marker, Lanes 1 to 14 - RsaI RE samples  
Fig 2. PCR-RFLP Patterns using Hae III Restriction Enzyme in Deoni breed

**Molecular characterization of prolactin gene (exon 3 & 4):** In this study, 72 lactating Deoni cows and 62 HF cows were screened for PCR-RFLP patterns for Prolactin gene (exon 3 and 4). The PCR product of 156 bp exon of PRL gene digested with RsaI cleaved into two bands of 82 and 74 bp in B allele whereas A allele lacked RsaI site. Thus, three genotypes viz., BB, AA and AB with the frequencies 0.32, 0.09, 0.58 were observed (Fig-3). The estimated allelic frequencies of A and B alleles were 0.39 and 0.61, respectively. Similarly, in exon 4 with 294 bp PCR product digested with

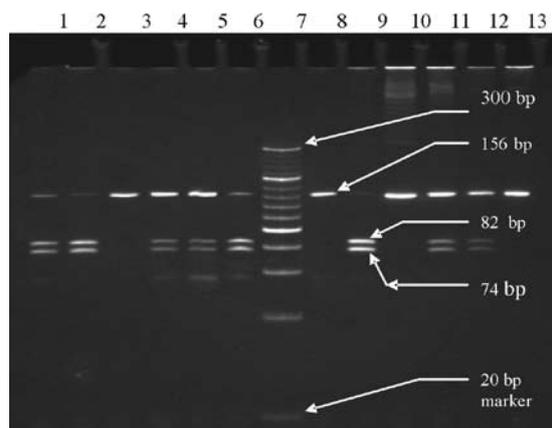


Fig.3 PCR- RFLP patterns of Prolactin gene Exon 3 using Rsa I in Deoni Cattle Lanes 1 to 6 & 8 to 13: Deoni samples Lane 7: 20 to 300 molecular marker

RsaI, three genotypes viz., BB, AA, and AB were found with the frequencies of 0.18, 0.09 and 0.72, respectively. Corresponding allelic frequencies of A and B were 0.45 and 0.55, respectively. The milk yield of first five lactations were recorded in Deoni animals. The milk samples were collected for estimating fat and protein per cent. In these animals, the mean first lactation milk yield was recorded as  $847.28 \pm 47.25$  kg with a lactation length  $200.41 \pm 9.07$  days. The overall lactation milk yield recorded was  $911.14 \pm 51.60$  with a lactation length of  $206.03 \pm 8.48$  days. The mean fat and protein percent were recorded as  $5.87 \pm 1.08$  and  $4.92 \pm 0.15$ , respectively.

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

Performance of graded Friesians in Punjab under intensive production systems: A total of fifteen commercial dairy farms maintaining graded Holstein Friesians located around Ludhiana, Moga, Mohali and Chandigarh were visited and personal interviews with the farmers were conducted. The performance of these farms housing more than 2100 animals was evaluated. These farms have on an average 65 milch animals, 22 dry, and 55 young stock female. The milking (wet) average ranged from 12 to 32 with a mean of 21.00 kg. The average peak yield ranged from 20 to 42 kg. The animals that attained peak yield of >40 kg constituted 25 % of the milch stock. All the farms studied have characteristic high roof housing, milk parlour suiting to the herd strength, chaff cutter, spacious mangers and water bins. Feeding is well balanced with advice on feed formulation from scientists and other department officials. The balanced feeds are supplemented by sodium bicarbonate to reduce acid load, feeding whole fat as extra source of energy and a large combination of cakes to cover all amino acids. For high yielders (>20 liters per day), the concentrates and silage are fed *ad-libitum*. The general feeding regime at these farms involves supply of 18.86 to 20.58 kg dry matter, 1.61 to 1.86 kg DCP and 47.87 to 52.91 Mcal of metabolizable energy per milch cow. Round the year, silage feeding is being preferred over fresh greens as the latter is considered labour intensive on day-to-day basis. Farmers are adopting innovative silage making practices with “above the ground” rectangular bins supported by thick mud infused brick walls. The intensive management inputs coupled with expert advice are resulting in good conception rate, regular calving, healthy growth of young stock and higher yields.

#### 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:** Samples were collected from different areas of Nagpur city. Samples were evaluated by 13 judges, and based on the evaluation following typical characteristics of Khoa jalebi were identified: Khoa jalebi has round to irregular shape with two or three coils, resembling the traditional jalebi. However, the coils are thicker in the case of khoa jalebi. The colour is dark brown to very dark brown with light and dark shades appearing on surface in many pieces. The body of the khoa jalebi is 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 caramelised and comparable to that of khoa - gulab jamun. The jalebi pieces were varying in the width, weight and coil thickness. The physico-chemical characteristics of the collected samples were (%): Moisture 17.48 - 21.96; Fat 9.86 - 16.6; Ash 1.14 - 1.55; Protein 5.50 - 9.76; Lactose 12.4 - 13.9; Sucrose 26.2 - 27.4; Water activity 0.721 - 0.798; pH 5.84 - 6.65. The hardness value as indicated by the force required for the needle probe of Texture Analyser to penetrate 10 mm into the product surface ranged from: 449 - 1420 g. The hardness of one sample, which was evaluated as very hard, ranged from 1860 - 2466 g. The results indicated that the product was liked with pleasant, nutty flavour, and it possessed characteristics different from those of traditional maida jalebi.

**Development of functional whey drinks for health promotion:** Cheese whey was used for proteolysis using 0.01% Flavourzyme at pH 7.0 for 30 min at 50°C to hydrolyse to 5-7% level. After stopping the reaction by heating it to 80-85°C for 5 min, this proteolysed whey was used for further hydrolysis of lactose using 0.01%  $\beta$ -galactosidase at 30°C for 30 min at pH 4.5 to obtain 25-35% hydrolysis lactose for whey drink preparation. pH of whey was adjusted from 7.0 to 4.5 by using citric acid before hydrolysis of lactose. As reported, 25-35% of lactose hydrolysis may be suitable for lactose intolerant people to consume whey drinks, hence this hydrolysed whey was used for further palatable whey drink preparation. Whey became bitter after hydrolysis of protein. Among starch (1&2%), sodium alginate (0.1&0.2%), glycine (1%) and guar gum (0.1%) addition of 1% edible starch in the hydrolysed whey not only reduced the bitterness but also increased the viscosity of the

drinks. Incorporation of mango pulp (4-6%) and sugar (7-10%) increased the acceptability of the drinks. Formulation of whey drink preparation from this hydrolysed whey is in progress to increase the consumer acceptability.

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

**Production of Kashi Halwa:** *Kashi halwa* is an ethnic sweet delicacy popular in many parts of India. Attempts were made to standardize the technology to enhance the shelf-life of *kashi halwa*. Pre-cooking of grated ash gourd at 15 psi pressure for no hold has improved textural properties of the product and also reduced the process time. Use of 30% sugar (w/w based on ash gourd) was found to produce kashi halwa with optimum sensory qualities. Use of 10% each of khoa and ghee resulted in production of kashi halwa with optimum sensory attributes. Addition of khoa at the final stages of halwa production was found to retain granular texture of khoa in halwa. The chemical analysis of kashi halwa revealed that the product had fat content of 17.3%, protein- 3.2%, sucrose- 44.1%, lactose- 3.3%, ash 0.98%, fibre- 0.39% and energy value of 358.1 kcal per 100 grams of halwa. The fresh halwa had water activity of 0.835 and acidity of 0.28 milliliter of NaOH per ten grams of product. The product packed in LDPE pouch had shelf-life of 14 days while that packed in multilayered pouch had shelf life of 21 days at 35°C. The thermal treated sample (steaming for 5 and 10 minutes, and pressure treating at 5 psi for 5 minutes) was found to improve the shelf-life to more than 90 days. The fresh product processed at 15psi for 15 minutes was more browner compared to other treated sample and the browning increased during storage. No significant changes in shelf-life were found between other thermal treatments. The product had good microbiological quality even at the end of 90 days of storage.

### Millet Products

**Foxtail millet and concentrated whey based health food:** Study was conducted for the production of foxtail millet and concentrated whey based health food product. The foxtail millet containing 11.50, 4.30, 12.80, 68.61, and 3.35% moisture, fat, protein, carbohydrates, minerals, respectively, concentrated paneer whey containing 15.08, 0.56, 1.49, 1.47 and 13.87 % of TS, fat, protein, ash, and lactose, respectively and 0.5% of salt mixture was cooked in a pressure cooker, to obtain the product, called *Nuchhu* in semisolid consistency like porridge. The

trials were carried out to check the suitability of cheese whey for the product, but sensory results revealed that paneer whey was more suitable. An acceptable product could be produced by using foxtail millet and concentrated whey with 15% TS in the ratio of 1:7. Furthermore, to improve the shelf-life, the pressure-time combination of 15 psi/20 min was employed for in-packet sterilization of the product. The product samples were stored at 30°C & 37°C and evaluated for sensory, microbiological and physico-chemical characteristics at different intervals. Gross composition of final product was observed to be - Fat 1.08, Protein 3.57, Ash 0.95, Carbohydrates 17.83, and moisture 75.20%. The paneer whey based porridge prepared with pressure-time combination of 15 psi/ 20 min had a shelf-life of 31 days at 30°C and 24 days at 37°C storage. The approximate cost of production of the product is Rs. 30.00 per kg of the product.

**Ragi - Milk Drink:** Modifications were made on the earlier reported method of preparation of Ragi - milk drink to reduce the processing time, to simplify the procedure and to improve the organoleptic properties of the final product. Unlike the earlier method wherein the grains were soaked for 48 h, the grains (160 g) were soaked in water only for 12 h. After removing the water, the soaked grains were ground and extracted with two litres of water. The suspended solids were removed to get a clear Ragi - milk extract. The extract had the following chemical composition - Total solids, fat, starch, protein, ash, calcium, and magnesium. Milk and sugar were added to the clear Ragi milk extract followed by boiling for 5 min. The product prepared by using this modified method gave good taste with pleasant aroma of ragi.

To enhance the shelf-life of the product, it was packed in glass bottles, crown capped and heat sterilized at 15 lbs for 15 min. Sterilization imparted slight brown colour and pleasant caramel flavour to the product. It also improved viscosity of the product. The product remained well with acceptable organoleptic score up to one month, after which it lost the freshness of flavour. However, no syneresis was visible in the product even after one month of storage.

### Dietetic Sweets

**Green gram dal - poppy seed payasam:** The ingredients used to prepare this payasam were green gram dal, poppy seeds, skim milk powder and sugar. The proportions of the ingredients were adjusted to get the desired flavour and consistency of the final product. The method of production was as follows:

Dal roasted to a light brown colour was ground to get coarse powder. The larger particles removed by sieving were further ground to smaller size. Poppy seed powder was also prepared in a similar way. Required proportions of dal, poppy powder and SMP were mixed to prepare dry mix base.

Payasam was prepared by reconstituting different levels of dry mix base and sugar in potable water. This product with a total solid level of 30% of which 50% was sugar had most acceptable quality. Trials were made to replace sugar with sucralose, an artificial sweetener keeping the solids level of other ingredients same as that in control. It was observed that the consistency/viscosity was high with the artificial sweetener. Hence, T.S. level was lowered to get desired consistency in sugar free samples. Payasam with 12.5 % dry mix base and 40 mg sucralose compared well with the control with respect to flavour and consistency.

Pieces of nuts like cashew, pista were roasted to light brown colour with minimum amount of ghee and added to the product at 2 to 3% level. This increased the acceptability of the product. Evaluation of the sugar free product for keeping quality is in progress.

**Studying the effect of non-nutritive sweeteners on quality of shrikhand:** Chakka made by using skim milk containing 9% SNF was found suitable for production of Shrikhand. Use of higher level of SNF in milk resulted in powdery flavor and grainy texture in Shrikhand. Between the two acidity levels in chakka tried, 1.6% LA in Chakka was found most suitable for Shrikhand production. In order to obtain desirable sweetness in Shrikhand, the individual artificial sweeteners (at maximum permitted levels) in combination with different levels of cane sugar were tried. The results indicated that sucralose at 750 ppm with 50% of cane sugar, saccharine at 500 ppm with 75% cane sugar, aspartame at 200 ppm with 75% of cane sugar were found most acceptable levels for production of shrikhand. No significant difference in sensory scores was observed when compared to control Shrikhand. The Shrikhand samples thermised at 65°C for 15 min was found to have the shelf life of 5 days at 37°C and 30 days at refrigerated temperature (6 – 8°C). The microbiological studies indicated that the yeast and mold counts were < 30 / g at the end of 5 days at 37°C, and < 30 / g at the end of 30 days of storage at refrigerated temperature and coliforms counts were < 30 / g and < 30 / g, respectively. The chemical composition showed that none of the Shrikhand samples prepared by using artificial

sweeteners had TS conforming to PFA standards. However, the fat, protein, sucrose and ash contents of the samples conformed to the standards.

**Technology of dietetic chhana podo production:** Chhana podo prepared by using 2.0% milk fat was the best product among 1.0, 1.5, and 2.0 % fat. Optimized fat level was used with different binding agents like maltodextrin, suji and sago at 10% and 15% for manufacture of podo. Podo prepared with maltodextrin and sago showed moist appearance with unbaked body and off flavour. Suji with 10% level was selected to replace sugar with artificial sweetener. Since aspartame had lost its activity on high baking temperature in acidic medium and use of saccharin sodium showed some after taste, podo prepared with sucralose was found to be the most suitable and similar to control. Among 50, 75 and 100% levels of sugar replacement by sucralose, 50% level was adjudged to give product very similar to control podo in terms of porousness in body & texture and caramelized cooked flavor. Podo baked with medium temp-time (115-135°C for 140-145 min) was found to be optimum.

The calorie content of dietetic podo was 25% lower than control. The pH of dietetic podo was slightly higher than control but hardness was observed to be lower than control. Coliform count was nil and Y & M count was found to be 10 -15 /gm in fresh product. Shelf -life of dietetic podo was 3 - 4 days and 7 - 8 days without and with 0.15% potassium sorbate, respectively at room temperature when packed in polyethylene pouches. The corresponding shelf life of control podo was 7-8 days and 11-12 days, respectively. Dietetic podo without preservative had shown 16-17 days of shelf- life at refrigerated temperature while all others had shown more than 3 weeks.

**Active packaging of chhana podo and kunda for enhanced shelf-life:** Chhana podo and Kunda were packed in EVOH laminate (LDPE/ BA/ EVOH/ BA/LDPE (140 μ)) and PET laminate (LDPE/ BA/PET/BA/ Al foil/BA/LDPE (134 μ)) pouches (175X150 mm) and under different atmospheres containing air, vacuum, 100% CO<sub>2</sub>, 100% N<sub>2</sub> and ZPT 100 MBC (Ageless oxygen scavenger). The packaged samples were stored at 30°C for up to 80 days. Vacuum packaging did retard microbial growth, but adversely affected the textural and sensory attributes of both products. Oxygen absorber coupled with high-barrier EVOH and PET laminates extended the shelf-life of Chhana podo to more than 45 days and that of Kunda to more than 80 days without the appreciable loss of sensory and textural characteristics.

**Development of spiced and herbal buttermilk drinks:** A series of trials was conducted for selection of the type of milk, lactic culture and extent of dilution of *dahi* for preparation of buttermilk drinks with desired flavour and texture characteristics. *Dahi* was prepared from double toned or skim milk by using probiotic mixed culture (Lb + St) which produced high acid. Churning and dilution of dahi 2 or 3 times produced buttermilk with desired sensory quality. A clean acid flavour, smooth viscous body and absence of whey separation are the important characteristics of a good quality buttermilk. The use of permitted stabilizers in buttermilk drink was studied to improve the organoleptic properties.

The stabilizers were more effective when added after fermentation rather than before fermentation of milk. Though several stabilizers increased consistency of buttermilk, maximum consistency was obtained with 1:1 blend of locust bean gum (LBG) and Carrageenan. Addition of stabilizers decreased the whey separation and increased viscosity in thermized buttermilk. While LBG was the most effective stabilizer in increasing the viscosity, a 1:1 blend of pectin + LBG was the most effective in preventing whey separation while increasing viscosity, in the thermized product.

Methods were standardized to incorporate certain spices such as ginger, pepper, cumin, cardamom, turmeric into butter milk to prepare spiced butter milk drinks. Different levels of the finely ground spices were added to butter milk alongwith salt. The samples were subjected to sensory evaluation to optimize the levels of the spices to be incorporated into butter milk. It was observed that ginger, pepper and cumin when added at a rate of 0.25% and cardamom at a rate of 0.05% gave product with acceptable quality. The required level of the finely ground spices like ginger, jeera and pepper were boiled in a small quantity of water (200 ml) and the filtered extract was added alongwith the remaining quantities of water being used for dilution of dahi. Use of certain combinations of the spices like ginger with cumin gave acceptable sensory properties to the butter milk drinks.

*Tulsi* and *pudina*, the house hold herbs, are well documented to have general health beneficial and therapeutic properties. Therefore, an attempt was made to develop buttermilk drinks incorporated with *tulsi* and *pudina* extracts and having satisfactory organoleptic properties. Buttermilk was prepared using high acidic low fat dahi by diluting it 1:2 times. The optimum level of *tulsi* and *pudina* extracts each having 2.0 % TS to be incorporated into butter milk to give acceptable flavour score was

standardized. Butter milks having *tulsi* extract at 4.0 % and *pudina* extract at 5.0 % level were judged the best based on flavour attributes. To enhance the taste of the drinks, ginger powder @ 0.1 % and salt @ 0.6 % were added to the product. Stability of the product improved considerably with the addition of 0.15 % sodium alginate to milk before fermentation. Further studies on the development of buttermilk drinks are in progress.

### Nutritional and Therapeutic Aspects of Milk and Milk Products

**Development of probiotic direct vat set (DVS) ferment(s) for short set Dahi:** For the development of probiotic freeze dried cultures, four organisms viz. *Lc. lactis* ssp. *diacetylactis* (Ld), *Lb. bulgaricus* (Lb), *St. thermophilus* (St), *Lb. acidophilus* (Lt), with established probiotic characteristics were selected. A combination of cultures was required for producing an effective freeze dried culture for dahi manufacture. For prolonged viability of the cells during fermentation, processing and storage, the compatibility of cultures is very important factor. Hence, compatibility studies were carried out on the selected cultures. Twelve combinations of the cultures were grown on MRS media and no zones of inhibition were observed, which indicated that all the cultures were compatible with each other.

For maximum growth and for obtaining maximum number of bacterial cells, growth conditions such as pH, type of growth media and temperature were standardized.

Freeze drying process resulted in destruction of cell membrane leading to loss in viability of the bacteria. Hence, use of cryoprotective agents was examined for improving survivability of ferments during freeze drying. Two categories of cryoprotective agents were tried, viz. carbohydrate: lactose, glucose and glycerol and protein: whey proteins and horse serum. The survivability recorded by these cryoprotectants was above 90% on MRS and M17 media. The cryoprotective effect of these agents was also confirmed by assessing the metabolic activity of DVS. Among the cryoprotective agents examined, whey protein was selected due to the restriction on use of ingredients from animal sources.

Lyophilisation parameters with respect to cell concentration and duration of freeze drying were investigated. Observations suggested that the cell concentration to 1/7 of its initial volume and freeze drying for 2-3 hrs resulted in survival rate of about 98%, and prolonged time of lyophilisation under above conditions did not show any further

improvement in the survival rate. Hence, freeze drying time was restricted up to 3 hrs.

Freeze dried cultures were packaged in two packaging materials viz. EVOH and polythene, and stored at three temperatures: 20°C, -20°C and 8°C. Performance evaluation of DVS ferments during storage for dahi preparation was conducted. The sensory and textural quality of dahi was examined to assess the efficacy of the stored cultures. The results revealed that DVS culture stored at 8°C even up to seven months could be used for preparation of dahi with good organoleptic properties.

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

**Heat and mass transfer phenomena during manufacture of *gulabjamun* and *pantao*:** The heat penetration pattern, moisture loss, fat/oil absorption and changes in textural characteristics, crust colour and ball volume during frying of *gulabjamun* were determined. For *gulabjamun*-making, the dough was prepared by blending khoa (65% moisture on dry matter basis), refined wheat flour (12%) and baking powder (0.8%) on wt. basis. Balls of 15 g weight were made from the dough, and fried in an electric-powered mini fryer (6 L capacity). Frying was done at three temperatures viz. 135, 145 and 155°C. The core temperature of the balls during frying was recorded at 10 s intervals using a needle-type thermocouple. Samples were drawn at specified intervals for the determination of the moisture loss, texture, crust colour and volume.

Textural profile analysis indicated that the hardness decreased gradually from the surface towards the core of the ball. The colour of the dough was determined by scanning the product in a flat bed scanner and importing the picture into Adobe Photoshop software. The lightness and hue parameters decreased with increasing frying time and temperature. Conversely, for all oil temperatures, the chroma values showed an upward trend till 90-120 s of frying, and thereafter it decreased consistently.

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

**Dairy Production Systems of Kerala State:** A survey was carried out on dairy production systems of Kerala State. The study revealed that Kerala dairy farmers are facing the constraints

of high cost of roughages and feed and feeding related reproductive problems. The breeding policy of introduction of purebred HFs has to be discouraged as farmers do not have resources to maintain these high yielding animals. In Kerala crop production is limited to paddy cultivation. Under existing conditions of high cost of labour and other inputs paddy production, most of the farmers thrive on intensive plantation agriculture. As a result the farmers depend on import of crop residues predominantly paddy straw from Tamil Nadu. Very few farmers grow green fodder (<5%), that too on a meagre cultivable area.

Animals therefore depend on concentrate for their nutrient requirements. Industrial agricultural wastes with high moisture (Tapioca, Pine Apple, Maize waste etc.) constitute bulk of concentrates. In general feeding is imbalanced and it is recommended that Government of Kerala or farmers themselves have to take all necessary steps to improve feeding. State extension agencies should educate farmers on critical concepts of balanced feeding. Based on the study, the alternate strategies are suggested as follows:

- Popularise the concepts of “complete feed”.
- Establish feed mixing units in border districts of Tamil Nadu /Karnataka and import ready mix feed.
- All water logging lands in Kerala can be converted into ‘Para Grass fields’ thus improving fodder availability.
- Farmers should be educated on importance of fitmely breeding.
- Farmer should be educated that for their existing level of inputs, a smaller body sized breed like jersey is best suited.
- The animal housing layouts need reorientation. To the extent possible animal housings should be in open areas.
- Regarding disease control, it is observed that Foot and Mouth disease is well under control. However, the incidence of Brucellosis has to be controlled by vaccination .

### **Application of Energy Monitoring and Targeting (EMT) System in a Dairy Plant**

The present study was undertaken to implement EMT in a commercial dairy products plant

viz., Nandini Milk Products (NMP), Bangalore. General technical details of the dairy plant and details on the consumption of various utility services of the unit, including, water, steam, refrigeration, fired heaters, compressed air etc, and also the production details, such as, installed capacity, actual production, type of production etc., were also recorded, with a view to identify the major energy consuming units and the present consumption pattern for the utilities.

The data was analyzed to compute the average monthly specific energy consumption pattern of the plant. It was observed that the energy consumption peaked during the summer months and was mainly attributed to the increased production of energy intensive products like sterilized flavoured milk. Cumulative SUM (CUSUM) analysis of the actual energy consumption data against the baseline energy use was also carried out for the two years (2007-2008).

Also, the general technical details of the dairy plant are being recorded with a view to identify the major energy consuming units and the present consumption pattern for the utilities. A proforma was prepared for recording the general details on the consumption of various utility services of the unit, including, water, steam, refrigeration, fired heaters, compressed air etc, and also the production details, such as, installed capacity, actual production, type of production etc.

#### **A Profile Study on Nutraceutical and Therapeutic Use of Milk and Milk Products in Traditional Systems in Southern States / Region**

Data collection was carried out in selected sampling units. The researchers, academicians and practicing doctors of selected R&D units, educational institutions and selected centres respectively were contacted for this purpose. Visits were made to the selected sampling units in Bangalore, Hyderabad and Coimbatore and discussion was made with the resource personnel. Data collection was done with the pretested questionnaire for relevant information on the selected parameters for the documentation of the needed data from the selected sampling units. The summary of the data collected so far from the resource persons is as follows:

The types of milk being utilised by the traditional medicinal systems viz., Ayurveda, Unani, Siddha & Homeopathy system of medicine include Milk of Cow, Buffalo, Goat, Human, Camel, Sheep, Elephant, Horse, Ass, Dog, Cat and Monkey. The

milk products used in these systems include curd, buttermilk, butter, ghee, cream, whey and paneer.

Ayurveda uses Ghee for preparation of many kinds of medicated ghee called “Ghrithm” viz., Pippaladi Ghritha, Tailvaga Ghritha, Vasa Ghritha, Palasa Ghritha, Asvagandha Ghritha and Milk foam also in some preparations. 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.

As expressed by the resource persons contacted, the milk and milk-based products are used in the traditional medicinal systems for a wide range of purposes including both nutraceutical and therapeutic purposes. As opined by the resource persons, the milk and milk products play a passive role as adjuvant, co-factor, medium or carrier in preparations of the traditional medicine or active role as rejuvenator, vitaliser, astringent, stimulant, appetizer, aphrodisiac, exhilarant, haemopoietic, laxative, carminative and diuretic. In Ayurveda, milk and milk products are used extensively for external and internal application. Milk, ghee and butter are considered cold in potency in Ayurveda and curd, buttermilk & whey are considered hot in potency. In Siddha, milk and ghee are used as main drug; butter, curd and ghee are used as ancillary drug.

Milk and milk products are either incorporated directly or pre-treated before use in the medicinal formulations of traditional medicinal systems. In Unani system Paneer Maya is one such treatment product. Heating and Re-heating treatments are followed for some Ayurveda preparations. Specific extraction procedures are followed in case of Homeopathy and Siddha systems.

In Ayurveda, in addition to the therapeutic role, specific role of medicines was outlined for milk and milk products as they enhanced the property of main drug in body for quick absorption; improved the palatability of medicine and compensated for potency of medicine i.e., hot medicine were accompanied by milk, ghee and butter and cold medicine accompanied by curd, buttermilk and whey. Further work is under progress.

**Studies on organic milk production system in the plains of West Bengal**

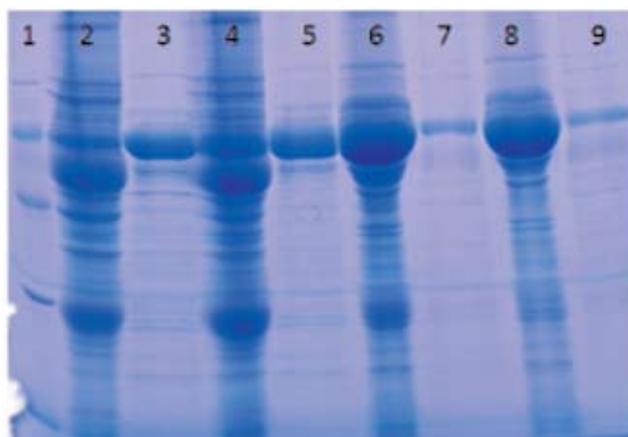
The milk production performance of the experimental cows reared under organic farming system increased in 7 out of 12 cows. There was drastic drop in milk production in case of three cows. The milk yield of the remaining two cows was slightly lower compared to the previous year. The reproductive performance of most of the cows was comparable with the previous year.

The experimental plots were prepared with Farm Yard Manure for growing organic fodder like Berseem + Chinese cabbage, Oats, Maize, Maize + Cowpea Sorghum Sudan Grass Hybrid + Rice bean and Rice bean for feeding to the experimental cows. There was drop in green fodder production grown under organic farming system except Berseem fodder as compared to the fodder grown under conventional production system. Chemical compositions of concentrate mixture are being determined. Proximate analysis of organic fodder as well as fodders grown conventionally is under progress.

Concentration of heavy metals in milk, water, soil, feed and fodder samples from farm and field was determined. A total of 87 samples were collected during the year. The result showed Mercury (Hg) concentration above permissible limit in some of the milk samples. The level of Arsenic (As) obtained was within the permissible limit. Most of the milk samples had Lead (Pb) values above Maximum Residue Limit (0.02ppm). The Cadmium (Cd) level in all the samples exceeded the permissible limits.

Concentration of pesticide in all the samples and antibiotic residues for milk samples (42) was determined. Most of the milk samples had pesticide and antibiotic residues within the permissible limit.

Soil samples were collected from farm and the status of basic soil nutrient profiles was determined. The test values showed normal soil pH (6.5 - 7.5) for all the samples. The Organic carbon (%), available Phosphate ( $P_2O_5$ ) and Potash ( $K_2O$ ) were medium. The available Nitrogen (kg/ha) was low to medium.



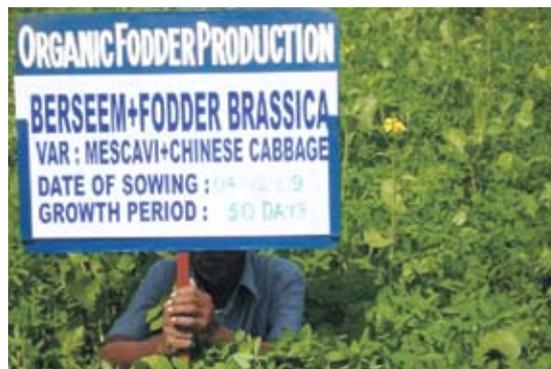
1. Molecular weight marker
2. 30% cut off protein pellet
3. 30% cut off protein supernatant
4. 40% cut off protein pellet
5. 40% cut off protein supernatant
6. 50% cut off protein pellet
7. 50% cut off protein supernatant
8. 60% cut off protein pellet
9. 60% cut off protein supernatant

Fig : Fractionated oviductal secretory protein

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

Cattle ovaries were collected from Kolkata slaughterhouse and brought to the laboratory in normal saline supplemented with streptopenicilline at 30-35°C. Immature oocytes were collected by aspiration method and subjected *in vitro* maturation to modular incubator chamber for 24 h. After maturation, oocytes were fertilized

with capacitated sperms for 14-18 h. The oocytes were washed and kept in primary culture media for cleavage. After 40-42 h of culture, cleaved oocytes were placed in replacement media for further development. A total of 238 oocytes were collected from 288 ovaries and used for the *in vitro* maturation. A total of 25.63% oocytes cleaved after 40-42 h of insemination and 61 in 2-cell stage, 46 embryos in 4-cell stage, 32 embryos in 8-cell stage, and 12 embryos in 16-cell/morula stage were found.



Organic Fodder Cultivation at ERS Fodder Farm

Oviductal tissues were collected from the Kolkata slaughter house and brought to laboratory keeping in ice pack. After removing fascia and other tissues, oviducts were cut into small pieces and kept in 100 ml normal saline at -20°C. The trimmed oviducts were subjected to freeze and thaw repeatedly for 5-6 times. The thawed oviductal tissues were centrifuged at 16,000 rpm for 15 minutes. The supernatant was collected and proteins present were quantified by Lowry method. The supernatant containing the oviductal secretory proteins were fractionated by ammonium sulfate precipitation (30%, 40%, 50% and 60%). Most of the oviductal secretory proteins were found to be precipitated at 30% ammonium sulfate precipitation. The protein samples were dialyzed in 50 mM Tris-HCl pH7.0 buffer in every 6 hour intervals to remove ammonium sulfate. Dialyzed samples were loaded into SP Sephadex cation exchange column equilibrated with 50 mM Tris-HCl pH7.0. After the binding was over, protein bound SP-Sephadex column was extensively washed with the same buffer till the optical density of the unbound protein was zero. The bound proteins were eluted in 50 mM Tris-HCl pH 7.0 containing 1.5 M NaCl. The eluted proteins were cationic (basic) in nature and subjected to extensive dialysis in the presence of normal saline. The proteins were quantified and lyophilized for further use. For purification of anionic proteins (acidic proteins), the unbound fractions after SP-Sephadex fractionations were bound in an anion exchange column containing DEAE Sephadex pre-equilibrated in 50 mM Tris-HCl pH 7.0. The eluted protein fractions were dialyzed in

normal saline, quantified and lyophilized for further use. The unbound fractions from DEAE Sephadex column contained the secretory proteins belonging to the neutral range and subjected to dialysis in normal saline followed by quantification and lyophilization. In the present study, three different fractions (viz. cationic (basic), anionic (acidic) and neutral) of oviductal secretory proteins were fractionated which will be used to see their effect in IVMFC.

### Studies on Proximate Composition and Dietary Protein & Fiber Fractions in Concentrate Ingredients and Fodders at Different Stages of Maturity

The proximate composition, fiber fractions and protein fractions in different fodder at different stages of maturity were studied. The locally available concentrate ingredients were collected and analyzed for the proximate composition and dietary protein & fiber fractions.

The fodder samples such as Maize, SSG, Sorghum, Cowpea, Oat, Berseem etc. were collected. The Oat fodder at weekly intervals was collected from three different plots for two consecutive years. Maize and Cowpea Fodder was also collected at different stages of maturity (50 to 90 days) from 3 different plots. The concentrate samples such as Maize grain, Rice grit, Mustard cake, tisi cake, Gram chuni, Moong chuni, Masoor bhushi etc. and locally available concentrate mixtures were collected.

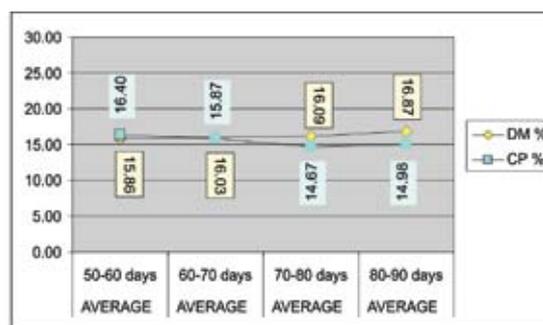
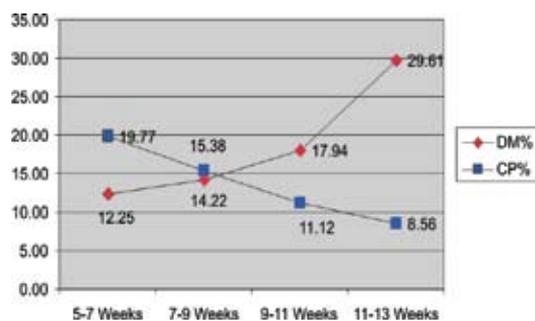


Fig : Change in DM and CP content of Oat and cowpea fodder at different days after sowing

The change in proximate composition of Oat fodder at different stages of maturity was analyzed. It was observed that the NFE and CF content (% of DM) increased whereas, the CP and EE content (% of DM) decreased as the stage of maturity of oat fodder advanced. Similarly, the proximate composition of Maize and cowpea fodder at different stages of maturity was also studied.

Depending on solubility in different solvents such as phosphate buffer, neutral detergent solvent and acid detergent solvent protein fractions namely A, B1, B2, B3 & C were estimated following Cornell Net Carbohydrate Protein System (CNCPS). There was no significant change in A+B1 and B2 fractions with the advancement in days after sowing. The B3 fraction did not change up to 11 weeks but thereafter showed a declining trend. The C fraction (as % of CP) increased steadily with the stage of maturity indicating the increase in percent of ADIP in total protein. The NDF content (% DM) increased from 49.38% (5 week) to 68.75% (13 week). The increase was gradual and steady up to 10 week (60.32%) then there was a steep increase in 11 week (67.29%) and thereafter there was not much change. In case of ADF content increased from 23.41% (5 week) to 37.92% (13 week). The increase was slow but steady from 6 week (22.71%) to 10 week (31.26%) and then there was a steep increase in 11 week (36.98%) and then there was no change.

In case of cowpea fodder there was no significant change in A+B1, B2, B3 and C fractions with the advancement in days after sowing. The NDF content (% DM) increased from 47.85% (50-60 days) to 50.12% (80-90 days) indicating the NDF content to increase by only 4.74%. The ADF content was almost similar (30 to 31%) in four treatment groups.

In case of maize fodder the A+B1 fraction gradually declined and the B2 fraction gradually increased up to 70-80 days stage and then remained unchanged. There was no significant change in B3 and C fractions up to 60-70 days stage and then increased at 70-80 days stage and thereafter remained unchanged. The NDF content (% DM) increased from 64.98% (50-60 days) to 66.7% (80-90 days) indicating the NDF content to increase by only 2.65%. The ADF content (% DM) increased from 30.12% (50-60 days) to 32.84% (80-90 days) indicating the ADF content to increase by around 9.03%.

The proximate principles (dry matter, organic matter, crude protein, ether extract, crude fiber and total ash) were studied for different concentrate ingredients. The comparative protein Fractions (A+B1, B2, B3 and C) and the NDF, ADF and

Acid Insoluble ash content were also analysed for these feeds. The NDF content was the highest in case of Soyabean cake followed by rice bran. The ADF content was found to be very high in case of Tisi cake, Matar chuni, Gram chuni, rice bran, moong chuni indicating poor quality and possible adulteration.

### **The Distribution and Utilization Pattern of Bank Credit for Livestock Development in Nadia and Burdwan Districts of West Bengal**

The study was conducted in Burdwan and Nadia districts of West Bengal. The 50 loan holder of SBI Kalna branch in Kalna -1 block of Burdwan district and the 50 loan holders of UBI, Jaguli and Ranaghat were selected for the study. The following observations were made:

- Majority of the sample house holds belonged to the general caste in both the district but was higher in Nadia (57%) followed by Schedule caste in both the districts.
- The main source of income of the majority of the sample respondent was dairy in both the districts but was higher in Nadia with 70% while it was 44 percent in Burdwan.
- Average no. of goat purchased from the loan was found higher in Burdwan (17goats) than that of Nadia (10 goats). The number of crossbred cattle per beneficiary house hold was lower in Burdwan (2 crossbred cattle) than that of Nadia (7 crossbred cattle).
- The average value of goat purchased from loan amount was similar in both the study areas.
- Rearing of goat is common in West Bengal being an important meat animal. The net cost of rearing one goat was estimated and found only Rs. 50/- higher in case of Nadia over Burdwan. The live weight of the similar age of the goat was slightly higher in case of Nadia. This may be due to better feeding to the goat. The net profit and cost-benefit ratio was also observed higher in Nadia over Burdwan.
- The cost of maintenance of milking crossbred in a year was estimated and found higher Rs. 41301/- (bank loan) and Rs.36967/- (SHG loan) in Nadia in both cases as against Burdwan (Rs.36354/-). However, the cost of milk production per kg was lower in Burdwan (Rs.14.47/-).
- Net cost of maintenance per year of milking buffalo was determined as Rs. 49072/- with the milk production 2650 kg in 300 days. The cost-benefit ratio of milking buffalo was estimated

1:1.08 on the farm. It indicated that 8 paise was the profit over one rupees investment for the maintenance of buffalo by the farmer.

Loan holders are facing problem for getting quality animal from loan amount due to non availability of quality milking animals in the state. Cost of milk production is higher than sale price of milk. Farmers are unable to repay the instalment of the loan amount.

