2023

वार्षिक रिपोर्ट
ANNUAL REPORT

1923 से नवीनतम डेरी तकनीकियों के विकास के साथ देश की सेवा में समर्पित

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

VISION

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

MISSION

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

GOAL

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

MANDATE

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

वार्षिक रिपोर्ट 2023

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(Deemed University) Karnal - 132 001 India

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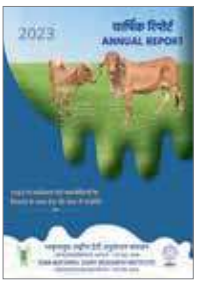

India's first cloned cow calf "Ganga" along with donar. Ganga was born on March 16, 2023 and birth weight was 32 Kgs.

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MILESTONES

Milestones in Institutional Growth

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

1936 Renamed as "Imperial Dairy Institute".

1955 Established as National Dairy Research Institute (NDRI) at Karnal with Southern Regional Station of the Institute at Bangalore

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

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

1962 Western Regional Station established at Bombay.

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

1966 Institute brought under the aegis of ICAR.

1975 Operational Research Project initiated.

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

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

1980 Karan Swiss cattle breed developed

1982 Karan Fries cattle breed developed

1983 IDD (DH) started at Bangalore.

1985 "Farm Advisory Bureau" and "Industrial Consultancy Cell" set up.
NDRI recognized as Centre of Excellence in Animal Biotechnology.

1987 Embryo Biotechnology Centre established.

1989 The Institute granted "Deemed to be University" status.
National Library of Dairy Science established
M.Sc. in Biotechnology started.

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

1991 20 bedded Hospital Complex set up and made functional.

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

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

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

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

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

2000 A Guest House with two suites named as "Kamdhenu" was constructed at SRS, Bangalore.
Web-site of NDRI was created and launched by the Hon'ble Union Minister for Agriculture on 23rd December 2000.

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

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

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

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

2006 New Animal Biotechnology Centre commissioned.

2007 Creation of Video Conferencing Lab and Mini Auditorium.

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

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

2011 M.Sc. in Forage Production Introduced at NDRI, Karnal.
NDRI recognized as Centre of Advanced Faculty Training (CAFT) in the Disciplines of Dairy Production and Dairy Processing.

2012 Sahiwal Calf "Holi" through Ovum Pick up (OPU-IVF) technique born on 7th March, 2012.
NRC on Milk Quality and Safety established at NDRI, Karnal.
Business Planning and Development (BPD) Unit established at NDRI, Karnal.

2013 First female calf named 'Mahima' was born to a cloned buffalo on 25th January 2013.
A male cloned buffalo calf named 'Swarn' was born on 18th March 2013. Donor somatic cell used was isolated from the seminal plasma of an elite bull.
A Diploma in Dairy Technology started at Southern Regional Station, Bangalore.

2014 NDRI bagged the Sardar Patel Outstanding ICAR Institution Award presented by Hon'ble Prime Minister of India, Sh. Narendra Modi Ji.
NDRI produced a clone of endangered wild buffalo of Chhattisgarh named "Deepasha" on 12th December, 2014.
A new extension education approach "Farmers' Farm School" was started at NDRI, Karnal.
NDRI got ISO 9001: 2008 certification.
NDRI implemented MIS/FMS to carryout administrative and financial activity of the Institute.

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

2017 Additional KVK established at Eastern Campus, Kalyani.
One month Foundation Course for newly admitted students of 2017-18 batch introduced.
Automation of the 'Academic Management System' implemented.

2018 A mega world-bank funded Institutional Development Plan (IDP) of National Agricultural Higher Education Project initiated.
National Referral Center for Milk Quality and Safety (NRCMQS) granted accreditation by NABL.
Set up Atal Incubation Centre at Southern Campus of NDRI, Bengaluru under Section 8 of Companies Act, 2013.

2019 Three cloned calves produced using donor cells of elite bulls.

2020 Twenty three Faculty members and fifty five students successfully completed their International training in 25 Overseas Universities located in 8 different countries under NAHEP.

2022 ICAR-NDRI ranked first among all Agricultural Universities and four Deemed Universities of ICAR consecutively for five times (2016-2017, 2017-2018, 2018-2019, 2019-2020 and 2020-2021).
Service center of ICAR-NDRI established at Goras, Sheopur, Madhya Pradesh.
Centenary year celebrations of the Institute inaugurated.

2023 Ganga was born on March 16, 2023 and birth weight was 32 Kgs.
19th Convocation of the ICAR-National Dairy Research Institute was held in the august presence of Hon'ble President of India Smt. Droupadi Murmu Ji.

प्रस्तावना

PREFACE

मुझे बेहद खुशी है कि मैं आईसीएआर-एनडीआरआई की वार्षिक रिपोर्ट 2023 प्रस्तुत कर रहा हूँ। यह रिपोर्ट पूरे वर्ष के दौरान डेरी अनुसंधान, शिक्षा, विस्तार और संबंधित गतिविधियों के क्षेत्र में की गई संस्थान की महत्वपूर्ण उपलब्धियों पर प्रकाश डालती है। यह जानकारी इस प्रमुख डेरी संस्थान के कामकाज और योगदान का व्यापक अवलोकन प्रदान करने के लिए की गई है।

वर्ष 2023 में, आईसीएआर-एनडीआरआई ने भारत की गिर नस्ल की पहली क्लोन देशी गाय गंगा को पैदा कर पशु क्लोनिंग तकनीक में एक ऐतिहासिक उपलब्धि हासिल की। अल्ट्रासाउंड-निर्देशित सुइयों का उपयोग करके जीवित साहीवाल पशुओं से अंडकोशिकाओं को अलग कर उन्हें नियंत्रित परिस्थितियों में परिपक्व और नाभिका रहित किया गया और श्रेष्ठ गिर गायों की दैहिक कोशिकाओं के साथ जोड़ा गया। परिणामी भ्रूणों को ब्लास्टोसिस्ट अवस्था में संवर्धित कर प्राप्तकर्ता माताओं (क्रॉस-ब्रेड गायों) में स्थानांतरित किया गया जिसके परिणामस्वरूप 16 मार्च, 2023 को गंगा का जन्म हुआ। इस ऐतिहासिक उपलब्धि को भारत की माननीय राष्ट्रपति श्रीमती द्रौपदी मुर्मू जी ने देखा। वर्ष 24 अप्रैल, 2023 को आईसीएआर-एनडीआरआई के अपने दौरे के दौरान गंगा की क्लोनिंग से डेरी पशु उत्पादन प्रौद्योगिकियों को आगे बढ़ाने की नई संभावनाएं खुलती हैं और जो देशी गायों में कम उत्पादकता की चुनौतियों का समाधान होगा |

एक और महत्वपूर्ण सफलता CRISPR/Cas9 और सोमैटिक सेल न्यूक्लियर ट्रांसफर (SCNT) तकनीक का उपयोग करके जीन-संपादित भैंस बछड़े का उत्पादन था जो मांसपेशियों की

It is with immense pleasure that I present the ICAR-NDRI Annual Report 2023. This report highlights the significant achievements of the Institute in the realms of Dairy Research, Education, Extension, and related activities undertaken throughout the year. The information is organized to provide a comprehensive overview of this premier dairy institute's functioning and contributions.

In 2023, ICAR-NDRI made a landmark achievement in animal cloning technology by producing Ganga, India's first cloned indigenous cow of the Gir breed. Oocytes were isolated from live Sahiwal animals using ultrasound-guided needles, matured and enucleated under controlled conditions, and fused with somatic cells from superior Gir cows. The resultant embryos were cultured to the blastocyst stage and transferred to recipient mothers (cross-bred cows), culminating in the birth of Ganga on March 16, 2023. This historic achievement was witnessed by Hon'ble President of India, Smt. Droupadi Murmu Ji, during her visit to ICAR-NDRI on April 24, 2023. The cloning of Ganga opens new possibilities for advancing dairy animal production technologies and addresses the challenges of low productivity in indigenous cows.

Another significant breakthrough was the production of a gene-edited buffalo calf utilizing CRISPR/Cas9 and

वृद्धि को रोकने वाले मायोस्टैटिन जीन को नष्ट करने के लिए था। यह मील का पत्थर भारतीय डेरी पशुओं में उत्पादन लक्षणों को बेहतर बनाने के उद्देश्य से जीनोम-संपादित भैंस मॉडल के लिए मार्ग प्रशस्त करता है। इसके अतिरिक्त, आईसीएआर-एनडीआरआई ß-लैक्टोग्लोबुलिन जीन नॉकआउट क्लोन भैंस भ्रूण के उत्पादन पर काम कर रहा है जिससे मानव उपभोग के लिए हाइपोएलर्जेनिक दूध का उत्पादन हो सकता है।

संस्थान ने देशी डेरी पशुओं की संख्या बढ़ाने और उन्हें संरक्षित करने पर भी ध्यान केंद्रित किया है। इन प्रयास में सेक्स-सॉर्टेड वीर्य का उपयोग करके साहीवाल मादाओं का एक विशिष्ट झुंड विकसित करना शामिल है, जिसमें दिसंबर 2023 तक 107 गर्भाधानों से 47 गर्भधारण की पुष्टि हुई है। लुप्तप्राय भदावरी भैंस नस्ल की जीनोम असेंबली पूरी हो चुकी है, जो भविष्य के जीनोम-वाइड शोध के लिए एक संदर्भ प्रदान करती है।

पशु स्वास्थ्य के क्षेत्र में, दूध के एक्सोसोम को थनेला रोग के उपचार के लिए दवा प्रवाहन वाहन के रूप में खोजा गया है। दूध के एक्सोसोम के भीतर एंटीबायोटिक्स को समाहित करने से सबक्लिनिकल और क्लिनिकल थनेला से पीड़ित साहीवाल गायों में दूध की दैहिक कोशिका गणना और जीवाणु भार को कम करने में आशाजनक परिणाम मिले हैं।

डेरी प्रसंस्करण में, संस्थान ने विभिन्न मूल्यवर्धित डेरी उत्पाद विकसित किए हैं, जैसे दूध-अलसी आधारित किण्वित उत्पाद, देसी छाछ पाउडर तथा दूध प्रोटीन सामग्री से प्रसंस्कृत पनीर। खाद्य कोटिंग्स का उपयोग कर बर्फी के शेल्फ जीवन को बढ़ाने तथा लैक्टिक कल्चर- मध्यस्थ विटामिन बी 12 बायो-फोर्टिफाइड किण्वित दूध के उत्पादन के लिए प्रौद्योगिकी विकसित की गई है। गैर-गोजातीय दूध की क्षमता का दोहन करने की पहल भी शुरू की गई है।

दूध की गुणवत्ता सुनिश्चित करने के लिए, दूध में सोर्बिटोल का पता लगाने के लिए एक सरल पेपर-आधारित डिस्क पद्धति विकसित की गई है। इसी प्रकार, दूध में लिस्टेरिया मोनोसाइटोजेन्स और ईकोलाई का पता लगाने के लिए स्ट्रिप-आधारित परीक्षण बनाए गए हैं। इसी तरह, मेटाबोलोमिक्स अध्ययनों ने थारपारकर और करण फ्रिज गायों के बीच दूध के मेटाबोलाइट्स में अंतर का पता लगाया है।

आईसीएआर-एनडीआरआई मानद् विश्वविद्यालय में शैक्षणिक कार्यक्रमों की निरंतर समीक्षा की जाती है और उन्हें अद्यतन किया जाता है ताकि छात्रों को वैश्विक चुनौतियों का सामना करने के लिए आवश्यक ज्ञान और कौशल से लैस किया जा सके। 19 वां दीक्षांत समारोह 24 अप्रैल, 2023 को मुख्य अतिथि भारत की माननीय राष्ट्रपति श्रीमती द्रौपदी मुर्मू जी की उपस्थिति में आयोजित किया गया । कुल 544 विद्यार्थियों को डिग्रियाँ दी गयीं, जिनमें 158 पीएचडी, 308 मास्टर और 78 बी.टेक छात्र

somatic cell nuclear transfer (SCNT) technologies to knockout the myostatin gene, an inhibitor of muscle growth. This milestone paves the way for genome-edited buffalo models aimed at improving production traits in Indian dairy animals. Additionally, ICAR-NDRI is working on producing β-lactoglobulin gene knockout cloned buffalo embryos, which could lead to the production of hypoallergenic milk for human consumption.

The Institute also focused on multiplying and conserving indigenous dairy animals. Efforts include developing an elite herd of Sahiwal females using sex-sorted semen, with 47 confirmed pregnancies from 107 inseminations as of December 2023. The genome assembly of the endangered Bhadawari Buffalo breed has been completed, providing a reference for future genome-wide research.

In the realm of animal health, milk exosomes have been explored as drug delivery vehicles for treating mastitis. Encapsulating antibiotics within milk exosomes showed promising results in reducing milk somatic cell counts and bacterial load in Sahiwal cows with subclinical and clinical mastitis.

In dairy processing, the Institute has developed various value-added dairy products, such as a milk-flaxseed-based fermented product, desi chhaach powder, and processed cheese from milk protein ingredients. Technologies have been developed for enhancing the shelf life of burfi using edible coatings and for producing lactic culture-mediated vitamin B_{12} bio-fortified fermented milk. Initiatives to harness the potential of non-bovine milk have also commenced.

To ensure milk quality, a simple paper-based disc methodology has been developed to detect sorbitol in milk. Likewise, strip-based tests for detecting *Listeria monocytogenes* and *Escherichia coli* in milk have been created. Similarly, metabolomics studies have revealed differences in milk metabolites between Tharparkar and Karan Fries cows.

The academic programs at ICAR-NDRI Deemed University are continuously reviewed and updated to equip students with the necessary knowledge and skills to meet global challenges. The 19th Convocation was held on April 24, 2023, with Hon'ble President of India, Smt. Droupadi Murmu Ji, as the Chief Guest. A total of

शामिल हैं। संस्थान बहु-विषयक दृष्टिकोण, विवेचनात्मक सोच को अपनाकर और समस्या-समाधान कौशल को बढ़ावा देकर, मिश्रित शिक्षण प्लेटफार्मों को अपनाकर और अनुभवात्मक शिक्षण अवसरों को एकीकृत कर राष्ट्रीय शिक्षा नीति-2020 (एनईपी-2020) को लागू करने के लिए प्रतिबद्ध है। संस्थान ने वर्ष 2023 में नई तकनीकों और कार्य संस्कृतियों को सीखने के लिए संस्थान के 13 संकाय सदस्यों को विदेश में भेजा गया।

वर्ष 2023 में, एनडीआरआई ने 14 परियोजनाओं के लिए कुल 870.28 लाख रुपये की राशि बाहर से वित्तपोषण के रूप में प्राप्त की। संस्थान उद्योग के लिए 05 तकनीकों का व्यवसायीकरण करने में सफल रहा। संस्थान को कुल 06 पेटेंट प्रदान किए गए। संस्थान ने एनडीआरआई सिग्नेचर के लिए ट्रेडमार्क पंजीकरण भी हासिल कर लिया है और डॉ. हिमांशु पाठक, सचिव डेयर और महानिदेशक भाकृअनुप ने 29 सितंबर 2023 को इसे आधिकारिक तौर पर जारी किया।

विभिन्न आउटरीच गतिविधियों के माध्यम से, आईसीएआर-एनडीआरआई ने 2023 में 55,270 डेरी किसानों को लाभान्वित किया। डेरी मेला में संस्थान की गतिविधियों को प्रदर्शित किया गया, रिकॉर्ड 37,583 आगंतुक शामिल हुए। जनजातीय उप-योजना (टीएसपी), उत्तर पूर्वी क्षेत्र (एनईएच) और अनुसूचित जाति उप-योजना (एससीएसपी) के तहत किए गए प्रयास का उद्देश्य डेरी को पेशे के रूप में उपयोग कर विभिन्न सामाजिक वर्गों का उत्थान करना है।

ये उपलब्धियाँ एनडीआरआई बिरादरी के समर्पण, कड़ी मेहनत, सहयोग और समझ से संभव हुईं। संस्थान डेरी अनुसंधान, शिक्षा और आउटरीच को बढ़ावा देने के लिए एक विश्व स्तरीय मॉडल बनने के लिए प्रतिबद्ध है, जिससे लाखों किसानों के सामाजिक-आर्थिक जीवन में बदलाव आएगा।

मुझे पूरी उम्मीद है कि आईसीएआर-एनडीआरआई की वार्षिक रिपोर्ट 2023 देश के अन्य उच्च शिक्षा संस्थानों और डेरी विकास संगठनों के पेशेवरों के लिए सूचना का एक मूल्यवान स्रोत बनेगी।

(धीर सिंह)
निदेशक, भाकृअनुप–राडेअनुस

544 students graduated, including 158 PhD scholars, 308 Master's, and 78 B. Tech students. The Institute is committed to implementing the National Education Policy-2020 (NEP-2020) by adopting a multidisciplinary approach, promoting critical thinking and problem-solving skills, embracing blended learning platforms, and integrating experiential learning opportunities. The Institute has deputed 13 faculty members abroad to learn new technologies and work cultures in the year 2023.

In 2023, NDRI secured external funding for 14 projects totalling Rs. 870.28 lakhs. We have been successful in commercializing 05 technologies to the industry. A total of 06 patents have been granted to the Institute. The institute has also secured trademark registration for NDRI signature and Dr. Himanshu Pathak, Secretary DARE and Director General ICAR officially released it on 29th September 2023.

Through various outreach activities, ICAR-NDRI benefitted 55,270 dairy farmers in 2023. A record 37,583 visitors attended the Dairy Mela, showcasing the Institute's activities. Efforts under the Tribal Sub-Plan (TSP), North Eastern Region (NEH), and Scheduled Caste Sub-Plan (SCSP) aimed to uplift various social segments using dairying as a profession.

These accomplishments were made possible by the dedication, hard work, cooperation, and understanding of the NDRI fraternity. The Institute remains committed to becoming a world-class model for promoting dairy research, education, and outreach, transforming the socio-economic lives of millions of farmers.

I sincerely hope that the ICAR-NDRI Annual Report 2023 serves as a valuable source of information for professionals at other institutions of higher learning and dairy development organizations in the country.

(Dheer Singh)
Director, ICAR-NDRI

कार्यकारी सारांश

भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल राष्ट्र का एक प्रतिष्ठित अनुसंधान संगठन है । यह देश के डेरी विकास कार्यक्रमों को अनुसंधान एवं विकास तथा मानव संसाधन विकास में सहायता देने के प्रति समर्पित है। इसकी स्थापना सन् 1923 में बैंगलोर में की गई थी जिसके मुख्यालय को सन् 1955 में करनाल स्थित इसके वर्तमान स्थान पर स्थानांतरित कर दिया गया। इसके दो क्षेत्रीय केंद्र है, एक बेंगलुरू में तथा दूसरा कल्याणी में जो कृषि जलवायु स्थिति को ध्यान में रखते हुए क्षेत्र विशेष के लिए सहयोग देता है। सन् 1989 से आईसीएआर-एनडीआरआई को मानद् विश्वविद्यालय का दर्जा प्राप्त है जिसके माध्यम से यह शैक्षणिक कार्यों को कार्यान्वित करता है। संस्थान को भारत के सभी कृषि विश्वविद्यालयों में, जिसमें चार मानद् विश्वविद्यालय सम्मिलित हैं, विगत 5 बार से लगातार अर्थात 2016-17, 2017-18, 2018-19, 2019-20 तथा 2020-21 के दौरान सर्वश्रेष्ठ कृषि विश्वविद्यालय का दर्जा प्राप्त हुआ।

संगठनात्मक संरचना

आईसीएआर के मानद् विश्वविद्यालय प्रणाली के प्रशासनिक पैटर्न के अनुरूप संस्थान विभिन्न नीति/निर्णय लेने वाले निकायों, यथा प्रबंध मंडल, अनुसंधान सलाहकार समिति, विद्वत परिषद, कार्य परिषद तथा विस्तार परिषद के द्वारा प्रबंधित होता है। निदेशक मुख्य कार्यपालक अधिकारी होता है जिसे अनुसंधान, शैक्षणिक तथा विस्तार कार्यों को प्रबंधित करने में संयुक्त निदेशक सहायता करते हैं। संस्थान के अनुसंधान एवं विकास गतिविधियों के तीन प्रमुख क्षेत्र हैं- i) डेरी उत्पादन, ii) डेरी प्रसंस्करण और iii) डेरी विस्तार/ प्रबंधन। सभी अनुसंधान एवं विकास गतिविधियाँ तेरह अनुसंधान प्रभागों/ अनुभाग के माध्यम से प्रबंधित की जाती है, अर्थात् पशु आनुवंशिकी एवं प्रजनन, पशुधन उत्पादन एवं प्रबंधन, पशु पोषण, चारा अनुसंधान और प्रबंधन, पशु शरीर क्रिया विज्ञान, पशु जैव रसायन, पशु जैव प्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी अभियांत्रिकी, डेरी रसायन, डेरी सूक्ष्म जीवाणु, डेरी विस्तार और डेरी अर्थशास्त्र, सांख्यिकी एवं प्रबंधन। संस्थान में एक कृषि प्रौद्योगिकी सूचना केंद्र (एटीआईसी), कृषि विज्ञान केंद्र और डेरी प्रशिक्षण केंद्र, कृत्रिम प्रजनन अनुसंधान केंद्र, के.वी.के. में कृषि और डेरी विकास केंद्र, पिपराकोठी, पूर्वी चंपारण, मोतिहारी, बिहार और मॉडल डेरी केंद्र, लालुखेड़ा, मुजफ्फरनगर, यूपी में है | संस्थान में पशुधन अनुसंधान केंद्र, चारा अनुसंधान एवं प्रबंधन केंद्र, पशु स्वास्थ्य परिसर, छोटे पशु घर, मॉडल डेरी प्लांट, प्रौद्योगिकी बिजनेस इनक्यूबेटर, कृषि व्यवसाय इनक्यूबेशन सेंटर, दूध की गुणवत्ता और सुरक्षा के लिए राष्ट्रीय रेफरल प्रयोगशाला, प्रयोगात्मक डेरी संयंत्र, परामर्श

EXECUTIVE SUMMARY

ICAR-National Dairy Research Institute, Karnal is a premier research organization of the nation dedicated to provide Research and Development (R&D) and Human Resource Development (HRD) support towards dairy development programmes in the country. Established in 1923 at Bangalore, the headquarters of the Institute was moved to the present location at Karnal in 1955. It has two regional stations, one at Bengaluru and the other at Kalyani for providing region-specific support suited to their agro-climatic conditions. ICAR-NDRI has the distinction of being a Deemed University for implementing its academic programmes since 1989. The Institute has been ranked first among all Agricultural Universities of India including 4 Deemed Universities, consecutively for the five times in the year 2016-17, 2017-18, 2018-19, 2019-20 and 2020-21.

ORGANISATIONAL STRUCTURE

In consonance with the administrative pattern of the Deemed University System of the ICAR, the Institute is managed through various policy/decision-making bodies, *viz*. Board of Management, Research Advisory Committee, Academic Council, Executive Council and Extension Council. The Director is the Chief Executive Officer assisted by the Joint Directors for managing research, academic and extension functions. The Institute has three major areas of R&D activities viz. i) Dairy Production, ii) Dairy Processing and iii) Dairy Extension/ Management. All the R & D activities are managed through thirteen Research Divisions/ Sections, namely, Animal Genetics & Breeding, Livestock Production and Management, Animal Nutrition, Forage Research and Management, Animal Physiology, Animal Biochemistry, Animal Biotechnology, Dairy Technology, Dairy Engineering, Dairy Chemistry, Dairy Microbiology, Dairy Extension and Dairy Economics, Statistics and Management. The Institute also has an Agricultural Technology Information Centre (ATIC), Krishi Vigyan Kendra and Dairy Training Centre, Artificial Breeding Research Centre, Krishi and Dairy Vikas Kendra at KVK, Piprakothi, East Champaran, Motihari, Bihar and Model Dairy Centre at Lalukheri in Muzzafarnagar, U.P. The Institute has infrastructure consisting of central facilities such as Livestock Research Centre, Forage Research and Management Centre, Animal Health Complex, Small Animal House, Model Dairy Plant, Technology Business Incubator, Agribusiness Incubation Centre, National Referral Laboratory for Milk Quality and Safety,

इकाई, पुस्तकालय और राष्ट्रीय जैव सूचना विज्ञान केंद्र, कंप्यूटर केंद्र, संपदा अनुभाग और अनुरक्षण इंजीनियरिंग अनुभाग केन्द्रीय सुविधाओं से युक्त बुनियादी ढांचा है। प्रशासनिक कार्य अर्थात् क्रय, भण्डारण और सुरक्षा संयुक्त निदेशक (प्रशासन एवं वरिष्ठ कुलसचिव) के प्रशासनिक नियंत्रण में है, जबकि वित्त शाखा, नियंत्रक के नियंत्रण के अधीन है। संस्थान में वर्तमान में निदेशक के 01 तथा संयुक्त निदेशक के 03 पद सहित वैज्ञानिकों के 133 पद, 157 तकनीकी पद, 108 प्रशासनिक कर्मचारी (ग्रुप ए, बी तथा अराजपत्रित) और 228 कुशल सहायक कर्मचारी हैं।

बजट परिव्यय

संस्थान का वित्तीय व्यय वर्ष 2023-24 के दौरान वास्तविक व्यय 27309.92 लाख रुपये था तथा वर्ष 2023-24 के लिए बजट संस्वीकृत 27354.02 लाख रुपए थी। इन आंकड़ों में क्षेत्रीय परिसरों के सुदृढ़ीकरण के लिए वित्तीय परिव्यय भी शामिल था। वर्ष 2023-24 के दौरान क्षेत्रीय परिसरों सहित संस्थान की राजस्व प्राप्तियां 1135.89 लाख रुपये थी।

अनुसंधान

- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में मार्च, 2023 में भारत की पहली क्लोन्ड गोपशु नामत: ''गंगा'' ने जन्म लिया।
- दोहरी मांसपेशियों के लिए मायोस्टेटिन जीन-संपादित भैंस कटड़े का सफलतापूर्वक उत्पादन किया गया, जो भारतीय कृषि पशुओं के लिए जीन संपादित पशु उत्पादन प्रौद्योगिकी की दिशा में एक बड़ी छलांग है।
- भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में आनुवंशिक दृष्टि से उन्नत साहीवाल सांडों के लिंग सॉर्टेड वीर्य का उपयोग करके चार बेहतर मादा नवजात बछड़ियों को सफलतापूर्वक पैदा किया गया।
- पहली बार 86.6% सम्पूर्णता के साथ संकटाकालीन भैंस नस्ल ''भदावरी'' की सम्पूर्ण जीनोम एसेम्बली सृजित की गई।
- कैल्शियम और विटामिन डी की उपस्थिति में कैजीन व्युत्पन्न पेप्टाइड का संवर्धित अस्थि-सुरक्षात्मक प्रभाव सिद्ध किया गया।
- करण फ्रिज तथा थारपरकर गोपशु में तापीय दबाव का पूर्वानुमान लगाने के लिए मशीन लर्निंग मॉडल विकसित किए गए।
- भैंस की प्राथमिक कायिक कोशिकाओं में बीएलजी-जीन को संपादित किया गया और बीएलजी-जीन KO भ्रूण उत्पन्न किया गया।
- मवेशियों के शुक्राणुओं द्वारा शुक्र कोशिकीय बाह्य पुटिकाओं के अवशोषण के लिए एक स्व:पात्रे मॉडल विकसित किया गया।

Experimental Dairy Plant, Consultancy Unit, Library and National Bioinformatics Centre, Computer Centre, Estate Section and Maintenance Engineering Section. The administrative functions viz. purchase, stores and security are under the administrative control of the Joint Director (Administration & Registrar) whereas the finance wing is is under the administrative control of the Comptroller (Finance). The Institute presently has 133 scientists including the Director (1) and Joint Directors (2), 157 Technical, 108 Administrative Staff (Group A, B and non-gazetted) and 228 skilled supporting staff.

BUDGET OUTLAY

The financial outlays of the Institute in terms of actual expenditure during the year 2023-24 was Rs. 27309.92 lakhs and budget sanctioned for the year 2023-24 was Rs. 27354.02 lakhs. These figures also include the financial outlays for the strengthening of Regional Campuses. The revenue receipts of the Institute including regional campuses were Rs. 1135.89 lakhs during 2023-24.

Research

- India's first cloned cattle, named 'GANGA', was born in March 2023 at ICAR-NDRI Karnal.
- Myostatin gene-edited buffalo calf for double muscling was successfully produced, which is a huge leap towards gene edited animal production technology for Indian farm animals
- Using sex sorted semen of genetically improved Sahiwal bulls at NDRI, 4 superior elite female calves were produced successfully.
- Whole genome assembly of threatened buffalo breed "Bhadawari" was created for the first time with 86.6% completeness.
- Enhanced osteoprotective effect of casein derived peptide(s) was established in the presence of calcium and vitamin D.
- Machine learning models for prediction of thermal stress were developed in Karan Fries and Tharparkar cattle.
- β-lactoglobulin (BLG) gene was edited in primary somatic cells of buffalo, and produced BLG-gene KO embryos.
- An *in vitro* model was developed for uptake of seminal extracellular vesicles by cattle spermatozoa.

- Y-विशिष्ट तथा X-विशिष्ट भैंस भ्रूण की सटीक पहचान करने के लिए पीसीआर आमाप विकसित किया गया।
- कृत्रिम गर्भाधान के 30 दिन बाद गर्भवती पशुओं से निदान नमूने के रूप में दूध पर गाय तथा भैंस में गर्भावस्था का पता लगाने के लिए BuPAG-1, BuPAG-2, BuPAG-7 एवं BuPAG-18 का उपयोग करके पार्श्वीय प्रवाह आमाप विकसित किया गया।
- भैंस के मूत्र से प्रमुख प्रति-सूक्ष्मजीवीय पेप्टाइड (AMPs) खोजे गए और एस.ऑरियस एवं ई.कोलाई के विरूद्ध इनकी प्रभावशीलता का पता लगाने के लिए इनकी स्व:पात्रे जांच की गई।
- bta-miR-2388 तथा bta-miR-1584 के miRNAs में पहचाने गए mirSNPs का संबंध करण फ्रिज तथा थारपारकर गोपशु में ताप सहिष्णुता के साथ पाया गया जिनका उपयोग बेहतर ताप सहिष्णुता के लिए पशुओं का चयन करने में किया जा सकता है।
- थनैला रोग के लिए एक्सोसोम्स सम्पुटित एंटीबायोटिक आधारित चिकित्सा की क्षमता का विकास और परीक्षण किया गया।
- मदकाल में भैंस की लार अथवा सैलाइवा के विशिष्ट फर्न पैटर्न के लिए उत्तरदायी अणुओं की पहचान की गई।
- भारतीय भैंस में माइटोकॉण्ड्रियल पृथक्करण के लिए बफर्स की प्रभावशीलता में ऊतक विशिष्ट भिन्नता देखने को मिली।
- डेरी पशुओं के स्वास्थ्य की निगरानी करने के लिए सेंसर आधारित गोपशु नोड्स विकसित किए गए।
- आईआईटी, खड़गपुर द्वारा थनैला रोग का पता लगाने में विकसित किए गए एक सस्ते प्रोटोटाइप को भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल में जांचा गया और उप-क्लीनिकल थनैला रोग की पहचान के लिए गांवों को अंगीकृत किया गया।
- मूत्र में किसपेप्टिन का स्तर गुणात्मक रूप से प्लाज्मा किसपेप्टिन के समान था, जो संकर नस्ल के मवेशियों में मदकाल और प्रारंभिक गर्भावस्था की भविष्यवाणी करने के लिए एक संभावित गैर-आक्रामक बायोमार्कर के रूप में कार्य करता है।
- दस पीपीएम स्तर पर पूरक अजैविक कॉपर (Cu) को 5 पीपीएम नैनो-Cu द्वारा प्रतिस्थापित किया जा सकता है, जबकि 8.38 पीपीएम Cu युक्त मूल आहार प्राप्त करने वाले करण फ्राइज़ बछड़ों में खनिज स्थिति और प्लाज्मा प्रति-ऑक्सीकारक गतिविधि में सुधार किया जा सकता है।
- स्वदेशी गोपशु नवजात मूल के स्ट्रेन लिमोसीलैक्टोबैसिलस रीटेरी SW27 तथा लिजीलैक्टोबैसिलस सैलिवेरियस

- PCR assay was developed to identify the Y-specific and X-specific buffalo embryos accurately.
- Lateral flow assay was developed using BuPAG-1, BuPAG-2, BuPAG-7 and BuPAG-18 for pregnancy diagnosis in cow and buffaloes on milk as diagnostic sample from pregnant animals after 30 days' post artificial insemination.
- Key antimicrobial peptides (AMPs) were discovered from the urine of buffalo and tested *in vitro* for their efficacy against *S. aureus* and *E. coli*.
- The mirSNPs identified in the miRNAs of bta-miR-2388 and bta-miR-1584 which were found to be associated with heat tolerance in KF and Tharparkar cattle, could be used for selection of animals for better heat tolerance.
- Developed and tested the potential of exosomes-encapsulated antibiotic based therapeutics for mastitis.
- Molecules responsible for typical fern patterns of buffalo saliva at estrus were identified.
- Tissue-specific variations were observed in the effectiveness of buffers for mitochondrial isolation in Indian buffalo.
- Sensor-based cattle nodes were developed for monitoring health of dairy animals.
- A low-cost mastitis detection prototype by IIT Kharagpur was tested at ICAR-NDRI, Karnal and adopted villages for subclinical mastitis detection.
- Urinary kisspeptin levels qualitatively mirrored plasma kisspeptin, serving as a potential non-invasive biomarker for predicting estrus and early pregnancy in crossbred cattle.
- Supplementary inorganic copper (Cu) at 10 ppm level could be replaced by 5ppm of nano-Cu while improving mineral status and plasma antioxidant activity in Karan Fries calves receiving basal diet containing 8.38ppm Cu.
- The strains *Limosilactobacillus reuteri* SW27 and *Ligilactobacillus salivarius* RBL22 of indigenous cattle calves' origin were spray dried and a product was developed for feeding to calves.
- Micronutrients blend (Zn, Cu, Mn, Cr, Co, vitamin A and vitamin E) supplementation in optimum ratio to Sahiwal males resulted in better immunity as well as antioxidant status and also achieving early

RBL22 का सूखा छिड़काव किया गया और नवजात बछड़ों को आहार देने के लिए एक उत्पाद तैयार किया गया।

- साहीवाल नर पशुओं को इष्टतम अनुपात में सूक्ष्म पोषक तत्व मिश्रित (जिंक, कॉपर, मैग्नीज, क्रोमियम, Co, विटामिन ए तथा विटामिन ई) अनुपूरक की आपूर्ति करने के परिणामस्वरूप बेहतर प्रतिरक्षा के साथ-साथ प्रति-ऑक्सीकारक स्थिति देखने को मिली और साथ ही पोषक तत्व इनटेक और पाचक क्षमता को प्रभावित किए बिना यौवनकाल और लैंगिक परिपक्वता को जल्दी हासिल किया गया।
- हर्बल आहार संयोज्य जैसे कि एण्ड्रोग्राफिस पैनीकुलेटा (कालमेघ), कैरिका पपाया (पपीता) पत्तियों तथा मैग्नीफेरा इंडिका (आम) बीज गुठली को अलग-अलग स्तर पर अथवा 5-10% शामिल करने के स्तर पर संयोजन में प्रयोग करना 15-18% तक की सीमा तक आंतों से निकलने वाली मीथेन गैस को कम करने में एक प्रभावी विकल्प पाया गया और साथ ही इसका पाचन क्षमता पर और स्व:पात्रे परिस्थिति में अन्य जुगाली किण्वन पैरामीटरों पर कोई प्रतिकूल प्रभाव देखने को नहीं मिला।
- पांच प्रतिशत आम की गुठली के साथ 50% रैमी चारे का संयोजन आंतों से निकलने वाले मीथेन उत्सर्जन को 36% तक कम करने में अत्यधिक प्रभावी पाया गया जबकि स्व:पात्रे परिस्थिति में प्रमुख जुगाली शरीर क्रियाविज्ञान पैरामीटरों को बनाए रखने में भी यह अत्यधिक प्रभावी पाया गया।
- गोपशु तथा भैंस दोनों में नस्ल विविधता स्तर कम (सिम्पसन सूचकांक – क्रमश: 0.46 एवं 0.36) पाया गया। स्वदेशी गोपशु तथा भैंस पॉपुलेशन (लगभग 2.24% से 2.49%) की तुलना में संकर नस्ल वाली गोपशु पॉपुलेशन की वृद्धि दर अधिकतम (लगभग 15%) पाई गई।
- डेरी गायों की स्तनग्रंथि स्वास्थ्य प्रोफाइल का पूर्वानुमान लगाने के लिए पारंपरिक लीनियर मॉडल की तुलना में दुग्ध कम्पोजिशनल पैरामीटरों का उपयोग करके मशीन लर्निंग मॉडल (BRNN, kNN, RF, SVM) कहीं बेहतर थे।
- माइटोक्विनन @200nM तथा एल-कार्नीटिन @2mM के साथ सम्पूरित एक्सटेंडर से उल्लेखनीय रूप से शुक्राणु मृत्युदर, कार्यपरक मेम्ब्रेन अखंडता तथा एक्रोसम अखंडता हिम-परिरक्षण उपरांत में सुधार देखने को मिला।
- साठ ग्राम/दिन की आपूर्ति करने पर संकर नस्ल की गायों में रूमेन संरक्षित कोलीन और मिथियोनाइन पूरकता की प्रभावकारिता ने दूध उत्पादन दक्षता में वृद्धि की (P<0.05)।
- डेरी सूक्ष्मजीव के अंतर्गत वीटीसीसी रिपोजिट्री में कुल 27 लैक्टिक संवर्धन जमा कराए गए।

attainment of puberty and sexual maturity without affecting nutrient intake and digestibility.

- Herbal feed additives such as *Andrographis paniculata* (Kalmegh), *Carica papaya* (papaya) leaves, *Mangifera indica* (mango) seed kernel individually and/or in combination at 5-10% inclusion level was found to be an effective choice for enteric methane mitigation to the extent of 15-18% without affecting the digestibility and other rumen fermentation parameters under *in vitro* condition.
- Combination of 50% Ramie fodder with 5% Mango Seed Kernel was found to be highly effective for reducing enteric methane emissions by 36%, while maintaining key rumen physiological parameters under *in vitro* condition.
- Breed diversity level in both cattle and buffalo was found low (Simpson Index = 0.46 and 0.36 respectively). The growth rate of cross-bred cattle population was found highest (approx. 15%) compared to indigenous cattle and buffalo population (approx. 2.24% to 2.49%).
- Machine learning models (BRNN, kNN, RF, SVM) using milk compositional parameters were found better than conventional linear models for predicting mammary health profile of dairy cows.
- Extender supplemented with mitoquinone 200 nM and L-carnitine 200 nM significantly improved sperm motility, functional membrane integrity, and acrosome integrity post cryopreservation.
- Efficacy of rumen protected choline and methionine supplementation in crossbred cows enhanced milk production efficiency (P<0.05) when supplemented 60g/day.
- Twenty-seven lactic cultures were deposited in the VTCC repository under Dairy Microbes.
- Lifetime water footprint was estimated for different breeds of cattle and buffalo and it was observed that the Gir breed was the most water-efficient.
- A study on biogas plants revealed that the creation and maintenance of biogas plants are economically feasible (average net returns from biogas plants estimated at Rs. 6,393/year).
- A protocol developed for the purification of native immunoglobulins (IgGs) from Yak colostrums.

- गोपशु एवं भैंस की विभिन्न नस्लों के लिए जीवनपर्यन्त जल फुटप्रिंट का अनुमान लगाया गया और यह पाया गया कि गिर नस्ल सर्वाधिक जल प्रभावी थी।
- बायोगैस संयंत्र पर किए गए अध्ययन से पता चला कि बायोगैस संयंत्रों का सृजन एवं रखरखाव आर्थिक दृष्टि से व्यावहारिक है (बायोगैस संयंत्र से औसत शुद्ध लाभ का अनुमान प्रतिवर्ष रुपये 6,393/- है)।
- यॉक खीस (कोलोस्ट्रम) से देशज इम्यूनोग्लोबुलिन (IgGs) का शुद्धिकरण करने के लिए एक प्रोटोकॉल तैयार किया गया।
- व्यवहार्य प्रोबायोटिक जीवों की तेजी से गणना के लिए एक प्रोटोटाइप PMA-qPCR आमाप विकसित किया गया।
- सिन्बायोटिक मिस्टी दही और स्वास्थ्य को बढ़ावा देने वाले अन्य किण्वित डेरी खाद्य को तैयार करने के लिए उच्च शर्करा सहिष्णु बहु स्ट्रेन प्रोबायोटिक डीवीएस तैयार किया गया।
- गाय के दूध में अंकुरित रागी आटे (2%) का उपयोग करके रागी-दूध आधारित कम्पोजिट किण्वित पेय तैयार किया गया और उसे लैक्टिकेजीबैसिलस रैम्नोसस (2%) के साथ किण्वित किया गया और 12 घंटे के लिए 37°C तापमान पर उष्मायित किया गया।
- लैक्टिक संवर्धन मध्यस्थ विटामिन B12 जैव प्रबलित किण्वित दूध तैयार किया गया।
- लैक्टिक खमीर अथवा यीस्ट किण्वित दूध (LYFM) लैक्टिक से तैयार किया जाता है: खमीर अथवा यीस्ट कल्चर में 1% अल्कोहल होता है और इसमें रोगाणुरोधी और प्रतिरक्षा-संशोधक गुण होते हैं।
- दूध में लिस्टेरिया मोनोसाइटोजीन्स तथा ई.कोलाई का पता लगाने के लिए स्ट्रिप आधारित जांच विकसित की गई।
- पेपर आधारित डिस्क का उपयोग करके दूध में सार्बिटोल का पता लगाने के लिए एक आसान कार्यप्रणाली तैयार की गई।
- घी में सोयाबीन तेल, पामोलिन, भेड़ शरीर वसा तथा चूजा शरीर वसा के साथ-साथ इनकी मिलावट का क्रमश: 1% एवं 3.3% तक पता लगाने के लिए ATR-FTIR कार्यप्रणाली को इष्टतम बनाया गया।
- मैग्नेटिक मॉलिक्यूलर इंप्रिंटेड पॉलीमर (एमएमआईपी) पर आधारित एक चयनात्मक विधि विकसित की गई है, जिसका उद्देश्य दूध से बायोटिन को कुशलतापूर्वक निकालना है।
- किण्वित दही में भुने हुए अलसी के आटे, स्टेबलाइजर और चीनी को मिलाकर दूध-अलसी आधारित किण्वित उत्पाद तैयार किया गया।
- देसी छाछ को नैनोफिल्ट्रेशन और स्प्रे शुष्कन का उपयोग करके पाउडर में बदलने के लिए तथा साथ ही इसे विभिन्न प्रकार के इंस्टेंट लस्सी पाउडर में परिवर्तित करने के लिए एक प्रक्रिया विकसित की गई।

- A prototype PMA-qPCR assay developed for rapid enumeration of viable probiotic organisms.
- High sugar tolerant multiple strain probiotic DVS developed for the preparation of synbiotic Misti Dahi and other health-promoting fermented dairy foods.
- Finger-millet-milk-based composite fermented beverage prepared using germinated finger-millet flour (2%) in cow milk and fermented with *Lacticaseibacillus rhamnosus* (2%), and incubated at 37°C for 12h.
- Lactic culture mediated vitamin B_{12} bio-fortified fermented milk prepared.
- Lactic Yeast Fermented Milk (LYFM) prepared with lactic: yeast cultures having 1% alcohol and having antimicrobial and immune-modulatory properties.
- Strip-based test developed for detection of *Listeria monocytogenes* and *E. coli* in milk.
- A simple methodology developed to detect sorbitol in milk using a paper-based disc.
- ATR-FTIR methodology optimized to detect soybean oil, palmolein, sheep body fat, and chicken body fat as well as their admixture in ghee up to 1% and 3.3%, respectively.
- A selective method based on Magnetic Molecularly Imprinted Polymer (MMIP) developed to efficiently extract biotin from milk for its estimation.
- The milk-flaxseed-based fermented product prepared by adding roasted flaxseed flour, stabilizer, and sugar to fermented curd.
- A process developed for the valorization of desi chhaach to powder employing nanofiltration and spray drying as well as converted into different variants of instant lassi powders.
- A technology developed for the shelf life enhancement of burfi using the edible coating from 15 days to 18 days at 4 ± 1°C and from 6-9 days at 30 ± 1°C.
- A microbial Smart Time-Temperature Indicator developed for Paneer.
- Metabolomics-assisted compositional and technological variations in the milk of Beetal, Barbari and Jamunapari goats elucidated.

- 4 ± 1˚C तापमान पर 15 से 18 दिनों और 30 ± 1˚C. तापमान पर 6 से 9 दिनों तक खाद्य आवरण का उपयोग करके बर्फी के जीवनकाल को बढ़ाने के लिए एक प्रौद्योगिकी विकसित की गई।
- पनीर के लिए एक सूक्ष्मजीवीय स्मार्ट समय तापमान संकेतक विकसित किया गया।
- बीटल, बारबरी और जमुनापारी बकरियों के दूध में मेटाबोलोमिक्स-सहायतार्थ संरचनागत और तकनीकी विविधताओं को स्पष्ट किया गया।
- एक बहुउद्देश्यीय स्वचालित नियंत्रण दर तापन प्रणाली विकसित की गई (घनाभ डिजाइन : 50 लीटर क्षमता)।
- दूध को गरम करने की एक मैग्नेटिक इंडक्शन आधारित प्रणाली (1.5 से 2.0 लीटर) विकसित की गई।
- बायोपॉलिमर पुलुलन में प्रोजेस्टेरोन के सम्पुटीकरन के लिए इलेक्ट्रो-स्पन नैनोफाइबर का उत्पादन करने के लिए एक प्रक्रिया विकसित की गई। स्व:पात्रे रिलीज काइनेटिक अध्ययनों से नियंत्रित डिलीवरी के लिए प्रोजेस्टेरोन-लोडेड पुलुलन नैनोफाइबर की क्षमता का संकेत मिलता है।
- मोरिंगा से समृद्ध फ्लेवर्ड दूध और योगार्ट की भौतिक-रासायनिक तथा जैव कार्यपरक विशेषताओं का मूल्यांकन करने पर पता चला कि मोरिंगा फली गूदे का उपयोग मूल्य वर्धित डेयरी उत्पादों को तैयार करने में क्षमताशील कार्यपरक संघटक के रूप में किया जा सकता है।
- रागी माल्ट तथा सोरगम माल्ट का उपयोग करके न्यूट्रिसीरियल्स सम्मिलित प्रोबायोटिक डेरी स्प्रेड को तैयार करने के लिए प्रौद्योगिकी विकसित की गई।
- इक्कीस से बयालिस दिन के बढ़े हुए जीवनकाल के साथ प्रसंस्कृत मोजारेला चीज (PMC) की प्रौद्योगिकी विकसित की गई।
- दूध उत्पादन क्षेत्र की स्वच्छता के लिए प्रति-सूक्ष्मजीव जिंक ऑक्साइड नैनोपार्टिकल-पेप्टाइड कोन्जुगेट्स तैयार किए गए।
- एकीकृत कृषि प्रणाली को लाभकारी उद्यम पाया गया जिसके अंतर्गत उल्लेखनीय रूप से कहीं अधिक लाभप्रदता और आर्थिक व्यवहार्यता पाई गई (अधिकतम 1.57 के लाभ लागत अनुपात के साथ)।
- व्यावसायिक डेरी फार्म की टिकाऊ क्षमता का मूल्यांकन करने के लिए एक कम्पोजिट सूचकांक तैयार किया गया। यह पाया गया कि केरल में व्यावसायिक डेरी फार्म में मध्यम स्तरीय टिकाऊ क्षमता (सूचकांक स्कोर – 0.55) है। पुन: टिकाऊ क्षमता स्तर तथा झुंड आकार के मध्य सकारात्मक सह-संबंध की पहचान की गई।
- सघन प्रणालियों में नवोन्मेषी प्रबधंन को लागू करने पर ब्लैक बंगाल बकरियों पर सकारात्मक प्रभाव देखने को मिला और साथ ही इनके शरीर क्रियाविज्ञान, जैव रसायन

- A multipurpose automatic controlled rate heating system (cuboid design: 50-litre capacity) developed.
- A magnetic induction-based milk heating system (1.5 to 2.0 litres) developed.
- A process developed for the production of electro-spun nanofiber for the encapsulation of progesterone in a biopolymer pullulan. *In vitro* release kinetic studies indicate the potential of progesterone-loaded pullulan nanofibers for controlled delivery.
- Assessment of physico-chemical and bio-functional properties of Moringa-enriched flavoured milk and yoghurt, revealed that Moringa pod pulp could be used as a potential functional ingredient for the formulation of value-added dairy products.
- Technology developed for preparation of nutri-cereals incorporated probiotic dairy spread using finger millet malt and sorghum malt.
- Technology of processed Mozzarella Cheese (PMC) developed with extended shelf life from 21 days to 42 days.
- Antimicrobial zinc oxide nanoparticle-peptide conjugates prepared for sanitation of the milk production area.
- The integrated farming system was found to be a profitable venture reporting significant higher profitability and economic feasibility (with benefit cost ratio maximum 1.57).
- A composite index was prepared to assess sustainability of commercial dairy farms. It was observed that, commercial dairy farms in Kerala are having medium level sustainability (Index score= 0.55). Further, positive correlation was identified between sustainability level and herd size.
- Implementation of innovative management in intensive systems positively influenced Black Bengal goats without any adverse effects on physiological, biochemical, and hematological parameters.
- Conducted bio-fertilizer and bio-pesticide based fodder crop demonstrations in West Bengal, which yielded high quality fodder crops without deteriorating the soil quality.

तथा रूधिरविज्ञान पैरामीटरों पर किसी प्रकार का प्रतिकूल प्रभाव नहीं देखा गया।

- पश्चिम बंगाल में जैव उर्वरक तथा जैव नाशकजीवनाशी आधारित चारा फसल प्रदर्शन आयोजित किए गए जिनमें मृदा की गुणवत्ता को नुकसान पहुंचाए बिना उच्च गुणवत्ता वाला चारा उत्पन्न हुआ।
- पशुधन वितरण तथा प्रशिक्षण के माध्यम से पूर्वी एवं उत्तर पूर्वी भारत में आदिवासी किसानों का सशक्तिकरण किया गया।

शिक्षा

- विश्वविद्यालय के संकाय और शोधकर्ताओं को सेन्सिटाइज़ करने के लिए "नई शिक्षा नीति-2020" पर 02 संकाय विकास कार्यक्रम (एफडीपी) आयोजित किए गए।
- आईडीपी-एनएएचईपी के तहत 23 दिसंबर, 2023 को राष्ट्रीय शिक्षा नीति-2020: डेरी और पशु विज्ञान की तैयारी उच्चतरत शिक्षा संस्थानों (एचईआई) पर एक सम्मेलन आयोजित किया गया जिससे एनईपी-2020 के अनुसार शैक्षणिक गतिविधियों को सुव्यवस्थित किया जा सके।
- डेरी किसानों और उद्यमियों के लाभ के लिए भाकृअनुप-राडेअनुसं और भाकृअनुप-नार्म ने साझेदारी की है जिससे विस्तृत ओपन ऑनलाइन पाठ्यक्रम (एमओओसी) के लिए डिजिटल सामग्री विकसित की जा सके। इनमें दूध एवं दूध उत्पाद प्रसंस्करण, पनीर एवं किण्वित दूध उत्पादों की प्रौद्योगिकी, पारंपरिक डेरी के तकनीकी पहलू उत्पाद, दूध और दूध उत्पादों की पैकेजिंग और वाणिज्यिक डेरी फार्मिंग शामिल हैं।
- मिश्रित शिक्षण मंच (बीएलपी) को अपनाकर पाठ्यक्रम वितरण को सुदृढ़ बनाना।
- आईडीपी-एनएएचईपी परियोजना के तहत 16 कार्यशालाएं, 02 उद्यमशीलता कौशल विकास कार्यक्रम, 04 सॉफ्ट-स्किल विकास सत्र, 01 सेमिनार, 03 संकाय विकास कार्यक्रम और 03 विचार-मंथन सत्र सहित कुल 29 कार्यक्रम आयोजित किए गए हैं।
- वर्ष 2023 में आईडीपी-एनएएचईपी परियोजना के अंतर्गत विभिन्न देशों के 13 विश्वविद्यालयों में आईसीएआर-एनडीआरआई के कुल 19 बी.टेक छात्र और 06 संकाय सदस्यों ने सफलतापूर्वक विदेश में प्रशिक्षण पूरा किया।
- 25 छात्रों के एक बैच ने मानसिंह इंस्टीट्यूट ऑफ टेक्नोलॉजी (एमआईटी), मेहसाणा और आईसीएआर-एनएएआरएम, हैदराबाद में एक महीने के प्रशिक्षण कार्यक्रम में हिस्सा लिया।
- वैश्विक पूर्व छात्र नेटवर्क के डेटाबेस को मजबूत करने के लिए इसका अद्यतन किया गया और पूर्व छात्रों के बीच बेहतर संचार के लिए एक समर्पित वेबसाइट विकसित की गई।

- Empowered tribal farmers in Eastern and Northeast India through livestock distribution and training.

Education

- Organized 02 Faculty Development Programmes (FDPs) on "New Education Policy-2020" to sensitize faculty and researchers of the university.
- A conclave "National Education Policy-2020: Preparedness of Dairy & Animal Science Higher Education Institutes (HEIs)" under the IDP-NAHEP was organized on 23rd December, 2023 to streamline the academic activities as per NEP-2020.
- ICAR-NDRI and ICAR-NAARM have partnered together in developing digital content for offering Massive Open Online Courses (MOOCs) for the benefit of dairy farmers and entrepreneurs. These include Milk & Milk Products Processing, Technology of Cheese & Fermented Milk Products, Technological Aspects of Traditional Dairy products, Packaging of Milk & Milk Products and Commercial Dairy Farming.
- Strengthening of Curriculum Delivery by adopting the Blended Learning Platform (BLP).
- A total of 29 events including 16 workshops, 02 Entrepreneurial Skill Development programme, 04 soft-skill development sessions, 01 Seminar, 03 Faculty Development Programme, and 03 Brainstorming Sessions have been organized under IDP-NAHEP project.
- A total of 19 B.Tech. Students and 06 faculty members have successfully completed the overseas training at 13 universities across different countries under IDP-NAHEP Project of ICAR-NDRI in the year 2023.
- A batch of 25 students attended one-month training programme at Mansinh Institute of Training (MIT), Mehsana and ICAR-NAARM, Hyderabad.
- Alumni data base was updated to strengthen global alumni network and a dedicated website is developed for better communication among the alumni.