### Dietary Manipulation of Rumen Fermentation to Study the Nutrient Utilization and Growth Performance of Calves

The effect of dietary supplementation of sunflower oil on nutrient utilization, rumen fermentation pattern, feed conversion efficiency and growth performance was studied in growing crossbred male calves. Twelve male cross bred calves (3-4 months old) with an average body weight of 51.3 + 1.64 kg, were divided into three groups (G1, G2 and G3) and were fed individually under stall feeding for 120 days on a roughage (maize green fodder) and concentrate mixture based diet. Sunflower oil was supplemented @ 0, 2 and 4 % of the daily dry matter intake for consecutive three days in every week to the calves of G1, G2 and G3 group, respectively. CP content of concentrate mixture and maize fodder was 18.6 and 10.8 % (on DM basis), respectively. Daily dry matter intake and nutrient digestibility were similar among the three groups. Dietary supplementation of sunflower oil had no effect on fibre digestibility in growing calves. Plane of nutrition was also similar among the three groups. Dietary supplementation of sunflower oil did not influence the rumen pH, TVFa and total nitrogen concentration. However, ruminal ammonia nitrogen concentration was reduced significantly due to dietary supplementation of sunflower oil. Highest fall in rumen pH was observed after six hours of post feeding. Rumen ciliate protozoal population was found significantly lower in sunflower oil supplemented group (G2 & G3) than non supplemented control group (G1). Rumen enzyme profile e.g., activity of carboxymethyl cellulase, xylanase and  $\beta$ -glucosidase was not influenced by the dietary supplementation of sunflower oil. Level of blood glucose, blood urea and blood protein was not influenced by the dietary supplementation of sunflower oil. Total body weight gain, average daily gain and feed conversion efficiency were better in sunflower oil supplemented calves. It was concluded that sunflower oil may be supplemented alongwith feed @ 2 % of daily dry matter intake for consecutive three days in a week to improve the growth performance of growing calves.

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

Screening of natural plant extract was done for reducing ruminal methanogenesis and rumen protozoal population *in vitro*. Addition of aqueous, aqueous methanol and aqueous ethanol extract of *Agave americana* resulted in higher total gas production per gram dry matter compared to control. However, due to inclusion of aqueous ethanol extract of beetel leaves resulted in reduction (about 80 %) in methane production significantly. Extract of *Agave Americana* and aqueous extract of *Andrographis paniculata* had no effect on methane production. Total rumen protozoal number and holotrich protozoal population was reduced due to addition of aqueous ethanol extract of *Agave Americana*, *Caoltropis gigantean* and beetel leaves. Ammonia nitrogen concentration was reduced significantly due to addition of aqueous ethanol extract of *Agave Americana*, *Caoltropis gigantean* and beetel leaves. In general, TVFA production was reduced due to addition of aqueous, aqueous-methanol and aqueous-ethanol extract of *Agave Americana*, *Andrographis paniculata* and beetel leaves in the incubation medium. These plants extract did not have any effect on VFA composition e.g. acetate and propionate percentage. Due to inclusion of plant extract in the incubation medium enzyme activity of carboxymethyl cellulase and xylanase decreased except in case of extract of beetel leaves. Different plant extracts in different solvents influenced the *in vitro* true dry matter degradability in different ways. In general, dry matter degradability was reduced due to addition of aqueous, aqueous methanol and aqueous ethanol extract of *Agave americana*, *Caoltropis gigantean* and *Andrographis paniculata* in the incubation medium. It was inferred that beetel leaves could be used to manipulate rumen fermentation for improving the productivity of animals.



Training of girl students at newly developed Milk Processing Unit at ERS

### 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	702
Conception rate	49.20%
A.I. in Buffaloes	321
Conception Rate	45.50%
No. of Crossbred calves born	205
No. of buffalo calves born	117
General Treatment cases	290

##### Infertility and Veterinary aid Campaigns

A total of 36 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 826 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 of fodder crops (berseem and oat) were organized as per the following details.

Location	Crop	Variety	No. of cuts	yield (q/ha)
IGFRI, Jhansi in collaboration with under the project on participatory varietal selection				
Subhri and Narukheri	Berseem	Wardan	5	856
		JHB-146	5	893
	Oat (2)	JHO-822	2	433
		JHO-851	4	489

##### Kissan Sanghosthi

The Extension Division organized 36 Kissan Sanghosthies in adopted villages to improve the dairy farming practices and to ensure adoption of scientific technologies developed at Institute. A total of 645 farmers participated in these programmes and lectures were organized on livestock management, clean milk production, common cattle diseases and preventive measures, veterinary services, balanced diet of animals, role of dry cow therapy, silage making, preparation of value added milk products etc.

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

##### Research-Extension Interface with Progressive Dairy Farmers

NDRI, Karnal organized Research-Extension Interface with Progressive Dairy Farmers on 8th May, 2009. The main purpose of this programme was to solicit farmers' research needs from the grassroots level and to enlighten them on specific research interventions and training facilities available with NDRI. It also envisaged capacity building of Farmers Organizations and ensuring support to prioritize farmer-led agricultural research.

Seventy Dairy Farmers participated in the Interface in which the subject matter specialists of NDRI responded to the queries raised by the farmers.

### Dairy Education at Farmers' Door

An Extension Education Programme "Dairy Education at- Farmers' Door" was 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.

During the visits, interactions were carried out regarding the existing dairy farming practices in the villages and the constraints faced by farmers. Farmers were provided need based scientific interventions on aspects of breeding, feeding, health care, management, processing of milk and marketing. The main issues that emerged during the discussions included retention of placenta in the animals specially in buffaloes, ticks infestation, incidence of mastitis, use of draft purpose bulls for breeding, low price of milk and non-availability of high pedigree germplasm for cattle, as expressed by most of the progressive dairy farmers.

### Integrated Dairy Development Programme

Integrated dairy development programme was conducted by the Institute at Pusar, Bagpat and Lalukheri (Muzaffarnagar) of Uttar Pradesh to utilize the facilities of Model Dairy Centre created under Integrated Rural Development Project during 2002-2005 and veterinary services and training programmes were organized.

### Infertility Campus

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

220 anoestrus and 120 repeat breeding problems were mainly detected in these animals. The prevalent of bacterial, viral and protozoan infections was also high.

### Off Campus Training

Exposure visits, and 3 training programmes in dairy processing were organized during the year. Training on "Value added milk and milk products" was organized in Model Dairy Centre in village Pusar, in which more than 100 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.

### Students Practicals in Villages

Students practical sessions were conducted in adopted villages. These practical sessions comprised the topics on training need assessment of farming community on dairying, evaluation of skill of farm women in preparation of paneer, participatory rural appraisal, animal husbandry practices and working pattern of gram panchayat under Panchyati Raj System.

Dairy Samachar a newsletter in Hindi was sent/distributed as a regular service to the farmers, dairy owners and other dairy entrepreneurs in different states throughout the country.

### Advisory Services

The Division provided regular advisory services through postal, e-mail, phone to individual farmers / NGO's / relevant departments all over the country in response to their particular / general queries regarding the 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.



Director NDRI addressing the Agriculture Officers from J & K attending training programme at KVK

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. While designing the courses, the entire concept of farming system is taken into consideration to make the enterprises economically viable for the farmers. 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.



*Demonstration on scientific method of ghee making to the trainees*

### Training Programmes Organized by KVK from January to December, 2009

Title of the course		Duration (days)	No. of courses	No. of beneficiaries	Mandays trained
<b>(A) On-Campus Programmes</b>					
Dairy Production	At KVK	4-5	10	469	1985
	At DTC	3-5	51	1478	7275
Dairy Processing	At KVK	5	6	98	490
	At DTC	5	1	10	50
Crop Production	At KVK	3	7	156	414
	At DTC	7	1	13	91
Vermiculture		2-3	4	58	162
Bee-keeping		4	3	85	340
Fish Farming		4	2	31	124
Home Science		2-9	12	224	818
Short Integrated Training Programmes		1	30	1172	1172
<b>Total (A)</b>			<b>127</b>	<b>3794</b>	<b>12921</b>

**B) Off-Campus Programmes**

Dairy Production	1	7	169	169
Dairy Processing	1	2	64	64
Crop Production	1	5	77	77
Vermiculture	1	3	60	60
Bee-keeping	1	2	32	32
Fish Farming	1	2	32	32
Home Science	1-32	8	261	792
<b>Total (B)</b>		<b>29</b>	<b>695</b>	<b>1226</b>
<b>Grand Total (A) + (B)</b>		<b>156</b>	<b>4489</b>	<b>14147</b>

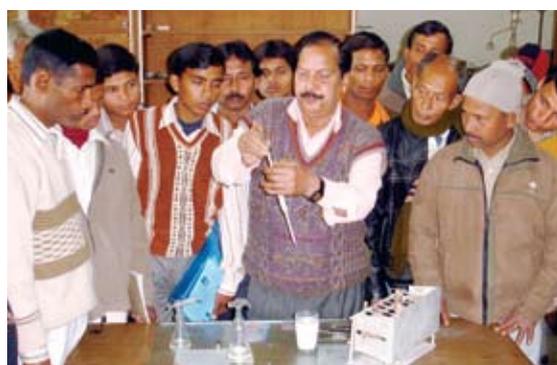
**Courses Conducted by Dairy Training Centre (Jan. to Dec., 2009)**

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 Pradesh	5	19	596	2980
Scientific Dairy Farming for farmers sponsored by Agricultural Technology Management Agency (ATMA), Rajasthan	4-7	4	131	693
Scientific Dairy Farming for farmers sponsored by Govt. of Himachal Pradesh	5	4	115	575
Scientific Dairy Farming for farmers sponsored by Govt. of Bihar	4-5	14	406	1996
Scientific Dairy Farming for farmers sponsored by Director Mahila Dairy Vikas Pariyojna, Uttarkhand	5	1	28	140
Scientific Dairy Farming for Women Extension functionaries sponsored by Rashtriya Mahila Kosh Dehli	4	1	19	76
Scientific Dairy Farming for Extension functionaries sponsored by State Institute for Rural Development (SIRD) Assam	5	8	183	815
Refresher course in Dairy Processing for Extension functionaries sponsored Govt. of Punjab	5	1	10	50
Dairy Farming and balanced & Integrated use of fertilizers for Agriculture Officers sponsored by Deputy Director, Agriculture (Training) Kashmir Division Gandubad, J & K	5	1	13	65
<b>Total</b>		<b>53</b>	<b>1501</b>	<b>7390</b>

(Revenue Generated from DTC Courses in Dairy Production = Rs. 9,10,087/-)

### State-wise Beneficiaries of KVK Training Programmes (Jan to Dec. 2009)

State	No. of Beneficiaries
Haryana	1727
Uttar Pradesh	900
Himachal Pardesh	551
Bihar	407
Rajasthan	366
Assam	183
Uttrarakhand	187
Punjab	63
Delhi	50
Orrisa	19
Jammu & Kashmir	15
Gujrat	6
Maharashtra	5
Madhya Pardesh	5
Chhatisgarh	3
Jharkhand	1
Karnataka	1
<b>Total</b>	<b>4489</b>



*Trainees being demonstrated Test of Milk adultration*

### Extension Activities

- The KVK has four stockman centres in the adopted villages, namely: Uchana, Kailash, Taprana & Phusgarh and one Stockman Centre at Jundla Gate, Karnal to take care of animal health



*Animal Health Camp organized in KVK adopted village*

and artificial insemination in the operational area. The animal health management activities and field extension activities were carried out through these stockman centres. At these centres, 7315 cases were attended, out of which 265 cases were for general treatment, 8 for infertility treatment, 266 for dehorning, 315 for pregnancy diagnosis and 800 cases were for Food and Mouth Disease (FMD) vaccination. A total of 3787 cattle and buffaloes were artificially inseminated and as a result 1874 calves were born.

- In association with the Dairy Cattle Physiology Division of the Institute KVK team conducted trials on estrus synchronization and set time - A.I under field situation. During these trials PGF<sub>2μ</sub> and Estradiol were used for treatment of anoestrus and repeat breeding problems in 103 Buffaloes of Shahapur, Dadupur, Kutail and Kohand villages of Karnal district.
- Trials in preparation of Khoa by bulk and batch methods were conducted by the subject matter specialists of Home Science. The Khoa made was judged through sensory evaluation of the samples by the participating 18 rural women. It was inferred that Khoa prepared by batch method was found better in terms of flavour, body, texture and taste.
- 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. The scientific methodology for preparation of Dahi using the NDRI Dahi cultures was demonstrated at each location and the curd, thus, prepared was checked on various parameters. The curd was strongly accepted by the consumers based on its consistency, thickness, colour, flavour, taste acidity and shelf life.
- During the reporting period, two On-Farm trials on gram variety BG-1103 were conducted in village Brass and the crop is still standing.
- During the reporting period, three On-Farm Trials on Toria variety T-9 and PT- 303 were conducted in village Nagla Rodan in four acre area and average yield of toria from PT - 303 & T-9 was 4 qtls. per acre and 3.5 qtls per acre, respectively.

### Front Line Demonstrations

- Pusa Jai Kisan, and Pusa Bahar varieties were used for conducting Field Level Demonstrations

(FLD) on Mustard. The demonstrations were conducted in 4 hectare area on farmers' fields and 10 farmers were selected. These varieties performed well in demonstration plots as compared to local check plots. An average increase of 26% yield in Pusa Jai Kisan and 21.9% in Pusa Bahar on demonstration plots was observed as compared to local check plots. The overall performance of variety Pusa Jai Kisan and Pusa Bahar was found to be good.

- During the Rabi season 2008-09, total six FLDs on Gram crop were laid in 2.2 hectare area under irrigated conditions. The variety HC-5 was used for conducting FLDs. In the demonstration plot, an average production was observed 18.60 q/ha, which was 22.69% higher than local check. The overall performance of this variety of Gram was found to be good.
- During the Rabi season 2008-09, total 15 FLDs on wheat crop were laid in 6.0 hectare area under irrigated conditions. Variety DBW-17 was used for conducting FLDs other than oilseed and pulses. In the demonstration plot, an average yield was observed 58.47 q/ha, which was 20.25% higher than local check. In one of the demonstration plot in village Wajida Jatan, a record yield of 25 q was also recorded. The overall performance of this variety of wheat was found to be good.
- During the kharif season 2008-09, total six FLDs on fodder crop maize were laid in 2.4 hectare area under irrigated conditions. African Tall Variety was used for conducting FLDs. The average production was found 165 q fodder per acre.
- During the period under report, total four FLDs of cauliflower crop were laid in 1.6 hectare area under irrigated conditions. The variety Pusa Meghna was used for conducting FLDs. The average production was found 90 q per acre.
- In the summer season, moong variety SML-668 procured from P.A.U. Ludhiana was used in laying 13 demonstrations in different villages of the district. The average production was found 7.31 q per hectare.
- During the Rabi season 2009-10, 6.0 ha. area was allotted under oilseed and 4.0 ha. area was under pulse crops. Under oilseed mustard variety, RH-30 was used for conducting FLD and 10 demonstration on gram variety HC-5 was used under pulse crop. The total 25 demonstrations were organized in various

villages of Karnal district. Most of the varieties used under demonstration were procured from the Haryana Agriculture University, Hisar, Punjab Agriculture University, Ludhiana and Regional Station of Indian Agriculture Research Institute, Karnal. The crops of different varieties are standing in the fields.

- During the Rabi season 2009-10, total 20 FLDs on wheat crop were laid in 8.0 hectare area under irrigated conditions. The variety DBW-17 & PBW - 343 were used for conducting FLDs.
- Zero Tillage technology in Wheat crop production was demonstrated to various groups of farmers and farm women of the Karnal district and also to other states. It was also promoted in different villages.
- KVK recorded milk production in cross bred Karan Fries cattle for 24 hours in a dairy farm of an ex-trainee of KVK at village Dadupur on 21-22 February 2009 and in one crossbred cow the milk recorded was 59.5 kg in 24 hours that was found to be the highest in the country from one cow in one day under field conditions.
- KVK celebrated for the first time World Animal Day at Shri Krishan Gaushala at Karnal in which the exhibition of the Kendra was also organized.
- Twenty seven progressive farmers from KVK adopted villages were taken to Kisan Mela on 17.09.09 at PAU, Ludhiana to acquaint them with latest technologies in Agriculture.
- SAC meeting of KVK was organized on 11.11.2009 in which 46 officials of different line department including Director, CSSRI, Director, NBAGR, Head, Regional Station IARI and Deputy Director, ICDP participated. The meeting was chaired by Director, NDRI.



*Treatment of Bee colonies for varroa mite*

- As per the direction of ICAR, KVK celebrated technology week from 30th November to 5th December, 2009. During the week the various technologies ready for dissemination were demonstrated to about 250 farmers, 100 farm women and 75 school students. They were also shown various activities of the Institute including Cattle Yard and Experimental Dairy.
- During the period under report, three awareness programmes on Biodiversity & Environmental issues were organized in KVK adopted villages in which 610 farmers, farm women and students participated. These awareness programmes were organized under the aegis of Awareness Year as communicated by the ICAR.
- Visit of Hon'ble Governor of Haryana state Sh. A. R. Kidawai at NDRI, Karnal.
- Hindi Sanghoshthi Diwas celebration held at NDRI on 21<sup>st</sup> January 2009.
- Visit of Dr. H. P. Singh, DDG Horticulture and Agriculture Extension, ICAR, New Delhi on 18<sup>th</sup> Feb., 2009 at NDRI, Karnal.
- Paddy Mela organized by CCSHAU, RRS, Kaul in Kaithal district on 24th Sept., 2009.
- Ganna Mela organized by CCSHAU, RRS, Uchani in Karnal district on 29<sup>th</sup> Sept., 2009 and KVK stall was adjudged first in displaying the exhibits.



*Dr. A. K. Srivastava, Director, NDRI addressing the farm women on occasion of Women in Agriculture*

### Exhibitions Organised

KVK organized the following exhibitions depicting the activities of KVK

### Radio Talks Delivered

- “On farm trials and Front line programmes of KVK, NDRI” by Dr. Dalip K. Gosain from All India Radio, Kurukshetra on 13.05.2009.
- “Vermi-compost making” by Mr. Mohar Singh from All India Radio, Kurukshetra on 13.05.2009.
- Recording on Crop production programmes by Doordarshan Kendra, New, Delhi on 07.08.2009.

### Revenue Generation in KVK & DTC

Receipts	Revenue (Rs.)
<b>Demonstration Units</b>	
Crop & Seed Production (January to December, 2009)	12,58,425
Horticulture Unit (January to December, 2009)	20,200
Vermicompost Unit (July 2007 to June 2009)	1,915
Fisheries Demonstration Unit (January to December, 2009)	70,606
Bee-keeping Unit (January to December, 2009)	29,110
Revenue generated from KVK/DTC	9,95,087
Revenue generated from other activities	3,10,105
<b>Grand Total</b>	<b>26,85,448</b>

## AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

The Agricultural Technology Information Centre (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. As per mandate, ATIC was engaged to disseminate information, technical know-how and sale of products through different activities.



### Knowledge Dissemination & Advisory Services

Approach of single window facility at the main gate of institution helped the farmers/clientele to get the required information for the solution to their problems particularly in dairying and agriculture. ATIC provided technical know-how about the technologies available for transfer to enhance the productivity and income of the farmers/clienteles. Advisory services were provided on different aspects of dairying & agriculture to minimize the adoption gaps so that animal and crop productivity could be improved.

A total of 20199 clientele from 16 states and 01 Union Territory visited ATIC to discuss problems related to different fields of Agriculture and Dairying. Maximum number of farmers visited ATIC was from Haryana (7456) followed by Punjab (5143). Apart from this 2124 farmers from UP, 2731 and Rajasthan, 723 visited the centre. Maximum number of farmers visited during month of October 2009 (2813) during Rabi season and in March 2010 (3418) during Kharif season. Apart from this foreign delegates (56) from France, Sri Lanka, Bhutan, Rawanda, China, Brazil, Mexico and Nepal visited Agriculture Technology Information Center during period under report.

### Technical Information & Advisory Services (State Wise)

A large number of farmers visited Agriculture Technology Information Centre NDRI Karnal to seek solutions to their problems in the area of dairying, agriculture and other allied fields to improve the

productivity and income from various activities.

Maximum number of farmers interacted regarding feeding problems (6025) followed by management (1626) and processing (922). A large number of farmers (9177) visited Agricultural Technology Information Centre, NDRI, Karnal to discuss problems related to crop production particularly paddy, wheat and fodder crops. A large number of farmers were interested to know about the training programme particularly in dairying and agriculture by different institutes/training centre located at Karnal.



### Feed Back on Specific Technological Interventions

To provide feed back to research system, data was analyzed to assess area-wise problems faced by farmers in the area of Animal Nutrition, Animal Breeding, Animal Physiology and Animal Health Care in different states.

Critical appraisal of the data indicated that 6025 farmers from 16 states and 01 UT interacted on different problems faced in dairy production system i.e. animal nutrition, animal breeding, animal physiology and animal health and management problems viz repeat breeding, metritis, anestrus, mastitis, balanced feed, formulation of feed, shelter, ecto and endo parasites, vaccination schedule etc. Maximum number of farmers discussed about problems related to Animal Nutrition (2523) followed by Animal Health Care (1404), Animal Breeding (1376) and Animal Physiology (722). A large number of farmers (9177) had interaction related to crop production system i.e. package of practices, insect and disease problems, fertilization, irrigation and use of quality seeds. Farmers from different states visited ATIC to procure the quality seed of different crops.

**Area Specific Feed Back:** To assess the need of technological intervention in specific areas, data was collected and analyzed in the areas of Animal

Nutrition, Breeding, Physiology, Health Care, Dairy Economics & Management and Crop Production.

**Animal Breeding and Animal Nutrition:** Data of different problems related to animal breeding and live stock production management such as

Repeat Breeding, Anestrous, Lactation Yield, Breed Specification, Calving Interval, Milking Techniques, Care of Calves, Care of Milking Animals, Housing, Quality Semen were recorded. It was observed that maximum numbers of problems were related to repeat breeding followed by anestrous.

### Feed Back on Specific Problems related to Animal Breeding and Nutrition

Animal Breeding	Number of Farmers	Animal Nutrition	Number of Farmers
Repeat Breeding	381	Concentrate Mixture	971
Anestrous	206	Silage Making	121
Lactation Yield	72	Deficiency of Mineral	502
Breed Specification	42	Treatment of roughages	142
Calving Interval	54	Feed Blocks	79
Milking Techniques	21	By-pass Protein/Fat	106
Care of Calves	98	Balance Feeding	201
Care of Milking Animals	106	Cultivation of fodder crops	219
Housing	42	Fodder Round the Year	182
Quality Semen	119	<b>Total</b>	<b>2523</b>
Dairy Establishment	235		
<b>Total</b>	<b>1376</b>		

In Animal Nutrition, data on different aspects such as Concentrate Mixture, Silage Making, Deficiency of Minerals, Treatment of roughages, Feed Blocks, Bypass Protein/Fat, Balanced Feeding, Cultivation of fodder crops and round the year Fodder Production were recorded. Critical appraisal of data indicates that maximum number of farmers enquired about feeding of concentrate mixture followed by deficiency of minerals. Significant number of farmers interacted about treatment of roughages, cultivation technology of fodder crops, balanced feeding, silage making, by-pass protein/fat, feed blocks and availability of fodder through the year.

#### Animal Health Care and Animal Physiology:

Data on different problems in animal health care and physiology was recorded during period under report. Analysis of data indicates that major areas of concern under animal health care are Mastitis, Metritis, Endo & Ecto Parasites and Prolapse of litesus. Many farmers interacted regarding vaccination schedule and also discussed about milk fever, cow pox, diarrhea and timpany etc.

**Crop Production:** Most of the stakeholders are adopting integrated farming system where crops and animals are the major components. A large number of farmers are visiting the Agricultural

technology Information Centre to find solutions to the problems which are responsible for decreasing productivity and income.

Sale of biofertilizers, vermicompost and good quality seeds of fodder and cereal crops attracted the farmers to visit ATIC centre of NDRI Karnal. Out of 9177 farmers visiting ATIC, 5058 farmers visited to procure seed whereas 3854 farmers discussed about the problems responsible for low yield of different crops. Thirty one farmers were guided for soil testing so that proper dose of nutrients can be applied to get maximum production.

#### On-Line Guidance

Two way interaction between scientists and stake holders is the most critical component for dissemination of the information. To facilitate this, a Toll Free Number (1800 180 1199) has been established. A limited number of stakeholders has started making use of email.

#### Sale of Publications

A total of 1572 books were sold through ATIC which generated revenue of Rs. 1,48,598. Sale of English Publications generated on income of Rs. 1,13,998, whereas Hindi Publications generated an income of Rs. 34,600.

### Sale of Seeds, Biofertilizers & Vermicompost

Seed production Unit and KVK are engaged in production of good quality seeds of improved varieties of different crops such as maize, sorghum, mustard, oats, paddy and wheat.

Moreover, biofertilizer produced by Dairy Microbiology Division and vermicompost by KVK are available for sale through ATIC. Details of information regarding sale of seeds, biofertilizers and vermicompost are tabulated below.

#### Sale of Seeds through ATIC

Name of Crop/Unit	Variety	Quantity (kg)	Amount (Rs.)
<b>Seed Production Unit</b>			
Maize	Vijay Composite	1755	35100
Sorghum	PC-9	1965	68775
Mustard	Chinese Cabbage	232	8930
Oats	Kent	4260	119294
Oats	OS-6	6789	190092
Paddy	Pusa-44	17880	411000
	Pusa-1121	260	9100
<b>Total</b>		<b>33141</b>	<b>842291</b>
<b>KVK, NDRI, Karnal</b>			
Wheat	PBW-343	7080	120360
	DBW-17	10600	265000
Vermicompost		75 Packets	750
<b>Total</b>		<b>17680</b>	<b>386110</b>
<b>Microbiology Division</b>			
Culture	Rhizobium Culture	145 Packets	1450
<b>Grand Total</b>		<b>50821</b>	<b>1229851</b>

ATIC sold 50821 kg seed of improved varieties of maize, sorghum, mustard, oats, wheat and paddy to the visiting farmers worth Rs. 1229851/-. Further 145 packets of Rhizobium culture developed by Division of Microbiology for treatment of berseem & lucerne seed were also sold through the centre worth Rs. 1450/-. Total 75 packets of vermicompost developed by KVK, NDRI, Karnal were also sold through the centre.

### Film Shows & Face to Face Interaction

Various Institute activities are displayed through two documentaries 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 displays a film on "Savach dugadh utpadan - Dugadh

Padarath Nirman Aur Packaging" of 16 minutes to exposure the visitors about the advantages of clean milk production. ATIC has also collected some DVDs on different subjects of agriculture and veterinary science.

### Exhibitions

The centre has displayed some panels to display information on various technologies developed by NDRI, Karnal. Methodology and advantages of these technologies are 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 16781 visiting farmers during the year (2009-2010). Exhibition Unit exhibits information through posters and pamphlets from time to time. Exhibition panels help the stakeholders 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, (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 following courses were offered by NDRI Deemed University during the academic session 2009-10. The courses have been so designed as to provide broad base as well as specialized training on different aspects of dairying.

### B.Tech. (Dairy Technology)

This degree programme offers intensive training in processing and quality control of milk and milk products; and engineering aspects of milk processing plants.

### Masters in Dairying and Ph.D. Programme

The Institute offers Masters in Dairying and Ph.D. 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; and xii) Dairy Extension Education.

### Scholarship and Fellowships

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

The National Talent Scholarship (NTS) @ Rs.1000/- per month is awarded by ICAR on merit of 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.

### 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. (DT) 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 25<sup>th</sup> June, 9<sup>th</sup> - 10<sup>th</sup> July, 2009, respectively at NASC Complex, New Delhi.

### Entrance Examination

An all India Competitive entrance examination for admission to Ph.D. programme for the session 2009-10 was conducted by NDRI on 19<sup>th</sup> June, 2009 at three centers i.e. Karnal, Bangalore and Kalyani.

### Admissions

A total of 47 students joined B.Tech.(DT), Programme. Also 128 students including nine foreign nationals from Rawanda, one from Iran and one from Ethiopia, joined Masters degree and 83 students including two foreign nationals from Sri Lanka and one from Iran joined the Ph.D. Programme.



*Dance Performance by girl students of NDRI during Vasantotsava*

### Degrees Awarded

During the period under report, 23 B.Tech. (DT), 84 Masters in Dairying and 32 Ph.D. students were awarded degrees.

### Meetings

- 63<sup>rd</sup>, 64<sup>th</sup>, 65<sup>th</sup> and 66<sup>th</sup> meeting of the Standing Committee on Courses Curricula and Academic Affairs were held on 23<sup>rd</sup> July, 10<sup>th</sup> Sept., 23<sup>rd</sup> Nov., 2009 and 23<sup>rd</sup> Feb., 2010, respectively.
- 43<sup>rd</sup> and 44<sup>th</sup> meeting of the Standing Committee on Faculty Students Problems and Discipline were held on 10<sup>th</sup> Sept., 27<sup>th</sup> October and 10<sup>th</sup> Nov., 2009, respectively.
- 36<sup>th</sup> meeting of the Standing Committee on Scholarship, Financial Assistance and Academic Progress Discipline was held on 31<sup>st</sup> October, 2009.
- 28<sup>th</sup> meeting of Academic Council was held on 11<sup>th</sup> March, 2010.

### Eighth Convocation of NDRI Deemed University

Eighth Convocation of NDRI Deemed University was held on 13<sup>th</sup> March, 2010. Dr. A. P. J. Abdul Kalam, Former President of India, delivered the Convocation Address and Dr. S. Ayyappan, Director General, ICAR and Secretary, DARE presided over the function. Dr. A. K. Srivastava, Director & Vice Chancellor, NDRI Deemed



University presented the Convocation Report. A total of 148 students (including 30 girls) were conferred different degrees i.e. B.Tech. (Dairy Technology) -23, Master's -84 and Doctoral - 41. Four topper students were awarded the Director's Gold Medals; Ms. Richa Singh (B.Tech, DT); and Ms. Anisha, P. V. (Processing Group), Mr. Jay Prakash Gupta (Production Group), Mr. Kale Rajiv Baliram (Management Group) in the Master's degree programme. Ms. Priyanka Meena, B. Tech. DT, Ms. Dingle K. Simon, M. Tech. Dairying in Dairy Engineering (Processing Group), Mr. Manoj, M., M.V. Sc. Dairying in Animal Genetics & Breeding (Production Group) and Mr. Midhun, T. R., M.Sc. Dairying 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.

Dr. A. P. J. Abdul Kalam delivered his talk on the topic "Dairy Technology Empowers National Development".



### Best Thesis Awards

Best Thesis Awards have been instituted for the first time for Masters and Doctoral theses (one each in Production, Processing and Management Groups). Best thesis award carries 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:

**Processing Group:** Dr. P.A. Shankar, UAS, Bangalore (Chairman), Dr. G. S. Sharma, NDRI Karnal (Member) and Dr. N.S. Rathore, MPUAT, Udaipur (Member).

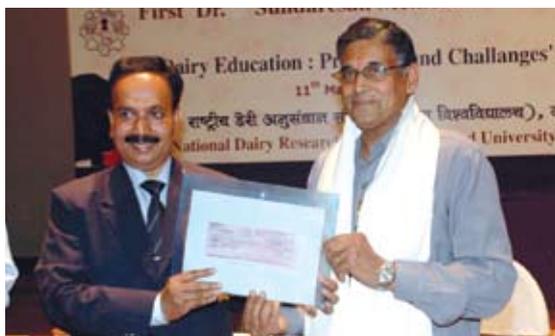
**Production Group:** Dr. N. Balaraman, Ex-VC, TRANUVAS, Chennai (Chairman), Dr. A. S. Nanda, GADVASU, Ludhiana (Member) and Dr. R. K. Sethi, CIRB, Hisar (Member).

**Management Group:** Dr. Rajvir Singh, Commission for Agricultural Costs & Prices, New Delhi (Chairman), Dr. B. S. Hansra, IGNOU, New Delhi (Member), Dr. S. S. Raju, NCAP, New Delhi (Member).

Following students received the Best Thesis Awards on 13<sup>th</sup> March, 2010 during the eighth convocation of NDRI Deemed University.

### 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 and research in agriculture and allied sectors. The award carries an amount of Rs. 20,000, a citation, shawl and a certificate. The first award was bestowed on eminent educationist Dr. S. L. Mehta, former Vice-Chancellor, MPUAT, Udaipur; and Ex- DDG (Education), ICAR, New Delhi. Dr. Mehta delivered the lecture on the topic “Dairy Education: Prospects and Challenges” on 11<sup>th</sup> March, 2010.

### Presentation of Academic Achievements and Innovations in Teaching

The Heads of Divisions and Head SRS made presentations on “Academic Achievements and



Innovations in Teaching” of their respective Divisions/SRS on 9<sup>th</sup> March, 2010 before a panel of experts. The panelists included Dr. M. L. Madan, Dr. N. Balaraman, Dr. R. T. Patil, Dr. Surat Singh, Dr. V. Venkatasubramaniam.



Signature of NDRI released

## 5 HONOURS / AWARDS

### HONOURS/AWARDS

- **Dr. B. S. Chandel** was awarded the coveted Commonwealth Academic Staff Fellowship 2009 to work on “**Development of Multi-Market Models for Policy Analysis of Dairy Sector**” at University of Reading (UK) till March 2010.
- **Ms. Jaspreet Kaur**, Ph.D. in Animal Biochemistry got “**Best Doctoral Thesis Award**” in Production Group during Eighth Convocation of NDRI, Deemed University. Major Advisor: **Dr. Gautam Kaul**.
- **Ms. Ramya Iyer**, Ph.D. in Dairy Microbiology got “**Best Doctoral Thesis Award**” in Processing Group during Eighth Convocation of NDRI, Deemed University. Major Advisor: **Dr. Sudhir Kumar Tomar**.
- **Ms. Sanvedna Kumari**, Ph.D Scholar (Dairy Extension Education), was awarded “**Best Doctoral Thesis Award 2010**” in Management Group during Eighth Convocation of NDRI, Deemed University. Major Advisor: **Dr. Jancy Gupta**.
- **Ms. Arpana Verma Kumari**, M.Sc. Dairying in Animal Biotechnology got “**Best Master Thesis Award 2010**” in Production Group during Eighth Convocation of NDRI, Deemed University. Major Advisor: **Dr. T. K. Datta**.
- **Ms. Archana Chandran**, M.Sc. Dairying in Dairy Microbiology got “**Best Master Thesis Award**” in Processing Group during Eighth Convocation of NDRI, Deemed University. Major Advisor: **Dr. V. K. Batish**.
- **Mr. Bitan Mondal**, M.Sc. Dairying in Dairy Economics got “**Best Master Thesis Award**” in Management Group during Eighth Convocation of NDRI, Deemed University. Major Advisor: **Dr. B. S. Chandel**.
- **Mr. A. Kumaresan** was awarded “**Best Research Presentation Award 2009**” during 25<sup>th</sup> Annual Convention of the Indian Society for the Study of Animal Reproduction and International Symposium on “**Expanding Horizons of Reproductive Technologies for Augmenting Fertility in Farm and Pet Animals in the Global Scenario**” held at Veterinary College and Research Institute, Namakkal, Tamil Nadu from 10<sup>th</sup> - 12<sup>th</sup> December 2009.



- **Dr. Avtar Singh**, Dr. P. S. Oberoi and Dr. B. K. Joshi received “**First Best Paper Award**” for the paper entitled “**New Computer Simulated Excel based Software for Analysis of Techno-economic Feasibility of Dairy Farming**” published in Indian Dairyman for the year 2008 in the “**Commercial Aspects Area**” on 19<sup>th</sup> February, 2010 from Dr. N. R. Bhasin, President, IDA, New Delhi at NIMHANS, Bangalore.
- **Dr. S. K. Tomer**, and **Dr. J. P. Sehgal**, received “**Best Paper Award**” for their research paper entitled “**Nutrients Requirements for Pregnant Buffaloes**” during the International Buffalo Conference on “**Optimizing Buffalo Productivity through Conventional and Novel Technologies**” organized by Indian Society for Buffalo Development held at NASC Complex, New Delhi on 1<sup>st</sup> April, 2010.
- **Dr. V. Sharma**, **Dr. Tushar Makwana**, **Dr. S. Arora**, **Dr. Amit Kumar**, **Dr. D. Lal**, **Dr. R. Seth**, **Dr. (Mrs.) B. K. Wadhwa**, and **Dr. G. S. Sharma** were awarded “**First Best Paper Award**” for the paper entitled “**A Rapid Method of Cholesterol Estimation in Ghee using Non-enzymatic Diagnostic Kit**” published in Indian J. Dairy Sci. 61 (5): 353-359 during XXXVII Dairy Industry Conference from 17<sup>th</sup> - 19<sup>th</sup> Feb., 2010 at NIMHANS, Bangalore organised by IDA (SZ).
- **Dr. S. Arora**, **Mr. S. Yarrakula**, **Mr. K. Narendra**, **Dr. V. Sharma**, **Dr. (Mrs.) B. K. Wadhwa**, **Dr. A. K. Singh**, and **Dr. G. S. Sharma** were awarded “**Second Best Paper Award**” for the paper entitled “**Analysis of Saccharin and Acesulfame-k and their Storage Stability in Kalakand**” Indian J. Dairy Sci. 61 (3): 170-177 during XXXVII Dairy Industry Conference from 17<sup>th</sup> - 19<sup>th</sup> Feb., 2010 at NIMHANS, Bangalore organised by IDA (SZ).

- **Mr. G. Jagan Mohanrao, Mr. G. Raj Kumar and Dr. S. K. Atreja** received Prof. N. J. Chinoy Award for “**2nd Best Oral Presentation**” on the paper entitled “**Analysis of Tyrosine Phosphoproteome of Capacitated Buffalo (Bubalus bubalis) Spermatozoa**” during International Symposium on endocrinology and Reproduction: Molecular Mechanisms to Molecular Medicine organised by the Society for Reproductive Biology and Comparative Endocrinology at Special Centre for Molecular Medicine, Jawahar Lal Nehru University and NIHF, New Delhi from 4th – 6th February, 2010.
- **Dr. R. S. Gandhi** was awarded “**Bioved Honorary Fellowship Award - 2010**” by Bioved Research and Communication Centre, Allahabad (UP) on the occasion of 12th Indian Agricultural Scientists and Farmer’s Congress held at Allahabad University, Allahabad from 20<sup>th</sup> – 21<sup>st</sup> February, 2010.



- **Mr. M. Manoj, Dr. R. S. Gandhi, Mr. T. V. Raja, Dr. Avtar Singh and Dr. G. K. Sachdeva** were awarded “**Best Oral Presentation Award**” for the paper entitled “**Genetic Parameters of various First Lactation Traits in Sahiwal Cattle**” by Bioved Research and Communication Centre, Allahabad (UP) on the occasion of 12<sup>th</sup> Indian Agricultural Scientists and Farmer’s Congress held at Allahabad University, Allahabad from 20<sup>th</sup> - 21<sup>st</sup> February, 2010.
- **Dr. B. S. Prakash** presented the prestigious **Dr. C. R. Sane Oration Lecture** in the 25<sup>th</sup> Annual Convention of Indian Society for Study of Animal Reproduction (ISSAR) and International Symposium on Expanding the Horizons of Reproductive Technologies in Global Scenario for Augmenting Fertility in Farm and Pet Animals, held at Veterinary College and Research Institute Namakkal, Tamilnadu from 10<sup>th</sup> - 12<sup>th</sup> Dec., 2009.
- **Dr. (Mrs.) Jancy Gupta** was nominated by Planning Commission, Govt. of India, as Convenor of the Livestock Extension Sub-group of Advisory Committee for development of Animal Husbandry and Dairying and as a member to take up for the task of quick formulation of a new scheme of Livestock Extension incorporating the salient recommendations of the sub-group on Livestock Extension of Planning Commission by Principal Adviser, Planning Commission.
- **Dr. (Mrs.) Jancy Gupta** was re-elected as Associate Editor of Asian Journal of Extension Education, Maharashtra Society of Extension Education.
- **Dr. Heartwin Amaladhas, P. and Dr. Milford A. Hanna** received “**Best Poster Award**” in the field of food packaging - for the poster entitled “**Starch-Whey Protein Isolate Films: Effect of Whey Protein Ratio and Pelleting on Selected Film Properties**” at the 20<sup>th</sup> Indian Convention of Food Scientists and Technologists, Organized by Association of Food Scientists and Technologists (India), 21<sup>st</sup> – 23<sup>rd</sup> December, 2009.
- **Dr. B. Surendra Nath** was Nominated as Editor, Dairy Products for Journal of Food Science and Technology Published by Association of Food Scientists and Technologists (India).
- **Dr. Satish Kulkarni, Dr. B. Surendra Nath and Dr. B. C. Ghosh** were selected as Members in the Scientific Panel on Pesticide and Antibiotic Residues, Food Safety and Standards Authority of India, New Delhi.
- **Dr. B. C. Ghosh** was awarded “**Australian Endeavour Executive Award**” by Australian Government for four months to carry out research work at Victoria University in Melbourne.
- **Mr. A. Kumaresan** was awarded “**Better Opportunities for Young Scientists in Chosen Areas of Science and Technology (BOYSCAST) Fellowship**” by Department of Science and Technology, Ministry of Science and Technology, Government of India to carry out advanced research and training in upstream areas of Reproduction Technology at Division of Reproduction, Swedish Agricultural University, Uppsala, Sweden for a period of one year from (April 1<sup>st</sup> 2010 to March 31<sup>st</sup> 2011) under the guidance of Prof. Dr. Heriberto Rodriguez-Martinez.

- **Mr. D. Vasanth, Mr. Arun Kumar De, Mr. Y. S. Akshey and Dr. Dhruva Malakar** were awarded **"Second Best Paper Award"** for their paper entitled **"A Preliminary Study of Establishment of Embryonic Stem Cells from In Vitro Fertilized Goat Embryos"** by Indian Dairy Association in the Dairy Production Area during the 38th Dairy Industry Conference held at Bangalore, 17 - 19<sup>th</sup> Feb., 2010.
- **Mr. Arvind, A. Rajorhia, Dr. R. R. B. Singh, Dr. A. A. Patel and Dr. G. R. Patil** got **"First Prize in Poster Presentation"** in the subject of Functional Food for paper entitled **"Antihyperlipidemic Effect of Arjuna Ghee (Herbal Ghee)"** at the Indian Convention of Food Scientists held at Bangalore from 21<sup>st</sup> - 23<sup>rd</sup> December, 2009.
- Dairy Technology Division won the **"First Prize"** and Dairy Cattle Nutrition Division was adjudged second among all stalls and different transferable technologies demonstrated and explained to farmers during the Dairy Mela organized by NDRI, Karnal from 24<sup>th</sup> - 26<sup>th</sup> Feb., 2009.
- **Prof. I. K. Sawhney** was awarded **"Best Paper Award"** for his research paper entitled **"Laghu Satar Ke Dugadh Prasanskaran Upkaran"** presented during 11<sup>th</sup> Rashtriya Vigyan Sangoshti at IARI, New Delhi.
- **Ms. Manju G., Mr. N. Kumar, Mr. G. Das and Dr. R. K. Malik** got **"First Poster Presentation Award"** for their poster paper entitled Bacterial Spore Based Iodometric Assay to Monitor Beta Lactum Group of Antibiotic Residues in Milk presented in XXXVIII Dairy Industry Conference held at NIMHANS convention centre Bangalore on 17<sup>th</sup> -19<sup>th</sup> Feb., 2010.
- **Dr. R. C. Upadhyay, Dr. Ashutosh, Dr. S. V. Singh, Dr. S. P. S. Somvansi, Ms. Rita Rani** and **Ms. Radha Rani** received **"First Poster Presentation Award"** for the Research Paper entitled **"Jalvayu Parivertan Me Bhartiya Pashuo Ke Bhumika Ka Yogdan"** at NDRI, Karnal on 14<sup>th</sup> September, 2009.
- **Mr. D. Kumar, Mr. T. Anand, Mr. K. P. Singh, Mr. M. K. Singh, Mr. R. A. Shah, Dr. M. S. Chauhan, Dr. P. Palta, Dr. S. K. Singla and Dr. R. S. Manik** were awarded **"Best Poster Award"** for their paper entitled **"Expression of Transcription Factors and In Vitro Differentiation of Buffalo (*Bubalus bubalis*) Embryonic Stem Cells Cultured on Different Feeder Layers"** at the International Buffalo Conference on Optimizing Buffalo Productivity through Conventional and Novel Technologies held at New Delhi from 1<sup>st</sup> - 4<sup>th</sup> February, 2010.
- **Mr. Vijay Kumar, Dr. Ashwani Sharma, Dr. Avtar Singh and Mr. Madhusudan Tantita** got **"Second Prize"** for their poster paper entitled **"Incidence of Bovine Leukocyte Adhesion Deficiency Cyndrome (BLAD) in Carrier Karan Fries Bulls"** during poster presentation competition on the occasion of Hindi Pakhwada on 14<sup>th</sup> Sept. 2009 at NDRI, Karnal.
- **Ms. Purna Saini, Ms. Aparna Gupta, Dr. (Mrs.) Bimlesh Mann and Dr. Rajesh Bajaj** got **"Third Best Research Paper and Poster Presentation Award"** for their paper entitled **"Anubandhit Jeevanuon Dwara Nirmitt Cheddar Cheese Se Caseinophosphopeptides: Unki Maatraa Avum Pratioxikark Gatividhi Mein Paripakwata Ke Dauraan Parivartan"** on the occasion of Hindi Divas celebrated on 14<sup>th</sup> September, 2009 at NDRI, Karnal.
- **Dr. Dheer Singh** re-elected as National Executive of Indian Society for the Study of Reproduction and Fertility, India.



*Mr. Naveen Jindal, Member Parliament at Livestock Farm of NDRI*

## 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
Multiplication of Superior Germplasm	Establishment and Maintenance of Buffalo Embryonic Stem Cell Lines (M. S. Chauhan)	DBT
Probiotic/Nutraceuticals	Exploring Propionibacteria as a Potential Source of Vitamin B12 and Functional Probiotic Ingredient in a Dairy Based Nutraceutical Formulation (S. K. Tomar)	DBT
Animal Nutrition	Increasing the Anticarcinogenic Potency of Buffalo Milk by Enhancing its CLA Content through Dietary Modification (A. K. Tyagi)	DBT
Animal Nutrition	Mitigation of Methane Emission through Rumen Manipulation for Increased Productivity in Buffaloes (S. K. Sirohi)	DBT
Animal Nutrition	Evaluation of Cellulase and Xylanase (Exogenous Fibrolytic Enzymes) as Feed Additives for Growth and Milk Production in Ruminants (S. S. Thakur)	DBT
Animal Nutrition	Uncertainty Reduction in Methane and Nitrous Oxide Emission from Indian Livestock (Madhu Mohini)	NATCOM
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 ( <i>Capra grunniens</i> L.) and its Hybrid using in vitro Embryo Production Techniques (M. S. Chauhan)	DBT
Functional Foods	Technology for Plant and Dairy Ingredients based Formulated and Functional Foods using Extrusion Technology (A. K. Singh)	Indo-US-Agricultural Knowledge Initiative (AKI - Division)
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-à-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

### 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 Dairy Microbiology, WBUAFS
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)
Milk Enzymes	Development of Simple Enzymatic Tests for Monitoring Heat Treatments in Milk and Milk Products under Pasteurization Conditions (Rajan Sharma)	AP Cess, 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
Quality Assurance	Development of Method for the Detection of Adulteration of Milk with “Soya Milk” (Rajan Sharma)	HSCST, Chandigarh
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

### NAIP Projects

Area	Project/PI	Collaborating Agencies
<b>NDRI as Lead Institute</b>		
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, Adult 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
Proteomics	Analysis of Mammary Gland Transcriptome and Proteome during Lactation and Involution in Indigenous Cattle and Buffalo for Identification of Probable Mammary Biomarkers (A. K. Mohanty)	NBAGR, Karnal, NCHGSR, Punjab University
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
Functional Dairy Products	Novel Approaches for Production of Nutraceuticals 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
Reproduction Augmentation	Value Chain on Zona Free Cloned Embryos for Quality Animal Production from Elite Buffaloes and Pashmina Goats' (S. K. Singla)	SKUAST, Srinagar
E-education	Development of e-course for B.Tech (Dairy Technology) Degree Programme (A.A. Patel)	SVVU, Triupati, AAU, Anand
<b>NDRI as Consortium Partner</b>		
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 (Bhupendra Singh)	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

## 7 EMPOWERMENT OF WOMEN AND MAINSTREAMING OF GENDER ISSUES

The women empowerment trainings and campaigns were organized with the objective to create awareness in the field of dairying and home science, and also impart skill in these areas so that farm women could generate more income from dairying and maintain healthy atmosphere in their respective family. The detail of these programmes is as under:

- Three refresher training programmes on “Clean Milk Production” were organized for 50 farmwomen at villages- Shahpur, Nasirpur Tilla and Subri on 18<sup>th</sup> Feb., 26<sup>th</sup> & 27<sup>th</sup> March, 2010, respectively.
- One awareness campaign on “Women Empowerment through Dairy Self Help Group” was organized for 12 farmwomen at village- Shahpur on 9<sup>th</sup> Feb., 2010.
- Two training programmes were organized on “Achar Preparation from Fruits & Vegetables” for 76 farmwomen belonging to SC/ST category at KVK Uchani on 23<sup>rd</sup> December, 2009 and 12<sup>th</sup> January, 2010, respectively under Inter- Institutional Women Empowerment Programme.
- Two training programmes were organized on “Scientific Dairy Farming” for 79 rural women at KVK Uchani on 19<sup>th</sup> December, 2009 and 26<sup>th</sup> January, 2010, respectively under Inter- Institutional Women Empowerment Programme.



*Extension functionaries being taught about silage making*

- Three training programmes on “Capacity Building of Farmwomen in Dairy Farming” were organized for 83 rural women at villages- Subri, Nasirpur Tilla and Shahpur on 11<sup>th</sup> June, 2009 and 17<sup>th</sup> -18<sup>th</sup> & 24<sup>th</sup> -25<sup>th</sup> March, 2010, respectively.
- Two training programmes on “Dairy Milk Products” were organized for 35 rural women at villages- Subri, and Shahpur on 8<sup>th</sup> Sept., and 20<sup>th</sup> Nov., 2009 respectively.
- Three awareness campaigns were organized on “Balance Diet for Children, Pregnant and Lactating Mothers” for 40 rural women at

villages- Ganjogarhi, Kulweheri on 12<sup>th</sup> Aug., 12<sup>th</sup> Nov., and 17<sup>th</sup> Nov., 2009 respectively.

- One vocational training programme on “Paneer Making and Tomato Sauce” was organized for 31 rural women at village- Subri on 10<sup>th</sup> -11<sup>th</sup> Nov., 2009.
- Thirteen training programmes were organized for Rural Women and girls in the areas of preservation of fruits & vegetables, preparation of tomato ketchup, milk based sweets, minimization of nutrient loss, value added milk products, kitchen gardening & its importance, child care and nutrition, and storage of food grains participated by 322 women from KVK adopted villages, NDRI, Karnal.
- During sponsored training programmes organized by KVK & DTC, NDRI in Scientific Dairy Farming for farmers and farmwomen, 96 farm women from Himachal Pradesh and Bihar were imparted training and they were explained and demonstrated the relevant dairy production and processing technologies.
- KVK celebrated Technology Week from 30<sup>th</sup> November, 2009 to 5<sup>th</sup> December, 2009. During the week the various technologies ready for dissemination were demonstrated to about 100 farmwomen. They were also shown various activities of the Institute including Cattle Yard and Experimental Dairy.
- KVK organized a function on the eve of **Women in Agriculture Day** on 4<sup>th</sup> December, 2009 in which around 100 farmwomen from different villages of Karnal district participated. They were apprised of the recent developments in dairy farming and also activities of the Kendra.



*Extension Functionary being honoured during Women in Agriculture Day celebrated at KVK*

- About 50 farmwomen from KVK, NDRI, Karnal adopted villages were taken to Paddy Mela organized by CCS, HAU, RRS, Kaul, distt. Kaithal on 24<sup>th</sup> September, 2009 to acquaint them with the latest developments in Paddy Crop production.

- More than 250 farmwomen from KVK adopted villages and other states were mobilized for their participation in Dairy Mela organized on 26-28<sup>th</sup> March 2009 by NDRI Karnal.
- About 150 farmwomen from KVK adopted villages were taken to Ganna Mela organized by CCS, HAU, RRS, Uchani in Karnal district on 29<sup>th</sup> Sept., 09.
- During the period under report, 3 awareness programmes on Biodiversity & Environmental issues were organized in KVK, NDRI adopted villages in which 310 farm women participated.
- During World Breast Feeding Week, KVK, NDRI organized a programme on Child Care & Nutrition on 6<sup>th</sup> August 2009 in village Uncha Samana about 70 rural women participated.
- A training programme of five days duration was organized in entrepreneurship development in block printing for 14 women trainees from adopted villages of KVK, NDRI, Karnal.
- A training programme of 32 days duration was organized in “Stitching of Ladies Garments” for 13 women trainees in adopted village Palnagar of KVK, NDRI, Karnal.
- One training programmes on “Clean Milk Production” was organized for 31 rural/farm-women of Karnal district at KVK, NDRI, Karnal.
- Two training programmes of two days duration each in Entrepreneurship Development through value added Milk Products i.e. Paneer Making and Khoa making for self employment generation were organized for 53 farm women of Self Help Groups from adopted villages of KVK, NDRI, Karnal.



*World breastfeeding week celebrated in KVK adopted village Unchasmana*

- A seminar on Financial Literacy and Agricultural Diversification was organized in association with the Oriental Bank of Commerce (OBC) on 26<sup>th</sup> Dec., 2009 at NDRI, Karnal for 50 farm women.
- One training programme of three days duration on “Vermicompost Making & its Importance in Organic Farming” was organized for 11 rural women at KVK, NDRI, Karnal. Most of the rural women trained have adopted this technology.
- A training programme on Scientific Dairy Farming for 19 women extension functionaries was organized by KVK & DTC, NDRI, Karnal.
- Two capsule courses on Dairy Cattle Management were organized for the Ichhamati Milk Union in 24 (N) Parganas on 18<sup>th</sup> - 22<sup>nd</sup> and 22<sup>nd</sup> - 26<sup>th</sup> Feb., 2010, respectively. A total number of seventeen women members participated.
- Three orientation programmes of one day duration were organized on 5<sup>th</sup> - 16<sup>th</sup> Jan. and 21<sup>st</sup> Feb., 2010 in which 79 woman dairy unit members participated and interacted with the scientists on improved dairy management practices. The programmes were organized on the request of the Lokhatia Farmers’ Welfare Society, an NGO in 24 (N) Parganas.
- Three Induction programmes were organized for woman members of Ichhamati Milk Union, 24 (N) Parganas, on 16<sup>th</sup> - 20<sup>th</sup> and 27<sup>th</sup> Feb., 2010 in which 83 women participated. In these programs awareness and knowledge about improved dairy management and clean milk production were emphasized upon.



*Sports contingent from Bara Pani (North East) during ICAR Inter-Zonal Sports Meet held at NDRI from 12-14<sup>th</sup> Dec., 2009*

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## Animal Biotechnology Centre

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## 9 CONSULTANCY, PATENTS & COMMERCIALISATION OF TECHNOLOGIES

### INDUSTRIAL CONSULTANCY SERVICE

In pursuance of the technology policy of Govt. of India which lays stress on the development of indigenous technologies and their effective transfer to industry, a Consultancy Service Board has been established at NDRI, Karnal. The 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 2009 to March 2010, the Board provided services to 424 organizations and generated a total revenue of Rs.43,72,552/-.

#### Contract Research Projects/Consultancy Projects/Consultancy

- "Effect of Feeding of Feed Supplement Concentrate Cow & Buffaloes on Milk Production in Cow & Buffaloes Breed" sponsored by M/s Godrej Agrovet Ltd., Mumbai (Dr. J. P. Shegal).
- "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).
- "Climate Change Concerns vis-a-vis Livestock and Dairy Products in India" sponsored by Wintrock International India, New Delhi (Dr. R. C. Upadhayay).

#### Consultancy Services

- Consultancy for setting of Dairy Farm to Dev Arjuna Promoters and Dev. Pvt. Ltd., Ludhiana (Dr. M. L. Kamboj).
- Consultancy for setting of Dairy Farm to Arun Bihani, 168 B, Ranjeet Avenue, Amritsar (Dr. M. L. Kamboj).
- Consultancy for setting of Dairy Farm to Mr. Mohit Jain, "Vandana" Dehradun (Dr. M. L. Kamboj).
- Consultancy-cum-Short Training Course to Panjab Dairy Development Board, Chandigarh from 28th July to 3rd August, 2009 (Dr. Rajesh Bajaj).
- Consultancy-cum- Short Training Course on "Basic Microbiology for Nestle Employees" to M/S Nestle India Limited, Gurgaon from. 23rd - 24th September, 2009 (Dr. Naresh Goel).
- Consultancy for setting of Dairy Farms to Goodricke Group of Companies, Camellia House, 14, Gurusaday Road, Kolkata and Eastern Milk Products Pvt. Ltd., Purnia, Bihar, Indi-Swift Limited, Chandigarh, Ambootia Soil and More Pvt. Ltd., Kolkatta, M/s Maa Durga Dairy Farm, Yamunanagar, respectively (Dr. M. L. Kamboj).
- Supply of Microbial Culture, Sale of Semen, Analysis of Milk and Milk Products Samples and the Services Rendered during the year (including Training of the Students from Various Academic/Research Institutions).

#### Technologies Transferred

- Detergent Kit and Antibiotic Kit through NRDC, New Delhi.
- Acido Whey Soft Drink through NRDC, New Delhi.
- TOT Calcium fortification of Milk through NRDC, New Delhi.

#### Gross Revenue Generation

- Contract Research Rs. 5,46,028/-
- Contract Services Rs.17,93,086/-

• General/ Advisory Consultancy	Rs. 3,85,461/-
• Licencing/Royalty/ Certification/TOT	Rs. 3,40,866/-
• Training	Rs. 13,07,111/-
Grand Total	Rs. 43,72,552/-

### Intellectual Technology Management Committee (ITMC)

ITMC regularly meets to examine IPR issues and provides all support to file patent applications. The patent applications cleared by ITMC are then sent to National Research Development Corporation (NRDC), Delhi for submitting to patent office. ITMC also takes steps to invite experts to give lectures on IPR issues. Dr. R. K. Sharma, Managing Attorney for the elite Intellectual Property Law Firm “IP Jurix” with Offices at Delhi, Lucknow and Bangalore, delivered two lectures on (i) IP Coverage, Issues and Basics of Patenting and Patentable Research and (ii) Case Histories and Issues concerning Technology transfer and Commercialization of patented Technology on 24-10-2009. ITMC meetings were held on 15-07-2009, 24-10-2009 and 29-03-2010.

Institute Technology Management Unit (ITMU) has also been re-constituted. It includes (i) Dr. Y. S. Rajput (ii) Dr. Rajeev Kapila (iii) Dr. Rajan Sharma and (iv) Dr. Naresh Kumar. The ITMU is a functional unit which works under the guidance of ITMC.

### Patent Applications Filed (2009-10)

- Enhancement of value addition of khoa production through herbal feed additives from cow milk. (Mayank Tandon and S. N. Rai), Patent Application No. 1256/DEL/2009 dated 18.06.2009.
- Enhancement of value addition of condensed milk through herbal feed additives from cow milk (Mayank Tandon and S. N. Rai), Patent Application No 1843/DEL/2009 dated 17.9.2009.
- Enhancement of value addition of milk powder production through herbal feed additives from cow milk. (Mayank Tandon and S. N. Rai) Patent Application No 1844/DEL/2009 dated 17.9.2009.
- Process for the preparation of folate rich functional ‘Dahi’, (Ramya Iyer and S. K. Tomar), Patent Application No 2345/DEL/2009 dated 13-11-2009.
- An improved and optimized process for manufacture of Doda Burfi (G. R. Patil, Rekha Chawla and A. K. Singh), Patent Application No 2357/DEL/2009. dated 16-11-2009.
- Synbiotic Ice Cream and process for the preparation thereof. (Omkar Kumar, T. Rai and R. K. Malik), Patent Application No 2729/DEL/2009 dated 30-12-2009.
- Three stage thin film scraped surface heat exchanger for continuous manufacture of khoa, (A. K. Dodeja, Dharam Pal and S. P. Agrawala), Patent Application No 583/DEL/2010 (Provisional), dated 12-03-2010.



ITMC Meeting in Progress

## 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 research organizations at National and International levels; research monitoring through internal and external mechanisms; development of research database and technology bank and research documentation by undertaking publications of the Institute are the major functions existing and visualized to achieve the mandate of the Institute by R&D activities.

### Research Advisory Committee (RAC)

The main functions of the RAC are i) to suggest research programmes based on national and global context 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 18th - 19th July and 24th December, 2009 at NDRI, Karnal. The other Expert members who attended the meetings were Dr. J. S. Dhillon, Dr. V. P. Chitale, Ch. Ved Pal, 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. The proceedings of the RAC Meeting were documented and the recommendations of RAC were categorized under different heads such as Policy, Technical, Administrative etc. as per the directives from the Council.

### 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-localational projects. The mid-term review of IRC projects of NDRI was taken up during 4th to 8th, 11th to 12th, 18th August and 13th Oct., 2009 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 6th Feb., and 16th to 19th March, 2010. At these meetings, new proposals for research projects to be initiated from the year 2010 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 nineteen NAIP projects; for eight NDRI is the them as consortium leader. The total budget outlay is Rs. 3271.82 lakhs. Although major thrust of NAIP projects at NDRI is on basic and strategic research, best with the award of NAIP project on 'e-courses on Dairy Technology' dairy education will also get boost. During the year, three NAIP projects viz. (i) Novel Approaches for Production of Nutraceuticals from Milk and Indian Herbs for Potential Use in Functional Dairy Foods'; CPI- Dr. R. R. B. Singh, (ii) 'Molecular basis of capacitation like Changes in the Assessment and Prevention of Cryodamage during Cryo-preservation of Bovine Spermatozoa (Buffalo and Crossbred Bulls)'; CPI- Dr. S. K. Atreja and (iii) 'Development of e-courses for B, Tech (Dairy Technology) Degree Programme' were launched. A number of laboratories are renovated and high costs equipments are either purchased or are under way. With the availability of high cost equipments and budget provisions



DBT task force meet



*Research Advisory Committee Meeting held on 24<sup>th</sup> Dec., 2009*



*Review Meeting of PMAC in progress*

under recurring head, NDRI has become obvious preferred place for carrying out basic research. The facilities are being used by students in pursuing research work in front line areas such as cloning, stem cell, nanotechnology, biosensor, proteomics and genomics.

Consortium Implementation Committee (CIC) and Consortium Advisory Committee (CAC) Meetings 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.

### Database Management

A database of research projects was updated for all the projects in operation during the year 2009. The project numbers were allotted discipline wise as per the codes laid out by the ARIS section of ICAR. 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 2008-2009 was edited and published through this cell. Research Projects of the Institute were also documented under the Research Programmes 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 2009 - 2010. 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; Database on innovative agricultural technologies developed for SAARC countries. 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 (2009) covering relevant points relating to the Institute and also prepared comments of the Institute in terms of Action Taken Report on recommendations made in the proceeding of Directory’s Conference of ICAR Institute (2010); Institutional performance in respect of NDRI; Establishment of linkages with various organizations; IPR issues; Provided information under Right to Information Act, 2005; Information on technologies developed,

transferred and commercialized; Prepared concise report on the achievements (last 5 years) of the Institute; performance of goat herd maintained at NDRI; Consolidated the list of NDRI research publications published in various National and International Research Journals (2007-2009) for CeRA impact study; Consolidated information regarding findings recorded on the experimental trails conducted on oxytocin, details of indigenous products developed through research during last years, details of R&D activities being undertaken under Network Project and any research being carried out on Nano-technology in milk processing; Consolidated information with regard to broad areas of research with respective mentors to host candidates for developing countries under CCSTDS fellowship programme; Compiled the information and prepared Action Taken Reports based on the recommendations made in the proceeding of the 20th Regional Committee Meetings No. V of ICAR. 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. The RCM unit forwarded research papers/popular articles for publication in scientific journals. 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-5 Identification of genetic polymorphism for performance traits in Sahiwal cattle and Murrah buffaloes. I. D. Gupta, Archana Verma, A. K. Chakaravarty and R. S. Gandhi (2006-2009)
- 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 (2008-2009)
- 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. Srinivas (2008-2010)
- A-22 Studies on the effect of oviductal secretory proteins for in vitro maturation and fertilization of cattle oocytes. S. K. Dass, D. K. Sharma, A. K. Mohanty, A. Santra and A. Chatterjee (2008-2009)

- 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 (2009-2009)
- 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)
- B. RESEARCH PROGRAMME: DEVELOPMENT OF STATE-OF-THE-ART DAIRY PRODUCTION SYSTEMS USING BETTER HOUSING AND FERTILITY MANAGEMENT PRACTICES**
- B-1 Participatory research for evaluation of promising technologies for augmenting quality milk production in peri-urban dairying. S. S. Kundu, S. K. Sirohi, G. Sankhala, and B. S. Punia (2007-2009)
- B-3 Effect of biological stressors and immunomodulators on lymphocyte function in buffaloes. Sujata Pandita, R. C. Upadhyay and Manju Ashutosh (2006-2009)
- B-5 Thermal stress relief requirements of cattle and buffaloes. R. C. Upadhyay, S. V. Singh, Parveen Kumar, T. K. Mohanty and A. K. Sharma (2007-2009)
- B-6 Impact of stress on immune responses, antioxidants status, stress hormone and milk production of crossbred cattle. S. V. Singh, R. C. Upadhyay, Parveen Kumar and S. S. Kundu and S. De (2007-2009)
- B-7 Interrelationship between Heat Shock Protein ((HSP-70) and physiological states in Zebu and crossbred cattle exposed to thermal stress. Ashutosh, Manju Ashutosh and R. C. Upadhyay (2007-2009)
- B-10 Climatic effects on metabolic and oxidative status in peri-parturient cows in relation to production responses. Anjali Aggarwal, Ashutosh, Veena Mani, Parveen Kumar and Harjeet Kaur (2007-2009)
- B-11 Studies on nutritional, endocrinal and reproductive profiles in lactating Deoni cattle. B. Srinivas, 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-Dec., 2010)
- Development of model dairy unit using state of the art management system for dairy cattle and buffaloes. Shiv Prasad (2006-2009)
  - Development of feeding management practices for high yielding cattle and buffaloes including automated feed dispensing system. A. K. Tyagi (2006-2009)
  - Development of computer assisted herd management information system. T. K. Mohanty (2006-2009)
  - Improved feeding and management of dairy heifers for early sexual maturity and higher productivity. M. L. Kamboj (2006-2009)
- 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 (2009-2009)
- B-15 Study of vocalization patterns of Sahiwal cows. S. S. Lathwal, A. P. Ruhil and T. K. Mohanty (2009-Dec, 2009)
- B-16 Hormone release and behaviour during milking in Murrah buffaloes Mahendra Singh, Anjali Aggarwal 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. Katakaltware, A. Obi Reddy and B. Srinivas (2009-2010)

**C. RESEARCH PROGRAMME: 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-5 Comparative performance of rye grass, oats and chinese cabbage in mixture with berseem in terms of fodder yield and quality. D. S. Sohi, A. S. Harika and S. K. Tomer (2006-2009)
- C-6 Effect of sowing time and harvesting stage on yield and quality of green fodder and grains of dual-purpose wheat varieties. A. S. Harika, K. K. Singhal and D. S. Sohi (2007-2009)
- C-7 Fortification of low-grade roughage based complete feed blocks with ruminal fungal zoospores J. P. Sehgal, and A. K. Punia (2007-2011)
- C-8 Studies on proximate composition and dietary protein & fiber fractions in concentrate ingredients and fodders at different stages of maturity. A. Chatterjee, R. B. Singh, A. Santra and P. K. Roy (2007-2009)
- C-9 Dietary manipulation of rumen fermentation to study the nutrient utilization and growth performance of calves. A. Santra, S. K. Das and A. Chatterjee (2006-2009)
- C-10 Evaluation of certain binding agents/nutrients of counteract heavy metals toxicity in crossbred calves. Veena Mani, Harjit Kaur and Neelam Kewalramani (2005-2009)
- C-12 Supplementation of feed additives to improve rumen fermentation in relation to mitigation of methane emission in indigenous breeds. Madhu Mohini, K. K. Singhal, S. K. Sirohi, Veena Mani and Shiv Prasad (2007-2009)

- 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, M. Mukesh (NBAGR) and S. S. Kundu (2009-Dec., 2009)

**D. RESEARCH PROGRAMME: 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. Thompson, Suman Kapila 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 and Satish Kulkarni (2007-2009)

- D-6 Evaluation of diagnostic kits for cholesterol estimation in ghee and development of a method for estimation of residual adsorbent in low-cholesterol ghee. Vivek Sharma, Sumit Arora, Dharshan Lal, B. K. Wadhwa and Raman Seth (2007-2009)

- D-12 Development of functional food ingredients by enzymatic modification of whey proteins. Bimlesh Mann, Rajesh Bajaj, Shilpa Vij and B. K. Wadhwa (2007-2009)
- D-13 Immunomodulatory and bone health promoting biofunctional peptides of milk origin. Suman Kapila, A. K. Dang, Sumit Arora and Rajeev Kapila (2007-2009)
- D-15 Development of probiotic Direct Vat Set (DVS) ferment (s) for short set dahi. Chand Ram, M. K. Bhavadasan and K. Jayaraj Rao (2007-2009)
- D-16 Protection of intestinal epithelial cells from camptothecin induced cytotoxicity with bioactive peptides obtained from milk fermented with a probiotic lactobacillus. P. K. Aggarwal, and Suman Kapila (2008-2009)
- 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-18 Analysis of sweetener blends (aspartame x acesulfame-k & aspartame x saccharin) and their stability in whey beverage. Sumit Arora, Vivek Sharma, B. K. Wadhwa, A. K. Singh and S. K. Tomer (2008-2009)
- D-19 Studies on antioxidant potential of milk-fruit preparations. Rajesh Kumar, 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 and F. Magdaline Eljeeva Emerald (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)
- E. RESEARCH PROGRAMME: VALUE ADDITION TO TRADITIONAL MILK PRODUCTS THROUGH APPLICATION OF NEW PROCESSES, BIOTECHNOLOGICAL INTERVENTIONS, PACKAGING AND MECHANIZED MANUFACTURING SYSTEM**
- E-1 Studies on the manufacture of dairy whitener employing ultrafiltration technology. V. K. Gupta and G. R. Patil (2005-2009)
- E-2 Development of raabdi-like cereal based traditional fermented milk foods with extended shelf life. S. K. Kanawjia, S. K. Tomar (DM), F. C. Garg and A. K. Singh (2006-2009)
- E-3 Development of Quarg type fresh cheese with enhanced health attributes and shelf life. S. K. Kanawjia, A. K. Singh and Surajit Mandal (2007-2009)
- E-8 Development of a mechanized system for production of malai laccha. R. K. Kohli, Bikram Kumar and I. K. Sawhney (2007-2009)
- 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 (2008-2009)
- E-11 Performance evaluation of thin film SSHE for continuous manufacture of burfi. A. K. Dodeja, Bikram Kumar and P. S. Minz (2008-2009)
- E-12. Characterization and process standardization for production of Khoa-Jalebi. C. N. Pagote 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)
- F. RESEARCH PROGRAMME: 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-2 Development of a bacteriocin based formulation for mastitis therapy. R. K. Malik,

- Naresh Kumar, R. C. Upadhyay and Shiv Prasad (2006-2009)
- 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-4 Evaluation and augmentation of *in vitro* phagocytic activity of bovine milk neutrophils. A. K. Dang, Suman Kapila, Charan Singh. Rajeev Kapila and A. K. Mohanty (2007-2009)
- F-7 Structure-active relationship (SAR) analysis of alamethicin and phospholipids from alamethicin sensitive and resistance pathogenic/spoilage G<sup>+</sup>ve bacteria. S. K. Sood (2007-2009)
- 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<sup>+</sup>ve bacteria. S. K. Sood, V. K. Kansal and A. K. Mohanty (2009-2010)
- G. RESEARCH PROGRAMME: PROMOTING DAIRY ENTERPRISE THROUGH TRANSFER OF TECHNOLOGIES, IMPROVED FARM FINANCING, SUPPLY CHAIN MANAGEMENT, AND BETTER MARKET ACCESS**
- G-2 Statistical evaluation of economic traits of cattle on milk production at organized dairy farm. Ravinder Malhotra, K. K. Kalra, D. K. Jain and Avtar Singh (2006-2009)
- 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. Chakarvarty, Ravinder Malhotra and A. P. Ruhil (2007-2009)
- G-8 An economic study of buffalo marketing in Haryana State. J. P. Dhaka, B. S. Chandel, A. K. Chauhan and Smita Sirohi (2007-2009)
- G-12 Strategic nutrient supplementation for enhancing milk & reproductive performance in dairy animals under field conditions - An Action Research. Gopal Sankhala, S. S. Thakur, K. S. Kadian, J. P. S. Chauhan, S. S. Kundu and S. K. Jha (2007-2009)
- G-13 Human resource development of rural youth for dairy based enterprises: An action research. Ritu Chakravarty, Khazan Singh, Ram Kumar and D. S. Brar (2007-2009)
- 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 (2007-2009)
- G-15 Impact of training programmes and exposure visits in scientific dairy farming in district Sirmour of Himachal Pradesh. Dalip K. Gosain, Sanjay Kumar, K. K. Chadha (KVK, Dhaulakuan, Distt. Sirmour) (2007-2009)
- 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 Sentil 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-20 Studies on crossbred dairy production systems of Kerala States. A. Obi. Reddy, P. K. Dixit, D. N. Dass and B. Srinivas (2008-2009)
- G-21 Economic analysis of manufacture 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-23 The distribution and utilization pattern of bank credit for livestock development in Nadia and Burdhan districts of West Bengal. Lotan Singh, R. A. Dey and P. K. Roy (2008-2009)
- G-24 A study of the peri-urban milk production units in Kalyani, West Bengal and their potential for clean milk production and profitability. R. A. Dey and M. Singh (2008-2009)
- 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)
3. Establishment and maintenance of buffalo embryonic stem cell lines (DBT). M. S. Chauhan, P. Palta, R. S. Manik, S. K. Singla and S. L. Goswami (Sept., 2006- Sept., 2009)
4. Network Project on buffalo improvement (CIRB, Hisar-125001 (Haryana) -Network Project Nodal Officer. R. S. Gandhi (1-4-2007-31-3-2009)
5. 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)
6. 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)
7. 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)
8. 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)
9. 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)
10. 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)
11. Molecular basis of capacitation like changes in the assessment and prevention of cryodamage during cryopreservation of bovine spermatozoa (Buffalo and Crossbred

## B. EXTERNALLY FUNDED PROJECTS

### A. RESEARCH PROGRAMME: GENETIC IMPROVEMENT OF MILCH ANIMALS THROUGH IDENTIFICATION AND DISSEMINATION OF SUPERIOR GERMLASM BY APPLICATION OF EMERGING REPRODUCTIVE AND MOLECULAR TECHNOLOGIES

1. Identification of Quantitative Trait Loci in the Genome of Indigenous Breeds of Cattle and Buffaloes and their propagation through Marker Assisted Selection. (National Fellow) Dr. B.R. Yadav (Five years 2004 - 2009)
2. Buffalo production and reproduction genomics at NDRI-Karnal (Under Niche Area ICAR) T. K. Datta (2006-2009)

- 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)
12. 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)
  13. Developmental potency of parthenogenetic goat embryos- NAIP. D. Malakar, A. K. Mohanty and J. K. Kaushik (Jan, 2009- March, 2012)
  14. 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)
  15. Bio-prospecting of genes and allele mining for abiotic stress tolerance-NAIP. R. C. Upadhyay and S. De. (2009-2012)
  16. 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)
  17. Mechanism cholesterol transfer into milk a comparative gene expression and metabolism study in buffaloes and cattle - DST-DAAD. B. S. Prakash, A. K. Mohanty and A. K. Dang (2009-2011)
  18. Comparative analysis of epigenetic regulation of the CYP-19 gene in buffalo and cattle - DST-DFG. Dheer Singh and M. S. Chauhan (2008-2010)
  19. Molecular characterization of a semi domestic cattle breed of Jammu and Kashmir-SMS, KVK, Doda, SKUAST- Jammu. S. De (2008-2011)
  20. Application of reverse genetics: A novel approach for studying the molecular basis of immune response in Indian cattle feed-NAIP. D. N. Dass (2009-2012)
- B. RESEARCH PROGRAMME: 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. Upadhyay, 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 and Mukand Katakataware (SRS) (2007-2012)
  4. Development of plasma catecholamines assays for evaluation of sympathetic neuronal function and milk production performance in heat stressed cows - DAE. Mahendra Singh (2009-2012)
- C. RESEARCH PROGRAMME: RAISING PRODUCTIVITY OF DAIRY ANIMALS THROUGH IMPROVED FEEDING STRATEGIES, EFFICIENT NUTRIENT UTILIZATION AND USE OF NON-CONVENTIONAL FEED RESOURCES**
1. Increasing the anti-carcinogenic potency of buffalo milk by enhancing its CLA Content through dietary modification-DBT. A. K. Tyagi, Neelam Kewalramani, Harjit Kaur and K. K. Singhal (June, 2006-June, 2009)
  2. Evaluation of cellulase and xylanase as feed additives for growth and milk production in ruminants-DBT. S. S. Thakur, S. K. Tomer and S. K. Sirohi (Sept., 2006-Sept., 2009)
  3. 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)
  4. Rumen microbial manipulations for mitigation of methane emission and productivity enhancement in dairy animals-NFBSRA. S. K. Sirohi, L. C. Chaudhry (IVRI), M.Chandrasekharaiah (NIANP, Bangalore) and A. Santra (2007- 2012)
  5. 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 (Jan-2008 to Dec, 2009)

6. 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 PROGRAMME: 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 (2007-2009)
  2. Exploring Propioni bacteria as a potential source of vitamin B-12 and functional probiotic ingredient in a dairy based nutraceutical formulation-DBT. S. K. Tomer, Rajan Sharma, Sunita Grover and Y. S. Rajput (April, 2006-April-2009)
- E. RESEARCH PROGRAMME: VALUE ADDITION TO TRADITIONAL MILK PRODUCTS THROUGH APPLICATION OF NEW PROCESSES, BIOTECHNOLOGICAL INTERVENTIONS, 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, M. K. Bhavadasan, 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 nutraceuticals 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, A. A. Patel (2009-2012)
- F. RESEARCH PROGRAMME: 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 method for the detection of adulteration of milk with 'Soya Milk'-HSCST. Chd. Rajan Sharma, Y. S. Rajput (Feb., 2007-Feb., 2009)
  2. Development of simple enzymatic tests of monitoring heat treatment in milk and milk products under pasteurization conditions- Ap-Cess Fund. Rajan Sharma, Y. S. Rajput and Rajesh Kumar (2005-2009)
  3. 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) R. K. Malik and Raghu H. V. (Jan-2008 to March, 2012)
  4. Detection and mitigation of dairy pathogens and detection of adulterants using chemical biology - NAIP. Y. S. Rajput, Rajan Sharma and Naresh Goe (Jan-2009 to March, 2012)
  5. Monitoring of drug residues and other environmental pollutants - Out Reach Project. N. K. Goyal and Raghu, H.V. (2008-2012)
- G. RESEARCH PROGRAMME: 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/B. S. Chandel (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) IRC Meeting at ERS on February 6, 2010

# 11 HUMAN RESOURCE DEVELOPMENT

## SCIENTISTS/OFFICERS/SCHOLARS TRAINED ABROAD

**Dr. S. K. Das**, Senior Scientist, Dairy Biotechnology Section, Eastern Regional Station, NDRI, Kalyani deputed to avail Biotechnology Overseas Associateship, 2007-2008 (short term) awarded by DBT, Govt. of India, Ministry of Science & Technology, New Delhi at Stem Cell Lab, UNSW, Sydney, Australia for a period six months from January to June, 2009.