- महिला सशक्तिकरण के तहत महिला छात्राओं को आत्मरक्षा का प्रशिक्षण दिया गया।

विस्तार

- संस्थान ने एक नवोनमेषी विस्तार पहल की शुरुआत की है जो किसानों के फार्म स्कूल के माध्यम से डेरी और संबद्ध कृषि उद्यमों के क्षेत्र में औपचारिक शिक्षा प्रदान करेगा। इस स्कूल में, दीप जनेसरो गांव के 23 किसानों को फसल एवं डेरी से संबंधित सभी सम्बद्ध तथा नवीनतम सूचनाएं पर कक्षा शिक्षण के साथ व्यावहारिक कक्षाएं भी सभी जानकारी तथा वैज्ञानिकों द्वारा अनुसंधान के नवीनतम परिणामों पर जिसमे लैब से लैंड तक के कार्यक्रम जुड़े हैं दिए गए|
- संस्थान की विस्तार टीम के द्वारा पशु-चिकित्सा सहायता अभियान के तहत 4941 पशुओं का उपचार किया गया।
- "किसानों के द्वार पर डेरी शिक्षा" शीर्षक विस्तार शिक्षा कार्यक्रम के अंतर्गत उत्पादन, प्रसंस्करण और प्रबंधन समूह के विषय विशेषज्ञों सहित एनडीआरआई के वैज्ञानिकों ने करनाल जिले और उसके आसपास के गांवों का प्रत्येक माह के दूसरा शनिवार के दौरान दौरा किया। वर्ष 2023 के दौरान 5930 किसानों द्वारा उठाए गए प्रश्नों के उत्तर दिए।
- डेरी हितधारकों में डेरी फार्मिंग की नवीनतम प्रौद्योगिकी के बारे में जागरूकता पैदा करने के लिए गांव में पचास किसान संगोष्ठी का आयोजन किया गया।
- वर्ष 2023 के दौरान, डेयरी और इसके संबद्ध क्षेत्रों के विभिन्न पहलुओं के माध्यम से कुल मिलाकर 55270 डेयरी किसान लाभान्वित हुए।
- वर्ष 2023 के दौरान कुल 316 कॉलेजों/संस्थानों/ विश्वविद्यालयों के 23976 आगंतुकों (छात्रों और शिक्षकों) ने संस्थान का दौरा किया। आगंतुकों को संस्थान में उपलब्ध विभिन्न अनुसंधान, शिक्षण और सुविधाओं के बारे में जागरूक किया गया।
- जनजातीय उप-योजना (टीएसपी) के अंतर्गत, पूर्वी क्षेत्रीय स्टेशन (पूक्षेके), कल्याणी ने दो पशु स्वास्थ्य कार्यक्रम आयोजित किए तथा शिविर में 403 पशुओं का उपचार किया गया और और विभिन्न इनपुट दिए गए।
- पूर्वोत्तर क्षेत्र (एनईएच) के अंतर्गत, पूर्वी क्षेत्रीय स्टेशन (ईआरएस), कल्याणी ने 1109 किसानों के लिए वैज्ञानिक-किसान-संवाद बैठक सह प्रशिक्षण के अनेक कार्यक्रम

- Self-defense training for women students as a part of women empowerment initiatives was organized.

Extension

- The Institute started an innovative extension approach to provide formal education in the field of Dairying and allied farm enterprises through Farmers' Farm School. In this School, classroom teaching as well as practical classes on all relevant and latest information related to crop and dairy farming as well as latest outcomes of research done by scientists involving lab to land programme are imparted to 23 farmers in the village Deep Janesaro.
- A total of 4941 cases of animals were treated during the veterinary aid campaigns by extension team of the Institute.
- Under the Extension Education Programme "Dairy Education at Farmers' Door", NDRI scientists including subject matter specialists from production, processing and management groups visited villages in and around Karnal district on 2nd Saturday of each Month. The queries raised by 5930 number of farmers were addressed during the year 2023.
- Fifty Kisan Sangoshthies were organized at village level for creating awareness about the latest technologies of scientific dairy farming among dairy stakeholders.
- During the year-2023, overall 55270 numbers of dairy farmers were benefitted through various aspects of dairying and its allied fields.
- During the year-2023, a total of 23976 visitors (Students & Faculty) of 316 colleges/Institutions/ Universities visited the institute. The visitors were sensitized about the different research, teachingand facilities available in the Institute.
- Under Tribal Sub-Plan (TSP), Eastern Regional Station (ERS), Kalyani organized two animal health camps and 403 numbers of animals were treated and various inputs were distributed.
- Under North Eastern Region (NEH), Eastern Regional Station (ERS), Kalyani organized several scientists- farmers- interaction meeting cum

आयोजित किए। इन कार्यक्रम में (19860 चूजे), बत्तख के बच्चे (12065), चूजे और बत्तख के बच्चों का चारा (19075 किग्रा.), बकरियां (96), बकरी चारा (6010 किग्रा.), सूअर के बच्चे (99) और सुअर चारा (27950 किग्रा) 1156 संसाधन विहीन किसानों के बीच वितरित किया गया।

- अनुसूचित जाति उप-योजना (एससीएसपी) के अंतर्गत, पूर्वी क्षेत्रीय स्टेशन (ईआरएस), कल्याणी ने पश्चिम बंगाल के विभिन्न गाँव के अनुसूचित जाति बहुल क्षेत्रों में 17 पशु चिकित्सा शिविर लगाए तथा इन कैंपों में अनेक पशुओं के उपचार किए गए। कृषि एवं उससे सम्बद्ध क्षेत्रों के विभिन्न पहलुओं पर 617 अनुसूचित जाति के किसानों के सामाजिक-आर्थिक स्थिति में सुधार के लिए पाँच प्रशिक्षण कार्यक्रम आयोजित किए गए। विभिन्न इनपुट दिए गए।

आधारभूत संरचना

- परिसर में पानी की आपूर्ति की मांग की पूर्ति के लिए एक नया सबमर्सिबल पंप वाला एक नया बोरवेल स्थापित किया गया।
- संस्थान में सुरक्षा सुनिश्चित करने के लिए चारदीवारी का निर्माण किया गया।
- परेशानी मुक्त बिजली की आपूर्ति व्यवस्था सुनिश्चित करने के लिए परिसर में मुख्य द्वार से सबस्टेशन तक एक नई एचटी बख्तरबंद केबल बिछाई गई।
- प्रशासनिक भवन में एक नई यात्री लिफ्ट (15 यात्री की क्षमता वाला) स्थापित की गई।
- अलकनंदा छात्रावास में पेवर ब्लॉक के साथ वर्षा जल संचयन प्रणाली स्थापित की गई।

training programmes for 1109 farmers. During these programmes, inputs comprising Chicks (19860), Ducklings (12065), Chick & duckling feed (19075 kg.), Goats (96), Goat feed (6010 kg.), Piglets (99) and Pig feed (27950 kg.) were distributed among 1156 resource poor farmers during the year- 2023.

- Under Scheduled Caste Sub-Plan (SCSP), Eastern Regional Station (ERS), Kalyani organized 17 veterinary camps in SC dominated areas in different villages of West Bengal and several animals were treated in these camps. Five training programmes on various aspects of agriculture and its allied sector were conducted for 617 farmers to uplift the socio-economic condition of scheduled caste farmers. Various inputs were distributed.

Infrastructure

- One new bore well with a new submersible pump was installed in the campus to meet the water supply demand.
- Boundary wall of the Institute was to enhance security in the Institute.
- A new HT armored cable was laid from main gate to substation in the campus to ensure trouble-free power supply
- A new passenger lift (15 passengers) was installed at the administrative building
- Rain water harvesting system with paver block was installed in Alaknanda Hostel.

Dr. Himanshu Pathak, Secretary DARE & DG, ICAR releasing Pearl Millet based Beverage (Bajra Lassi) on March 27, 2023


19वाँ दीक्षाँत समारोह
भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल–132001 (हरियाणा)
Dr. D. Sundaresan

1. INTRODUCTION

ICAR-National Dairy Research Institute (NDRI) at Karnal, Haryana is one of the premier Institutes in dairy sector. The Institute has contributed tremendously in the growth of the Indian dairy industry and played a crucial role in India's development in milk production with its continuous research. Over ninety-year-old, NDRI's lineage goes back to the Imperial Institute for Animal Husbandry & Dairying, which was set up in Bangalore in 1923 as a center for dairy education. It was shifted to its present site in Karnal in 1955 and renamed as National Dairy Research Institute. The infrastructure of Imperial institute was retained as Southern Regional Station of NDRI and later in 1964 Eastern Regional Station was set up at Kalyani in West Bengal. NDRI was brought under Indian Council of Agricultural Research in 1970. The Institute has been granted a Deemed University status for implementing its academic programmes since 1989. ICAR-NDRI has the unique distinction of having been ranked first among all Agricultural Universities and Deemed Universities consecutively five times in the years 2016-17, 2017-18, 2018-19, 2019-20 and 2020-21. The Institute has been accredited by National Agricultural Education Accreditation Board, ICAR up to 2021. The Institute also finds a place in the Special Mention Category of Institutions by National Institute Ranking Framework (NIRF), Ministry of Human Resources Development, Ranking (2018). The Institute is also ISO 9001: 2015 certified. The primary goal of the Institute is to provide R&D support towards generation and dissemination of knowledge for development of national milch herd, milk production enhancement; greater productivity of the dairy industry and upliftment of the dairy profession, leading to socio-economic and environmental benefits to the nation as well as contribution towards manpower development programme. This is a unique campus, which alongside Deemed University and residential buildings, has various well equipped research laboratories as well as green spaces with perennial plants and gardens. Well-equipped sports facilities and attractive leisure time opportunities are offered to the students and employees of the Institute.

Southern Campus, Bengaluru

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

Eastern Campus, Kalyani

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

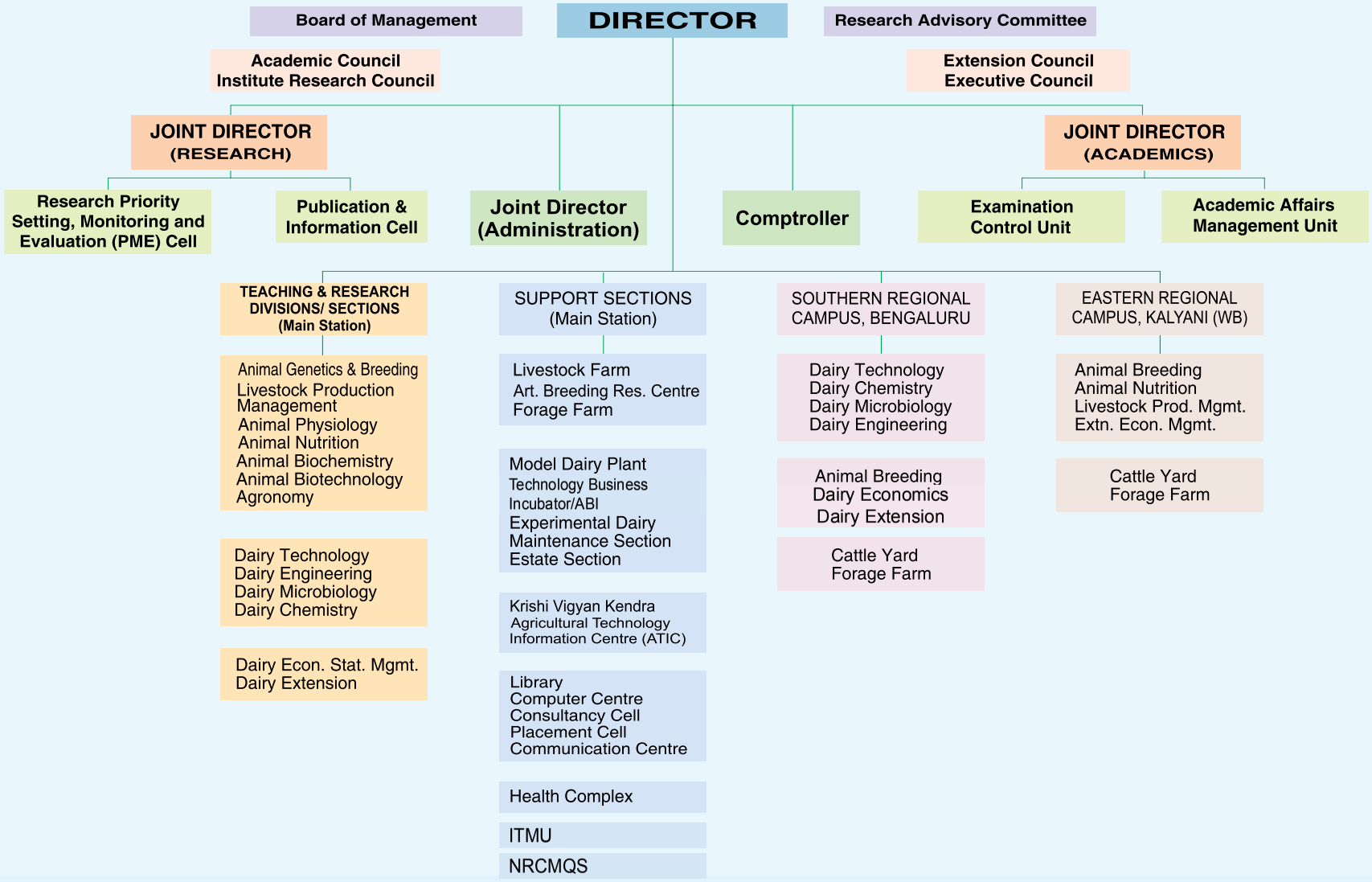
Krishi and Dairy Vikas Kendra, Piprakothi-Motihari

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

Model Dairy Centre, Lalukheri - Muzzafarnagar

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

Organizational Structure of NDRI



2. ORGANISATIONAL SETUP

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

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

The highest policy-making body is the Board of Management (BOM). The Director, NDRI, is the Chairman of this Board. The Research Advisory Committee (RAC) is responsible for the all-round progress in research at the Institute and its application. The Academic Council is responsible for all issues relating to 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 programs. The Institute Research Committee (IRC) is responsible for prioritization, monitoring and evaluation of research conducted in the Institute. The Executive Council is the main task-implementing body on Administrative matters and the powers and the function of this Council shall be those as may be delegated by the BOM. The research, education and extension activities of the Institute are managed by the Director and the Joint Directors through scientific, technical, administrative and supporting staff. The Director is the overall Administrative Head of the Institute and its Regional Stations. The Joint Directors in addition to extending support to the Director in the area of research, academics and administration are responsible to co-ordinate research and educational activities of various Divisions and Regional Stations, respectively. Each of the Regional Stations is administered through the Head located at the station. The scientific and teaching work at the main campus and its regional campuses is conducted in 15 subject-matter disciplines.

BOARD OF MANAGEMENT

Chairman	**Dr. Dheer Singh,** Director, ICAR-NDRI, Karnal
Member Secretary	**Sh. B. D. Phansal,** Joint Director (Admn.) & Senior Registrar, ICAR-NDRI
Members	
Dr. Rajan Sharma, Joint Director (Research), ICAR-NDRI	**Dr. A. K. Singh,** Joint Director (Academics), ICAR-NDRI
Dr. Triveni Dutt, Director, ICAR-IVRI, Izatnagar, Uttar Pradesh	**Dr. Anupam Mishra,** Vice-Chancellor, CAU, Imphal, Manipur
Dr. Inderjeet Singh, Vice-Chancellor, GADVASU, Ludhiana, PB	**Dr. Umesh Rai,** Vice Chancellor, Jammu University, Jammu
Dr. A. K. Puniya, PS, Dairy Microbiology Division, ICAR-NDRI	**Dr. A. K. Dang,** Head, Animal Physiology Division, ICAR-NDRI
Dr. P. Barnwal, Head, Dairy Engineering Division, ICAR-NDRI	**Dr. Suneel Kumar Onteru,** Head, Animal Biochemistry Division, ICAR-NDRI
Dr. Shilpa Vij, Academic Coordinator & Head, Dairy Microbiology Division, ICAR-NDRI	**Dr. Gopal Sankhala,** Head, Dairy Extension Division ICAR-NDRI
Dr. Manmohan Singh Chauhan, Vice Chancellor, GBPUAT, Pantnagar, Uttarakhand	**Dr. Ashok Kumar,** Assistant Director General (Animal Health), ICAR, Krishi Bhavan, New Delhi
Dr. A. K. Singh, Director, IARI, Pusa Campus, New Delhi	**Dr. Abhijit Mitra,** The Animal Husbandry Commissioner , Govt. of India, Department of Animal Husbandry & Dairying, Krishi Bhawan, New Delhi
Sh. D. D. Verma, Sr. Comptroller, IARI, Pusa Campus, New Delhi	**Commissioner,** Rohtak Division, Rohtak
Sh. Teg Singh Rana, Village & Post Office – Arainpura, H.No.645, Block-Gharounda, Distt. Karnal	**Sh. Sugriv Singh Chauhan,** Gram-Manouna, Post-Pinahat, Block-Pinahat, Tehsil-Bah, 152, Parshavnath, Panchvati, Fatehabad Road, Agra

RESEARCH ADVISORY COMMITTEE

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Member Secretary	**Dr. Rajan Sharma,** Joint Director (Research), ICAR-NDRI
Members	
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Dr. V. K. Saxena, Director (Research), BASU, Patna, Bihar	**Dr. Pratap Singh Birthal,** Director, ICAR-NIAP, New Delhi
Dr. Kusumakar Sharma, Ex-ADG (HRM), Education Division, Krishi Anusandhan Bhawan-II, New Delhi; H.No. D-5073, ATS Greens Paradise Sector-Chi-IV, Greater Noida	**Sh. S. S. Mann,** Founder, Mann Ventures Faridabad (Haryana) (Dairy Industry Partner)

ACADEMIC COUNCIL

Chairman	**Dr. Dheer Singh,** Director & Vice Chancellor, ICAR-NDRI
Vice Chairman	**Dr. A. K. Singh,** Joint Director (Academic)
Member	**Dr. Rajan Sharma,** Joint Director (Research)
Members	
Dr. Triveni Dutt, Director & Vice Chancellor, IVRI, Izatnagar, UP	**Dr. R. C. Agrawal,** Deputy Director General (Education), ICAR
Dr. Kusumakar Sharma, Former ADG (HRD), 05073, ATS Greens Paradiso, Sector Chi 04. Greater Noida, UP	**Dr. Naveen Prakash Singh,** Member (Official), CACP, 382 B, Krishi Bhawan, New Delhi
Sh. B. D. Phansal, Joint Director (Admn.) & Senior Registrar, ICAR-NDRI, Karnal - Member Secratery	**Dr. Suneel Onteru,** Head, Animal Biochemistry Division
Dr. Vivek Sharma, Head, Dairy Chemistry Division	**Dr. Deep Narayan Yadav,** Head, Dairy Technology Division
Dr. A. K. Dang, Head, Animal Physiology Division	**Dr. Gopal Sankhala,** Head, Dairy Extension Division
Dr. Subhashis Mandal, Head Dairy Economics Statistics & Management Division	**Dr. P. Barnwal,** Head, Dairy Engineering Division
Dr. Shilpa Vij, Head, Dairy Microbiology Division	**Dr. A. K. Samanta,** Head, Animal Nutrition Division
Dr. Jai Kaushik, Head, Animal Biotechnology Division	**Dr. Vikas Vohra,** Head, Animal Genetics & Breeding Division
Dr. Anurag Saxena, Incharge Forage Research & Management Centre	**Dr. Pawan Singh,** Head, Livestock Production & Management
Dr. Santanu Banik, Head, ERS of NDRI, Kalyani	**Dr. Arindham Dhali,** Head, SRS of NDRI, Bangalore
Dr. A. K. Dixit, Controller of Examination	**Dr. Anjali Aggarwal,** Academic Coordinator
Dr. Suman Kapila, Principal Scientist Animal Biochemistry Division	**Dr. B. S. Meena,** Principal Scientist, Dairy Extension Division
Ms. Ozal Singh, Master Topper	**Dr. Gopal Gowane,** Senior Scientist Animal Genetics & Breeding Division
Ms. Sravani, PhD Topper	

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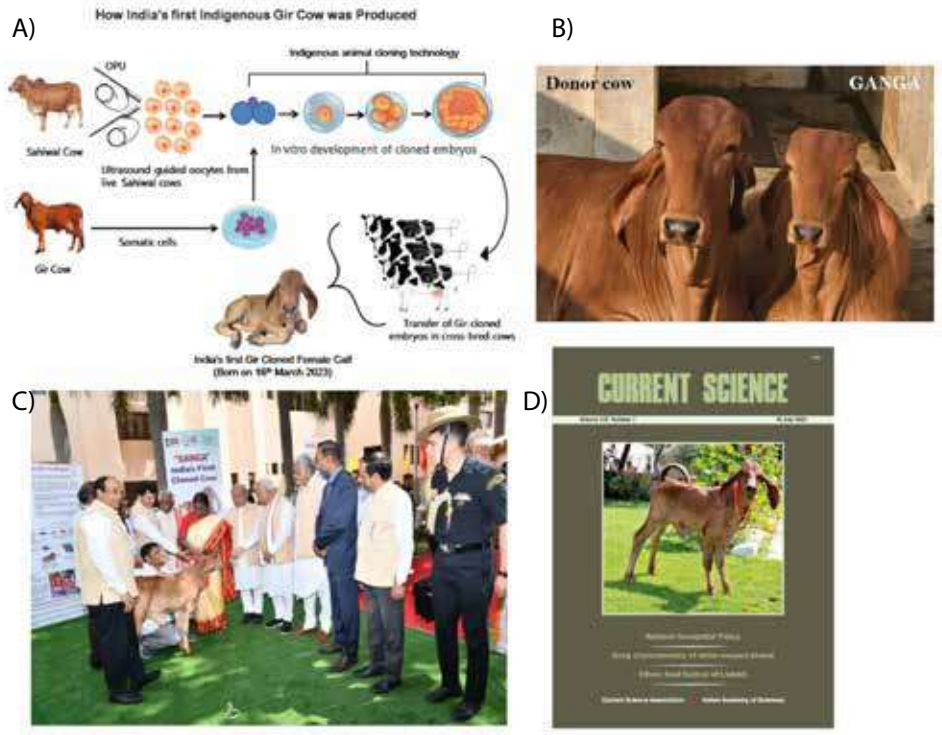
DDG (Extn. Education), ICAR, New Delhi or his nominee	**Dr. A. K. Misra,** In-charge, LPM Section, ICAR-National Dairy Research Institute, Karnal, Haryana.
Principal Scientist, DC Division ICAR-National Dairy Research Institute, Karnal, Haryana.	**Dr. R. Malhotra,** Head, DES&M Division ICAR-National Dairy Research Institute, Karnal, Haryana.
Dr. Suneel Onteru, Principal Scientist, ABC Division ICAR-National Dairy Research Institute, Karnal, Haryana.	**Dr. Pawan Singh,** In-charge ABRC ICAR-National Dairy Research Institute, Karnal, Haryana.
Dr. S. De, In-charge ABTC ICAR-National Dairy Research Institute, Karnal, Haryana.	**Dr. Kaushik Khamarui,** In-charge BPD Unit ICAR-National Dairy Research Institute, Karnal, Haryana.
Dr. A. K. Dang, Head, Animal Physiology ICAR-National Dairy Research Institute, Karnal, Haryana.	**Dr. Santanu Banik,** Head, ERS ICAR-National Dairy Research Institute, Kalyani, Nadia, West Bengal

3. RESEARCH ACHIEVEMENTS

BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY

GANGA: India's first cloned indigenous cow

Indigenous breeds like Gir, Sahiwal, Tharparkar, and Red-Sindhi are pivotal for India's dairy industry. However, the low productivity of Indigenous cows (3 to 4 kgs per day) is a major challenge for sustainable milk production. Globally, to produce quality animals, the application of assisted reproductive technologies has given satisfactory results. Among the several reproductive technologies, animal cloning can play a key role in faster multiplying elite animals and the conservation of endangered breeds. In this direction, ICAR-National Dairy Research Institute (NDRI) has initiated the work on the cloning of indigenous cows such as Gir, Sahiwal, and Red Shindi. Cattle cloning for multiplication and conservation of indigenous cows remains a challenging task due to the complexity involved in the cloning techniques. In the current investigation to produce cloned cow, oocytes were isolated from live Sahiwal cows using ultrasound-guided needles, and then, matured for 24 h under control conditions. The somatic cells of the Gir cow were used as donor genomes, which are fused with OPU-derived enucleated oocytes. Following chemical activation and in-vitro culture, the embryos are developed to the blastocyst stage which is then transferred into recipient mothers and after 9 months, a cloned calf was born and it was named as GANGA. Cattle cloning research carried out at the NDRI has potential to reach this advanced technology at farmers' doors for enhancing the productivity of their dairy animals which will lead to future sustainable milk production in the country.



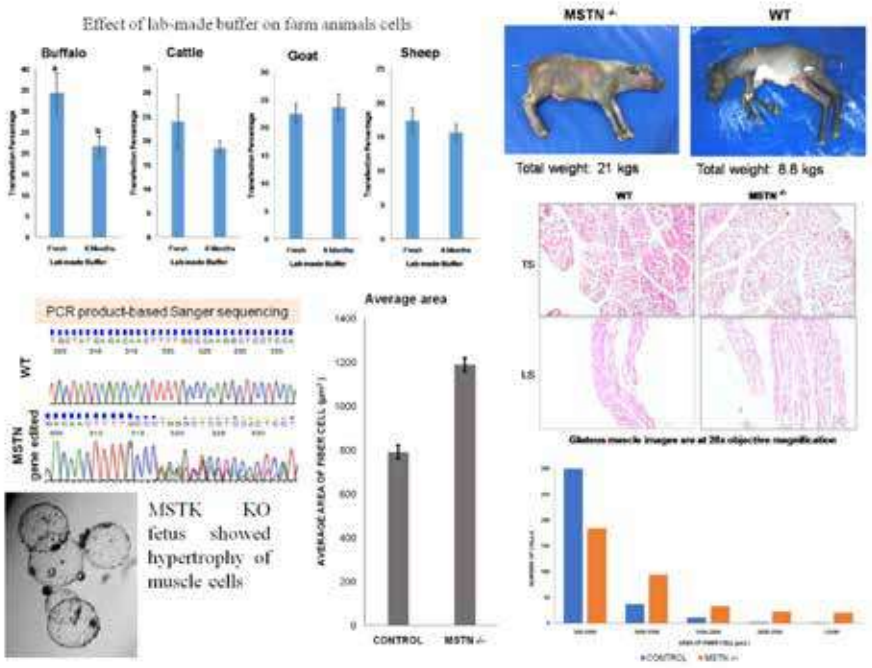
India's first cloned cow named GANGA*: A) Method used to produce cloned cow; B) Donor cow and Ganga (identical genotype and phenotype to donor cow); C) Hon'ble President of India, Smt. Droupadi Murmu Ji with GANGA and dignitaries; D) Current Science, India's prestigious journal, covered GANGA on its cover page*

Curcumin ameliorates heat stress and improves the efficiency of *in vitro* embryo production

Curcumin plays important role in cell homeostasis. Therefore, its anti-oxidant property was used for regulation of ROS level in embryo culture medium either under normal physiological or heat-stresses conditions. To prove this, immature oocytes (n=1330) were isolated from slaughterhouse-based buffalo ovaries and were subjected to *in vitro* maturation (IVM), fertilization (IVF), and culture (IVC) in presence of a different concentration of curcumin in culture media at 38.5°C and in combination with curcumin doses and heat stress (39.5°C) to presumed zygote for 2 h once after 48 h of IVF. The cleavage rate was found to be significantly higher ($P<0.05$) at 5 µM curcumin (64.11 ± 1.15%) compared to control (58.75 ± 2.25%) or 10 µM of curcumin (44.66 ± 4.28%) at 38.5°C. When these cleaved embryos were further cultured till the blastocyst stage, we found a significant increase ($P<0.05$) with 5 µM curcumin (21.46±0.67%) compared to 10 µM (6.50 ± 1.17%) and control (16.63 ± 1.49%), respectively. Similarly, superior cleavage and blastocyst rates were observed in curcumin supplemented groups at 39.55°C ($P<0.05$). Based on gene expression study, we found that at 38.5°C, the expression of HSP genes significantly ($P<0.05$) reduced when adding the curcumin, but at the higher temperature, both the HSP10 and HSP60 genes were highly up-regulated ($P<0.05$). At both temperatures, all anti-oxidant-related genes SOD2, SOD3, GPX1 and GPX2 had higher expression in presence of 5 µM curcumin compared to 10 µM or control. In conclusion, this study suggested that curcumin supplementation in embryo culture medium effectively combated the adverse effects of heat-stress and supports the embryo production *in vitro*.

Production of gene knock out buffalo calf

The CRISPR/Cas9 system and somatic cell nuclear transfer (SCNT) technologies have been utilized to knockout the myostatin (MSTN) gene, which is a potential inhibitor of muscle growth and development. The buffalo fibroblast's genome was modified using CRISPR to target the MSTN gene. Following stringent selection processes, six single-cell clonal populations were established, of which one displayed biallelic heterozygous MSTN gene modifications. These edited cells were then employed to develop blastocyst-stage embryos using handmade cloning techniques. The produced embryos were transferred into recipient animals leading to establishment of three pregnancies. However, two of the fetuses were aborted. Histological analysis of an aborted fetus (5 months old) showed that myofiber diameter of MSTN knock out (KO) fetus was bigger than that of control fetus. This achievement marked a significant milestone, laying the groundwork for generating genome-edited buffalo models to improve production traits, particularly in dairy animals in India.



Development of pipeline for production of MSTN-gene edited buffalo

Production of beta-lactoglobulin (BLG)-gene knock out cloned embryos of buffalo

The current study was carried out to establish beta-lactoglobulin (BLG) knockout cell clones, and the production of beta-lactoglobulin (BLG)-gene edited embryos. To achieve our aims, 3 sgRNAs against the BLG locus of buffalo were designed, and their editing efficiency was determined using Sanger sequencing followed by TIDE and ICE analysis. Among 3 sgRNAs, most efficient sgRNA was used to generate the clonal population of edited cells. Several single-cell clones were established and screened using the TA cloning and Sanger sequencing methods. Out of 14 single-cell clones screened, 8 were found to have BLG gene disruption events (57% editing rates). The cloned blastocyst stage embryos from 4 BLG-gene disrupted clonal cells were produced using the SCNT. The cloned blastocyst production rates (25 to 30%) were similar to non-edited control cells. Efforts are ongoing to establish pregnancies from BLG- knock out cloned embryos. This work can lead to generation of the designer buffaloes for the production of hypoallergenic milk for human benefits.

Sequencing of exon 1 of β-lactoglobulin gene of Karan Fries cattle and designing of CRISPR/Cas9 mediated sgRNAs for knockout of the β-lactoglobulin gene

The fibroblast cells of Karan Fries cattle were isolated and cultured. The genomic DNA was isolated from fibroblast cells of Karan Fries cattle using QIAGEN DNeasy Blood & tissue kit. Exon 1 of the β-lactoglobulin gene of the Karan Fries was amplified by using gene specific primers. The amplified PCR product was cloned in pJET1.2 blunt cloning vector. Sequence of the exon 1 of the β-lactoglobulin gene was confirmed by Sanger sequencing. Four SNPs at 27bp, 31bp, 73bp, and 94bp were detected in the exon 1 of β-lactoglobulin gene of Karan Fries as compared to exotic cattle (reference sequence). Four different sets of sgRNAs (single guide RNA) were designed against the β-lactoglobulin gene of cattle using CRISPR designing tools (Chopchop and GeneArt). These sgRNA were annealed and cloned in *BbsI* digested vectors (pX458 and pX459, Addgene). Orientation of the DNA clones were confirmed by colony PCR using HU6F (forward) and sgRNA specific (reverse) primers. The orientation of β-lactoglobulin mediated CRISPR vectors were confirmed through Sanger sequencing.

Genotyping of A1/A2 allele of beta casein gene and designing of CRISPR/Cas9 mediated sgRNAs for targeting A1/A2 allele of cattle

Blood samples from the female Karan Fries (crossbred) and Holsten Frisian cattle were collected from nearby villages of Karnal district. DNA was isolated from blood using QIAGEN Blood & Tissue kit. Genotyping of A1/A2 allele was performed by using PCR-PFLP technique. The PCR product was amplified from exon 7 of the β-casein gene and it was digested with *TaqI* restriction enzyme. After digestion, individuals showed the A1A1 (213bp, 38bp), A1A2 (251bp, 213bp), and A2A2 (251bp) genotypes, although all individuals have 116 bp as common band. Out of 13 Karan Fries individuals, one individual was found as A1A1, six were A1A2 and six were A2A2 types. Genotyping of A1/A2 allele was performed by AS-PCR technique. Among 11 Holsten Friesian, one individual was found as A1A1, five were A1A2 and five were A2A2 types. Overall genotypic frequencies of A1A1, A1A2 and A2A2 were as 8.3%, 45.8% and 45.8%, respectively. Some allele frequencies of A1 and A2 allele were observed to be 0.32 and 0.68, respectively. Amplified PCR product of beta casein derived from A1A1 individual was cloned in pJET1.2 blunt cloning vector. An A1 allele was confirmed through Sanger sequencing. Ear pinna of the A1A1 female Karan Fries and Holstein Frisian cattle was retrieved. The fibroblast cells from cattle were isolated, cultured and cryopreserved. Further, four different sets of sgRNAs targeting A1/A2 allele of beta casein gene were designed and they were cloned in *BbsI* digested vectors (pX458 and pX459, Addgene). The orientation of the CRISPR vectors were confirmed through colony PCR and Sanger sequencing.

Mesenchymal stem cells for curing animal wounds: An application towards regenerative medicine

Wounds in cattle and buffaloes are responsible for reduced milk production, subfertility, and lower reproductive efficiency. The present study was aimed to cure and prevent the wounds of cattle using umbilical cord blood-derived mesenchymal stem cells (UCB-MSCs). MSCs in animals induce release of anti-inflammatories, immunomodulatory, and anti-microbial cytokines, which kill the bacteria and regenerate the injured tissues and wounds of the animals. The umbilical cord blood-derived mesenchymal stem cells (UCB-MSCs) were isolated from a cow at NDRI Karnal. MSCs were cultured *in vitro* conditions in a CO_2 incubator and cryopreserved these cells and further revived treatment of the animals. The MSCs were characterized as per the guidelines of the International Society for Cellular Therapy. The MSCs were also further differentiated *in vitro* conditions

into adipogenic, chondrogenic, neurogenic, and osteogenic lineages. Allogeneic UCB-MSCs dose @ 5x106 cells were injected both locally and through intravenous injection (1 ml, each). The results of treatment using MSCs were very encouraging; all the massively wounded bulls were cured properly within a month. In conclusion, MSCs of umbilical cord blood cured the wounds in many animals completely within a month. These convincing results clearly indicated that MSCs have high potential to clear the large wounds in animals and could help in enhancing the productive performance and health of dairy animals.

The navel cord of a Sahiwal bull was severely wounded, swollen, and extended (left side). The Umbilical cord blood-derived mesenchymal stem cells treated bull and wounded area of the bull was cured within a month (right side)

Redesigned biologically active small-size Mucus-binding protein showed anti-adhesion activity against *Salmonella*

Mucus-binding protein (Mub) of *L. reuteri* is a large size protein of 354 kD. It is constituted of repetitive Type 1 and Type 2 domains each of approximately 200 amino acid in size. To explore the role of individual Mub domain, differences in the activity of two types of domains, and why nature selected repetitive domain structure, we cloned Type1-Type2 (T1T2) domains in pET vector and expressed in *E. coli*. The expressed protein was purified by using affinity chromatography. The purified protein T1T2 was used in an *in vitro* cell model against Salmonella infection. The cell binding assay suggested that T1T2 Mub protein was able to exclude Salmonella by >80% in comparison to a negative control (PBS). The preliminary results suggested that the small size Mub protein constituted of only two domains also possessed cell binding efficacy to preclude the binding of pathogens, which also share similar set of cell receptors as lactic acid bacteria. The small size Mub proteins might be used to fight pathogen infection in place of whole cell probiotics.

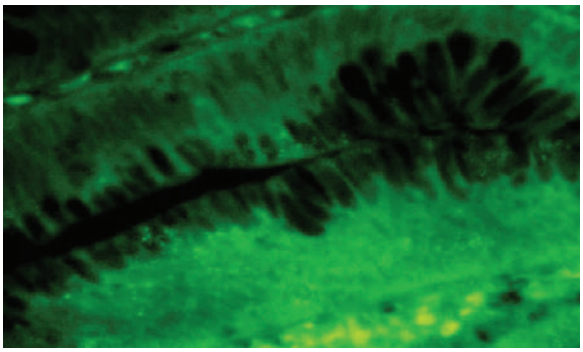
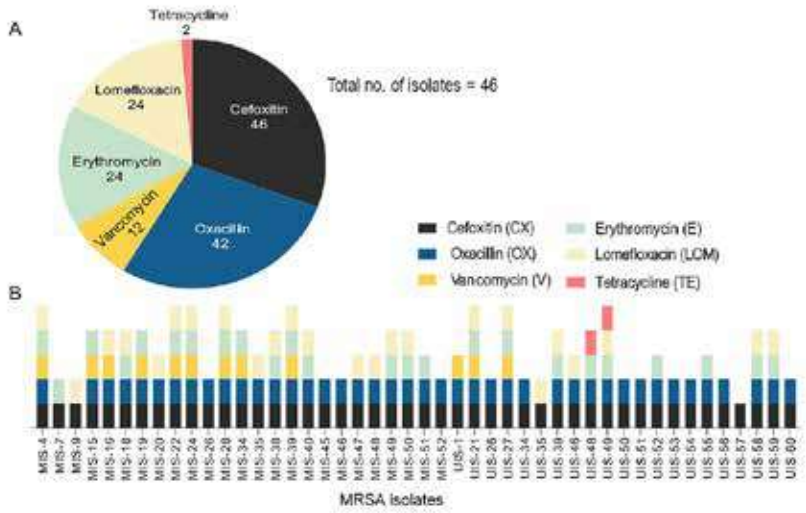


Figure shows the binding of T1T2 Mub protein to intestinal tissue. The immunofluorescence in green color (FITC) indicates the Mub protein binding to tissue.

Presence of methicillin-resistant *Staphylococcus aureus* (MRSA) isolates in bovine mastitis

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a pathogen that poses a significant threat in the outbreak of chronic mastitis in dairy animals. The ability of MRSA to persist in the host is attributed to various virulence factors, genes encoding surface adhesins, and determinants of antibiotic resistance, which provide it a survival advantage. This investigation focused to determine the virulence factors, antimicrobial resistance (AMR) profile and biofilm production potential of 46 MRSA isolates from 300 bovine mastitis milk samples. The study also evaluated various virulence factors/genes such as coa (n=46), nuc (n=35) hlg (n=36), pvl (n=14), tsst-1(n=28) spa (n=39) and enterotoxin genes sea (n=12) and seg (n=28) and identified antibiotic resistance determinants mecA and blaZ in 46 and 27 isolates, respectively. Intercellular adhesion genes icaA and icaD were present in 40 and 43 isolates, respectively and surface adhesion genes ebps, fnbpA, eno, sasG, cna, and bap were found in 43, 40, 38, 26, 21 and 1 isolates, respectively. Microtiter plate (MTP) assay revealed that 29 MRSA isolates were capable of producing biofilm, whereas 17 were not. Biofilm producing MRSA isolates possessed adhesion genes, virulence

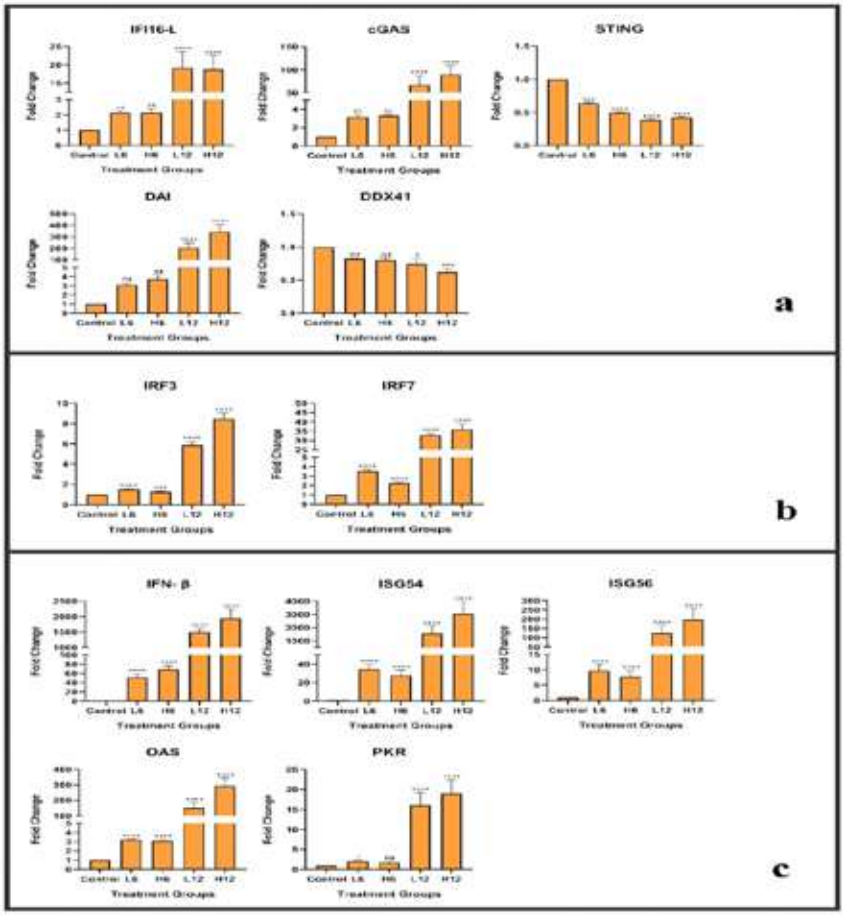
factors, toxin genes and AMR genes that may act synergistically towards a chronic disease progression, illness and severe damage to the udder, which generally persist for several months and very challenging to cure.



Antibiotic resistance profiling: a Pie chart illustrates comprehensive profile of antimicrobial resistance of 46 MRSA isolates. b Antibiotic susceptibility profiles of each 46 MRSA isolates determined by disc diffusion method. The colour code indicates resistance against respective antibiotic

Poly(I:C), a double stranded RNA analog, activates the anti-viral DNA sensors in buffalo fibroblasts

Polyinosinic:polycytidylic acid or poly(I:C) is a double stranded RNA analog that is known for stimulating RNA sensing pathways in a variety of cell culture and animal models. Activation of nucleic acid sensing pathways lead to the up-

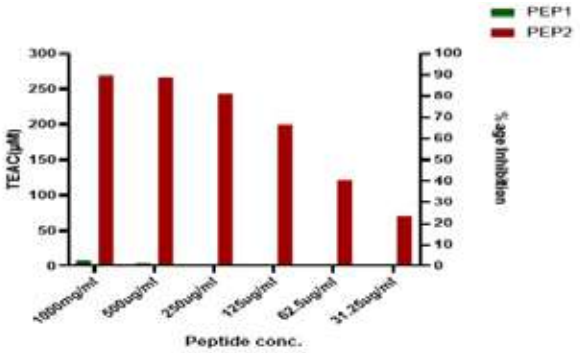


The relative expression of intracellular DNA sensing pathway genes in BFFs. The graphs represented in the figure have been categorized into a. DNA sensors, b. Transcription factors and c. Interferon and ISGs. The values corresponding to the asterisks are mentioned hereafter-0.1234 (ns), 0.0332 (*), 0.0021 (**), 0.0002 (***) and <0.0001 (****).

regulation of Interferon-β which ultimately creates an antiviral state in the host. mRNA expression of DNA sensors cGAS, IFI16-L (IFI16-like) and DAI are elevated while DDX41 and STING are down-regulated in poly(I:C) treated cells. However, STING activation is evident in poly(I:C) treated cells through the formation of aggregates around the nucleus. IFI16-L also aggregates like STING and translocates itself from the nucleus to the cytoplasm in response to poly(I:C). The activation of DNA sensors by a dsRNA mimic indicates that mammalian cells can use their own molecules for defending themselves against pathogenic RNA viruses. This study provides an opportunity to search for novel therapeutic targets against RNA viruses that evade detection by canonical pattern recognition receptors.

Characterizing milk colostrum of Ladakhi cows and yak for identification of biomolecules with therapeutic potential

The study was conducted to investigate the milk and colostrum of yak for identification of biomolecules with therapeutic potential by high throughput proteomics. Subsequent to LC-MS/MS analysis, the identified sequences were predicted *in silico* for the immunomodulatory activities using different bioinformatics tools and selected sequences were synthesized chemically. Synthesized sequences were assessed for the antioxidative activity and one of the peptide sequences was found to possess about 85% of antioxidative activity. The cytotoxic effect of synthesized peptide sequences was determined by MTT cell viability test. Cell proliferation assay was performed to assess the anti-inflammatory effect of synthesized sequences. The results showed that the peptides exhibited proliferation effect on the cell line against the untreated control. The IgG has been purified from Ladakhi yak colostrum by affinity chromatography employing Protein G column.



Antioxidant activity of synthesized peptides using ABTS assay

Exploring the antimicrobial potential of urine-derived peptides from Murrah buffalo

Antimicrobial peptides hold promising activities against disease causing bacterial pathogens. Murrah buffaloes' urine from three physiological states *vis-a-vis* heifer, pregnant and lactating animals were studied for their antimicrobial activities. Mass Spectrometry was used to profile these urine-derived peptides. Three peptides viz.,1778, 1509 and 1898 were identified from heifer, pregnant and lactating group, respectively. The crude peptide extract was used to check for their bactericidal activity against *E. coli* and *S. aureus* by disc diffusion method. *In silico* revealed several peptides possessed multiple bioactivities such as anticancer, anti-inflammatory, antihypertensive and antimicrobial activities. Out of these peptides, four peptide sequences with high antimicrobial activities score were selected and synthesized. Minimum inhibitory concentration (MIC) assay was determined for these synthesized peptides against *E. coli* and *S. aureus*. The peptides IV-18, AL-14, LL-15 and GL-19 showed MIC of 62.5, 15.62, 15.62 and 31.25 µg/ml, respectively for *E. coli*. MBC values were same as that of MIC for all the three peptides. Peptides were thereafter checked for their toxic effect on red blood cells and BuMec cell line with varying peptides concentration of 200-6.25 µg/ml. Peptides seemed safe on RBCs as the hemolysis was below 4%.

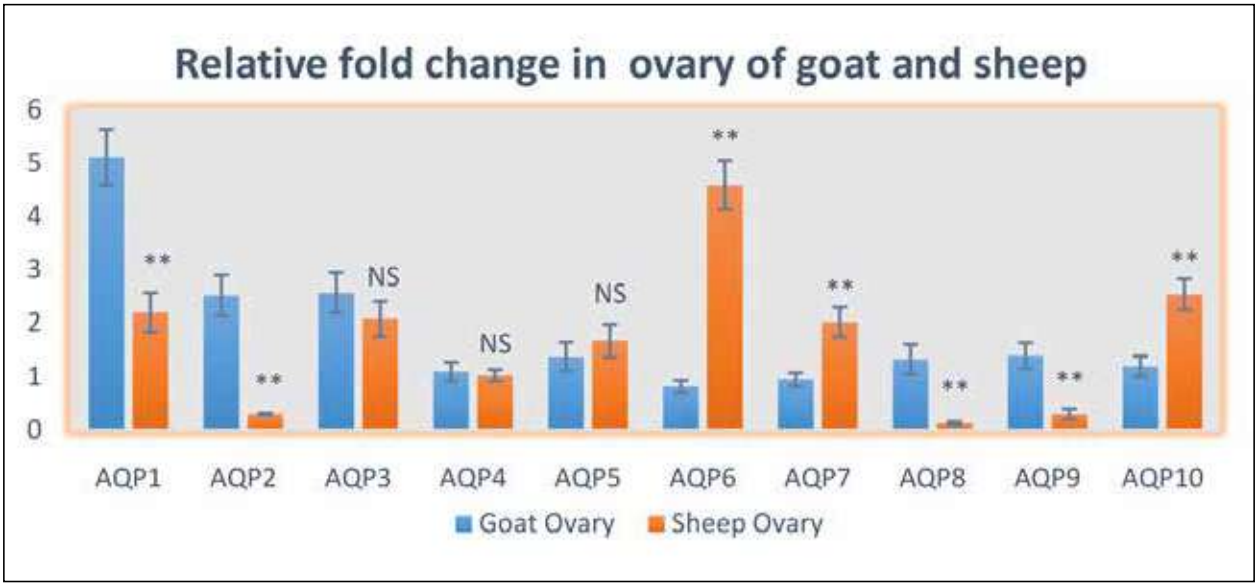
Antimicrobial susceptibility test against S. aureus. Zone of clearance indicates degree of inhibition of bacteria by peptides extract. BSA was used as a negative control (well shown in centre)

Mitochondrial DNA D-Loop SNPs unveil molecular signatures of milk production variation in Murrah Buffalo

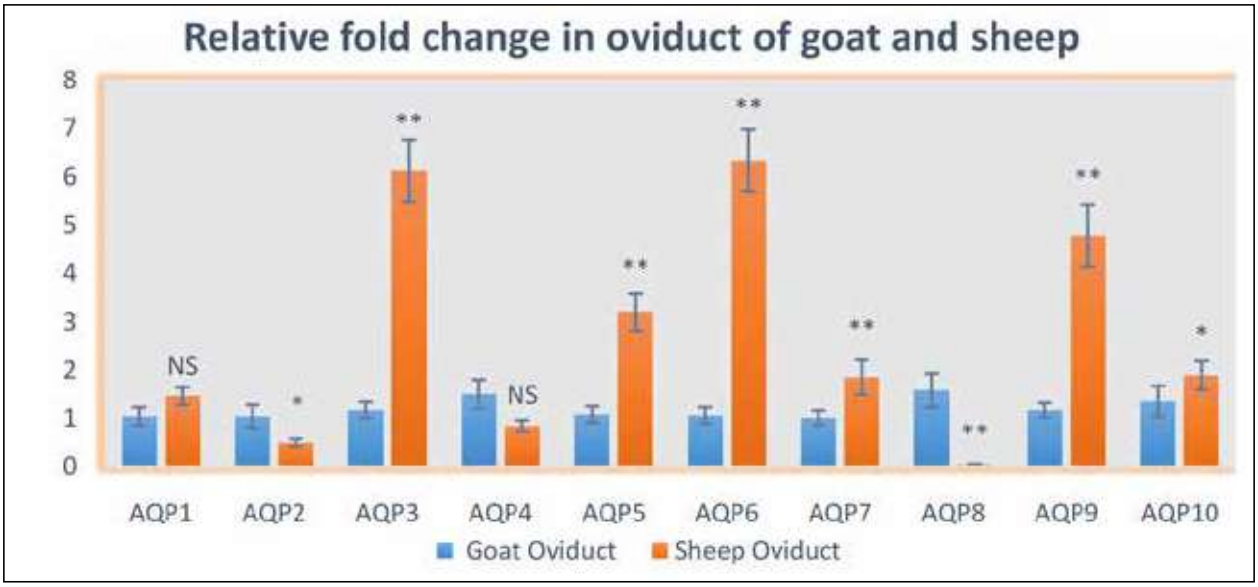
This study systematically investigates mitochondrial DNA (mtDNA) D-loop variations as prognostic markers for milk production variability in Murrah buffaloes. Bovine mtDNA, a circular genome crucial for the energetically demanding lactation process, heavily depends on the D-loop—a mutation-prone segment. Milk samples from 50 Murrah buffaloes underwent thorough analysis for milk yield, fat, and protein percentages over 30 days, categorized into low (group 1), medium (group 2), and high Energy Corrected Milk (ECM) (group 3) groups. Somatic cells were meticulously isolated and subjected to mtDNA D-loop analysis, revealing discernible genetic variations. Notably, group 2 showed an increased prevalence of SNPs, and group 3 exhibited more insertions and deletions. Group 1 displayed a higher frequency of transitions, while Group 3 had a greater proportion of transversions. A consistent "C" deletion at the 714th position was observed in groups 1 and 3, prevalent in 68% of group 2. Additionally, a G-A variation at the 93rd position was specifically associated with the medium ECM group. Negative Tajima D values identified unique variations in each group, with group 1 demonstrating the highest count. This study revealed that in Murrah buffaloes, diverse cytoplasmic backgrounds influence mtDNA D-loop variations, impacting replication and serving as markers for energy efficiency. The exploration holds promise for enhancing milk production and optimizing genetic traits in this pivotal breed.

Comparative Studies in immunohistochemistry, localization and gene expression of aquaporins in reproductive system between ovine and caprine

To test the expression and localization of aquaporins AQP1-10 goat and sheep in reproductive tract to explore the distribution of aquaporin and the comparison between two species the study was carried out. Real-time polymerase chain reaction and immunohistochemistry were used to determine AQP1-10 expression levels and localization in the reproductive tract of goat and sheep. Hormonal estimation was also carried out to assess the reproductive status. AQP1, AQP2, AQP8, and AQP9 were found significantly ($p<0.01$) higher in goat reproductive tract compared to sheep while, AQP3, AQP4, AQP5, AQP6, AQP7, and AQP10 were found to be significantly ($p<0.01$) higher in sheep compared to goat reproductive tract. The analysis revealed immunoreactivity was observed in granulosa cells of developing follicles. Immunohistochemistry revealed localization of AQPs granulosa cells of developing ovarian follicles, germinal epithelium and tunica albuginea in the ovary while muscle cells, luminal epithelial cells and lamina propria of the oviduct. In the uterus, localization at uterine epithelia cells and uterine gland at the endometrium was observed. Moreover, these results suggest that several subtypes of the AQPs (AQP1-10) are involved in the regulation of water homeostasis in the reproductive system of goats and sheep.



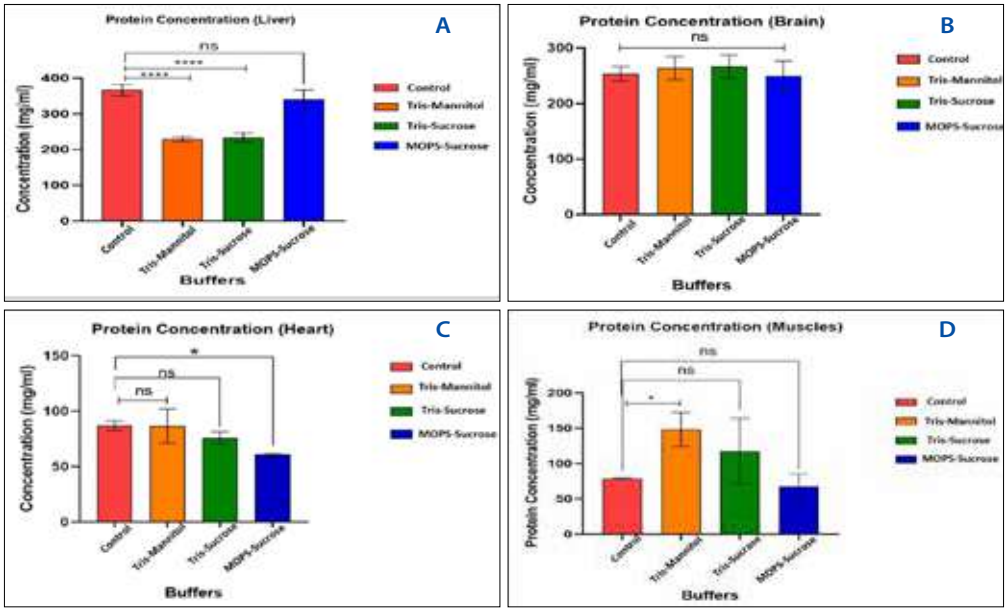
Relative gene expression levels ($2^{-\Delta\Delta CT}$) of AQPs in the ovary of sheep compare to goat {Bars with asterisk (*) varies significantly ($p<0.05$)}



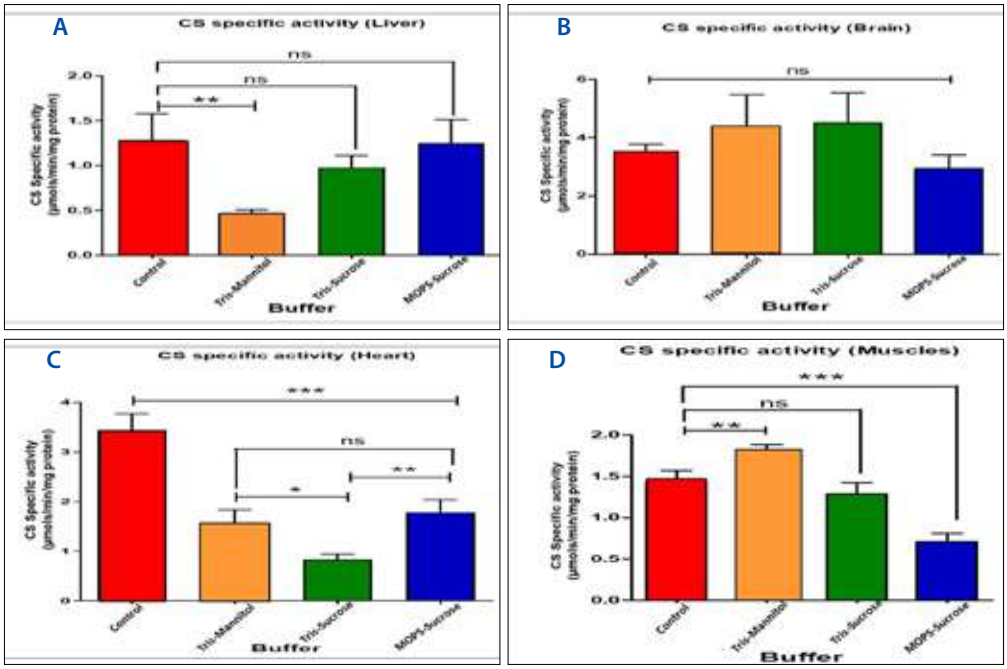
Relative gene expression levels ($2^{-\Delta\Delta CT}$) of AQPs in the oviduct of sheep compared to goat {Bars with asterisk (*) varies significantly($p<0.05$); Bars with asterisk (**) varies highly significantly($p<0.01$)}

Optimizing buffers for mitochondrial isolation in Indian buffalo uncovers tissue-specific variations and provides insights into functional assessments

This study aimed to address gap by isolating and meticulously studying functional mitochondria in buffalo. By employing proven conventional buffers for mitochondria isolation from rodent and human tissues. The evaluation was done to understand their effectiveness specifically in buffalo tissues. The study isolated mitochondria from buffalo tissues (liver, brain, heart, and muscles) of slaughtered buffalo (n=3) using three different buffers (Tris-Mannitol, Tris-Sucrose, and MOPS-Sucrose) and compared their efficiency to Cayman's MitoCheck® Mitochondrial Isolation Kit. The evaluation included assessing mitochondrial purity and functionality through protein concentration and marker enzyme assays. The findings unveiled tissue-specific variations in buffer effectiveness, highlighting MOPS-Sucrose's optimal performance for soft tissues (liver and brain) and Tris-Mannitol's efficiency for hard tissues (muscles and heart). This emphasizes the crucial role of buffer composition in enhancing the isolation of high-quality, functional mitochondria in buffalo.