**Dr. R. R. B. Singh**, Sr. Scientist, Dairy Technology Division visited Sweden on deputation from 1st - 5th July, 2009 for attending 1st overall meeting-cum-workshop of ISEKI-Mundus 2-Internationlization and Sustainability of ISEKI Food Network.

**Mr. Manoj Kumar**, Ph.D. Scholar, Dairy Microbiology Division (Major Advisor: Dr. P. K. Aggarwal, P.S.) was granted a foreign scholarship to visit and present a paper entitled "Anticarcinogenic role of Probiotic fermented milk against aflatoxin B1 induced rat liver carcinogenesis" in the Fifth Conference for the Asia Federation of Societies for Lactic acid bacteria during 30th June - 4th July, 2009 at National University, Singapore.

**Dr. Rajesh Kumar**, Sr. Scientist, Dairy Chemistry Division visited the Netherlands on deputation from 29<sup>th</sup> Sept. to 4<sup>th</sup> Oct., 2009 to present poster paper entitled "Effect of Enzymatic Treatment on Antioxidant Activity of Buffalo Milk Protein" at 6<sup>th</sup> NIZO Dairy Conference - Dairy Ingredients: Innovations in Functionality held at Papendal, the Netherlands. The visit was taken under NAIP project on "Novel approaches for production of nutraceuticals from milk and Indian herbs for potential use in functional dairy foods".

**Mr. Dheeraj Mohania**, Ph.D. student of Dr. V. K. Kansal, Head Division of Animal Biochemistry was granted foreign scholarship to deliver a lecture in the Fifth Conference for Asia Federation of Societies for Lactic acid bacteria during 30<sup>th</sup> June 4<sup>th</sup> July, 2009 at National University Singapore.

**Dr. B. S. Chandel**, Principal Scientist, Dairy Economics Statistics & Management - was deputed to avail Commonwealth Academic Staff Fellowship - 2009 for carrying out research work on "Development of Multi-Market for Policy Analysis of Dairy Sector" in U.K. for 6 months from 7<sup>th</sup> October, 2009 to 1st April, 2010.

**Dr. Dheer Singh**, Sr. Scientist, Animal Biochemistry was deputed to avail advance training under

NAIP consortia project entitled "Elucidating the Physiological and Genomics Regulation Process of Follicular Development, Oocyte Maturation and Embryogenesis in Buffalo" at USA from 30th March to 15<sup>th</sup> June, 2009.

**Dr. Dheer Singh**, Sr. Scientist, Animal Biochemistry was deputed to avail training under Joint Indo-German Collaborative Research Project (DST-DFG) entitled "Comparative Analysis of Epigenetic Regulation of the *Cyp 19* Gene in Buffalo and Cattle" at Germany from 24th Nov., to 14<sup>th</sup> Dec., 2009.

**Dr. A. K. Mohanty**, Sr. Scientist, Animal Biotechnology Centre was deputed to avail training in the area of Proteomics under NAIP Project at USA from 3<sup>rd</sup> to 16<sup>th</sup> Dec., 2009.

**Dr. A. K. Dang**, Sr. Scientist, Dairy Cattle Physiology was deputed to avail training for Implementation of the DST-DAAD joint research project entitled "Mechanisms of Cholesterol ... in Buffaloes and Cattle" at Germany from 13th October to 12<sup>th</sup> Nov., 2009.

**Dr. G. R. Patil**, Joint Director (A) attended the Global Entrepreneurship Leadership Symposium (GELS) at Berkeley California at Walter A Hass School of Business from 17<sup>th</sup> - 25<sup>th</sup> November, 2009.

**Dr. A. K. Punia**, Principal Scientist, Dairy Microbiology Division was deputed to attend 3rd International Conference on "Environmental, Industrial and Applied Microbiology" at Lisbon, Portugal from 2<sup>nd</sup> - 4<sup>th</sup> Dec., 2009.

**Dr. Vijay Kumar**, Principal Scientist, Dairy Technology Division was deputed to avail International training on "Creation of e-learning Modules/multimedia Development Learning Management System, e-Courseware Creation etc. and Hosting for Agricultural Sciences etc." under NAIP project at Cornell University, USA from 10th March to 28<sup>th</sup> March, 2010.

**Dr. D. Malakar**, Sr. Scientist, Animal Biotechnology Centre was deputed to attend 36th Annual Conference IETS/23rd Annual Meeting SBTC held at Cardoba, Argentina from 6<sup>th</sup> - 16<sup>th</sup> January 2010.

**Dr. A. K. Singh**, Sr. Scientist, Dairy Technology Division was deputed to avail Erasmus Mundus

Scholarship on the subject “Food Science, Technology and Nutrition” at Belgium, Ireland & Germany from 14<sup>th</sup> Feb. to 14<sup>th</sup> May, 2010.

**Dr. Rajan Sharma**, Sr. Scientist, Dairy Chemistry Division was deputed to avail training on “Lateral Flow Separation of Aptamer-linked Quantum Dots & Nanoparticles” from 10<sup>th</sup> March to 8<sup>th</sup> May, 2010 at USA.

**Dr. J. K. Kaushik**, Sr. Scientist, Animal Biotechnology Centre was deputed to avail training on Proteomics under NAIP project at USA from 30<sup>th</sup> March, 2010 to 12<sup>th</sup> April, 2010.

**Dr. (Mrs.) Suman Kapila**, Sr. Scientist, Animal Biochemistry Division was deputed to avail training on Nutraceuticals under HRD Programme on NAIP at USA from 31<sup>st</sup> March to 30<sup>th</sup> June, 2010.

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

Name & Designation	Title of Workshop/Seminar/Conferences Training	Period
Sh. I. K. Sawhney, PS Dr. Shiv Prasad, PS	11 <sup>th</sup> Vigyanik Sangoshthi “Saptrangi Kranti Hetu Krishi Avam Pashupalan Samekit Pranaliyan: Anusandhan Uplavdhyan Avam Raneeti” at IVRI, New Delhi	13th -15th April, 2009
Dr. S. K. Atreja, PS Dr. M. S. Chauhan, PS Dr. Naresh Kumar, Sr. Sci. Dr. R. R. B. Singh, Sr. Sci. Dr. Sachinandan De. Sr. Sci.	1st Annual Workshop of the Component-4 at IVRI, Izatnagar.	14th -15th April, 2009
Dr. (Ms) Sunita Grover, PS Dr. V. K. Batish, Emeritus Sci.	Symposium on “Probiotic” and to Participate in the Round Table Discussion on “Probiotic: Science for better Nutrition” by Nestle India at Hotel Hyatt, Mumbai.	18th -19th April, 2009
Dr. M. S. Chauhan, PS	International Conference on “Yak Husbandry – Challenges and Strategies” at Dirang.	20th -22nd April, 2009
Dr. B. S. Prakash, Head	Round Table on “Impact of Global Economic Slowdown on Indian Agriculture” at IARI, Pusa, New Delhi.	24th April, 2009
Dr. D. K. Jain, PS Dr. Ravinder Malhotra, Sr. Sci.	Workshop on “Design of Experiments: Golden Jubilee” Celebration of IASRI at IASRI, New Delhi.	29th April, 2009
Dr. Sachinandan De. Sr. Sci.	1st CIC (Consortium Implementing Committee) for ongoing NAIP Projects Meeting at PDC, Meerut.	4th May, 2009
Dr. A. K. Chakravarty, PS	Seminar on “Veterinary and Livestock Owners-Wining Partnership” at Chandigarh.	5th May, 2009
Dr. S. K. Jha, Sr. Sci.	Workshop on “Expert System on Wheat Crop Management” at DWR, Karnal.	12th - 13th May, 2009
Dr. Adesh Kumar Sharma, Sr. Sci	“5th International Conference on “Downtrend Challenges in IT (ICDCIT - 2009)” at Ludhiana.	22nd May, 2009
Dr. R. S. Gandhi, Head	8th Scientists Meet of AICRP on Cattle at SVV University, Tirupati.	22nd - 23rd May, 2009
Dr. Rameshwar Singh, Head Dr. R. K. Malik, PS Dr. V. K. Gupta, PS	International Workshop on “Enhancing India’s Global Competitiveness in Food Trade – New Avenues in Food Processing & Safety Management” at Hotel Le Meridean, New Delhi.	24th - 26th May, 2009
Dr. R. S. Gandhi, Head	Seminar-cum-Brain Storming Session on “Conservation and Utilization of Animal Genetic Resources of Haryana State” at NBAGR, Karnal.	3rd June, 2009
Dr. D. K. Sharma, Head, ERS Kalyani	1st Indian Science Congress at Sriperumbundur, Tamilnadu.	5th - 7th June, 2009
Dr. Sachinandan De. Sr. Sci.	Workshop on “Conservation of Utilization of Black Bengal Goat Resource for Rural Livelihood” at Tripura.	10th June, 2009
Dr. Dalip K Gosain, Sr. Sci. Mr. Mohar Singh, TO	Rural Advisory Committee, Delhi Doordarshan, Delhi.	11th June, 2009

Dr. R. C. Upadhyay, PS Dr. Parveen Kumar, PS Dr. S. V. Singh, Sr. Sci. Dr. Ashutosh, Sr. Sci. Mrs. Ritu Chakravarty, Sci. (SG)	Network project Launch Workshop on “Adaptation and Facilitation of Livestock to Impending Climate Changes through Shelter Management” at CSK HPKVV, Palampur (HP).	12th - 13th June, 2009
Dr. Sachinandan De. Sr. Sci.	Workshop on “Statistical and Computational Issues in Genomics” at Delhi.	22nd June, 2009
Dr. G. R. Patil, JD(A)	9th Agricultural Science Congress at SKAU-K, Srinagar.	22nd - 24th June, 2009
Sh. Pushpanayak, Sr. AO	Management Development Programme on “Tendering and Contracting” at NIFM, Faridabad.	22nd - 26th June, 2009
Sh. Ram Niwas, AAO Sh. Ishwar Diyal, AAO	Special training programme on “Handling of CAT Cases and Court Cases” at ISTM, New Delhi	24th - 26th June, 2009
Dr. Ravinder Malhotra, Sr. Sci. Dr. Adesh Kumar Sharma, Sr. Sci.	National Seminar on “Information Access Initiatives and Rural India” at Guru Nanak Dev Univ. Amritsar.	25th - 26th June, 2009
Dr. V.S. Raina, PS	Interactive Meet on “Buffalo Reproduction” at CIRB, Hisar.	27th June, 2009
Dr. R. C. Upadhyay, PS Dr. S. V. Singh, Sr. Sci.	Interim Review Workshop on “Vulnerability and adaptation Component of Agriculture Sector of Second NATCOM” at CRIDA, Hyderabad.	2nd July 2009
Dr. C. J. Juneja, TO	National Workshop on “Advances in Aquaculture and Fisheries: Prospects & Challenges in Fisheries” at ITPO, Pragati Maidan, Delhi.	2nd - 3rd July, 2009
Dr. S. N. Rai, PS	Workshop on Popularisation of Densified Feed Block organized Jointly by ELDEX and Poshak Feed Pvt. Ltd. at Delhi.	3rd July, 2009
Dr. R. C. Upadhyay, PS Dr. S. V. Singh, Sr. Sci.	Annual Workshop of ICAR Network Project on “Impact Adaptation and Vulnerability of Indian Agriculture to Climate Change” at CRIDA, Hyderabad.	3rd - 4th July, 2009
Dr. D. K. Gosain, Sr. Sci. Dr. Satyapal, TO	National Workshop on “Advances in Dairying: Prospects & Challenges in Dairying” at ITPO, Pragati Maidan, Delhi.	4th July, 2009
Dr. S. N. Rai, PS	National seminar on “New Paradigms in Dairying” organized at NASC Complex” at New Delhi.	4th July, 2009
Dr. A. K. Sharma, Sr. Sci.	Launching and training Workshop of PERMIS Net-II at IASRI, NASC Complex, New Delhi.	22nd July, 2009
Dr. Jancy Gupta, Head	Advisory Committee at Yojna Bhawan, New Delhi.	22nd July, 2009
Dr. A. P. Ruhil, Sr. Sci.	Workshop on “Soft Computing (Sofcom’09)” at ISI, Kolkatta.	27th - 31st July, 2009
Dr. K. K. Datta, Head	Short training course on “Economic Models for Human Analysis” at NCAP, New Delhi.	27th - 31st July, 2009
Dr. Mahendra Singh, Sr. Sci.	Seminar on “Quality Assurance Issues of Dairy Industry in Today Scenario” at Partapur, Meerut.	28th - 29th July, 2009
Dr. Sunita Grover, PS	New Perspectives in Research and Development in the Food Processing Sector at New Delhi.	31st July, 2009
Dr. K. K. Datta, Head	Workshop on “Economic of Milk Production and its Regular Monitoring in Punjab” at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana.	5th August, 2009
Dr. S. S. Thakur, PS Dr. A. K. Tyagi, Sr. Sci. Dr. S. K. Sirohi, Sr. Sci.	7th Regional Animal Nutrition Conference on “Scope for Augmenting Livestock Production through Nutrition in Rainfed Areas” at Post Graduate Institute of Veterinary Sciences, Akola (Maharashtra).	7th - 8th August, 2009

Dr. A. K. Dodeja, Head Sh. Prashant Saurabh Minz, Sci.	National Seminar on “Indian Dairy Industry” at Delhi.	8th August, 2009
Dr. Sumit Arora, Sr. Sci.	“Indian Dairy Industry”, Pragati Maidan, New Delhi, organised by NNS Media Group.	8th August, 2009
Dr. A. K. Sharma, Sr. Sci.	PMAC meeting of AGROWEB Sub-project of NAIP at NBPGR, New Delhi.	11th August, 2009
Dr. Y. S. Rajput, PS Dr. Rajan Sharma, Sr. Sci.	National Seminar on “Milk Adulteration - Issues & Challenges” at IMA Convention Center organized by Indian Dairy Association, New Delhi.	22nd August, 2009
Dr. B. R. Yadav, PS	Launch Workshop on “Strengthening of Digital library and Information Management under NARS (e-Granth)” at IARI, New Delhi	27th August, 2009
Dr.(Mrs.) Smita Sirohi, PS	National Seminar on “Dimension of Climate Change Affecting Education and Research Agenda for Livestock Health and Production” at Mathura.	24th Sept., 2009
Dr. R. C. Upadhyay, PS	National Seminar on “Dimensions of Climate Change Affecting Education and Research Agenda for Livestock Health and Production at Mathura.	24th - 25th Sept., 2009
Dr. A. K. Puniya, Sr. Sci.	National seminar on “Biotechnology & Microbiology in Human Welfare: the Indian Scenario” at MITS, Sikar (Rajasthan).	26th - 27th Sept., 2009
Dr. Bandla Srinivas, Sr. Sci., SRS Bangalore	Training Programme on “Chromatographic based Approach (HPLC and related) for Functional Food Constituents” at CFTRI Mysore.	5th - 9th October, 2009
Dr. Gopal Sankhala, Sr. Sci.	A Course on “Creative Writing in Agriculture” at Indian Institute of Mass Communication, New Delhi.	5th - 9th October, 2009
Dr. Naresh Kumar, Sr. Sci.	1st Conference of State Ministers of Food Processing Industries organized by Food Processing Industries, at Vigyan Bhawan, New Delhi.	6th October, 2009
Dr. A. K. Puniya, Sr. Sci.	Workshop on “Microbial Technology and its Application at Dolphin” at Post Graduate Institute, Dehradun.	10th-11th October, 2009
Dr. Jancy Gupta, Head	Interface Meeting of Livestock Extension Sub-group at IDA House, New Delhi.	13th October, 2009
Dr. Gopal Sankhala, Sr. Sci.	Training Programme on “Priority Setting Monitoring and Evaluation for Innovation in Agriculture” at Indian Institute of Management Lucknow.	19th - 23rd October, 2009
Dr. Jancy Gupta, Head	Brainstorming session on “Livestock Extension” at Yojana Bhawan, New Delhi.	21st October, 2009
Dr. A. P. Ruhil, Sr. Sci.	Winter School on “Decision Making in Agriculture Using Data Mining” at NCAP, New Delhi.	27th October - 16th Nov., 2009
Dr.(Ms) Sunita Grover, PS	5th International Nutraceutical Summit organized by CFTRI, CSIR & MM Activ Sci. Tech. at New Delhi.	28th - 30th October, 2009
Sh. S. George, CF&AO	Training Programme on “Accrual Accounting in Government” at NIFM, Faridabad.	29th - 30th October, 2009
Dr. (Mrs.) Bimlesh Mann, PS	Lecture on “Milk Devices Bioactive Peptides Ingredient for Fluidtional Foods” at Ludhiana.	31st October, 2009
Dr. Rameshwar Singh, Head	International Conference under EU-India Science & Technology Cooperation Days at New Delhi.	4th - 6th Nov., 2009
Dr. R. S. Gandhi, Head Dr. A. K. Puniya, Sr. Sci. Dr. P. S. Minz, Sci.	Training programme on “Web Based E-learning and Content Management” at NAARM, Hyderabad.	3rd - 13th Nov., 2009

Sh. Pushpanayak, Sr. AO	Workshop on “Management of Stress Related Disorder Hypertension Diabetes Cardiac Muscular Skeletal and other Psycho Somatic Diseases” at NAARM, Hyderabad.	5th- 6th Nov., 2009
Dr. C. J. Juneja, TO	4th National Conference on KVKs at Coimbatore.	6th - 8th Nov., 2009
Dr. Dalip K Gosain, Sr. Sci. Mr. Kulvir Singh, TO	Zonal Workshop cum Training Programme for the KVKs in Zone - I at SKUAST, Jammu	15th -17th Nov., 2009
Dr. P. K. Aggarwal, PS Dr. Chand Ram, Sr. Sci.	National seminar on “Bio-engineered Foods: Strategies and Prospective” at SLIET, Longowal, Panjab.	20th -21st Nov., 2009
Dr. Sunita Grover, PS	3rd Probiotic Symposium at New Delhi.	21st - 22nd Nov., 2009
Dr. Sudarshan Kumar, Sci.	Training Programme on “Course Offered” by G.E. Health Care at Bangalore.	24th -27th Nov., 2009
Dr. K. S. Kadian, Sr. Sci.	International conference on “Nurturing Arid Zones for People and the Environment: Issues & Agenda for the 21st Century” at CAZRI, Jodhpur.	24th -28th Nov., 2009
Dr. R. S. Gandhi, Head Dr. A. K. Chakravorty, PS Dr. G. K. Sachdeva, PS Dr. Ashwani Sharma, PS	National Symposium on “Conventional and New Age Breeding Technology for Livestock Centric Growth and Livelihood Security and 10th Annual Conference of ISAG&B” at Madras Vety. College, Chennai.	27th -28th Nov., 2009
Dr. S. V. Singh, Sr. Sci.	National Symposium on “Milk and Human Health” organized by Indian Dairy Association in collaboration of Ayurved India Ltd. at New Delhi.	28th Nov., 2009
Dr. A. K. Chakravarty, PS	Seminar cum Mid-Term Review of Network Project on “Buffalo Improvement” at CIRB, Hisar.	5th Dec., 2009
Dr. A. S. Harika, PS Dr. Uttam Kumar, TO	Training Programme on “Gahan Hindi Parshikshan Karyaashala” at CHTI, New Delhi.	7th -11th Dec., 2009
Dr. B. S. Prakash, Head Dr. V. S. Raina, PS Dr. A. Kumaresan, Sr. Sci. Dr. T. K. Mohanty, Sr. Sci.	25th Annual Convention of Indian Society for the study of Animal Reproduction (ISSAR) and International Symposium on Expanding the Horizons of Reproductive Technologies in Global Scenario for Augmenting Fertility in Farm and Pet Animals” at Deptt. of Animal Production, Gynecology Obstetnics, Veterinary College and Research Institute, Namakkal (TN).	10th -12th Dec., 2009
Dr. (Mrs.) Bimlesh Mann, PS	5th Workshop - cum - Training on “Dimension of Nono-science Nanotechnology and Society for Women Scientist & Technologists” at NIAS Bangalore.	14th -18th Dec., 2009
Dr. S. S. Kundu, Head Dr. S. S. Thakur, PS Dr. S. N. Rai, PS Dr. A. K. Tyagi, Sr. Sci. Dr. A. Santra, Sr. Sci. Dr. M. A. Katakaware, Sci.	13th Biennial Conference of Animal Nutrition Society of India on “Diversification of Animal Nutrition Research in Changing Scenario” at NIANP, Bangalore.	17th - 19th Dec., 2009
Dr. K. K. Datta, Head	69th Annual Conference of the “Indian Society of Agricultural Economics” at GNDU, Amritsar.	17th - 19th Dec., 2009
Dr. A. P. Ruhil, Sr. Sci.	4th Indian International Conference on “Artificial Intelligence” at Tunkur (Bangalore).	16th - 18th Dec., 2009
Sh. Puspendra Kumar, Sr. AO	Workshop on “Right to Information Act-2005 for CPIOs” at ISTM, New Delhi.	21st - 22nd Dec., 2009
Dr. G. R. Patil, JD(A) Dr. V.K. Kansal, Head	Indian Convention of Food Scientists and Technologists at NIMHANS, Bangalore.	21st - 23rd Dec., 2009
Dr. Dalip K. Gosain, Sr. Sci. Mr. Kulvir Singh, TO	National Seminar on “Enhancing Efficiency of Extension for Sustainable Agriculture and Livestock Production” at IVRI, Izatnagar	29th - 30th Dec., 2009
Dr. B. S. Prakash, Head Dr. Bimlesh Mann, PS	97th Indian Science Congress (ISC) at SBI Thumba Branch, Trivandrum.	3rd - 7th January, 2010

Dr. S. V. Singh, Sr. Sci. Dr. Ashutosh, Sr. Sci.	Brainstorming Session on “Impact of Climate Change on Indian Agriculture” at Krishi Bhawan, New Delhi	5th January, 2010
Dr. Jancy Gupta, Head	Brain Storming Session on the Issue of Improving Science and Technology in the Writing of Research Papers by Extension Scientists and Up-scale the Science Contents in the Extension Research Journals on organized by Agricultural Extension Division, Krishi Anusandhan Bhawan, ICAR, New Delhi.	5th January, 2010
Dr. A. K. Chakravarty, PS	North Zonal Livestock Championship-2010 at Mukatsar, Pb.	8th – 12th Jan., 2010
Dr. A. K. Dodeja, Head Dr. R. K. Kohli, PS	Engineering Intervention – Interactive Meet of ICAR scientists at CIAE Bhopal.	11th – 12th Jan., 2010
Dr. A. P. Ruhil, Sr. Sci.	Short term training on “Knowledge Discovery in the Data Bases: Date Information & Knowledge” at Kolkata.	11th – 15th January, 2010
Dr. Dalip K. Gosain , Sr. Sci. Sh. Mohar Singh, TO	National Seminar on “Rural India Developmental Alternatives: Sectoral Convergence for Livelihood Security” at CIRG, Makhdoom, Farah, Mathura	18th January, 2009
Dr. A.K. Dodeja, Head Sh. I. K. Sawhney, PS	International Conference on “Instrumentation (ICI-2009) and National Symposium on Instrumentation (NSI-34)” at Pune.	21st - 23rd January, 2010
Dr. R. R. B Singh, Sr. Sci. Dr. Lotan Singh, Sr. Sci. (ERS)	National Seminar on “Dairy Development in Eastern India: Bihar Summit” by IDA(EZ)” at Hotel Maurya, Patna.	23rd January, 2010
Dr. A.K. Puniya, Sr. Sci.	2nd annual Conference on “Recent Advances in Chemical and Environmental Sciences (RACES-2010)” at MMM College, Patiala.	22nd - 23rd January, 2010
Dr. R. S. Gandhi, Head Dr. S. S. Kundu, Head Dr. Rameshwar Singh, Head Dr. A. K. Gupta, PS Dr. G. K. Sachdeva, PS Dr. R. S. Manik, PS Dr. S. K. Kanawjia, PS Dr. S. K. Atreja, PS, Dr. Shiv Prasad, PS Dr. J. P. Sehgal, PS Dr.(Mrs.) Harjit Kaur, PS Dr.(Mrs.) N. Kewalramani, PS Dr.(Mrs.) Bimlesh Mann, PS Dr.(Mrs.) Veena Mani, PS Dr. O. K. Hooda, PS Dr. Parveen Kumar, PS Dr. S. S. Thakur, PS Dr. S. N. Rai, PS Dr. Ashwani, Sharma, PS Dr. Archana Verma, PS Dr. Avtar Singh, PS Dr. I. D. Gupta, PS Dr. S. K. Singla, PS Dr. M. S. Chauhan Dr. R. K. Mehla, Sr. Sci. Dr. R. R. B. Singh, Sr. Sci. Dr. K. S. Kadian, Sr. Sci. Dr. S. K. Tomar, Sr. Sci. Dr. Sohan Vir Singh, Sr.Sci. Dr. Anjali Aggarwal, Sr. Sci. Dr. A. K. Tyagi, Sr. Sci. Dr. Chander Dutt, Sr. Sci. Dr. Gopal Sankhala, Sr. Sci. Dr. M. L. Kamboj, Sr. Sci. Dr. S. S. Lathwal, Sr. Sci. Dr. S. K. Sirohi, Sr. Sci.	International Buffalo Conference on “Optimizing Buffalo Productivity through Conventional and Novel Technologies” from NASC, New Delhi.	1st – 4th Feb., 2010



*Dr. K. D. Kokate, DDG (Extn.) inaugurating Research Extension Farmers Interface held at NDRI on 8<sup>th</sup> May, 2009*

Dr. A. K. Sharma, Sr. Sci.	National Workshop on “Sensitization on Networking and Web hosting” at NAARM, Hyderabad.	2nd - 3rd Feb., 2010
Dr. D. K. Jain, PS	21st All India BTIS net Co-ordinators Meeting at CARI, Port Blair.	3rd - 4th Feb., 2010
Dr. A. K. Sharma, Sr. Sci.	PMAC Meeting of AGROWEB Sub-project of NAIP at NAARM, Hyderabad.	4th Feb., 2010
Dr. D. Malakar, Sr. Sci.	Symposium for Two Poster Presentation at Jawaharlal Nehru University, New Delhi.	4th - 6th Feb., 2010
Sh. I. K. Sawhney, PS	Dairy Industry Conference at Panjim, Goa.	7th - 9th Feb., 2010
Dr. R. S. Manik, PS Dr. M. S. Chauhan, PS Dr. P. Palta, PS Dr. S. K. Singla, PS Dr. S. K. Atreja, PS Dr. T. K. Datta, Sr. Sci. Dr. Dheer Singh, Sr. Sci. Dr. M. K. Singh, Sr. Sci.	International Conference on “Reproductive Health” and 29th Annual Meeting of the ISSRF at Univ. of Rajasthan, Jaipur.	8th - 10th Feb., 2010
Sh. Pushpanayak, Sr. AO (P)	Management Development Programme on “Communication and Presentation” at IIM Calcutta.	8th - 11th Feb., 2010
Dr. T. K. Mohanty, Sr. Sci.	Short term training on “Knowledge Discovery in the Data Bases: Data Information & Knowledge” at Kolkata	11th - 15th Feb., 2010
Dr. (Mrs.) Neelam Kewalramani, PS	World Conference on “Preparedness to Combat Challenges” organised by Animal Nutrition Association at NASC complex, New Delhi.	14th - 17th Feb., 2010
Sh. Ishwar Diyal, AAO	Workshop on “Right to Information Act-2005” for (CPIOs) at ISTM, New Delhi.	15th - 16th Feb., 2010
Sh. Puspendra Kumar, Sr. AO	Management Development Programme on “Management of Creativity and Innovation” at IIM Calcutta.	15th - 19th Feb., 2010
Sh. Prashant Saurabh Minz, Sci.	National Seminar “Value Addition of Agricultural Produces and Current Status of Small Scale (Food Processing Units)” at Maharaja Pratap University, Udaipur.	18th - 19th Feb., 2010
Dr. R.S. Gandhi, Head	12th Indian Agricultural Scientists & Farmers Conference at University of Allahabad, Allahabad.	20th - 21st Feb., 2010
Sh. J. K. Kewalramani, Chief Admn. Officer	Special Training Programme on “Vigilance Administration” at IISR, Calicut.	22nd- 24th Feb., 2010
Dr. K. K. Datta, Head, Dr. D. S. Sohi, PS Dr. (Ms) Sunita Grover, PS Dr. Vivek Sharma, Sr. Sci.	Training under NAIP Project on “Development of E-courses for B.Tech. (DT) Degree Programme” at NAARM, Hyderabad.	2nd - 12th March, 2010
Dr. S. Subash, Sci.	International Workshop for Theory, Practice & Policy, held at IIT, Delhi.	11th - 12th March, 2010
Dr. D. K. Sharma, PS Dr. A. K. Sharma, Sr. Sci.	National Workshop on “ICT Initiative of the NAIP with Special Reference to the Uniformly Guidelines for ICAR Websites at NBPGR, New Delhi.	19th March, 2010
Dr. A. K. Mohanty, Sr. Sci.	Workshop on “Proteomics; High Throughout Analysis of Proteins by Mass Spectrometry” at New Delhi.	22nd - 26th March, 2010
Dr. Avtar Singh, PS	Technical Seminar on “Livestock in the Balance” at New Delhi.	23rd March, 2010

## 12 SEMINARS/SYMPOSIA/WORKSHOPS/ FIELD DAYS ORGANISED

During the past one-year (April 2009-March 2010), 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:

- National Training Program on Advances in breeding and management technologies for improvement in livestock productivity 25<sup>th</sup> March to 14<sup>th</sup> April, 2009
- Dairy Mela (organized after a gap of 12 years) 26-28<sup>th</sup> March, 09
- International Seminar on French Genetics & Technologies 20<sup>th</sup> April 2009.
- World Veterinary Day 24-25<sup>th</sup> April, 09
- International Training Course on Sensory Evaluation of Milk and Milk Products 19<sup>th</sup> May, 2009
- Vacation Programme on Natural Resources 19<sup>th</sup> May 2009
- World Milk Day 1<sup>st</sup> June 2009
- Launch Workshop on Development of e-courses for B. Tech. (DT) Degree Programme 27<sup>th</sup> June , 2009
- Brainstorming Session on Vaccine & Diagnostics 10-11<sup>th</sup> July, 09
- New Paradigms in Dairying 4<sup>th</sup> July, 09
- Institute Technology Transfer and Management Committee (ITMC) Meeting 15<sup>th</sup> July, 2009
- Consortium Implementation Committee Meeting 8<sup>th</sup> July, 2009
- Summer School on Recent Advances in Analytical Techniques and Innovative Approaches for Quality Assurance and Safety of Dairy Foods 7<sup>th</sup> - 27<sup>th</sup> July, 2009
- Training Programme on Chemical Testing of Milk & Milk Products & Compounded Cattle Feed 28<sup>th</sup> July 2009 to 3<sup>rd</sup> August 2009
- Launch Workshop for Three Projects under NAIP 10<sup>th</sup> Aug., 2009
- Zonal Workshop on Front Line Demonstration on Oil Seed and Pulse Crop 12-13<sup>th</sup> Aug, 09
- Meeting of Bureau of Indian Standards 24<sup>th</sup> August, 09
- National Seminar on Need of the Dairy Industry - Initiative, Innovation and Improvisation 11-12<sup>th</sup> Sept., 09
- Training Programme on Fundamental Aspects of Dairy Microbes and their Safety Concerns in Dairy Industry 29<sup>th</sup> Sept., 2009
- Training Programme on Procurement Related Matters and Financial Management System 17<sup>th</sup> - 18<sup>th</sup> Aug., 2009
- International Non-Violence Day 2<sup>nd</sup> Oct. 2009
- Brain Storming Session on Environment & Animal Housing 5<sup>th</sup>-6<sup>th</sup> Oct., 2009



*Padam Blushan Dr. R. B. Singh & A. K. Srivastava at the exhibition stall during World Milk Day celebrations on June 1, 2009*



*Inauguration of the World Milk Day*

- Confederation of Indian Industry 22<sup>nd</sup> Oct., 2009
- Seminar on Higher Education in India during National Education Day 11<sup>th</sup> Nov., 09
- ADRP Meeting for 2008-09; North Zone ICAR Research Institutes 12-13<sup>th</sup> Nov, 09
- National Workshop on Security Management in Research and Educational Institutions 19<sup>th</sup> Nov., 09
- Seminar on sustainable Milk production and MMDR- 2009 1<sup>st</sup> Dec., 09
- Women in Agriculture Day 4<sup>th</sup> Dec. 09
- 34<sup>th</sup> Annual Convention of Vice-Chancellors of State Agricultural and Veterinary Universities and a National Symposium on Application of Bio-Nano Technology in Agriculture and Animal Sciences for Food Security 7<sup>th</sup> Dec., 09
- National Workshop on Emerging Machine Learning Techniques in Bioinformatics 17<sup>th</sup>-19<sup>th</sup> Dec., 2009
- National conference on specialized processed Foods for Health & Nutrition : Technology & Delivery 21<sup>st</sup> -23<sup>rd</sup> Dec., 09
- Seminar on Financial Literacy and Agricultural Diversification 26<sup>th</sup> Dec., 2009
- Review meeting of PMAC under NAIP Component-I 29<sup>th</sup> Dec., 09
- Training Programme on Conventional and Rapid Techniques for Monitoring Quality and Safety in Dairy Industry 7<sup>th</sup>-14<sup>th</sup> Jan. 10
- Wi Winter School on Recent Advances in Dairy Nutraceuticals and Bio-informatics Applications 1<sup>st</sup>-21<sup>st</sup> Feb., 10
- Dairy Industry conference on Indian Dairying : Productivity and Food Safety 17<sup>th</sup>-19<sup>th</sup> Feb., 10
- Plenary Session of 20<sup>th</sup> National Congress of Veterinary Parasitology 20<sup>th</sup> Feb., 2010
- Dairy Mela 24-26<sup>th</sup> Feb. 10
- Seminar on Indian Agriculture Today: Challenges Opportunities and Perspective during National Science Day 28<sup>th</sup> Feb. 10
- Brainstorming on Probiotics 5<sup>th</sup> March 2010
- Academic Week 9-13<sup>th</sup> March, 10
- Dr. D. Sundaresan Memorial Lecture 11<sup>th</sup> March, 10
- 8<sup>th</sup> Convocation 13<sup>th</sup> March, 10
- FAO sponsored International Training Programme on Milk Collection, Processing and Marketing for personnel involved in dairy development activities in Afghanistan 18<sup>th</sup> -31<sup>st</sup> March 2010



*An Inaugural view of world Veterinary Day*



*Director NDRI being explained the ongoing activities of the health camp*

## 13 DISTINGUISHED VISITORS

19.04.2009 Eleven member delegation from France led by Mr. Jean Noel Bonnet for one day seminar.

20-21.5.2009 Mr. Dinesh Pariyal, Principal Scientist and Mr. Kishore Kumar Shrestha, Sr. Scientist from National Agricultural Research Council, Nepal.

02.06.2009 Fifteen member delegation from Bhutan.

03.06.2009 Four member delegation from National Agricultural Research Organization (NARO), Uganda.

27.06.2009 Dr. D. V. G. Krishna Mohan, Vice Chancellor, SVVU, Tirupati.

11.07.2009 Eighteen Member team of Board of Director's from Krishna Milk Union.

10.08.2009 Dr. Mangala Rai, Hon'ble Secretary DARE & DG, ICAR, New Delhi.

25.09.2009 HE Lt.General Kayumba Nyamwasa, Ambassador of Republic of Rawanda.

03.10.2009 Four member delegation from CARP, Sri Lanka

23.10.2009 Twelve Member delegation from Guangxi Buffalo Research Institute, China



31.10.2009 Three member delegation from Danone, France.

- Mr. Anuj Mehta, Director, R & D and Quality, Danone, South Africa.
- Mr. Phillippe Pages, Director, Danone R & D, Nutrition.

- Mr. Cecile Mamen, Claims Manager, Danone R&D.



5.11.2009 Two member delegation from Brasil and Maxico.

- Prof. Dr. William G.Vole, Universidade Federal Rural Da Amazonia, Belem-Para-Brasil.
- Dr. Ismael Coronel Sicairos, Asociacion Mexicana, De Criadores De Buffalo, Amexbu, Maxico.

13.11.2009 Four member delegation from Dept. of Animal Husbandry, Livestock, Fisheries & Vety. Services, Krishi Bhawan, Tadong (Sikkam).

- Sh.Vishal Chauhan, IAS, Secretary to Govt. of Sikkam/AH&VS.
- Sh. L.T. Bhutia, Additional Director(C & D), AH&VS.
- Dr. N. B. Chhetri, Jt.Director (Dairy), AH&VS
- Sh. B. S. Nirola, AH&VS, DE (Civil).

13.11.2009 Officials of German Research Foundation (DFG) Office New Delhi, led by Dr. Torsten Fischer, Director DFG visited NDRI on 13th November, 2009.





*Hon'ble Dr. Mangala Rai, Former Director General ICAR at Experimental Dairy Plant of NDRI*

- |            |  |               |  |
|------------|--|---------------|--|
| 05.01.2010 | A Vietnamese delegation.   | 25.01.2010    | Five member delegation from NC State University, USA.  |
| 15.01.2010 | <b>Sh. Naveen Jindal</b> , Hon'ble Member of Parliament, New Delhi.  | 29-30.01.2010 | <b>Dr. Jayant Lohakare</b> , Fulltime Faculty, College of Animal Life Sciences, Kangwon National University, KNU Avfe-I, Chunchon, South Korea with five students. |
| 20.01.2010 | Eight member delegation from Ministry of Agriculture, Royal Govt. of Bhutan.   | 09.02.2010    | Four member delegation from General Mills, Minneapolis, USA.   |
| 22.01.2010 | <b>Dr. M. H. Karim</b> , Counselor & Director, Science & Education Section, Embassy of the Islamic Republic of Iran. | 10.02.2010    | <b>Mr. Craig Pedley</b> of Skellerup Industries Ltd., New Zealand.   |
| 23.01.2010 | <b>Mr. Ngoga Eugene Fixer</b> , First Counselor, Rawanda High Commission, New Delhi.                                 | 29-30.03.2010 | Eight Member delegation from Nepal.  |
|            |  | 11-13-03-2010 | <b>Prof. George Smith</b> , Michigan State University, USA.  |



*Winners of the Extra-curricular and sports Activities organised at NDRI, Deemed University with Director & Vice Chancellor, NDRI*

# 14 PERSONNEL

## INSTITUTE STAFF

As on 31st March, 2010

### General Administration

A. K. Srivastava, Ph.D.	Director
S. L. Goswami, Ph.D.	Joint Director (Research)
G. R. Patil, Ph.D.	Joint Director (Academic)
Rameshwar Singh, Ph.D.	Registrar
I. K. Sawhney, M. Tech.	Controller of Exams
J. K. Kewalramani, B.Sc., M.B.A.	Chief Admn. Officer
Pushpnayak, M.Sc.	Sr. Admn. Officer (Admn.)
Puspendra Kumar, B.Sc., M.E. (Civil)	Sr. Admn. Officer
S. George	Chief. Fin. & Account Officer
D. K. Arya	Fin. & Account Officer
Ram Shankar, M.A., P.G.D.T.	Asstt. Director (Off. Lang.)
C. K. Thakural, B. A.	Asstt. Fin. & Account Officer
J. I. P. Madan, B.Sc.	Asstt. Admn. Officer
Kuna Ram Kisku	Asstt. Admn. Officer (ERS, Kalyani)
S. C. Tuli, B.A.	Asstt. Admn. Officer
Punnu Ram	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	Asstt. Admn. Officer
S. Shashi Kala	Asstt. Admn. Officer (SRS, Bangalore)
S. S. Meena	Asstt. Admn. Officer
Saroj Khurana	Asstt. Admn. Officer
Saroj Setia	Asstt. Admn. Officer
Deepak Chopra, B.A.	Security Officer
O. P. Bareja, B.A.	Private Secretary
Sunita Chaudhary	Private Secretary
M. Jayalakshmi	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

### Scientists and Technical Officers

#### Dairy Cattle Breeding Division

R. S. Gandhi, Ph.D.	Head
G. K. Sachdeva, Ph.D.	Principal Scientist
B. R. Yadav, Ph.D.	Principal Scientist & National Fellow
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
Ashwani Sharma, Ph.D.	Principal Scientist
Avtar Singh, Ph.D.	Principal Scientist
A. P. Dabas, B.Sc.	Technical Officer
Subhash Chand	Technical Officer
Vinod Kumar, B.Sc.	Technical Officer

#### Livestock Production and Management Section

Shiv Prasad, Ph.D.	Principal Scientist & Incharge
R. K. Mehla, Ph.D.	Sr. 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
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. Upadhyay, 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.	Sr. 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
Prem Chand, M.Sc.	Technical Officer
P. C. Singh, M.Sc.	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

V. K. Kansal, Ph.D.	Head
Y. S. Rajput, 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
J. S. Rana, Ph.D.	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.	Sr. Scientist
Latha Sabikhi, Ph.D.	Sr. Scientist
A. K. Singh, Ph.D.	Sr. Scientist
Kaushik Khamrui, Ph.D.	Sr. Scientist
F. C. Garg, M.Sc.	Scientist (SG)
A. K. Sharma, B.Sc.	Technical Officer (DS)
M. K. Trehan, M.Sc., PGDCA	Technical Officer
Vinod Kumar, B.Sc.	Technical Officer
Ram Swarup, M.A.	Technical Officer
U. C. Govil, B.A., IDD	Technical Officer
Hari Ram Gupta, M.Sc.	Technical Officer
A. K. Kohli, Dip. (Mech. Engg.)	Technical Officer
Lehri Singh, M.Sc.	Technical Officer
S. K. Kharb, M.A.	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
Savitri Jhamb, B.Sc.	Technical Officer
Sanjeev Kumar, M.A.	Technical Officer

### Emeritus Scientist

G. K. Goyal, Ph.D.

### Dairy Engineering Division

A. K. Dodeja, Ph.D.	Head
I. K. Sawhney, M.Tech.	Principal Scientist
R. K. Kohli, Ph.D.	Principal Scientist
Bikram Kumar, M.Tech.	Principal Scientist
V. Chandrashekhar	Scientist (SS)
Prashant Saurabh Minz, M.Tech.	Scientist
M. P. Singh, A.M.I.E.	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
T. Rai, Ph.D.	Principal Scientist
R. B. Sangwan, 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
Moti Ram, Ph.D.	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.	Sr. 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
R. P. Singh, Ph.D.	Technical Officer
Inder Kumar, B.Sc.	Technical Officer

### Emeritus Scientist

V. K. Batish, Ph.D.

### Dairy Economics, Statistics and Management Division

K. K. Datta, Ph.D.	Head
J. P. Dhaka, Ph.D.	Principal Scientist
D. K. Jain, Ph.D.	Principal Scientist
N. K. Verma, 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.	Sr. Scientist
A. K. Sharma, Ph.D.	Sr. Scientist
A. P. Ruhil, Ph.D.	Sr. Scientist
Raka Saxena, Ph.D.	Sr. Scientist
Rishi Kanta Singh	Scientist
Jagjit Singh, M.Sc.	Technical Officer
L. S. Sandhu, Ph.D.	Technical Officer
Tara Chand, B.Sc.	Technical Officer

### Emeritus Scientist

S. B. Agrawal, Ph.D.

### Dairy Extension Division

Jancy Gupta, Ph.D.	Head
Ram Kumar, Ph.D.	Principal Scientist
Dalaur Singh Sidhu, M.Sc.	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
N. S. Sirohi, Ph.D.	Technical Officer
Parvinder Sharma, Ph.D.	Technical Officer

Mridula Upadhayay, M.A. Technical Officer  
 Ram Yattan Rai, Technical Officer

**Agricultural Technology Information Centre (ATIC)**

D. S. Sohi, Ph.D. Principal Scientist & 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. Program 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  
 R. B. S. Yadav Technical Officer  
 Brij Kishore Technical Officer  
 D. V. Sharma Technical Officer

**Forage Section**

A. S. Harika, Ph.D. Principal Scientist & 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  
 M. S. Tyagi, B. Sc. Technical Officer  
 Ramesh Chand, B. Sc. (Agri.) Technical Officer  
 Anil Kumar Dagar, M.Sc. Technical Officer  
 Rishi Pal, ITI, (Electrical) Technical Officer  
 Naresh Kumar, ITI (Workshop) Technical Officer  
 Sohan Lal Technical Officer  
 Satrugan Mehto Technical Officer  
 Lehrimal 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. Principal Scientist, Incharge  
 A. K. Tyagi, Ph.D. Sr. Scientist  
 T. K. Mohanty, Ph.D. Sr. Scientist  
 M. L. Kamboj, Ph.D. Scientist (SS)  
 Chaman Lal, Intermediate, Technical Officer  
 Dip. (Motor Mechanic)  
 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  
 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. Principal Scientist, 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  
 Jeeta Ram Technical Officer

**University Office**

G. R. Patil, Ph.D. Joint Director (Academic)  
 Rameshwar Singh, Ph.D. Registrar  
 I. K. Sawhney, M. Tech. Controller of Exams  
 S. S. Thakur, Ph.D. Chief Hostel Warden  
 A. K. Tyagi, Ph.D. Hostel Warden  
 Gopal Sankala, Ph.D. Hostel Warden  
 S. V. Singh, Ph.D. Hostel Warden  
 Madhu Mohini, Ph.D. Hostel Warden  
 Latha Sabikhi, Ph.D. I/c Placement Cell  
 P.R. Sani Asstt. Admn. Officer  
 Sheo Raj Singh Technical 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  
 & MSS, PMADT

**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  
 R. C. Nagpal, M.A. Technical Officer  
 Gian Singh, M.Sc. (Computer Science) Technical Officer

**Communication Centre/Auditorium**

Gopal Sankhala, Ph.D. Incharge  
 R. K. Mittal, B. E. (Mechanical) Technical Officer  
 G. D. Joshi, M.A. Technical Officer  
 S. K. Talwar, M.A., P.G.D. Technical Officer  
 Ganpat Rai, Matric, ITI Technical Officer  
 Bhupinder Kaur, M.Com., B. Lib. Sci. Technical Officer  
 Dharmbir, B.A. Technical Officer  
 Gulshan Kumar, B.A. Technical Officer  
 Mehi Lal, Matric Technical Officer  
 Ram Chander Technical Officer

**Official Language Unit**

Ram Shankar, M.A. P.G.D.T. Asstt. 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. Technical Officer, Incharge  
 Sarwan Kumar Technical Officer  
 R. K. Bansal, B.E. (Civil) Technical Officer

S. K. Saini	Technical Officer	P. S. Shivaprasad, Dip. (Elec.Engg.)	Technical Officer
Inder Lal (Draftsman- Civil)	Technical Officer	(PGDEPA)	
Tek Chand (ITI Electrical)	Technical Officer	M. Sreenath, M.Sc.	Technical Officer
Bhagwat Singh (ITI Workshop)	Technical Officer	Sarwar, M.Sc.	Technical Officer
Devinder Kumar (ITI Wireman)	Technical Officer	L. Krishna Murthy, M. Sc.	Technical Officer
<b>Hospitality Cell</b>		P. Aravindakshan, M.Sc	Technical Officer
R. P. Sharma, B.A.	Incharge	M.A. Usha, B.Sc.	Technical Officer
<b>Health Complex</b>		M. K. Vedavathi, B.Sc.	Technical Officer
R. K. Malik, Ph.D.	Principal Scientist, Incharge	B. K. Rajeshkaraiah, B.Sc.	Technical Officer
Rekha Sharma, M.B.B.S.	Sr. Medical Officer	J. Nageshwara Rao, Dip.(Mech)	Technical Officer
Manoj Kumar, M.B.B.S.	Medical Officer	Veeraju, B.E. (Civil)	Technical Officer
Richa Walia, Diploma Nursing	Technical Officer	K. L. Sampath, B.Sc.	Technical Officer
Saroj Kathuria, Diploma Nursing & Mid Wifery	Technical Officer	P. G. Satisha, B.V.Sc.	Technical Officer
<b>Estate Section</b>		K. P. Lakshminarayanappa DME (Mech.)	Technical Officer
Pushpendra Kumar, B.Sc., M.E. (Civil)	Sr. A. O. & Incharge	Meganathan, Dep. (Elect. Engg.)	Technical Officer
Sushil Kumar Kamboj, M.Sc.	Technical Officer	R. Keshvamarthy, B.Sc.	Technical Officer
Prem Singh, M.A.	Technical Officer	Gurunath Gouda Patil, B.Sc.	Technical Officer
P. M. Meena	Technical Officer	M. S. Nagarajaiah, Dip. (Civil Engg.)	Technical Officer
<b>Southern Regional Station, Bangalore</b>		B. R. Srinivasamurthy, B.Sc.	Technical Officer
Satish Kulkarni, Ph.D.	Head	Thivija Kumari	Technical Officer
A. Obi Reddy, Ph.D.	Principal Scientist	Siddaramanna	Technical Officer
C. N. Pagote, Ph.D.	Principal Scientist	<b>Eastern Regional Station, Kalyani</b>	
B. Surendra Nath, Ph.D.	Principal Scientist	R. A. Dey, Ph.D.	Acting Head
B. C. Ghosh, Ph.D.	Principal Scientist	D. K. Sharma, Ph.D.	Head (Under Suspension)
B. V. Balasubramanyam, Ph.D.	Principal Scientist	R. B. Singh, Ph.D.	Principal Scientist
P. K. Dixit, Ph.D.	Principal Scientist	P. K. Roy, Ph.D.	Sr. Scientist
K. P. Ramesha, Ph.D.	Sr. Scientist	Lotan Singh, Ph.D.	Sr. Scientist
B. Srinivas, Ph.D.	Sr. Scientist	S. K. Das, Ph.D.	Sr. Scientist
M. C. Arunmozhi Devi, Ph.D.	Sr. Scientist	A. Santra, Ph.D.	Sr. Scientist
K. Jayaraja Rao, Ph.D.	Sr. Scientist	Anupam Chatterjee, Ph.D.	Sr. Scientist
D. N. Das, Ph.D.	Sr. Scientist	M. K. Ghosh, Ph.D.	Sr. Scientist
P. Heartwin Amala Dhas, Ph.D.	Scientist (SS)	Ajoy Mandal, Ph.D.	Sr. Scientist
Rekha Ravindra Menon, M. Tech.	Scientist (SS)	V. P. Verma, M.A., B.Lib. Sci.	Technical Officer
F. Magdaline Eljeeva Emerald, ME (Agri.)	Scientist (SS)	Alokesh Goswami, M.Sc.	Technical Officer
Mukund Amritrao Kataktalware, Ph.D.	Scientist	Amitava Ghosh, M.V.Sc.	Technical Officer
S. Varalakshmi, Ph.D.	Scientist	Somnath Dutta, M.V.Sc.	Technical Officer
P. Murugananthan, M.Lib. Sci.	Technical Officer	Prabir Saha, M.Sc.	Technical Officer
M. Nanjundaswamy, M. Lib.Sci.	Technical Officer	S. C. Halder, B.Sc.	Technical Officer
V.R.V. Surendranath Naik, M.D.	Medical Officer	M. L. Ghosh, B.Sc.	Technical Officer
		K. Rabidass	Technical Officer



*Dr. C. D. Mayee, Chairman ASRB, declaring the ICAR Inter-Zonal Sports Tournament-2009 open on 12<sup>th</sup> December, 2009*

## PERSONNEL MILESTONES

### PERSONNEL MILESTONES

#### Joinings/Appointments

- Dr. Satish Kulkarni, Principal Scientist appointed as Head, Southern Regional Station, Bangalore w.e.f. 25.02.2009.
- Dr. S. S. Kundu, Principal Scientist appointed as Head, Dairy Cattle Nutrition Division at NDRI, Karnal w.e.f. 15.04.2009.
- Dr. R. S. Gandhi, Principal Scientist appointed as Head, Dairy Cattle Breeding Division at NDRI, Karnal w.e.f. 15.04.2009.
- Dr. K. K. Datta appointed as Head, Dairy Economics, Statistics & Management at NDRI, Karnal w.e.f. 04.06.2009.
- Dr. (Mrs.) Smita Sirohi, Principal Scientist (Agril. Eco.) joined at NDRI w.e.f. 04.06.2009 from NCAP, Pusa New Delhi on transfer.
- Dr. Manoj Kumar Singh, Scientist, (Biotechnology : Animal Science) joined at NDRI, Karnal w.e.f. 10.06.2009.
- Dr. Prashant Saurabh Minz, Scientist (ASPE) joined at NDRI, Karnal w.e.f. 19.06.2009.
- Sh. S. George, Chief Finance & Accounts Officer, joined at NDRI Karnal on transfer from NIAP, Pusa, New Delhi w.e.f. 07.07.2009.
- Dr. A. Kumaresan, Sr. Scientist (Animal Reproduction) joined at NDRI Karnal w.e.f. 09.07.2009.
- Sh. D. K. Arya, Finance & Accounts Officer joined at NDRI Karnal on transfer from IVRI-Muketheshwar w.e.f.10.08.2009.
- Dr. Chand Ram Sr. Scientist (Dairy Microbiology) joined at NDRI Karnal on transfer from SRS-Bangalore w.e.f.12.08.2009.
- Sh. Rishikanta Singh, Scientist (Agril. Economics) joined at NDRI Karnal w.e.f. 28.08.2009.
- Dr. Sudarshan Kumar, Scientist (Biotechnology : Animal Science) joined at NDRI Karnal w.e.f. 28.08.2009.
- Dr. Senthil Kumar R., Scientist (Veterinary Extension) joined at NDRI Karnal w.e.f. 29.08.2009.

- Mrs. Saroj Kumari, Asstt. joined as AAO at NDRI Karnal w.e.f. 01.09.2009.
- Dr. (Mrs.) S. Varalakshmi, Scientist joined SRS Bangalore on transfer from I.V.R.I, Izatnagar w.e.f. 29.10.09.
- Dr. Manoj Kumar Ghosh, Sr. Scientist (Animal Nutrition) joined at ERS of NDRI., Kalyani after transfer from National Research Centre on Yak, Dirang, Arunachal Pradesh on 16.11.2009.
- Dr. Rameshwar Singh, Principal Scientist appointed as Head, Dairy Microbiology Division w.e.f. 19.02.2010.
- Dr. Kaushik Khamrui joined as Sr. Scientist (Dairy Technology) at NDRI Kanral on 03.03.2010.
- Dr. Asik Mohammad joined as Scientist (Veterinary Extension Education) at NDRI Kanral on 06.03.2010.
- Dr. (Ms.) Raka Saxena joined as Sr. Scientist (Agril. Economics) at NDRI Kanral on 09.03.2010.
- Dr. S. Subash joined as Scientist (Veterinary Extension Education) at NDRI Kanral on 15.03.2010.

#### Transfers/Retirements

- Dr. Mukund Amrithrao Katakaltware, Scientist (Livestock Production and Management) joined at SRS, Bangalore on transfer from NRC on Yak, Dirang, Arunachal Pradesh w.e.f. 01.01.2009.
- Dr. Bandla Srinivas, Sr. Scientist (Animal Nutrition) joined at SRS, Bangalore on transfer from CSWRI, Avikanagar, Rajasthan w.e.f. 03.03.2009.
- Dr. K. S. Prasad, Principal Scientist, SRS, Bangalore transferred at NIANP, Bangalore w.e.f. 06.03.2009.
- Mr. P. K. Pal, T 7-8 (ERS, Kalyani) retired from Council's service w.e.f. 31.03.2009.
- Dr. M. K. Rao, Principal Scientist (AGB) SRS, Bangalore retired from Council's service w.e.f. 30.04.2009.
- Dr. Dharam Pal, Principal Scientist (Dairy Technology) retired from Council's service w.e.f. 30.04.2009.

- Mr. S. Ramachandra Raju, Technical Officer (SRS, Bangalore) retired from Council's service w.e.f. 30.06.2009.
  - Sh. Suresh Chandra, Sr. Finance & Accounts transferred from NDRI Karnal to join at IGFRI, Jhansi w.e.f. 07.07.2009.
  - Dr. V. K. Batish, Head, Dairy Microbiology Division retired from Council's service w.e.f. 31.07.2009.
  - Dr. V. Unikrishnan, Principal Scientist (Dairy Chemistry) SRS-Bangalore retired from Council's service w.e.f. 31.07.2009.
  - Dr. N. N. Balasubramanya, Principal Scientist (Biochemistry Animal Science) SRS-Bangalore retired from Council's service w.e.f. 31.08.2009.
  - Dr. Bhupinder Singh, Principal Scientist (Animal Nutrition) retired from Council's service w.e.f. 31.08.2009.
  - Dr. G. K. Goyal, Principal Scientist (Dairy Technology) retired from Council's service w.e.f. 31.08.2009.
  - Dr. (Mrs.) S. Vijaylakshmi, Principal Scientist (Agrl. Economics) took voluntary retirement from Council's service w.e.f. 01.09.2009.
  - Sh. M. L. Bhutani, AAO took voluntary retirement from Council's service w.e.f. 01.09.2009.
  - Dr. (Mrs.) Taruna Anand, Scientist (Biotechnology Animal Science) transferred from NDRI Karnal to join at NVTC, Hisar w.e.f. 03.09.2009.
  - Mr. S. K. Makkar, Sr. Scientist (ASPE) retired from Council's service w.e.f. 30.09.2009.
  - Dr. J.P.S. Chauhan, Principal Scientist, Dairy Extension Division retired from Council's service w.e.f. 31.10.2009.
  - Dr. M. K. Ghosh, Sr. Scientist (Animal Nutrition) joined at ERS, Kalyani on transfer from NRC on Yak, Dirang w.e.f. 16.11.2009.
  - Dr. S. Chinnadurai, Sr. Scientist, Dairy Extension Division removed from the Council's service vide ICAR order No.1-126/08/E-ID/182 c dated 18.11.2009.
  - Dr. P. K. Aggarwal, Principal Scientist, Dairy Microbiology Division retired from Council's service w.e.f. 30.11.2009.
  - Dr. Kishan Singh, Principal Scientist, Dairy Microbiology Division retired from Council's service w.e.f. 31.12.2009.
  - Dr. K. K. Singhal, Principal Scientist, Dairy Cattle Nutrition Division retired from Council's service w.e.f. 31.12.2009.
  - Mr. S. Swaminath Ram, T-5 (W/S) SRS, Bangalore retired from Council's service w.e.f. 31.12.2009.
  - Dr. M. K. Bhavadasan, Principal Scientist (Dairy Chemistry) SRS of NDRI Bangalore retired from Council's services w.e.f. 31.01.2010.
  - Dr. K.P. Ramesha, Sr. Scientist (AG&B) joined at SRS of NDRI Bangalore w.e.f. 03.02.2010 on transfer from IVRI, Izatnagar
  - Dr. Ajoy Mandal, Sr. Scientist (Animal Genetics and Breeding) after transfer from CIRG, Makhdoom joined ERS-NDRI, Kalyani on 18.02.2010.
  - Mr. M.S. Tyagi, T-7-8 (F/FT) and Mr. Naresh Kumar, T-5 (W/S) Forage Section retired from Council's service w.e.f. 28.02.2010.
  - Dr. V. S. Raina, Principal Scientist (LPM) retired from Council's services w.e.f. 31.03.2010.
  - Dr. R. B. Sangwan, Principal Scientist (Dairy Chemistry) retired from Council's services w.e.f. 31.03.2010.
- Promotions**
- Dr. Ashutosh, Scientist (SS) (Animal Physiology) promoted as Sr. Scientist w.e.f. 03.06.2003.
  - Mrs. Ritu Chakravarty, Scientist (SS) (Home Science) promoted as Scientist (SG) w.e.f. 16.05.2005.
  - Mr. P. Saha, T-6 (F/FT) ERS, Kalyani promoted as T-7-8 (F/FT) w.e.f. 01.01.2009.
  - Mrs. M. Jayalakshmi, PA promoted as Private Secretary w.e.f. 02.02.2009.
- Demise**
- Sh. Charan Singh, Principal Scientist (Livestock Production and Management) expired on 09.05.2009.
  - Dr. (Mrs.) Aruna Chhabra, Principal Scientist (Animal Nutrition) expired on 07.06.2009.
  - Dr. Sanjay Kumar, Sr. Scientist (Pharmacology) expired on 22.07.2009.

## 15 MAIN STATION

### RESEARCH DIVISIONS

#### Dairy Cattle Breeding Division

The Division is conducting research in the areas of animal genetics and breeding including cytogenetics and molecular genetics. The main thrust areas in research include genetic improvement of crossbred & Sahiwal cattle and Murrah buffaloes by progeny testing of breeding males and judicious selection of males and females, studies on selection criteria, development of optimum breeding plans, genetic polymorphism studies at molecular level and its association with production/reproduction traits and disease resistance, screening of young males for genetic disorders and male fertility assessment.

Development of skilled manpower in the field of animal genetics and breeding constitutes another important mandate of the Division. The Division also assists KVK/DTC and TBI (SINED) in training programs, consultancy services to farmers and various organizations, supplies superior germplasm in the form of frozen semen and breeding males to farmers, livestock developmental agencies and state governments.



The Center for Advanced Studies (CAS), recently named as Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at Division of Dairy Cattle Breeding during eighth plan continued its activities on strengthening research, teaching and imparting training to scientists/teachers from research institutes, State Agricultural Universities and Livestock Development Organizations in advanced areas of Animal Genetics and Breeding. A total of 26 National Training Programs have so far been organized under the aegis of CAS/CAFT 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 herd of cattle (Karan Fries, Sahiwal and Tharparkar) and Murrah buffaloes is 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 erstwhile Dairy Husbandry Division and subsequently of Dairy Cattle Nutrition Division till the end of the 6th Five Year Plan. In the year 1984, it received the status of an independent Division. The objectives of the Division are: i) To conduct basic and applied research and impart training in various aspects of Animal Physiology; ii) To undertake post graduate programmes of education in Animal Physiology at Masters and Doctoral levels and iii) Development and application of field level technologies.

The salient achievements of the Division are: 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-17 $\beta$  and PGFM; application of progesterone measurement in body fluids for fertility improvement viz. estrus confirmation, pregnancy/non pregnancy detection, monitoring cyclicity and identification of ovarian disorders, application of estrone sulphate determination in milk for confirmation of pregnancy and fetal viability. Indigenous production of progesterone antiserum and anti-rabbit IgG (second antibody) and their application in hormone immunoassays; parturition induction; neonate physiology; temporal endocrine interrelationships during different phases of growth, reproduction and lactations. Application of endocrine techniques for growth enhancement and fertility improvement. Optimum frequency

of feeding and milking; induction of lactation, augmentation of lactation through Growth Hormone administration, estimates of udder capacities, residual milk and milk secretion rates; somatic cell counts in milk of bovines during different stages of lactation, draught evaluation system, work efficiency of crossbred and indigenous bovine and buffalo bullocks and optimum work-rest cycle for working bullocks.

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, P. G. 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 for outstanding Ph.D. thesis 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.

### 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. & Ph.D. Animal Biotechnology program.

The objectives of the centre are i) 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, ii) to train manpower in application of Biotechnology in Dairy Production and Dairy Processing and iii) 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.

A state-of-the-art biotechnology research facility has been created to consolidate the biotechnology research at NDRI. The new lab facility offers a working space of more than 20,000 sq. ft. and have specialized laboratories on Animal Genomics, Prokaryotic and Eukaryotic Genome Analysis, Embryo Biotechnology and Proteomics 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 then Division of Human Nutrition and Dietetics. Research endeavors of the Division are presently directed towards: Development of probiotic foods; Dairy nutraceuticals and their mechanism of action; Validation of health benefit claims of Indian dairy products; Nutrigenomics; Characterization of buffalo fertility genes; Sperm functions and cryopreservation of semen; Spermatogonial stem cells research, Nanotechnology and Bioinformatics in dairy processing and production.

The Division has instrument rooms with modern equipments viz. Alpha- and Beta- counters, Ultra-centrifuge, High speed centrifuges, Micro-centrifuges, UV-visible spectrophotometers, Spectrofluorometer, PCR, Real time PCR, ELISA plate readers, High pressure liquid chromatography, Gas liquid chromatography, Inverted and fluorescent microscopes, Ice flaking machines, Freeze dryer, Gel documentation (Imaging) systems, Ultra filtration unit, Ultra-low temperature freezers and Carbon dioxide incubators. Division has a cold room for carrying out research at low temperature. Cell culture facilities are also available in the Division.

The salient research achievements of the Division are: Development of 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, gastrointestinal 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 Rafi Ahmed Kidwai Memorial Awards, Dr. P. G. Nair Award, AAAP/CAPRI Outstanding Research Award, two Jawahar Lal Nehru Awards, Young Scientist Award, IUIS/FIMSA Travel Bursary Award, Several foreign grants for presentation of research papers abroad 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 Nutregonomics, Functional foods and therapeutics; Prebiotics and probiotics; Bioactive peptides and immunology; Bioinformatics; Molecular Endocrinology, Reproductive Biochemistry and Stem cell research.

The Division manages Small Animal House that caters to the need of students and scientists; for laboratory animals viz. rat, mouse, rabbit and hamster etc. The unit possesses all facilities for formulation of feeds for laboratory animals.

### **Dairy Technology Division**

The Dairy Technology Division is one of the first Divisions set up at NDRI, Karnal and 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 research efforts of the Division faculty are channeled through in-house projects including dissertations of Masters and doctoral students, and extra-mural projects funded by various agencies.

The prominent research achievements of the Division are development of technologies for innovative processes for improved traditional dairy products including convenience formulations such as instant rasmalai mix, gulab jamun mix powder, khoa powder, salted sorghum lassi, salted bajra lassi, ready-to-reconstitute sorghum-based fermented milk beverage, whey-cereal based complimentary food, extended shelf-life milk-cake, instant kheer mix, basundi mix, kulfi mix powder, etc.; misti dahi, fruit-dahi, mango-lassi, ultrafiltered (UF) shrikhand, UF cheese, shrikhand powder, long-life paneer, low-fat paneer, shelf-stable paneer curry, long-life dalia dessert and dry dalia mix, rasogolla from buffalo milk, diet burfi, sugar-free kulfi and ice-cream; dairy whiteners from cow and buffalo milk, 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, spreads based on milk protein concentrate, 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, soybean-based weaning foods; 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; and egg-less cake mixes, plain and chocolate chhana murki, functional doda burfi and omega-3 fortified milk.

Technological 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 important research areas 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.



*International Training Programme for 24 personnel from Afghanistan*

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 chhana murki, triphala ghee and fiber-enriched doda burfi, herbal ghee, fiber-fortified milk, kheer, yoghurt and paneer, special dry milk-food formulation for cardiovascular health, functional ice-cream and high fiber whey-protein enriched 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 cereals 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 recognized the Division as Centre for Advanced Studies (CAS) in Dairy Technology since 1994. 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 so far organized 23 training courses under the CAS 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 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, and Dr. J.R. Patel Memorial Trust Award for teaching & research in Dairy Processing, 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, Condensed and Dried Milk Products Cell, Ice cream and Frozen Milk Products Cell, Dairy Analogues and Formulated Foods Cell, By-product 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 is contributing in teaching, research, training and industrial consultancy. There are nine teaching laboratory to conduct regular practicals. The Division is having research laboratory facility such as Process Engineering, Process Equipment Design, Unit Operating and Instrumentation. The Division have a modern R&D workshop for prototypes fabrication and an equipment testing hall for ready demonstration of the developed equipment. The Division has many prototypes for the manufacture of khoa, paneer, rasogola malai laccha etc. on the industrial scale and paneer gadget and cream separation attachment for small-scale applications.

Recently an experimental set-up on mechanical heat pump has been procured to study performance analysis of vapour compression refrigeration by measuring actual and theoretical carnot COP. A

three stage SSHE has also been developed with state-of-the-art technology by incorporating varying operating process features. It has been tried very successfully for the manufacture of Basundi, burfi and rubri apart of Khoa manufacture. M/s SSP Ltd. Faridabad, M/s Food and Biotech Faridabad, IDMC Anand and GCMF Anand have been actively collaborating for transforming the R&D knowledge to the field.

The contributions of the Division have been recognized by several best research paper awards and an outstanding teacher award to the faculty of the Division on different occasions. The Division also arranges specialized training to the graduate engineers during the summer months.

### 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 make up 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.

Technological/methods have been developed for the estimation of urea in milk using ammonia sensing electrode; a simple test known as "apparent solidification time test" for detection of foreign oils and fats adulterated in ghee; immobilized urease with enhanced storage and thermal stability; cholesterol estimation using enzymatic diagnostic kit and o-phthaldehyde (OPA) reagent; preparation of artificially sweetened whey lemon beverage and high antioxidant based fruit whey beverages; Estimation of artificial sweeteners and their degradation products (if any) in whey lemon beverage during storage. Two simple colour based methods for ascertaining the heat treatment of milk around 80°C have also been developed. Buffalo milk osteopontin has been purified and characterized and 12 peptides have been identified from the whey protein hydrolysates optimized for max. ACE Inhibitory activity, out of which eight peptides are known ACE Inhibitory peptides. Pyruvate, lactate and ammonia content coupled with the titratable acidity can be used as innovative and reliable tools for knowing the freshness of milk.

The Division has state-of-the-art Seminar room, Lecture room equipped with interactive board, LCD projectors, Visualiser, Podium etc., Quality control Lab, Undergraduate and Postgraduate labs, Instrument room, Research labs (lipids, proteins, minerals, enzymes, functional foods/neutraceuticals).

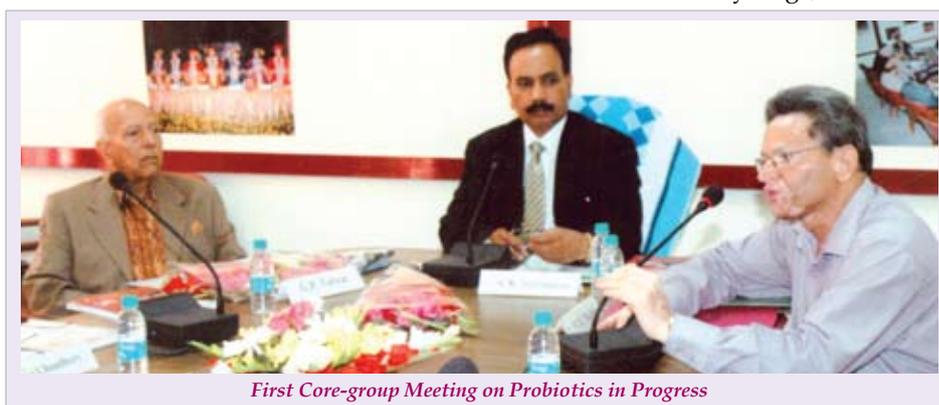
### Dairy Microbiology Division

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 major objectives of the Division are: i) To serve as a center of excellence for carrying out basic and applied research in different areas of Dairy Microbiology both at the level of milk production and processing; ii) To provide technical support and consultancy to dairy industry in all the areas related to microbiological aspects of milk and milk products and value addition through intervention of micro-organisms for improving health and nutrition alongwith safety and quality and iii) To conduct teaching programme at UG and PG level for NDRI Deemed University.

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

Division of Dairy Economics, Statistics and Management was created during the IV Five Year Plan. In the early stage, the focus of research



*First Core-group Meeting on Probiotics in Progress*

in the Division was on conducting research in Economics of Milk Production and Processing, with thrust on cost-returns studies. In 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. The Division maintains a mini computer unit, which is equipped with 5 Personal Computers loaded with the required user-friendly softwares to execute the word and data processing works of the Division. The Divisional Library is equipped with useful books and reports well serves the staff and students. The furnished seminar room has been a great facility for conducting seminars and other academic deliberations.

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 Grameen Dairy melas and demonstrations etc. are organized by the Division. Research-Extension-Industry-Farmer Interface is also organized by the Division to provide an opportunity for the convergence of all stake holders working together for dairy development. Interface not only helps the dairy organizations to find solutions for today's problems, but also to realize the vision for the future. The Division also organizes Technology Transfer Campaigns, Infertility and Veterinary aid Campaigns, Kisan Sanghosthi and Field Workshops at the adopted villages regularly. These activities strengthen the linkages with end users, help in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers.

## SUPPORT SECTIONS

### Livestock Farm

The total milk production of the herd during the current year was 1450491.5 kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 12.7 and 12.8 kg per head per day, respectively as compared to 11.0 and 13.0 kg per animal during the previous year (2008-2009). The milking average

of Sahiwal cows and Murrah buffaloes was 6.5 and 7.5 kg per animal per day, respectively. One Sahiwal cow (SW-1683) produced best milk yield of 20.5 kg in peak lactation. Best yield in Murrah buffalo (MU-5517) was 23.7 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 40 kg (KF-6791) and 33.0 kg (KS-4344), respectively.

### Bovine Strength of Cattle and Buffaloes as on 31.12.2009

Age group	Cattle				Total	Buffaloes	Total Bovines
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries		Murrah	
<b>Calves upto 6 months</b>							
Male	17	04	03	21	45	37	82
Female	27	08	-	42	77	37	114
Heifers	110	32	25	182	349	131	480
Cows	157	33	15	248	453	176	629
Male stock (young)	10	03	-	08	21	24	45
Bullocks/ Teaser	-	-	-	01	01	01	02
<b>Total</b>	<b>321</b>	<b>80</b>	<b>43</b>	<b>502</b>	<b>946</b>	<b>406</b>	<b>1352</b>

### Flock Strength of Goats as on 31.12.2009

Age Group	Alpine x Beetal	Sannen x Beetal	Total
<b>Female</b>			
Kids upto 6 months	39	26	65
Yearling	55	18	73
Goats	67	27	94
<b>Male</b>			
Kids upto 6 months	53	16	69
Bucks	12	08	20
<b>Total</b>	<b>226</b>	<b>95</b>	<b>321</b>

### Milk production at NDRI, Karnal during the year 2009 (1.1.2009 to 31.12.2009)

Total Milk production (kg) : 1450491.5 kg

Average Number of Animals in Milk per day : Cattle 299

Buffaloes 82

Goats 63

### Sale of Livestock during the year 2009 (1.1.2009 to 31.12.2009)

Mode of Disposal	Cattle	Buffaloes	Goats	Total
Public Auction	550150.00 (182)	290500.00 (27)	188000.00 (75)	1028650.00 (284)
On Book Value	314792.00 ( 28 )	23857.00 (04)	56696.00 ( 35 )	395345.00 ( 67 )
<b>Grand Total</b>	<b>864942.00 (210)</b>	<b>314357.00 (31)</b>	<b>244696.00 (110)</b>	<b>1423995.00 (351)</b>

• Auction of animals was conducted on 20<sup>th</sup> & 21<sup>st</sup> March and 19<sup>th</sup> & 20<sup>th</sup> September, 2009.

\* Figure in parentheses indicate the total number of animals sold.