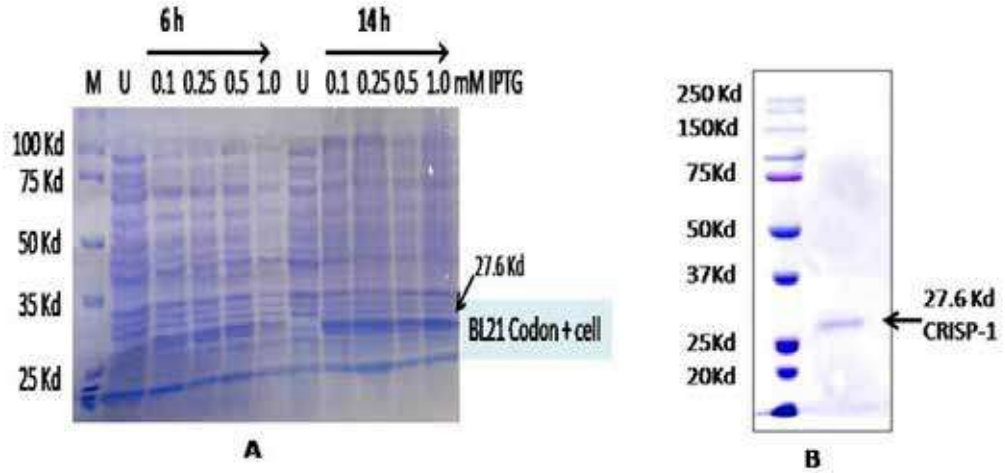
Total Protein Concentration (mg/ml) in mitochondria pellets of (A) Liver, (B) Brain, (C) Heart, (D) Muscle tissues obtained from control, Tris-Mannitol, Tris-Sucrose and MOPS-Sucrose buffer



Comparative analysis of Citrate Synthase (CS) specific activity in the mitochondrial suspension of (A) Liver, (B) Brain, (C) Heart, (D)Muscle tissue obtained from control, Tris-Mannitol, Tris-Sucrose and MOPS-Sucrose buffer

Production of recombinant buffalo CRISP-1 protein in *E. coli* and its functional characterization

Cysteine-rich secretory protein 1 (CRISP-1) is an acidic glycoprotein of epididymal plasma and is known to act as a decapacitation factor that acts in a reversible manner. Hence, adding CRISP-1 protein in the semen extender would prevent premature sperm capacitation during semen preservation and better maintain sperm quality. The 687 bp length buffalo CRISP-1 gene was cloned into the pET22b vector and recombinant buffalo CRISP-1 protein (27.6 kDa) was expressed in E. coli BL21 (DE3) cells in an insoluble form. Refolding of the protein by dialysis resulted in solubilisation and the protein showed bioactivity. The protein caused about 50% inhibition of sperm motility at 20 µg/mL concentration. The protein also reduced sperm capacitation and protein tyrosine phosphorylation and was non-toxic to sperm.



SDS-PAGE analysis of recombinant buffalo CRISP-1 protein produced in E. coli BL21(DE3) codon plus cell. ***A:*** *Protein expression under different IPTG levels and induction time,* ***B:*** *Purified protein fraction after Ni-NTA affinity chromatography purification*

GENETIC IMPROVEMENT OF DAIRY ANIMALS

A Milestone in Cattle Breeding: Introduction of sex-sorted semen technology at NDRI

The sex sorting of semen samples from two breeding bulls of high genetic worth was carried out having Dam's best yield of more than 4000kg/ 305 d milk yield. The insemination from the sex-sorted semen was started from Dec 2022 onwards. To date, 4 female calves were born out of 4 calving taking place. A total of 107 heifers were inseminated and 47 have confirmed the pregnancy diagnosis till Dec 2023.

Sahiwal female calves born using sexed semen

Breed Improvement Program of Murrah Buffalo (Institutional herd)

The progeny testing programme in the Murrah herd was followed for the test mating of the 20th set of bulls. Semen was collected from 10 bulls of the 20thset and three proven bulls from the 15th set were used, (bull no. 4354, 2459, and 6007). The dam's best lactation 305-day milk yield of bulls of NDRI under the 20th set had ranged from 3203 to 4814 kg. The performance parameters for the NDRI herd included that the average age at first calving of buffaloes was 42.4 months. The average service period of buffaloes has been estimated as 118.50 days. The overall female conception rate in the herd was 48.46% for the buffaloes inseminated during Jan-Dec, 2022. The overall mortality (0-3 months) during the year was only 3.77%. The wet and herd average was 7.80 and 4.7 kg, respectively. The average Milk Fat, SNF, Total Solid, Protein, and Lactose were estimated as 8.46 ± 0.11, 10.06 ± 0.04, 18.53, 3.2 and 5.61%, respectively.

About 07 Murrah buffaloes were identified as elite animals and were used in nominated mating. The average best lactation milk yield of elite Murrah buffaloes was 2936 kg which was 24.72% higher than the herd average. The best lactation milk yield of elite Murrah buffaloes ranged between 1542.5 kg to 3312.5 kg in 305 days. A total of 2,24,963 kg of milk was produced by an average of 87 milch buffaloes. Based on the 15th set evaluation results (across all the coordinating units), Bull no. 6007 from NDRI ranked second and was declared as a proven bull and selected for nominated mating.

Murrah Buffalo herd under breed improvement program at NDRI

Breed Improvement Program through Field Progeny Testing program of Murrah Buffalo

Field progeny testing (FPT) in Murrah buffaloes is being carried out in 25 villages of Karnal district. The NDRI FPT Murrah Centre is one of the coordinating centres for the project, the coordinating centre of the FPT Network of MurrahBuffaloes is ICAR-CIRB, Hisar. During the period, a total of 4844 artificial inseminations of the test Murrah bulls were performed at farmers' herds under field conditions, and data recording was done. During 2023, an overall conception rate of 48.14% was achieved in the FPT program. The average lactation yield in the field was recorded as 2282.20 ± 36.99 kg daily milk yield in the recorded daughter was 7.76 kg/day. The total herd strength of registered females and the breedable females at different centers was 6302 and 5004 respectively. As many as 16 breeding bulls belonging to the 20th Set were used for artificial insemination during the year 2022-23. To "Support to the Dairy Farmers" under the Network Project some general-purpose medicines, sprays, and calcium supplements were distributed as support to about 55 dairy farmers. To promote raising the good buffalo, a calf rally was organized.

AICRP Indigenous Breed Programme (Sahiwal)

NDRI has a germplasm production unit of Sahiwal bulls. A total of 68 growing males and breeding bulls were available at the Germplasm Unit. For bull selection 08 out of 47 males were selected in the bull screening meeting. The EPD % superiority of the selected males was 5.89% with a range of 3.83 to 11.8 % and Dam's best

Lactation Yield ranges from 3572-3710 kg. There at present 32 elite cows in the herd with the average best milk yield in first lactation being 2952 kg and 4012 kg best milk yield against herd average of 1794 kg and 3997 kg respectively. The average 305-day milk yield of elite cows was 2048 kg with an EPA of 2810 kg against herd average of 1895 kg and 1864 kg respectively. The semen samples from two breeding bulls of set IV and V were sex-sorted and insemination was started from Dec 2022 onwards in selected Sahiwal heifers. To date, 74 doses were inseminated covering 62 cows. The average number of services required was 2.3 and conception rate was 53.19% and 24 pregnancies were confirmed.

Assessing genetic relationship among production, functional, and linear type traits for selection of elite sires in indigenous and crossbred dairy cattle

Least square means and genetic parameters of 17 linear type traits of Sahiwal and KF cattle were estimated. Stature has a high positive genetic correlation with other linear type traits, viz., body length, chest girth, body depth, rump width, and rear udder height; which can be utilized by direct selection for a correlated response to selection. Stature, chest girth, and body length were having either low-negative or medium-positive genetic correlation with total milk yield and 305 DMY in Sahiwal and KF cattle, which was desirable in principle, even if no selection for linear type traits was carried out. These dairy-type traits can be utilized in the selection and genetic improvement program of Sahiwal and Karan Fries cattle. The selection index constructed using production and three linear dairy-type traits had 81% accuracy, which was appropriate.

Genetic evaluation of Alpine x Beetal and Saanen x Beetal goat for prospective dairy goat breeding

Alpine x Beetal (AB) and Saanen x Beetal (SB) goats were evaluated for their milk production efficiency. 1299 animals of AB and 659 records of SB goats were evaluated for 150-day milk yield (150 DMY), Lactation length (LL), Peak yield (PY) and total milk yield (TMY). It was observed that the estimates of 150 DMY, LL, PY and TMY were 196 ± 1.77 Kg, 229 ± 2.52 Days, 1.79 ± 0.01 Kg, and 256 ± 3.81 Kg in AB and 196 ± 1.77 kg, 229 ± 2.52 Days, 1.79 ±0.01 kg, and 256 ± 3.81 kg in AB and 196 ± 2.54 kg, 225 ± 3.6 Days, 1.18 ± 0.02kg and 253 ± 5.35 kg, in SB goats, respectively. The cross parity estimate for 150 DMY was 218 ± 1.39 and 224.67 ± 2.24 kg in AB and SB goats. Moderate estimates of heritability 0.18 ± 0.06 in AB and 0.24 ± 0.08 in SB were observed for 150 DMY. Similarly, across parity, moderate repeatability was also observed. Lactation curve modelling using 25998 test day records in AB and 12660 in SB revealed 0.26 heritability across the curve till 150 days in AB and SB goats using a random regression model (RRM). Growth analysis revealed moderate h^2 for birth weight (0.22 ± 0.05 in AB and 0.22 ± 0.08 in SB). However, the estimate of h2 for 12TD which corresponds to 3-month weight was low in AB (0.08) and moderate in SB (0.22). Overall h2 for growth till 25TD was 0.23 ± 0.04 in AB and 0.29 ± 0.07 in SB goats. Indices were created with the mother's first lactation milk and 12TD weight in kids with an accuracy of 71.7% in AB and 47.2% in SB. In an attempt to devise a workable model for these goats, we contacted 40 farmers from 19 villages (age 20-25), interacted, and found that these germplasms are more suitable for resource-rich farmers.

Identification of miRSNPs associated with thermo tolerance in cattle

Three miRSNPs were identified in the Karan Fries and Tharparkar population, which have a significant association with thermo tolerance in the miRNAs bta-miR-2388, bta-mir-1584, bta-miR-130b and bta-miR-21-3p. These SNPs were identified by *insilico*genome-wide scan for mapping of SNPs onto miRNAs and within the thermal stress-related QTLs using modifications in the customized SNPtool-miRNAQTLsnp software as well as whole transcriptome analysis. The expression of bta-miR-2388 and bta-miR-1584 in PBMCs was significantly higher in Karan Fries cattle in comparison to Tharparkar cattle at $p<0.01$ and $p<0.05$%, respectively. Other two miRNAs bta-miR-21-3p and bta-miR-130b with identified SNPs by whole transcriptome analysis were found to have similar expressions in Tharparkar and Karan Fries. So, the identified SNPs in the miRNA seed region of bta-miR-2388 and bta-miR-1584 may be used for the selection of animals for better heat tolerance in the Tharparkar and Karan Fries population, after validation on a large sample size.

Creation of de novo genome assembly for Bhadawari Buffalo (Threatened Breed)

We developed the first draft genome assembly of Bhadawari buffalo using short Illumina reads generated with Illumina HiSeq technology with 46x coverage. Based on accuracy parameters and efficiency evaluation, the Celera assembler was chosen for preparing the assembly. The draft assembly was generated from whole genome short paired-end (2*150) reads with an N50 size of 20 Mb and 15,973 Scaffolds. Validation of the assembly was done by completeness evaluation and remapping the filtered reads to the assembly. Remapping using BWA-

mem showed 99.91% of the reads to be properly mapped, and the assembly turned out to be 86.6% complete on BUSCO evaluation. The mitochondrial genome was assembled from a seed fragment of 1924 bp and extended to a final size of 16,358 bp. This newly developed Bhadawari genome assembly will serve as a reference assembly for future genome-wide research.

Bhadawari Buffalo

Whole-exome based approach to identify InDels for performance yraits in 4 buffalo breeds

SNP/InDels identification is a major avenue for exploring genes associated with complex traits in many species. An exome-wide assessment of SNPs and InDels that are probably associated with performance traits in Chhattisgarhi, Chilika, Gojri, and Murrah breeds of buffalo was done. GATK pipeline was used for variant identification. Approximately, 12,08,543 and 1,05,306 in Murrah, 7,75,361 and 63,327 in Chhattisgarhi, 7,08,476 and 57,371 in Gojri and 13,29,799 and 1,15,765 in Chilika, SNPs and InDels were identified, respectively. The snpEff annotated SNPs to 12523, 11621, 11463, and 12742 genes in Murrah, Chhattisgarhi, Gojri and Chilika breeds of buffaloes, respectively. Likewise, for InDels, 2848, 2623, 2555, and 3647 genes were annotated in Murrah, Chhattisgarhi, Gojri and Chilika breeds, respectively. SNP and InDels annotation recognized several non-synonymous SNPs and frameshift InDels that are probably associated with milk production traits.

Genome-wide profile of heat stress in Murrah buffalo

Murrah is considered to be more heat-stress-prone compared to cattle. Although heat stress in this breed could be achieved through proper management, a more sustainable approach could be to select the breeding Sire which is more heat tolerant and design the breeding program to increase heat tolerance in upcoming generations. So, with this aim, the genomic variance of heat stress was assessed on production; and potential SNPs associated with the effects of heat stress on milk yield in Murrah were identified. The study employed a retrospective dataset spanning forty-two years, from 1980 to 2022, comprising 1183 buffalos housed at LRC, ICAR-NDRI Karnal Haryana. To model the data effectively, a Random Regression Model was employed, utilizing Legendre Polynomials (LP). Bonferroni correction was applied, using a significance threshold of 6.6%. This correction identified 1936 significant SNPs associated with the impacts of heat stress. Furthermore, this analysis revealed approximately six genes within candidate regions that are closely associated with heat stress.

Genetic selection for milk traits using genomic approach in Sahiwal cattle

Analysis was performed to elucidate the genetic diversity based on seven decades of genealogical information on 4164 animals spread over 74 years between 1949 to 2023. The animals with confirmed ancestry in the whole population for the first three generations were 93.41, 83.58 and 70.99%, respectively. The maximum number of generations and the complete number of generations were 17 and 5, respectively. For the whole and reference population, the ratio (fe/fa) of the effective number of founders (fe) and ancestors (fa) was 1.67 and 1.90, respectively. There was a decline in the average generation interval from 8.2 years in the whole pedigree to 6.6 years in the reference population. The average effective population size for the maximum, equivalent and complete generation/s was 145.51, 50.36 and 32.31, respectively. Half of the genetic diversity was explained by nine ancestors, which declined effective population size. The population lost 2.4% genetic diversity and encountered bottleneck and genetic drift over time.

Genomic architecture and breed composition of Karan Fries (KF) cattle

To envisage the genetic architecture and breed composition of cattle a high-density array was applied in Karan Fries cattle developed at NDRI Karnal. The average linkage disequilibrium (LD) between SNPs was 0.13 in the present study. LD decay ($r^{2 = 0.2}$) was observed at 40 kb inter-marker distance, indicating a panel with 62765 SNPs was sufficient for genomic breeding value estimation in KF cattle. Pedigree-based Ne of KF was 78, whereas LD-based methods estimated Ne as 52 (SNeP), and 219 (GONE), respectively. Genetic distances between KF crossbred cattle and their parental breeds TP, HF, JS and BS were estimated using pairwise FST and Slatkin's distance (linearized FST). The results revealed that KF cattle exhibited an FST value of 6.5% and a Slatkin's distance of 6.9% indicating the closest genetic relationship to taurine HF cattle. In contrast, the genetic distance of KF with an FST value of 15.8% and a Slatkin's distance of 18.8% was the farthest with JS cattle. Furthermore,

Slatkin's linearized FST distance of KF was 16.5% from TP its zebu parent. Overall, the KF herd is stabilized with an exotic inheritance: of 61.7%; and a TP inheritance of 38.3%. This finding is very important to conclude that stabilization of the KF cattle population has been achieved at NDRI herd.

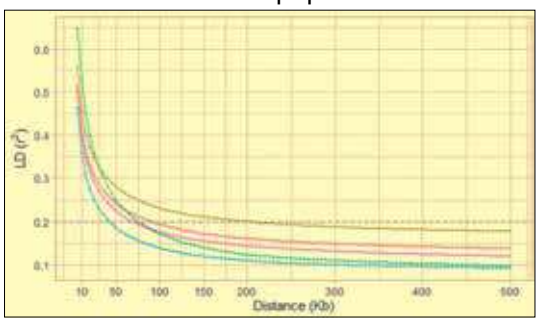
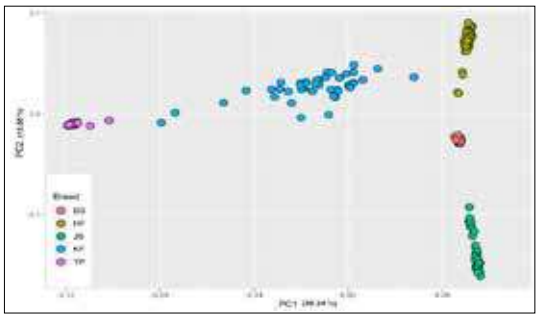


Figure showing Haplotype block diversity & Linkage disequilibrium in various breeds with the lowest LD and high haplotype diversity in KF cattle



PCA showed the KF cattle population is genetically distinct from parental breeds of HF and TP

Genetic evaluation of functional traits and their effect on production and reproductive traits of crossbred cattle

The overall incidence rate of DYS, SB, AB, PMB and ROP were 5.82, 2.20, 8.07, 3.02 and 17.34% in Jersey crossbred cattle. Season of calving significantly (P<0.05) affected the prevalence of abortion of animals and the highest incidence of abortion was observed in winter (15.4%) followed by rainy (11.0%) and summer (9.67%) seasons. Further, this study also revealed highly significant (P<0.01) influence of season of calving on premature birth of cows. Animals calved in rainy season had maximum (6.19%) incidence of premature birth as compared to cows calved in summer (5.25%) and winter (3.42%) seasons. Parity of animal had highly significant (P<0.01) influence on occurrence of premature birth in Jersey crossbred cattle and primiparous cows had higher AB (15.76%) and PMB (7.08%) than multiparous cows. Estimates of heritability by Paternal half sib method were low in magnitude (0.03- 0.08) for different calving traits. Direct heritability ($h^{2)}$ estimates ranged from 0.001-0.01, 0.01-0.04, 0.001-0.02 and 0.003-0.05 for DYS, AB, PMB and ROP, respectively in different animal models. Maternal heritability (m2) varied from 0.00-0.05 in different models for all the considered traits. Permanent maternal environment effect (c2) contributed 0-1% to the total phenotypic variance for all the traits in different models. Least-squares means for HL, PHL, TMP, NDL and NLC were 2964.83 days, 1879.55 days, 10709.56 kg, 1164.08 days and 3.42, respectively. Period of calving had significant effect on all herd life traits. Parity of animals showed significant effect on HL, PHL and TMP of animals. All herd life traits except NDL were significantly affected by genetic groups of animals. The crossbred animals having genetic constitution of ½ Jersey -½ Red Sindhi showed higher herd life, productive herd life as well as total lifetime milk production as compared to animals of other genetic groups. Estimates of heritability obtained by paternal half sib method were low to medium in magnitude for different herd life traits, which ranged from 0.06 to 0.38. Using animal model, the direct heritability estimates of all herd life traits ranged from 0.05 to 0.18 in this study.

Electronic platform to monitor cattle health and milk quality

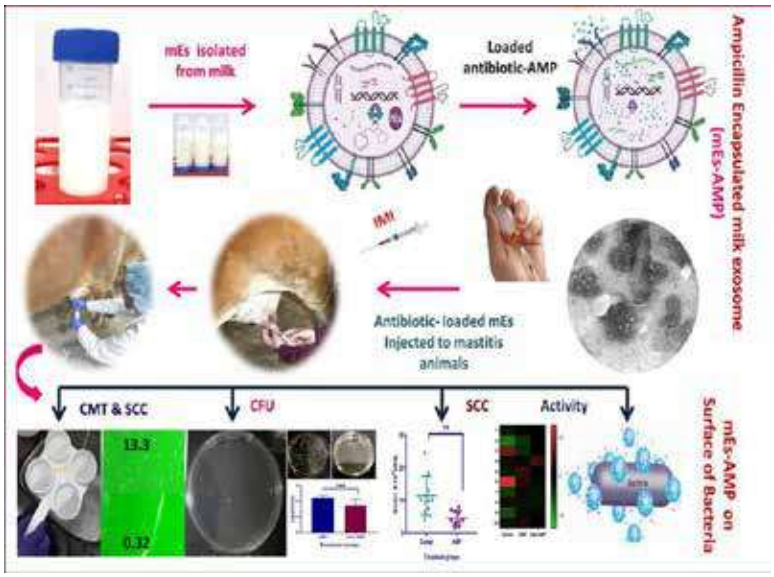
Based on the rumination, mastication and motor of the dairy cows, sensors are able to differentiate diseased cows and cows in estrum. During the period under report, a total of 29 cows were kept under the CCTV camera installed in the cattle herd of NDRI, Kalyani and among these animals, 10 healthy animals having CDAC fabricated sensor-based collar nodes showed average rumination time and feeding time of 506 and 318 mins., respectively. Whereas, the corresponding values obtained through manual recording from CCTV images were 499 and 250 mins., respectively. During this period, only one cow was sick and the rumination time of sick animal recorded through sensor device and manually was 339 and 340 mins, respectively. Eating time of this sick animal was recorded as 205 and 188 mins from sensor device and manually, resp. The average rumination time and eating time of cows in natural estrum were 418 vs. 386 mins (device vs. manual) and the corresponding figures for eating time were 170 vs. 169 mins. The results obtained from sensor-based device and manual recording corresponded well with each other for all categories of cows kept under observation.

Validating the sensor-based cattle nodes for animal health monitoring

INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS

Development of exosomes-encapsulated antibiotics-based therapeutics for mastitis

Mastitis poses a major burden on the dairy industry. It is becoming increasingly difficult to treat it due to the development of antibiotic resistance. Antibiotic therapy for mastitis is currently ineffective due to the intracellular persistence of *Staphylococcus aureus (S. aureus)* and less bioavailability of antibiotics at the site of infection. Therefore, the present study aimed to develop effective therapeutics for intracellular delivery of antibiotics into mammary epithelial cells to tackle *S. aureus.* The study primarily explored milk exosomes (mEs) for their unique potential as drug delivery vehicles as well as treatment modulators against *S. aureus.* The milk exosome (mEs), pre-characterized by zeta sizer and high-resolution transmission electron microscopy, were used for encapsulation of ampicillin (AMP). The mEs-loaded AMP (mEs-AMP) was contrived and tested against mastitis. The mEs-AMP had a significantly ($p < 0.001$) higher therapeutic efficacy than unloaded-AMP at the same dosage and frequency of treatment. The mEs-AMP had a 4.08-fold lower minimum inhibitory concentration (MIC) than that of AMP, and the mEs-AMPs killed *S. aureus more* effectively than AMP (74.35% vs 34.46%). The antimicrobial and therapeutic efficacies of mEs-AMP were tested in subclinical and clinical mastitis of Sahiwal cows, and found thatmEs-AMP reduced the number of somatic cells (4.53 0.69 to 3.39 0.51 lakh/mL; P 0.001) and bacterial log CFU (2.2 0.15 to 1.7 0.37; $p < 0.05$) in treated animal milk compared to AMP. Therefore, the mEs-AMP could be used as a therapeutic tool for the effective control of mastitis in dairy animals.



Exosomes-encapsulated antibiotics-based therapeutics for mastitis

Impact of conditioners on physical, chemical, and microbial properties of Recycled Manure Solids (RMS)

Six different conditioners, including calcium hydroxide (5%, 10%, and 15%), neem oil (5%, 10%, and 15%), sodium hydrosulphate (2%, 5%, and 8%), calcium silicate (2%, 5%, and 8%), and potassium hydroxide (1%, 2%, and 5%), were systematically blended with recycled manure solids on alternate days. These mixtures, contaminated with daily deposits of dung and urine, underwent thorough assessments for physical characteristics on both the 0^{th} and 10^{th} days, as well as chemical properties and microbial load on alternate days from the 0^{th} to the 10^{th} day. Remarkably, the presence of 10% and 15% lime exhibited a significant inhibition of *E. coli* growth throughout the entire 10-day period. Similarly, the 5% lime-infused mixture displayed inhibited growth from the 0th to the 4^{th} day, and the 8% sodium hydrosulphate-treated recycled manure solids showed restricted growth from the 2nd to the 10th day. Further, an intriguing observation revealed a substantial reduction in the growth of *Klebsiella spp.*, with 5% sodium hydrosulphate (4.30 ± 0.10) on Day 6 compared to 2% sodium hydrosulphate (5.14 ± 0.11). Following this analysis, the most effective microbial load reducers, namely calcium hydroxide and sodium hydrosulphate, were chosen for an in-depth combination study. The results underscored a significant increase in ash content and a simultaneous decrease in organic matter and carbon levels upon the addition of sodium hydrosulphate, particularly in combination with lime. Notably, the addition of 7.5% lime with 6% or 8% sodium hydrosulphate demonstrated a pronounced suppression of E. coli and Klebsiella spp. growth, particularly at depths of 15 and 20 cm.

Comparative evaluation of turmeric (*Curcuma longa*) rhizome extract and curcumin on cure rate of subclinical mastitis (SCM) in dairy cows

Phytochemical screening of ethanolic turmeric extracts revealed the presence of alkaloids, phenol, flavonoids, tannin, terpenoids, flavonoids and glycosides. Total phenol and flavonoid contents were more in concentration-dependent manner in curcumin than extracts. Similarly, antimicrobial activity against Staphylococcus epidermis and anti-inflammatory activity were also better in curcumin than extracts. Effects of intra-mammary (IMM) administration of curcumin (250 mg/quarter/day for three days; n=5) or ethanolic extract (375 mg/quarter/day for three days; n=5) in SCM affected quarter were evaluated through California mastitis test (CMT) score, milk somatic cell count (SCC), bacteriological culture, milk yield and its composition by univariate and mixed model procedure using SPSS software. IMM administration of curcumin resulted in significant reduction of CMT score and milk SCC at cow- and quarter-level (i.e., only treated quarters) than SCM affected cows treated with extract. IMM administration of extract or curcumin cause significant reduction of milk yield during treatment period, but improved during post-treatment period. It is concluded that significant reduction of SCC and CMT score among curcumin treated cows indicates its potential candidature for treating intra-mammary infections in dairy cows. Better efficacy of curcumin could be due to more phenolic and flavonoid constituents-mediated bioactivities than turmeric extract.

Wound healing potential of cow urine based formulation:

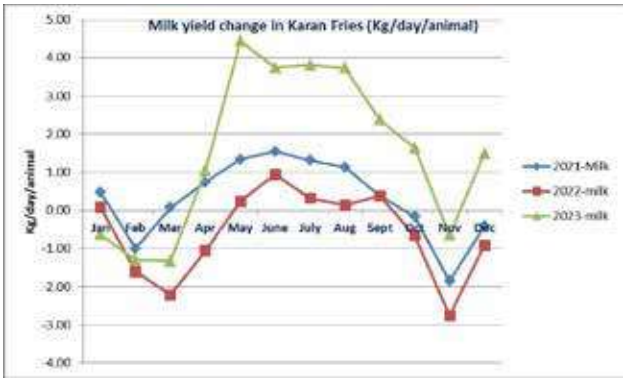
Preservative free cow urine based formulation consisting of 56% cow urine double distillate, 40% mineral oil, 2% SDS, 2% acetyl alcohol and 2% gelatin with 12 months storage efficiency was applied to the external wounds with moderate severity in cattle. The formulation made up with cow urine double distillate of *Deoni* cows (group 1, n=6), *HF crossbred* cows (group 2, n=6) was applied twice a day for 21 days and the rate of contraction of wounds was observed on zero, 10th and 21st day. Commercial herbal product 'X' (group 3, n=6) was used as positive control. Average % wound contraction on day 10 of treatment for *Deoni* cow urine based formulation and commercial herbal product 'X' was 39.6 and 38.66 % respectively; whereas group of animals treated with *HF* cow urine based formulation showed 21.33% average wound contraction.

Percent positive rate of methicillin-resistant *Staphylococcus aureus* (MRSA) in mastitic milk samples

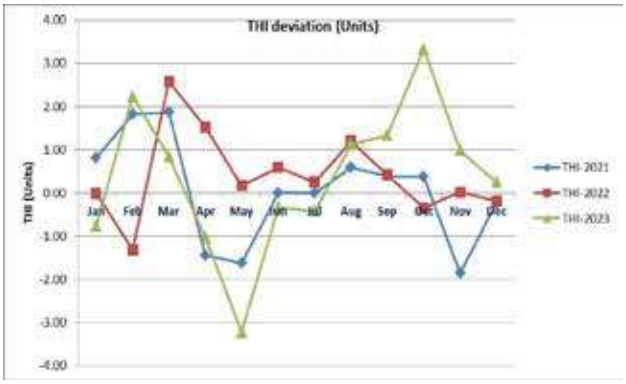
Estimation of percent positivity rate of Methicillin Resistant *Staphylococcus aureus* (MRSA) in milk samples of mastitis affected cows was done by isolating MRSA from milk of mastitis affected cows. Milk samples from102 mastitis affected quarters of cows from organized and unorganized farms were collected. Enrichment of collected milk was done in Mannitol salt agar broth. Single coagulase positive *Staphylococci* colony from MSA plate and confirmation of *S. aureus* was done by molecular detection of thermonuclease (nuc) gene by PCR. *S. aureus* isolates were checked for presence of methicillin resistance gene(s)-*mecA* and *mecC* genes. Percent positive rate of MRSA.

Integrated analysis of milk yield and Thermal-Humidity Index (THI) in Karan Fries Cows

This study aimed a comprehensive comparative analysis of milk yield and frequently changing Thermal-Humidity Index (THI) due to climate change impacts in crossbred cows (Karan Fries) over three consecutive years, spanning from 2021 to 2023 as compared to long-term climatic averages. The research aims to elucidate



(a) Milk yield change in Karan Fries during different years



(b) Month-wise THI deviations during different years

the potential relationship between environmental conditions, specifically THI, and milk production. In 2021, the milk yield data exhibited distinct monthly variations, with peaks in May and June and a noticeable dip in November. Concurrently, THI values fluctuated throughout the year. The correlation between milk yield and THI reveals potential links between environmental stressors and dairy productivity. The subsequent year, 2022, displayed a different pattern in milk yield, with reduced milk yield in March and April due to a sudden increase in THI values during the March and April months. The corresponding THI values highlighted a significant increase in thermal stress during the same period. This suggests a potential influence of environmental factors particularly temperature and humidity on milk production. In 2023, a substantial increase in milk yield during May aligns with a significant decline in THI, causing a positive impact on dairy productivity i.e. milk production. The integrated analysis of milk yield and THI provides valuable insights into the intricate relationship between climate conditions and dairy cattle productive performance.

This study contributes to the wider understanding of environmental impacts on milk production, aiding farmers in developing mitigation strategies to enhance the resilience and sustainability of dairy farming practices in different agroclimatic zones. The findings emphasize the importance of considering climate factors for sustainable and optimized productivity in Karan Fries cows in northern tropical climatic conditions.

Empowering farmers through selective interventions in salt-affected agroecosystems of Ghaghar Plains

Twenty-four lactating buffaloes were selected and equally divided into four groups *i.e.* Group-I (control-conventional feeding), Group-II (conventional feeding + cumin @15g/100kg BW/ day/ animal), group-III (conventional feeding + Molasses 10% of concentrate/ animal/ day) and group-IV (conventional feeding + combination of cumin and molasses). The IRT temperature at different anatomical sites was significantly lower ($P<0.05$) whereas haematological parameters (RBC, Hb, PCV) and plasma glucose were higher ($P<0.05$) in group-IV of lactating buffaloes compared to control during hot dry and hot humid seasons. The NEFA, antioxidant enzymes (catalase, SOD and TBARS) and stress hormones (cortisol and prolactin) levels were lower ($P<0.05$) in combination than the control group during both seasons. Higher ($P<0.05$) levels of interleukin-10, Immunoglobulin-G and lower levels of interleukin-2 were observed in the combination group than control during both seasons. The expression of HSP 70 and HSP 110 in PBMC of lactating buffaloes was higher ($P<0.05$) in the control than combination group during both seasons. Milk yield, lactose and fat % was higher ($P<0.05$) whereas SNF was lower ($P<0.05$) in combination than the control group. Higher ($P<0.05$) UFA, MUFA and PUFA were found in treatment groups and during the humid season compared to the control and hot dry seasons respectively. Supplementation of cumin, and molasses and their combination with lactating buffaloes improved milk yield by ameliorating the thermal stress by reducing the levels of biological stress markers.

Prediction of thermal stress in indigenous and crossbred cattle using infra-red thermography and emerging machine learning techniques

The thermograms and physiological responses of Karan Fries and Tharparkar cattle were recorded during winter, spring and summer seasons to develop and validate machine learning models for intelligent prediction of thermal stress (rectal temperature). The animal parameters like breed, the infrared temperature of eyes, the respiration rate and the environmental stress indicator i.e. temperature humidity index (THI) were used as input variables for the prediction of the rectal temperature/ heat stress using different machine learning algorithms such as Bayesian Regularized Neural Network (BRNN), K-Nearest Neighbors (KNN), Support Vector Machine (SVM) and Multiple Linear Regression (MLR). The four input parameters (RR, Eye temperature and THI) were selected based on the significant positive correlation with the rectal temperature. The final predictive model by the KNN algorithm exhibited a mean absolute error of 0.1627, a root mean square error of 0.2059 and an R^2 value of 0.7788 (R-value as 0.8825), which is comparatively better than the other models tested. Based on the results obtained, it can be concluded that the physiological parameters (IRT of eyes and respiration rate) and THI are the most accurate parameters for the prediction of stress levels (Rectal temperature) of cattle.

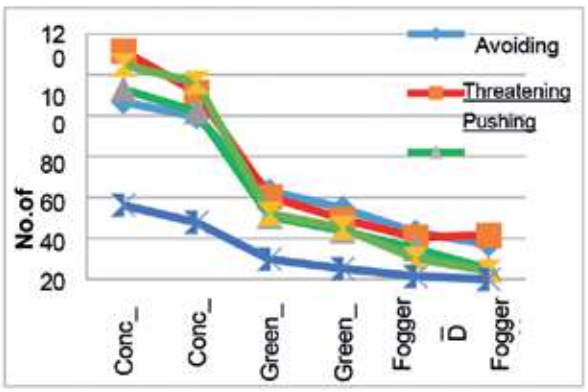
Studies on biochemical, hematological and physiological parameters of Black Bengal goat reared under intensive system at new alluvial zone of eastern India.

In new alluvial zone of eastern India, the supplementation of 2nd grade *Trigonella foenum* seeds to their animals used to do as indigenous practice (ITK) for various purposes viz: growth/vigor, easy birth/kidding, digestion,

milk production etc. *In vitro* experimentation revealed that the methanolic extraction of total phenolics and flavonoids and ethanolic extraction of saponins and alkaloids from 2nd grade *Trigonella foenum* seeds were satisfactory concentration of bio-active compounds in it. The farm experimentation (*in vivo*) with 2nd grade *Trigonella foenum* seeds supplementation (@ 2- 4 %) to Black Bengal goat reared under intensive systemrevealed that the relevant haematological parameters (Hb, PCV, TEC, TLC) and biochemical parameters (glucose, total protein, albumin, globulin, ratio of albumin globulin, BUN, SGPT/ALT, SGOT/AST) were found to be non-significant (P>0.05) among three groups experimental goats. Some important morphometric parameters (BL, HG, WH, HH) were showed significant (P<0.05) difference but punch girth was non-significant (P>0.05) among treatment and control group. The correlation study revealed that coefficient of correlation among BW and BL, HG, HW, PG, HH, ADG, BCS were highly, positively and significantly (P<0.01) correlated to each other. Therefore, 2nd grade *Trigonella foenum* seeds supplementation @ 2-4 % of concentrate DM does not alter much of important physiological, hematological and biochemical parameters of Black Bengal goats of this region without showing any deleterious effect.

Concentrate restriction is the most limiting resource for estimation of social hierarchy in buffaloes

For the estimation of social hierarchy in buffaloes, finding out the most motivating/limiting resource for expression of agonistic interaction is a pre-requisite. For this purpose, a pilot study was cconducted on 63 loose housed lactating Murrah buffaloes (1-6 parity). Three limited resources considered for observing agonistic interactions among buffaloes were : i) seasonal green fodders ii) concentrate mixture and iii) possession of space under the foggers during summer season. The manger length was restricted to allow for 10% of animals to eat feed and fodders simultaneously and 10% of foggers were operated so as to invite maximum aggression. Agonistic interactions for each of limited resource were recorded manually and by CCTV recordings five times at weekly intervals. A socio-metric matrix of all agonistic interactions was prepared and pooled data was analyzed using one way ANOVA. The proportion of buffaloes that participated for possession of limited resources was higher (p<0.01) for concentrate mixture (51.00 ± 0.86%) than for green fodders (33.00 ± 0.66%) and foggers (16.00 ± 1.80%). The mean number of all agonistic interactions per trial were also significantly (p<0.01) higher for possession of concentrate mixture (25.71 ± 0.54) followed by green fodders (8.71 ± 0.42) and foggers (3.60 ± 1.13).



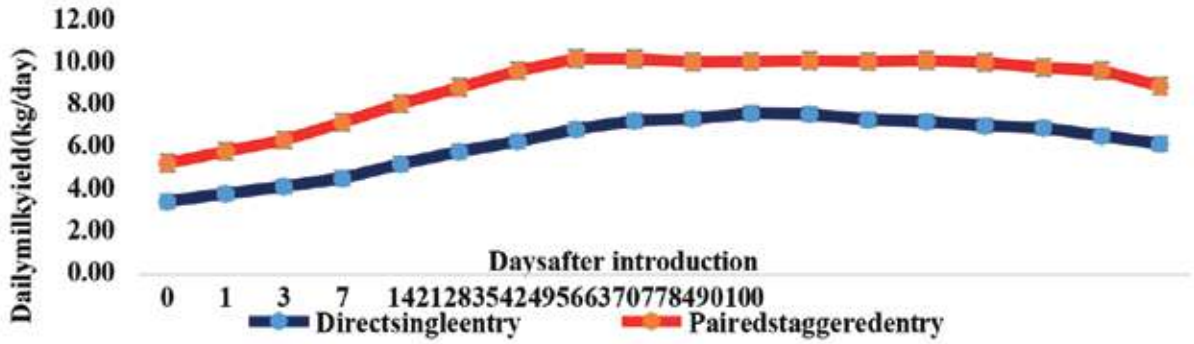
Mean number of all agonistic interaction per trial of loose housed buffaloes

The means of physical (fighting, bunting, pushing) as well as non-physical (threatening, avoiding) interactions per animal per trial were higher (p<0.01) for concentrate mixture (13.98 ± 1.27, 11.73 ± 1.00) than green fodder (4.01 ± 0.52, 4.69 ± 0.54) and foggers (1.09 ± 0.2, 2.51 ± 0.46). It was concluded that concentrate restriction motivates the most for expression of agonistic interactions for resource possession in a socially stable lactating group of Murrah buffaloes.

Staggered integration of freshly calved buffaloes in pairs instead of direct introduction individually into a resident group of loose housed lactating buffaloes improves the milk yield and behaviour

Buffaloes, being highly social animals, often face stress during regrouping due to changes in social hierarchy and agonistic interactions. To address this, an investigation was carried out with the objectives of studying the effects of staggered entry of freshly calved buffaloes in pairs into an established group on their behaviour, social stability, productive performance and milk quality. For this, a lactating herd of 70-80 Murrah buffaloes

maintained together in a loose house was considered as a resident group of animals. In this resident group, 36 freshly buffaloes allotted at random to two groups were introduced 5 days post-partum spread over 6 months (from May, 23 to October, 2023) in order of their calving. The buffaloes in one group (n=12) were directly introduced individually into the resident group of buffaloes as per existing farm practice (control, T0). The buffaloes in treatment (T1) group (n=24 in 12 pairs) were introduced into the resident group in pairs in a staggered manner over 4 days. On day 1,2 and 3 these buffaloes were kept in the resident group for 2, 4 and 8 h respectively and were withdrawn afterwards and housed separately where they were provided similar conditions of feeding and housing for the rest of the time. On day 4, the buffaloes were fully integrated into the resident group. The T1 buffaloes exhibited higher daily feeding time (340.81 ± 6.55 min/d) and rumination time (432.52 ± 9.53 min/d) compared to T0 (319.56 ± 9.38; 390.66 ± 15.04 min/d) respectively. The T1 buffaloes also displayed increased total lying time (611.09 ± 6.11 min/day) compared to T0 (558.50 ± 10.86 min/d). Agonistic interactions were significantly higher in T0 as compared to T1. There were no differences in the mean daily times spent on feeding, rumination, resting and number of agonistic interactions in the two groups of buffaloes after 3-4 weeks of introduction into the resident group indicating their social integration into the resident group.



Average daily milk yield of buffaloes entered individually directly vs. in pair in staggered manner into established group of buffaloes

T1 Buffaloes feeding in synchrony with other buffaloes

Video grab of T0 buffaloes fighting for feeding with other buffaloes

Additionally, T1 buffaloes demonstrated higher daily milk yield (8.91 ± 0.67 kg/d) and milk flow rate (0.977 ± 0.04 kg/min) compared to T0 (6.17 ± 0.98 kg/day, 0.861 ± 0.037 kg/min). Milk quality also favoured T1, showing lower somatic cell counts (2.01 ± 0.11 lakhs/ml) as compared to T0 (2.58 ± 0.13 lakhs/ml). Furthermore, plasma cortisol levels were significantly lower in T1 indicating reduced stress compared to T0. It was concluded that staggered entry of freshly calved buffaloes in pairs positively influenced behavior, social interactions, and productive performance. Gradual introduction in pairs resulted in improved behavior, enhanced milk yield, better milk quality, and reduced stress compared to direct single integration into the resident herd.

Strengthening dairy based integrated farming system for optimal resource utilization

Dairy production tends to be more complex than crop production because animals too often play a pivotal role in the overall farming system. The project on dairy based integrated farming system was laid on an area of 1.00 ha with different sub-components viz., crop production (0.4 ha), fodder production (0.4 ha), dairy production (cattle-3; buffalo-3, goats-20), poultry farming (05 birds), fish pond and vermin-compost pits (0.1 ha). The potentially important technologies that could make a significant increase in productivity are implemented. Supply of green fodder was a major challenge; hence emphasis was given on production of quality green fodder and feeding strategies for dairy animals.

Hybrid Napier- Moringa intercrop-based fodder production systems being developed for round the year fodder supply. About 30% of the allocated area is covered under perennial fodder crops (Hybrid Napier and Moringa) and rest of the area (70%) under annual fodder crops like maize + cow pea in summer, cowpea in rainy season and berseem were shown during winter season as intercrop between Moringa and Napier rows. The mean green fodder yield of 1868 q/ha with dry matter yield of 467 q/ha was recorded from the system.

Dairy based integrated farming system

The total milk yield of 6378 liters from cattle, 6215 liters from buffaloes and 1257 liters from goats was recorded with C: B ratio of 1.59, 1.78 and 1.98, respectively. The net return of Rs. 4,15,700/- was generated with 58.9 % contribution from dairy production, whereas food/fodder crops and subsidiary enterprises contributed 35.9 and 5.2 %, respectively to the net income. The dairy based IFS model not only increased the production and profitability but also ensured the food and nutritional security through regular supply of milk and round the year employment to the farm families and has potential to increase resource use efficiency and overall resilience of the production system.

Characterization of dairy farming practices of Leh Ladakh

The survey was conducted to study the existing dairy farming practices in Leh Ladakh in six villages with ten respondents from each village from three blocks of Leh district. Results showed that majority of the farmers were above 50 years of age, and dairy farming was often a secondary occupation. Most of the farmers were smallholders with less than two hectares of land. The average herd size was 4.05, and local breeds of cattle were prevalent in Nubra blocks, while crossbreeds were more common in Leh. Lucerne, oats, and straws were the primary fodder resources used by most farmers. Traditional practices of breeding, feeding and management are being followed by the majority of the farmers. Non-availability of feed and fodder, labour, inputs, and market facilities were identified as major constraints in dairy farming. Female participation in dairy production was noted to be higher than male participation.

Dairy farming practices of Leh Ladakh

The effect of seabuckthorn leaf meal supplementation on the production of dairy animals

The *in vitro* dry matter and organic matter digestibility were higher with 1% and 2% seabuckthorn supplementation, whereas, methane production decreased as the level of seabuckthorn supplementation increased. Based on the results of *in vitro*, feeding experiment on seabuckthorn supplementation was conducted in Hunder village with 14 lactating cows, divided into two groups: control and treatment. The control group was fed as per the farmers' usual feeding practices, while the treatment group was supplemented with seabuckthorn leaves at a @ 100 grams per cow per day for sixty days. The overall daily milk yield increased non-significantly with seabuckthorn leaf supplementation. The supplementation had a non-significant effect on milk composition and fatty acid profile of ghee. Seabuckthorn leaf supplementation had a non-significant effect on various blood biochemical parameters. However, it significantly increased the total antioxidant capacity and decreased cortisol levels in the treatment group at the end of the experiment. These findings provide valuable insights and the potential benefits of seabuckthorn leaf supplementation in Leh, Ladakh. Based on these findings, it can be concluded that seabuckthorn can be a valuable non- conventional feed resource for dairy animals. While it may not have resulted in statistically significant increases in milk production, the observed positive effects on immunity and antioxidant capacity make it a promising supplement for dairy farming in the region. Further research and experimentation may provide more insights into the optimal use of seabuckthorn in dairy ration.

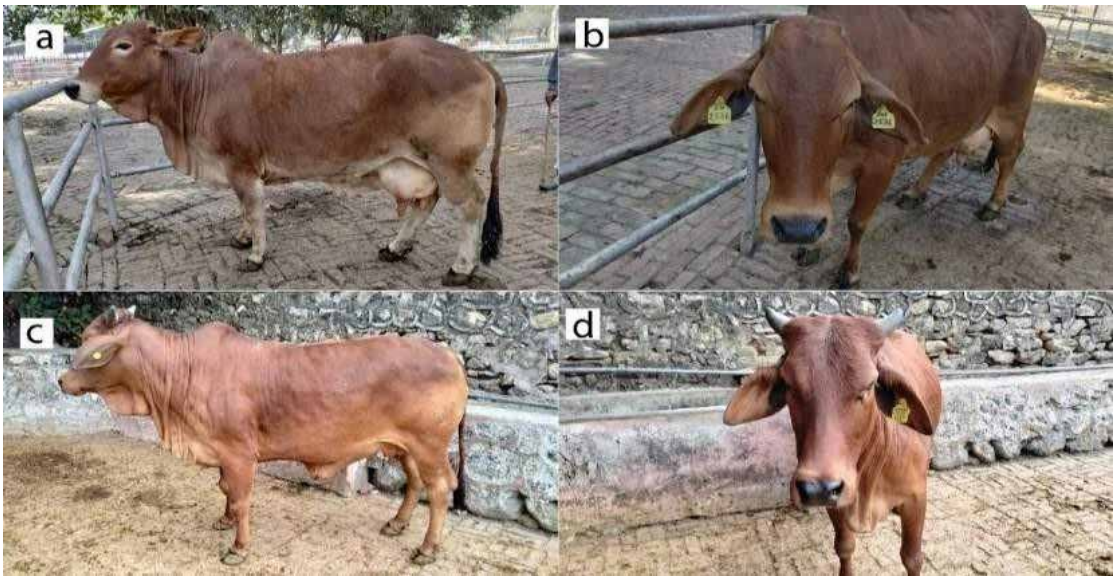
Effect of feeding Moringa and Neem leaf meal on growth performance and health of crossbred goat kids

Forty post-weaned crossbred Alpine x Beetal goat kids of both sexes at 3 months of age were selected from the Livestock Research Centre, NDRI, Karnal and divided into 4 groups based on their body weight. T1 group was maintained as control, T2 group was fed 20% Moring leaf meal, T3 was fed 20% Neem leaf meal and T4 group was fed 10% Moringa and 10% neam leaf meal for a period of 90 days. The concentrate mixtures were prepared using Moringa (20%) and Neem leaf meal (20) as one of the feed ingredients and were administered along with fodder in the ratio of 40:60 respectively as a total mixed ration as per ICAR, 2013 feeding standard. T1 was taken as the control concentrate feed and T2, T3, and T4 were taken as the treatment groups. An experiment was conducted for a period of three months from February to April 2023. All animals were kept under observation during the whole experimental period. They were housed separately from other animals in pens with concrete floors and walls. The kids were allowed 5 days of acclimatization before experimental feeding. Proper cleanliness and healthy surroundings were ensured throughout the experimental period. In winter, the sheds were fully

covered with tarpaulin sheets that were closed in the evening and opened in the morning to reduce the effects of cold weather on animals. Kids were initially weighed at the start of the experiment using a weighing balance. Thereafter they were weighed early morning at fortnightly intervals before feeding and offering water. The study revealed that dry matter intake (g/d) was higher (P<0.05) in T2 (460.26) as compared to T1 (421.86 g/d). The average daily gain (g/d) was also significantly higher in T2 (93.87g, 23.94%) as compared to T1 (75.74 g).

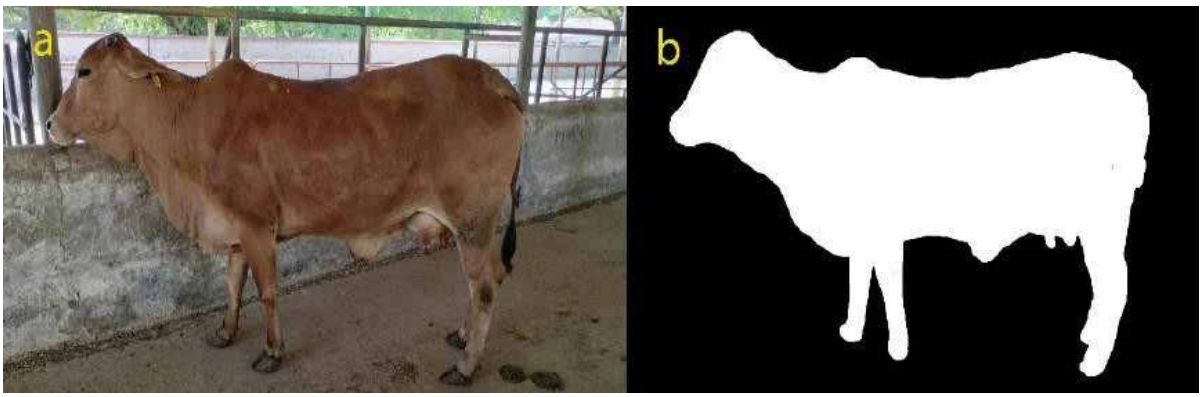
Identification and differentiation of similar looking indigenous cattle breeds using image processing and convolutional neural network models

The aim of this study was to develop a deep learning model for the identification and classification of Indigenous cattle breeds i.e Tharparkar and Hariana, and Sahiwal and Red Sindhi (Figure); as they are phenotypically similar-looking breeds and have subtle differences in visual appearance. The average age of cows for both breeds ranged from 3.5 to 9 years. Designing a deep learning model essentially requires an image dataset for training and classification tasks, and hence images of all four breeds were captured front side and left side, by using a mobile phone camera under natural environment. In order to address the issue of background interference in the



Cow images captured under natural conditions (a) Side view of Sahiwal cow (b) Front view of Sahiwal cow (c) Left view of Red Sindhi cow (d) Front view of Red Sindhi cow

captured images of cattle breeds, a CNN-based semantic segmentation model was developed to accurately identify the cow as a Region of Interest from the background (Figure). The accuracy of the classification model for the Tharparkar and Hariana classes was found to be 72.5%. Precision, recall value, and F1-Score for the Hariana breed were 73.7%, 70.0%, and 71.8%, respectively. Whereas precision was 71.4%, recall value was 75.0%, and F1-Score was 73.2% for Tharparkar. The accuracy of the classification model for the Sahiwal and Red Sindhi class was found to be 82.0%. Precision, recall value, and F1-Score for the Red Sindhi breed were 83.3 %, 80.0%, and 81.6% respectively. Whereas precision was 80.8%, recall value was 84.0%, and F1-Score was 82.4% for Sahiwal.

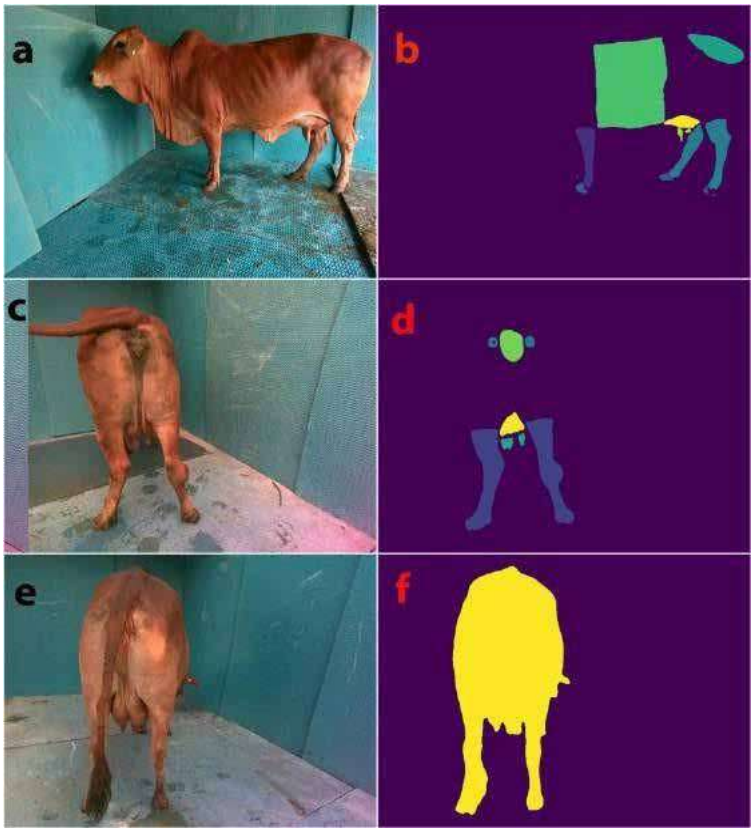


A sample of the annotated image curated using Label-studio software. (a) Original color image (b) Labelled image in which white represents cow region.

Development of a non-contact deep learning and computer vision-based system for automated assessment of linear type traits in Sahiwal cows

Illustration of image acquisition process

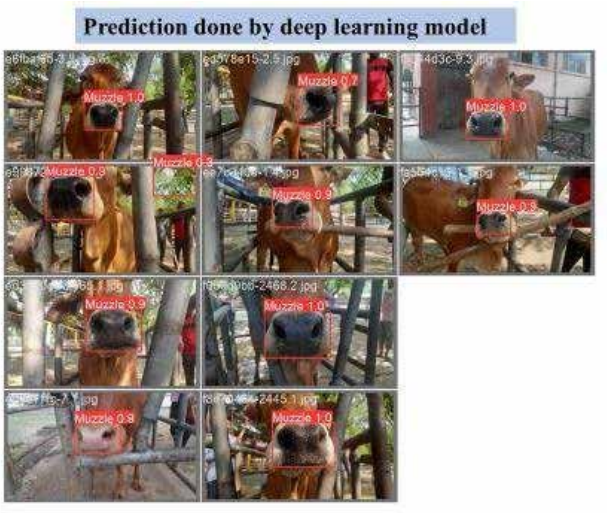
The evaluation and assessment of dairy cow's linear traits are important in determining the production potential, reproductive performance, and overall health. To address the challenges of manual/traditional methods, a non-contact, automated system, utilizing the depth camera and convolutional neural networks; was developed in this study. The study was conducted on elite multiparous Sahiwal cows (n=150) and images were collected as shown in Figure. Using the ResNet34 model, the developed segmentation system achieved mean intersection-over-union (96.12%) and F1-score (98.07%) for accurately segmenting cattle body parts from RGB images (Fig 2.). The system demonstrated high accuracy in determining cow stature (96.46%) and body depth (91.38%). However, accuracy percentages were comparatively lower for traits like rear teat placement (71.48%), foot angle (81.33%), and rump angle (82.19%). Traits with larger spatial scales, such as body depth, stature, and muscularity, showed comparatively lower errors (<6%) due to better segmentation. Conversely, traits with smaller spatial scales, like foot angle, udder depth, and teat thickness, exhibited higher errors (>10.0%) during estimation. The complexity and variability inherent in these traits might contribute to the challenges faced in accurately determining them from the images. Despite these limitations, the system's high accuracy in segmenting relevant image regions and extracting desired traits displays the efficacy of the CNN model. The study explores the potential of computer vision in facilitating precise trait evaluations while maintaining animal welfare.



Segmentation performance of developed model

Automated individual identification of dairy animals using computer vision and deep learning approach

Good quality muzzle images were collected from Sahiwal cows (n=70) to create a large database under natural environment. After image acquisition, firstly, annotation of collected images was done using 'label studio' software to mark the muzzle in the given image. For detection and localization of object (muzzle) in the image, transfer learning based using YOLO Model was used. Precision confidence curve and recall curve detected all classes at confidence threshold of 0.68 during training phase. F1 score of model during training phase was highest at confidence threshold of 0.65. Precision-recall curve of trained object detection model was 99.5% at mean average precision of 0.5. These results indicated good accuracy and efficiency of muzzle detection model for muzzle detection. Output of this model was cropped muzzle images with known coordinates of bounding box, which would be further used for detailed texture features study of muzzle of each animal identification.



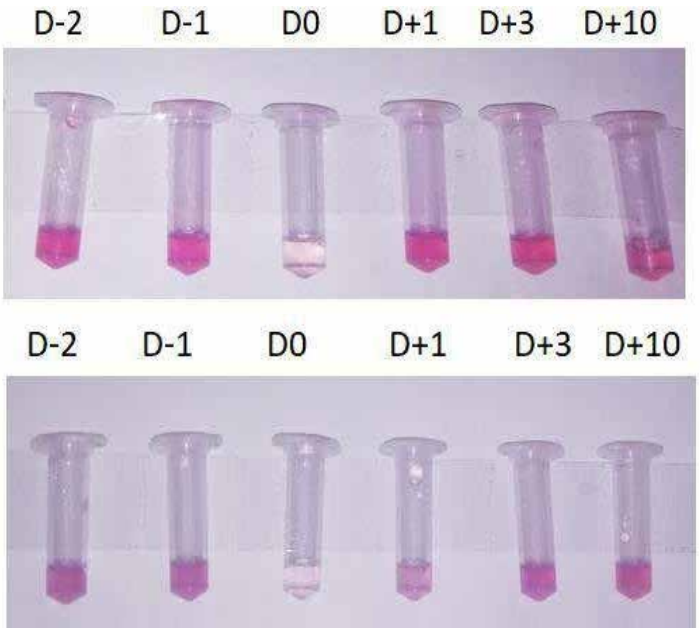
Identification of muzzle area in given cow image using deep learning approach

Effect of *M. Koenigii* leaves extract on buffalo granulosa cell functions in control and heat stress condition using 3-D granulosa cell culture model

Granulosa Cells (GCs) play a key role in regulating ovarian functions thus reproduction in females, however, summer-induced heat stress impairs the GCs functions resulting poor follicular development, delay onset of cyclicity and poor reproductive efficiency in buffaloes during the low-breeding summer season. Hence this study was conducted to ameliorate heat stress effect and improving GCs functions by using different modulators which will be helpful for developing a therapeutic strategy for improving the ovarian function of buffaloes during the low-breeding summer season. A 3-D GCs culture model was developed using hanging drop method by isolating GCs from healthy small follicles (2-4 mm) of buffalo ovaries collected from slaughter house. GCs were seeded at a seeding density of 2-4X10^5 cells per mL using DMEM/Ham's F-12 medium at 37˚C in an atmosphere of 5% CO_2 and 95% humidified air for a period of 24 h and then treated with plant extracts (aqueous; 3.125 mg/mL and methanolic; 0.39 mg/ mL) and then exposed to heat stress condition i.e. at 40.5 ^{0}C for 72 h. Heat stress exposure during the growth phase of GCs, affects proliferation and functions compromising the further development to preovulatory phenotype. *Murraya koenigii* plant extract treatment in GCs culture, showed a beneficial effect on GCs phenotype and allowed cells to maintain spheroid integrity and compactness. Pretreatment of GCs with plant extracts significantly improved PCNA expression of GCs exposed to heat stress conditions and also increased basal expression of GCs specific key genes (CYP19, FSHR) cultured under control and heat stress conditions. Further, plant extracts treatment significantly reduced heat stress-induced expression of HSP70 and BAX in GCs and simultaneously improved basal expression of the SOD2 gene.

Development of a gold-nanoparticle based in-solution colour-based assay against estrus candidate proteins for accurate identification of estrus in buffaloes

Estrus detection is a major problem in buffaloes because of its shy breeding nature and poor expression of estrus signs particularly during summer season that leads to wrong time insemination. Therefore, this study carried out to develop an AuNP-based colour assay using earlier identified estrus candidate proteins (HSPA1A and VMO1) for on-the-spot estrus detection in buffaloes. In-house generated polyclonal antibodies against HSPA1A and VMO1 proteins were conjugated with AuNP using optimized buffer solutions. Developed AuNPs-based colour reaction assay was used for testing saliva samples from different stages{(proestrus (D-2, -1), estrus, metestrus (D+1, +3), diestrus (D+10)} of estrous cycles of buffaloes. Interestingly, addition of saliva samples collected during estrus stage to the antibody conjugated AuNP solution cause aggregation and colour was changed from pink to colorless, however, in other non-estrus stages there was no change in colour of solution was observed. Performance of assay was evaluated and accuracy, sensitivity and specificity was 82%, 91%, 77% and 80%, 82% a, 77%, against HSPA1A and VMO1 proteins, respectively.



AuNP-based colour assay for detection of estrus candidate proteins (A. HSPA1A, B. VMO 1) in saliva of buffaloes. D-2, D-1 represents days before estrus and D+1, +3 &+10 represents days after estrus

Identifying factors affecting health behaviour of tribes of Uttarakhand and developing dairy based interventions to improve their health and livelihood status

Study was carried out in five villages of Haridwar district (Uttarakhand) namely Gaindikhata, Jaspur Chamariya, Rasoolpur, Mithiberi and Lal Dhaang which has a major population of Buksa tribe. Focused group discussions were organized in which farmers were sensitized regarding technologies for proper management of dairy animals. Mineral mixture and dewormers were distributed for improving the reproductive performance of dairy animals among tribal respondents. Publication and distribution of technical bulletin, folders and leaflets was carried out. There has been development of mobile app (Dairy Pashu Prajanan App) for the farmers. Animal health camps were organized in all 5 tribal villages of study area. It was observed that after providing dairy based interventions, there was considerable improvement in attitude, knowledge and adoption of dairy farming practices among tribal population. Majority of population (52%) started using artificial insemination for breeding of animals. Most of the respondent adopted correct dairy farming practices evidenced by considerable increase in population following vaccination, deworming, feeding mineral mixture, using correct method of milking, correct method of estrus detection etc.

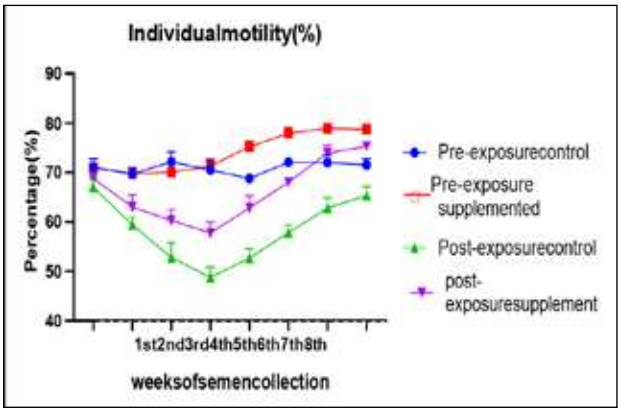
Effect of exposure of urine and urinary pheromones of bulls on early resumption of cyclicity in postpartum Sahiwal cows

Early resumption of ovarian cyclicity is one of the major concerns which would otherwise leads to reduced reproductive efficiency and calf crop. Animals releases volatile odours called pheromones which are invisible chemical signals that communicate information between members of the same species. A study was conducted for identification of urinary pheromones of Sahiwal bulls and evaluation of effect of urine and urinary pheromones on reproductive performance of Sahiwal cows. 36 urine samples were collected from Sahiwal bulls, processed and chemical metabolites/volatile compounds were identified using Gas Chromatography-Mass Spectrometry method. GC-MS concludes with 95 peaks from urine sample having molecular weights ranging from 42 to 917 Daltons with the constituents belonging mainly to alkanes, alkenes, alcohols, amides, aldehydes, carboxylic acids, ether, ketones, and phosphates. Based on behavioural investigations, 9 pheromonal compounds were selected. Afterwards, 18 Sahiwal cows were equally divided into 3 groups (T_0, T_1 and T_2). The T_0 group of cows were exposed to NSS which served as control, T_1 group was exposed to fresh bull urine and T_2 was exposed to mixture of synthetic pheromonal compounds which was applied from 20 days postpartum till resumption of ovarian cyclicity. Results indicated that interval from calving to resumption of cyclicity was significantly ($P \leq 0.05$) lower in T_1(55.33 ± 5.36days) as compared to T_0(88.33 ± 7.68days) and T_2 (82.33 ± 12.37days), first behavioural estrus was also significantly ($P \leq 0.05$) lower in T_1 compared to T_0 and T_2. The amount of progesterone concentration

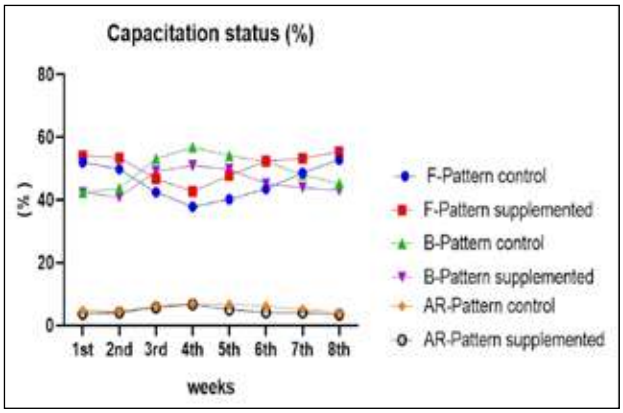
in T_1 group was significantly (P≤0.05) higher as compared to T_0 and T_2 group. It was concluded that bull urine exposed group resumed ovarian cyclicity earlier than control group possibly indicating a rapid response of cows to male stimuli and improved reproductive performance.

Effect of Curcumin supplementation on seminal attributes of crossbred bulls during induced heat stress

An imbalance between heat production in the body and its dissipation is called as state of heat stress. Bull fertility is adversely affected by heat stress. Any strategy which could reduce the adverse effect of heat stress on bull fertility would be a welcome innovation. A study was conducted to assess the effect of dietary curcumin supplementation on seminal and biochemical attributes in crossbred bulls during induced heat stress condition. Heat stress was induced by placing the animals in psychrometric chamber. Both control and supplemented group were exposed to a temperature and relative humidity of 37 ± 2°C and 50%, respectively for 8 h (9 AM to 5 PM) per day for 14 days. Pre and post heat exposure semen samples were evaluated during the experiment. The results indicated that mass activity, individual motility, sperm concentration, viability, plasma membrane integrity and sperm morphology at fresh and post thaw stage were significantly (P<0.05) altered by heat stress. However, these adverse effects were significantly (P<0.05) reduced in Curcumin supplemented groups evidenced by their higher values in supplemented group. Significantly (P<0.05) higher concentration of serum cortisol and testosterone were observed in curcumin supplemented group. It can be concluded that supplementation with Curcumin have been found to ameliorate adverse effects of heat stress in cross bred bulls. The nutritional supplements like curcumin to ameliorate the adverse effects of heat stress in animals could be a beneficial and novel strategy particularly for animals during heat stress.



Individual motility of semen in control and supplemented group during pre-exposure and post exposure period



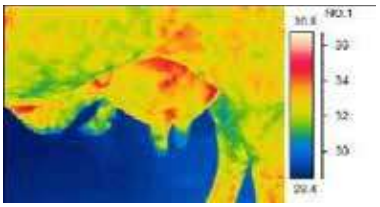
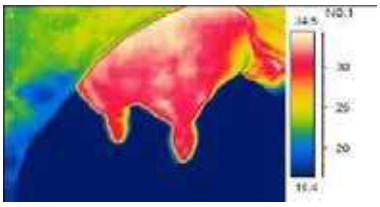
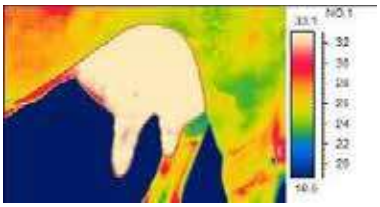
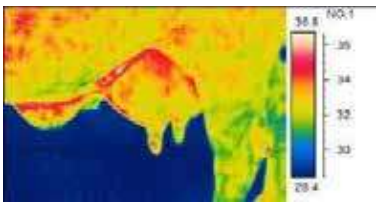
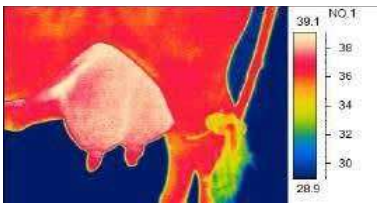
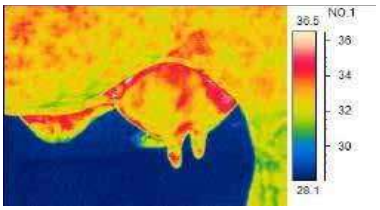
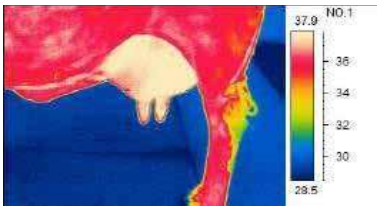
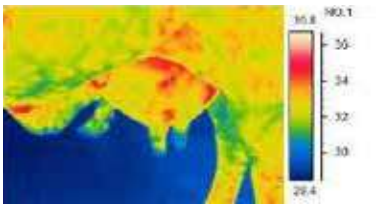
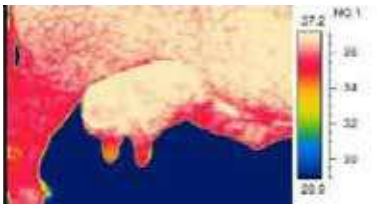
Sperm capacitation status (%) at the post-thaw stage of cryopreservation of control and supplemented group of bulls during post heat exposure

Short milking tube thermogram analysis can indicate sub-clinical mastitis in Cattle and buffaloes

Thermal images of the short milking tube of the milking machine during milking, using a hand-held digital infrared thermal camera (DarviDTL007), were analysed in lactating Murrah buffaloes and Sahiwal to assess the sub-clinical mastitis status. California mastitis test (CMT) and somatic cell count (SCC) of milk samples were carried out to screen the udder quarters as healthy, subclinical (SCM), and clinical mastitis (CM). The thermograms revealed an increase (p<0.05) of 2.19 and 3.72°C in the mean values of short milking tube (SMT) surface temperature among SCM and CM quarters compared to healthy quarters, respectively. The mean values of udder skin surface temperature (USST) for pre-milking, milking, and post-milking of SCM and CM compared to healthy quarters showed an increase (p<0.05) of 2.12 and 1.66°C and 3.07 and 2.45°C, respectively in Buffaloes. The thermogram analysis showed a significant increase (p < 0.05) of 1.11 and 2.04°C in the mean values of SMT surface temperature among SCM and CM quarters compared to healthy quarters, respectively, in Sahiwal cows. Cut-offs for short milking tube temperature were developed using the receiver operating characteristics analysis. Thus, a single thermogram of Short milking tube SMT alone can be used as an efficient detection tool in assessing sub-clinical mastitis in dairy animals.

Seasonal assessment of mastitis using thermogram analysis in Sahiwal cows

Thermal imaging of the udder and teat quarters of Sahiwal cows during different seasons was carried out to identify subclinical (SCM) and clinical mastitis (CM) cases using the Darvi DTL007 camera. A total of 24–69 lactating Sahiwal cows were screened out using IRT regularly throughout the year. The intramammary infection status was further assessed using the CMT. The receiver operating characteristic analysis was carried out to develop the current study's cut-off for various thermographic parameters. The thermogram analysis revealed a significant difference ($p < 0.01$) in the mean values of the udder and teat surface temperature of Sahiwal cows between healthy, SCM, and CM during different seasons. Thermograms showed a strong positive correlation with the CMT scores of SCM, CM cases, and healthy samples. Henceforth, irrespective of the seasons studied in the present work, IRT is an efficient, supportive tool for the early identification of subclinical mastitis.

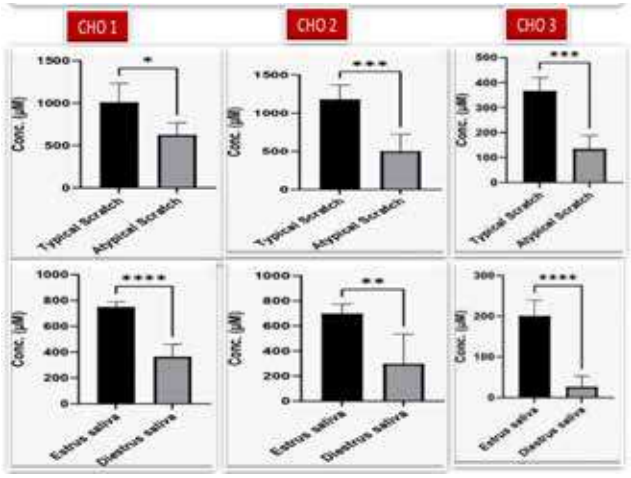
Season	Healthy	Subclinical	Clinical
Winter			
	29.07°C	*31.51°C*	*32.42°C*
Summer			
	36.78°C	*37.88°C*	*38.79°C*
Rainy			
	35.92°C	*36.77°C*	*37.75°C*
Autumn			
	32.47°C	*33.76°C*	*34.86°C*

Thermograms of healthy, subclinical, and clinical mastitis-affected quarters during different seasons of the year in Sahiwal cows

ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS

Glycosylated mucin 1 is responsible for typical fern-like patterns in buffalo saliva at estrus

It has been well established that the buffalo saliva either at the late protestrus or early estrus stage shows typical fern-leaf-like crystallization patterns after drying on a glass slide. Such an observation makes it easier for farmers to identify buffaloes at estrus by using a drop of saliva. However, observing typical fern-leaf-like patterns needs a simple and handy microscope. To avoid a microscope and to further simplify the identification of the ferning characteristic of buffalo saliva, studies were conducted to explore the molecule responsible for typical fern-like patterns of the buffalo saliva. Briefly, the dried saliva showing typical fern-like patterns and atypical fern-like patterns were scratched from the glass slide, and they were subjected to SDS-PAGE, followed by Mass-spectrometry for specific protein bands. The experimental results found that the glycosylated MUC1 is the main reason for typical fern-like pattern formation. In particular, the concentration of 3 candidate carbohydrates was significantly higher in the typical fern-like patterns of the dried saliva than that of atypical patterns. Likewise, higher concentrations of the candidate carbohydrates were found in the neat saliva of buffaloes at the estrus stage than in the diestrus stage.



Comparison of the selected carbohydrates concentrations between typical and atypical fern patterns in saliva, and also between estrus and diestrus saliva

Development of lateral flow immunoassay against BuPAG-1, BuPAG-2, BuPAG-7 and BuPAG-18 using bovine milk samples

Pregnancy detection in milk samples could be an attractive non-invasive method for farmers in dairy animals. Development of LFIA against BuPAG-1, BuPAG-2, BuPAG-7 and BuPAG-18 in milk samples was optimized in this study. The various parameters like type of NCM membrane, sample pad etc. were optimized to develop LFIA for bovine milk. LFIA was developed utilizing monoclonal and polyclonal Antibodies targeting BuPAG-1, BuPAG-2, BuPAG-7 and BuPAG-18 in sandwich type lateral flow immunoassays. The preliminary investigation revealed encouraging results to detect pregnancy in dairy animals by using milk sample.

Pregnant Non-pregnant

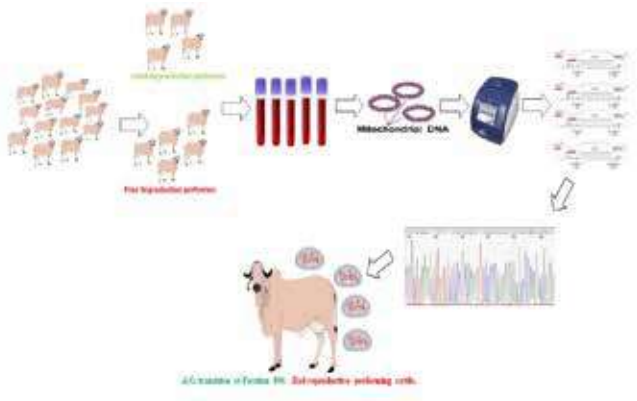
PAG2 based LFIA test for detecting pregnancy in animals by using milk samples

Development of lateral flow immunoassay based on urinary pregnancy-marker sex hormone binding globulin (SHBG)

A sandwich and a competitive format LFIA were developed based on urinary protein marker Sex Hormone Binding Globulin (SHBG). Two polyclonal antibodies generated against SHBG were used for LFIA- one for conjugation with gold nanoparticles while another used at test line. Anti-rabbit secondary antibody was used at control lines. Various development parameters of LFIA like sample pad, nitrocellulose membrane, conjugation pad were optimized for urine samples. The developed competitive LFIA was tested by spiking pure SHBG peptide in the urine samples as well as pregnant and non-

pregnant urine samples. In the competitive format of LFIA, positive sample showed a blank test line while negative sample is having Test line present.

The A/G Transition at Position 869 in the Mitochondrial DNA D-loop: A Key Indicator of Reproductive Performance in Gir Cattle

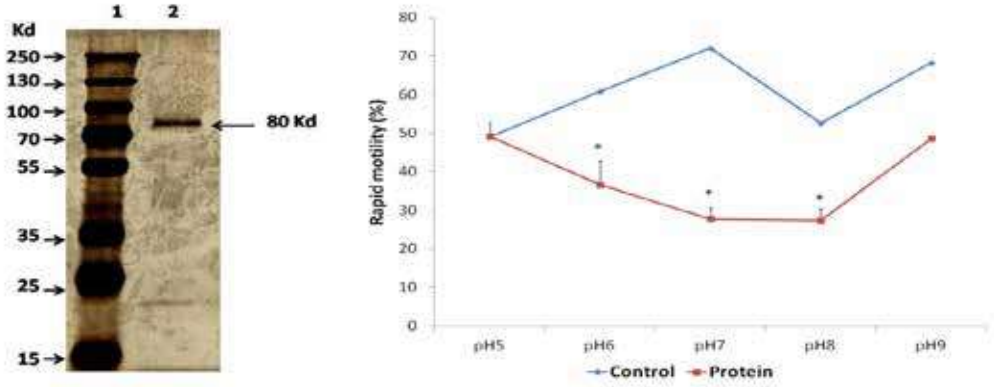


Schematic illustration of the detection of mtDNA D-loop SNPs in Gir cattle as a crucial marker for assessing reproductive performance.

The Gir cattle breed, pivotal to economic development, grapples with the challenge of optimizing reproductive traits amidst global population growth. Reproduction, crucial in livestock production, relies heavily on maternally inherited mitochondria and their unique genome, the Displacement loop (D-loop). This study explores mitochondrial DNA (mtDNA) D-loop single nucleotide polymorphisms (SNPs) in Gir cattle, categorizing animals based on reproductive performance. Good performers exhibit superior reproductive metrics, characterized by shorter calving intervals and gestation lengths. The mtDNA D-loop sequences through Sanger sequencing, revealed 29 haplotypes. Comparative analysis shows that poor performers have more polymorphic sites, transition/transversion biases, and insertions/ deletions (INDELs). Good performers display higher A/G and G/A substitutions, while poor performers show higher T/A, C/A, A/T, G/T, and G/C substitutions. The A/G transition at Position 869 was significantly associated with poor reproductive performance and appeared to impact secondary structure stability, potentially affecting energy efficiency. Further validation of these findings in a larger Gir cattle population and exploration of mtDNA polymorphisms in coding regions could establish a maternal lineage-based biomarker for assessing reproductive efficiency in this indigenous breed.

Purification of 80 kDa sperm–quiescent protein of buffalo cauda epididymal plasma and its functional characterization

The reversible inhibition of sperm capacitation and motility caused by cauda epididymal (CE) proteins has great potential for application in semen preservation. The 80 kDa sperm-quiescent protein of buffalo CE plasma was purified by a combination of Hydroxyapatite (HT) gel adsorption and DEAE-sepharose anion exchange chromatography techniques. The protein caused significant (about 50%) inhibition of sperm motility at 10 µg/ml protein. The protein showed optimum activity at pH 7 (activity present at pH range 6 - 9) and activity was lost after treatment at 70°C for 10 min. It also reduced protein tyrosine phosphorylation during *in vitro* capacitation of sperm.

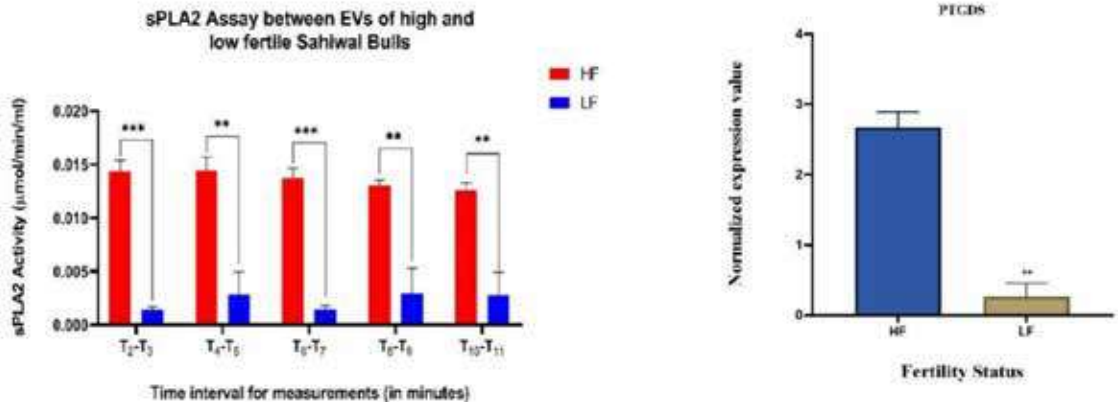


A B

Characterization of 80 kDa sperm-quiescent protein of buffalo CEP; A: SDS-PAGE analysis of purified protein. *1: Protein marker; 2: 80 kDa protein in active fraction of DEAE sepharose chromatography analysis of buffalo CEP;* **B: Effect of pH on protein activity,** *Control: Percoll-washed buffalo sperm in spTALP buffer of different pH, Protein: Sperm treated with 10 µg/ml of purified 80 kDa protein in corresponding buffer*

Identification of sperm functions related enzyme carriages in seminal extracellular vesicles of cattle bulls as a fertility indicator

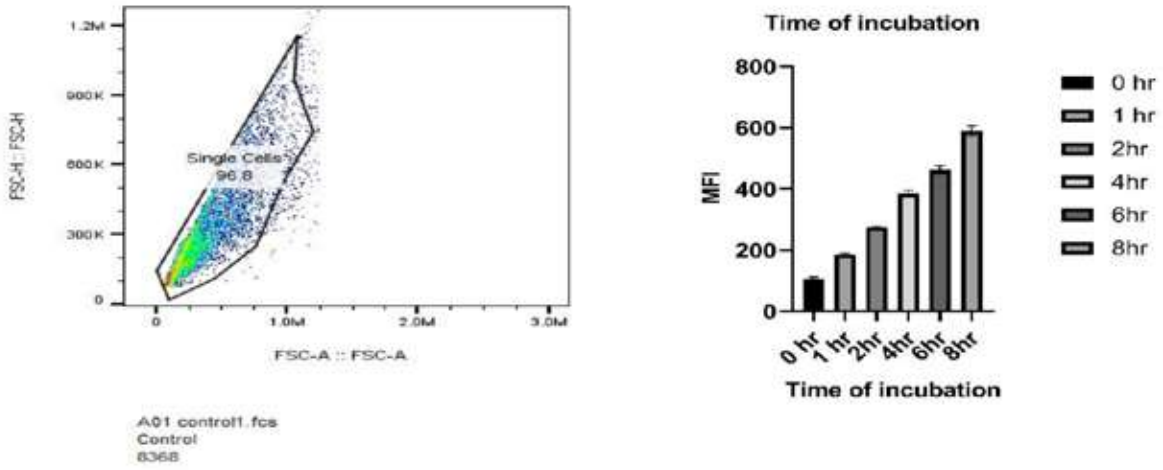
Seminal plasma enzymes such as phospholipase A2 (PLA2), estrogen sulfotransferase (EST), and prostaglandin D2 Synthase (PTDGS) are intricately associated with surface remodeling of spermatozoa in male reproductive tract (MRT) which ultimately determine the fertilizing potential of ejaculated semen. In this study, we assessed the presence of PLA2, EST and PTDGS enzymes in seminal extracellular vesicles (EVs) in distinct fertility Sahiwal bulls. Seminal EVs were isolated and purified by using size exclusion chromatography and pure pool of EVs of distinct fertile bulls were utilized for estimation of PLA2 activity using specific kit with specific substrate. The PLA2 activity was found to be significantly higher ($p<0.05$) in EVs of seminal fluid of high fertile bulls as compared to low fertile. The active mediator D2 (PGD2) modulate various sperm related functions such as motility and capacitation. To confirm the presence of EST and PTGDS in seminal EVs of distinct fertility Sahiwal bulls, protein was isolated from the different pool of SEC fractions of seminal EVs followed by confirmation of abundance of PTGDS and EST using western blotting with β-actin as normalizing control. The PTGDS and EST proteins (log Fc >1.3) were found to be significantly ($p<0.05$) abundant in high fertile EVs as compared to LF seminal EVs. These evidences clearly indicate that millions of heterogeneous populations of EVs in seminal plasma with their enzyme cargo can be utilized for remodeling sperm surface raft as a novel strategy to enhance the fertilizing potential of ejaculated semen of cattle bulls.



Fold change in phospholipase A2 activity and prostaglandin D2 Synthase abundance in seminal extracellular vesicles of high fertile and low fertile Sahiwal bulls

Development of an *in vitro* co-incubation assay for uptake of seminal extracellular vesicles by spermatozoa

To utilize seminal extracellular vesicles (EVs) of high fertile bulls as an essential factor for enhancing the fertilizing potential of low fertile bull sperm, we aimed at developing an *in vitro* uptake model by co-incubation of EVs and sperm at different pH and time interval. Suitability of different pH (6.6, 6.8 and 7.0) and time (0 to 8 h, 1 h interval) was determined for uptake of EVs by spermatozoa using mean fluorescence intensity (MFI) index of flow cytometry. The EVs were initially labelled with PKH26 dye and protocol was optimized with different concentration of dye followed by separation of labelled EVs using size exclusion chromatography (SEC). The PKH26 labelled EVs was utilized for uptake by spermatozoa at different pH conditions such as pH 6.6, 6.8, 7.0. The flow cytometer data as MFI values show that uptake of EVs by spermatozoa increased from pH-6.6; MFI, 682.0 to pH;6.8 MFI, 854.3 and finally decreased at pH 7 with MFI value of 576. Simailrly, optimum incubation period required for uptake of EVs by spermaotozoa was determined in a co-incubation assay from 0 to 8 h with one hour interval. The MFI of spermatozoa cells up taking the labelled EVs on different time of incubation was observed at 1 hr, MFI value of 185.3 and 8 h, MFI value of 590 with an increment order of MFI in between 2 to 7 h without compromising sperm quality. These evidences indicated that pH 6.8 provided the optimal condition for uptake of EVs by spermatozoa *in vitro* model and time of incubation was directly proportional to the uptake of EVs by the spermatozoa. The optimized conditions might be utilized for the uptake of proteins on spermatozoa through EVs *in vitro* conditions.



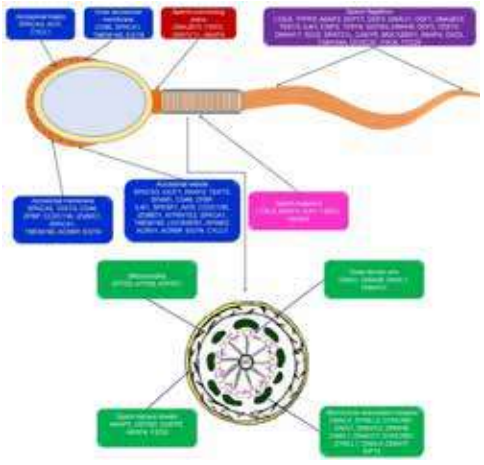
Flow cytometry analysis of the spermatozoa treated with labelled (PKH26 dye) seminal extracellular vesicles at varying times of incubation and graphical representation of mean flouresence indices (MFI) at different time intervals.

Aptamer based enrichment of X- and Y- chromosome bearing sperms and identification of sex specific genes

The Y-sperm specific aptamer (1Y) was used for selectively binding with Y chromosome bearing sperm in mixed bovine semen. Following the enrichment process, aptamer 1Y could bind with Y-chromosome bearing sperms and unbound fraction got enriched with X-chromosome bearing sperms as confirmed by qPCR and subsequently PCR confirmation of IVF embryo. Based on data we observed that X-specific buffalo sperms were enriched with aptamer 2Y, resulted in an increase in the production of more female embryos (65%) as compared to mixed semen using IVF. Further, 'Y' specific (11 genes) and 'X' specific genes (6 genes) were selected to identify the best X- and Y- specific genes for confirmation of gender of the sorted semen and embryos. Genomic DNA was isolated from mixed semen (XY), sorted semen (X and Y) and female blood. Quantitative PCR analysis showed that the HSFY and TSPY genes exhibited the higher amplification with Y-sperm genomic DNA. On the other hand, MAOA and SHROOM2 genes revealed the higher amplification with X-sperm genomic DNA. Our results indicated that HSFY and TSPY were observed suitable to distinguish Y-chromosome bearing sperm, while MAOA and SHROOM2 genes were considered as superior indicator for X-chromosome bearing sperm. Further, *In vitro* fertilization (IVF) trials were conducted to produce buffalo embryos using 3types of buffalo sperm samples, viz., mixed sperms, X- sorted sperms, and Y- sorted sperms. Single embryo PCR was performed via IVF using mixed, X- and Y- sorted sperm. Our results indicated that HSFY and TSPY genes based PCR can be used to identify the Y- specific embryos, and MAOA and SHROOM2 genes for identification of the X-specific buffalo embryos. These genes may be used for determining the sex of embryos and validation of semen sorting.

Fertility associated sperm proteins and their differential abundance in buffalo bulls

Sperm harbours a wide range of proteins regulating the sperm functions and fertility. In the present study, we made an effort to characterize and quantify the proteome of buffalo bull spermatozoa, and to identify fertility associated sperm proteins through comparative proteomics. Using high-throughput mass spectrometry platform, we identified 1305 proteins from buffalo spermatozoa and found that these proteins were mostly enriched in glycolytic process, mitochondrial respiratory chain, tricarboxylic acid cycle, protein folding, spermatogenesis, sperm motility and sperm binding to zona pellucida ($p<7.74E-08$) besides metabolic ($p=4.42E-31$) and reactive oxygen species ($p=1.81E-30$) pathways. Differential proteomic analysis revealed that 844 proteins were commonly expressed between spermatozoa from both the groups while 77 and 52 proteins were exclusively expressed in high- and low-fertile

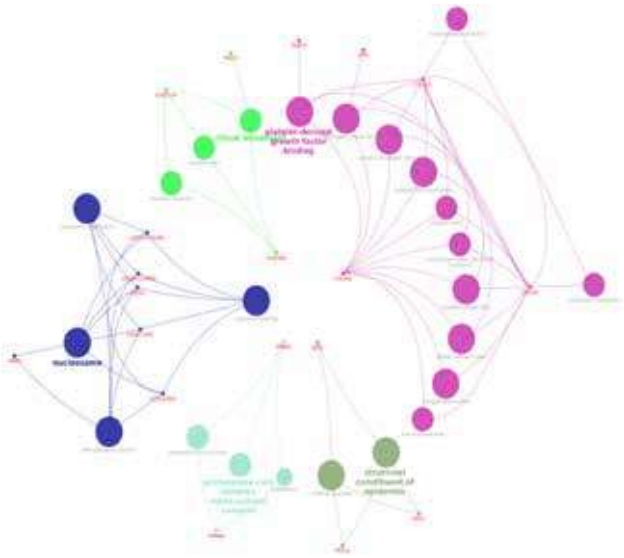


Fertility associated sperm proteins" in blue and italics as earlier

bulls, respectively. In low-fertile bulls, 75 proteins were significantly ($p<0.05$) upregulated and 176 proteins were significantly ($p<0.05$) downregulated; these proteins were highly enriched in mitochondrial respiratory chain complex I assembly ($p=2.63E-07$) and flagellated sperm motility ($p=7.02E-05$) processes besides oxidative phosphorylation pathway ($p=6.61E-15$). The down regulated proteins in low-fertile bulls were involved in sperm motility, metabolism, sperm-egg recognition and fertilization. These variations in the sperm proteome could be used as potential markers for the selection of buffalo bulls for fertility.

High-throughput proteomic characterization of seminal plasma from bulls with contrasting semen quality

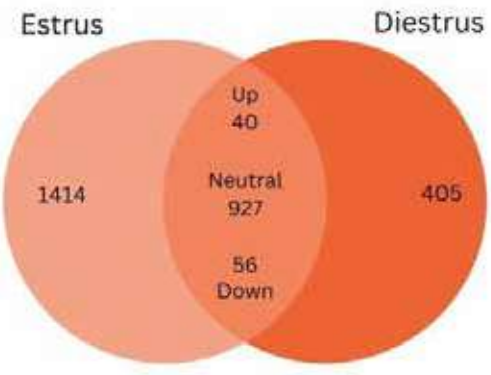
Seminal plasma proteins are the major extrinsic factors that can modulate the sperm quality and functions. The present study was carried out to compare the proteomic profiles of seminal plasma from breeding bulls producing good and poor quality semen in an effort to understand the possible proteins associated with semen quality. A total of 910 and 715 proteins were detected in the seminal plasma of poor and good-quality semen producing bulls, respectively. A total of 705 proteins were common to both the groups, in which 380 proteins were upregulated and 89 proteins were downregulated in the seminal plasma of poor quality semen, while 236 proteins were co-expressed. The proteins negatively influencing sperm functions such as CCL2, UQCRC2, and SAA1 were among the top 10 upregulated proteins in the seminal plasma of poor quality semen. Proteins having a positive role in sperm functions (NGF, EEF1A2, COL1A2, IZUMO4, PRSS1, COL1A1, WFDC2) were among the top 10 downregulated proteins in the seminal plasma of poor quality semen. The upregulation of oxidation-reduction process related proteins, histone proteins (HIST3H2A, H2AFJ, H2AFZ, H2AFX, HIST2H2AB, H2AFV, HIST1H2AC, HIST2H2AC, LOC104975684, LOC524236, LOC614970, LOC529277), and ubiquinol-cytochrome-c reductase proteins (UQCRB, UQCRFS1, UQCRQ, UQCRC1, UQCRC2) indicate deranged oxidation-reduction equilibrium, chromatin condensation and spermatogenesis in poor quality semen producing bulls. The expression of proteins essential for motile cilium (CCDC114, CFAP206, TEKT4), chromatin integrity (PRM2), gamete fusion (IZUMO4, EQTN), hyperactivation, tyrosine phosphorylation, and capacitation [PI3K-Akt signalling pathway related proteins (COL1A1, COL2A1, COL1A2, SPP1, PDGFA, NGF)] were down regulated in poor quality semen producing bulls.



High-throughput proteomic characterization of seminal plasma

Global proteomic profiling of saliva for identification of potential salivary proteins for estrus detection in dairy cows

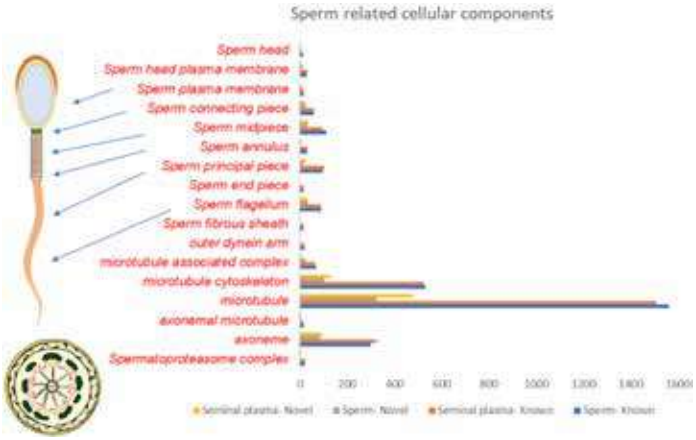
Identification of estrus and breeding at right time is a prime requisite for achieving high reproductive efficiency in dairy cattle. In the present study, comparative global high-throughput proteomic analysis strategy was used out to identify estrus specific salivary proteins in cows. Saliva was collected from cows during estrus and diestrus, and subjected to LC-MS/MS-based proteomic analysis. A total of 2842 proteins were detected in the saliva of cows, out of which, 2437 and 1428 non-redundant proteins were identified in estrus and diestrus saliva, respectively. Further, it was found that 1414 and 405 salivary proteins were specific to estrus and diestrus, respectively while 1023 proteins were common to both the groups. Among the significantly dysregulated proteins,



Proteome profile of cow saliva in estrus and diestrus

expression of 56 proteins was down-regulated (abundance ratio <0.5) while 40 proteins were up-regulated (abundance ratio>2) in estrus compared to diestrus saliva. A majority of the estrus specific salivary proteins were involved in metabolic process, estrogen signaling and steroid biosynthesis pathways. It was inferred that estrus-specific salivary proteins HSD17B12, INHBA, HSP70, ENO1, SRD5A1, MOS, AMH, ECE2, PDGFA, OPRK1, SYN1, CCNC, PLIN5, CETN1, AKR1C4, NM NAT1, CYP2E1, and CYP19A1 have the potential to be used for estrus detection in cattle.

Distinct miRNA cargo in semen of breeding bulls with contrasting fertility: Implications for fertility prediction



Distinct miRNA cargo in semen of breeding bulls with contrasting fertility

"How to predict bull fertility?" is a billion-dollar question due to composite nature of fertility but answering that will benefit every cattle farm around the globe as semen from a single bull is used to artificially breed several thousands of cows. Although miRNAs have been studied extensively as a biomarker for various diseases, their utility in male fertility prediction is yet to be ascertained. Therefore, we analysed the genome-wide miRNAs in semen of bulls with contrasting fertility, with the aim to find out fertility associated miRNAs. We detected 2628 miRNAs (Known-534, Novel-2094) in bull semen (sperm-1002 and seminal plasma-2005). The abundantly expressed known miRNAs in sperm and seminal plasma of low-fertile bulls were involved in spermatogenesis (miR-135a, -197), sperm motility (miR-151-5p, -874), embryonic development (miR-34c, -11976) and epigenetic inheritance (miR-16a). The target genes of these miRNAs were linked to MAPK signaling pathway and PI3K-Akt signaling pathway. MiRNA expression in seminal plasma differentiated bulls based on their fertility. Among the 2094 miRNAs novel to Bos taurus genome, 2071 were new candidate miRNAs. Validation of ten selected miRNAs in sperm and seminal plasma revealed that miR-2285bu and bull-miR-291 were significantly upregulated in seminal plasma of low-fertile bulls. This study points out that miRNAs could be a major player in the background for bull infertility by targeted repression of mRNAs involved in the MAPK and PI3K-Akt signaling pathway.

DMXL1 could be a potential candidate gene for semen quality in Holstein Friesian bulls

The herd's overall financial success is closely tied to the reproductive efficiency of the breeding bulls. Reduced reproductive efficiency in dairy cattle often arises due to the subfertility or infertility of the breeding bulls. We identified candidate genes containing SNPs within the QTL region, with the goal of using them as markers to predict semen quality. It was found that DMXL1 gene and sperm motility were closely related in cattle bulls. Diverse studies emphasized the significance of DMXL1 in various cellular processes and pathways, encompassing cell cycle regulation, cell proliferation, and signal transduction. Further investigation into the DMXL1 gene could offer valuable insights and potentially position it as a candidate gene for semen quality in breeding bulls.

Letrozole: a non-steroidal aromatase inhibitor on ovarian function and controlled breeding in cattle and buffaloes

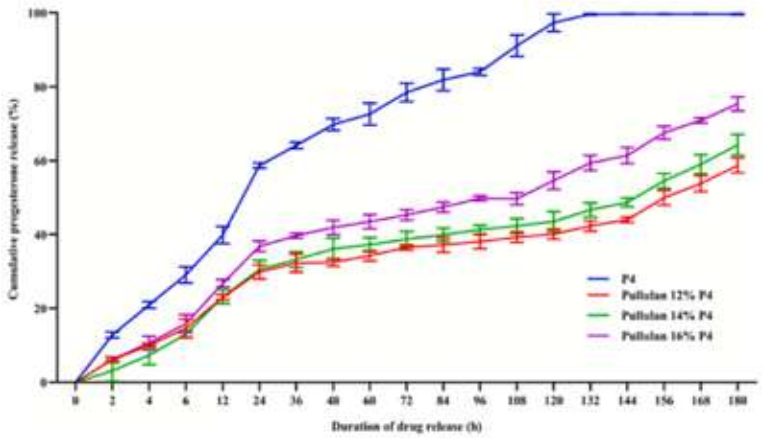
Letrozole, a non-steroidal aromatase inhibitor, can be an alternative approach for estrus synchronization in cattle. The present study was aimed to determine the effect of an aromatase inhibitor (Letrozole) on ovarian function in dairy cattle, and to evaluate the efficiency of an aromatase inhibitor on estrus synchronicity and ovulation rate. A total of 16 Deoni cattle were selected and grouped as a blank vaginal sponge plus PGF2α plus GnRH group (control) (n=6), and a Letrozole vaginal sponge plus PGF2α plus GnRH group (treatment) (n=6). The ovaries of all the animals were observed ultrasonographically before and after treatment to monitor follicular growth, ovulation, and corpus luteum development. Animals that came to heat in each group were inseminated with Deoni bull semen. Results revealed that treatment with Letrozole intravaginal sponges for four days at

random stages of the estrous cycle resulted in synchronization of estrus. The diameter of the dominant and pre-ovulatory follicles significantly ($p < 0.05$) increased in the Letrozole treatment group as compared to the control. The CL diameter, volume & area of the resultant corpus luteum (CL) formed after ovulation was significantly higher ($p < 0.05$) in the Letrozole treatment group. There was no significant difference in CL blood flow area between the Letrozole treatment and control groups. Ovulation was more synchronous in the Letrozole treatment group with higher pregnancy rate than control.

Day wise USG monitoring of dominant follicle growth from the day of sponge removal to ovulation

Development and characterization of progesterone loaded nanofibre for controlled breeding in dairy cattle

Progesterone is a commonly used drug in humans and livestock that possesses huge therapeutic potential in the regulation of pregnancy and fertility in females. The hydrophobicity and need for prolonged therapy of progesterone restrict the exploitation of its therapeutic potential to the fullest. Recently, polymeric nanofibers have evolved as interesting drug carriers, especially for hydrophobic drugs. The present study aimed to encapsulate the hydrophobic drug progesterone in pullulan by electrospinning for controlled delivery. The progesterone was successfully incorporated in pullulan nanofibers and the mean fiber diameter ranged from 68.68 ± 9.71 to 123.12 ± 17.41 nm. Fourier transform infrared spectroscopy revealed the interaction of the drug with the polymer. The cumulative drug release profile indicated prolonged release of progesterone for 7 days from pullulan nanofibers. The kinetic modelling of the drug release revealed Fickian diffusion of progesterone from the polymeric matrix. Cytotoxicity assay revealed optimal survivability of Baby Hamster Kidney cells (60.51 ± 5.81 to 72.39 ± 0.53 %) on exposure to progesterone loaded pullulan nanofibers ensuring biocompatibility. The present study presents process optimization for successful electro-entrapment of progesterone in biopolymer pullulan and its characterization suggesting the potential of progesterone loaded pullulan nanofibers for controlled delivery.

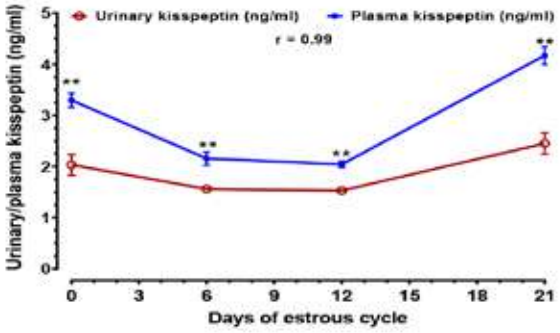


Cumulative drug release from progesterone loaded pullulan nanofibers. Progesterone release from the pullulan nanofibers were significantly ($p < 0.05$) prolonged compared to non-conjugated progesterone. (P4: Progesterone).

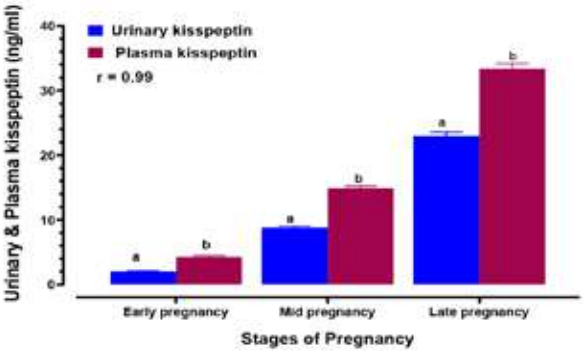
Unravelling the dynamics of urinary kisspeptin during bovine estrous cycle vis-à-vis pregnancy

The aim of present study was to unravel the dynamics of urinary kisspeptin during bovine estrous cycle vis-à-vis pregnancy. Urinary and plasma kisspeptin were estimated in the samples collected from the cyclic cows (n=12) on day 0, 6, 12 and 21 of the estrous cycle and every fortnightly from pregnant crossbred cows (n=58). Our results revealed that urinary kisspeptin levels followed similar trend qualitatively as that of plasma kisspeptin (r=0.99) both during estrous cycle & pregnancy. The plasma kisspeptin concentration on day 0, 6, 12 and 21 of the estrous

cycle in crossbred cows were found to be significantly higher (P<0.01) than urinary kisspeptin. Plasma kisspeptin/creatinine ratio on day 0, 6, 12 and 21 of the estrous cycle in both crossbred cows and black Bengal does was significantly higher (P<0.05) than urinary kisspeptin/creatinine ratio. Plasma and urinary kisspeptin concentrations were found to increase significantly (P<0.05) from early through late pregnancy in both crossbred cows and Bengal does. Plasma kisspeptin/creatinine ratio during different days of the pregnancy in crossbred cows and black Bengal goats was found to be significantly higher than urinary kisspeptin/creatinine ratio (P<0.01). Urinary/plasma kisspeptin and its respective ratio to urinary/plasma creatinine may be used as a potent biomarker and also a non-invasive tool for the prediction of estrus and early pregnancy in crossbred cattle.



Dynamics of urinary vis-à-vis plasma kisspeptin concentrations on day 0, 6, 12 and 21 of the estrous cycle in crossbred cows



Dynamics of urinary and plasma kisspeptin (ng/ml) during different stages of bovine pregnancy. Plasma kisspeptin during all stages of pregnancy was found to be significantly higher (P<0.01) than urinary kisspeptin

Elucidating the crosstalk of endogenous phoenixin, osteocalcin and adiponectin during bovine estrous cycle and pregnancy

Based on the recent studies that spotlighted the potential of kisspeptin (KP) as an antioxidant conferring protective effects against oxidative stress on sperms, the aim of the study was to elucidate the impact of KP supplementation on the post-thaw quality of buck spermatozoa post-cryopreservation. Varying concentrations of KP-10 viz., 0 (control), 5 (T1), 10 (T2), 20 (T3), and 40µM KP-10 (T4) were tested. In the post-thaw evaluation, T3 significantly (P<0.05) enhanced all *in vitro* sperm characteristics and reduced lipid peroxidation level. Functional membrane integrity and acrosome integrity were consistently maintained (P<0.05) across all treatments, and lipid peroxidation was notably reduced in T3 and T4. In conclusion, our findings suggest that KP-10 at a concentration of 20µM is advantageous for the preservation of semen under cryopreserved conditions. These insights underscore the nuanced and context-dependent effects of kisspeptin supplementation on semen quality and provide valuable guidance for optimizing artificial insemination protocols.

Table: Mean (± SEM) *in vitro* sperm characters in post-thaw semen of Black Bengal bucks supplemented with different concentrations of KP-10

Parameters	Control	T1	T2	T3	T4
Progressive motility (%)	37.22 ± 1.41^{a}	40.67 ± 1.45a	41.39 ± 0.97^{a}	44.44 ± 0.80^{b}	41.11 ± 1.03^{a}
Sperm Viability (%)	51.04 ± 2.39^{a}	53.88 ± 1.21a	54.11 ± 1.74^{a}	57.29 ± 0.84^{b}	55.71 ± 1.25^{a}
Functional membrane integrity (%)	40.09 ± 1.25^{a}	48.87 ± 1.00b	50.03 ± 1.16^{b}	54.04 ± 0.78^{b}	53.10 ± 0.70^{b}
Acrosome integrity (%)	62.81 ± 2.95^{a}	68.86 ± 1.65b	69.14 ± 1.46^{b}	72.72 ± 2.16^{b}	72.12 ± 1.79^{b}
MDA(µmol/ml)	2.67 ± 0.07^{a}	2.52 ± 0.03^{a}	2.48 ± 0.04^{a}	2.13 ± 0.05^{b}	2.14 ± 0.05^{b}

Note: Value with different superscripts within each row differed significantly (P<0.05).