### Performance of Dairy Animals during the year 2009 (1.1.2009 to 31.12.2009)

Particulars	Genetic Groups				
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
Average number of animals in milk per day	81	12	09	197	82
Average number of dry animals per day	72	22	05	45	66
Milking average (kg) per day	6.5	5.9	12.7	12.8	7.5
Overall average (kg) per day	3.5	2.1	8.2	10.5	4.2
Best yield (kg) in a day	19.0	18.0	29.0	38.0	23.7
Animal Number	SW-1683	TP-1122	KS-4344	KF-6791	MU-5517

### Flock Performance of Goats during the year 2009 (1.1.2009 to 31.12.2009)

Particulars	Genetic Groups	
	Alpine x Beetal	Sannen x Beetal
Average number of animals in milk per day	45	18
Average number of dry animals per day	19	10
Milking average (kg) per day	1.5	1.5
Overall average (kg) per day	1.0	1.0
Best yield (kg) in a day	4.0	4.4
Animal Number	AB-805	SB-71

**Month-wise Milking Average (kg) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal 2009 (1.1.2009 to 31.12.2009)**

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)/ animal/ day	No of Animals in milk/ day	Milk yield (kg)/ animal/ day	No of Animals in milk/ day	Milk yield (kg)/ animal/ day	No of animals in milk/ day	Milk yield (kg)/ animal/ day	No of animals in milk/ day	Milk yield (kg)/ animal/ day
Jan.	71	6.3	15	5.8	06	11.8	190	14.1	68	8.1	67	1.6	27	1.6
Feb.	80	6.8	12	7.1	07	11.3	205	14.5	71	7.8	65	1.6	26	1.5
Mar.	93	6.5	13	6.4	10	12.5	200	14.4	76	7.5	61	1.6	25	1.5
Apr.	83	6.7	13	5.6	10	15.1	194	13.9	77	7.5	56	1.6	24	1.7
May	85	6.3	13	5.4	10	14.9	200	13.6	76	7.4	53	1.5	22	1.6
June	86	6.3	14	5.8	10	13.5	197	13.0	74	7.5	48	1.4	20	1.5
July	82	6.4	12	5.7	12	11.3	192	11.9	72	6.9	39	1.0	18	1.0
Aug.	90	6.4	14	5.5	10	11.8	195	11.5	75	6.8	23	0.8	10	0.7
Sept.	83	6.3	14	5.2	10	9.8	201	10.9	85	6.9	12	0.8	04	0.6
Oct.	80	6.5	11	5.3	09	10.3	195	11.2	102	7.7	14	1.3	05	1.4
Nov.	73	6.8	10	5.0	08	12.5	196	12.4	97	8.0	48	1.4	17	1.5
Dec.	68	7.2	09	4.7	09	13.0	194	13.2	108	7.8	56	1.6	21	1.7
Avg.	81	6.5	12	5.9	09	12.7	197	12.8	82	7.5	45	1.5	18	1.5

**Month-wise Milking Average (kg) as Fat Corrected Milk of Cows and Buffaloes Maintained at NDRI Karnal (2009)**

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. 09	71	6.86	15	6.29	06	12.16	190	15.05	68	9.93
Feb. 09	80	6.64	12	6.79	07	10.53	205	13.71	71	8.57
Mar. 09	93	7.08	13	7.10	10	13.65	200	15.28	76	8.70
Apr. 09	83	7.07	13	5.77	10	15.22	194	14.13	77	8.73
May 09	85	6.93	13	5.56	10	15.67	200	13.75	76	9.25
June 09	86	6.73	14	6.20	10	13.87	197	13.74	74	9.65
July 09	82	7.01	12	6.17	12	12.45	192	13.07	72	9.60
Aug. 09	90	6.76	14	5.62	10	12.81	195	11.84	75	7.99
Sept. 09	83	6.47	14	5.71	10	9.85	201	10.90	85	8.56
Oct. 09	80	7.35	11	5.51	09	11.12	195	12.17	102	9.10
Nov. 09	73	7.25	10	5.39	08	12.65	196	12.82	97	9.30
Dec. 09	68	8.12	9	5.08	09	14.26	194	13.91	108	9.70
<b>Average</b>	<b>81</b>	<b>7.01</b>	<b>12</b>	<b>5.97</b>	<b>09</b>	<b>12.91</b>	<b>197</b>	<b>13.36</b>	<b>82</b>	<b>9.04</b>

### Fat and SNF Percentage of Cattle and Buffaloes (2009)

First Lactation					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No of observations	347	30	13	910	356
Average Fat %	4.62	4.41	4.62	4.39	7.92
Range	3.81-5.53	3.80-5.49	4.30-5.08	3.53-5.52	6.05-10.08
Average SNF %	8.72	8.65	8.72	8.70	9.75
Range	7.61-9.12	8.21-8.97	8.55-8.89	8.50-9.13	9.08-10.12
All Lactations					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No. of Observations	907	134	105	2362	914
Average Fat %	4.59	4.50	4.43	4.41	7.95
Range	3.55-5.66	3.63-5.49	3.69-5.29	3.50-5.52	5.26-10.53
Average SNF %	8.72	8.71	8.70	8.70	9.75
Range	7.61-9.09	8.52-9.09	8.38-9.03	8.43-9.13	9.08-10.53

### Protein and Lactose Percentage of Cattle and Buffaloes (2009)

First Lactation					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No of observations	347	30	13	910	356
Average Protein	3.08	3.06	3.14	3.05	3.67
Range	2.64-3.66	2.87-3.44	2.89-3.29	2.52-4.80	3.16-4.63
Average Lactose	4.71	4.67	4.76	4.68	5.58
Range	4.40-5.07	4.44-4.99	4.56-5.00	4.06-5.28	4.72-6.23
All Lactations					
Particulars	Cows				Buffaloes Murrah
	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	
No. of Observations	907	134	105	2362	914
Average Protein	3.09	3.07	3.06	3.05	3.68
Range	2.64-3.69	2.73-3.95	2.39-3.55	2.50-4.10	3.16-4.88
Average Lactose	4.71	4.68	4.71	4.68	5.60
Range	4.27-5.07	4.49-4.99	4.50-5.05	4.02-5.35	4.72-6.41

### Production and Reproduction Performance of Cattle Initiating their Lactation during (2008) and completing in 2009

Traits	Sahiwal	Tharparkar	Karan Swiss	Karan Fries	Murrah
<b>First Lactation</b>					
Age at 1st calving (Months)	38.53(26)	47.86 (19)	--	32.24 (65)	40.75(31)
Total milk yield (kg)	2327(20)	1288 (2)	--	4235 (56)	2639(32)
305 or less days milk yield (kg)	2021(20)	1213 (2)	--	3673 (66)	2302(25)
Lactation length (days)	353(20)	210 (2)	--	357 (57)	399(22)
Dry period (days)	110(15)	58 (1)	--	59 (41)	105(15)
Service period (days)	186(15)	172 (1)	--	136 (45)	147(13)
Calving interval (days)	465(15)	395 (1)	--	394 (41)	468(15)
<b>All Lactations</b>					
Total milk yield (kg)	1968(65)	1007(28)	3654 (10)	4445(149)	2419(81)
305 or less days milk yield (kg)	1888(65)	986(28)	3350 (10)	4099(171)	2256(86)
Lactation length (days)	280(65)	179(28)	305 (9)	340(150)	342(81)
Dry period (days)	114(49)	174(19)	150 (7)	69(106)	102(21)
Service period (days)	117(52)	87(20)	147 (7)	136(114)	131(61)
Calving interval (days)	406(50)	365(19)	400(7)	399(106)	424(21)
Average number of lactations	2.77(65)	2.89(28)	5.3(10)	2.4(171)	2.65(81)
<b>Best Lactation (305 or less days)</b>					
Milk yield (kg)	3595	2656	6679	6693	3813
Animal number	1679	1181	4360	6579	5517
Lactation number	3	2	5	2	1
<b>Best Lactation</b>					
Milk yield (kg)	4339	2885	7150	8216	4428
Animal number	1786	1137	4360	6579	5517
Lactation number	1	3	5	2	1
Lactation length (days)	490	357	350	415	427

Figures in parentheses indicate number of animals.

### Artificial Breeding Research Centre

The Artificial Breeding Research Centre (ABRC) has infrastructure capacity of managing 140 bulls of Sahiwal, Tharparkar, Karan Fries breeds of cattle and Murrah breed of buffalo. The ABRC Centre is presently involved in achieving the following objectives:

- Research on genetic improvement of dairy cattle and buffalo.
- Research on reproduction management of male animals/ breeding bulls.
- Production, processing, evaluation and preservation of superior male germplasm.
- Training and consultancy on male animal reproduction.
- Dissemination of superior germplasm of cattle and buffaloes.

The Centre is involved in production, processing, preservation and utilization of quality semen from cattle and buffalo bulls of high genetic merit. The

cattle and buffalo bulls maintained at A.B.R.C. are vaccinated regularly against FMD, HS and BQ. During the year, 94,090 doses of frozen semen were produced with total stock of 5,09,887 frozen semen doses of livestock breeds i.e., Sahiwal, Tharparkar, Karan Swiss, Karan Fries cattle and Murrah buffaloes as on 31.12.2009. The centre supplies frozen semen to Central Govt., State Govt. Agencies, Military Dairy Farms, NGOs, private developmental agencies and farmers. Chilled semen of high producing bulls is also supplied to the farmers from surrounding villages. This centre is looking after artificial insemination and reproduction management of the Institute herd. The centre is also catering to the needs of training, advisory services and consultancy in the field of AI & semen preservation, testing of AI equipment, cryocontainers. In addition to Institute's research projects on genetic improvement of different breeds of cattle and Murrah buffaloes, this centre is involved in research project on augmenting superior germplasm production. This centre is also catering to the research needs of scholars of various divisions viz., Dairy Cattle Breeding, Physiology, Chemistry, Biochemistry, Biotechnology and other Divisions of the Institute.

### Reproductive Status of NDRI Herd (2009)

Particulars	Breeds				
	SW	TP	KS	KF	MU
<b>Cows/Buffaloes</b>					
No. of Observations	114	23	11	161	84
Services Period (in days)	110.04	126.52	114.36	150.25	170.22
No. of Service/ Conception	1.70	1.86	1.90	1.94	1.76
<b>Heifers</b>					
No. of Observations	32	12	12	66	24
Average Age of Maturity (Months)	28.21	31.75	25.66	25.5	34.29
Average Age at Conception (Months)	29.43	33.00	26.33	26.86	40.08
No. of Services/ Conception	1.46	1.41	1.5	1.62	1.91
<b>Conception Rate</b>					
Conception Rate by 1 <sup>st</sup> Service (%)	45.26	50.00	53.84	40.26	39.55
Conception Rate by 3 <sup>rd</sup> Service (%)	82.63	80.00	76.92	76.23	73.88
Over all Conception Rate (%)	47.09	48.19	48.07	41.04	41.54

### Semen Production & Utilization (1.1.2009 to 31.12.2009)

#### A. Production of Semen

Breed	Collection	Neat Semen (ml)	Chilled Semen (ml)	Frozen Semen Doses	Frozen semen Doses Received	Doses in hand as on 31-12-2009
HF Imp.	0	0	0	0	0	1245
BS Imp.	0	0	0	0	0	410
HF NDRI	0	0	0	0	0	1040
SW	419	1722.5	12395	19650	0	72079
TP	10	41	0	1580	0	3980
KS	0	0	0	0	0	88759
KF	1200	5905	51888	45460	0	233389
MU	720	2152	19685	27400	5472	109015
<b>Total</b>	<b>2349</b>	<b>9820</b>	<b>83968</b>	<b>94090</b>	<b>5472</b>	<b>509887</b>

#### B. Utilization of Semen

Breed	Inst. Herd (FS)	Ext. Div. (FS)	KVK	IVLP	SRC	NOB NDRI	NOB CIRB	PTP	Farmer's Sale		DCB Div./ SRS		Discarded	Total	Balance of Frozen semen as on 31.12.2009	
									CH	FS	CH	FS				
HF imp	58	0	0	0	0	0	0	0	0	0	0	0	0	058	1303	
BS imp.	7	0	0	0	0	0	0	0	0	34	0	0	0	41	451	
HF NDRI	0	0	0	0	0	0	0	0	0	2	0	0	1	3	1043	
SW	889	15	1270	100	0	0	1110	110733	17843	0	1200	2422	366	22793	75222	
TP	213	0	20	0	0	0	0	0	150	0	500	0	11	894	3294	
KS	1585	100	0	0	0	0	0	0	681	0	0	0	17	926	89685	
KF	128	2435	3885	1470	3610	1000	0	120	47878	51817	0	4280	21535	796	70998	
MU	723	1375	2525	860	0	4405	4065	0	19105	23085	0	1357	2820	508	38903	
<b>Total</b>	<b>3603</b>	<b>3925</b>	<b>7700</b>	<b>2430</b>	<b>3610</b>	<b>5405</b>	<b>4065</b>	<b>12305</b>	<b>78056</b>	<b>93612</b>	<b>0</b>	<b>7337</b>	<b>26777</b>	<b>1699</b>	<b>134616</b>	<b>544971</b>

**Revenue generated:** During the period under report, 94090 doses of frozen semen worth Rs. 395490 /- were produced. The receipts of Rs. 390280/- (Chilled semen), Rs. 1056100/- (Frozen semen), Rs. 22040 /- (Liquid nitrogen) Rs. 350388/- (Sale of Animal).

### Forage Section

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 is made available for feeding 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 requirements of the Institute and requirements for transfer of technology programmes and partial fulfillment of the grain component of feed.

#### Allocations of the Farm Land to Different Units

Production Unit	Area (ha)
Farm Section	303.34
Seed Production Scheme	35.30
Forage Research Farm	5.08
Dairy Demonstration Unit(KVK)	13.52
<b>Total cultivated land</b>	<b>357.24</b>

### Fodder/Seed/Feed Production and Supply

A total of 1,59,456 quintal good quality green fodder was produced from high yielding varieties of fodder crops of maize, sorghum, sorghum x sudan grass hybrids and cowpea during kharif season and lucerne, berseem, oats, 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 1,80,973.75 q of fodder including 1,69,802.75 q green 5111.0 q silage and 6060.00 q dry fodder was supplied to cattle yard. Total production of grains, wheat, barley and oats was 1965.17 q.

#### Production and Productivity of Forage Crops in term of Green Fodder

Crop	Area (ha)	Average Yield (q/ha)	Production (q)
Berseem + Mustard	55.97	871.97	48804.00
Oats	84.62	363.47	30757.25
Turnip	4.86	646.09	3140.00
Lucerne	4.86	528.03	2566.25
Maize	170.88	158.63	27106.75
Mustard	3.32	533.96	1772.75
Jowar(Multicut)	35.75	728.09	26029.50
Jowar(Single cut)	41.90	372.38	15602.75
Cowpea	18.28	201.15	3677.00
<b>Total</b>	<b>420.44</b>	<b>-</b>	<b>159456.25</b>

#### Production and Productivity of Grain Crops

Crop	Area (ha)	Average yield (q/ha)	Production (q)
Wheat	22.25	49.99	1112.36
Oats	22.94	17.18	394.16
Barley	16.49	27.81	458.65
<b>Total</b>	<b>61.68</b>	<b>--</b>	<b>1965.17</b>

### Dry Fodder

Sufficient quantity of dry fodder as wheat, barley & oats straw in the form of by product of these crops (665.75.00 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 & oats straw were supplied.

### Revenue Generation

Through sale of farm produce and providing tractors on lease to sister Institute, an amount of Rs. 995169.00 was realized and an amount of Rs. 14,90,835.00 was saved by the use of Farm Produce as Seed/Feed.

#### Revenue Generation by the Sale of Farm Produce

Item sold	Qty. (q)	Rate (Rs./q)	Amount (Rs.)
Wheat grain	1.50	1000/-	1500.00
Wheat grain	158.70	1080/-	1,71,396.00
Wheat seed	168.80	2500/-	4,22,000.00
Oats seed	42.60	2800/-	1,19,280.00
Paddy (PS-1121)	57.18	2100/-	1,20,078.00
Tractors leasing out	-	-	1,60,230.00
Farm yard Manure	68.50	10/-	685.00
<b>Total</b>			<b>9,95,169.00</b>

### Budget Saved by the Use of Farm Produce as Seed/Feed

Produce	Qty. (q)	Rate (Rs./q)	Amount (Rs.)
Wheat seed	34.05	2500/-	85,125.00
Wheat feed	730.81	1080/-	7,89,275.00
Oats seed	128.61	2800/-	3,60,108.00
Oats feed	394.35	650/-	2,56,327.50
<b>Total</b>	<b>1287.82</b>	<b>-</b>	<b>14,90,835.00</b>

### Revenue Generation by Seed Production (RFS)

Name of Crop	Quantity of Seeds (q)	Rate (Rs./q)	Amount (Rs.)
Maize V.C	139.77	1700	2,37,609.00
Jowar PC-9	32.00	2000	6,4000.00
Oats OS-6	41.85	2800	1,17,180.00
Mustard Chinese cabbage	4.96	4000	19,836.00
Berseem Muscavi	0.75	5500	4,125.00
Paddy Pusa-44	240.00	2200	5,28,000.00
Turnip purple top	0.72	15000	10,830.00
<b>Total</b>	<b>460.05</b>	<b>--</b>	<b>9,81,580.00</b>

### 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 40 hectare area to produce the seeds of improved varieties of fodder crops for cultivation at Institute farm and sale to farmers, ICAR Institutes and other agencies. During the year under the report, a total of 460.05 q seeds of improved varieties of fodder crops, 61.35 q undersized grains and 16,486 q green fodder were produced and a revenue of Rs.10,42,690.50 was generated.

### 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

### Revenue Generation by Grain Production under RFS

Name of Crop	Quantity of grains (q)	Rate (Rs./q)	Amount (Rs.)
Maize	22.25	850.00	18912.50
Mustard	2.25	1400.00	3150.00
Paddy grains	25.00	1050.00	26250.00
Wheat	11.85	1080.00	12798.00
<b>Total</b>	<b>61.35</b>	<b>-</b>	<b>61110.50</b>

### Fodder Supplied to Cattle Yard (q) under RFS

Green Fodder	14,427.20
Maize Kadbi	3,57.50
Jowar Dry	1,098.75
Berseem Dry	54.25
Wheat Bhusa	16.50
Paddy Straw	5,32.25
<b>Total</b>	<b>16,486.45</b>

the surplus milk into variety of dairy products such as, Milk Powder, Pasteurized Butter, Ghee, Paneer, Burfi, Kalakand, Lassi, Ice Cream, Processed Cheese etc. These products are sold through the Milk Parlour located at the Institute's main entrance.

### Special Features

- Experimental Dairy provides practical teaching & 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 57 student were provided training during the year 2009-2010 from several Institutions.
- Experimental Dairy, self sustaining dairy has been running under Revolving Fund Scheme since 1989-90. Revenue generated through scheme is being utilized for development of infrastructure of Experimental Dairy.
- Experimental Dairy is certified under Quality management system I.S/ISO 9001-2000 and

food safety (IS-15000-1998) HACCP by BIS Chandigarh. Now it is going to install newly developed IS/ISO 9001-2008.

• The revenue generated during the year 2009-2010 was Rs.3,41,40,970/- .

### Sale of Milk and Milk Products (April 2009 - March 2010)

Items	Quantity	Amount (Rs.)
Ghee Cow (kg)	26252	6962030
Ghee (kg)	1187	317350
Paneer (kg)	18962	2871700
Pasteurised Butter (200 gm)	4956	230520
Paneer (500 gm) (kg)	16004	2351470
Paneer (250 gm) (kg)	6939.25	1016315
Ice Cream (Cup)	93916	1189560
Flavour D. Drink (200 ml)	304954	2741550
Lassi (200 ml)	152692	1354754
Dahi (200 gm)	11668	97388
Kalakand (kg)	11673.05	1750470
Burfi (kg)	4769	715590
Skim Milk Powder (R ) (kg)	43484	7392280
Gulab Jamun Mix (kg)	6029.55	904500
Pizza Cheese (200 g)	4610	184400
Carry Bag (No.)	6217	36470
Cooking Butter (kg)	94	21620
Mozzarella Cheese (kg)	1565.93	187912
Cheddar cheese (kg)	14225.38	769807
Process Cheese Slice (200 g)	800	56000
Tomato Soup (Cup)	1058	8464
Table Cream (200 g)	6	300
Khoa (kg)	84	11760
Skim Milk Powder (S) (500 g) (kg)	14	2100
Pasteurised Butter (Loose) (kg)	16.5	3300
Model Dairy Plant Ghee (kg)	12501	2937735
Jalzira Whey Drink (200 ml)	2840	22720
Mango Whey Drink (200 ml)	415	2905
<b>Total</b>		<b>34140970</b>

### Computer Centre

The Computer Centre is engaged in multifarious academic and service providing activities such as teaching computer 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 2Gbps National Knowledge Network Node and three leased lines. Various licensed software such as language compilers, application software packages and operating software are available.

### Scientific Data Processing

The Centre processed scientific data pertaining to research projects of the Institute as submitted by the scientists and also the data for dissertation/thesis work submitted by the research scholars. Apart from the existing general programs to process the scientific data, new specific programs were also developed to meet the specific requirements of the users as and when needed.

### Management Information Service

The Computer Centre prepared daily, fortnightly and monthly reports relating to milk production, supply of feeds and fodder, herd performance, animal management system, etc., for decision support to the appropriate authorities. The services for the preparation of feeding schedule were also provided. The processing of pay bills and GPF transactions of different categories of staff as well as generation of various reports was also carried out by the centre. The Entrance Exam data for admission to Ph.D. programme was also processed.

### Agricultural Research Information System (ARIS)

The ARIS Cell worked effectively during the year with regard to LAN management in order to provide network services. The biodata of staff of the Institute is being regularly updated as part of PERMISNET. The data is also being maintained on Academic and other information for NISAGENET. Intelligent Reporting System (IRS) of ICAR is also operational for about two years in which information is being uploaded quarterly. Recently, the PIMSNET has also been undertaken.

A Statistical Cell is also functioning in the Centre which maintains information on students and faculty as per the requirement of UGC.

The Video Conference facility is being used by ICAR as well as by authorities of the Institute for conferencing with each other and also with other Institutions.

### 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.

Bioinformatics training under the Traineeship/Studentship schemes of BTIS Project was provided on the following topics:

- Arrangement of BAC Clones of Bos taurus Y Chromosome.
- 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 has been developed and is operational. Salient features of the new website include role based security for instant updating of the information.

### Training programme conducted

Imparted training to 50-60 scientists on e-learning using e-LMS MOODLE for creating e-learning environment in the institute.

## Library

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 200 periodicals are subscribed to keep track of the current scientific/technical developments. There are 94,150 volumes, which include 50,045 books 31,210 bound journals, 8,200 bulletins, 3,227 theses, 268 microfiches and 1,200 CDs. Library has an excellent computer section having forty workstations for students and staff of the institute. Students use it to get current information in the advanced research areas and for communication. The Library also provides Internet, Email, Documentation, Reference, Current Awareness Services, Literature scanning through CD-ROM of 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. Computerised 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 and visits of dignitaries to the Institute.

During the period under report, A total of 27928 nos Digital photos, 165 scanned photos, 232 CD, 210 colour photos (35 mm roll, 138 PC print), 1040 4x6" P.C. print, 5451- 5x7 prints, 95 PP set, 8x10" 3, 10x12" 116, 12x15" 10 & 20x24" Blow up 8 were made. A sum of Rs.3361/- was realised through supply of photographs.

**Video Lab:** Being a central facility of the Institute, the facilities of video film production, computerized audio video editing with video effect transitions recording of video & audio on DVD & VCD, dubbing, mixing, & converting analog image to digital format etc. were extended to the staff & students for their research & research projects. Video coverage of 53 events of the Institute consisting of National & Inter-national seminars, workshops, meetings, conferences, cultural programmes, Dairy Mela, Cattle Shows, Kisan Sangoshti, Exhibitions, Calf Rallies, research & scientific activities, and other functions of the Institute were carried out. To propagate the

message of the Institute and strengthening the dairy sector, 279 DVD were made and distributed to the various prestigious organizations during the current year.

**Audio & Projection Unit:** The Audio & Projection Unit arranged the Audio Visual facility in the Main Auditorium, Mini Auditorium and Director's Conference Hall during the important seminars, workshops and student activities held at NDRI, Karnal. Also arranged PA system in the play ground for students and staff and Students Hostel activities. Beside this, Audio Visual Lab fixed the Translite Scroller show during the exhibitions held at Delhi and other places of NDRI. Revenue generated from Mini Auditorium from 1.04.08 to 31.03.09 was Rs, 8000/-.

## Exhibition Unit:

The following exhibitions were organized:

- World Milk Day at NDRI on 1<sup>st</sup> June, 2009.
- Foundation Day of DWR at Karnal on 9<sup>th</sup> Sept., 2009.
- Sugarcane Mela at CCS Regional Station at Uchani, Karnal on 29<sup>th</sup> Sept., 2009.
- Rabi Kisan Mela at CSSRI, Karnal on 20<sup>th</sup> Oct., 2009.
- IIT.F at Pragati Maidan, New Delhi during 14<sup>th</sup>-27<sup>th</sup> Nov., 2009.
- Vice-Chancellor Convention at NDRI, Karnal during 7<sup>th</sup>-8<sup>th</sup> December, 2009.

## Maintenance Section

This section provides services related to mechanical, electrical, civil, refrigeration & AC etc; New works addition/alterations required in the labs/Institute; Maintenance of the Sub-Station, overhead line, street lights, service connection maintenance of electric supply to the office area as well as residence of the Institute; Generator supply to office area in case of power failure; Liaison works with HSEB, CPWD, Haryana State Pollution Control Board & UPRNN; Water supply & sewage disposal system in the Institute; House building advances of the employee & their houses inspection at different stages of construction; Planning and inspection of new buildings in the Institute and maintenance of STP & Bio Gas Plants.

### 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.



Doctors render medical aid in Allopathy, Ayurveda & Homoeopathy. Qualified nurses, laboratory technicians and pharmacists assist the medical officers in providing medical facilities.



### 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.

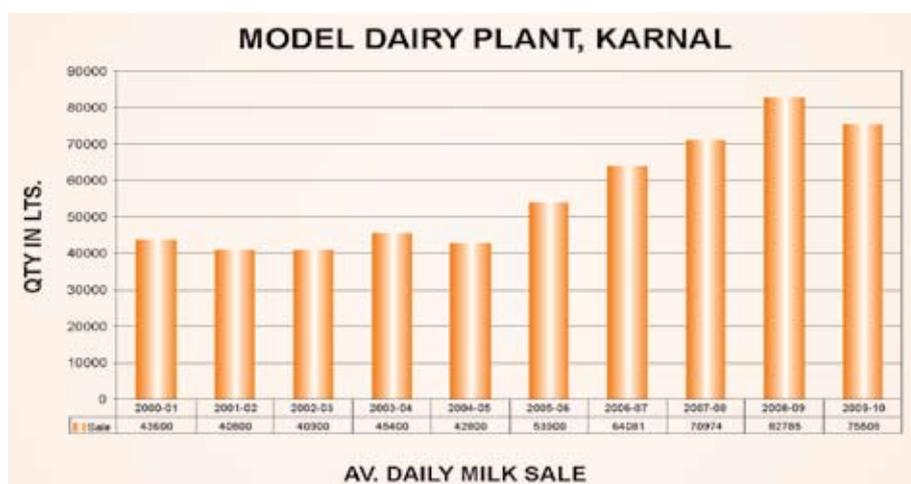
### Special Features

- Model Dairy Plant (MDP) provides one year In-plant training to the students of B.Tech. (DT) of the NDRI Deemed University during the 4th year of the course curriculum.
- The students are provided with complete infrastructure for training, which helps them in gaining sufficient experience in managing the modern commercial Dairy Plant and instills confidence in handling real life problems in production management.
- It also provides infrastructure facilities to the scientists of NDRI for scaling up R & D concepts from laboratory scale to industrial scale under commercial environment.

Model Dairy Plant (MDP), an autonomous unit of ICAR, is independently managed by a committee, whose Chairman is the Director of NDRI. The other committee members are: Representative of NDDDB, 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)

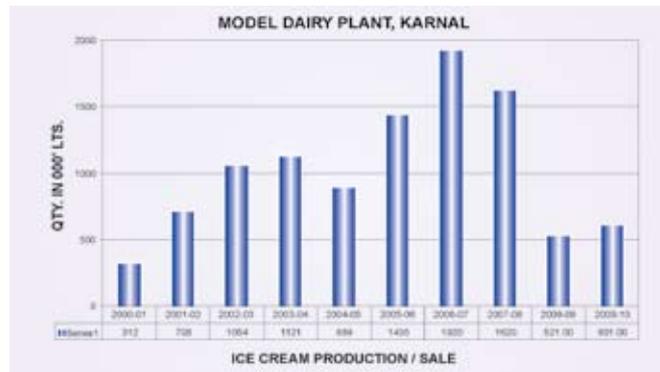
MDP is currently engaged in processing and packaging of milk for Mother Dairy in five different variants (Full Cream, Standard, Toned, Double Toned and Skim Milk). MDP is presently processing / packing 70 - 75 TLPD of polypack Milk in all the varieties for Mother Dairy, Delhi. The plant is running in three shifts and the supplies from MDP are dispatched in the evening & morning to Delhi market thereby utilizing the plant to more than its full capacity.



### Ice Cream Manufacture (Capacity 7000 lpd)

MDP 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

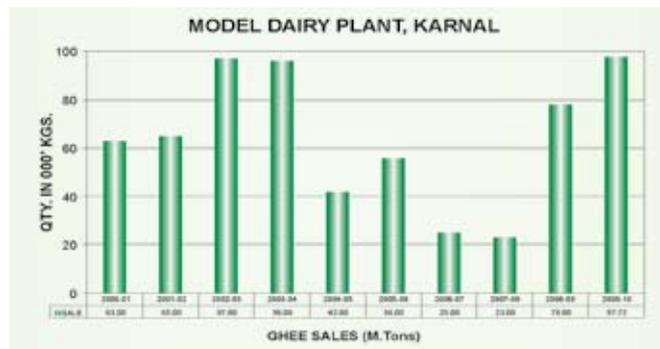
12000 LPD during the summer season. The ice cream manufactured at MDP is of different varieties i.e. Vanilla, Strawberry, Mango, Butter Scotch etc. and as per the requirements of Mother Dairy.



### Ghee Manufacture (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 7-8 metric tons per month. All the Ghee manufactured at MDP is being sold through the MDP Sale Counter.

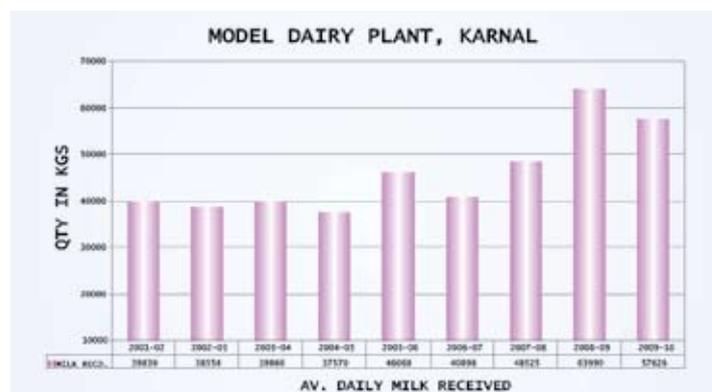


### Cheese And Paneer (Capacity 1500 kg per day)

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

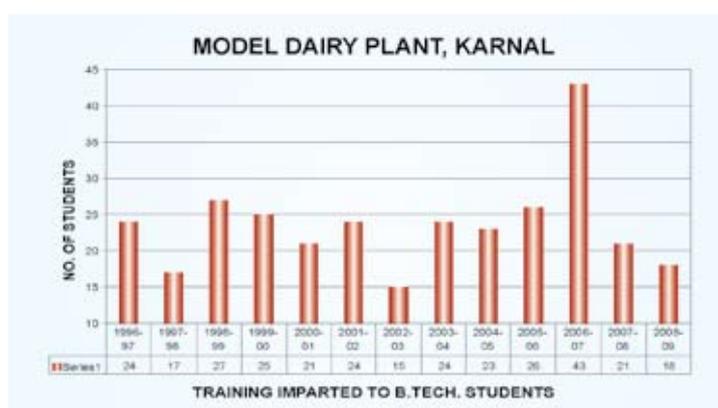
MDP does not have its own infrastructure for milk procurement and is receiving milk on behalf of Mother Dairy from the units of Punjab/Rajasthan/Uttar Pradesh State federations on NMG rates. The average milk procurement per day is around 55,000 to 60,000 LPD, which is sufficient to meet day to day demand 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 no. of 333 students have been trained so far during last year, 18 students were trained at MDP.

Students are given hands on experience for plant operations and trained to manage the shift activities of the plant under the guidance of trained technical staff. In addition to the above, students are also made to involve in Small Group Activities etc. The feedback regarding Inplant Training, from the students trained at MDP and now working in different capacities with different organizations is quite positive and encouraging.



### Quality Management System

Model Dairy Plant is presently certified under the Quality Management System IS / ISO 9001:2000 and Food Safety (IS 15000:1998) HACCP. MDP shall be implementing Food Safety Management System (FSMS) ISO 22000:2005 by the end of this calendar year.

### HRD Programmes

MDP has well trained Technical Staff to handle 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 and student trainees, which has been quite beneficial and helpful both to the employees and the organization.

### Visits by Dignitaries

Model Dairy Plant is regularly visited by dignitaries from India & abroad. Faculty members and students of different institutions also visit the plant. Visitors and dignitaries, so far visited, have appreciated the quality of work vis-à-vis hygiene and the facilities made available for training the students of Deemed University NDRI.



Dr. A. P. J. Abdul Kalam interacting with school children at NDRI Campus

## 16 REGIONAL STATIONS

### SOUTHERN REGIONAL STATION, BANGALORE

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.

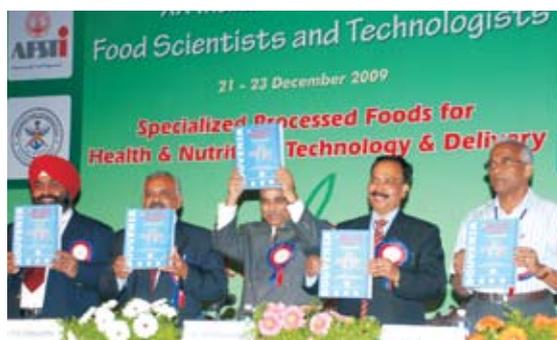
#### Infrastructure

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 constitute the dairy herd of the Institute.



*Release of Brochure on "Jill Cow"*

The Campus has good laboratory and infrastructural facilities for carrying out research 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.



*Release of commemorative souvenir specialised Processed Foods for Health & Nutrition Technology & Delivery at ICFOST-09*



*Lighting the ceremonial Lamp, Dr. A. K. Srivastava, Dr. M. N. Venkataramu and Dr. Satish Kulkarni (From left to right)*

There are network connected computer facilities to facilitate data analysis, documentation, e-mail communication and programming packages for students.



*H.E. Shri H.R. Bhardwaj, Governor of Karnataka at the Award ceremony of AFST (I), during the ICFOST 09*

A LAN with a modern web server networks the computers of different sections and Internet facilities are provided to all the sections through the server. An effluent treatment plant and effluent-testing laboratory are functioning at the campus. A sensory evaluation laboratory for evaluation of dairy products has also been established.

The library is stocked with 12300 books, 10252 bound volumes of journals, 1034 theses and 1295 reprints. Library subscribes to 125 Indian / Foreign Journals relevant to various disciplines of Dairy

Science. In addition, a few journals were also received on gratis basis from different Institutions / organizations of the country and abroad. Library Automation Software procured for facilitating the automation of library functions and 8080 entries of book database have been entered into 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 203 including 17 Scientific and 42 Technical staff.

### Resource Generation (2009-2010)

Name of Account	(Rs. in lakhs)
Sale of Farm Produce	5.77
Sale of Livestock	1.20
License Fee	5.06
Int. earned on Loans & Advances	1.34
Analytical Testing Fee	0.51
Application Fee from candidates	0.18
Income Generated from Internal Resource	2.13
Miscellaneous Receipt	4.01
<b>Total</b>	<b>20.2</b>

### Training Programmes Organised

Name of the Training Programme	No. of Batches	No. of Participants
Dairy Production	07	19
Processing of Milk for Market Milk Industry	01	06
Production of Cheese and Related Products	01	05
Standard Techniques for Assessment of Chemical Quality of Dairy Products	01	05
Assessing Microbial Quality of Dairy Products	01	03
Modern Dairy Management Practices for Dairy Entrepreneurs	01	01
Scientific Dairy Farming Practices for Dairy Farmers	01	37
In-plant Training	01	16
In-lab Training	02	02
Project Work	01	04

### 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 ITC Foods, Heritage Foods, Hatsun Agro Products (I) Ltd. The students of previous batches are placed in ITC Foods, GCMMF, Hatsun Agro Products Ltd. Kerala Department of Dairying and academic institutions.

### Extension Activities

- Advisory services were rendered to twenty seven clients who visited the institute for technical advice. The advisory services were rendered on setting up of a dairy farm, training programmes available for dairy entrepreneurs, consultancy for starting dairy project, feasibility report to start a dairy farm, availability of indigenous breeds, high yielding cross-bred animals & buffaloes and availability of seeds & root slips for green fodder cultivation, availability of dairy products as raw material, feasibility of dairy farming projects and mega dairy project on milk processing.
- Videoshows on Animal Health Care, Management of livestock, Clean Milk Production, Mechanised Dairy Farming, Green Fodder Production and Machine Milking were presented for clientele comprising of farmers, students and trainees of the institute.
- During the period under report, 1187 visitors visited the Institute in 33 batches comprising students, trainees, farmers, entrepreneurs and rural youth. The visitors were taken round the various sections and explained the ongoing activities as per their needs.
- A team of extension scientists organised exhibitions in Krishimela 2009, organised by University of Agricultural Sciences, Bangalore at GKVK Campus, UAS, Bangalore from 19th to 22nd November 2009. The Station also organised exhibition stall depicting innovative & educative information on dairy production and processing technologies, Indigenous breeds of South India & Indigenous dairy products for the benefit of the farming community & participants of the Conference, respectively during XX Indian Convention of Food Scientists and Technologists on “Specialized Processed Foods for Health & Nutrition: Technology & Delivery”.
- 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.

- The Institute has adopted 18 villages in Bangalore Rural District under MoU with a NGO, People’s Trust for Rural Extension Programme. Regular weekly visits were made to the adopted villages for providing needed technical advice on scientific dairy farming practices and Veterinary Extension Services to the needy clientele group.

Sl. No.	Type of veterinary service	No. of cases treated in Adopted Villages
1.	Artificial Insemination	793
2.	Re-insemination	204
3.	Calves born: Male	210
	Female	162
4.	First-aid Cases	2470
5.	Infertility Cases	814
6.	Deworming	3499
7.	Dehorning	177
8.	Castration	253
9.	Tattooing	261
10.	Taurine treatment	267
11.	Pregnant Animals	340
12.	Sale of Born Calves	101
13.	Abortion	17

### Livestock Farm

The campus maintains a dairy herd of about 200 animals of zebu cattle. Efforts are being made to improve the performance of the milch herd.