FEED, FODDER AND ANIMAL PRODUCTIVITY

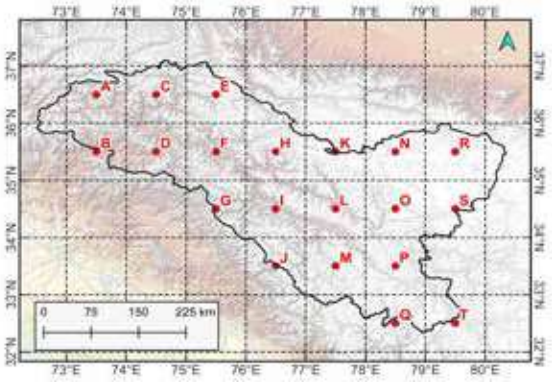
Fodder crop assessment for the dairy industry and potential areas of intensification at the state level

Ground truth data, spectro-radiometer readings, and plant samples were gathered at NDRI farm during the 2022-23 rabi season. Using Google Earth Engine, estimated the acreage of various fodder crops. Employing machine learning algorithms and cloud computing, we achieved a 92% accuracy in delineating the areas of berseem, mustard, napier, oats, wheat, maize, forest (trees), and fallow land by February 2023, totalling 396.14 hectares.

Observations recording with Radio Spectro-photometer

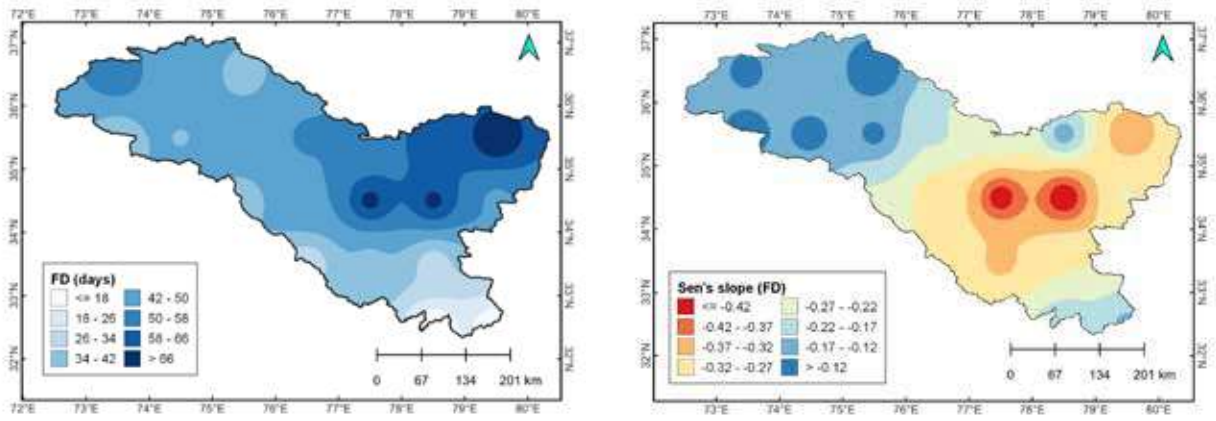
Climate resilient and sustainable agri-based systems for better food, feed, nutritional and livelihood security options for the farming community of Cold arid region in Ladakh

Study area map was generated and divided into 20 grids, each with a size of 1˚ × 1˚ using GIS tools based on data from Survey of India, while elevation and slope gradient data obtained from Bhuvan and digital elevation model available on open topography (Figure). Climatic indices, developed by World Meteorological Organization's Expert Team on Sector-Specific Climate Indices (ET-SCI), analyses completed by employing R-based Cimpact 3 tool.

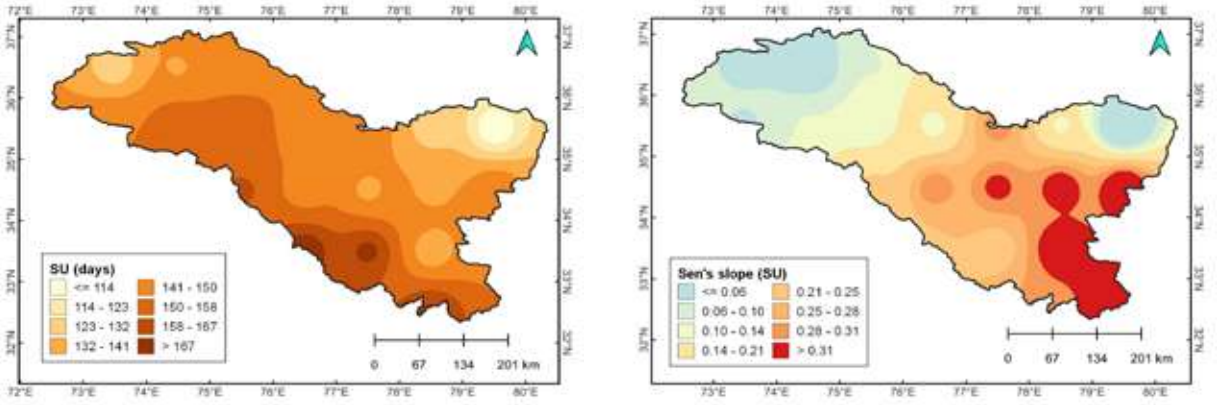


Study area locations with grids

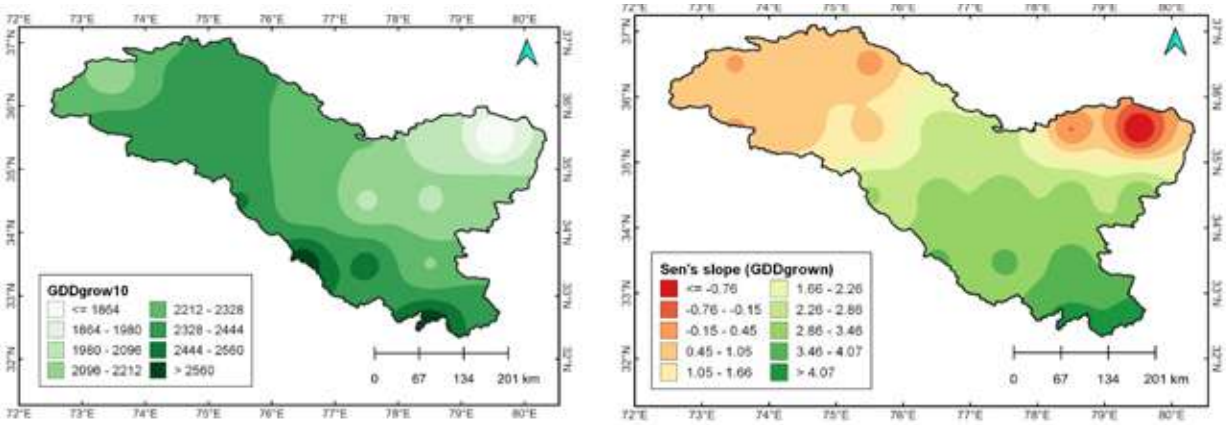
Frost days have steadily decreased across all locations, with projections indicating an average reduction of 10 days by 2040, 18 days by 2070, and a substantial drop of 25 days by 2100 compared to 2010. In areas with human settlement, this decline in frost days is particularly pronounced (Figure). Conversely, the annual number of summer days (exceeding 25˚C) has notably increased (Figure), and growing degree-days exhibit a consistent upward trend, expected to continue (Figure). Under the RCP 4.5 scenario, it is estimated that by 2040, the average daily minimum temperature will rise by up to 1˚C, reaching 2.2˚C by 2070 and 2.6˚C by 2100 compared to 2010.



Spatial distribution of long-term average frost days (Left) and Sen's slope indicating the changing trend of frost days in Ladakh (Right)



Spatial distribution of the long-term average of summer days (maximum temperature remains above 25˚C) (Left), and its Sen's slope indicating its changing trend (right)



Spatial distribution of the long-term average of GDD (Left) and Sen's slope indicating its changing trend (Right)

Fodder resources of Ladakh

Potential fodder plants identified in Ladakh are *Cicer microphyllum, Convolvulus arvensis, Ephedra gerardiana, Fagopyrum esculentum, Heracleum pinnatum, Hippophae rhamnoides, Iris lacteal, Lepidium latifolium, Medicago falcate, M. media, M. sativa, Melilotus officinalis, Populus nigra, Salix alba, S. daphnoides, Sisymbrium loeselii* and *Stellaria media*.

Fodder conservation at Leh

High-quality silage was prepared from sorghum and maize crops using plastic bags. After 3 and 6 months of storage, sorghum silage contained approximately 28.2% dry matter, 8.2% crude protein, and 26.8% crude fiber, while maize silage had about 27.6% dry matter, 10.2% crude protein, and 27.4% crude fiber. These findings provide valuable nutritional information essential for livestock feeding and winter fodder management in Ladakh.

Effect of sewage water on berseem-maize cropping system under different nutrient management practices

Water scarcity is a global concern, urging the conservation of fresh water and the adoption of lower-quality water for irrigation. Treated wastewater emerges as a vital resource amidst decreasing water availability. In India, the shortage of forage crop seeds, notably berseem, is critical. An experiment was conducted on a berseem-maize system, assessing three water sources and four nutrient management levels. Results highlight sewage water's efficacy with a 75% fertilizer dose, yielding superior growth and yield parameters in berseem and maize. Notably, judicious sewage water use can reduce chemical fertilizer application by up to 25% in berseem and maize cultivation and seed production.

View of Berseem crop and effect of various sources of water on root growth

Evaluation of *Moringa oleifera L.* cultivars for quality fodder production under differential plant geometry in eastern Haryana

A field experiment evaluated various moringa cultivars for biomass quality under intensive conditions. PKM-2 at 45×30 cm^2 spacing emerged as the top performer, yielding the highest green fodder and superior proximate analysis results. This cultivar exhibited lower fiber fractions, higher digestibility, and superior nutrient content. Cultivating PKM-2 at 45×30 cm^2 spacing yielded the highest returns and maintained soil health.

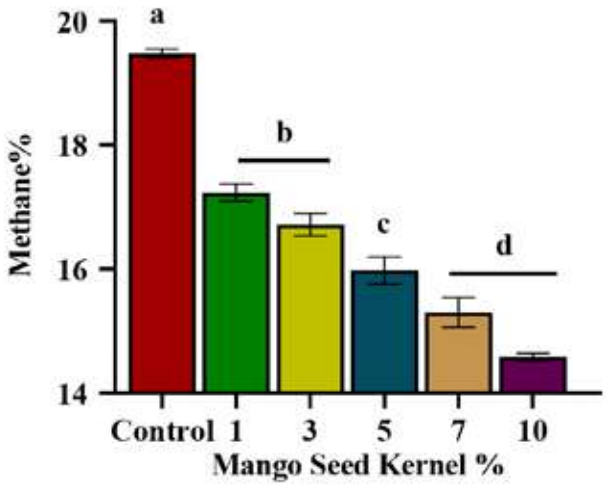
Moringa harvesting for fodder

Integrated organic nutrient management practices for fodder–food–based cropping systems

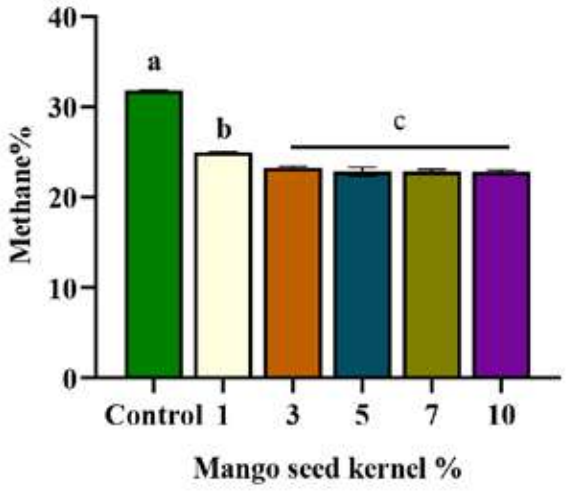
Experiment conducted with six treatments in a fodder food-based cropping system, the results revealed that recommended fertilizer dose yielded the highest in maize+cowpea-wheat-green gram system. PGPR+100% RDN through FYM + panchagavya spray at 25, 35, and 45 DAS, increased available N (196.6 kg ha^{-1}), P (28.0 kg ha^{-1}), and K (208.2 kg ha^{-1}) content.

Effect of mango seed kernel and Ramie fodder on *in vitro* rumen fermentation, methane production and rumen microbial profile

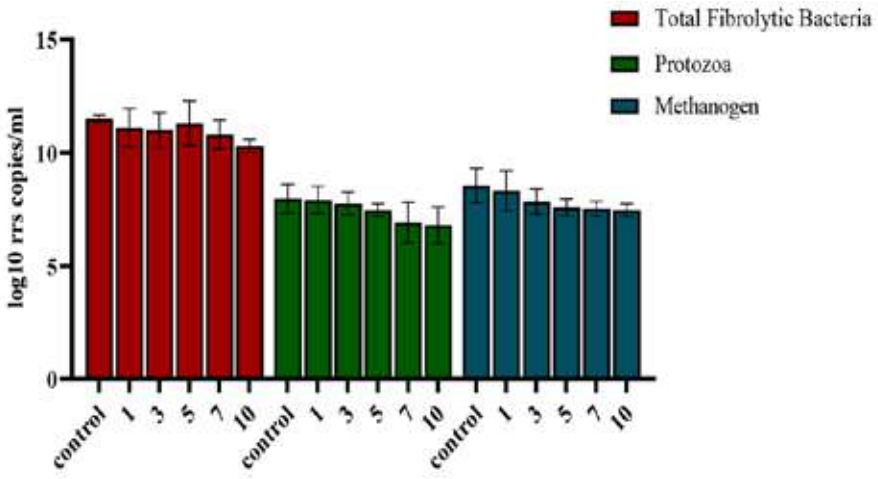
This study was conducted to examine the effect of Ramie fodder (replaced by berseem at 10%, 20%, 30%, 40%, and 50 % levels), and Mango Seed Kernel (1%, 3%, 5%, 7% and 10% level) in 60:40 roughage and concentrate (60R:40C) under *in vitro* condition, individually and in combination. Results revealed that on replacement of Berseem with Ramie total gas production and methane production significantly reduced (p<0.05), and maximum methane reduction was seen at 50% replacement i.e. 14.95%. In addition, Mango Seed Kernel total gas production and methane production significantly reduced (p<0.05), while maximum methane reduction (25.17%) was seen at a 10% level. The combination of 40% Ramie and Mango Seed Kernel significantly (P<0.005) decreased total gas and methane production in all treatments, and maximum methane reduction (27.64%) was seen at 10% mango seed kernel with 40% Ramie. The combination of 50% Ramie and Mango Seed Kernel significantly (P<0.05) decreased total gas and methane production in all treatments, and maximum methane reduction (36.74%) was seen at 10% mango seed kernel with 50% Ramie. Therefore, it can be concluded that the combination of 50% Ramie fodder with 5% Mango Seed Kernel offers a highly effective strategy for reducing enteric methane emissions by 35.99% while maintaining key rumen physiological parameters under *in vitro* conditions.



Effect of 40% Ramie fodder and various levels of mango seed kernel on in vitro methane production (%)



Effect of 50% Ramie and Various levels of mango seed kernel on in vitro methane production (%)



Effects of 50% Ramie and various levels of MSK on abundance (log $_{10}$ copies/ml) of total Fibrolytic bacteria, archaea and protozoa

Efficacy of rumen protected choline and methionine in crossbred cows on health and milk production

Synthetic source of rumen protected choline (RPC) and methionine (RPM) were evaluated against their herbal conjugates and observed herbal sources were superior because these intrinsic molecules are present in conjugation with other biomolecules. Conjugated herbal sources are enhancing the milk production efficiency ($P< 0.05$) when supplemented 60 g/day. The recommended combinations were herbal RPC and RPM or herbal RPC and synthetic RPM.

Improvement of Black Bengal goats for enhancement of productivity in eastern region of India

Black Bengal goat is one of the important dwarf meat type breeds due to its high prolificacy, early maturity, low kidding interval as well as for their delicious meat and high-quality black skin. Effect of different dietary energy and protein level on nutrient utilization, growth performances and carcass quality in growing Black Bengal kids were studied under intensive feeding. To observe the growth performances and carcass quality under intensive feeding, twenty-four weaned Black Bengal kids (90 days age) were divided into four groups e.g., G1, G2, G3 and G4 and were fed under stall feeding for duration of 275 days. Four types of composite ration (contained oat hay and concentrate mixture) were prepared which contained various levels of energy and protein (Diet-1: 14% CP, 55% TDN; Diet-2: 14% CP, 63% TDN; Diet-3: 16% CP, 55% TDN and Diet-4: 16% CP, 63%TDN). The experimental kids in each group were fed the respective diet e.g., Diet-1, Diet-2, Diet-3 and Diet 4 were fed to the kids from G1, G2, G3 and G4 groups, respectively. The diets which fed to the kids (diet-4) in G4 group had 15% more protein (CP) and 15% more energy (TDN) than the diet (diet-1) fed to the goats in G1 group. Daily dry matter intake per unit body weight as well as digestibility of DM, OM and CP were higher ($P<0.01$) in high protein and high energy diet fed group (G4 group) than low protein low energy fed group (G1 group). Kids in G1, G2, G3 and G4 groups consumed 61.3, 65.8, 63.5 and 67.9 g DM/kg$W^{0.75}$/d, respectively. OM digestibility was 60.4, 62.8, 61.3 and 63.7% while cellulose digestibility was 48.2, 43.8, 47.5 and 44.6% in the kids of G1, G2, G3 and G4 groups, respectively. Average daily body weight gain, feed conversion efficiency and dressing % were higher ($P<0.01$) in high energy high protein fed group (G4) than low energy and low protein fed group (G1). Similarly, average daily body weight gain, feed conversion efficiency and dressing % were also higher ($P<0.01$) in the high energy low protein fed kids (G2 group) than low energy and high protein fed kids (G3 group).

Influence of dietary supplementation of inorganic and organic chromium on body weight gain, carcass traits and meat quality of Black Bengal goats

Chromium is one of the important trace elements possessing roles on different metabolic function in animals. The effect of dietary chromium (Cr) supplementation on body weight gain, carcass traits, and meat quality of Black Bengal goats, was studied. The experimental diets comprised a basal diet supplemented with Cr at the rate of 0 (control), 1.0 and 1.5 mg/kg of inorganic Cr (Cr(III)-chloride, and 1.0 and 1.5 mg/kg of organic Cr (Cr-yeast). The average daily gain (ADG) of Black Bengal kids in all Cr supplemented groups were better than the control group, and the ADG of the organic Cr (@1.5 ppm) supplemented group was significantly higher than the rest of the groups($P=0.039$). Cr supplementation improved the feed conversion ratio per DMI ($P=0.09$) and CPI ($P=0.023$) in all the treatment groups. The body morphometry (body length, heart girth, paunch girth, loin width, leg circumference), and the carcass traits, were not significantly ($P>0.05$) changed due to Cr supplementation. However, organic Cr supplementation (1.0 and 1.5 mg/kg) resulted in a reduction of breast and back fat thickness ($P<0.05$) compared to the control group. Crude protein contents in the liver, muscle, kidney, and lungs were greater ($P<0.05$) in the organic Cr groups. In meat (longissimusdorsi muscle), total saturated fatty acid concentration was lower ($P<0.05$) and the unsaturated fatty acid concentration (including palmitoleic acid, hepta decenoic acid, elaidic acid, and arachidonic acid) was greater ($P<0.05$) in Cr-supplemented groups than in the basal diet group. Dietary supplementation of organic Cr in Black Bengal goats significantly improved the bodyweight gain and meat quality with greater protein content, lean, and healthier fatty acids for human consumption.

Impact of feeding nutrient enriched rice straw based total mixed ration with or without exogenous fibrolytic enzymes on growth performance of Jersey crossbred calves

A growth trial of 105 days was conducted on 15 crossbred calves (5-7 months of age) divided in three groups of five animals each, to which fed untreated rice straw (RS) based total mixed ration (TMR) (T0) or with urea-lime-molasses treated RS based TMR (T1) and T1 diet supplemented with EFE mixture @ cellulase6,000 and xylanase18,000 IU/kg TMR DM basis (T2). For T1 and T2 diet RS was pre-treated with Urea, Lime and Molasses

at particular levels in 40L of water, ensiled for 18 days. The TMR was prepared in the ratio of 40:40:20 where 40 parts Concentrates, 40 parts untreated RS/ Pre-treated RS and 20 parts green fodder for all three groups on DM basis. There was significantly ($P<0.05$) lower NDF, ADF and ADL in pretreated TMR diet (T1 and T2) over control diet (T0). The intake of DM, OM and CP ($g/kgBW^{0.75}$) increased significantly ($P<0.05$) in T1 and T2 over T0, but no significant difference between T1 and T2. However, availability of digestible and metabolizable energy intake (Mcal/d/calf) was significantly ($P<0.05$) higher in EFE supplemented group T2, followed by T1 and then T0. The Average Daily Gain (ADG, g/d) was significantly higher in T2 (590.6), followed by T1 (555.8) and then T0 (415.6) whereas, feed efficiency was significantly ($P<0.05$) higher in T1 (14.75) and T2 (15.48) groups as compared to T0 (13.73) group but remained comparable between T1 and T2. Feeding of T1 and T2 diet has economized the ration by 15.42% and 17.99%, respectively over control group (T0). Thus, feeding of nutrient enriched rice straw based TMR diets with or without EFE improved the growth performance and economized the ration.

Effects of ameliorant in rations with different levels of aflatoxin B_1 on feed intake, milk yield and composition

Aflatoxin is one of the greatest challenges faced by the livestock industry for safe animal production. Efforts are being underway to find the suitable nutritional strategies for amelioration of mycotoxin. In this regards, 25 lactating Karan Fries (KF) cows were selected from Livestock Research Centre of ICAR-National Dairy Research Institute, Karnal and divided into 5 groups of 5 animals each based on milk yield, body weight and days in milk (30-50 d). In group T_1, the animals were given basal diet while in groups T_2 and T_3 were also added with $AFLB_1$ to simulate practical situation. The animals in groups T_4 and T_5 were given mannan-oligosaccharides (Nutrivet-MOS) @ 15g/animal/d for amelioration of probable adverse effects of $AFLB_1$. The $AFLB_1$ level in groups T_1, T_2, T_3, T_4 and T5 was about 15, 35, 55, 35 and 55 ppb, respectively. The haematology data (Hb conc. (g/dL), neutrophil concentration (% of DLC) and lymphocyte concentration (% DLC) showed improvement due to MOS addition in the ration of crossbred cows. Reproduction parameters (Days to first insemination, Days to conception, pregnancy rate (insemination/pregnancy) were not affected by the treatments.

Effect of supplementation of nano copper on mineral status and antioxidant activity in Karan Fries calves

Copper is a vital trace element involved in various physiological and biochemical processes and its mode of delivery results in better availability and functionality. Twenty-five Karan Fries calves were divided into five groups with five animals each based on their body weight and age in a randomized block design to study feed intake, nutrient utilization and blood profile. All the animals were fed a basal diet as per nutrient requirements (ICAR, 2013). However, the animals in groups T_1, T_2, T_3, T_4 and T_5 were supplemented with 0, 10 ($CuSO_4$), 1, 5 and 10 ppm (nano Cu), respectively. Concentrate mixture and maize fodder were supplied in the ration in ratio of 40:60 (DM basis) to all the animals. The dietary concentration of Cu was 8.38, 20.07, 9.62, 13.92 and 18.86 ppm of DM in groups T_1, T_2, T_3, T_4 and T_5, respectively. There was significant effect ($P<0.05$) of nano-Cu on absorption of Cu (% intake), 16.14±0.79 and 17.20±0.12 in T_4 and T_5 as compared to 13.10±0.38 in T_2. All Cu supplemented groups had higher ($P<0.05$) Fe absorption than T_1 and the highest value was found in group supplemented with 10 ppm nano-Cu. The plasma concentration of Cu and Fe was higher ($P<0.05$) in all Cu treated groups and highest value found in group supplemented with 10 ppm nano-Cu. The SOD activity was higher ($P<0.05$) in all Cu supplemented groups and lowest value was observed in T_1 and highest in T_5. The GPx, catalase and FRAP activity was higher ($P<0.05$) in all Cu fed groups except in group T_3.

Inclusion of taste and aroma in the total mixed ration and their effect on dietary preference and growth performance of calves

The present investigation was conducted to evaluate the inclusion of taste and aroma in the paddy straw-based diet TMR and their effects on dietary preference and growth performance of calves. Tastes include sweet (sucrose), umami (MSG), salty (NaCl), bitter (urea) and sour (citric acid). Whereas, aromas include lacto-vanilla, maize, guar korma, green grass and silage. In phase 1, sequential elimination trial was conducted and sweet was the most preferred ($p<0.01$). Among the aromas, lacto-vanilla was preferred. These two were carried in phase 2 for growth trial, where the study revealed that net weight gain and average daily weight gain were higher ($p<0.01$) in the taste and aroma-supplemented groups. The higher ($P<0.05$) DM intake (kg/100 kg BW; g/kg BW0.75) was observed in group fed 62.5 g sucrose/kg DM and in group fed combination of both sucrose and lacto vanilla. Thus, paddy straw can be better utilized in the diet of calves by supplementation of 62.5 g/kg DMI of sucrose as sweet taste and 2.5/kg DMI g of lacto vanilla flavour.

Inclusion of flavour in mustard cake based diet and their effects on feed intake and growth performance of Sahiwal calves

The growing global demand for proteins in human and animal nutrition leads to increased interest in other protein sources. Rapeseed / mustard an established ingredient for the production of edible oil could be a promising alternative protein source for animals. Due to greater amount of glucosinolates present in mustard/ rape seed oilcake, which can have varying negative effects on animal performance, palatability, intake, nutrient utilization and general health. If cake is suddenly incorporated in the diet, ruminant animals become off feed. The present study was conducted to mask the flavor of mustard cake. The present study was carried out in 24 *Sahiwal* calves by conducting growth trial for 90 days. The mustard cake was included at 50%, 75% and 100% levels in the diet along with Lacto vanilla flavour supplementation of 2.5 g/kg DMI/d. The higher ($P<0.05$) nutrient intake was observed in 50 and 75% groups compared to control. The highest DM intake (kg/100 kg BW; g/kg $BW^{0.75}$) was observed at replacement of 75% along with increased ($P<0.05$) net body weight gain and the average daily gain in *Sahiwal* calves.

Optimisation of densified total mixed ration in briquette form and their effect on feed intake and performance of *Sahiwal* calves

The compaction of ration carried out using biofuel briquetting screw-press, leads to densification of feed ingredients of low bulk density to higher values thus, minimizing feed wastage and expenses of feed storage and transportation. The complete feed/ rations were processed in the briquette screw press for densification by using molasses as a binder and 24 h cooling time was given for the densified product to harden. Four briquettes were prepared (isocaloric and iso-nitrogenous) varying in NDF and concentrate: roughage ratio (T_1= 65:35, T_2= 60:40, T_3= 55:45, T_4= 45:55). A preferential trial on 24 *Sahiwal* calves was conducted which revealed no significant difference in growth parameters among 4 groups with favorable instantaneous feed response for all four types of briquettes suggesting that animals accepted briquettes readily.

Elucidating the role of spray-dried encapsulated calf-origin probiotics on gut health through *in vivo* models

Probiotics has emerged as the most common and safe feed additive, alternative to antimicrobial growth promoter in animals. The strains *Limosilactobacillus reuteri* SW27 and *Ligilactobacillus salivarius* RBL22 of indigenous cattle calves' origin were spray dried using cryo-protectants (sucrose and trehalose) and prebiotic (isomalto-oligosaccharide). The integrity of the cell membrane of spray-dried bacteria was confirmed by fluorescence microscopy using LIVE/DEAD bacterial viability kit. Further, *in vitro* safety assessments of spray-dried SW27 and RBL22 showed that both strains were non-hemolytic and showed negative responses to gelatinase, urease, biogenic amines, and DNase activities. Moreover, both strains were sensitive to key therapeutic antibiotics except for vancomycin, nallidixic acid, and tetracycline according to the antibiotic disc diffusion assay. Further, an *in vivo* study was carried out by orally feeding (10^8 CFU/mouse/day) of spray dried *L. reuteri* SW27 and *L. salivarius* RBL22 for 35 days against *Salmonella Typhimurium* LT2 (10^7CFU/mouse/single dose/0.2ml). Sixty pathogen-free Swiss albino mice of 2-3 weeks old were randomly assigned to five groups: Group I: CON (control), Group II: SAL, Group III: LS-SAL, Group IV: LR-SAL, and Group V: consortium (LS+LR-SAL). All twelve mice in each group fed adlib diet and the experiment lasted for 35 days. The LS-SAL, LR-SAL, and LS+LR-SAL groups received *L. salivarius* RBL22, *L. reuteri* SW27, and a consortium of both probiotics by gavage every day for the first 17 days of the trial, whereas the control and SAL groups received sterile saline. On day 17, half of each group's mice were slaughtered and samples were collected for analysis. On day 18, *Salmonella* was administered by gavage/single dosage to the remaining animals to the SAL, LS-SAL, LR-SAL, and LS+LR-SAL groups. On the 35th day, the remaining mice were slaughtered and samples taken for analysis. There was no significant deviation in the haemato-biochemical profile, and relative organ indices of the mice before the *Salmonella* challenge. Whereas, a significant ($p<0.05$) decrease was observed in Hb, RBC, and platelet counts, and increased ($p<0.05$) WBC, neutrophils, SGOT, SGPT, urea, and creatinine levels after *Salmonella* challenge. But the negative effects were more pronounced in SAL groups compared to the groups received SAL and LS or LR or both. The levels of harmful enzymes were highest in SAL groups followed by LS-SAL, LR-SAL, and LS+LR-SAL wit lowest levels in control.

Spray-dried encapsulated calf-origin probiotics for gut health

Development of silage inoculant for bioconversion of paddy straw and agro industrial byproducts into strawlage for lactating goats

In order to improve the nutrient utilisation of paddy straw, twelve native silage-specific lactic acid bacteria with fibrolytic activity were isolated and identified for their potential application as silage inoculants. Based on their fibrolytic activity and lactic acid content, two homofermentative bacteria: *Lacticaseibacillus casei* (Lc) and *Lactiplantibacillus argentoratensis* (La)*;* and two heterofermentative bacteria: *Lactiplantibacillus pentosus* (Lp) *and Limisolactobacillus fermentum* (Lf) were selected for lab scale silage preparation and evaluation. Paddy straw was co-ensiled with potato waste and wet distillers' grains in a specific ratio along with xylanase as chemical additive for 40-, 50- and 60-days duration.

Lactic acid bacteria isolated from good quality silage samples

The mean DM content (%) was highest in LcLf group (39.78) as compared to control group (38.06) strawlage. The pH, lactic acid content as well as aerobic stability was significantly higher in strawlage prepared using isolated silage inoculant mixture (*Lacticaseibacillus casei* + *Lactiplantibacillus pentosus and Lactiplantibacillus argentoratensis* + *Limisolactobacillus fermentum*). The *in vitro* dry matter degradability and *in vitro* organic matter degradability of paddy strawlage with silage inoculants were found to be better as compared to other treatment groups. These inoculants, selected based on their silage fermentation potential, were then used for preparing silage for feeding trial in lactating goats. Dry matter intake, body weight, nutrient digestibility and the fat-corrected milk yield were similar in all the groups. A decrease of 18.30% methane (CH_4/kg FPCM) was also found.

Micronutrient blend to attain early sexual maturity in males

Twenty-four calves, ageing 4-5 months with similar bodyweight were divided into four (n=6 animals) i.e. Control group fed as per ICAR (2013) standard consisting of the basal diet concentrate, green roughage and dry roughage as per availability in the farm while animals in groups T_2, T_3 and T_4were fed with basal diet plus micronutrient blend comprising (Zn, Cu, Co, Mn, Cr, it a and vit E). Glutathione peroxidase (GPx) activity was higher ($P<0.05$) in vitamin E supplemented groups T_2 and T_3 while superoxide dismutase (SOD) activity increased in T_1 and T_3 groups. Testosterone concentration was similar at the beginning of the experiment, while 90 days onwards testosterone level was improved ($P<0.05$) in supplemented groups. LH surge was higher($P<0.05$) in group T_3 followed by T_1, T_2 and C. Insulin like growth factor-1 (IGF-1) and blood biochemical parameters like glucose, total protein, albumin, globulin, SGPT and SGOT remains unaltered in groups. Effect on scrotal biometry, where scrotal circumference, paired testicular weight and paired testicular volume was increased linearly ($P<0.05$) with the increase of days. However, seminal parameters viz., sperm concentration, total sperm count, live sperm count, mass activity, progressive motility, acrosomal integrity and HOST response increased while abnormal spermatozoa reduced by micronutrients supplementation at the age of attainment of puberty and after sexual

maturity also. Age of puberty was reduced in T_3 group, followed by T_1, T_2 and C. Therefore, supplementation of micronutrients above the basal level was beneficial for better testicular growth and hormone status, resulted in almost 75 days earlier in puberty and sexual maturity.

Herbal feed additives as methane inhibitors

The current study investigated the methane-mitigating potential and impact on rumen fermentation parameters of seven herbaceous feed additives, namely *Andrographis paniculata, Swertia chirata, Artemisia annua, Mangifera indica* seed kernel*, Carica papaya* leaves*, Euphorbia thymifolia*and *Heliotropium indicum*. Additionally, a synergistic herbal formulation comprising *Andrographis paniculata*, *Mangifera indica* seed kernel, and *Carica papaya* leaves was evaluated at 6 different inclusion levels- 0, 1, 2, 5, 7, 10% levels in 3 TMRs of NDF 30, 40, 50. Individually, *Andrographis paniculata*, *Mangifera indica* seed kernel and *Carica papaya* leaves reduced the methane production under *in vitro* condition up to 20% at 5-7% inclusion level. Other plants' potential was about 5-10% up to 10% level of inclusion. However, the herbal formulation comprising *Andrographis paniculata*, *Mangifera indica* seed kernel, and *Carica papaya* leaves at different ratio, manifests a substantial reduction in methane of 23% in NDF 30. Negligible changes are observed at NDF 40 and 50, indicating effective methane mitigation without compromising digestibility. Hence, both individual herbal plants and the admixture of the plants could be effective in methane mitigation at 5-10% inclusion levels, thereby positioning them as promising eco-friendly alternatives in ruminant nutrition, however, *in vivo* trials need to be conducted for further evaluation.

Comparative metabolite profile of high and low-fertile bulls during different seasons

Fertility is a complex trait with low heritability, and it is influenced by many factors including environmental factors, nutrition and management. It is expected that there is ejaculate to ejaculate variations in sperm and seminal plasma metabolites. In the present study, out of 1820 metabolites in spermatozoa, 81 metabolites were differentially expressed ($P<0.05$), in which 51 metabolites were up-regulated and 30 metabolites were down-regulated in summer season as compared to winter season. Likewise, in seminal plasma in the total of 1150 metabolites, 50 metabolites were differentially expressed ($P<0.05$) out of which 23 metabolites were up-regulated and 27 metabolites were down-regulated. The top 10 metabolites included top 5 up-regulated and top 5 down-regulated metabolites *viz.*, N-dodecanoylsphinganine (11.10 fold change), acetylcadaverine (10.93 fold change), arachidoyl ethanolamide (8.87 fold change), spermine (7.63 fold change) and threonylserine (7.46 fold change) were significantly ($P<0.05$) up-regulated in high-fertile spermatozoa during summer as compared with winter season. The top 5 down regulated ($P<0.05$) in high-fertile spermatozoa during summer were found to be palmitoylcarnitine (-8.21-fold change), sphingomyelin (-7.79 fold change), N, N-dimethylaniline (-7.27 fold change), N-hexacosanoylglycine (-6.10 fold change) and 1-stearoylglycerol (-6.08 fold change). The heat map depicts the fertility related metabolites found in spermatozoa of HF bulls (winter *vs.* summer).

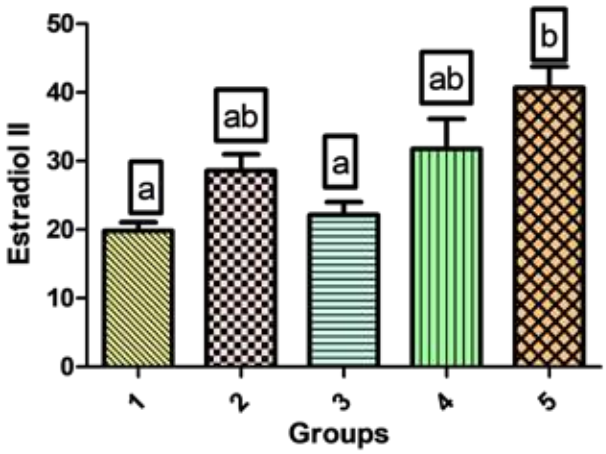
Screening of lactic acid bacteria from milk of *Sahiwal* cow and characterization for probiotic potentiality to prevent bovine mastitis

The aim of the current investigation was to isolate lactic acid bacteria (LAB) with probiotic potential having ability to inhibit mastitis causing pathogens to prevent bovine mastitis. The findings of present study revealed that twenty-three lactic acid bacteria displayed higher acid and bile tolerance ability having more than 90% survivability and less than one log reduction in colony forming units (CFU). Auto-aggregation percentage for SML7 and SML41 was greater ($p<0.05$) being 80.38 ± 0.19% and 80.28 ± 0.04%, respectively. Evidently, the chloroform had the highest percent hydrophobic value as compared to other solvents. SML10 (92.04 ± 0.26 µmol/ml) revealed the highest ($p<0.05$) FRAP activity while SML20 (52.1 ± 0.99 %) presented the highest DPPH scavenging activity. All the strains were non-haemolytic and non-mucinolytic. The highest antimicrobial activity was observed in several strains (SML41, SML63, SML76 and SML60) against common mastitis causing pathogens namely, *Escherichia (E.) coli* ATCC25922, *Staphylococcus aureus* ATCC25923, *Enterococcus faecalis* NCDC114, *Streptococcus agalactiae* NCDC208 and *Enterococcus faecium* NCDC124. The co-aggregation efficacy of SML20 with *S. aureus* was the highest while SML41 showed the highest (69.75±0.29%) co-aggregation efficacy with E. faecali NCDC114 and SML63 with *S. agalactiae* NCDC208. The isolates *Lactobacillus helveticus* SML41, *Lactobacillus helveticus* SML60, *Weissella confusa* SML61, *Lacticaseibacillus rhamnosus* SML63, *Weissella confusa* SML64, and *Pediococcus acidilactici* SML76 found to possess the most desirable characteristics of potential probiotics based on principal component analysis (PCA).

NOVEL APPROACHES IN VALUE ADDITION AND FUNCTIONAL FOODS

Development and evaluation of milk-flaxseed based probiotic beverages for menopausal health

A milk-flaxseed-based fermented beverage suitable for general health management of the female population has been developed. In such a product, milk acts as a source of calcium, whereas, flaxseed can provide phytoestrogen and probiotic can be useful in digestion, nutrient absorption and overall health management for female. Roasted flaxseed have been used in the study. The functional organism *Lactiplantibacillusplantarum* (NCDC 296) was used to ferment low fat milk for suitable time. The milk-flaxseed-based fermented product was prepared by adding roasted flaxseed flour, stabilizer, and sugar in fermented curd. The efficacy of the developed product was evaluated in ovariectomized female rat of 3 months old for 6 weeks and blood estradiol level was evaluated. The optimized product had an overall acceptability score of 8.21 ± 0.5 and a probiotic count of 10^8 CFU/ml. The composition of product was 2.6% fat, 4.47% protein, and 0.71% ash. The beverage was having a shear thinning behavior with the respective L*, a*, and b* values of 69.87 ± 0.30, 2.06 ± 0.67, and 10.83 ± 0.21. The optimized beverage showed favorable effect on blood estradiol level in ovariectomized murine model. The developed beverage was found suitable in addressing hormonal imbalance in female as established by study in ovariectomized murine model. In toxicological study of the product, no toxicity was observed in murine model.



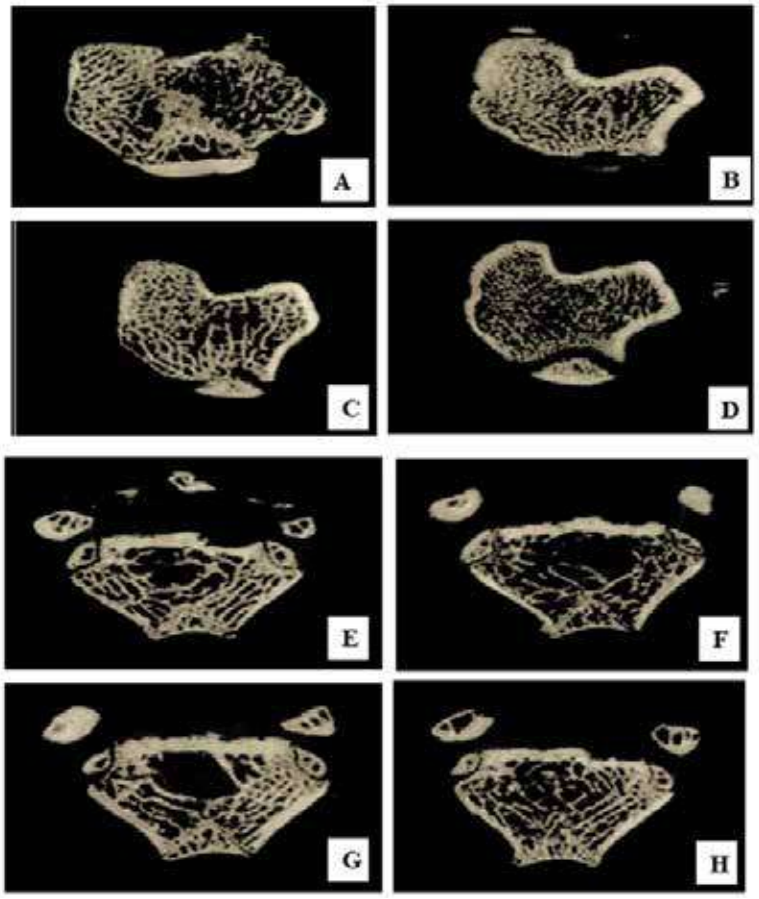
Group 1: Control
Group 2: Sham Control
Group 3: Product without flaxseed
Group 4: Product with flaxseed
Group 5: Developed Sweet product

Effect of optimized product on estradiol level (pg/ml) in murine model

Milk-flaxseed based probiotic beverages

Development and validation of flaxseed lignan-enriched set-type fermented milk to manage postmenopausal osteoporosis

A functional set dahi with a desirable probiotic (Lacti plant ibacillus plantarum A5) count of 9.36 log CFU/mL and excellent techno-functional attributes (DPPH: 41.95% RSA, firmness: 485.49 g, sensory overall acceptability: 8.51) was developed to contain 260 mg of SDG in 20 g of dahi. Twenty-four female Albino Wistar rats (3 months old, >180 g) were ovariectomized (OVX) and divided into three groups: OVX control, OVX and control dahi, and OVX and SDG-enriched dahi. The animal study found that ovariectomy decreased serum calcium, oestrogen, and bone ash calcium levels by 32.27, 30.95, and 48.46 percent, respectively, compared to the sham group (n = 8), while daily administration of SDG-enriched dahi (20 g) for eight weeks restored them. The proximal tibial metaphysis and distal femoral epiphysis micro-CT study showed that the ovariectomy lowered bone mineral density (BMD) by 11.06% and 9.18%, respectively, and lowered Trabecular thickness (TbTh) by 12.66% and 11.86%, respectively, while increasing Trabecular separation (TbSp.) by 90.69% and 87.70%, respectively, compared to the sham control-group rats. SDG-enriched dahi improved BMD by 16.06 and 12.24% and TbTh by 35.32 and 19.62%, respectively, and decreased TbSp by 47.04 and 47.22%, respectively, in OVX rats. The results suggest that the developed set dahi may help treat postmenopausal osteoporosis.

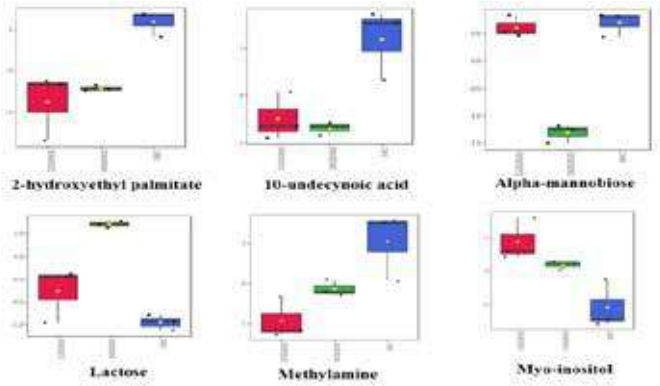


Representative micro-CT 3-D images of proximal tibial metaphysis and distal femoral epiphysis regions. (A) Tibia trabecule—sham control. (B) Tibia trabecule—OVX control. (C) Tibia trabecule—OVX and control dahi. (D) Tibia trabecule—OVX and SDG-enriched dahi. (E) Femur trabecule— sham control. (F) Femur trabecule—OVX control. (G) Femur trabecule—OVX and control dahi. (H) Femur trabecule—OVX and SDG-enriched dahi. Representative micro-CT 3-D images of epiphysis regions. (A) Tibia trabecule—sham control. (B) Tibia trabecule—OVX control. (C) Tibia trabecule—OVX and control dahi. (D) Tibia trabecule—OVX and SDG-enriched dahi. (E) Femur trabecule—sham control. (F) Femur trabecule—OVX control. (G) Femur trabecule—OVX and control dahi. (H) Femur trabecule—OVX and SDG-enriched dahi.

Association studies of metabolome and technological parameters of yoghurt prepared from *Beetal* and *Barbari* goat milk

Yoghurt samples were prepared with three different levels of total solids (TS) (12, 14 and 16%) and types of culture (Commercial culture, NCDC 263, NCDC 144) at the level of 2%. It was found that NCDC 263 exhibited significantly higher ($p<0.05$) firmness, viscosity and lower ($p<0.05$) whey syneresis than NCDC 144 at 16 % total solids. Further, NCDC 263 was used at two different levels (2 and 3%) in the milk with 12 and 16% TS level and the results indicated that rate of acidity development increased with increase in culture level at same TS level. Flow behavior indicated shear thinning behavior of all the yoghurt samples, while yoghurt also exhibited viscoelastic property. Viscosity and firmness were found to be significantly highest ($p<0.05$) at 16% TS level using 3% NCDC 263 culture and lowest for 12% TS level using 2% NCDC 263 culture. Metabolite profiling studies revealed that 12 metabolites and 21 metabolites were differentially regulated ($p<0.05$) in the *Barbari* and *Beetal* breed yoghurt. PCA plots exhibited that TS level in *Barbari and Beetal milk* (12 % and 16% TS) along with type

(NCDC 263 and commercial culture) and level of culture (2% and 3%) had significant effect ($p<0.05$). Regression models demonstrated the significant association of two potential metabolites, methylamine (R2 =0.669) and myo-inositol (0.947), with firmness of *Barbari* yoghurt. Further, firmness of *Beetal* yoghurt was significantly associated with five potential metabolites, 2-palmitoylglycerol, myo-inositol, phenylpyruvic acid, butenedioic acid, and D-talofuranose, each with regression coefficients exceeding 0.6.



Differentially expressed metabolites in Barbari yoghurt

Metabolites	Relative concentration	Firmness (g)	R^2
Myo-Inositol	3486324	69.19	0.947
Methylamine	2242236	69.19	0.669
alpha-Mannobiose	1581955	69.19	0.546
10-Undecynoic acid	62231	69.19	0.264
2-Hydroxyethyl palmitate	484350	69.19	0.166
Lactose	1998913	69.19	0.015

Regression models for metabolites in Barbari yoghurt

Shelf-life enhancement of burfi using edible coating of tapioca starch

Burfi, the khoa-based traditional Indian sweet, despite being rich in various nutrients, contains a high amount of moisture and free fat making it prone to spoilage. Due to the high moisture content, shelf life of the unpackaged *burfi* is restricted to a few days at room temperature. The present study was aimed at enhancement of shelf life of *burfi* using edible coating of tapioca starch. It was observed that 6% starch (w/v) concentration and 1.8% glycerol (v/v) was found to be optimum for development of coating on *burfi*. Optimum time temperature combination for dipping in starch solution was found to be 30˚C for 10 seconds. The optimized coated sample was evaluated for its shelf life at 4 ± 1˚C and 30 ± 1˚C in cardboard as well as poly-propylene (PP) boxes. Significant decrease ($p<0.05$) in moisture content was observed during storage of edible coated *burfi*. Additionally, there was significant difference ($p<0.05$) in free fatty acid content, TBA value, standard plate count and yeast and mold counts of *burfi* during storage at both the storage temperatures. The study (at 4 ± 1˚C) was terminated after 15 days for control and 18 days for coated samples as the SPC exceeded beyond standards at both the packaging materials. At 30 ± 1˚C, due to growth of yeast and mold the storage was terminated after 6 days for control sample and 9 days in case of coated sample.

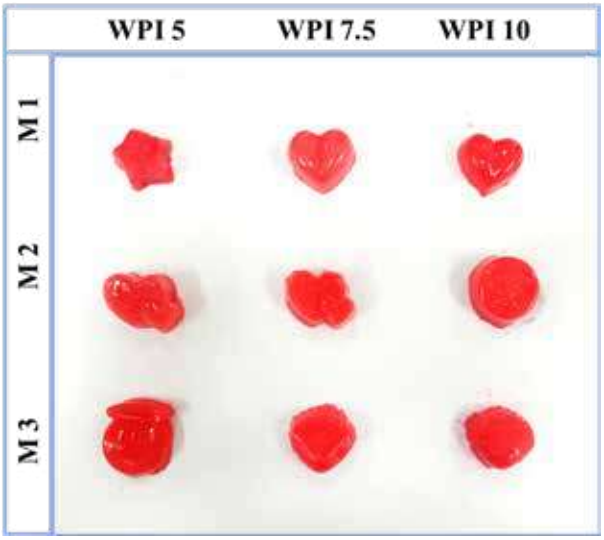
Development of an energy efficient method for industrial preparation of *ghee* using fermented cream

Ghee, a form of heat clarified butterfat, is one among the major indigenous dairy products consumed in India because of its unique pleasing flavour. Further, *ghee* prepared from fermented cream (or fermented white butter) is more preferred as compared to fresh cream (or white butter) because of the volatiles generated as a result of starter propagation. Butteroil is also a fat rich dairy product containing fat level similar to that of *ghee*, but it lacks severely in terms of flavor profile. This is due to the absence of the '*ghee* boiling step' during its preparation. This also makes butteroil preparation an economic process because of the fact that moisture evaporation is performed

under sub-atmospheric conditions. Considering these facts, the present study was conducted to simulate the flavor of indigenous (*desi*) *ghee* in butteroil. This involved mixing butteroil with *ghee* prepared from varying percentages (50%, 60%, and 70% fat) of fermented cream. *Ghee* preparation from fermented cream involved a heat treatment ranging from 110°C to 130°C for 10 to 30 minutes, and final mixing ratio of *desighee* to butteroil. The optimized process was compared with direct cream method of *desighee* preparation. Energy calculations performed during the "*ghee* boiling" step showed that simulating *ghee* flavor using butteroil was a more cost-effective process compared to the conventional method of *ghee* preparation using direct cream method.

Effect of whey protein isolate and gelling agents on quality attributes of gummy confection

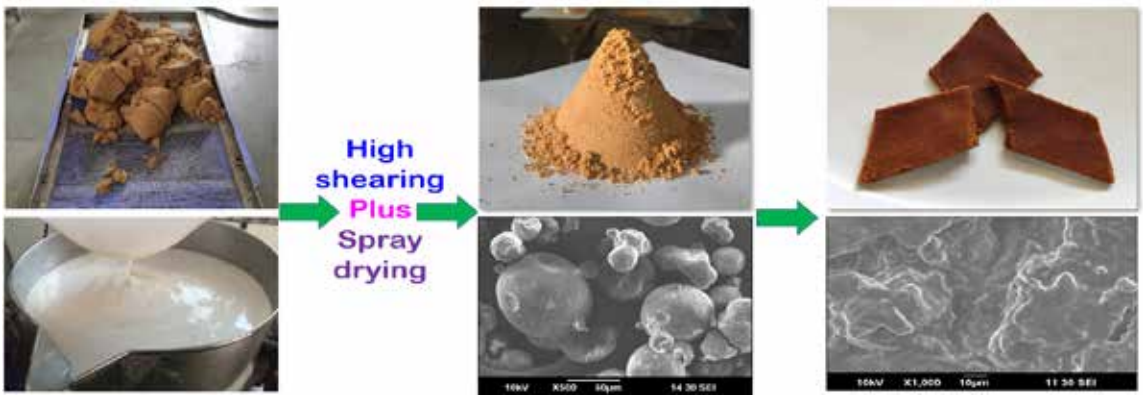
Gummies are a class of confections, which consists of a network of gelling agents holding relatively high moisture containing sugar syrup. In the present investigation, attempts were made to replace gelatine with whey protein isolate (WPI) on the quality attributes of gummies were studied. Control gummies were prepared by using gelatine (6% w/w), malic acid (1% w/w) and sucrose. Experimental samples were prepared by supplementing WPI @ 5, 7.5 & 10% w/w (WPIG) in the control gummy formulation. Variation in malic acid levels (1-3% w/w) had no significant impact on the physico-chemical properties of pectin and agar-agar based gummies, but the hardness values were significantly ($P<0.05$) affected. Agar-agar based gummies received higher sensory scores than pectin gummies. The protein content of agar-agar and pectin based gummies was found to be 4.41 ± 0.14% (w/w) and 4.39 ± 0.16% (w/w), respectively. Overall, the results suggest that vegetarian gummy confections can be prepared by replacing gelatine with WPI and pectin/agar-agar.



Images of gummy confections prepared by varying levels of Malic acid and Whey protein isolate

Preparation of dairy powders from dairy by-products and their application in heat desiccated products/ convenience formulations

The study was aimed to manufacture simulated khoa powder (SKP) using SCBM and ghee-residue. Developed SKP was characterized for various powder parameters and also explored to formulate *burfi* and *gulabjamun*. SEM micrograph revealed presence of variable particle size, clustering and particle infusion responsible for poor dispersibility and solubility. The overall acceptability of SKP samples varied between 'liked moderately' to 'liked very much', but overall acceptability of burfi samples made from them varied from 'liked slightly' to 'liked moderately' on 9-point hedonic scale. SEM micrograph revealed close knit texture and compact body in burfi samples. The use of SKP in preparation of *gulabjamun* was not feasible due to crust formation that hindered the penetration of sugar syrup *inside gulabjamun* samples. Developed SKP powders were stored at 4 ± 1°C and 25 ± 1°C. Storage induced changes in different properties of SKP samples are in progress. The developed powder could be used as a food ingredient in different food formulations.



Conversion of ghee-residue and sweet cream buttermilk into simulated khoa powder and burfi

Technology development for the preparation of ice cream and *kulfi* with the incorporation of ghee residue powders

ice cream is a complex food consisting of small air cells dispersed in a partially frozen, continuous aqueous phase. Ghee residue powder by virtue of its high milk solids could serve as an important ingredient for *kulfi* and ice cream. A process standardization for the preparation of chocolate ice cream and kulfi was targeted with 25-75% replacement of total milk solids (TMS) from ghee residue dispersions and powders. Ice cream and *kulfi* samples were prepared using sugar, cocoa powder, a blend of emulsifiers and stabilizers, prepared dispersions, and powders. Ice cream and *kulfi* mixes prepared with 25-75% TMS replacement. Sensory scores were used to compare control and prepared ice cream and kulfi samples. Ice cream prepared with 50% TMS replacement from SMAGRP obtained maximum sensory scores, while sensory scores of kulfi formulated from the same powder with 25% TMS replacement stand next to the control. Samples with higher sensory scores were selected and stored at -18 ± 2°C for 3 months. During storage, overrun and lightness (L*) values and sensory scores of selected ice cream & its counterpart decreased ($p<0.05$) significantly, however, their hardness, melting rate, a* and b* significantly ($p<0.05$) increased during storage. In case of kulfi, TS, hardness, a*, and b* values of control and selected sample significantly ($p<0.05$) increased, whereas their melting rate, L* value, and sensory attributes significantly ($p<0.05$) decreased during storage.

In vitro & *in vivo* studies on the antioxidant effect of selected dairy by-product powders

This investigation has been aimed to evaluate the antioxidant potential of selected (ghee residue powder, GRP-P1; skim milk admixed ghee residue powder, SMAGRP-P2; Sweet cream buttermilk admixed ghee residue powder, SCBAGRP-P3; desi buttermilk powder, DBMP-P4) dairy by-product powders. This study was conducted in two phases i.e., *in vitro* and *in vivo* studies. Through, *in vitro* assessment, degree of protein hydrolysis and antioxidant capacity determined in terms of DPPH, ABTS, FRAP, flavonoid and total phenolic content of powders was measured. Thereafter, antioxidant effect of these powders was evaluated through *in vivo* studies in mice model up to 75 days. Diabetes was induced in mice model to cause oxidative stress using streptozotocin (STZ) and nicotinamide. Total 48 animals were divided in to six groups consisting of control group, diabetic control group and four treatment groups. Overall feeding of these powders suppressed the elevation of blood glucose levels and different parameters of lipid profile. Among treatment group, the concentration of insulin in the blood serum was T2>T3>T4>T1 which clearly indicated efficacy of these powders against oxidative stress. Levels of oxidative stress markers such as thiobarbituric acid reactive species (TBARS), superoxide dismutase (SOD), reduced glutathione (GSH) and catalase in liver homogenate of treated animals advocated similarity with control group. The concentration of serum urea, creatinine and uric acid (kidney function tests) and aspartate aminotransferase-AST, alanine aminotransferase-ALT (liver function test) were significantly ($p<0.05$) lower in treatment groups over diabetic control group.

Preparation and shelf-life improvement of phospholipids enriched instant *lassi* powder from *desi chhaach*

Desi chhaach is a by-product widely available in the villages. Owing to its higher nutritional value, attempts were made to prepare instant *lassi* powder from it. *Desi chhaach* samples meeting the organoleptic criteria were collected in early morning, pooled and brought to ICAR-NDRI, Karnal in pre-sterilized SS cans (40 kg) at the earliest. For each trail 160 kg sample was used. Just after receiving the pooled sample at ICAR-NDRI, Karnal, it was immediately subjected to physico-chemical analysis. Reverse osmosis (RO) and nanofiltration (NF) was applied to concentrate *desi chhaach* and the former performed better in dewatering of *desi chhaach*. NF could raise the TS of *desi chhaach* up to 19%. Thereafter, it was concentrated, spray dried and the obtained powder was subjected to its detailed characterization. Developed powder was stored at 30 ± 1^{0}C and was stable till 6 month of storage. Furthermore, developed powder was successfully converted into plain, sweet and spiced variant of instant buttermilk spiced and the cost of production for the developed was also estimated.

Manufactured desi chhaach powder

Preparation of buffalo milk protein concentrate 80 having improved solubility

Raw buffalo milk was collected from the experimental dairy plant of ICAR-National Dairy Research Institute, Karnal, India. Buffalo milk was preheated, separated, pasteurized and subjected to chemical analysis. Pasteurized buffalo skim milk was heated and subjected to a pilot scale ultrafiltration and concentrated under constant transmembrane pressure (TMP) at 1 bar until achieving a protein to TS ratio of 0.8 ± 0.01. The permeate flux was continually recorded from flow meter in l/h/m^2 (LHM). The different treatments were given to increase the solubility like infusion of CO_2 at the time of membrane processing and addition of Sodium bicarbonate in the retentate weight before drying along with high shear mixing. The obtained retentate was dried in a single-stage spray drier at 200 ± 5°C and 90 ± 5°C inlet and outlet temperature respectively to obtained BMPC80 powder.

Electrospinning interventions for drying of *Lactiplantibacillus plantarum* inbiopolymeric nanofibres

Electrospinning was employed for drying of *Lactiplantibacillus plantarum* in biopolymericnanofibres. Lyoprotectants such as dextran, lactose and trehalose at 10, 20 and 30% concentrations were evaluated. The mean fibre diameter ranged from 90.32 to 192.50 nm, and the highest survival rate of 91.51% was achieved at 18 kV with 20% trehalose. Factorial analysis showed that voltage had the highest effect ($p<0.05$) on survival rate, followed by the type and concentration of lyoprotectants. FTIR spectra and DSC thermograms of electrospunfibres confirmed the successful encapsulation of probiotic. Electrospinning helped in maintaining the viability of *L. plantarum* above 8 log CFU/g under acid and bile salt conditions. *L. plantarum* was also spray-dried using pullulan and WPI and also freeze-dried using pullulan with cryoprotectants. Fluorescent microscopic images of spray- and freeze-dried *L. plantarum* had very high proportion of live probiotic. The freeze-dried encapsulates had the highest survival rate of 89.97% for *L. plantarum* with 30% lactose as cryoprotectant. The BET surface area of *L. plantarum*-loaded electrospunfibres was 3.81 m^2/g, manifesting Type II adsorption isotherm. In comparison, the BET surface area of spray- and freeze-dried encapsulates was much less at 1.49 m^2/g and 0.23 m^2/g, respectively, and exhibited Type I isotherm. The survival rate of *L. plantarum* in spray- and freeze-dried encapsulates after *in vitro* digestion was also much less at 63 to 73% and 74 to 77%, respectively.

Optimization of process parameters for preparation of foxtail millet payasam mix

Process upgradation of a popular milk-millet dessert, namely *thinai*/foxtail millet payasam was attempted through preparation of a convenience mix of the product using dry – crystallization process. The formulation of foxtail millet *payasam* mix was optimized using mixture design approach. The overall sensory acceptability scores of reconstituted samples varied from 7.08 to 8.00, while viscosity varied from 4.13 to 5.36 N.s. The reconstitution time for all the samples was less than 14 minutes, indicating a ready to reconstitute mix. There was no significant difference ($p<0.05$) between the predicted and experimental values of sensory properties of the payasam mix. Further,the processing conditions for preparing foxtail millet *payasam* mix in a mechanical unit were also optimized. The optimized mixing speed and steam pressure of the mechanical unit were 30-50 rpm and 1.2-1.8 kg/cm^2. The product prepared using the mechanical unit also scored well on sensory parameters.

Assessment of physicochemical and bio-functional properties of Moringa-enriched flavoured milk and yoghurt

Milk and milk products serves as very good vehicle to carry the plant derived bioactive substances. Moringa (*M. oleifera)* based ingredients have proven to be a greater potential to be used in the formulation of various functional foods including dairy foods. Therefore, under this work Moringa pod pulp (MPP) enriched yoghurt and falvoured milk were developed. For MPP powder preparation process was optimized with freeze, oven, microwave and sun drying methods. The prepared MPP ingredients were analyzed for its composition, physicochemical, bio-functional, and antimicrobial properties along with its safety study. Our study had shown that the prepared MPP is good source of dietary fiber and various macro and micro nutrients. In the extended study, MPP ingredients based yoghurt and flavoured milk preparation methodology was optimized. Yoghurt and flavoured milk were fortified with 0.5% and 0.25% MPP powder respectively. Fortified yoghurt exhibited significantly higher values for water holding capacity, firmness, consistency, and lower values for synersis compared to control. Both products exhibited significantly higher values for total phenol content, and total flavonoids content (4-5 folds), antioxidant activity (4 folds), antidiabetic properties (4 folds), and antihypertensive activity (5 folds). The study reports that the MPP could be used as a potential functional ingredient for the formulation of value added dairy products.

Technology for preparation of nutri-cereals incorporated probiotic dairy spread

Finger millet malt and sorghum malt were studied for their prebiotic potential and it was found that sorghum malt significantly ($P<0.05$) increased the viable probiotic *Lactiplantibacillus plantarum* & *Lacticaseibacillus casei* count in the milk –millet composite medium compared to finger millet malt and control. The probiotic curd (PC) was prepared using mixture of sorghum malt (SM), milk protein concentrate (MPC) and skimmed milk and inoculated with probiotic *Lactiplantibacillus plantarum* & *Lacticaseibacillus casei* (1:1) mixed strains. Thus prepared probiotic curd was used as an ingredient in preparation of dairy spread. The levels of other ingredients viz. Butter, MPC, SM, PC and stabilizer were optimized using I-optimal mixture design technique. The ingredients were mixed, heat processed to 85oC for 4 min and homogenized using high shear mixer. Formulation with 39% PC, 13.1% butter, 7.3% MPC, 5% SM and 0.5% stabilizer, 4% cheese, 0.75% salt and 30% water produced sensorially superior product. The probiotic composite dairy spread was found to have viable probiotic count of 10.36 log cfu/g. The probiotic dairy spread thus developed contained 55.6 % moisture, 15.70 % fat on dry basis, 10 % protein on dry matter basis, 16.29 % carbohydrate and dietary fibre 272 mg/100g. The product packed in PS cups and laminated flexi tube (PE/Al/PE) and stored at 5 ± 1°C found to be sensorially acceptable up to 50 days and 60 days and recorded the viable probiotic count of 7.25 and 8.34 log cfu/g, respectively. Consumer acceptability study revealed that, 94 % of the total respondents liked the product.

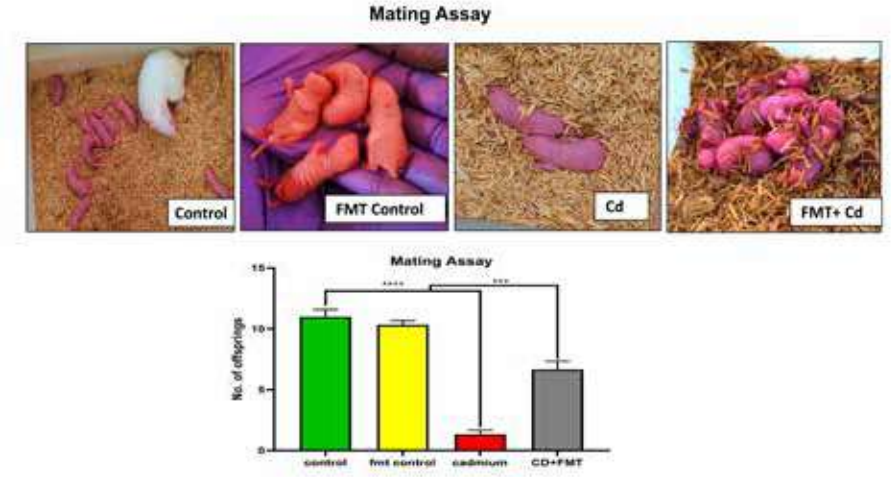
Development of Processed Mozzarella Cheese by incorporating rennet casein gel and whey protein hydrolysate for enhanced functionality

Processed Mozzarella Cheese (PMC) was developed by utilizing Mozzarella cheese as a base material followed by heat processing in the presence of emulsifying salts to produce homogenous glossy mass of cheese with extended shelf life. PMC showed improved meltability and spreadability but due to heat processing its stretching properties gets affected. This happened due to decrease in casein-casein interactions in the presence of emulsifiers and solubilisation of colloidal calcium to soluble calcium due to exchange with sodium, thus meltability increased but it created negative impact on stretchability. An optimized formulation was developed by incorporating rennet coagulated gel (RCG), whey protein hydrolysate (WPH) and combination of 3 different emulsifying salts. The 3 different optimized emulsifiers include trisodium citrate (0.5%), sodium tripolyphosphate (0.5%) and glycerol monostearate (0.5%), thus kept the total emulsifiers content of 1.5% in OPMC. To improve the stretchability, RCG were incorporated at different concentration i.e. 5 to 15% in PMC. Further, 15% RCG provided best stretchability but when PMC was analyzed on pizza base, the cheese threads obtained were found so rubbery and sensory evaluators felt difficulty in chewing. Therefore, some part of 15% RCG was replaced with %WPH in PMC to increase the bio functional and sensorial properties of PMC. The concentration of RCG and WPH was standardized using mixture component-optimal custom design of response surface methodology. The design revealed that RCG and WPH at 11.98% and 3.02%, respectively was best to obtain maximum meltability and stretchability in PMC. The peptide profile of optimized PMC was compared with Mozzarella cheese, other PMC variants and standard (casein) using Electrophoresis. It was observed that β and α-casein bands became more intact on adding RCG as compared to Mozzarella cheese. The contribution of peptides from WPH increased the number of low molecular weight peptides in optimized PMC. During sensory Analysis, Mozzarella was found acceptable up to 2-3 weeks of storage whereas optimized PMC was found acceptable up to 6 weeks of storage. From microbial analysis, shelf life of Mozzarella was found 2-3 weeks whereas optimized PMC has shown shelf life up to 6 weeks.

Therapeutic efficacy of faecal microbiota transplantation on cadmium-induced testicular degeneration in rats

The evaluation of faecal microbiota transplantation (FMT) from rats fed with probiotic (HD-48) to the male rats in which infertility has been induced by cadmium feeding revealed several interesting observations towards therapeutic efficacy of FMT. The Cd + FMT group exhibited increased feed intake, body weight, organ weights, and testes size compared to the Cd control group. Histopathological examinations confirmed the protective effects of FMT on testicular structures, reducing irregularities observed in the Cd control group. Quantitative analyses demonstrated improvements in histomorphometric parameters in both testes and intestine. Mating assays and atomic absorption spectroscopy results indicated a significant increase in the number of offspring and cadmium concentration in faeces for the Cd+FMT group. Male germ cell counts, motility, viability, and membrane

integrity were notably improved in the Cd+FMT group. Antioxidant enzyme levels, including SOD, catalase, and GPx, were significantly enhanced in testis tissues. Overall, the study concludes that oral administration of FMT effectively improves antioxidant enzyme activity, restores testicular integrity, and enhances sperm parameters adversely affected by elevated cadmium levels in male Wistar rats.



*The graph depicts the matting assay of different groups. Statisitical significance was evaluated using One-Way Anova followed by Tukey's test. The bars and error bars represent mean ± SEM. (*** represent P<0.001 and ****P<0.0001)*

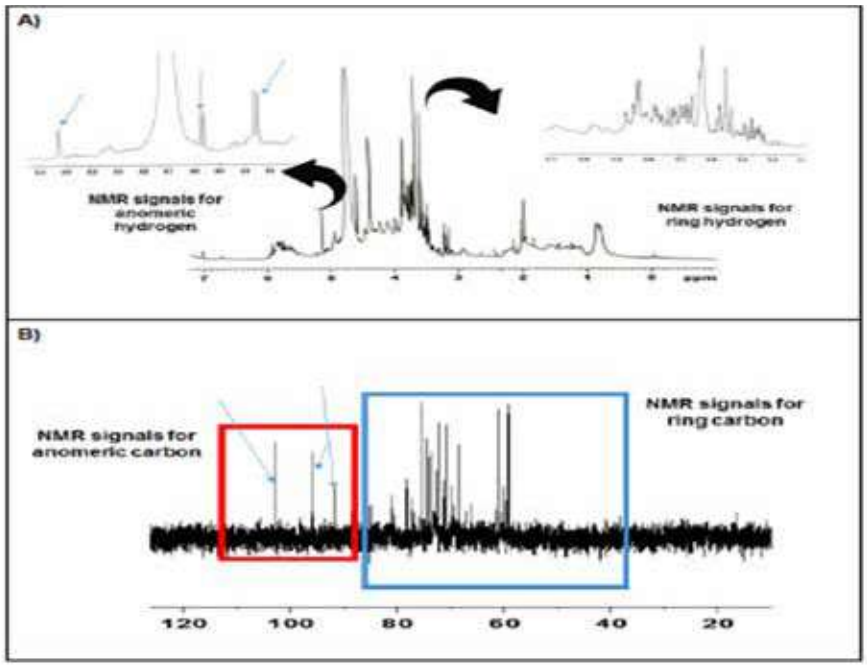
Effect of secondary microbial succession on combined heat and psychological stress-induced female infertility in murine model

The study provided the protective potential of faecal microbiota transplantation (FMT) agnaist female infertility. The FMT was performed from the mice fed with a probiotic *L. plantarum* HD-51 to the female mice, in which infertility was induced by stressors, such as restraint stress, tilted cage stress, feed deprivation, wet bedding stress and heat stress in female Swiss albino mice. The feed intake, body weight and its related parameters were improved in the CS+FMT group when compared to the CS (Control stress) group. The diestrous phase in the CS+FMT group was significantly improved as compared to the CS. Similarly, liver function tests and ovarian antioxidant enzymes activity were also improved in CS+FMT group than the CS group. Behaviour parameters recorded from sucrose preference test, plus maze test, open field test, forced swim test and tail suspension test showed a decrease in the mobility, which is an indication of the depressive-like behaviour, in the CS group mice. However, the CS+FMT group showed a significant increase in their mobility, indicating their active behaviour. Histology of the intestine showed abnormal crypts and leaky gut appearance in the CS group than the CS+FMT group. Likewise, ovarian histopathology also showed the degraded follicles and ruptured ova in the CS group compared to the CS + FMT group, indicating the positive role of FMT on a recovery from stress. Mating Assay confirmed the beneficial effects of FMT, CS + FMT group produced more no. of offspring than the combined stress group.

Extraction and partial characterization of extracellular matrix components derived from probiotic lactobacill

Extracellular matrix components, such as surface proteins (SP), EPS and peptidoglycan (PGN), from probiotic lactobacilli were extracted in the present study. The yield of SP including accessory proteins were found to be highest at 8 and 12 h of growth from *L. fermentum* (LF) MTCC 5898 (0.5 ± 0.05 mg/g) and *L. rhamnosus* (LR) MTCC 5897 (2.65 ± 0.17 mg/g), respectively. Similarly, the total sugar determined in the extracted surface proteins was 1.01 ± 0.23 mg/g and 1.33 ± .09mg/g at 8 h and 12 h of growth in LF and LR, respectively. The SDS-PAGE electrogram of extracted surface proteins from *L. fermentum* and *L. rhamnosus* showed about fifteen and 21 major and minor protein bands, respectively. The major intense bands ranged between 35-70 kD, with the presence of a glycoprotein band of 70.6 kDa during the stationary growth phase of *L. fermentum*. The bound EPS (EPS-b) production in *L. fermentum* was found to be directly related

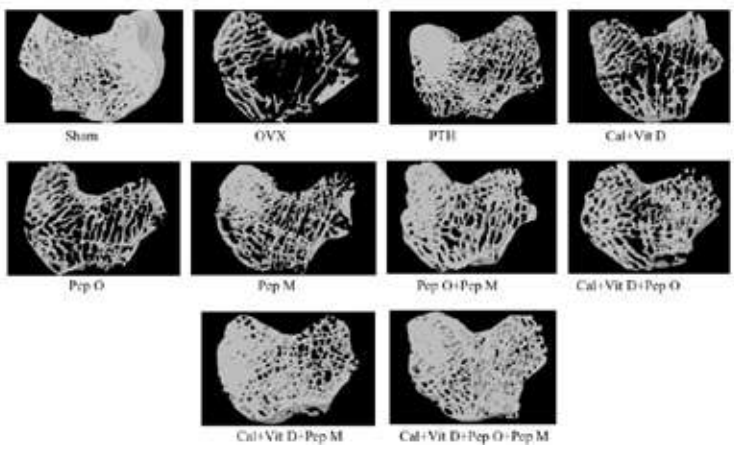
to bacterial growth phase. Ion exchange chromatography on the DEAE sepharose column was carried out to fractionate EPS-b extracted from either of the *lactobacillus* strains (*L. fermentum* and *L. rhamnosus*). Amongst the 4-5 peaks eluted with a stepwise gradient of NaCl (0.1 M to 0.9 M), one peak eluted with 0.1 M NaCl was detected as the major peak having most of the EPS-b with a molecular weight of 96.97 kDa and 59 kDa from *L. fermentum* and *L. rhamnosus*, respectively. Subsequently, the purified EPS was characterized by UV-Vis spectrophotometry, Fourier Transform Infra-Red Spectroscopy (FT-IR), NMR and chemical analysis. In addition, PGN was extracted and its yield was remarkably ($P<0.05$) increased from the early to late logarithmic growth phase of *L. fermentum* and *L. rhamnosus*. The isolated PGN was confirmed qualitatively using lysozyme assay. Additionally, UV spectral analysis of extracted PGN revealed a sharp absorbance peak of carbohydrates at 210 nm indicating the qualitative characteristics of PGN. Furthermore, the content of glucosamine and uronic acid was also estimated to be 26.29±2.42 and 20.65±1.45 g/100g of total carbohydrate, respectively, confirming the successful isolation of PGN. Finally, the molecular weight of the PGN complex was also determined using SDS PAGE.



NMR spectral analysis of EPS extracted from probiotic L. fermentum

Osteoprotective effect of casein-derived peptide(s) supplemented with calcium and vitamin D in OVX rats.

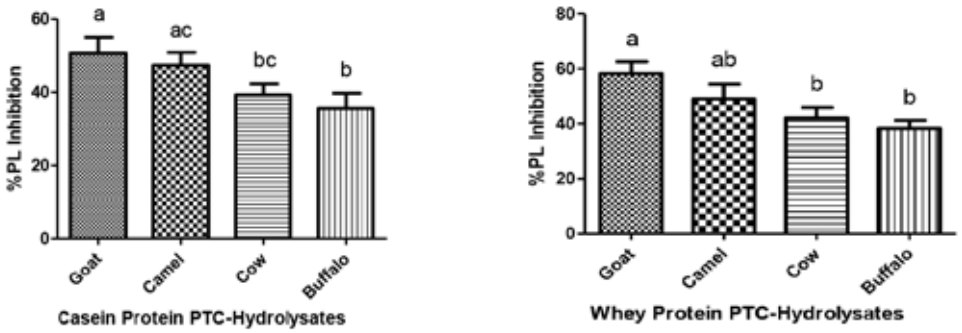
The present study was initiated to analyze the osteoprotective effect of casein-derived peptide(s) supplemented with calcium and vitamin D in ovariectomized (OVX) rats. It was observed that the OVX group treated with calcium, vitamin D, Pep O and Pep M has significantly inhibited atrophy of uterine wall thickness. In all the treatment groups, bone resorption was reduced by inhibiting bone turnover markers (ALP and OCN) and decreased proinflammatory cytokines TNFα and IL-6. Bone resorption marker, TRAP5b was decreased in groups treated with formulations having calcium and vitamin D, and RANKL was decreased only in Pep O and Pep M treated groups. Micro-computed tomography analysis of distal epiphysis of the femur and proximal metaphysis of the tibia revealed that alteration of bone microarchitecture due to OVX was recovered mainly in the group treated with calcium, vitamin D, Pep O and Pep M, depicting a similarity to the normal sham group. RANKL/OPG gene expression ratio is a marker of bone resorption, the decrease in the ratio was found to be significant in groups administered with two different formulations, one containing Pep O and Pep M; and the other having calcium, vitamin D, Pep O and Pep M. Principal component analysis also supported the results. The experiments of the biosafety study showed that formulations with different peptide concentrations have not disturbed general health attributes in comparison to the control. The apparent digestibility coefficient and retention of calcium were improved in groups treated with formulations compared to the control group and the bone anthropometric parameters and bone ash calcium of treated groups were similar to the control group.



Effect of different osteoprotective formulations on the trabecular microarchitecture of the tibia bone in OVX rats. The pictures represent the 3D micro-CT images of the proximal tibia metaphysic region of various experimental groups

Milk casein and whey protein hydrolysates exhibited anti-obesity potential

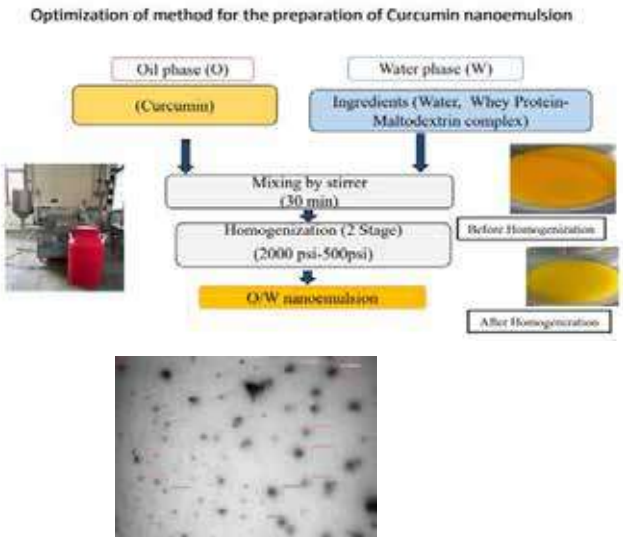
Obesity is abnormal or excessive fat accumulation in the body that impairs health. Obesity kills more people than malnutrition and underweight. The important target for the treatment of obesity includes inhibitors of enzymes involved in fat digestion among which the important enzyme is pancreatic lipase enzyme. Casein and whey proteins derived from goat, camel, cow and buffalo milk were hydrolysed by Pepsin (P), Trypsin (T) and Chymotrypsin (C), PT, PC, CT and PTC. The hydrolysates were filtered through 10 KDa ultrafiltration membranes. The filtrate is then assessed for pancreatic lipase inhibition potential. Among all the hydrolysates prepared from milk of different species, PTC exhibited the maximum inhibition. In comparison, casein and whey protein PTC-hydrolysate exhibited the pancreatic lipase inhibition potential in the following order: goat>camel>cow>buffalo.



Pancreatic lipase (PL) inhibition by (a) casein protein hydrolysates and (b) whey protein hydrolysates derived from goat, camel, cow and buffalo milk by pepsin (P), trypsin (T), chymotrypsin (C), PT, PC, TC and PTC

Curcumin nanoemulsion using whey protein- maltodextrin conjugate

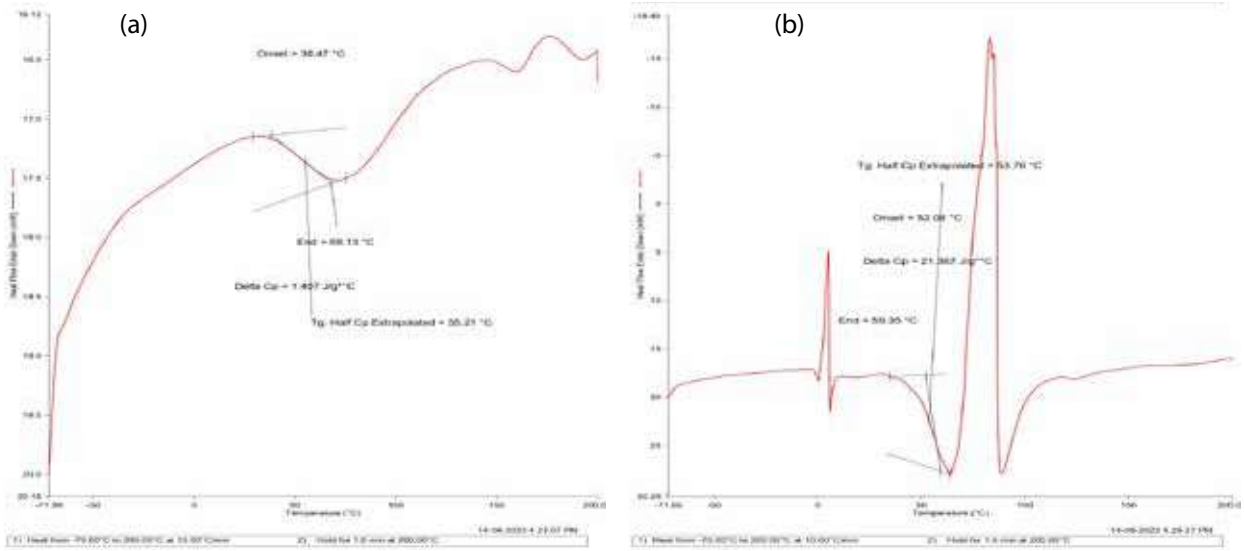
The process for the preparation of whey protein—maltodextrin conjugate-based curcumin nanoemulsion was optimized. Whey protein concentrates and maltodextrin in the ratio of 1:2 was heated at 60°C for 60 min at pH 7.0 to get the WP-MD complex. The degree of glycation corresponded to 25.83 ± 3.19%. The prepared complex showed excellent emulsifying properties. The particle size of curcumin nanoemulsion using conjugate corresponded to 134.53 ± 1.27 nm and zeta potential -5.28 ± 0.29 mV. The nanoemulsion was stable during storage at 7° C and 25° C over one week. The magnitude of the zeta potential remained similar during storage. Curcumin emulsion was stableunder different processing conditions such as pH (3-8) and temperature (40-60), however, non-significant changes were observed under ionic concentration (0.1M to 1M). Under simulated GI conditions, the nanoemulsion showed a slow release of curcumin. The bio-accessibility of curcumin under *in vitro* gastrointestinal conditions was observed to be 39.23 ± 0.53%.



TEM analysis of curcumin nanoemulsion

Change in Glass transition temperature of lactose hydrolysed milk powders

Milk powder samples i.e., SMP (P1), single enzyme-based lactose hydrolyzed milk powder (P2) and multi enzyme-based LHMP (P3) were analysed for their Tg using differential scanning calorimetry (DSC) (Fig. a, b, c). The DSC thermograms of milk powders revealed that Tg values of powder P1, P2 and P3 on the initial day of storage were 55.21 °C, 52.49 and 53.76, respectively. The highest value of Tg was observed for powder P1 and the Tg value of LHMP (P2 and P3) was comparatively lower. This lowering down of Tg for powder P2 and P3 was due to the hydrolysis of lactose into glucose and galactose. Glucose and galactose are lower molecular weight carbohydrates as compared to lactose. The Tg of carbohydrates decreases with a decrease in molecular weight. However, the Tg obtained for LHMP (P1 and P3) was higher than those reported in the literature. This increase in Tg of powder P2 and P3 can be due to the presence of GOS in the milk powder. The Tg value of pure GOS is 135.1°C which is higher than the Tg of lactose (101 °C), glucose (30 °C) and galactose (31 °C). Hence, the presence of GOS increased the overall Tg of powders P2 and P3. Powder P3 has a slightly higher Tg than powder P2, this increase may be due to a reduction in glucose content of the powder brought about by the use of glucose oxidase as the molecular weight of gluconic acid is 196 g/mol which is higher as compared to glucose (180 g/mol). The reduction in glucose content decreases, and the monosaccharide ratio to GOS (from 8:1 to 6.7:1) results in a higher Tg.

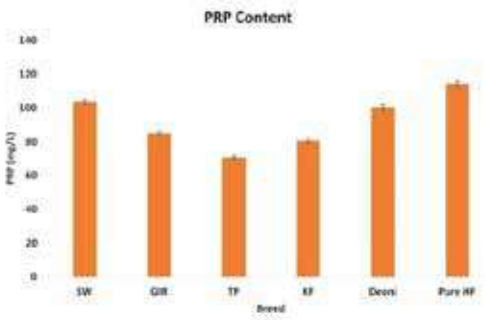


Differential scanning calorimetry (DSC) thermogram of (a) SMP (P1); (b) Multi enzyme-based LHMP (P3) at 0 day

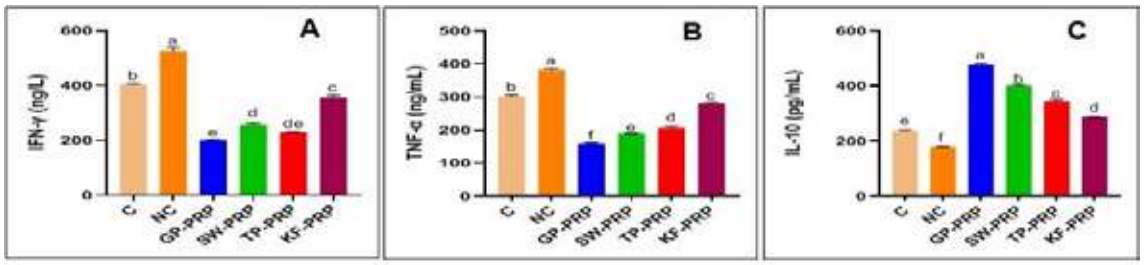
DEVELOPMENT AND VALIDATION OF HEALTH PROMOTING DAIRY FOODS

Isolation of proline-rich polypeptides from colostrum of select indigenous cattle breed and evaluation of their nutraceutical potential

Proline-rich polypeptides were isolated from Deoni and HF breeds and compared with other breeds viz., Sahiwal, Gir, Tharparkar and Karan Fries. Sahiwal has highest amount of PRPs content compared to other indigenous breeds, however, HF colostrum has maximum amount of PRPs. The bands of electro gram confirmed that isolated PRP has molecular weight less than 10 kDa. The total proline content of the isolated PRP has 21.4% proline, hence, it confirmed that the isolated PRP is proline rich. Total number of sequences identified were 2199 and 2724, respectively in Sahiwal and HF breed. Out of these 26 sequences of Sahiwal and same number of sequences from HF breed were annotated with UNIPORT data base, having expect (e) value less than 10-3. *In vitro* analysis indicated higher phagocytic activity and moderate lymphocyte proliferation index of PRPs from Indigenous breeds. Furthermore, immunomodulatory effect of the PRP was evaluated through the *in vivo* studies in mice model. It revealed that serum of mice challenged with *E. coli* has higher IgG and IgA concentrations when fed with PRP from Indigenous breeds compared to PRPs of Karan Fries. Level of anti-inflammatory cytokines (IL-10) was higher and pro-inflammatory cytokines (TNF-α, IFN- γ) was lower in mice fed with PRPs from indigenous breeds.



Proline rich polypeptides (PRPs) concentration from colostrum of different breeds, expressed in mg/L.

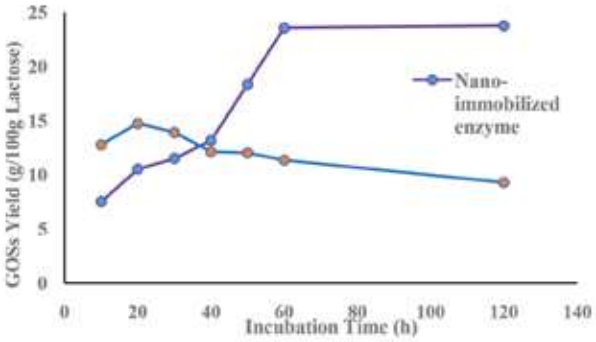


C-Control; NC-Negative Control; GP-PRP from Gir; SW- PRP from Sahiwal; TP-PRP from Tharparkar; KF-PRP from Karan Fries; IFN-γ - Interferon-gamma; TNF-α - Tumour Necrosis Factor - Alpha and IL-10 - Interleukin 10

Effect of PRP supplementation on cytokine profile

Application of nano-immobilized β-galactosidase for production of galactooligosaccharides from dairy by-product

The β-galactosidase immobilized on glutaraldehyde functionalized mesoporous silicon dioxide nanoparticles to enhance the stability and galactooligosaccharides (GOSs) production ability in paneer whey. Nano-immobilization increased the stability of enzyme under extreme environmental conditions (temperature (30-70 °C) and pH (5.0-8.0) and during storage. The nano-immobilized enzyme produced 2.35 times more GOSs than the free enzyme in concentrated paneer whey under batch condition. The GOSs production remained



Nano-immobilization enhanced the stability and galactooligosaccharides (GOSs) production ability in paneer whey

consistent for several cycles of operation (5 cycles of operation). The nano-immobilized enzyme also showed consistency in GOSs production under continuous mode of operation in a packed bed reactor. Overall, the nano-immobilized enzyme showed better GOSs production ability under batch and continuous mode of operation from paneer whey.

Valorization of ghee residue as a source of phospholipids for application in select food products

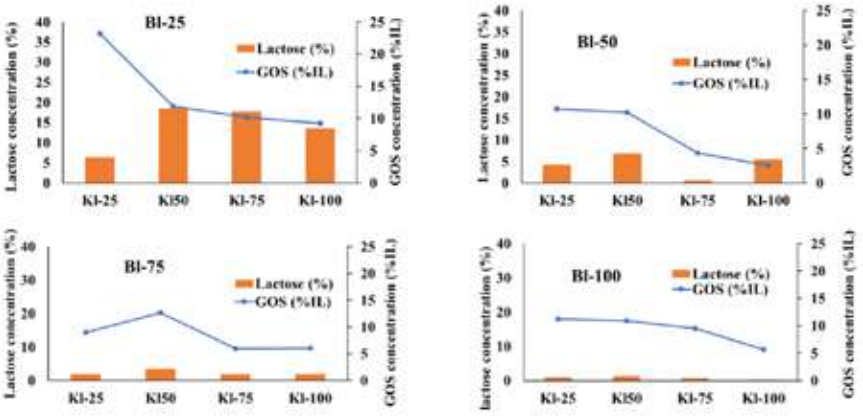
The phospholipid rich extract obtained by microwave and ultrasonication assisted extraction of ghee residue was evaluated as an emulsifier in ice cream and dairy spread. Utilization of phospholipid rich extract obtained from ghee residue for preparation of ice cream. In case of ice cream, based on preliminary trials, experiments were designed to replace guar gum in four proportion (25, 50, 75 and 100%) and glyceryl monostearate (GMS) in two proportions (50 and 100%). For ice cream, replacement of guar gum and glyceryl monostearate at 50% level resulted in comparable attributes for texture, fat stabilization, overrun and melting properties to the respective control sample. Significant difference for firmness values of ice cream samples was observed for the extract obtained with microwave assistance at (50 and 100% replacement), while, no significant difference in the firmness was observed in samples added with extract obtained with ultrasound assistance. The effect of replacement of emulsifier in ice cream mix with extract from ghee residue was also evaluated on its physico-chemical properties i.e. pH, total solids and acidity. All attributes evaluated for different ice cream samples showed no-significant difference ($p<0.05$). With increase in extract addition, ice cream samples scored lesser for attributes like structural consistency and icy structure. Overall acceptability of samples also showed decreasing score with inverse in extract replacement in ice cream. Colour and appearance did not show any significant change across samples studied. Another important attribute, melt in mouth also not showed much change across different samples studied. Control sample and experimental samples formulated with extract prepared with ultrasound assistance as a replacer at 25 and 50% levels showed no significant difference.

Utilization of obtained PL rich extract for preparation of dairy spread

The best product was selected based on the sensory evaluation as well as spreadability of the product. For the microwave assisted extract treated samples, best score was obtained for upto 50% replacement with an overall acceptability of $8.3 \pm .042$ and for the ultrasonication assisted extract treated samples, optimum replacement was found to be 75% with an overall score of 8.25 ± 0.45. The composition of the product made by 75 % replacement of the STPP with the ultrasonication treated extract was found to be 51.35% moisture, 48.64 % total solids, 25.16% fat, 5.73% protein, 1.82% ash, 15.93% total carbohydrate. Thus, it can be concluded that the microwave and ultrasonication treated ghee residue extract rich in phospholipid can be efficiently incorporated in the low fat dairy spread and it adds value to the by-product. In case of dairy spread; 50% level of STPP was replaced using microwave assisted obtained extract while 75% replacement of STPP was possible using ultrasonication assisted extract leading to overall sensory acceptability scores of $8.3 \pm .042$ and 8.25 ± 0.45, respectively. It is therefore concluded that the phospholipid rich extract can be obtained from ghee residue; a dairy industry by-product and it could also be successfully used in both the dairy products as substitute of conventional emulsifier and stabilizers.

Utilization of paneer whey for production of bioactive lactose-derived oligosaccharides

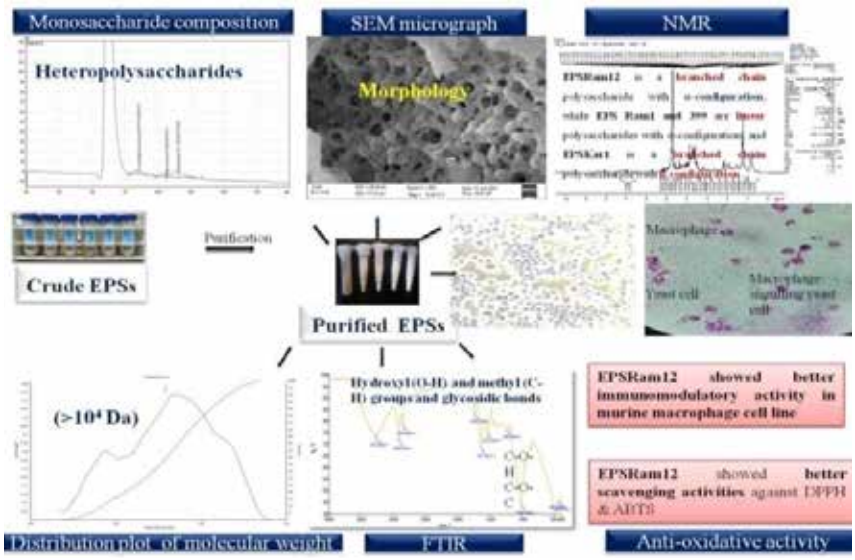
The effectiveness of four β-galactosidase enzymes from various microbial sources—*Bifidobacterium bifidum (Bf), Kluyveromyces lactis (Kl), Bacillus licheniformis (Bl), and Aspergillus oryzae (Ao)*—in producing Galacto-oligosaccharides (GOS). Concentrated paneer whey (CPW), which was enriched to contain 50% TS and 40% lactose, along with increased cationic minerals. Single enzyme treatment to CPW, yielded the highest GOS with Bf (21.52% IL) over 10 h, and with Kl (16.31% IL) over 4 h. Remarkably, both Bf and Kl enzymes produced the most GOS within just 4 h. To further improve the GOS production and reduce the hydrolysis time, combination of enzyme has been used for which Kl was selected for its efficient GOS production and shorter hydrolysis time, paired with Bl, which showed lower hydrolytic activity at 4 h. Two methods were used: simultaneous and sequential hydrolysis. The simultaneous method, using Bl and Kl at 25 U/g each, yielded a GOS production of 14.09% (%IL) after 4 h, which was lower than the single enzyme method. The sequential approach, however, achieved a maximum GOS production of 23.2% (%IL). This was done by first hydrolyzing CPW with Bl (25 U/g lactose) for 1 hour, followed by Kl (25 U/g lactose) for 3 h.



Galactooligosaccharides production using BIfor 1h and KI for 3h

Isolation and Functional characterization of lactic acid bacteria strains under (VTCC Netwrok Project)

Twenty-five homemade curd samples were collected from different regions in Karnal and Odisha Districts. Twenty-seven isolates belonging to the species of *Lactobacillus acidophilus*, *Lactobacillus delbreuckii*, and *Lacticaseibacillus rhamnosus* were deposited in the VTCC repository (VTCC DM0000728B to VTCC DM0000754B). In the second part of the project, EPS produced from LAB strains including *S. thermophilus* Ram1, *S. thermophilus* 399, *Lacticaseibacillus rhamnosus* Ram12, *Lacticaseibacillus rhamnosus* Kar1, and *Limosilactobacillus fermentum* NCDC400 were investigated for their antioxidative and anti-inflammatory properties. The analysis revealed that the isolated EPS were heteropolysaccharides while EPSRam12 possessing higher molecular weight of $2.6x10^6$ Da showed greater anti-oxidative properties. Further, EPSRam12 enhanced pro-inflammatory and reduced anti-inflammatory immune markers in LPS-treated macrophages, suggesting its potential immunomodulatory nature for further investigation in *in vivo* models.

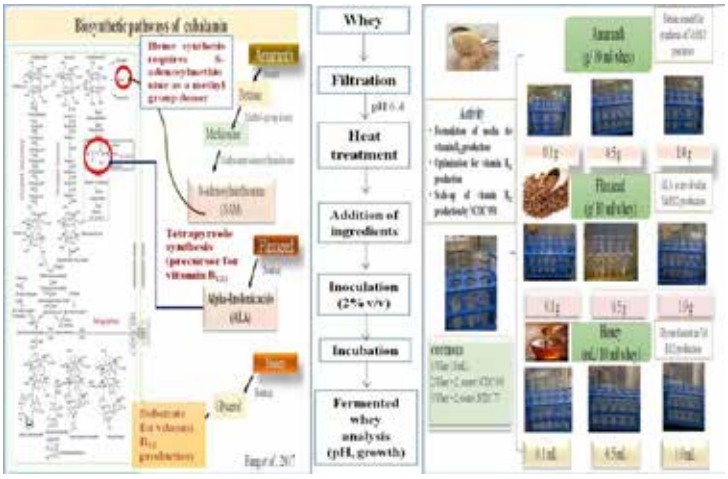


In vitro anti-oxidative and anti-inflammatory activity of exopolysaccharide (EPSRam12)

Characterization and bioprocess optimization for enhanced vitamin B_{12} production by *Limosilactobacillus reuteri* NCDC 958

Vitamin B_{12} production by *L. reuteri* NCDC 958 was reconfirmed via the cbiK gene (cobalt chelatase). The specific carbohydrate (glucose, galactose, sucrose, fructose, lactose, salicin, trehalose, maltose and glycerol) utilization ability of these strains was analyzed using Phenol red carbohydrate broth. We also analyzed carbohydrate fermentation by measuring the pH of the Phenol red carbohydrate broth, which ranged from 4.21±0.25 to 5.82±0.11 for *both L. reuteri* strains after specific carbohydrate fermentation. A whey-based medium with varied

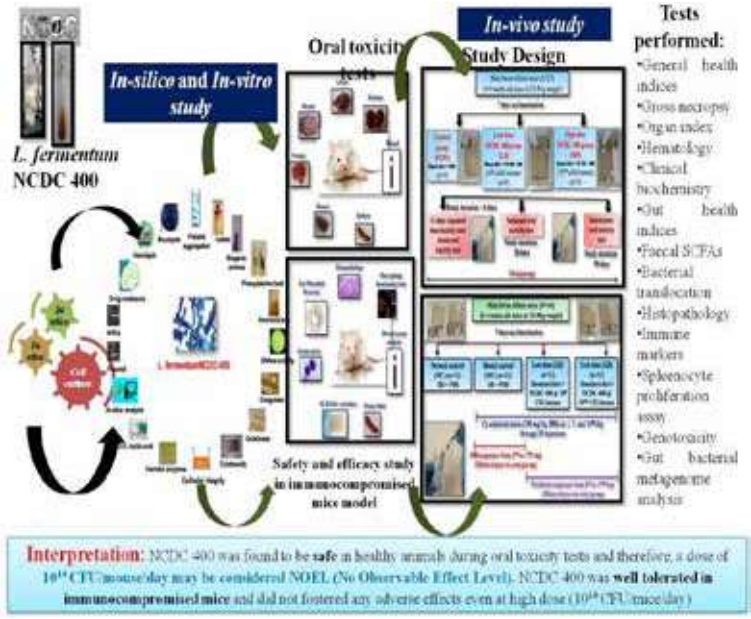
amaranth, flaxseed and honey concentrations (0.1, 0.5, 1g/10mL and 0.1, 0.5, 1mL/10mL) was evaluated for the growth of *L. reuteri* NCDC 958. *L. reuteri* NCDC 958 lowered medium pH to around 4.0 with amaranth, flaxseed and honey (from 0.1g to 0.5g/10 mL) indicating its better growth in the formulated media.



Preparation of whey-based medium for the growth of vitamin B_{12}-producing L. reuteri NCDC958

Safety evaluation of probiotic *Limosilactobacillus fermentum* NCDC400

We assessed the safety of *Limosilactobacillus fermentum* NCDC 400, an industrially important hypocholesterolemic probiotic strain. In vitro tests showed no harmful enzyme activity, platelet aggregation, mucin degradation, or adverse metabolite production. The strain was sensitive to human serum and antibiotics, with no unusual antibiotic resistance genes. Virulence genes were absent, and bioinformatics analysis confirmed lack of lateral transferable antibiotic resistance genes. Cell culture assays demonstrated non-cytotoxicity, while oral toxicity tests in mice revealed no treatment-related issues. Immuno-compromised mice also tolerated the strain well and showed improved immune responses. The study suggests a safe dose of 10^{10} CFU/mice/day and highlights the potential for further human clinical trials.

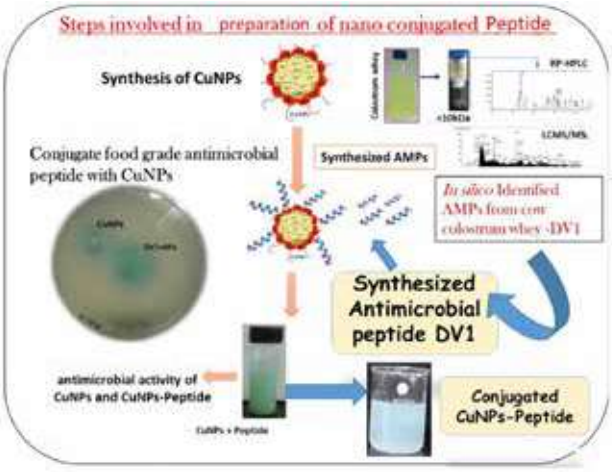


Safety evaluation of probiotic L. fermentum NCDC400

Colostrum whey-derived potent functionalized antimicrobial peptide against antibiotics resistant pathogens

Conjugated peptide-copper nanoparticle combinations were prepared to combat antibiotic-resistant bacteria. These hybrid materials showed synergistic effects, with the copper nanoparticles enhancing the antimicrobial properties of the synthesized peptide. Conjugated AMPs-CuNPs exhibited the highest antimicrobial activity

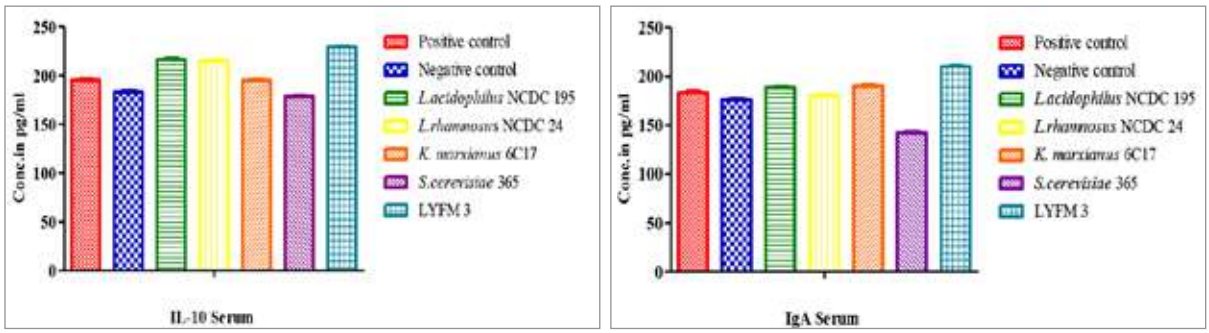
against clinical isolates of antibiotic-resistant *E. coli* (ESBL) (Extended-spectrum beta-lactamases), *S. aureus* (MRSA) and *Acinetobacter* 1379. The conjugation of a whey-derived peptide and copper nanoparticles was effective against a range of drug-resistant bacteria, including MRSA (methicillin-resistant *Staphylococcus aureus*).



Preparation and conjugation of cuNPs with peptide (CuNPs-peptide)

Preparation of bio-functional lactic-yeast fermented milk

Fermented dairy products with the lactic-yeast fermentation of milk (LYFM) have not been explored much. The LYFM made with 1:3 ratios of lactic: yeast cultures by normal fermentation were selected for *in vivo* animal study. Around 1% alcohol was produced in the LYFM at the optimized condition of 1% LAB and 3% yeast culture at 37°C for 24h with a sensory score of 7.5 ± 0.34. The lactic and yeast counts were (10.878 ± 0.001) and (8.228 ± 0.333) log CFU/ml. The immuno-modulatory properties of the LYFM *in vivo* Swiss albino mice model showed significant improvement in immune organs like the spleen and thymus. An increase in IgA (210.36 ± 1.23), anti-inflammatory cytokine IL-10 (229.20 ± 0.74) and a decrease in the pro-inflammatory cytokine TNF-α (163.99±0.80) was seen. In macrophage phagocytosis activity, a significant difference between the positive control group (24.42 ± 4.32) and the LYFM group (56.87 ± 3.73) was observed. Antioxidative markers like SOD (343.63 ± 1.997), GSH (327.44 ± 6.35), GPX (89.98 ± 2.464), and catalase (364.32 ± 8.13) were also improved in the LYFM group compared to other treated groups. A similar trend was obtained in histopathological results of the colon tissue that showed normal lamina propria, thickening and regeneration of epithelial cells etc. The Lactic yeast fermented milk product developed had potential immunomodulatory effects along with bio-functional properties including antimicrobial and antioxidative properties. Therefore, it may be used for enhancing immunity in cases of bacterial infection.

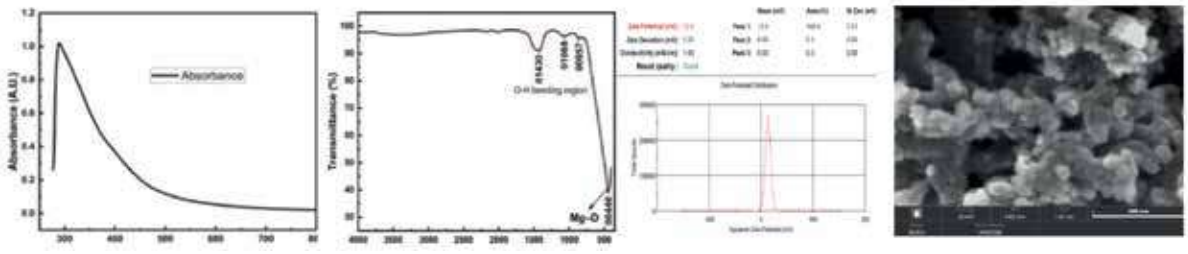


Immuno-modulatory cytokines IgA, IL-10

Production of antimicrobial zinc oxide nanoparticle-peptide conjugates for the sanitation of milk production area

Magnesium oxide nanoparticles were developed with the help of *Syzygium cumini* leaves and magnesium nitrate, further optimized by temperature and pH. The produced nanoparticles were primarily identified by the colour changes to brownish colloidal formation and the appearance of a peak at 291 nm, using UV visible

spectroscopy. Biophysical characteristics of synthesized G-MgO NPs confirmed the spherical shape and 35 nm size as evaluated by Field Emission Scanning Electron Microscopy (FE-SEM). The strong band at 440 cm^{-1} functional group indicated the presence of stretching and bending vibrations of Mg–O confirmed by Fourier-transformed infrared (FTIR). The X-ray diffraction analysis illustrated that the G-MgO NPs were crystalline with a face- profile, confirming the presence of magnesium and oxygen. A zone of inhibition by G-MgO NPs at 25mg/mL and 50 mg/mL concentrations were 10 ± 0.88 mm and 13 ± 0.58 mm, respectively, confirming the antibacterial activity against *Listeria monocytogenes* strains. This study presents a rapid, low-cost, environmentally friendly green approach for G-MgO NPs synthesis and obtained G MgO NPs can also be used against other pathogenic microbial species in the future.