The total milk production of Deoni herd during the current year was 60867 kg. The milking average of deoni cows was 4.8 kg per day. Best yield of Deoni cow was 8.0 kg during 2008-09. The details of herd strength and production profile are mentioned in the following tables.

#### Deoni Herd Strength

Age group	Male	Female	Total
Calves up to 6 months	15	15	30
6 months to 1 year	15	07	22
1 to 2 years	18	19	47
Above 2 years	02	58	60
Milch Animals	-	38	38
Dry Animals	-	45	45
Breeding Bulls	08	-	08
Bullocks	10	-	10
<b>Total</b>	<b>68</b>	<b>192</b>	<b>260</b>

### Performance of Deoni Animals

Average no. of Animals in milk	33
Average no. of Animals in dry	42
Milking Average (kg/ day)	4.5
Herd Average (kgs/ day)	2.0
No. of calves born (M + F)	49 (28+21)
No. of animals died	06
Mortality per cent	2.3
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.

### 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.

### Sale of Milk and Milk Products (April 2009 to March 2010)

The Experimental Dairy has processed and sold milk and milk products as per the details given below:

Milk (lits)	31,284	5,00,552
Skim Milk (Lit)	960	13,440
Milk Sweet (kg)	426.50	58,768
Flavoured Milk (200 ml. Pkts)	5001	37,932
Process Cheese (250g Pkt)	4345	2,18,405
Paneer (kg)	502	71,187
Jamun mix (200 g Pkts)	521	15,676
Cheese Puri (200 g Pkts)	523	15,640
Ada Payasam (200 g Pkts)	32	928
G.G. Payasam (200 g Pkts)	13	377
Ice-cream (o) Cups	2381	22,595
Ice-cream (o) F.P.	84	7,020
Ice-cream (s) Cups	1490	15,800
Ice-cream (s) F.P.	74	6,920
Podo (200 g Pkts)	850	31,850
Yoghurt (Cups)	6298	59,689
Curd (200 g Pkts)	3166	23,484
Butter (kg)	213.50	34,036
Khoa (kg)	23.00	3,568
Kunda (Cups)	1964	27,224
<b>Total</b>		<b>11,65,091</b>

## EASTERN REGIONAL STATION, KALYANI

The Eastern Regional Station of National Dairy Research Institute has infrastructure facilities like Cattle Herd, Fodder Production Farm, Research Laboratories, Library, Guest House, Computer section etc. There are six sections namely (1) Animal Nutrition, (2) Livestock Production & Management, (3) Dairy Economics, (4) Dairy Extension, (5) Dairy Biotechnology and (6) Animal Genetics & Breeding which are actively engaged in research, training and extension work.



ERS of NDRI Kalyani

The main objective of the Station is to identify the major constraints in the field of dairy production in the eastern and north eastern regions and to offer plausible solutions through research and extension to these problems for speedy and scientific development of the dairy industry in the region. It serves as a vital link between the National Dairy Research Institute 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 projects undertaken at this station are mainly applied in nature and the thrust of research is to improve the socio-economic condition of the dairy farmers of this region, who are either land less or have marginal land holding.

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 the region.

## Support Sections

### Livestock Farm

The Cattle Yard of the station maintains 150 cattle including Jersey crossbreds and few purebred Tharparkar. 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 animals. The Library contains 1497 books, 3360 volumes of bound journals and other periodicals in the field of Dairying. The computer centre has networking and data entry facilities for statistical analysis of experimental data of various research projects and cattle yard. In addition, the data of milk production, fodder and feed supply, reproductive performance and meteorology is maintained on day to day basis.

### Reproductive Performance of ERS-NDRI Herd (2009)

Particulars	Jersey Cross	Tharparkar	Over all
Herd strength as on 31.12.2009	176	5	181
Total milk production (kg)	127730.0	1423.0	129153.0
Av. no. of cows in milk/day	52.1	1.2	53.3
Av. no. of cows in dry/day	14.6	3.8	18.5
Wet average (kg)/day	6.72	3.25	6.65
Herd average (kg)/day	5.25	0.78	4.94
Age at first calving (month)	35.7	0	35.7
No. of AI/conception	2.0	3.7	2.1
Service period (days)	135	157	138
Conception rate (%)	49.3	30.0	47.0
Inter calving period (days)	462	568	467
Mortality (%)	8.3	0	8.1

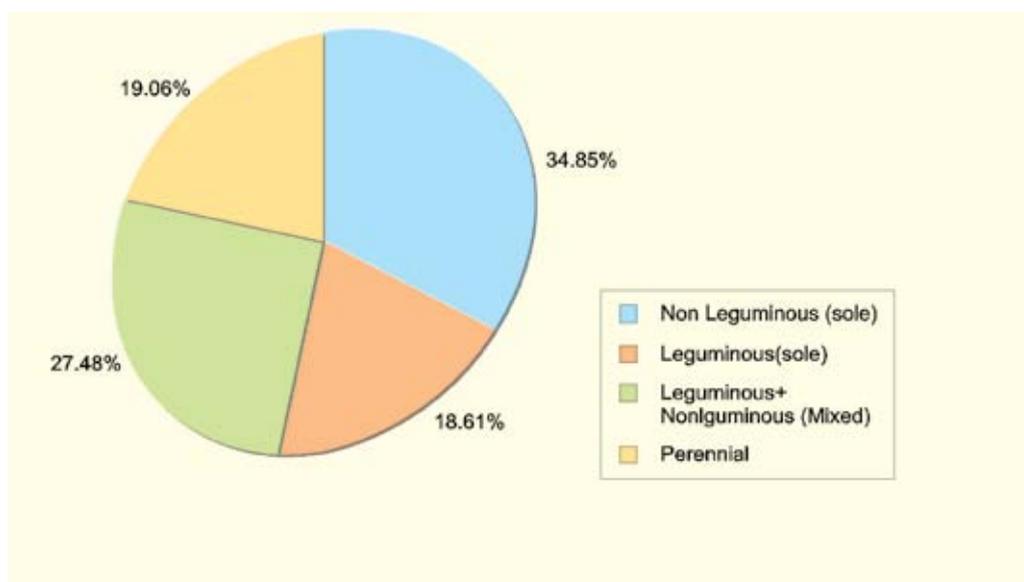
### Milk Production Pattern of ERS-NDRI Herd (2009)

Months	Milk Prod. (kg)	Wet Av. (kg)	Herd Av. (kg)	FAT %	SNF%
January	10423.5	6.53	5.12	4.79	8.70
February	9301.0	6.54	5.01	4.86	8.66
March	9907.5	6.28	4.71	4.82	8.73
April	9743.0	7.14	4.59	4.78	8.76
May	10618.5	7.40	4.74	4.81	8.69
June	11667.5	7.60	5.23	4.74	8.62
July	13255.5	7.55	5.70	4.77	8.71
August	12266.0	6.80	5.31	4.84	8.67
September	10381.0	6.34	4.68	4.76	8.75
October	11045.0	6.26	4.75	4.85	8.67
November	10152.5	5.93	4.64	4.75	8.74
December	10392.0	5.57	4.61	4.80	8.65
<b>Overall</b>	<b>129153.0</b>	<b>6.65</b>	<b>4.94</b>	<b>4.80</b>	<b>8.70</b>

### Production of Different Fodder Crops

Type of Fodder	Production (Quintals)
Berseem / Berseem+ Mustard	2162.70
Maize / Maize+Cowpea	1426.20
Oats/ Oats + Mustard	1397.98
Lucerne	7.85
Sorghum/Sorghum+Cowpea/ Sorghum + Maize+ Cowpea	4059.03
Sorghum+Ricebean/ RiceBeam	764.80
Hybrid Napier	2087.20
Guinea grass	130.45
Para grass	94.65
<b>Total</b>	<b>12130.86 qtl.</b>

### Fodder Production Scenario at ERS farm during 2009



### Library

This station has good laboratory facilities for the research work of M.Sc. and Ph. D. Scholars. Field visits, Farmer- Scientist Interface, orientation programmes are organised at regular intervals for the farmers of Dairy Cooperative Societies and NGOs on request. Training programmes on “Scientific Dairy Farming”, “Dairy Cattle Management” and “AI and Veterinary First Aid” for educated unemployed rural youth is being organised every quarter for educating the rural masses in dairying. The feasible technologies are being taken up for transfer through these trainings, field visits and village extension programmes where all efforts are made by the Institute to popularize latest suitable technologies in order to enhance dairy farming activity.

### Resource Generation

Heads	Amount (Rs.)
Sale of Milk	14,07,319
Sale of green Fodders	42,050
Sale of Animals	98,000
Trainings	25,525
Others	1,03,252
<b>Total</b>	<b>16,76,146</b>

### Extension Activities and Trainings

- One Certificate course on Scientific Dairy Farming was organized for 8 unemployed rural youth from two districts during 14<sup>th</sup> to 30<sup>th</sup> July, 2009.
- A six weeks training programme on “AI and Veterinary First Aid” was organized from 8<sup>th</sup> March, 2010. Eleven trainees participated deputed by Ichhamati Milk Union and by an NGO from 24 (N) Parganas.



*Training on AI & Veterinary First Aid at ERS, Kalyani*



### **Institute Farm Visits**

- Sixty farmers from Bankura dist in West Bengal visited the Institute farm on 11<sup>th</sup> Nov., 2009.
- Twenty five B.Tech (DT) 1st year students visited the Institute farm on 8<sup>th</sup> Dec., 2009.
- Eight youth undergoing a Krishak Mitra Training at KVK, Gayespur visited the farm on 14<sup>th</sup> December, 2009.
- Forty five vocational course students of government school from dist. Purulia visited the Institute and had interaction with the scientists on 1<sup>st</sup> Feb., 2010.
- Eight state veterinary officers undergoing training at the IVRI ERS, Belgachia visited the Farm on 18<sup>th</sup> March, 2010.
- Eight ARS probationers of 89<sup>th</sup> FOCARS. undergoing FET program visited the farm on 18<sup>th</sup> March, 2010.

- Thirty two rural women and ten men members of SHGs under Bagmundi Panchayat Samity from Purulia visited the farm on 24<sup>th</sup> March, 2010.

### **Special Veterinary & Reproductive Health Camps**

- Thirty two special camps were conducted during the year. During these camps, sessions of interaction were conducted between the society members and experts from the institute to educate them on balanced feeding of cattle, computation of ration from locally available feed resources, feeding of mineral mixture, causes of repeat breeding and its mitigation. A total of 866 members of WDCS of Ichhamati Milk Union and MPS of Kisan Milk Union were benefited. Besides it, veterinary services were given to 1647 animals in two villages of 24 (North) parganas.



*Reproductive cum Health camps in two villages of 24(N) Parganas*



### **Village Extension Programme**

- Four health camps were conducted at Murrachha village, Nadia district. A total

no. of 24 farmers attended these camps and 47 cattle and goats were rendered treatment.

- A competition was organized to select the households whose members maintained clean sheds and cattle. In two milk cooperative societies (Kathalpur and Amdob) during August, 2009. The objective was to motivate livestock owners to adopt 'clean milk production' practices. Three members were selected from each society.



*Exhibition Stall of ERS on 'Improved Dairying' at Kolkata*

### Exhibition

One exhibition stall was set up on 'Improved Dairying' at the 17<sup>th</sup> State Science & Technology Congress 'organized by the WBUFS at Belgachia, Kolkata on 4<sup>th</sup> - 5<sup>th</sup> March, 2010.



### Fodder Demonstrations on Farmers Field

Fourteen rabi fodder demonstrations were organized in WDCS of Ichhamati Milk Union and individual farmer's field in Kalna and Nadia district. Initially two group discussions were arranged for the women members of the cooperative societies. In



*Fodder Demonstration on Farmers' Fields*

all, 80 cottahs were brought under demonstration for oats and berseem (50 cottahs for milk unions and 30 cottah for the 2 farmers).

### Short Training to Students

- Four girl students from Durgapur College of Biochemistry, W.B. attended a 45 days training course on Analytical Biochemistry of Milk from 1<sup>st</sup> June to 15<sup>th</sup> July, 2009. This was a practical training programme and students were given sufficient exposure for analysis of milk, cream, colostrums, dahi and ghee.
- One B.Tech (Biotechnology) student from Institute of Technology and Marine Engineering, Diamond Harbour Road, Amira, WB, has undergone 45 days hands on training in the area of embryo biotechnology.



*Dr. K.M.L. Pathak, Deputy Director General (Animal Science), ICAR, New Delhi inaugurating Dairy Mela-2010 organised at NDRI, Karnal*

## राजभाषा एकक

- ★ संस्थान में गत कई वर्षों से कर्मचारियों को राजभाषा (हिंदी) में कार्य करने के लिए प्रोत्साहित करने हेतु मूल हिन्दी वैज्ञानिक/तकनीकी लेख लेखन प्रोत्साहन योजना चलाई जा रही है। इस योजना के अन्तर्गत इस वर्ष 16 वैज्ञानिकों/तकनीकी अधिकारियों को आकर्षक नकद पुरस्कारों से पुरस्कृत किया गया।
- ★ संस्थान द्वारा एक अन्य प्रोत्साहन योजना चलाई जा रही है जिससे अन्तर्गत मूल रूप से हिंदी में टिप्पण/मसौदा तथा अन्य कार्य करने के लिए संस्थान के प्रशासनिक तथा चतुर्थ श्रेणी के कर्मचारियों को प्रोत्साहित किया जाता है। इस प्रोत्साहन योजना के अन्तर्गत इस वर्ष 10 कर्मचारियों को पुरस्कृत किया गया।
- ★ संस्थान गत वर्षों की भांति इस वर्ष भी 14 सितम्बर से 27 अक्टूबर तक राजभाषा मास का आयोजन किया गया जिसमें विभिन्न प्रतियोगिताएं आयोजित की गईं जिनमें वैज्ञानिकों, तकनीकी अधिकारियों एवं शोध छात्रों हेतु 'शोधपत्र/पोस्टर प्रदर्शन प्रतियोगिता', प्रशासनिक कार्मिकों हेतु 'टिप्पण एवं मसौदा लेखन प्रतियोगिता' तथा नगर राजभाषा कार्यान्वयन समिति के सदस्य कार्यालयों हेतु 'गीत-गायन प्रतियोगिता' आयोजित की गईं। दिनांक 27 अक्टूबर, 2009 को मुख्य राजभाषा समारोह एवं पुरस्कार वितरण समारोह संपन्न हुआ। जिसमें विभिन्न प्रतियोगिताओं के विजयी प्रतिभागियों को नकद पुरस्कार एवं प्रमाणपत्र वितरित किए गए।
- ★ संस्थान को राजभाषा कार्यान्वयन में उत्कृष्ट कार्य हेतु संस्थान को दिनांक 16 जुलाई, 2009 को भारतीय कृषि अनुसंधान परिषद के 80वें स्थापना दिवस के अवसर पर 'राष्ट्रीय राजर्षि टंडन राजभाषा पुरस्कार योजना' के अन्तर्गत वर्ष 2008-09 के लिए द्वितीय पुरस्कार से सम्मानित किया गया। यह पुरस्कार माननीय केन्द्रीय मंत्री, डा० फारूक अब्दुल्ला जी, नवीन और अक्षय ऊर्जा मंत्री के कर कमलों द्वारा प्रदान किया गया। संस्थान की ओर से यह पुरस्कार निदेशक महोदय एवं राजभाषा स्टाफ ने प्राप्त किया।
- ★ इस वर्ष संस्थान के दो कार्मिकों ने सी०डैक नोएडा द्वारा आयोजित पांच दिवसीय कंप्यूटर पर कुशल हिंदी प्रशिक्षण कार्यक्रम में भाग लिया।
- ★ संस्थान राजभाषा कार्यान्वयन समिति की तिमाही बैठकें नियमित रूप से निदेशक महोदय की अध्यक्षता में आयोजित की गईं। बैठकों में लिए गए निर्णयों पर अनुवर्ती कार्रवाई सुनिश्चित की गई।
- ★ केन्द्रीय मात्स्यिकी शिक्षा संस्थान, मुम्बई द्वारा 'राजभाषा हिन्दी का वैश्वीकरण' विषय पर दिनांक 11-16 जनवरी, 2010 तक छः दिवसीय प्रशिक्षण कार्यक्रम एवं कार्यशाला आयोजित की गईं जिसमें संस्थान की ओर से श्री रामशंकर गौतम, सहा० निदेशक राजभाषा ने भाग लिया तथा इस अवसर पर प्रकाशित स्मारिका में एक आलेख भी प्रस्तुत किया।
- ★ भारतीय जन संचार संस्थान, नई दिल्ली द्वारा 'प्रिन्ट एवं इलेक्ट्रॉनिक मीडिया के आगामी प्रयोग' विषय पर दिनांक 5 से 9 अक्टूबर, 2009 तक एक पांच दिवसीय प्रशिक्षण कार्यक्रम आयोजित किया गया जिसमें संस्थान के सहा० निदेशक (राजभाषा) श्री आर.एस.गौतम एवं डा० गोपाल सांखला, वरि० वैज्ञानिक, डेरी विस्तार प्रभाग ने संस्थान का प्रतिनिधित्व किया।
- ★ नगर राजभाषा कार्यान्वयन समिति, करनाल की छःमाही बैठकों में संस्थान द्वारा प्रतिनिधित्व किया जाता रहा है। दिसम्बर, 2009 में आयोजित छःमाही बैठक में संस्थान की ओर से डा० एस.एल.गोस्वामी संयुक्त निदेशक (अनुसंधान), श्री पुष्पनायक, वरि० प्रशा० अधिकारी एवं श्री आर.एस.गौतम सहा० निदेशक राजभाषा ने भाग लिया।
- ★ संस्थान की वार्षिक गृह पत्रिका 'दुग्ध गंगा' 2010 का प्रकाशन किया गया।
- ★ संस्थान के सहा० निदेशक (रा०भा०) श्री आर.एस.गौतम को राजभाषा कार्यान्वयन में उत्कृष्ट योगदान के लिए हिन्दी साहित्य सम्मेलन, प्रयाग ने 12 मई, 2009 को 'सारस्वत सम्मान' से सम्मानित किया। इसमें एक प्रशस्ति पत्र प्रदान किया गया।
- ★ संस्थान के वैज्ञानिकों के वैज्ञानिक एवं लोकप्रिय लेखों, प्रशासनिक एवं प्रभागों से प्राप्त विभिन्न प्रकार के कार्यों, छात्रों के शोध सांराश, संस्थान की वार्षिक प्रतिवेदन आदि के अनुवाद का कार्य राजभाषा एकक द्वारा किया जाता है।

# हिन्दी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान

## हिन्दी सारांश

राष्ट्रीय डेरी अनुसंधान संस्थान राष्ट्र का एक अग्रणी एवं प्रतिष्ठित अनुसंधान संस्थान है जो कि देश में डेरी विकास कार्यक्रमों के लिए अनुसंधान एवं विकास तथा मानव संसाधन विकास में सहयोग के लिए पूर्ण रूप से समर्पित रहा है। वर्ष 1923 में स्थापित इस संस्थान के मुख्यालय को वर्ष 1955 में करनाल में स्थानान्तरित कर दिया गया। इस संस्थान के दो क्षेत्रीय केन्द्र हैं जो कि बंगलौर एवं कल्याणी में स्थित हैं। 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 प्रबंधमंडल, अनुसंधान सलाहकार परिषद्, विद्या परिषद् एवं विस्तार परिषद्, 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 हैं। संस्थान के अनुसंधान और विकास के तीन मुख्य क्षेत्र (1) डेरी उत्पादन (2) डेरी प्रसंस्करण तथा (3) डेरी प्रसार/प्रबन्धन हैं। सभी अनुसंधान एवं विस्तार कार्यक्रम संस्थान के मुख्यालय तथा इसके दो क्षेत्रीय केन्द्रों पर संस्थान के बारह अनुसंधान प्रभागों/अनुभागों डेरी पशु प्रजनन, पशुधन उत्पादन एवं प्रबन्धन, डेरी पशुपोषण, डेरी पशु शरीर क्रिया विज्ञान, पशु जीवरसायन, पशु जैवप्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी अभियांत्रिकी, डेरी रसायन, डेरी सूक्ष्मजीव विज्ञान, डेरी विस्तार तथा डेरी अर्थशास्त्र सांख्यिकी एवं प्रबन्धन प्रभाग के अन्तर्गत संपन्न होते हैं। संस्थान में एक कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक), कृषि विज्ञान केन्द्र तथा डेरी प्रशिक्षण, पशु प्रजनन अनुसंधान केन्द्र भी है। संस्थान में पशुधन फार्म, चारा फार्म, प्रौद्योगिकी व्यवसाय संवर्धक, पशु स्वास्थ्य परिसर, मॉडल डेरी संयंत्र, प्रयोगात्मक डेरी संयंत्र, परामर्श एकक, पुस्तकालय सेवा एवं राष्ट्रीय जैवसूचना केन्द्र, कंप्यूटर केन्द्र, संपदा अनुभाग तथा अनुरक्षण अभियांत्रिकी अनुभाग जैसी केन्द्रीय सुविधाएं उपलब्ध हैं। प्रशासनिक कार्यकलाप जैसे वित्त, क्रय, भंडार, स्थापना तथा सुरक्षा के कार्यकलाप मुख्य प्रशासनिक अधिकारी के नियंत्रण में हैं। संस्थान में इस समय 147 वैज्ञानिक 315 तकनीशियन, 179 प्रशासनिक तथा 711 चतुर्थ श्रेणी (ग्रुप-डी) कर्मचारी सेवारत हैं।

### बजट

वर्ष 2008-2009 में संस्थान में योजना और गैर-योजना के अन्तर्गत कुल व्यय बजट 6410.86 लाख रूपए था तथा वर्ष 2009-10 के लिए कुल बजट 7871.23 लाख रूपए

स्वीकृत किया गया। जिसमें दोनों क्षेत्रीय केन्द्र (बंगलौर व कल्याणी) का बजट भी सम्मिलित है।

### अनुसंधान

वर्ष 2009 के दौरान कुल 90 अन्तःसंस्थान अनुसंधान परियोजनाओं पर कार्य चल रहा था। मूल एवं महत्वपूर्ण अनुसंधान कार्यों 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 जिसमें राष्ट्रीय डेरी अनुसंधान संस्थान या तो नेतृत्व करेगा अथवा सहायक सहयोगी होगा। राष्ट्रीय कृषि नवोन्मेषी परियोजना के अन्तर्गत वर्ष 2009-10 के दौरान उन्नीस परियोजनाएं लगभग 33 करोड़ रूपए की राशि से जारी रहेगी। कई अनुसंधान कार्यक्रमों के राष्ट्रीय स्तर पर जैव प्रौद्योगिकी (डी. बी. टी.), नैशनल कम्युनिकेशन टू युनाइटेड नेशनस फ्रेमवर्क कनेक्शन ऑन क्लाउडमेट चेंज (एन. ए. टी. सी. ओ. एम. यू. एन. एफ. सी. सी.) खाद्य प्रसंस्करण उद्योग मंत्रालय, राज्य कृषि विश्वविद्यालयों तथा राज्य विकास विभागों के साथ अन्तःसंस्थानिक संबंध थे। इस अवधि की कुछ महत्वपूर्ण अनुसंधान उपलब्धियों का विवरण निम्नवत् है।

- ★ छठे सैट के कुल 16 मुराह सांडों का मूल्यांकन किया गया तथा राष्ट्रीय डेरी अनुसंधान संस्थान केन्द्र के सांड संख्या 4.5.6 ने (प्रजनक सूचकांक-1972 कि0ग्रा0) दूसरा स्थान प्राप्त किया तथा इस सैट में तीन सांडों में से 8.90% श्रेष्ठता के साथ प्रजनक घोषित किया गया।
- ★ दैनिक, साप्ताहिक तथा वार्षिक परीक्षण दिवस दुग्ध उत्पादन का प्रयोग कर परीक्षण दिवस ब्याँत वक्र माडल विकसित किए गए तथा क्षेत्रीय परिस्थितियों के अन्तर्गत संगठित पशु समूहों में मुराह भैंसों के मासिक तथा कुल ब्याँत दुग्ध उत्पादन के पूर्वानुमान के लिए आंशिक ब्याँत रिकार्ड किए गए।
- ★ करन फ्रीज गायों में कुल 2755 कृत्रिम गर्भाधान किए गए जिसके परिणामस्वरूप दिसम्बर, 2009 तक क्षेत्रीय परिस्थितियों के अन्तर्गत 49.0% गर्भाधान दर प्राप्त की गई। कृषकों के पशुसमूह में कुल 925 (479 बछड़े तथा 446 बछड़िया) करन फ्रीज बछड़े-बछड़िया उत्पन्न हुए तथा क्षेत्रीय परिस्थितियों के अन्तर्गत सांडों के मूल्यांकन के लिए 802 करन फ्रीज बछड़ों पर प्रदर्शन आकड़े रिकार्ड किए गए।
- ★ पाक्षिक (एफ.टी.डी.वाई.), मासिक (एम. टी. डी.वाई.) तथा द्विमासिक (बी. टी. डी.वाई.) परीक्षण दिवस दुग्ध उत्पादन के लिए 305 दिन दुग्ध उत्पादन के पूर्वानुमान की यथार्थता कर्ण फ्रीज गो पशुओं में एफ.एफ.टी.डी.वाई.-11, एम.टी. डी.वाई.-6 तथा बी.टी.डी.वाई.-4 के लिए (60-61%) उच्चतम पाई गई।

- ★ 305 दिन दुग्ध उत्पादन के पूर्वानुमान के लिए श्रेष्ठ पूर्वानुमान समीकरण उत्पन्न किए गए तथा कर्ण फ्रीज गोपशुओं में स्टैपवाइज वैकवर्ड रिग्रेशन विधि के प्रयोग द्वारा परीक्षण दिवस दुग्ध उत्पादन में श्रेष्ठ संयोजन का प्रयोग करके प्रजनक मूल्यांकन किया गया। एल.ए.ए.क्यू. तथा एस.आर. एल.एस. के द्वारा ई.बी.वी.एस. के बीच श्रेणी सह-समन्वयन अधिकतम थे उसके पश्चात् वास्तविक एवं पूर्वानुमानित 305 दिन दुग्ध उत्पादन पर आधारित बी.एल.यू.पी. तथा एस.आर.एल.एस. का स्थान था। अन्य विधियों की अपेक्षा एल.ए.ए.क्यू. अपेक्षाकृत अधिक सक्षम पाई गई लेकिन वास्तविक 305 दिन दुग्ध उत्पादन पर आधारित स्थिरता में लगभग समान थी। बी.एल.यू.पी. पूर्वानुमानित 305-दिवस दुग्ध उत्पादन पर आधारित अन्य विधियों की अपेक्षा सक्षम पाई गई लेकिन स्थिरता में लगभग समान थी।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल पर रखे गए साहीवाल बछड़े तथा बछड़ियों के लिए औसत साप्ताहिक शरीर भार (जन्म से 26 सप्ताह) अंकित कर विकास वक्र तैयार किए गए। बछड़े तथा बछड़ियां दोनों में विकास वक्र रेखीय प्रकृति के थे। जन्म से छब्बीस सप्ताह (6 मास) की आयु तक औसत दैनिक भार ग्रहण बछड़ियों में 339.11 ग्राम/दिन तथा बछड़ों में 333.50 ग्राम/दिन था।
- ★ साहीवाल बछड़ों-बछड़ियों में 26 सप्ताह के शरीर भार का प्रयोग करके बछड़ों तथा बछड़ियों के लिए विकास बैंड निर्मित किए गए। बछड़ों/बछड़ियों दोनों के लिए जन्म के समय विकास बैंड तंग थे तथा आयु बढ़ने के साथ-साथ ये भी चौड़े होते गए। इन विकास बैंडों का प्रयोग प्रारंभिक आयु के समय युवा बछड़ों-बछड़ियों के चयन के मापदंड के रूप में भी किया जा सकता है।
- ★ साहीवाल गोपशुओं में सात शरीर भार एवं पांच प्रथम ब्याँत परीक्षणों के विभिन्न संयोजनों का प्रयोग कर चयन प्रक्रियाओं की संरचना की गई। अनुकूलतम चयन सूचकांक ने अठारह मास, चौबीस मास, तीस मास पर शरीर भार तथा प्रथम ब्याँत के समय भार को समाविष्ट किया।
- ★ साहीवाल गोपशुओं में 305 दिन दुग्ध उत्पादन के प्रथम ब्याँत के पूर्वानुमान के लिए बहुगुणन रेखीय रिग्रेशन (एम. एल.आर.) तथा कृत्रिम न्यूरल नेटवर्क (ए.एन.एन.) मॉडलों का विकास किया गया। इसके लिए स्वतन्त्र परिवर्तकों के रूप में विभिन्न आयु पर शरीर भार तथा आश्रित परिवर्तकों के रूप में प्रथम ब्याँत 305 दिन दुग्ध उत्पादन का प्रयोग किया गया तथा दोनों माडलों की फिटिंग की यथार्थता की तुलना की गई। दोनों माडलों से पूर्वानुमान की यथार्थता काफी कम पाई गई। तथापि आंकड़ों के टैस्ट सेट के लिए एम.एल.आर. माडल की अपेक्षा ए.एन.ए. माडल में पूर्वानुमान की यथार्थता अपेक्षाकृत उच्चतर पाई गई। जबकि ए.एन.ए. पूर्वानुमान ने टैस्ट डेटा सेट में एम.आर.ए. की तुलना में एस.डी. अनुपात तथा न्यूनतम आर.एम.एस.ई. के साथ उच्चतम आर2 मान दिए, यह अर्थ लगाया जा सकता है कि साहीवाल गोपशुओं में शरीर भार का प्रयोग कर प्रथम ब्याँत 305 दिन दुग्ध उत्पादन का पूर्वानुमान ए.एन.ए. की तुलना में अपेक्षाकृत अधिक सही था।
- ★ कोशिकीय आनुवांशिकी जांच ने प्रजनन दृष्टि से क्षीण पशुओं एवं जुड़वा जन्में बछड़े-बछड़ियों में लैंगिक क्रोमोसोम की कुल अनियमितताएँ प्रकट की।
- ★ एक अन्तःलैंगिक संकर बकरी में नर लैंगिक व्यवहार का एक मामला पाया गया।
- ★ एस0 एरियस से संबंधित थनेला जीनुस में आनुवांशिक पोलिमार्फिज़्म की जांच पर अध्ययन किए गए।
- ★ साहीवाल गोपशुओं ने आई0एल-8 जीन (एकजोन 4 तथा 3 यू.टी.आर. युक्त 320005-3783 एन.टी. से 578 बी.पी. भाग) के दो जीनोटाइप प्रदर्शित किए इसे क्रमशः 0,846 तथा 0.154 के रूप में सी0 ता डी एलेल की आवृत्ति के साथ डी आर. ए.। रिस्ट्रिक्शन किण्वक का प्रयोग कर पी.सी.आर.-आर.एफ.एल.पी. द्वारा प्रदर्शित किया गए।
- ★ मुराह भैसों में आई0एल 8 जीन के एकजोन 4 के डी0 आर. ए.। रिस्ट्रिक्शन एन्जाइम का प्रयोग करके पी. सी. आर.-आर. एफ.एल.पी. विश्लेषण ने तीन जीनोटाइप (ए.ए., ए.बी. तथा बी. बी.) प्रदर्शित किए। तथापि ये जीनोटाइप मुराह भैसों में थनेला की घटना के साथ महत्वहीन सम्पर्क इंगित करते हैं।
- ★ बी.एस.आई. एच0के0ए1 रिस्ट्रिक्शन एन्जाइम का प्रयोग करके टी.एल.आर. 4 जीन के पी.सी.आर.-आर.एफ.एल.पी. विश्लेषण द्वारा मुराह भैसों में टी.एल.आर. 4 जीन के ए.ए., ए.बी. तथा बी. बी. जीनोटाइप पहचाने गए।
- ★ दक्षिण क्षेत्रीय केन्द्र, बंगलौर पर गोपशुओं की हालीकर तथा डिओनी देशी नसलों में एम.एच.सी. लोकस गोपशुओं के अन्तर्गत बी.ओ.एल.ए. डी आर.बी. 3.2 एलेल का अभिलक्षण किया गया। उच्च लवण विधि का प्रयोग करके सम्पूर्ण रक्त से डी.एन.ए. वियोजित किया गया।
- ★ प्रोलेक्टिन जीन के लिए पी.सी.आर.-आर.एफ.एल.पी. के लिए लगभग 72 दुधारू डिओनी गायों तथा 62 होलस्टीन फ्रीजियन गायों का परीक्षण किया गया।
- ★ लिनोलिक अम्ल के स्रोत के रूप में आहारीय तेल के सम्पूर्ण पर ब्यूट्रीविबरीओ फाइबरीसोल्वनस संयुक्त लिनोलिक अम्ल उत्पन्न कर सकता है।
- ★ पौषणिक प्रयोग में सुधार के लिए फाइब्रोलाइसक एन्जाइमों के आहारीय सम्पूरण के लिए एक विधि मानकित की गई। फाइब्रोलाइसक एन्जाइमों के साथ फसल अपशिष्ट आधारित आहार 1.5 ग्रा./कि.ग्रा. शुष्क पदार्थ की दर पर सम्पूरित करने की सिफारिश की गई।

- ★ फ़्यूमरिक तथा मेलिक अम्ल (6.5 एम. एम.) के साथ संयुक्त रूप से मिलाने से मीथेन रीलीज एक सहयोगी विधि में कम होती है।
- ★ मीथेन उत्पादन को कम करने के लिए सान्द्रित अवयवों के रूप में हरी फलियां, सरसों की खली तथा बाजरा जैसी कासनी तथा सफेद क्लोवर, सरसों के साथ जुगाली करने वाले पशुओं की आहारिय संभाव्यता इन विट्रो अध्ययन प्रकट करते हैं।
- ★ भारी धातुओं के बढ़ते आक्सीकारक दबाव इंगित करने वाले इन विट्रो अध्ययनों के अन्तर्गत अरगजी तथा सीसे की बढ़ती मात्रा के साथ लिम्फोसाइट प्रोलिफरेशन कम होती है तथा एस.ओ.डी. अभिव्यंजना बढ़ती है।
- ★ दुग्धरू गायों के आहार में अनाजों (जौ तथा सोरगम) के द्वारा प्रदान की गई 80% ऊर्जा बबूल की फली से सम्पूरित गायों के दूध में पाई गई टेनिनस की उपापययता उनके दूध पौषणिक मूल्य में सुधार करती है।
- ★ गेहूँ के भूसे पर आधारित सम्पूर्ण आहार खण्ड जिन में न्यूकैलीमास्टिक्स स्पै. जी. आर.-1 के फंफूद चलबीजाणु विद्यमान हैं पर आधारित भैंस के कटडों के आहार में 0.22% की दर से सल्फर (गन्धक) मिलाने के विकास दर, प्रोक्सीमेट सिद्धान्तों की पाच्यता तथा रुमेन किण्वन में सुधार होता है।
- ★ परखनली (इन विट्रो) परीक्षण प्रदर्शित करते हैं कि कार्बनिक अम्लों के मिलाने से प्रोपायोनैट उत्पादन के लिए हाइड्रोजन अपवर्तन की संभाव्यता रहती है जिसके बदले में मीथेन उत्पादन में कमी होती है।
- ★ अनाज/उपोत्पाद कुल गैस उत्पादन तथा आ.एन. पाच्यता में उच्चतर पाए गए, जबकि मीथेन उत्पादन में सामान्य तथा एन.एच3 एन. उत्पादन में न्यूनतम पाए गए।
- ★ मेमनों के 50 पी.पी.एम. पी.बी. के अनुप्रयोग ने रक्त पैरामीटरों पर कोई प्रतिकूल प्रभाव नहीं देखा गया, तथापि विकास दर में कमी पाई गई। पी. बी. के प्रतिकूल प्रभावों को कम करने में जेड.एन. के सम्पूरण से लाभप्रद प्रभाव था।
- ★ अधिष्ठान के लिए हीटसिन्च प्रोटोकाल तथा उसके बाद कृत्रिम गर्भाधान क्षेत्रीय परिस्थितियों के अन्तर्गत भैंसों के मदकाल तथा आवृत प्रजनन में परिणाम स्वरूप 52% गर्भाधान हुआ।
- ★ प्रारम्भिक दुग्धस्त्रवण के दौरान दुग्ध न्यूट्रोफिलस की भक्षक-कोशिका (फेगोसाइटिंग) क्षमता न्यूनतम थी उसके पश्चात अन्तिम एवं मध्यम दुग्ध-स्त्रवण का स्थान था।
- ★ लिम्फोसाइट प्रक्रिया जैसे - लिम्फोसाइट प्रोलिफरेशन तथा एन.ओ. उत्पादन के अनुमापन का प्रयोग मुराह भैंसों में कोशिका मध्यस्थता प्रतिरक्षा के क्रियात्मक स्तर को इंगित करने के लिए प्रयोग किया जा सकता है।
- ★ शुष्क अवधि एवं ब्याने के दौरान गायों की शारीरिक स्थिति 3.0 तथा 3.5 के बीच व्यवस्थित रखी जानी चाहिए तथा गायों के संशोधित उत्पादन के लिए शुष्क अवधि के दौरान विटामिन ई. 1000 आई. यू./प्रतिदिन की दर से सम्पूरित की जानी चाहिए।
- ★ विश्व की दूसरी क्लोनड कटड़ी 'गरिमा' का जन्म 'हैंडमेड क्लोनिंग' के प्रयोग से हुआ।
- ★ सरफेस मार्कर सी.डी. 9 तथा सी.डी. 90 की अभिव्यंजना के लिए भैंस के एम्ब्रयोनिक स्टेमसेल पाए गए तथा आ.सीटी 4, एस.ओ.एक्स. 2, एफ.ओ.एक्स.डी. 3, आर.ई.एक्स.-1 तथा न्यूक्लिओरटेमिन जैसे ट्रांसक्रिप्शन-आधारित मार्कर पाए गए। इन मार्करों की भैंस के भ्रूणों द्वारा 2-सैल, 4-सैल, मौरुला तथा ब्लास्टोसिस्ट अवस्थाओं में भी अभिव्यंजना की गई।
- ★ भैंस के अनुमानित ई.एस. कोशिकाओं की स्वतः प्रवर्तित विभेदीकरण द्वारा रचित एम्ब्रियोड पिडों में सभी तीनों प्रकार की जीवाणु सतहें जैसे एक्टोडर्म, मेसोडर्म तथा एंडोडर्म से कोशिकाएं पाई जाती हैं, जैसा कि इन कोशिकाओं के मार्कर की अभिव्यंजना द्वारा पुष्टि की गई।
- ★ डी. एम. एस. ओ. की मौजूदगी में ई. एस. कोशिकाएं पेशी कोशिकाओं जैसी कोशिकाएं बनाने के निर्देश दे सकती हैं जिसकी पहचान एक्टीनिन, एन.वाई.एफ.-5, एम.वाई.ओ. डी. तथा मायोजीनिन जीनों की अभिव्यंजना द्वारा पुष्टि की गई। ई.एस. कोशिकाओं को न्यूरोन कोशिकाओं से रेटिनोइक अम्ल की मौजूदगी में विभेदीकरण के लिए निर्देशित की गई जैसा की एन.एफ. 68 जीन की अभिव्यंजना द्वारा पुष्टि की गई।
- ★ स्तनीय एपीथिलिअल कोशिकाएं दूध में से इम्यून एफीनिटी परिशुद्धता तकनीकी द्वारा वियोजित एवं अभिलक्षित किए गए।
- ★ दुग्धस्तनीय एपीथिलिअल कोशिकाओं के प्रोटीओम प्रोफाइल, ई.एस.आई.-एम.एस. का प्रयोग कर शाटगन प्रोटियोमिक्स तकनीकी द्वारा अभिलक्षित किए गए।
- ★ एम.जी.पी.-40 के विभिन्न यूके रायोटिक अभिव्यंजना इसकी सम्पूर्ण अभिव्यंजना तथा क्रियात्मक एस्से के लिए पहचाने गए।
- ★ जी.एफ.पी. आधारित अभिव्यंजना रचना की ट्रांसफेक्शन एस्से सी.ओ.एस. स्तनीय अभिव्यंजना होस्ट में मानकित की गई।
- ★ भैंस के भ्रूणों को 8 कोशिका स्थिति पर विकसित करने में एम्ब्रयोनिक परिवर्तन से मातृक निर्धारण करने में ट्रांसक्रिप्शन प्रवर्तन संबंधित जीनों की अभिव्यंजना में सहायक है।
- ★ नवीन पोलिमार्फिक एलैल भैंस के बीटा-केसीन जीन के लिए वियोजित थे। भैंस बीटा-केसीन दो विभिन्न पोलिमार्फिक रूपों में मौजूद हैं। टाइप बी सर्वाधिक (85%) एलैल तथा टाइप ए (15%) पाया गया।