A B C D

UV Visible absorption spectrum (A); FTIR spectrum (B); Zeta potential (C) and FESEM images of G mg O NPs (D)

Development of finger-millet-based composite fermented beverage

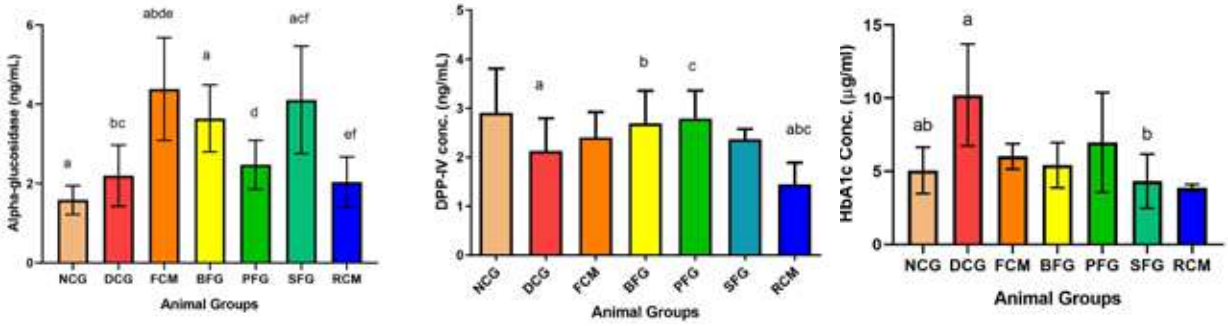
For the preparation of finger-millet-based composite fermented beverage, finger-millet flour was procured from the local market, Karnal and mixed with cow milk @2%. The composite medium was heated at 95 C for 5 minutes and cooled to 37^{0}C. The conditions such as finger-millet concentration, inoculum level, incubation time, and incubation temperature were optimized for the preparation of the finger-millet-based composite fermented beverage. Freshly grown active culture RL-4, *Lacticaseibacillus rhamnosus* was inoculated (@2% in it and incubated at 37°C for 12h. The culture RL-4, *L. rhamnosus* was selected based on phytase activity (25mm), proteolytic activity, and antimicrobial activity. Based on pH, acidity, and lactic counts, 2% finger-millet flour, 2% inoculum level, and incubation temperature 37°C for 12 h. of incubation time were optimized for the preparation of finger-millet-based composite fermented beverage. The finger-millet-based composite fermented beverage showed pH (4.2) and titratable acidity (0.86% L.A.).

Finger-millet-milk-based composite fermented beverage

Antidiabetic efficacy of fermented camel milk and *Lacticaseibacillus rhamnosus*

In this research, fermented camel milk prepared using *Lacticaseibacillus rhamnosus* (RL4) was evaluated for its antidiabetic potential both in vitro and *in vivo*. The experiment involved rats categorized into different groups based on their diet: Negative Control Group (NCG), Fermented Camel Milk group (FCM), Bacteria Fed Group (BFG), Peptide Fed Group (PFG), Sitagliptin Fed Group (SFG), Diabetic Control Group (DCG), and Raw Camel Milk group (RCM). Notably, the FCM and BFG exhibited a significant increase in α-glucosidase activity, measured at 4.38±0.21 ng/mL and 3.64±0.18 ng/mL respectively, compared to the positive control group (SFG) 2.20±0.11 ng/mL. Additionally, DPP-IV activity was also higher in the FCM (2.31±0.12 ng/mL) and BFG (2.87±0.14 ng/mL) groups compared to the positive control group (2.26±0.11 ng/mL). Moreover, a marked decrease in HbA1c

levels was observed in the FCM (6.02±0.30 µg/mL) and BFG (5.42±0.27 µg/mL) groups relative to the positive control group (10.21±0.51 µg/mL). The study indicated the potential of fermented camel milk and *Lacticaseibacillus rhamnosus* as effective antidiabetic agents. The significant increase in α-glucosidase and DPP-IV activities, along with the notable decrease in HbA1c levels, suggests that these interventions could improve both immediate and long-term blood glucose regulation. This promising outcome warrants further investigation into the mechanisms of action and potential therapeutic applications of fermented camel milk and *Lacticaseibacillus rhamnosus* in diabetes management.

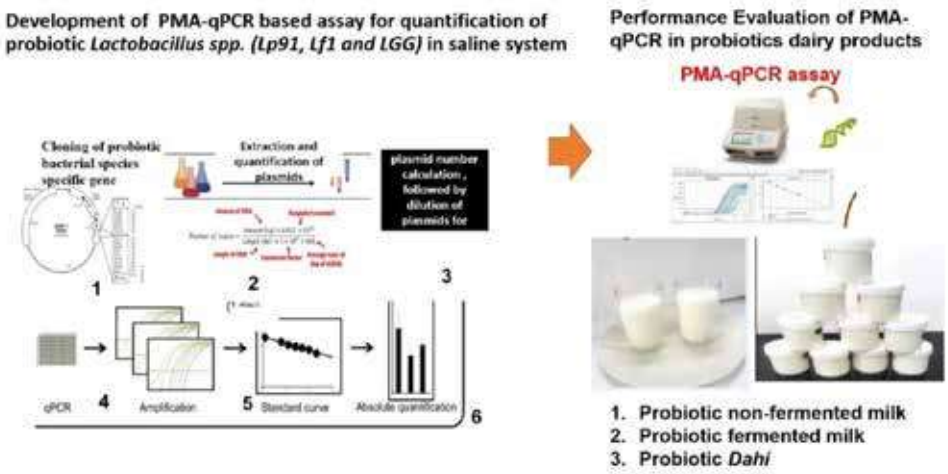


α-glucosidaseactivity DPP-IV Activity HbA1c concentration

Antidiabetic efficacy of fermented camel milk and Lacticaseibacillus rhamnosus in animal model
**NCG= Negative control Group, FCM= Fermented camel milk, BFG= Bacteria Fed group, PFG= Peptide Fed group, SFG= Sitagliptin Fed group, DCG= Diabetic control group, RCM= Raw camel milk*

Development of quantitative molecular assays for rapid enumeration of viable probiotics from probiotic food products

The assay prototype was explored for the absolute quantification of viable probiotic cells from milk and milk products. For that, three different genomic DNA extraction protocols were tried to extract DNA of good concentration and purity from the milk matrix. The modified laboratory protocol yielded DNA of good quantity and satisfactory quality for the PMA-qPCR-based absolute quantification of viable probiotic bacteria. Then, PMA-qPCR was used for the absolute quantification of viable probiotic bacteria. The developed PMA-qPCR assay was used as a quality control method in the storage and distribution of probiotic bacteria, where temperature abuse was reported to decrease the viability of probiotic bacteria. The absolute quantification of target probiotic bacteria by PMA-qPCR yielded highly comparable results with those of the conventional method, with reported r values in the range of 0.8760-0.9980. The accuracy found in the entire PMA-qPCR-based assay for the quantification of *Limosilactobacillus fermentum* Lf1 (Lf1) and *Lactiplanitibacillus plantarum* Lp91 (Lp91) with reference values was in the range of 0.86 and 0.91. Precision in the detection of *L. fermentum* Lf1 (Lf1) and *L. plantarum* Lp91 (Lp91) using PMA-qPCR was found to be 3% and 2%, respectively, in fermented milk products. The developed PMA qPCR-based assay is a sensitive, accurate, precise, less biased, repeatable, and reproducible method for the detection of probiotic *Lactobacillus* spp.



Propidium monoazide-quantitative polymerase chain reaction (PMA-qPCR) based assay for the rapid enumeration of viable probiotic cells

Characterization of Antimicrobial resistance in *Lactobacillus* species from dairy niches

In this study, a total of 52 traditional Dahi samples were collected from many areas of the Haryana region for the isolation of indigenous lactobacilli strains and to study the prevalence of antimicrobial resistance among the bacteria. A total of 100 Lactobacillus strains were initially isolated from all the collected dairy samples. These isolates were identified by phenotypic and genotypic methods. All 100 lactobacilli isolates were then tested for their antibiotic resistance profile against a total of 29 clinically important antibiotics. The highest resistance was showed against Nalidixic acid, Norfloxacin, Ofloxacin, Trimethoprim, Co-Trimoxazole, Teicoplanin, oxacillin, followed by Amikacin and Vancomycin. The lowest resistance was observed in the case of Gentamicin followed by Cefuroxime and Cefotaxime. Many of the isolates were also observed to cross the MIC breakpoints for Gentamicin, Cefuroxime, Cefepime, Cefotaxime and Streptomycin. Furthermore, PCR studies were also carried out and could detect different aminoglycoside resistance genes viz. aac(6') – aph(2") gene in 2 isolates, ant (4'-Ia) gene in 2 isolates and aph(3")- III gene in while 3 lactobacilli isolates.

Freeze dried Probiotic DVS starters of *Lactiplantibacillus plantarum* CRD 7 and its performance in Dahi preparation

Developed freeze drying process for preparation of probiotic direct vat set (DVS) starters using Indigenous strains of aflatoxin M1 binding *Lactiplantibacillus plantarum* CRD7 for preparation of Dahi to reduce ameliorate AFM1 burden. Commercialization of the process would help meet the demand for indigenous probiotic dairy starters for the manufacture of fermented milk products. The probiotic DVS starters and Dahi prepared from the same were launched on 1st June, 2023 on Milk World Day by the Director, ICAR-NDRI, Karnal.

Freeze dried Probiotic DVS starters of Lactiplantibacillus plantarum CRD 7 and its performance in Dahi preparation

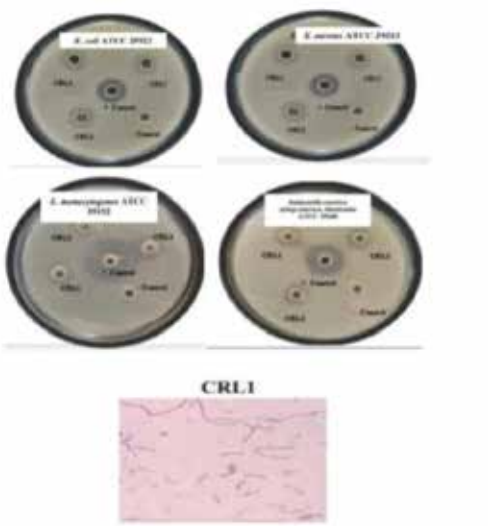
Development of lactic culture mediated vitamin B_{12} bio-fortified fermented milk

The study aimed to address vitamin B_{12} deficiencies in vegetarian and lacto-vegan populations by bio-fortifying fermented milk with vitamin B_{12} using *Limosilactobacillus* cultures. Four cultures were evaluated for their vitamin B_{12} production potential, with *L. reuteri* NCDC958 showing the highest yield. Combinations of cultures were tested, and the *L. fermentum* NCDC701: *L. fermentum* NCDC400 combination at a 1:1 ratio and 2% inoculum rate was identified as the most effective for vitamin B_{12} secretion. Bio-fortified fermented milk demonstrated a >5-fold increase in vitamin B_{12} concentration compared to un-inoculated milk. The product was microbiologically

safe and had altered texture properties, though sensory acceptability was slightly lower than the control. *Limosilactobacillus* vitamin B_{12} bio-fortification in fermented milk is suggested as an effective strategy.

Development of multiple strains probiotic direct vat set starter for preparation of Synbiotic *Misti dahi*

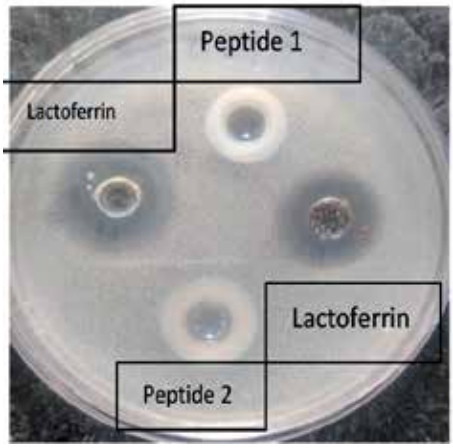
Three *Lactiplantibacillus plantarum* strains (CRD7, HD48, and HD51) and one *Streptococcus thermophilus* CRL1 were co-cultured to evaluate compatibility and biomass production. *Streptococcus thermophilus* CRL1 showed acid and bile tolerance, and high cell surface hydrophobicity, but sensitivity to certain antibiotics. It also exhibited antimicrobial activity against *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 29213, *Salmonella abaetetuba* ATCC 35640, and *Listeria monocytogenes* ATCC 35152. This combination was used to create a multiple-strain probiotic DVS by freeze-drying. The lyophilized probiotic DVS remained stable at -20, 4, and 30°C without loss of activity for an extended period. Enrichment of Misti dahi with prebiotics improved quality and achieved a 24-day shelf life under refrigeration. This developed freeze-dried multiple-strain probiotic DVS holds promise for creating Synbiotic Misti dahi and other health-promoting fermented milk products. The technology for its production is poised for commercialization.



Freeze dried Probiotic DVS starters of Lactiplantibacillus plantarum CRD 7 and its performance in Dahi preparation

Antifungal potentials of cow colostrum whey-derived Lactoferrin-rich fermentate preparations against mucormycosis-causing molds

Mucormycosis is an opportunistic deadly infection that is caused by fungi of the order Mucorales including species belonging to the genus Rhizopus, Mucor, Mycocladus, Rhizomucor, and Apophysomyces. Lactoferrin and colostrum-derived fermented whey against the opportunistic mucormycosis-causing Mold showed antifungal potential. The lactoferrin and lactoferrin-rich preparations showed antifungal activity against different mucormycosis-causing moulds, i.e., NCDC 52, MTCC 602, 8805, 10574 and 10711. Cow colostrum whey by microbial fermentation by *Lactiplantibacillus plantarum C2* and *Lacticaseibacillus rhamnosus* (C25) the peptide sequences in the 50kDa fractions. A total of 1294 peptide sequences were obtained from C2 and 1832 from C25 fermented whey. Convenient and efficient *in silico* tools were used to identify and predict peptides from LC-MS/MS data as antifungal peptides.



Anti-fungal activity of Lactoferrin and peptides against Rhizopus oryzae NCDC 52

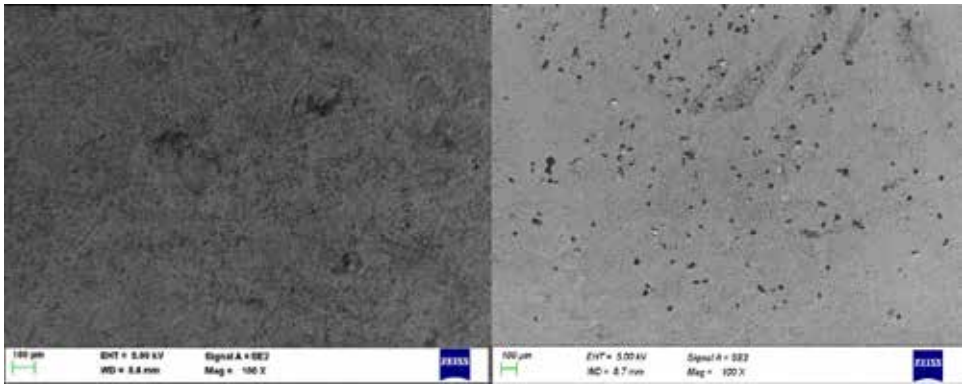
MECHANIZATION AND PROCESS ENGINEERING

Therminol 55 based alumina-doped zinc oxide nanofluid as heating medium in tubular heat exchanger

Alumina-doped zinc oxide nanoparticles (AZO NPs) and zinc oxide nanoparticles (ZnO NPs) were synthesized using cow urine as reducing, capping and stabilizing agent. The particle size of AZO NPs (12.42 nm) was less than that of ZnO NPs (17.40 nm). Therminol 55 (synthetic oil) was used as the base fluid for the preparation of nanofluids (NFs). Therminol 55-based ZnO and AZO NFs were prepared at 0.1, 0.2 and 0.3 vol.% and used as heating medium in tubular heat exchanger for heating milk. AZO NFs showed higher thermal conductivity than ZnO NPs. The AZO NFs showed a maximum increase of 30, 19.98 and 22.63% for convective heat transfer coefficient, overall heat transfer coefficient and energy efficiency, respectively when compared to Therminol 55. Additionally, the maximum reduction in energy consumption after utilising ZnO and AZO NFs was 3.26 and 5.40%, respectively.

Evaluation of corrosion effect of titanium dioxide based nano-fluid and phase change material on stainless steel

A study was carried out to evaluate the corrosive effect of new generation nanofluids that are used as heat transfer fluid and phase change material (PCM). Custom designed test rigs were used for static and dynamic evaluation of TiO_2 based nanofluid. The metal coupons were exposed to the nanofluid for 8 h at 80°C at 100 lph, while for static analysis, the coupons were immersed in the nanofluid and subjected to freezing-thawing cycles. The analysis of corrosion using various methodologies in the study confirmed that the base fluid (control experiments) had near negligible effect on the metal coupons, both for static and dynamic test modes. In contrast, pitting corrosion was noted when the metal coupons were exposed to the nanofluid. Further, it was also deduced that metal coupons exposed to PCM of higher concentrations exhibited a higher risk of iron leaching as well as pit formation, as compared to coupons exposed to nanofluids as a heat transfer fluid.



(a) (b)

SEM Images of metal coupon exposed to (a) blank base fluid and (b) freezing thawing cycles in 1% TiO_2 nanofluid for 80 days

Development of multipurpose automatic controlled rate heating system for production of dairy products

Two multipurpose automatic controlled rate heating systems of 20 litre (cylindrical design) and 50 litre (cuboid design) were developed. The systems were evaluated for heating milk from 20 to 90 °C. Whey dewatering mechanism was modified and provision was made to integrate cylindrical and square hoop. The optimized solution had moisture contents of 45.27%, 46.24% and 48.81% for top, middle and bottom layers, respectively. The obtained yield (20.78%) was in the standard range (18-24%) for *paneer* prepared from buffalo milk. The yield obtained in cuboid design was higher than cylindrical system. Milk (9 to 10 kg) with 2.5 min centrifugation time was good combination to obtain *Paneer* with desired moisture, yield and textural properties. Power

Prototype (Capacity-50 litre)

requirement of the developed systems were 2 kW and 6 kW for 20 and 50 litre, respectively. The developed system was found suitable for multiple unit operations like milk heating, incubation for production of yogurt, and heating cum coagulation for *paneer* production.

Development of improved bioreactor prototype for cattle waste management

An algorithm was developed to compare different geometries of biogas-fired burners. The various designs parameters were considered e.g. burner geometry, number and diameter of flame porthole, gas flow rate, and air-gas mixing ratio. The algorithm was successfully used to compare five different burner configurations (BD1, BD2, BD3, BD4 and BD5). On this basis, integrated hybrid stove was designed using BD3 burner and fabricated. Performance evaluation of the burner indicated power generation in the range of 1.1 to 2.5 kW. The effect of slurry temperature on the performance of a bioreactor was evaluated at three different temperatures: 30, 40, and 50°C. The amounts of biogas produced at 30, 40, and 50°C were 0.20 m^3, 0.23 m^3, and 0.17 m^3, respectively. The effect of mixing frequency on the performance of a bioreactor was evaluated by comparing the amount of biogas produced under different mixing frequencies, such as 0, 2, 4, and 6 times/day. The amounts of biogas produced under these mixing frequencies were 0.22 m^3, 0.29 m^3, 0.35 m^3, and 0.29 m^3, respectively. Highest COD reduction (65.2%) and energy value (9.3 MJ) were obtained at four times/day (mixing frequency).

Development of automatic integrated hybrid solar system for fermented dairy products

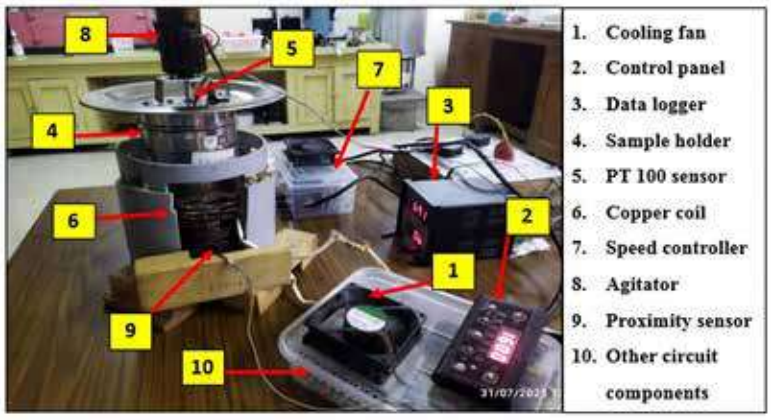
An automatic integrated hybrid solar system with the thermal cabinet for fermented dairy products was developed. The curd cups were placed in four numbers of shelves in a stainless steel frame put inside from the top of cabinet. It is a simple design which proved to be energy efficient in maintaining of incubation temperature with 270 min incubation period. After the entire incubation period, the cups were precooled using an evaporative cooler. There was a 16°C drop in the temperature of dahi and yogurt cups in the summer season. In the peak winter season, the system was able to cool the cups to 5.5°C.

Development of thermic fluid based small scale mechanized process unit for *rasogolla* cooking

A thermic fluid based mechanized cooking system was fabricated for *rasogolla*. Feasibility testing for working of screw conveyor for cooking and conveying of *rasogolla* was successful. The performance evaluation and optimization of process parameters of the fabricated system was conducted based on the design obtained from Response Surface Methodology. The effect of mass of ball (6, 9, 12g) and screw speed (5, 10, 15 rpm) was studied on different properties of *rasogolla* formed including textural properties, physico-chemical and sensory properties. The effect on cooking time, sphericity, L*, whiteness index, springiness, expansion ratio, percentage absorbed sugar, overall acceptability was found significant. The cooking time, sphericity, *L**, whiteness index, springiness and overall acceptability of product were 18.00 ± 1.15 min, 0.97 ± 0.005, 77.76 ± 1.40, 73.98 ± 1.61, 0.19 ± 0.03 and 8.00 ± 0.00, respectively at optimized solution (mass=6g, screw speed=5rpm) selected based on maximum desirability. Validation was done by comparing the predicted values with experimental values using student's t-test which was found non-significant.

Development of Magnetic Induction based Milk Heating System for Paneer

A magnetic induction based milk heating system (1.5 to 2.0 Litre) was developed. Experiments were conducted (Full Factorial design) for optimization of process parameters (induction power: 500 W, 1000 W, 1600 W; three different size containers with three different heights of sample). The study investigated the impact of different induction powers on the heating time, physicochemical, microbiological and sensory characteristics of milk. The optimized parameters were 1600 W

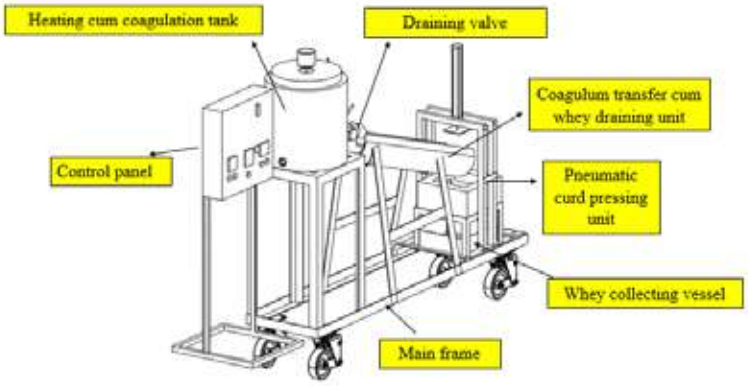


Magnetic Induction Based Milk Heating System (1.5 to 2.0 Litre)

induction power, 12 cm sample height and 1.25 cm gap. The optimized conditions were used to compare MIH system with electric heater. The results revealed a significant variation in heating time, MIH system took 7 min and electric heater took 45 min for 1360 ml of milk with 1600 W power. However, the fat, SNF, protein, acidity and pH content of the electric heater and MIH treated milk samples were similar to that of raw cow milk (4.08% fat, 8.49% SNF, 3.09% protein, 0.117% LA acidity and 6.52 pH).

Development of Inline Milk Coagulation cum Coagulum pressing unit for Paneer manufacturing at small scale

Image analysis experiments were conducted in the coagulation tank at different coagulation temperatures (70, 75, and 80°C) and different agitator speed (20, 30, and 40 rpm) during coagulation. The various images were captured from dosing of coagulant to till complete separation of whey from coagulum. A steady decline in the *a** value was observed during the first 60 seconds of coagulation, followed by a sudden drop in the *a** value, indicating the formation and separation of whey. Overall, the optimal conditions for efficient coagulation and whey separation involve a careful balance of agitation speed at 40 rpm and coagulation temperature at 70 °C. Inline milk coagulation cum coagulum pressing unit (20 Litre capacity) was fabricated. It comprised several components e.g. a double-jacketed heating and coagulation tank, a coagulum transfer cum whey draining unit for coagulated mass, a curd pressing unit, and a process control unit. Preliminary trials were conducted to determine the acceptable range of process parameters (coagulation temperature: 70-80 °C; pressing pressure: 1.5-4.5 kg/cm^2; and pressing time: 9-15 min) for experimental design.



Inline Milk Coagulation cum Coagulum pressing unit

Monitoring and characterization of yogurt fermentation process on the basis of electrical properties

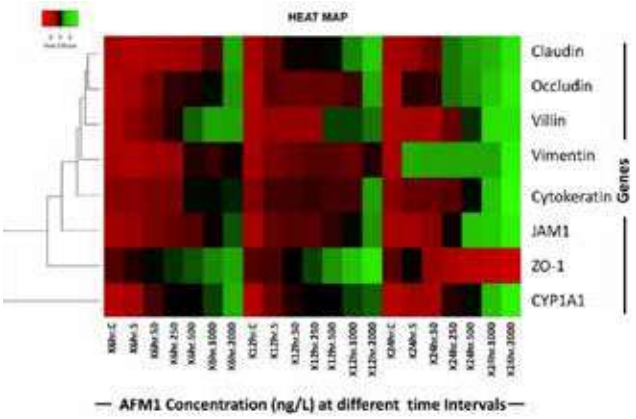
A test chamber equipped with temperature controller, image capturing system and provision of measurement of electrical properties was fabricated for measurement of pH, electrical properties as well as colour simultaneously. During yogurt fermentation process, pH and electrical conductivity were recorded w.r.t. time. It was observed that pH reached to 4.5 in approx. 250 min, when fermentation was allowed at 40-42°C. The pH vs. time trend was significantly linear ($R^2 = 0.93$). The trend of electrical conductivity vs. time was also significantly linear ($R^2 = 0.95$) and linearity was more than pH vs. time trend.

Commercialization of Technology titled "Spore based kit for detection for antibiotic residues in milk at dairy farm" on June 8, 2023 at NDRI, Karnal

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

Aflatoxin M1 influences intestinal epithelial integrity by decreasing the expression of genes encoding tight junction proteins

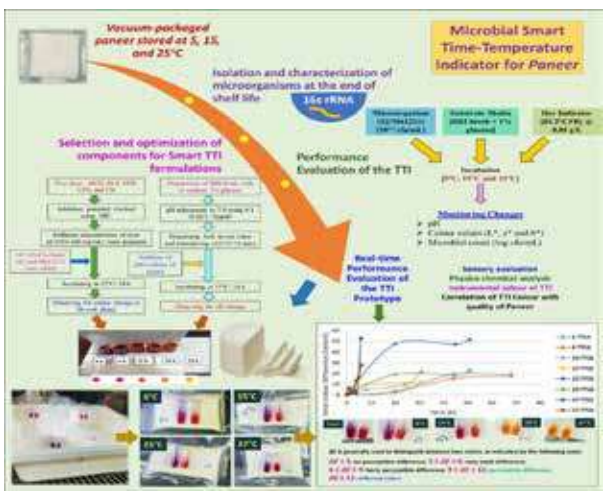
Aflatoxin M1 (AFM1) is often found in milk and can be harmful to our cells. The study focused on how AFM1 affects cells in our intestines, specifically using the Caco-2 cells. Primarily, the study checked the shape and health of these cells when exposed to different amounts of AFM1 for different lengths of time. Interestingly, AFM1 didn't change the cellular morphology, but there was a small but important 10% drop in cell viability when the concentration of AFM1 was higher than 1000 ng/L after 12 h of exposure. One test showed that after 6 h of exposure to AFM1, reactive oxygen species (ROS) were produced at a significantly higher level than the control. The gene expression analysis found that some genes related to the structure of the cells increased, suggesting the cells were stressed. On the other hand, genes related to the tight junctions between cells decreased, indicating that AFM1 might be causing problems in the connection between intestinal cells. To confirm these findings, an additional transwell experiment was conducted, which supported the idea that AFM1 affects the connections between cells. In summary, although AFM1 in milk may not visibly harm cell shape or health, the study shows that it can cause problems at the molecular level, potentially affecting the protective barrier in our intestines. This raises concerns about the possibility of a "leaky gut." The study emphasizes the need to keep investigating the safety of our food for public health reasons.



Quantitative real-time reverse-transcription PCR (qRT-PCR) analysis on specific Caco-2 cell transcript markers influenced by AFM1 (Kumar et al., 2023. Mycotoxin Research 39, 4: 453-467)

Microbial smart time-temperature indicator for *Paneer*

Thermal abuse due to mishandling in the supply chain of dairy products is a common problem. In the present investigation, for the development of a biological (microbial) smart time-temperature indicator (TTI) for *paneer*, 14 isolates were obtained from the spoiled vacuum-packaged *paneer*. Out of these, four isolates were selected based on their different phenotypic attributes and changes in pH of skim milk at 25°C/ 4 days and 10°C/ 20 days. The 16s rRNA gene sequencing revealed these four isolates as *Enterococcus casseliflavus* (S2), *Bacillus cereus* (M5111), *Atlantibacter hermannii* (M5114), and *Enterococcus faecium* (M61211). Based on preliminary trials, the substrate media was formulated for the TTI development. It was found that the isolates S2 and M61211 were able to drastically decrease the pH of substrate media from 7.0 to 4.71 and 4.43, respectively. The working of TTI at different storage temperatures (5, 15, and 25°C) was assessed using 10^3-10^4 cfu/mL inoculum of culture isolates. No significant changes in pH and the microbial counts were observed at a storage temperature of 5°C. While at 15°C, the pH of

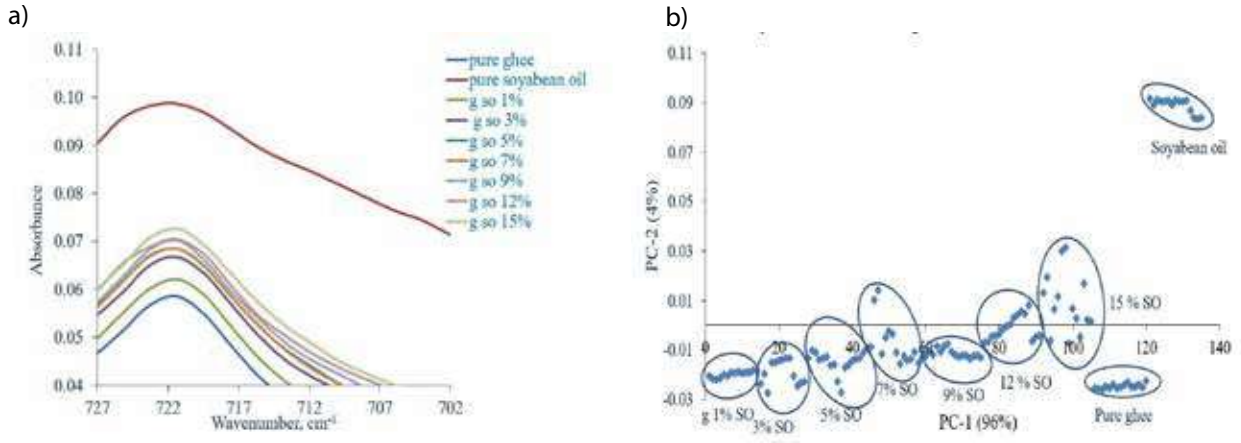


Microbial Smart Time-Temperature Indicator for Paneer

media decreased gradually to around 4.52-4.89 after 5 days with a concomitant increase in microbial load to 7 log cfu/mL from an initial pH value of 6.92-7.02 and microbial count of 3 log cfu/mL at 0th and 2nd day. Likewise, endpoint pH at 25°C reached after 30 h of incubation at 25°C. Microbial count at this temperature increased to 8 log cfu/mL from 3 log cfu/mL during this time frame. The association analysis of the colorimetric changes in the biological TTI was carried out with the quality attributes of the *paneer*. Based on the studies, it can be concluded that a biological smart TTI could be developed for monitoring the temperature abuse of *paneer* in the supply chain with good association with quality changes in the *paneer*.

Attenuated total Reflectance-Fourier transform infrared spectroscopy coupled with chemometrics to detect palmolein, soybean oil, chicken and sheep body fats in ghee

ATR-FTIR based method has been developed for the detection of adulteration in ghee. Wave number regions which were found useful for detecting adulteration of ghee with soybean oil (SO), palmolein (PO), sheep body fat (SBF), and chicken body fat (CBF) were 727-702, 1167-1137, 732-710 and 1120-1083 and 1190–1145 cm-1, respectively. Wavenumber regions which were found useful for detecting adulteration of ghee with an admixture of SO+CBF, PO+CBF, SO+SBF and PO+SBF were 740-700, 1760-1735, 1190-1130 and 1120-1060, 730-710 and 740-700 cm-1, respectively. PCA applied in the selected regions showed separate clusters of pure ghee even for the lowest level of spiking of each adulterant, and as the level of spiking of adulterants increased, the clusters shifted towards the pure adulterants. SIMCA applied in the selected wavenumber regions showed classification efficiency for pure mixed ghee, body fats and vegetable oils as 100% indicating that models were effectively developed. Using ATR-FTIR, detection of upto 1% of soybean oil, palmolein, sheep body fat, chicken body fat, and 3.3% of their admixture in ghee is possible.

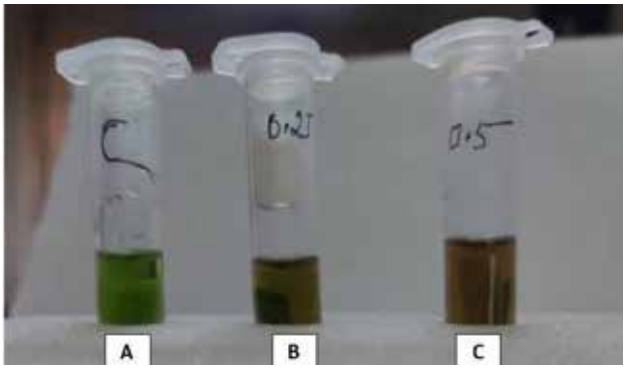


a) FT-MIR spectraof the selected wavenumber region (727-702 cm^{-1}) and b) PCA applied in the same to detect the presence of soyabean oil in ghee

A simple methodology to detect sorbitol in milk using paper-based disc has been developed

Sorbitol is being used as an additive by the unscrupulous traders to diluted milk to manipulate the lactometer reading. Sorbitol is not a permitted additive for liquid milk as per FSSAI. The developed dry paper discs can be used by the dairy industry, and dairy cooperatives at their milk collection centres and field level to detect this malpractice of sorbitol adulteration in milk. In the present invention, the two paper based square discs (disk 1 & 2) developed in the laboratory have been used, which are to be added sequentially in the milk filtrate obtained using a specific coagulating agent. Discs 1 & 2 when added sequentially to milk filtrate, the sorbitol positive samples show a brownish or pinkinsh color, whereas in the case of sorbitol negative samples green color is appeared. The limit of detection was 0.25% of added sorbitol in milk. The developed discs are easy to use and the test can be used as a platform test to detect the presence of sorbitol in milk received at milk collection centres in the milk procurement chain.

Disks D1 & D2 to be used to detect sorbitol in milk



Colour development on adding disks D1 & D2 to milk filtrate (A) Pure milk without sorbitol (B) Positive sample with added sorbitol @ 0.25% (C) Positive sample with added sorbitol @ 0.5%

Magnetic molecular imprinted polymer (MMIP) for extraction of biotin and vitamin B12 from milk.

The synthesis process includes the preparation of oleic acid-coated iron magnetite particles obtained through co-precipitation using FeCl2 and FeCl3 under alkaline conditions which were further used for creating MMIP. Five different MIPs were prepared by varying ratios of template (T) and functional monomer (FM) as 2, 4, 6, FM and cross-linker (C) as 5, 10, and initiator (I) and FM as 5, 16. For biotin, MMIP 2 (T: FM- 4; FM: C- 5; I: FM- 16) demonstrated the highest binding capacity (3.1 ± 0.11 µg per mg polymer) and good imprinting factor (11.48) and selectivity (91.29 %). For vitamin B12, MMIP 4 (T: FM- 4; FM: C- 10; I: FM- 16) exhibited the highest binding capacity (2.4 ± 0.21 µg per mg polymer) with good Imprinting factor (6.48) and selectivity (84.58). The effect of type of solvent and pH were also studied for their effect on binding and data indicated good selectivity in water and buffer of pH 6.5-7.0 for both vitamins. A cross-reactivity study indicated minimum interference of other B vitamins on the binding of biotin and vitamin B12 to their respective MIPs. The prepared MIPs were also used for the enrichment of biotin and vitamin B12 from milk and recovery of 70.38 and 60.18%, respectively was obtained.

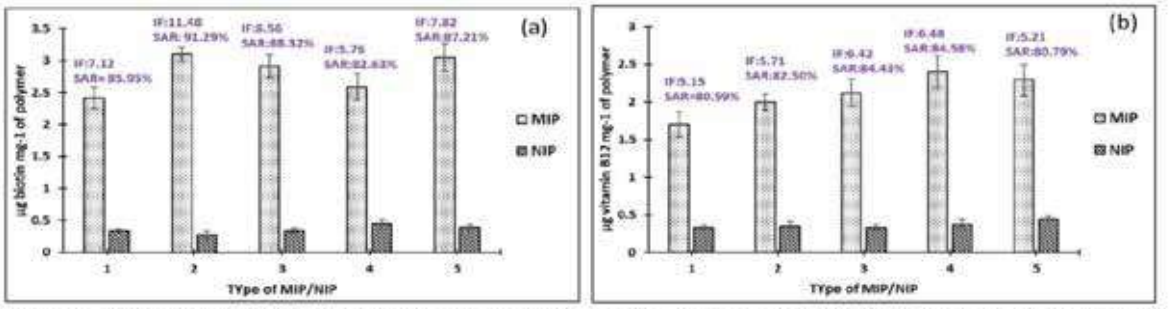


Fig: Imprinting factor (IF)and Selective adsorption ratio (SAR) of prepared MIPs for Biotin (a) and vitamin B12 (b)

Imprinting factor (IF) and selective adsorption ratio (SAR) of prepared MIPs for Biotin (a) and vitamin B12 (b)

Quality of milk from selected indigenous cattle breeds

Milk from selected Indigenous breed cow (Gir, Sahiwal, Tharparkar) and crossbred (Karan fries) cattle were analysed for compositional analysis, distribution of nitrogen fractions and mineral profile. On comparison of milk composition from low yielding cattle (below 5 kg) to average milk yield above 6 kg, a relatively 0.5% level higher SNF and fat content was observed. Fatty acids analysis in raw milk from different breeds of the cow maintained under similar feeding regimes showed that the saturated fatty acids were higher in Karan Fries, monounsaturated fatty acids were higher in Gir, Sahiwal, and Tharparkar. The oleic acid content of Karan Fries milk was significantly lower than Gir, Sahiwal, Tharparkar. On applying principal component analysis (PCA), it was found that the fatty acid profile of indigenous cow breeds showed distinct variation with milk of Karan Fries. Indigenous cow breeds had greater levels of important and bioactive fatty acids, w-3 linolenic acid (C18:3), and CLA. The technological parameters on milk processing were assessed for rennet clotting behavior, alcohol stability and heat stability. Milk from Gir breed exhibited relatively shorter renneting time compared to Sahiwal

and Tharparkar. No significant difference on heat coagulation time and ethanol stability was observed between different indigenous breeds of cattle.

Strip-based test for the detection of *Escherichia coli* in milk

A strip assay was developed to detect *E. coli* in milk using a specific enzyme-substrate reaction principle. The assay began with three references *E. coli* strains. Initial optimization in ECSM broth involved parameters like substrate volume (20 µL), incubation time (5 h), and temperature (37°C). Grade 3 Whatman filter paper was chosen for superior colour development on the strip. The assay was further refined for *E. coli* detection over 8 h in ECSM broth. It was also optimized for detecting ESBL *E. coli* in spiked sterilized milk within 8 h. Under field conditions, 120 raw milk samples were evaluated. The strip detected *E. coli* in 8 h. Notably, the functionalized paper strips remained stable at 4°C for up to 4 months. In conclusion, the developed strips are effective for field-based *E. coli* infection detection and assessing AMR profiles in mastitis milk.

Strip for detection of *Listeria monocytogenes* in milk

A paper strip for "detection of antimicrobial resistant *Listeria monocytogenes* in milk" was created based on a unique enzyme-substrate reaction concept. Initially, five *L. monocytogenes* strains were obtained and verified using ISO 11290-1:2017 and the Kirby-Bauer disc diffusion method. The strip assay was optimized for parameters like substrate and media component volume (60 µL), incubation time (7 h), and temperature (37°C) in LSEM broth spiked with 7 ± 0.5 log cfu/ml of *L. monocytogenes*. Grade-3 Whatman filter paper was chosen for its excellent colour development. The protocol was further refined as a two-stage assay in LSEM broth spiked with 1.5 ± 0.5 log cfu of *L. monocytogenes*, enriched for 24 ± 1 h. Stage 1 showed black colouration, followed by green colouration within 7 h for *L. monocytogenes*. The strips were tested for *L. monocytogenes* detection in spiked milk, involving enrichment for 24 h, followed by detection within 9 h. The strip assay was evaluated with 35 samples of raw and pasteurized milk, identifying *L. monocytogenes* in one raw milk sample. The results from the strip-based test were validated using ISO 11290-1:2017 and the disc diffusion method, yielding comparable outcomes. Shelf-life testing at 4°C showed the strips to be stable for up to three months. This study presents a practical and approachable technology for the industry to detect *L. monocytogenes* in milk using the developed strip assay.

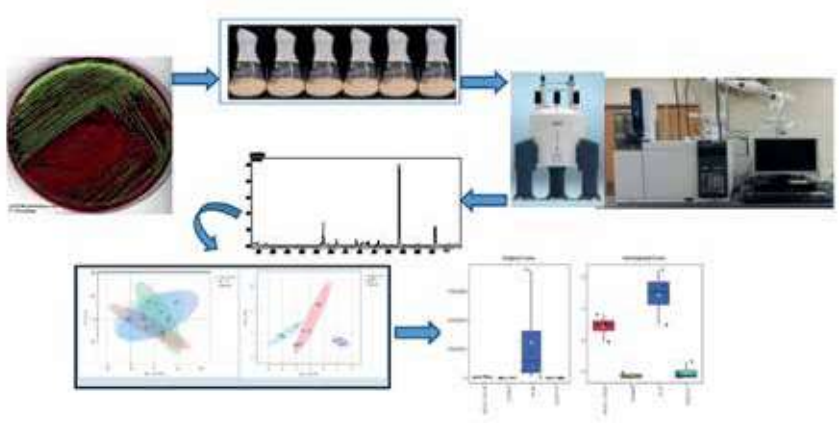
Metabolomic fingerprinting of *E. coli* in milk system

The study aimed to carry out a metabolomic profiling of 3 strains of *E. coli* (*viz. E. coli* K-12, *E. coli* ATCC 11775 and *E. coli* O157:H7) and identify key metabolites at strain level. Skim milk was fermented by a specific count of the three strains for a defined period and then prepared for running in two different metabolomic platforms *viz.* H^1NMR (400 Hz) and GC-MS. Chemometric analysis was carried out for the NMR data and statistical analysis was carried out in Metabolanalysts. The NMR data revealed six significant metabolites, while GC-MS revealed 30 significant metabolites between the four groups including skim milk. Univariate tests such as fold change analysis, t-test and volcano plot analysis of the NMR dataset between O157:H7 and ATCC 11775 identified 10 metabolites and 17 metabolites between O157:H7 and K-12. The univariate analysis of the GC-MS dataset revealed 38 differential altered metabolites between O157:H7 and ATCC 11775 and 34 metabolites between O157:H7 and K-12. Finally, 3 metabolites *viz.* Butanoic acid, fucose and 3-hydroxybutyric acid were found to be commonly up-regulated in between the pathogenic and non-pathogenic strains by both the NMR and GC-MS platforms. Furthermore, the targeted fatty acid profile (Butanoic acid and decanoic acid) of the certain samples validated using GC-FID was comparable to the results obtained in the same samples by GC-MS and NMR.

NMR spectroscopy based Metabolomic Fingerprinting of *E. coli* in Milk System

The present research was carried out to study the metabolomic profiling of specific strains of E. coli and identify metabolomic variations at strain level. Initially, 3 strains of E. coli viz. O157:H7, ATCC 11775 and K-12 were genetically validated for their strain identity. Thereafter, skim milk was fermented by all three strains until the late log phase. The samples were then prepared and run in two metabolomic platforms (H 1 NMR Spectroscopy and GC- MS). Chemometric analysis was carried out for the NMR data and statistical analysis was carried out in Metabolanalysts for both datasets. NMR data revealed six significant metabolites, while GC-MS revealed 30 significant metabolites between the four groups including skim milk. Three univariate tests of the NMR dataset

between O157:H7 and ATCC11775 identified 10 metabolites and 17 metabolites between O157:H7 and K-12. The univariate analysis of the GC-MS dataset revealed 38 differential altered metabolites between O157:H7 and ATCC 11775 and 34 metabolites between O157:H7 and K-12. A total of 18 metabolites were found to be most significantly altered between the pathogenic and non-pathogenic strains. A total of 3 metabolites (Butanoic acid, fucose and 3-hydroxybutyric acid) were found to be commonly up-regulated in both the NMR and GC-MS platforms. Finally, the targeted fatty acid profile (Butanoic acid and decanoic acid) of the analyzed samples by GC-FID showed similar results as obtained in the same samples by GC-MS and NMR. The present work shows that metabolomics can identify strain-specific metabolites in food systems that can further be utilized for strain identification and traceability.



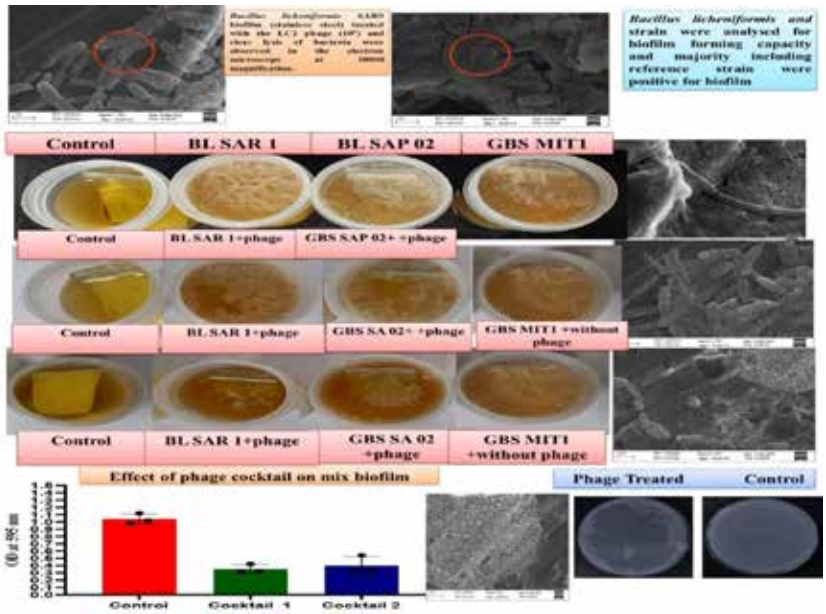
NMR spectroscopy based Metabolomic Fingerprinting of E. coli in milk System

Production of antimicrobial zinc oxide nanoparticle-peptide conjugates for the sanitation of milk production area

A technology was developed for the production of zinc oxide nanoparticle peptide conjugate (ZONPC). For the production of zinc oxide nanoparticle peptide conjugate, $Zn(NO_3)_2.6H_2O$ was used as a precursor and 10KDa peptide fraction as the reducing agent. Zinc oxide nanoparticle was produced with the same precursor but the reducing agent used was NaOH (0.1 Mol/L) at 90°C reaction temperature and reaction time of 4 h. The size of the zinc oxide nanoparticle peptide conjugate was 152.6 nm, and the zeta potential was -4.16. An extra amide III bond was present presence after conjugation. Zinc oxide nanoparticle peptide conjugate showed antimicrobial activity against resistant organisms and the zone of inhibition was in the range of 34-40 mm. The minimum inhibitory concentration and minimum microbicidal concentration of zinc oxide nanoparticles against resistant organisms were 2µg/ml and 65µg/ml, respectively and the minimum inhibitory concentration and minimum microbicidal concentration of zinc oxide nanoparticle peptide conjugate against resistant organisms was 2µg/ml and 16.5 µg/ml respectively. The developed zinc oxide nanoparticle peptide conjugate was found effective against samples collected from various areas of Livestock Research Centre, NDRI-Karnal with an average zone of inhibition of 36 mm. With a treatment of 200µl/mL ZONPC for contact time of 5-10 min, the initial count of *S. aureus* (125×10^3), Coliform (180×10^4), *B. cereus* (56×10^4), salmonella and shigella (265×10^4) count were nil. Overall, an 8-10 log CFU reduction in the microbial count was obtained. The developed zinc oxide nanoparticle peptide conjugate can act effectively against AMR microbes and could be used as a sanitizing agent in milk production areas.

Antimicrobial activity of optimized ZnONPs against different organisms (A-E. coli, B-S. enterica subs. enterica, C-B. cereus) at 100µL

Isolation and screening of bacteriophages for removal of *Geobacillus stearothermophilus* biofilm on stainless steel surfaces.



Isolation and screening of bacteriophages for removal of Geobacillus stearothermophilus biofilm on stainless steel surfaces.

The study aimed to isolate bacteriophages effective against *Bacillus licheniformis* and *G. stearothermophilus* biofilms on stainless steel surfaces in dairy manufacturing plants. These biofilms often harbour harmful microbes, posing contamination risks to dairy products. Among 140 bacterial colonies, 12 *Geobacillus* and 20 *Bacillus* species were identified based on phenotypic traits. Using specific primers and RNA sequencing, 10 *G. stearothermophilus* and *Bacillus* strains were confirmed. A total of 32 lytic phages were isolated against different strains, displaying a broad host range. Their morphology, examined via TEM, indicated classification under Siphoviridae, Myoviridae, and Podoviridae families in the Caudovirales order. Phage behaviour concerning infection rates and host adsorption was evaluated. Electron microscope analysis revealed the phages' ability to not only eliminate bacterial cells but also degrade the EPS-forming biofilms on stainless steel surfaces caused by these strains. This study signifies the potential of these phages in combating biofilm-related contamination in dairy environments.

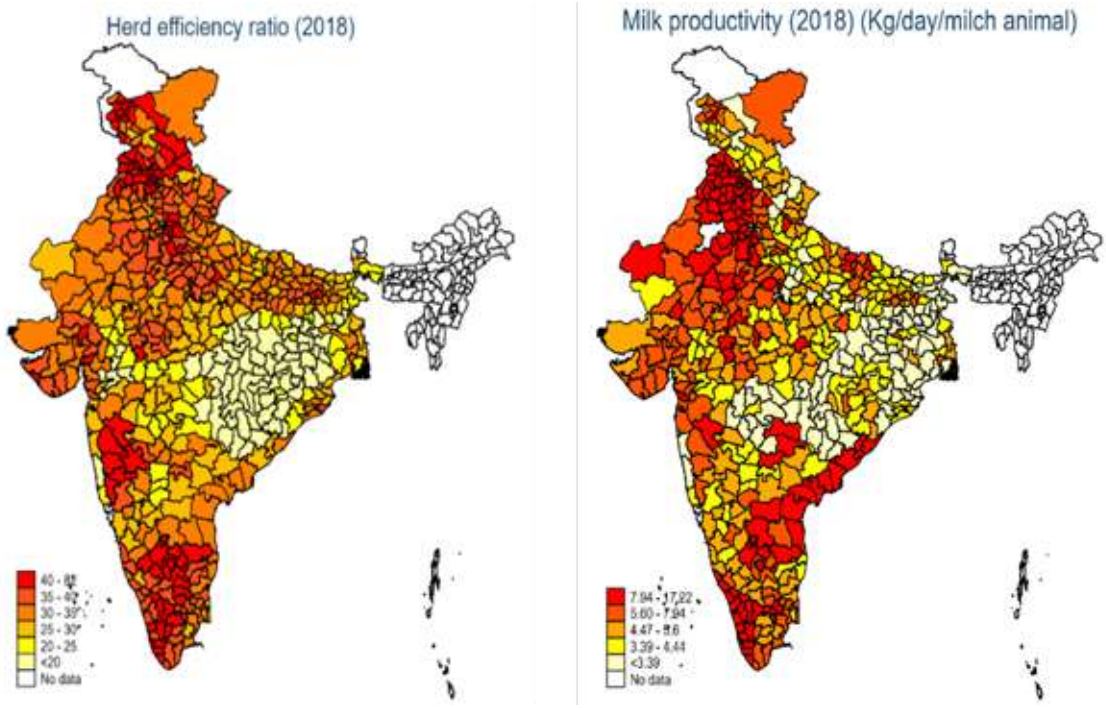
Quorum quenching potential of green nanoparticles to inhibit biofilm formation by *Listeria monocytogenes* on food contact surface

Listeria monocytogenes bacteria are widely found in soil, contaminating dairy products in the supply chain. The high rate of death associated with Listeria infection makes it a significant public health concern. The magnesium oxide nanoparticles by a greener approach against pathogenic Listeria were synthesized. These magnesium oxide nanoparticles were developed with the help of *Syzygium cumini* leaves and magnesium nitrate, further optimized by temperature and pH. The produced nanoparticles were primarily identified by the color changes to brownish colloidal formation and the appearance of a peak at 291 nm, using UV visible spectroscopy. Biophysical characteristics of synthesized G-MgO NPs confirmed the spherical shape and 35 nm size. The strong band at 440 cm^{-1} functional group indicated the presence of stretching and bending vibrations of Mg–O confirmed by Fourier-transformed infrared (FTIR). The G-MgO NPs were crystalline with a face- profile, confirming the presence of magnesium and oxygen. A zone of inhibition by G-MgO NPs at 25mg/mL and 50 mg/mL concentrations were 10 ± 0.88mm and 13 ± 0.58mm, respectively, confirming the antibacterial activity against *Listeria monocytogenes* strains. This study presents a rapid, low-cost, environmentally friendly green approach for G-MgO NPs synthesis and obtained G MgO NPs can also be used against other pathogenic microbial species in the future.

DAIRY DEVELOPMENT: POLICY ANALYSIS, STRENGTHENING DATABASE AND IMPACT ASSESSMENT

Bovine population dynamics and milk production in India: A household and district level analysis

The study used bovine demographic data for 526 districts of 20 major states from two quinquennial rounds of livestock census for the years, 2012 and 2018. The bovine ownership data for 13797 dairy households was extracted from Livestock Holdings Survey, conducted by NSSO in 2018-19. Between 2012 and 2018, the population share of indigenous cattle has declined across the districts, giving way to crossbred cattle. Notably, buffaloes dominated districts of Haryana, Punjab and Andhra Pradesh registered a decline in the share of buffaloes. The eastern and tribal districts of India were found to have higher share of indigenous cattle, lower ratio of in-milk bovines to total bovine stock (herd efficiency ratio) and low milk productivity. Districts found in Haryana, Punjab, Kerala, Punjab, Tamil Nadu, Haryana, Karnataka are marked by higher share of crossbred cattle, higher herd efficiency ratio and milk productivity. The polynomial regression analysis that herd efficiency ratio can be used as a potential indicator of dairy development. Household level regression analysis showed that herd efficiency ratio was significantly higher among landless and small landholding households and female headed households. The landless households had the highest average milk productivity. The study reveals that dairying contributes to a greater share of farm income to marginal and small farmers.