- ★ भैंस, गाय, बकरी तथा ऊंट से लेक्टोफेरिन के प्रोटीन-प्रोटीन पारस्परिक क्रिया सामान्य जठरीय पी.एच. पर लौह निर्मुक्त क्षमता के लिए भैंस के लेक्टोफेरिन के विभिन्न लाभ सुझाए गए। इसके औषधीय गुणों के कारण भैंस के लेक्टोफेरिन की जांच के लिए यह अत्यावश्यक संकेत प्रदान करता है।
- ★ दो प्रकार की प्रोबायोटिक दही अर्थात् एसिडोबिफिडस दही तथा एसिडोप्लानटेरम दही का मूल्यांकन किया गया। डी.एम. एच. प्रवृत्त जठरीय आन्त्रीय क्षेत्र के विकास को कम करने के कैंसर प्रतिरोधी गुण पाए गए। कार्सिनोजेने-सिस ने पायरोक्सीकैम के साथ कैंसर उपचार की क्षमता में भी वृद्धि कर दी है।
- ★ आहारिय संयुग्मित लिनोलिक अम्ल (सी.एल.ए.) शारीरिक वसा पिड़ों को कम करता है तथा आहार में सपरेटा दुग्ध चूर्ण (एस.एम.पी.) मिलाने से प्रभाव और बढ़ जाता है।
- ★ सी.एल.ए. के शारीरिक स्लिमिंग प्रभाव में ऐडीपोज ऊतकों तथा कंकाली मांसपेशियों में वसीय अम्ल के कम होते जैवसंश्लिष्ट विद्यमान हैं।
- ★ आहारिय कैल्सियम सीरम कोलस्ट्रॉल को कम करता पाया गया तथा डेरी कैल्सियम भी अधिक प्रभावकारी पाया गया।
- ★ सी.एल.ए. के अतिरिक्त आहारिय अन्तर्गहन के कारण वसीय जिगर तथा तिल्ली का बढ़ना पाया गया तथा अवसीय दुग्ध अवयवों द्वारा इसका खंडन किया जा सकता है।
- ★ वीर्य प्रवर्तकों में 50 एम एम0 टारिन तथा 100 एम.एम. ट्रिहेलोज़ मिलाने से भैंस के शुक्राणु क्रोयोडैमेज का महत्वपूर्ण रूप से संरक्षण होता है जैसा कि पश्च था गतिक्रमता, शुक्राणु जीवनक्षमता, मेम्ब्रेन अखण्डता, कुल प्रतिआक्सीकारक स्तर तथा शुक्राणु संधारिता का मूल्यांकन किया गया।
- ★ भैंस के शुक्राणुओं के परखनली (इन विट्रो) संधारिता के दौरान ग्लूटाथासोन एस. ट्रांसफेरस एम.यू. 3, पायरूवेट डिहाइड्रोजिनेज, ई. संधंटक उपयूनिट-बीटा ग्लाइसिरोल-3-फास्फेट डिहाइड्रोजिनेज तथा टायरोसाइन फास्फोरिलेटिड प्रोटीन जैसे वोटैज आश्रित एनियन चयन चैनल प्रोटीन-2 प्रोटीन अभिलेखित किए गए।
- ★ ताजे एवं क्रायोपरिरक्षित भैंस के शुक्राणुओं में डी.एन.ए. विखंडन वीर्य के कुल प्रतिऑक्सीकर के साथ सीधे सहसमन्वित पाए गए।
- ★ कोशिका मेम्ब्रेन परिवर्तक एक सामान्य प्रक्रिया एंट्रोकोकस फेकेलिस तथा बी. सीरस प्रतिरोधी एल्मेथिसिन के प्रतिकूल पीडियोसिन से प्रतिकूल प्रतिरोध शक्ति के विकास के लिए उत्तरदायी पाया गया।
- ★ पी. एसिडिलेक्टिसी एन.सी.डी.सी. 252 तथा पेंटासेक्योस एन. सी. डी. सी. 273 द्वारा उत्पादित पीडियोसिन, पीडियोसिन पी.ए.-1 से समरूप पाए गए।
- ★ कृत्रिम न्यूरल नेटवर्क का प्रयोग क्लोरोमीट्रिक बायोसेन्सिंग नेने. सोमस के संरचना में दिए गए इन विट्रो प्रतिक्रिया के पूर्वानुमान के लिए एक विश्वस्त माडलिंग विधि के रूप में प्रयोग किया जा सकता है।
- ★ भैंस के दूध, गाय के दूध तथा बटरमिल्क से डेरी व्हाइटनर बनाने की प्रक्रिया मानकित की गई।
- ★ अल्प वसा तथा उच्च रेशे के अंश तथा ओमेग-3 भरपूर दूध युक्त एक क्वारग किस्म की ताजी चीज विकसित की गई।
- ★ मैट्रिक्स सामग्री तथा प्रतिजैविकी के साथ सह-सूक्ष्म इनकेप्सुलेशन द्वारा प्रतिजैवीय अवयवों की स्थिरता की वृद्धि के लिए एक प्रक्रिया मानकित की गई।
- ★ जैवपरिरक्षकों का प्रयोग करके सोरगम-माल्ट (सोरगम लस्सी-नमकीन) अथवा पर्ल मिलेट माल्ट (बाजरा लस्सी-नमकीन) का प्रयोग करके रबड़ी जैसे किण्वित दूध पेय की शेल्फ लाइफ बढ़ाने की विधियां मानकित की गई हैं।
- ★ स्प्रे ड्राइंग विधि को अपना कर किण्वित दुग्ध पेय पर आधारित पुनः संरचिता के लिए तैयार सोरगम/पर्ल मिलेट तैयार करने की प्रौद्योगिकियां/विधियां मानकित की गईं।
- ★ दक्षिण क्षेत्रीय केन्द्र, बंगलौर पर काशी हलवा तैयार करने की विधि मानकित की गई।
- ★ फाक्सटेल मिलेट तथा सान्द्रित दूध आधारित स्वास्थ्यवर्धक खाद्य उत्पाद तैयार करने के लिए अध्ययन आयोजित किए गए।
- ★ प्रसंस्करण समय को कम करने, प्रक्रिया को सरल बनाने तथा अन्तिम उत्पाद के आरगेनोलेटिक गुणों में सुधार करने के लिए रागी-दुग्ध पेय तैयार करने की विधि की प्रारम्भिक रिपोर्ट विधि में संशोधन किए गए।
- ★ आहारिय छैना पेड़ा बनाने की प्रौद्योगिकी मानकित की गई।
- ★ उच्च बैरियर ई.बी.ओ.एच. तथा पी.ई.टी. लेमिनेटस युक्त आक्सीजन अवशोषक ने छैना पेड़ा की सुरक्षित रखने की अवधि (शेल्फ-लाइफ) 45 दिन से अधिक तक तथा कुंडा की बिना संवेदी तथा संरचनात्मक गुणों को खोए 80 दिनों से अधिक समय तक बढ़ाई गई है।
- ★ मसालेदार बटर मिल्क पेय पदार्थ तैयार करने के लिए बटर मिल्क में अदरक, काली मिर्च, सफेद जीरा, मोटी इलायची, हल्दी जैसे कुछ मसाले समाविष्ट करने की विधियां मानकित की गईं। तुलसी तथा पुदीना युक्त बटर मिल्क पेय विकसित करने के प्रयास किए गए तथा संतोषजनक आरगेनोलेटिक गुण उपस्थित पाये गये।
- ★ दूध प्रोटीन तथा होर्स सीरम के प्रयोग से 10% सान्द्रण पर उच्चतर परीक्षित क्रायोसंरक्षात्मक कारकों में पशु स्त्रोतों से अवयवों के प्रयोग पर प्रतिबन्ध के कारण दूध प्रोटीन का चयन किया गया। प्रशीतित शुष्क जामनों (संवर्धनों) को दो प्रकार के पैकिंग सामग्री अर्थात् ई.वी.ओ.एच. तथा पोलीथीन में

- पैक किया गया। शोध परिणाम प्रकट करते हैं कि 8° से ग्रे. पर संग्रहीत डी.वी.एस. कल्चर का सात मास तक अच्छे आरगेनोलेटिक गुणों के साथ दही बनाने के लिए प्रयोग किया जा सकता है।
- ★ मलाई लच्छा बनाने की विधि पूरी की गई।
  - ★ थ्री स्टेज एस.एस.एच.ई. विधि का प्रयोग कर निरन्तर बरफी बनाने की एक विधि विकसित की गई।
  - ★ घरेलू प्रयोग के लिए दूध के लगभग तीन लीटर बैच को संचालित करने के लिए ऊष्मन, स्कंदन एवं दबाने की प्रक्रिया पनीर बनाने का गैजिट (जुगत) विकसित किया गया।
  - ★ दूध को लगभग 80° से ग्रे. पर ऊष्मा उपचारित करने के लिए दो सरल रंग आधारित विधियां विकसित की गई।
  - ★ कृत्रिम रूप से मीठा व्हे नींबू पेय तैयार करने की एक प्रौद्योगिकी विकसित की गई। संग्रहण के दौरान व्हे नींबू पेय पदार्थों में कृत्रिम स्वीटनर्स तथा उनके अवक्रमित उत्पादों के आकंलन की विधियां मानकित की गई। एच. पी. एल. सी. विश्लेषण प्रकट करते हैं। उत्पाद में कृत्रिम स्वीटनर्स संग्रहण के दौरान स्थिर थे।
  - ★ भैंस के दूध ओस्टिओपोनटिन को विशुद्ध एवं अभिलक्षित किया गया।
  - ★ मैक्स ए.सी.ई. निरोधक प्रक्रिया के लिए व्हे प्रोटीन जल अपघटन से बारह पेप्टाइडों की पहचान की गई, जिनमें से आठ पेप्टाइड ए.सी.ई. निरोधक पेप्टाइडों के रूप में जाने गए।
  - ★ अनुमाय अम्लता के साथ संयोजित पायरूवेट, लेक्टेट तथा अमोनिया अंश का प्रयोग दूध की ताजगी के बारे में जानने के लिए नवीन प्रक्रिया तथा विश्वसनीय साधन के रूप में प्रयोग किया जा सकता है।
  - ★ विटामिन बी 1 2 से भरपूर 'प्रोपायानि योर्घर्ट' जिसमें प्रोपायानि बैक्टीरियम, फ्रेड्यूनिरिचि सबस्पै. प्रेड्यूनिरिचि पी.आर.एस.आ. विद्यमान हैं, विटामिन की कमी तथा संबंधित रोगों की समस्या का पता लगाने की संभाव्यता के साथ विटामिन बी 1 2 करने वाली मूल तथा नवीन किस्म को तैयार करने के लिए एक प्रौद्योगिकी विकसित की गई।
  - ★ उच्च फोलेट उत्पन्न करने वाली तथा प्रोबायोटिक (प्रतिजै. विकी) किस्म (एस. थर्मोफिलस आर.डी. 1 04) युक्त एक 'फोलेट भरपूर क्रियात्मक दही' जो कि स्वदेशी किण्वित दुग्ध उत्पादों से जैवलक्षित है, एक क्रियात्मक डेरी खाद्य पदार्थ के रूप में प्रयोग के लिए विकसित की गई।
  - ★ दही से वियोजित एक स्वदेशी किस्म 'ल्यूकोनोस्टक मेसेन्टरायड एफ.डी. 27 का प्रयोग करके कम कैलोरी अंश एवं विशेष संवेदी गुणों (एफरविसेन्स, फिज़, टिंगिनैस) द्वारा अभिलक्षित एक 'कार्ब डाऊन' प्राकृतिक कार्बोनेटेड किण्वित दुग्ध उत्पाद विकसित किया गया।
  - ★ बी.एस.एच. पोजिटिव एल. प्लानटेरम 91 के साथ उपचारित करने के बाद उच्च कोलस्ट्रॉल आहारित एस.डी. चूहों में प्लाज़्मा कुल कोलस्ट्रॉल, एल.डी.एल. कोलस्ट्रॉल तथा ट्रिग्लाइसराइडस को कम करने में बी.एस.एच. की भूमिका क्रमशः 18,27 तथा 27% पाई गई।
  - ★ ए.टी.पी. डी., बी.एस.एच. तथा मब जीन की अभिव्यंजना एल. प्लानटेरम 91 में महत्वपूर्ण रूप से व्यवस्थित था जब इन विट्रो तथा इन विवो दोनों परिस्थितियों के अन्तर्गत क्रमशः पी.एच. 2.5, 1.3% बाइल साल्ट तथा 0.05% म्यूसिन अभिव्यंजित किया गया।
  - ★ आई.एल.-01 की सापेक्षिक अभिव्यंजना एच. टी. 29 तथा बृहदान्त्र-शोथ अभिप्रेरित्र चूहों में क्रमशः 11.97 तथा 70.64% तक व्यवस्थित किया गया जब एल.पी. 91 के साथ विरोध किया गया जो कि मानक प्रतिजैविक किस्म के साथ प्राप्त की अपेक्षा कहीं अधिक था।
  - ★ ग्याहरवीं पंचवर्षीय योजना में 'डेरी जीवाणुओं पर योजना' प्रारम्भ की गई जिसमें राष्ट्रीय डेरी अनुसंधान संस्थान सहकारी केन्द्र के रूप में तथा गोबिन्दबल्लभ पन्त कृषि एवं प्रौद्योगिकी विश्वविद्यालय, पन्तनगर, एस.एम.सी. डेरी विज्ञान कालेज, ए.ए.यू. आनन्द तथा डेरी विज्ञान कालेज, हैबल, बंगलौर तीन समन्वयन केन्द्र के रूप में थे। इस योजना का उद्देश्य देश के विभिन्न भागों में स्वदेशी किण्वित खाद्य पदार्थों से महत्वपूर्ण डेरी अवयवों के स्रोत बनाना, उन्हें अभिलक्षित करना तथा आगे उपभोक्ताओं को वितरित करने के लिए गोदाम में जमा करना है।
  - ★ ग्याहरवीं पंचवर्षीय योजना में 'पशुचिकित्सा जीवाणुओं पर योजना' भी स्वीकृत की गई जिसमें राष्ट्रीय डेरी अनुसंधान संस्थान सहकारी केन्द्रों में से एक था तथा राष्ट्रीय पशु पोषण एवं पशु शरीर क्रिया संस्थान, बंगलौर समन्वयन केन्द्र के रूप में था।
  - ★ डेरी आधारित उद्योगों के लिए ग्रामीण युवाओं हेतु मानव संसाधन विकास पर एक अध्ययन आयोजित किया गया। यह अनुमान लगाया गया कि डेरी-आधारित उद्योगों ने लोगों को स्वरोजगार दिया तथा आय में वृद्धि (96%) हुई जो कि इससे पहले 42% थी, समाज में इज्जत (80%) परिवार के लिए सुरक्षा (92%) तथा स्वतंत्र रूप से निर्णय लेने की क्षमता में (66%) तक वृद्धि हुई। सम्पूर्ण रूप से ज्ञान में औसतांक वृद्धि 16.32 से 29.73 वृद्धि तथा सम्पूर्ण जागरूकता के औसतांक में 21.91 से 32.43 तक वृद्धि हुई।
  - ★ क्षेत्रीय परिस्थितियों के अन्तर्गत दूध एवं प्रजनन में वृद्धि के लिए अनुकूल पौषणिक सम्पूरण पर एक अध्ययन किया गया। उच्च उत्पादकता वाले डेरी पशुओं को प्रसव से 45 दिन पूर्व 250-300 ग्रा0 प्रतिदिन बायपास वसा तथा 50 ग्राम/ प्रतिदिन खनिज मिश्रण खाने को दिया गया। यह पाया गया कि दोनों परीक्षणों में प्रयोगात्मक पशुओं का दुग्ध उत्पादन पूर्व

दुग्ध स्त्रवण की अपेक्षा अधिक था। गाय तथा भैंस के श्रेष्ठ उत्पादन में क्रमशः लगभग 4.00 तथा 3.00 लीटर वृद्धि हुई। इसी प्रकार गर्भस्थापन की कमी हुई। गाभिन डेरी पशुओं को बाय-पास वसा एवं खनिज सम्पूरण खिलाने से नवजात बछड़ों के औसत भार में 3.66 कि०ग्राम प्रति बछड़ा वृद्धि हुई। प्रयोगात्मक पशुओं की शारीरिक स्थिति में बाय-पास वसा एवं खनिज मिश्रण खिलाने से काफी सुधार हुआ है।

- ★ हरियाणा में डेरी फार्मिंग के विकास पर स्वयं सहायक समूहों (एस.एच.जी.) का प्रभाव देखने के लिए एक अध्ययन किया गया। इससे यह प्रकट हुआ कि सदस्य कृषकों में ज्ञान का उच्च स्तर (35.00%) तथा स्वीकार्यता (37.00%) था जो कि असदस्यों में यह काफी कम अर्थात् क्रमशः 11% तथा 01% था। सदस्यों एवं असदस्यों के बीच ज्ञान एवं स्वीकार्यता का औसत अन्तर सांख्यिकीय दृष्टि से काफी महत्वपूर्ण था। डी.आर.डी.ए. द्वारा बनाए गए स्वयं सहायक समूहों (एस.एच.जी.) की अपेक्षा एन.जी.ओ. द्वारा बनाए गए स्वयं सहायक समूहों (एस.एच.जी.) में अधिक ज्ञान एवं स्वीकार्यता थी।
- ★ महाराष्ट्र में व्यावसायिक डेरी फार्मिंग के अनुदर्शन तथा लक्ष्य पर एक अध्ययन किया गया। शहरी बाजार में दूध के उच्च दाम, डेरी सहकारी समितियों द्वारा समय पर भुगतान, संशोधित डेरी फार्मिंग विधियों को अपनाना, समय पर प्रसार सहायता व्यावसायिक डेरी फार्मिंग को प्रभावित करने वाले प्रमुख समझे गए।
- ★ पश्चिमी बंगाल में कम संसाधनों वाले गरीब परिवारों के बीच मिश्रित फार्मिंग पर एक अध्ययन किया गया। परिणाम दर्शाते हैं कि खेतों की जुताई के अधिकतम कार्य प्रमुख रूप से पुरुषों द्वारा किए जाते हैं। महिलाएं फसल कटाई के बाद के कार्यों एवं बीज उपचार में ही अधिकतर लगी रहती हैं। डेरी फार्मिंग संबंधी अधिकतर कार्य मुख्य रूप से महिलाओं द्वारा संपन्न किए जाते हैं। पुरुष मुख्य रूप से पशुओं को चराने, घास काटने तथा ले जाने, भूसे को कूटने, दूध एवं दुग्ध उत्पादों को बेचना, पशुओं को उपचार एवं गर्भस्थापन के लिए ले जाना, सान्द्रणों का क्रय करना तथा पशुओं को बेचने एवं खरीदने के कार्य में संलग्न रहते हैं।
- ★ पश्चिमी बंगाल में दुग्ध बाजार नवप्रवर्तन प्रणाली पर विश्लेषणात्मक अध्ययनों से यह प्रकट होता है कि कृषि प्रोजेक्ट सहायक डेरी कृषकों को दुग्ध विपणन संबंधी तथा पश्चिमी बंगाल के लगभग सभी क्षेत्रों में कृषि के विभिन्न पहलुओं पर जानकारी हस्तांतरित करने में एक बहुत ही महत्वपूर्ण भूमिका निभाते हैं। निजी दुग्ध संग्रहण एजेन्ट अन्य क्षेत्रों की तुलना में लेटराइट तथा लाल मिट्टी वाले क्षेत्र में कहीं और अधिक महत्वपूर्ण भूमिका निभाते हैं। पश्चिमी बंगाल में दूध विपणन के क्षेत्र में आने वाली मुख्य बाधाएं—वित्त की कमी, बाजार से संबंधित जानकारी व बाजार समाचारों के प्रति जागरूकता में कमी तरल दूध का कम मूल्य, क्रय विधियों में गलत प्रक्रियाएं, भुगतान में देरी, दूर-दूर स्थित दुग्ध संग्रहण केन्द्र, प्रसार

एजेन्सियों के साथ सम्पर्क का निम्न स्तर, संग्रहण सुविधाओं की कमी, परिवहन सुविधा, नियमित बाजार एवं सहकारी समितियां, बाजार सुविधाओं तथा स्वच्छ दुग्ध उत्पादन के प्रति जागरूकता की कमी इत्यादि हैं।

## शिक्षा

- ★ भारतीय कृषि अनुसंधान परिषद द्वारा गठित कत्याल समिति की सिफारिशों के अनुसार मॉस्टर एवं डाक्टरेट कार्यक्रमों में नए स्नातकोत्तर पाठ्यक्रम कार्यान्वित किए गए।
- ★ शैक्षिक विनियमों को पुनः बनाया गया जिनमें परीक्षा प्रणाली, उपाधियां देने के लिए ग्रेडिंग प्रणाली तथा पी. एच.डी. छात्रों के लिए परिज्ञान परीक्षा प्रारंभ करना सम्मिलित थे।
- ★ वर्ष 2009-10 के दौरान राष्ट्रीय डेरी अनुसंधान संस्थान ने रवांडा, इरान, इथोपिया, श्रीलंका आदि के अन्तर राष्ट्रीय 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 23 विदेशी छात्र अध्ययन कर रहे हैं।
- ★ अनुसंधान कार्य की गुणवत्ता में सुधार एवं प्रतिस्पर्द्धा की भावना को प्रोत्साहित करने के लिए मास्टर एवं डाक्टरेट छात्रों के लिए सर्वश्रेष्ठ थीसिस पुरस्कार प्रारम्भ किया गया।
- ★ डेरी प्रौद्योगिकी प्रभाग में 'दूध एवं दुग्ध उत्पादों के संवेदी मूल्यांकन' पर दिनांक 18-31 मई, 2009 मई तक मैसर्स फैन मिल्क इंटरनेशनल ए./ एस., डैनमार्क के अधिकारियों के लिए एक अन्तरराष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- ★ अफगानिस्तान के कार्मिकों के लिए दिनांक 18-31 मार्च, 2010 तक 'दुग्ध संग्रहण, प्रसंस्करण एवं विपणन' विषय पर एक अन्तरराष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान पर इंडो फ्रेंच समन्वय कार्यक्रम के अन्तर्गत दिनांक 20 अप्रैल 2009 को दुग्ध उत्पादन के सुधार के लिए 'फ्रेंच आनुवांशिकी' एवं प्रौद्योगिकियां' विषय पर एक अन्तरराष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- ★ परामर्श सेवा कार्यक्रम के अन्तर्गत दिनांक 18-31 मई 2009 के दौरान 'दूध एवं दुग्ध-उत्पादों के संवेदी मूल्यांकन' विषय पर एक अन्तरराष्ट्रीय प्रशिक्षण कार्यक्रम आयोजित किया गया।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान पर 07-27 जुलाई, 2009 के दौरान 'डेरी खाद्य पदार्थों की सुरक्षा एवं गुणवत्ता आश्वासन के लिए विश्लेषणात्मक तकनीकियां तथा नवीन प्रक्रियाओं में नवीन प्रगति' पर एक समर स्कूल आयोजित किया गया।

- ★ संस्थान में 18 मई, 2009 को 'प्राकृतिक संसाधन वी0पी0 एन0 आर0-2009' पर एक व्यावसायिक कार्यक्रम आयोजित किया गया।
- ★ संस्थान में 7 दिसम्बर, 2009 को 34वां वार्षिक सम्मेलन आयोजित किया गया जिसमें राज्य कृषि विश्वविद्यालयों एवं पशुचिकित्सा विश्वविद्यालयों के 35 कुलपतियों एवं भा.कृ. अनु. परिषद् के संस्थानों के 15 निदेशकों ने भाग लिया।
- ★ संस्थान में 'खाद्य सुरक्षा के लिए कृषि एवं पशु विज्ञान में बायो-नैनो प्रौद्योगिकी के अनुप्रयोगों पर एक राष्ट्रीय संगोष्ठी भी आयोजित की गई।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान के स्नातकों एवं संस्थान के द्वारा दिनांक 11-12 सितम्बर, 2009 के दौरान 'डेरी उद्योग प्रारम्भ, नव प्रवर्तन एवं प्रयोजनमूलक प्रबन्धन की आवश्यकता' पर एक राष्ट्रीय संगोष्ठी भी आयोजित की गई।
- ★ संस्थान में बी-टैक (डेरी प्रौद्योगिकी) उपाधि कार्यक्रम के लिए ई0-पाठ्यक्रमों (e-courses) के विकास पर दिनांक 27 जून, 2009 को एन.ए.आई.पी. परियोजना की लांच वर्कशाप आयोजित की गई।
- ★ डेरी न्यूट्रासियूटिकलस तथा जैव-सूचना अनुप्रयोगों में नवीन प्रगतियां विषय पर संस्थान में दिनांक 1-21 फरवरी, 2010 के दौरान एक विंटर स्कूल आयोजित किया गया।
- ★ संस्थान में 'चीज तथा किण्वित डेरी खाद्य पदार्थों में प्रौद्योगिकी विकास' विषय पर दिनांक 02-22 जून 2009 के दौरान एक लघु पाठ्यक्रम आयोजित किया गया।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय का आ. ठंवा दीक्षान्त समारोह दिनांक 13 मार्च, 2010 को संपन्न हुई। भारत के भूतपूर्व राष्ट्रपति डा. ए.पी.जे.अब्दुल कलाम ने दीक्षान्त अभिभाषण दिया तथा छात्रों को उपाधियां, स्वर्ण पदक, मेरिट प्रमाण-पत्र एवं पुरस्कार दिए। डा. एस.अय्यपन महानिदेशक, भारतीय कृषि अनुसंधान परिषद् एवं सचिव डेयर ने समारोह की अध्यक्षता की।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान, मान्य विश्वविद्यालय की शैक्षिक उपलब्धियों को केन्द्रित तथा पुनरावलोकन करने के लिए दिनांक 09-13 मार्च, 2010 तक शैक्षणिक सप्ताह मनाया गया।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान के महान् निदेशक डा. डी. सुन्दरेसन की स्मृति में डा. डी. सुन्दरेसन व्याख्यान प्रारम्भ किया गया। डा. एस.एल. मेहता पूर्व कुलपति एम.पी.यू.टी., उदयपुर एवं पूर्व उपमहानिदेशक (शिक्षा) भा.क.अनु.प. ने 'डेरी शिक्षण: संभावनाएं एवं चुनौतियां' विषय पर प्रथम स्मारक व्याख्यान प्रस्तुत किया।
- ★ राष्ट्रीय विज्ञान दिवस दिनांक 28 फरवरी, 2010 को मनाया गया। इस दिन बी.टैक., मास्टर एवं डाक्टरेट कार्यक्रमों

के छात्रों के लिए 'माई आइडिया प्रतियोगिता' आयोजित की गई।

- ★ छात्र समुदाय में सदाचार एवं नैतिक मूल्यों को मन में बैठाने तथा महत्वपूर्ण सामाजिक मामलों के प्रति संवेदनशील बनाने के लिए राष्ट्रीय शिक्षा दिवस एवं अन्तरराष्ट्रीय अहिंसा दिवस मनाए गए।

## विस्तार

- ★ संस्थान द्वारा विकसित विभिन्न प्रौद्योगिकियों को हस्तांतरित करने के लिए अपनाए गए गाँवों में डेरी कृषकों के साथ कुल 37 किसान संगोष्ठियां आयोजित की गईं। किसानों 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 की 49.20% तथा भैंसों में 45.0% देखी गई।
- ★ अपनाए गए गाँवों में बांझपन नियंत्रण तथा पशु चिकित्सा सहायता हेतु मासिक कैंप लगाए गए। देर से परिपक्व होने वाले अमदकाल तथा पुनरावृत्ति प्रजनन के कुल 826 पशुओं की जांच की गई तथा उनके निदान हेतु पर्याप्त उपचार दिए गए।
- ★ संस्थान के डेरी विस्तार विभाग के वैज्ञानिकों ने आई.जी.एफ. आर.आई.झांसी के साथ सांझा कार्यक्रम के अन्तर्गत कृषकों के खेत पर उच्च उत्पादन वाली चारे की फसलों (बरसीम तथा जई) का प्रदर्शन किया गया। बरसीम की वरदान, जे.एच. बी.-146, तथा जई की जे.एच.ओ. 822, जे.एच.ओ., 851 तथा कैट किस्म का प्रदर्शन अपनाए गए गाँवों अर्थात् कुलवेहड़ी तथा सुबरी में किया गया। इन उच्च उत्पादक चारे की फसलों का उत्पादन देशी किस्मों की अपेक्षा लगभग 12% अधिक था।



डेरी मेला अवसर पर हिन्दी प्रकाशन (स्मारिका) का विमोचन

- ★ संस्थान स्तर पर डेरी मेला 24-26 फरवरी, 2010 को आयोजित किया गया। मेले में विभिन्न कार्यक्रम आयोजित हुए जिनमें पशुओं की नस्ल सौन्दर्य प्रतियोगिता, दुग्ध उत्पादन

प्रतियोगिता, महिलाओं के लिए दुग्ध-दोहन क्षमता प्रतियोगिता आदि सम्मिलित थी। राष्ट्रीय डेरी अनुसंधान संस्थान तथा भारतीय कृषि अनुसंधान परिषद के अन्य संस्थानों तथा प्राइवेट संगठनों आदि द्वारा प्रदर्शनियां आयोजित की गईं। किसान संगोष्ठी एवं प्रश्नोत्तरी सत्र का आयोजन किया गया जिसमें राष्ट्रीय डेरी अनुसंधान संस्थान के विशेषज्ञों ने डेरी कृषकों की समस्याओं का समाधान किया।

- ★ कृषक समुदाय में डेरी उत्पादन तथा प्रसंस्करण प्रौद्योगिकियों को प्रभावी तथा प्रचार-प्रसार को सुदृढ करने के लिए 'कृषकों के द्वार पर डेरी शिक्षण' कार्यक्रम प्रभावी ढंग से चल रहा है। इस कार्यक्रम के अन्तर्गत राष्ट्रीय डेरी अनुसंधान संस्थान के वैज्ञानिकों की एक टीम जिसमें डेरी उत्पादन, प्रसंस्करण तथा प्रबन्धन वर्ग से विषय-विशेषज्ञ सम्मिलित हैं, प्रत्येक माह के दूसरे शनिवार को विभिन्न गाँवों में कृषकों के द्वार पर नियमित रूप से डेरी शिक्षण कार्यक्रम एक अभियान के रूप में चला रहे हैं।
- ★ वर्ष के दौरान कृषि विज्ञान केन्द्र/डेरी प्रशिक्षण केन्द्र ने 209 प्रशिक्षण कार्यक्रम (परिसर के अन्दर तथा बाहर दोनों) आयोजित किए। यह कार्यक्रम डेरी उत्पादन, डेरी प्रसंस्करण, कृषि, कृमिसंवर्धन, मधुमक्खीपालन, मत्स्यपालन तथा गृह विज्ञान के विभिन्न पहलुओं पर आधारित थे। इनमें कुल 5990 प्रशिक्षणार्थियों ने भाग लिया। इन प्रशिक्षण कार्यक्रमों के दौरान कुल प्रशिक्षित श्रम दिन 21537 थे।
- ★ कृषि प्रौद्योगिकी केन्द्र (एटिक) को और सुदृढ किया गया। रिपोर्टाधीन अवधि के दौरान तकनीकी जानकारी एवं परामर्श सेवा प्राप्त करने के लिए 17460 कृषक एटिक में आए। एटिक सहायता सेवा प्रदान करने, प्रकाशनों के बिक्री, बीजों, जैवउर्वरकों तथा वर्मीकम्पोस्ट की बिक्री, प्रदर्शनी, फिल्म प्रदर्शन तथा आमने-सामने परस्पर सम्पर्क स्थापित कराने के कार्यों में लगा हुआ था।

### आधारीय संरचना

- ★ चार दिवारी एवं स्काई लाइटों के लगवाने सहित खेल के मैदान (स्टेडियम) का नवीकरण।

- ★ छात्रों को प्रयोग करके सीखने के लिए प्रयोगात्मक डेरी की संरचनात्मक सुविधाओं का प्रसार।
- ★ बच्चों के नवविकसित पार्क की संरक्षात्मक घेराबन्दी करना।
- ★ पुस्तकालय की मरम्मत एवं नवीकरण।
- ★ लघु पशुगृह की मरम्मत एवं नवीकरण का कार्य संपन्न।
- ★ डेरी रसायन प्रभाग, डेरी पशुजीवरसायन प्रभाग, डेरी पशुशरीरक्रिया प्रभाग, डेरी प्रौद्योगिकी प्रभाग तथा पशु जैवप्रौद्योगिकी केन्द्र में प्रयोगशालाओं को सुसज्जित एवं नवीकरण करना।
- ★ भ्रूण जैव प्रौद्योगिकी केन्द्र भवन/केन्द्रीय भंडार/कृत्रिम प्रजनन अनुसंधान केन्द्र की मरम्मत।
- ★ पशु प्रजनन अनुसंधान परिसर पर रोगी पशुओं के शेडों की आहार नॉर्वों/ कार पार्किंग की मरम्मत।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान के डा. डी. सुन्दरेसन सभाभवन में सी.सी.टी.वी. आधारित सुरक्षा निगरानी प्रणाली संस्थापित।
- ★ राष्ट्रीय डेरी अनुसंधान संस्थान के छात्रावासों में बिजली की तारों, फिटिंग तथा स्विचों का नवीकरण।
- ★ सी.,डी.,ई. तथा एफ. टाइप के आवासीय क्वार्टरों का नवीकरण।
- ★ अन्तरराष्ट्रीय छात्रावास, कावेरी छात्रावास तथा कृष्णा छात्रावास का नवीकरण।
- ★ वर्षा के पानी को जमा करने की प्रणाली का निर्माण।
- ★ निदेशक कार्यालय एवं वैज्ञानिक गृह की मरम्मत एवं नवीकरण।
- ★ फार्म अनुभाग की चारदीवारी का निर्माण।
- ★ पशुशाला की दुग्ध दोहन गोशाला नं०-1 से मुख्य सीवर लाइन तक पी./एल. सीवर लाइन का निर्माण।



भारतीय कृषि अनुसंधान परिषद के पुरस्कार वितरण समारोह (16-07-2009) के अवसर पर राजभाषा कार्यान्वयन के क्षेत्र में श्रेष्ठ कार्य हेतु राष्ट्रीय राजभाषा राजर्षि टंडन द्वितीय पुरस्कार (वर्ष 2008) माननीय केन्द्रीय मंत्री डा. फारूख अब्दुल्ला से प्राप्त करते हुए डा. ए.के. श्रीवास्तव, निदेशक रा.डे.अनु.सं. एवं राजभाषा स्टाफ

# GUIDE MAP OF NDRI, KARNAL

## **ADMINISTRATIVE BLOCK**

<b>DIRECTOR'S OFFICE</b> (1st. Floor)	1
JOINT DIRECTOR	1
JOINT DIRECTOR (RESEARCH)	1
CHIEF ADMINISTRATIVE OFFICE (1st Floor)	1
UNIVERSITY OFFICE	1
COMPUTER CENTER	1
RESEARCH COORDINATION AND MANAGEMENT UNIT	1
OFFICIAL LANGUAGE CELL	1
CENTRAL LECTURE HALL	1
RECEPTION CELL	1

## **DIVISIONS, SECTIONS AND SUPPORTING UNITS**

DAIRY MICROBIOLOGY	2
LIBRARY	3
DAIRY TECHNOLOGY (Ground & 1st. Floor)	4
DAIRY ECONOMICS, STATISTICS & MANAGEMENT (1st. Floor)	4
EXPERIMENTAL DAIRY	5
ANIMAL BIO-CHEMISTRY (Ground Floor )	6
DAIRY CHEMISTRY (1st. Floor)	6
DAIRY CATTLE NUTRITION (Ground Floor)	7
DAIRY CATTLE PHYSIOLOGY (1st. Floor)	7
DAIRY CATTLE BREEDING (2nd Floor)	7
LIVESTOCK PRODUCTION & MANAGEMENT	7
DAIRY ENGINEERING (Ground, 1st & 2nd Floor)	8
DAIRY EXTENSION (2nd Floor)	8
LIVESTOCK FARM	9
GENERATOR HOUSE	10
TECHNOLOGY BUSINESS INCUBATOR (TBI)	11
ANIMAL HEALTH COMPLEX	12
SMALL ANIMAL HOUSE	13
KENDRIYA BHANDAR	14
FEED PLANT	15
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F.M. SECTION	17
BIO - GAS PLANT	18
SEWAGE TREATMENT PLANT	19
ARTIFICIAL BREEDING RES. CENTRE	20
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DAIRY TRAINING CENTRE	23

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SHOPPING CENTER	49
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SECURITY SECTION	52
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BRAHMAPUTRA	24
SUTLEJ	25
KRISHNA	26
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