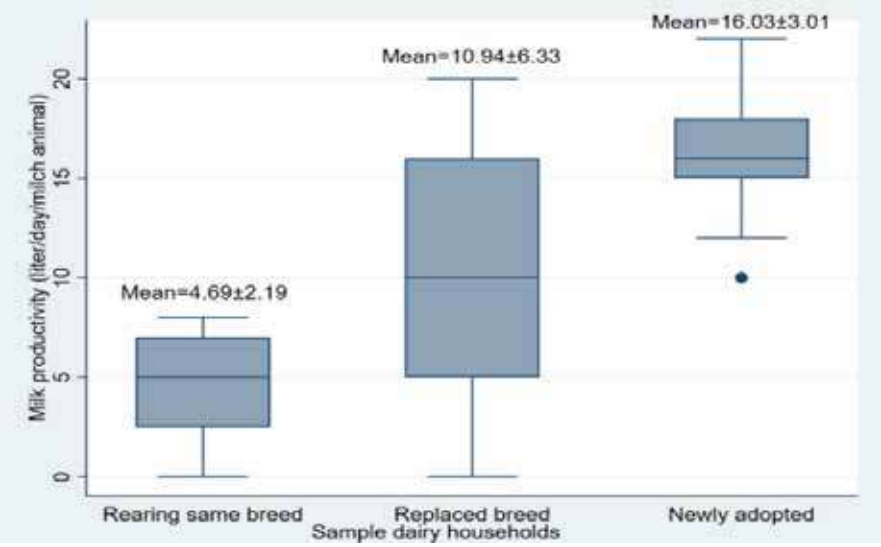


District level bovine (a) herd efficiency ratio and (b) milk productivity in India in 2018-19

Changing breed preference among dairy farmers in Andhra Pradesh: Patterns and determinants

The field survey was conducted in the Anantapur, Chittoor, and Nellore districts of Andhra Pradesh and the total sample of 270 dairy farmers were interviewed. The study revealed that in the last ten years, over 35 per cent of sample dairy households from Anantapur replaced the indigenous cattle with crossbred cattle, over 34 per cent of households started dairying with crossbred cattle, and 31 per cent continued to prefer the same breed, mostly indigenous Hallikar cattle. In Chittoor district, the majority of dairy households (54%) started dairying with crossbred cattle, whereas 29 per cent of sample dairy households shifted from indigenous to crossbred cattle. In

contrast, most of the sample dairy households (80%) in Nellore district preferred to rear the same breeds, mostly non-descript buffaloes and indigenous cattle due to their adaptive and productive traits under local hot and humid conditions. The herd size and milk productivity were higher in the case of newly adopted dairy households, followed by replaced dairy households. Probit analysis showed that breed adoption was significantly high among landless, marginal and small landholders. Association with farmer producer organisations and private processing companies, access to artificial insemination, formal training in dairy farming, farm mechanisation and adequate water availability had a significant positive influence on breed adoption.



Milk productivity among various category of sample farmers in Andhra Pradesh

Economic impact of COVID-19 pandemic on dairy sector of West Bengal

The study aimed to assess the economic impact of the COVID-19 pandemic on major stakeholders of the dairy sector of West Bengal. A sample of 180 dairy farmers, 3 milk unions, 18 dairy cooperatives (DCS), 60 milk vendors and 180 dairy consumers were selected from Howrah, Nadia and N-24 Parganas districts of West Bengal. The study period consisted of pre-lockdown (1st January 2020 to 23rd March 2020), lockdown (24th March 2020 to 31st May 2020) and post-lockdown period (1st June 2020 to 31st December 2020) of 1st wave of the COVID-19 pandemic.

Dairy farmers: The major constraints faced by the dairy farmers during the pandemic were unavailability and increased prices of feed and fodder, reduction in farm gate milk prices, unavailability of animal health services and delayed payments. The net returns from dairying were reduced significantly for both DCS members and non-members but it was more for non-members (-80 to -90%) than the DCS members (-10 to -18%). The rise in per litre cost of milk production for non-members was mainly due to decreased farm gate milk prices and the significant surge in input prices.

DCS/Milk Unions: The majority of the DCSs faced constraints regarding the transportation of milk from collection centres to chilling units and less availability of concentrate feed and labour during the pandemic. The total marketing margin of milk unions from the sale of milk increased by 6 to 7% and total marketing cost decreased by 8 to 11%. During the lockdown period, there was a sudden hike in sales of toned milk (5 to 25%), curd (5 to 56%), paneer (11 to 26%) and ghee (40 to 80%) but the sale of lassi (-25 to -50%) and peda (-50 to -80%) decreased.

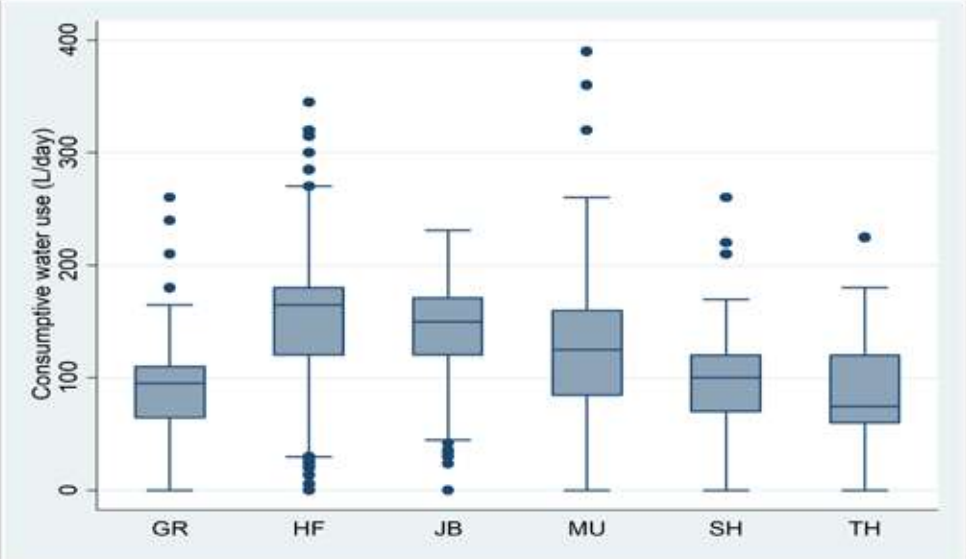
Private milk vendors: Private milk vendors faced constraints concerning milk procurement and demand for milk. Private milk vendors suffered the worst during the COVID-19 pandemic as net returns decreased (70 to 682%) for all types of vendors in all the study districts.

Dairy Consumers: The major constraints faced by dairy consumers during the pandemic were difficulties in visiting the market, less availability and increased prices of dairy products. The analysis using the Gini index and Lorenz curve showed that the high-income group of consumers was more stable with respect to the consumption of milk and milk products as compared to the low-income group during the COVID-19 pandemic.

EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING

Life time water footprints of different dairy breeds at field level

Global water scarcity has put a challenge on governments and policy makers to formulate sustainable production system with lower footprints. In the light of emerging problem, life time water footprints of dairy animals were assessed. A detailed survey on different breeds (*Gir, HF, Jaffarbadi, Murrah and Shaiwal*) of dairy animals (2036 numbers from 520 farmers) were conducted in Gujarat (*Amreli, Junagadh and Rajkot* districts), Rajasthan (*Barmer, Jaisalmer, Jodhpur and Sri Ganganagar* districts), Haryana (*Sirsa* district), Punjab (*Fazilka* district) for this purpose. The water footprint assessment offers useful data to develop an efficient water utilization system for rearing of the dairy animals. The consumptive water use (CWU_{milk}= CWU_{Direct}+ $CWU_{Indirect}$) was estimated for lifetime period. Overall, water productivity was estimated to be 0.016/per liter of water (implying 1.6 liter of milk produced by using 1000 liter of water). Water requirement was found to be negatively dependent on lactation length and positively dependent on lactation number (animal age). The results showed that *Gir* breed was most water efficient followed by *Sahiwal*.



Consumptive water use of different breeds of dairy animals based on life time assessment

Kernel based Regularized Least Squares (KRLS) framework was adopted to identify the factors affecting consumptive water use assuming the target function as : and approximating it to ; where, captures the similarity between (x), i.e., point of interest and covariate vector out of N vectors by assigning weight. Further, green fodder and other fodder (indirect component) are the major contributors to the water footprint for a dairy animal and must be optimized.

Economics and impact of domestic biogas plants on farm households in Southern Karnataka

Livestock waste management is increasingly challenging due to rising livestock populations and shrinking spaces. Biogas plants are a promising solution. A study in Southern Karnataka analyzed the economics, adoption factors, and socio-economic impact of domestic biogas plants using data from 75 adopters and 75 non-adopters. Popular fixed dome plants (91%) cost Rs. 24,500, slightly less than floating drum types (Rs. 27,900), with similar net returns of Rs. 6,393/year. Extension services and space availability boosted adoption. Benefits included reduced fuel costs, improved air quality, and lower GHG emissions. The GHG emission of adopter households was 62.64 per cent less than the non-adopter households. Constraints included lack of awareness and subsidies, and winter gas reduction. Promoting awareness, compact designs, and technical training can enhance biogas adoption.

Breed-wise economics of milk production in Gujarat – A comparative analysis

Secondary data analysis of population of cattle and buffalo in India over the years reveals that growth rate of cross-bred cattle population is the highest (range of14.62% for in-milk animals to 15.14% for milch animals) and lowest for indigenous cattle and buffalo population (range of 2.24 % to 2.49 % across different category). Breed diversity level in both cattle (Simpson Index = 0.457) and buffalo (Simpson Index = 0.359) is found low. Further, pasture and fallow land, rainfall, temperature, etc., affect breed diversity for cattle and buffalo. The impact of AI is insignificant for cattle breed diversity, although found positively significant for buffalo breed diversity.

Economic analysis of dairy-based integrated farming systems in coastal region of West Bengal

The Integrated Farming System (IFS) involves integrating two or more interdependent agricultural components. In coastal West Bengal, which has a diverse livestock population, environmental challenges like cyclones and flooding encourage diversified farming. A study identified major dairy-based IFS, such as Dairy + Crop (D+ C), Dairy + Fishery (D + F), Dairy + Crop + Fishery (D + C + F), Dairy + Crop + Goat (D+C+G), Dairy + Crop + Poultry (D + C + P), and Dairy + Crop + Fishery + Goat (D + C + F+ G).). Dairy + Fishery (D + F) yielded the highest net return of Rs. 1,00,677/year. The most profit-efficient system was Dairy + Crop (D+ C), with a mean profit efficiency of 0.84. Profitability was positively influenced by veterinary charges and farm capital, while education and experience reduced profit inefficiency. Salinity limited green fodder growth, affecting cattle adoption.

Dynamics of milk production and sustainability assessment of commercial dairy farms in Kerala

Milk production of Kerala experienced a modest growth rate of 0.99 per cent. In conducting a species-wise analysis, it is observed that cows exhibited the highest Compound Annual Growth Rate (CAGR) of 1.15 percent, while buffaloes demonstrated the lowest CAGR of -0.65 per cent. The in-milk bovine population in Kerala state has shown a negative compound annual growth rate of -3.26%. Indigenous species experienced the most significant decline at -14.02 per cent, followed by buffalo at -3.94 per cent and crossbred at -2.38%. The state-level milk production instability was classified as low (8.99), suggesting that the overall milk production at the state level remained stable throughout the period with minimal changes and low volatility. The milk production of buffalo exhibited significant volatility. *Wayanad* district emerges as the most technically, allocative, and economically efficient district, exhibiting impressive efficiency scores of 0.92, 0.88, and 0.81, respectively. Among large, medium, and small herd sizes in commercial dairy farms (CDFs), those with larger herds tend to demonstrate greater levels of both technical (0.90) and economic efficiency (0.79). The overall composite sustainability index of commercial dairy farms in Kerala was 0.55; it comes under moderately sustainable level. The Palakkad district was more sustainable when compared with *Wayanad, Thiruvananthapuram*. Large CDFs were more sustainable with a composite sustainability score of 0.60 for different herd sizes, than followed by medium (0.54), small (0.50). The major constraints faced by the producers in the study area related to production were the high cost of concentrates and food supplements (71.40 per cent), low productivity of milch animals (67.44 per cent), inadequate manpower in health care management (60.71 per cent), poor conception rate of cow, buffalo (55.87 per cent), unavailability of green fodder around the year (55.86 per cent).

Economic analysis of milk production in North-Eastern States

The Indian government aims to transform long-term planning by focusing on underdeveloped regions like the North-Eastern states to improve agriculture and livestock. This study assessed milk production yield gaps, crossbreeding effects, economic efficiency, and constraints. Assam, Meghalaya, and Tripura were chosen based on high milk production, with 300 dairy households surveyed. Results showed Yield Gap-II was higher than Yield Gap-I, with Meghalaya having the lowest Yield Gap-II at 35.60%. Crossbreeding led to an 87.36% increase in milk yield. Small farms were more efficient than large ones, with socio-economic factors influencing efficiency. Major issues included feed constraints and economic losses from breeding and abortion. The estimated loss due to the major problems was relatively higher in Tripura (Rs. 2.80 million) than in Assam (Rs. 2.65 million) and Meghalaya (Rs. 2.52 million). This study revealed that economic loss due to repeat breeding (Rs. 1.8 million) and abortion (Rs. 3.1 million) was the single most important problem in the region. Total estimated loss due to the affected animals in surveyed farming households was Rs. 8 million, annually.

Consumption of dairy-based functional foods influenced by socio-economic conditions: Study in Ranchi city

Dairy-based functional foods can be defined as foods containing significant levels of biologically active components that provide specific health benefits besides the traditional nutrients. The top sources of information for dairy-based functional food among consumers in Ranchi city were TV advertisements (33%) and word-of-mouth (25%). Most of probiotic drinks were consumed occasionally as (39%) was observed nearly less than 3 times a month, while around 38% of respondents consumed fortified milk on a daily basis. Majority of the consumers had preferred retail shops to purchase the fortified milk (58%) and supermarkets for the purchase of the probiotic drinks (53%). The monthly average consumption of fortified milk for per capita was only 8.6 liters, with an expenditure of Rs. 518.8, while the corresponding figures for the probiotic drink was 949.4 ml, with an expenditure of Rs. 270. It was also found that the income, education, and occupation had positively influenced the monthly per capita consumption expenditure of probiotic drinks and fortified milk, while age had significant negative impact on probiotic and food habits had significant negative impact of fortified milk.

NDRI climate services: A tool to promote climate resiliency in the murrah buffalo production system of Haryana

ICAR-NDRI, Karnal has initiated a weekly Temperature Humidity Index(THI)-based "NDRI Climate Services" to promote Climate Resiliency in the Murrah buffalo production system of Haryana. District specific THI-based climate advisory services were prepared and disseminated every week (Tuesday or Wednesday) through mobile app, SMS portal and WhatsApp groups. Weekly module has been disseminated through more than one lakh SMS and WhatsApp bulletins among 360 farmers across the 24 villages of Hisar, Jind and Rohtak districts of Haryana. Treatment effect of climate services was also found to be significant on adoption of the climate resilient feeding practices and milk yield during summer (0.38, 0.44 and 0.50 litre/animal) from Text SMS, WhatsApp and MobileApp, respectively.

Perceived sensitivity and adaptive capacity to climate change in the smallholder dairy production system of Bihar

A total of 120 smallholder dairy farmers, having 1-5 milch animals and at least 10 years of dairy farming experience, were selected from three districts namely Darbhanga, Gaya, and Nalanda from three different vulnerability zones of Bihar. The sensitivity of the dairy production system was assessed using the Analytical Hierarchy Process (AHP) with 30 sub-components under seven components. In all three districts, "feed and fodder availability" was perceived as the most sensitive component. In the Darbhanga and Gaya districts, average daily milk yield was considered as the most sensitive under the productive parameters, while in Nalanda district, lactation length was prioritized by the respondents. Regarding the indicators of reproductive parameters, heat detection was perceived as most sensitive in the Darbhanga and Nalanda districts, whereas in the Gaya district, the conception rate was prioritized. The study used the Sustainable Livelihood Approach (SLA) to analyze the adaptive capacity of the respondents by considering the combined effect of five capitals. In Darbhanga district, the majority of farmers (82.50%) exhibited a low level of adaptive capacity, whereas in Gaya district (52.50%) and Nalanda (57.50%), most of the farmers showed a medium level of adaptive capacity. The study enlisted reactive and proactive adaptation strategies from various sources and respondents. The mean index score of each strategy and each household was calculated to rank the strategies and assess respondents' adaptation behaviour. The majority of dairy farmers in Darbhanga (52.50%) and Gaya (40%) districts demonstrated a medium level of adaptation behaviour, while most of those in the Nalanda (45%) district displayed a low level of adaptation behaviour. Hence, findings of the will formulate an adaptation planning for smallholder dairy farmers to cope up with climate change.

Standardization of a perception scale to appraised dairy farmers' perception towards new age digital advisory services

A perception scale was developed with the help of Likert's Summated Rating Scaling technique to appraise dairy farmers' perception towards the new age digital advisory services. Initially, 60 statements were collated, scrutinized, and relevancy tested. Finally, 18 statements, having "t" value greater than equal to 1.75, were selected for the developed scale. Cronbach alpha was calculated to test the reliability of the developed scale and

found alpha = 0.90 which indicated a high level of internal consistency of the standardized scale. This scale was administered among the smallholder and commercial dairy farmers of eastern Haryana. The developed scale was able to differentiate perception of smallholder dairy farmers from commercial farmers regarding the use of new age digital advisory services. It was found that 50 percent of smallholder dairy farmers were having a lower level of perception, while the majority of the commercial farmers were having medium level of perception.

Construction of a psychometric scale to measure attitude of women farmers towards climate resilient dairy farming practices

Understanding farmers' attitude is instrumental in initiating/formulating any strategy to promote the adoption of technology. A scale was developed to analyze the attitude of women farmers towards climate resilient dairy farming practices. A list of 50 statements comprising both positive and negative statements were collated and refined based on Edward's 14 principles and 35 statements were retained for administering to women farmers from non-sampling area for further analysis. Finally, "t" value for each statement and found that 17 statements were having "t" value greater 1.75. The 17 statements were retained for final scale and administered for reliability and validity testing. Cronbach alpha coefficient of 0.786 confirmed internal consistency of the developed scale. The content validity of the scale was ascertained based on the judgement of the experts. The final developed scale can be used to measure the attitude of women farmers on climate resilient dairy farming practices in the present context and beyond the study area with modifications.

Development of a test to measure the knowledge level of women farmers towards climate resilient dairy farming practices

A total of 35 statements were administered to 60 women respondents for item analysis. Based on the standardized cut-off of difficulty and discrimination indices as well as point biserial correlation coefficient, 15 items were retained for the final test. Validity and reliability of the instrument have been established through expert opinion and Spearman brown coefficient using split half method, respectively.

Farmers' Participatory Assessment of "Salivascope for Estrus Detection" Method in Buffalo

A pilot study was conducted to understand the reproductive issues of the buffalo faced by the farmers and it was found that majority of the farmers were facing the issues related anestrus (30%), silent estrus (24%) and repeat breeding 32%). Majority (71%) of the buffalo farmers expressed their willingness to adopt "*Salivascope* for Estrus Detection" method in their herd for better reproductive management.

Awareness and adoption of precision dairy farming in Eastern Haryana

An awareness index was formulated to appraise dairy farmers' awareness of precision dairy farming using five components viz., usefulness, risks, relative costs, simplicity, and compatibility. A majority (55.00%) of the dairy farmers had a medium awareness of precision dairy farming. From the inter-correlation between the different components and overall awareness, it was found that usefulness, simplicity, and compatibility were significant and positively correlated with awareness of precision dairy farming. About 23.33 percent of the dairy farmers adopted milking machines, 13.33 percent, and 2.50 percent of the dairy farmers adopted fogger systems and computers for data recording, respectively. A SWOT analysis was done with the help of the Analytical Hierarchy Process (AHP) to identify and prioritize the internal and external factors responsible for the adoption of precision dairy farming technologies. Ranking based on the overall priority weights, availability of subsidies was ranked first followed by high initial investment cost (II), individual animal-centric management (III), provision of bank loans (IV), and improved milk quality (V) found to be influencing the adoption of precision dairy farming technologies as perceived by the dairy farmers. Therefore, the necessary interventions should be implemented to train farmers and increase the usage of precision dairy farming technologies.

Improving adaptive capacity of women farmers of Haryana through climate resilient dairy farming practices

Dairy farming has been an integral part of rural life and women play a very significant role in management of dairy animals. In India 75 million women are engaged in dairying as against 15 million men. Considering the above facts, the present study was undertaken in Hisar, Jind and Rohtak districts of Haryana. Three hundred

and sixty women farmers were considered as respondents for the study. Difference-in-difference research design was used. Six selected climate resilient practices were intervened to the experimental group. Significant improvements (at 1% level) in adaptive capacity of farmers was observed in treatment clusters (Mineral mixture, buffer and combination groups) in which input was supplied along with necessary information on the practices and significant improvement (at 5% level) in adaptive capacity was also observed in treatment cluster where advisory services on ration and feeding management were provided. The counterfactual (control group) shows that adaptive capacity of farmers was decreasing over the time and highlights the need for adoption of climate resilient dairy farming practices.

Women-centric vulnerability mapping and participatory adaptation planning to climate change for dairy farmers in Haryana

Women are more vulnerable to climate change when compared to their male counterparts. So, the present study aims to map the hotspots using the Gender-based Climate Vulnerability scores by applying Global Moran's I and Getis Ord G* tools in ArcGIS (Geographic Information System) software. A Gender-based Socio-Climatic Vulnerability index (GSVI) to climate change was standardized using suitable indicators categorized under the components, Exposure, Sensitivity and Adaptive Capacity to measure the gender inequality, discrimination against women and climatic vulnerability at district level. The results revealed that Sirsa, Palwal, Mewat, Mahendragarh, Jind and Fatehabad districts had high gender-based social vulnerability to climate changeSirsa was identified as the Gender-based Socio-Climatically Vulnerable hotspot in Haryana.

Vulnerability Mapping and Participatory Adaptation Planning to Climate Change

Appraisal of perceived risk of climate change on dairy farming in coastal low-lying region of Kerala

Alappuzha is a district in Kerala which has about 80% of the land in coastal region and includes areas which are even below mean sea level. Therefore, the present study was undertaken in coastal low-lying areas of Alappuzha to ascertain farmers' awareness towards climate change and its impact on dairy farming, to assess the risk faced by the dairy farmers due to climate change as well as to identify and prioritize climate risk minimization strategies followed in the study area. The overall awareness level among the respondents were found to be high (78.33%) and in general, farmers found to have more awareness regarding the features or impacts they experienced frequently, which can be observed in line with the prevailing climatic scenario of the study area. Climate Change Risk Index (CCRI) was developed to assess the risk faced by the dairy farmers based on the approach of IPCC AR5. Majority of respondents (78.33%) were in the low risk category, which indicate the relatively stronger adaptive capacity developed among the members of the farming community despite medium levels sensitivity, exposure and hazard observed in the coastal low-lying region. Findings of the study may help in formulating adaptation planning exclusively for the coastal low lying region.

Dairy farming practices *vis-a-vis* quality of life of tribal farmers in Rajasthan

The study was conducted, purposively, in Dausa and Karauli districts of north-eastern Rajasthan having a high population of tribals. Quality of life (QoL) index was developed for this study and applied, which resulted in a higher mean index value for infrastructure development (0.65), self-perception rate (0.60), health (0.48), and recreation (0.43); while a lower mean index value was seen in livestock wealth status (0.33), economic status (0.20), work participation (0.17) and social capital (0.14). Overall, the study found that 43.00% of the respondents had moderate quality of life; but also a sizeable percentage of them (33.00%) had low quality of life. Only around one-fourth of them had high quality of life. A farmers' perception scale was also developed, to measure the intended constructs in the specific context of the contribution of dairy farming to the quality of life of tribal farmers and the majority of the respondents (57.00%) fell in neutral category indicating that dairy farming had a significant contribution to their quality of life. Other variables viz. herd size, annual income from

dairy, farm asset possession, feeding parameters, and treatment of sick animals were found to have a significant and positive impact on the quality of life; while animal morbidity was found to be significantly and negatively correlated with the QoL.

Promotion of dairy farming for upliftment of socio-economic status of tribal farmers through technological Interventions in NEH Region

Dairy interventions were introduced in NEH region and it was found that there have been notable changes in various aspects. In terms of animal breed, there has been a shift from predominantly non-descript cattle in 2020 to a mix including Jersey, HF cross, and Sahiwal breeds in 2023. The artificial insemination increased from 27% to 36%. The herd composition among tribal communities there was a notable increase in Jersey cross (17.35%) and Graded (Sahiwal) (7.29%) cattle. There was an increase in the quantity of green fodder from 3-4 kg in 2020 to 4-6 kg in 2023. The productive performance of cattle exhibited notable changes between 2020 and 2023. The peak yield of animals increased significantly from 3.64 ± 0.37 liters in 2020 to 5.47 ± 1.22 liters in 2023. The lactation length of animals showed a positive trend, growing from 155±15 days in 2020 to 169±17 days in 2023. Regarding reproductive performance, positive changes were observed from 2020 to 2023. The puberty age of animals decreased from 34 ± 6 months to 31 ± 7 months, and the age at first calving reduced from 41± 7 months to 39± 9 months. The service period of animals also saw improvement, decreasing from 141 ± 37 days to 127 ± 31 days. The number of services per conception decreased from 3 ± 1 to 2 ± 1, indicating enhanced reproductive efficiency. Additionally, the calving interval of animals reduced from 411 ± 46 days to 397 ± 37 days, reflecting better reproductive management.

Capacity building of resource poor farmers in paddy-wheat cum dairy production system through farmer FIRST programme under irrigated agro-eco region of Haryana

One hundred demonstrations were conducted for the seed production of new wheat varieties, DBW-327 and DBW-332, with average yields recorded at 62.49q/hac and 60.28q/hac, respectively. New paddy crop varieties (PB-1847, PB-1885, and PB-1886) were introduced, and 173 demonstrations were carried out for paddy growers, covering an area of 74.41 hectares. The average yields were 60.51q/hac for PB-1847, 59.28q/hac for PB-1885, and 58.04q/hac for PB-1886. For crop diversification of mustard (PM-32 & Pusa Tarak), 48 demonstrations were conducted, and the average yield for PM-32 was recorded as 22.23q/hac, while Pusa Tarak yielded 18.59q/hac. In response to inadequate green fodder availability, particularly in lean periods (May-June and November-December), 33 demonstrations of Maize J-1006, 25 of Oats (Kent), 25 of Chinese cabbage, and 50 of fodder kits in Rabi were conducted. The average yields were 518.7 q/hac, 444.6 q/hac, 395.2 q/hac, and 494 q/hac, respectively. Testing milk samples through strip tests helped in the early detection of mastitis, enabling timely treatment by farmers and reducing losses. The overall prevalence of subclinical and clinical mastitis in cows was found to be 45 percent and 28.33 percent on an animal basis. For buffaloes, the overall prevalence of subclinical mastitis and clinical mastitis was found to be 25.00 percent and 20.00 percent, respectively, on an animal basis.

Interventions under farmers FIRST project of ICAR-NDRI

Sustainable livelihood development of scheduled caste farmers through livestock based technological interventions in Kolar district of Karnataka

The present study was conducted in Kolar District of Karnataka State, selected purposefully for having significant percentage (30.32%) of Scheduled Caste (SC) population. Based on the baseline survey data after problem identification, suitable technological interventions were prioritized based on weighted mean score viz., 'balanced feeding, green fodder production (2.27), breeding & reproduction management (2.13), clean milk production (1.85), cattle health & infertility management (1.56) and also backyard poultry to supplement the income were implemented. The overall adoption level of improved livestock farming practices among the respondents has increased to the extent of 53.00 per cent, post implementation of technological interventions. Further, the technological interventions resulted in improved dairy cattle productivity leading to enhance income among the beneficiaries. The average monthly milk yield before the intervention was 192 lit/cattle which increased to 230 liters and accordingly the monthly income of the farmers from dairying was increased by 19.00 per cent after implementation of the project. In order to supplement farmers' agricultural income, backyard poultry units were established which resulted in realizing an additional income of Rs.2050/per bird. Thus, through integration of different livestock interventions, it is possible to augment farmer's income, provide additional employment to farm women.

Dairy Startups in Karnataka state: an ecosystem analysis

The present study is being carried out on various stakeholders of the dairy Startup ecosystem comprised of dairy based Startups, incubators & accelerators, mentors and investors. The Likert Scale developed to measure the effectiveness of stakeholders of the startup ecosystem.The overall distribution of entrepreneurs based on 'entrepreneurial competencies & performance' as perceived by the entrepreneurs revealed that majority of the respondents (58.43%) possessed 'high level of competencies' and most (45.16%) of the Startups belonged to 'moderate level of performance'. The overall effectiveness of the Agri-Startup ecosystem was perceived as 'moderate level of effectiveness' by the entrepreneurs (61.29%).

Farmer FIRST: enriching knowledge-integrating technology and institutions for holistic village development in horticulture based farming system

Significant progress was made in the adopted villages through various institute interventions. These included on-campus and on-farm training, interactive sessions, animal health care, and demonstrations on balanced nutrition and quality milk production. Regular animal infertility and health camps were organized in Hosadurga, Balepura, Yeremgere, and Vasappanadoddi villages, addressing issues such as mineral deficiency, conception problems, and mastitis for 210 dairy cattle. Eighty-six beneficiary farm families received mineral supplements, rumen alkalizers, and dewormers. Training on scientific dairy management and health-nutrition sensitization was conducted, benefiting farmers, farmwomen, and youth. These interventions enhanced technical know-how and dairy management practices, improving animal health.

Glimpse of an animal health camp

Dairy entrepreneurship development among rural youth and women in aspirational districts of Karnataka state

The baseline information from the 550 farmer's respondents from two Aspirational Districts of Karnataka State i.e. Raichur and Yadgir was collected. Through information need assessment survey carried out among the respondents and other stakeholders, identified various technological interventions, viz., 'balanced feeding, green fodder production, clean milk production and value addition to milk'. The farmer-beneficiaries were

sensitized about the balanced feeding and improved fodder crop inputs were distributed for augmenting green fodder production.

Agri-startup ecosystem in Bengaluru, Karnataka: an exploratory study

Agri-startup ecosystem in Bengaluru, Karnataka: an exploratory study

The present study was conducted in Bengaluru covering fifty-six Agri-Startups. The major findings of the study revealed that overall distribution of performance more than half (51.79 %) of the Agri Startups, half (50.00 %) of the Incubators, Accelerators and Investors had showed moderate level of overall performance. Majority (66.67%) of the mentors observed the high level of performance. The Chi-square analysis reveals that among independent variables such as education (0.046), domicile (0.043), experience (0.035) and training (0.016) had significant relationship with performance of Agri- Startup at five per cent level. Majority of the Agri-Startup entrepreneurs (41.07 %) perceived high level of incubator effectiveness followed by Accelerators (48.21 %), Mentors (44.64%) and Investors (46.43 %), Policy support (37.50 %) and Higher Education and Research Institutes (39.29 %) had moderate level of effectiveness. Overall effectiveness of stakeholders revealed that more than two fifth (41.07 %) stakeholders had moderate level of effectiveness as perceived by the entrepreneurs.

Entrepreneurial potential of dairy farm women in Kolar and Chittoor districts of Southern region

The study was conducted in the selected districts viz., Kolar in Karnataka and Chittoor in Andhra Pradesh, to assess the entrepreneurial potential of the women involved dairy farming, to analyse the role of stakeholders in entrepreneurship development and to identify the constraints in entrepreneurship development among dairy farm women Overall entrepreneurial potential was found to be 'High' among 36.70 per cent of the respondents in Kolar and 26.70 per cent in Chittoor. Entrepreneurial orientation had significant association with Entrepreneurial Potential. The major constraints faced by the dairy farm women comprise, lack of capacity building activities for entrepreneurial activities (56.11), Lack of awareness about developmental programmes and financial supports (52.45) and Low level of awareness about milk production and processing technologies (52.48).

Agri-startups in Telangana state: an exploratory study

The present study was conducted in Telangana State covering 53 Agri-Startups selected randomly by using multistage stratified random sampling method. The major findings of the study revealed that the overall distribution of entrepreneurs based on entrepreneurial competencies as perceived by the entrepreneurs revealed that most of the respondents belonged to 'medium level of competencies' of 'opportunity seeking competence' (45.28%), 'conceptual competence' (47.17%), 'organizing competence' (64.15%) and 'strategic competence' (35.85%). Whereas, 'relationship competence' (37.73%) and 'commitment competence' (35.85%) belonged to 'high level of entrepreneurial competency'. The overall distribution of Agri-Startups based on performance as perceived by the entrepreneurs revealed that two-fifth (41.51%) of the Startups belonged to high level of performance. The major constraints faced by Agri-Startup entrepreneurs were 'inadequate incentives provided by the Government (47.87)', 'inadequate scalable technologies for commercialization (47.70)', 'low level of knowledge about marketing strategies (54.04)', and 'difficulty in attracting investors/funds (47.70)'.

Fodder crop management interventions through bio-fertilizers and bio-pesticide for sustainable dairy farming

The average CP content of demonstrated maize, sorghum, berseem and oats fodder crop was 8.84±0.19, 7.65±0.09, 18.53±0.13 and 10.09±0.12, respectively. In parallel, the study also embraced a holistic evaluation of the milk composition resulting from the utilization of the demonstrated fodder crops, achieved through a comparative analysis vis-à-vis milk derived from crops grown conventionally with the utilization of chemical fertilizers and pesticides. The average fat percentage in the milk produced by feeding maize, sorghum, berseem and oats fodder crop grown by using bio-fertilizer and bio-pesticide was 4.12±0.11, 4.14±0.11, 4.13±0.11 and 4.13±0.15, respectively. The research systematically prioritized positive and negative factors linked to adopting bio-fertilizer and bio-pesticide-based practices in fodder crop cultivation.

Tribal development through backyard livestock/poultry farming in Eastern India

- Direct benefit transfers (DBTs): Superior breeds of chicks (9500), and ducklings (5200) were distributed to help families raise healthier and more productive birds.
- Animal support: Feeds, mineral mixtures, supplements, dewormers, and equipment like feeders and waterers were provided to enhance animal health and production.
- Training: Over 1109 farmers participated in sessions (on-farm and off-farm) on various aspects of animal care, including dairy farming, goat husbandry, pig farming, poultry, and duck farming.
- Veterinary care: On-site health camps treated sick animals and vaccinated cattle, goats, and poultry against dreaded diseases.

Overall, these efforts in West Bengal demonstrate the positive impact of supporting tribal communities through improved livestock rearing. By providing resources, training, and veterinary care, programs like these empowered families to improve their livelihoods and well-being.

Direct benefit transfer to tribal farmers of Eastern India

Demonstrated crop production technologies increased tribal farm family income

The average yield of mustard was recorded at 1380 kg/ha with the Benefit: Cost (B:C) ratio (1.53) of the demonstrated technology, this was found encouraging (1.53). The average yield of black gram was recorded at 1071.13 kg/ha. The Benefit: Cost (B:C) ratio of the demonstrated technology was also found encouraging (1.91). The average yield of berseem fodder was recorded at 550.5 quintals/ha with B:C ratio of 2.40. The average

Demonstration of crop production technologies to tribal farm families

yield of oats fodder was recorded at 345.0 quintals/ha. The Benefit: Cost ratio of the demonstrated technology (2.01) was highly promising for fodder cultivation by the tribal farmers in the study areas. The yield of elephant foot yam has motivated tribal farmers for more tuber crop cultivation with the yield of 25.8 tonnes/ha and this variety was demanded by local farmers due to its higher B:C value (2.4). The bio-fortified (rich in anthocynonin) variety of sweet potato (Cv Bhu-Krishna) yielded little less crop production (18.0tonnes/ha) than other farmers variety, however, B: C ratio was impressive (2.5) and it is a value-added crop.

Livestock based integrated farming encouraged farmers in north eastern region

Total of 96 goats and 6010 kg goat feed were distributed among 70 and 299 needy tribal farmers, respectively; 99 piglets along with 27950 kg of pig feed were also distributed to 30 beneficiary farmers; 10360 chicks and 6835 ducklings along with 19075 kg chick/duckling feed were distributed to 757 resource poor beneficiary farmers, respectively along with other inputs, like feeders, waterers etc. Off-farm Interaction-cum-Training sessions were also conducted to train 1070 farmers on different aspects of dairy farming, goat husbandry, pig farming, poultry and duck farming.

Interaction-cum-Training sessions in north eastern region

Enhancement of socio-economic condition of Scheduled Caste farmers through livestock based integrated farming in Eastern India (SCSP)

On the basis of technological needs of the farmers, a total of 500 chicks and 500 ducklings of 28 days of old were distributed among 100 SC farmers in different districts. Other inputs like supply of goat feed (2800kg), poultry feed (2500 kg), bypass fat (595 kg), mineral mixture (255 kg), dewormer, vaccine, medicines, feeder/waterer etc. were also distributed among the SC farmers in the project area. Several animal health and vaccination camps (17 nos.) and 6 nos. of scientists-farmers' interaction meet was organized in the project areas of different districts of West Bengal. Awareness camp on subclinical mastitis was also conducted in 2 villages of Nadia district. One livestock mela was also organized in the Birbhum district of West Bengal. During this period a 3-days training programme for skill development of SC women farmers' of Birbhum district was organized at this station for scientific/precision dairy farming.

Chicks & feeder distribution program in Bolpurarea of Birbhum District

Performance Assessment of Farmer Producer Companies in Northern India

A significant portion of FPCs (22%) in North India have a turnover greater than Rs. 75 lakhs. This can be considered as an indicator of the presence of relatively larger and more successful FPCs in the region. Majority of FPCs (60 %) operate with share capital between Rs.0-25 lakh, indicating a relatively balanced financial standing. About one-third (30 %) of FPCs have working capital of more than Rs. 50 lakhs indicating a diverse range of

agricultural activities across the FPCs. Majority of FPCs (65 %) in North India convene monthly meetings. Cereal crops, with around 15.73 per cent of FPCs dedicated to the production, of its products stands out as a major product being the staple food in the North India, underscoring its vital role in various industries, from food and other by-products. Credit access and asset ownership status had statistically significant difference between FPC members and non-members, with p-values of 0.04 and 0.002, respectively. Availability of MSP for cereal crops, family orientation, target fixing without undertaking the demand analysis etc were found to be the major reasons for not achieving the desired level of performance in the northern region as compared to the southern and western regions of the country.

Controlling subclinical mastitis through NIF's indigenous medication at farmer's field in the regions of Haryana

The technology of NIF was demonstrated to assess the prevalence of mastitis in study area, on-farm evaluation of NIF's indigenous medication in control of subclinical mastitis condition at farmers' field. Ten farms were investigated against the prevalence of mastitis in cattle by examining 78 animals using California Mastitis Kit (CMT) reagent and 40 animals were found to be positive for mastitis. Among the infected animals, 101 quarters were found to be positive for CMT reactions out of 160 quarters. It was found that 73 quarters had shown improved udder condition for CMT on the 5^{th} day of observation. While calculating impact of medication at individual farm after the 5 days treatment, the value ranged between 68.75% and 90.90%. Positive results could be observed due to intervention and the selected farmers in ten villages of Karnal and Yamunanagar districts were convinced of the cost-effectiveness of the solution.

Farm Diversification in Haryana: An Appraisal for Future Farming

The study revealed that Crop Diversification Index of the Haryana state was found to be decreasing ($0.272_{(2010)}$ to $0.262_{(2018)}$), while Farm Diversification Index of the state was found to be increasing ($0.509_{(2010)}$ to $0.546_{(2019)}$). Proximity to NCR (0.896), increased road density (0.857) and improved access to market information (0.801) were found to influence farm diversification extensively. Market uncertainties (0.876) and climate induced factors (0.796) were perceived to hinder the farm diversification considerably. Farm diversification with enterprises such as sheep (3-3.8), piggery (2.4-2.66), apiary (2.55), mushroom (4.8), ber (5-6) and cauliflower (2.6-5) provided better income in comparison to the traditional field crops. Kaithal district (2.46) reported the highest farm diversification efficiency followed by Bhiwani (1.88) and Hisar (1.64) districts.

Socio-economic status and empowerment of scheduled caste farm families in Karnataka

More than half of SC farm families (55 %) belonged to low empowerment category while 57.08 per cent non-SC farm families fell in medium empowerment category. While SC farm families in Mysore district had higher level of empowerment with a mean index score of 0.47, Gulbarga district scored lowest level of empowerment (0.32). Annual income, size of land holding, livestock possession, and employment under MGNREGA were very positively related with economic empowerment of SC farm families. Brainstorming and Delphi technique suggested periodical critical gap analysis in knowledge and skill, removal of constraints in disbursements of loans to trained SC youths, inclusion of SC farm families in impact evaluation of SC centric schemes, and a grievance redress cell, strengthening collectives and their capacity building, and deployment of para-professional agents to disseminate improved farming practices as strategies to improve their standard of living and technology adoption.

Dynamics of agri-starups and scenario forecasting for their suitability

An '*Agri-Startup Progressiveness Index*' was developed using quantitative data on 5 domains, 12 sub-domains and 44 indicators for 24 states. The states were divided into i.e. high, moderate and low agri-startup progressive zones. Telangana, Haryana and Bihar states were selected from each zone respectively by simple random sampling for primary data collection. From each state, fifteen agri-startup cases were selected through purposive sampling. Thus, the total sample size was 45 cases. The domain specific index value of ASPI revealed that Telangana excelled in human capital, infrastructure, macro environment, and market support for agri-startups domains but do need improvement in access to finance and resource integration. While, Haryana has strong market support, skilled workforce, and excellent infrastructure but requires improvements in finance availability

and to create congenial startup ecosystem. Bihar performed well in human capital but faces challenges in other domains like infrastructure, finance, startup support, and market support. Prioritization of social media platform using Analytical Hierarchy Process showed that 'Instagram' was highly preferred with highest priority value (0.2608), followed by Facebook with a priority value of 0. 2431. The scenario forecasting, analysis indicated that for the sustainable growth of Agri-Startup ecosystem of India, the promoting indicators should be at the indicated compound annual growth rate, GVA at 2.23 per cent, Credit Inflow at 6.53 per cent, Export of Ag. and Allied Sector at 3.37 per cent, Per Capital Consumer Expenditure at 3.56 per cent, Index Number for Agricultural Production at 2.69 per cent, Expenditure by ICAR on R& D at 5.06 per cent, Per Capita National Income at 5.43 per cent should grow at the given compound annual growth rate.

A multi-stakeholder perspective on correlates of milk consumption level *vis-a-vis* lifestyle diseases in salem district of Tamil Nadu

A non-significant and inverse relationship between milk consumption level and lifestyle diseases such as diabetes, hypertension, overweight and anaemia was observed, while a positive relationship was found for cancer. Three-fourths of the adult population (74.67%) consumed less milk than the recommended level by ICMR. None of the children consumed the recommended level. No significant correlation between milk consumption levels and lifestyle diseases could be observed from the field data. An inverse relationship was found between Lifestyle Index score and level of lifestyle diseases. The study suggests promoting healthy lifestyle practices and accessibility and affordability of healthcare for all. The study acknowledged the limitations of relying on self-reported data for lifestyle diseases and emphasized further validation using real-time medical examinations and larger sample size for more accurate data in the future.

Prof. Cedric Gondro with Dr Dheer Singh, Director, ICAR-NDRI along with faculty members and students during the organisaton of an international workshop on "Genomic Analysis and Artificial Intelligence Applied to Animal Genetics and Breeding" from August 21 to September 01, 2023

4. RESEARCH PRIORITIZATION, MONITORING AND EVALUATION

The objective of Research Prioritization, Monitoring and Evaluation (PME) Cell is to put in place a robust mechanism for managing research functions and for developing and strengthening the research ecosystem. The essential elements of such an ecosystem, viz., generation of knowledge and facilitation of research, innovation and technology development for industrial & societal benefits, are addressed by human resource, intellectual capital, governance and financial resources, information management system, research promotion & guidance, Integrity and ethics, capacity building and research monitoring. The PME creates a conducive environment for enhanced research productivity, encourages collaboration across industry, government, community based organizations, and agencies at the local, national, and international levels and to facilitate research through mobilization of resources and funding. PME Cell at ICAR-NDRI coordinates and manages research activities and facilitates the decision support system with the following terms of reference:

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

Research Advisory Committee (RAC)

The new Research Advisory Committee (RAC) for ICAR-NDRI, Karnal was constituted as per the provisions of 'functions' of RAC provided under clause 71C of the ICAR Society rules, which includes, among other functions: (i) to suggest research programs in national and global context of research in thrust areas, and (ii) to review the research achievements of the Institute and deliberate as per the program developed by the institute and the provision 71F of the ICAR Society rules. The meeting of RAC of ICAR-NDRI was conducted on June 27-28, 2023 under the Chairmanship of Dr. Nagendra Sharma, Former-Vice-Chancellor, SKUAST,Jammu and Former Director, ICAR-NDRI, Karnal and ICAR- CIRG, Makhdoom, Mathura.

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-Institutional projects. The IRC meetings to evaluate the outcome of the completed research projects and to consider new research projects proposals were held on May 22-25, 2023 and June 15, 2023 for ICAR-NDRI, Karnal, SRS, Bengaluru and ERS, Kalyani. The completed and new research projects were critically discussed in order to address current emerging issues of the dairy sector. The mid-term review of IRC projects of ICAR-NDRI was taken up during October 3-6, 2023 at ICAR-NDRI, Karnal. The meetings were conducted under the Chairmanship of Director and convened by Joint Director (Research), ICAR-NDRI, Karnal.

Screening and Evaluation of Concept Proposals of Externally Funded / Contract / Consultancy Projects

The meetings of the PME Unit were convened for thorough deliberations on the functions envisaged under the purview of PME Cell with the overall objective of facilitating the decision support system of ICAR-NDRI, Karnal.

PME also screened and evaluated Externally Funded / Contract / Consultancy research proposals received from time to time. A total of 52 PMC Meetings were conducted during the year- 2023 to consider and screen 145 No Externally Funded / Contract / Consultancy research proposals. In addition, proposals for external funding grants for research as well as training were also screened online by seeking expert comments of members of PMC through mails for submission to external funding agencies such as Dept of Science and Technology (DST); Dept of Biotechnology (DBT); SERB; DAHD; BIRAC-PACE Scheme, Ministry of Food Processing Industries (MoFPI) New Delhi; National Fund; HSCSIT; Ministry of Health (Grant-in-Aid Scheme); SERB-Power Grant; DST SERB Power Grant; National Livestock Mission; ICMR; FSSAI; ICSSR; Uttrakhand Council of Biotechnology; Department of Animal Husbandry and dairying; NABARD; Central University of Jammu & Kashmir and National Livestock Mission etc. The Proceedings of the above PMC meetings were also documented and accordingly proposals were modified and aligned with priorities of the Institute.

PME also coordinated with scientists of the divisions and regional stations and facilitated submission of research proposals after proper documentation. The cell also handled all the correspondence and maintained liaison with SMD, ICAR for smooth implementation of research and training proposals.

Formulation of Guidelines

In order to provide robust mechanism for developing and strengthening the research ecosystem, PME Unit formulated guidelines related to submission of Project Proposals for External Funding / Consultancy / Contract Research. PME Cell also prepared guidelines for smooth function of the Unit by way of defining roles to be performed by the members of the ITMU.

MoUs Signed and Implemented

PME Unit provided all the logistic support for scrutinizing / finalizing the following MoUs signed between ICAR-NDRI and Other State Agricultural Universities and Central Universities.

- MoU signed with ICAR- Indian Institute of Wheat and Barley Research, Karnal on 09.02.2023
- MoU signed with Kerala Livestock Development Board (KLDB) on 16.02.2023
- MoU signed with Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut on 13.09.2023
- MoU signed with NDRI Graduates Association, Karnal on 30.09.2023
- MoU signed with Britannia Industries Limited, Bangalore on 19.10.2023
- MoU signed with Chr. Hansen India Pvt.. Limited, Mumbai on 24.11.2023

Agricultural Research Management System (ARMS)

The PME Unit implemented on-line database / computerization of research projects under ARMS introduced in 2022. A Nodal Officer (ARMS) was appointed to manage the ARMS data base.

Technical Screening Committee Meetings

Technical Screening Committee constituted under the Chairmanship of Joint Director (Res.) evaluated the manuscripts for publication in the form of books, technical bulletins, manuals etc. Based on the recommendations of the committee, the manuscripts were also sent to outside experts for evaluation. The same were again evaluated in light of the comments received from experts and the contents of the publications got modified and subsequently got published as Institute publications. During the period under report, the following manuscripts were screened, evaluated and allotted publication numbers of ICAR-NDRI:

- NDRI Sire Directory- 2023
- Technologies Available at NDRI for Commercialization
- Dairy Smarika (Hindi)
- Introduction and basic concept of instrumentation, measurement and process control
- Manual of Animal Physiology

Research Documentation and Publication

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

- Annual Report -2022
- ICAR-NDRI News Letter-a quarterly newsletter in English
- Director's Report for the 19th Convocation
- Research Projects (2023)
- Institute Research Committee (IRC) Proceedings (2 No) under the identified research programmes of the Institute
- Research achievements of ICAR-NDRI for inclusion in ICAR / DARE Annual Report 2023-24

XIII Plan EFC Memo Document (2021-26)

- Formulation of EFC plan document under the theme: "Dairy Production &Technology Development" amounting to Rs. 469.71 Crores comprising Sub-scheme: ICAR-NDRI, Karnal with total outlay of (Rs.238.27) Crores: ICAR-CIRB, Hisar with total outlay of (Rs.64.19) Crores; ICAR-CIRB, Network Project on Buffalo Improvement, Hisar with total outlay of (Rs.27.31) Crores; ICAR-CIRC, Meerut with total outlay of (Rs.76.81) Crores; ICAR-CIRC, All India Co-ordinated Research Project, Meerut with total outlay of (Rs.30.37) Crores, ICAR-NRC on Camel, Bikaner with total outlay of (Rs.32.76) Crores and submitted for consideration and final approval.

Half Yearly / Quarterly / Weekly/ Monthly Reports

- PME unit consolidated the half yearly / Quarterly / Weekly/Monthly Reports of the Institute in the prescribed formats and submitted to the Council. Likewise, quarterly reports were consolidated in terms of financial and physical targets of TSP activities being carried out at Eastern Campus, Kalyani.
- Quarterly, Half Yearly and Annual progress report were consolidated with respect to implementation of Tribal Sub Plan (TSP), North-Eastern Hill (NEH) Region and SCSP schemes being carried out at Eastern Regional Station, Kalyani.

Action Taken Reports (ATRs) and Information Collation

This Unit also prepared the **Action Taken Reports** on recommendations emerged during the meetings Animal Science Division of ICAR, New Delhi. Besides, PME Cell also collated information towards agenda and nine action taken reports on the recommendations of ICAR- Regional Committees No. I, II,III, V, VI, VII and VIII held from time to time. The Unit also collated information sought by the Council from time to time on the Institute activities, achievements, technologies, training programmes, initiatives undertaken for the growth of dairy sector for realizing various components of white revolution scheme for next 5 years, GB meetings as well as for third party evaluation at SMD level.

Information for Parliamentary Standing Committees and Parliament Questions

PME cell consolidated information for Parliamentary Standing Committee on Agriculture on the performance review of NDRI; ATRs on the recommendations / observations contained in the 39th Report based on comprehensive agricultural research based on "Geographical Conditions and Impact of Climatic Changes to Ensure the Food Security in the Country" of Parliamentary Standing Committee on Agriculture. During the period under report, a total number of 17 parliament questions (Lok Sabha & Rajya Sabha) were attended.

Promotion of National and International Linkages

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

Research Projects 2023 (In-House: on going)

S. No.	Project No.	Title	PI
1.	A-80	Optimization of method to produce cloned embryos of indigenous cows **(Lead Division: Animal Biotechnology)**	Naresh Selokar
2.	A-81	Genetic evaluation of Alpine x Beetal and Saanen x Beetal goat for prospective dairy goat breeding **(Lead Division: Animal Genetics and Breeding)**	Gopal Ramdasji Gowane
3.	A-82	Explore the use of mesenchymal stem cells for early maturity of cattle and buffalo heifers **(Lead Division: Animal Biotechnology)**	D. Malakar
4.	A-83	Enhancing economy of livestock farmers of SC community through artificial insemination using cloned buffalo bull semen **(Lead Division: Animal Biotechnology)**	Manoj Kumar Singh
5.	A-84	Exploring the potential of OPU-IVF in buffaloes **(Lead Division: Animal Biotechnology)**	Naresh Selokar
6.	A-85	To elucidate the genomic architecture and breed composition of Karan Fries cattle using High Density SNP Array **(Lead Division: Animal Genetics and Breeding)**	Sabyasachi Mukherjee
7.	A-86	Genetic selection for milk traits using genomic approach in Sahiwal cattle **(Lead Division: Animal Genetics and Breeding)**	Anupama Mukherjee
8.	A-87	Optimization of strategies for genomic selection suitable for crossbred cattle for enhancing milk production **(Lead Division: Animal Genetics and Breeding)**	Rani Alex
9.	A-88	Exploring the prevention of wounds of cattle using umbilical cord blood-derived mesenchymal stem cells **(Lead Division: Animal Biotechnology)**	D. Malakar
10.	A-89	Evaluation of genetic merit in Deoni cattle using emerging machine learning algorithms **(Lead Station: Southern Regional Station, Bengaluru)**	D. N. Das
11.	B-58	Enhancement of socio-economic condition of scheduled caste farmers through livestock based integrated farming in eastern India. (SCSP) **(Lead Station: Eastern Regional Station, Kalyani)**	Ajoy Mandal
12.	B-60	Strengthening dairy based integrated farming system for optimal resource utilization **(Lead Division: Livestock Production Management)**	Arun Kumar Misra
13.	B-61	Augmentation of ovarian, testicular function and fertility in buffaloes during low-breeding summer season by dietary supplementation and hormonal intervention **(Lead Division: Livestock Production Management)**	Rubina K. Baithalu
14.	B-63	Development and Characterization of progesterone loaded nano fibre for controlled breeding in dairy cattle (**Lead Station: Southern Regional Station, Bengaluru)**	Vedamurthy G.V.
15.	B-64	Evaluation of recycled manure solids as a potential cow bedding material **(Lead Station: Southern Regional Station, Bengaluru)**	Mukund A. Kataktalware
16.	B-66	Need based interventions for improving the productivity of indigenous breeds of cattle at Goras, Sheopur (M.P.) (**Lead Division: Livestock Production and Management**)	S.S. Lathwal
17.	B-67	Determination of Sample Size and Covariance Structure for Animal Studies involving Linear Mixed-Effects Models **(Lead Station: Southern Regional Station, Bengaluru)**	M. Sivaram
18.	B-68	Automated individual identification of dairy animals using computer vision and deep learning approach **(Lead Division: Livestock Production and Management)**	Indu Devi
19.	B-69	Social dominance in buffaloes and its implications for their performance and welfare **(Lead Division: Livestock Production and Management)**	M. L. Kamboj
20.	B-70	Letrozole: a non-steroidal aromatase inhibitor on ovarian function and controlled breeding in cattle and buffaloes **(Lead Station: Southern Regional Station, Bengaluru)**	S. Jeyakumar
21.	C-58	Evaluation of Moringa oleifera L. cultivars for intensive quality forage production under different plant geometry in eastern Haryana **(Lead Section: Agronomy)**	Rajesh Kumar Meena
22.	C-62	Effects of ameliorant in rations with different levels of aflatoxin B1 on nutrient use, production performance and carryover rate in milk in bovines (**Lead Division: Animal Nutrition)**	Chander Datt

S. No.	Project No.	Title	PI
23.	C-63	Utilisation of paddy straw as strawlage: A complete feed solution for dairy animals **(Lead Division: Animal Nutrition)**	Nitin Tyagi
24.	C-67	Nutritional enrichment of rice straw: evaluation and utilization in crossbred cattle ration **(Lead Station: Eastern Regional Station, Kalyani)**	A. Chatterjee
25.	C-68	Effect of sewage water on berseem-maize cropping system under different nutrient management practices **(Lead Section: Agronomy)**	Hardev Ram
26.	C-69	Development of organic nutrient management practices on fodder–food based cropping systems **(Lead Division: Animal Nutrition & Agronomy)**	Sanjeev Kumar
27.	C-70	Effect of residue management on soil microbial activities under salt affected soils in rice-wheat system **(Lead Section: Animal Nutrition & Agronomy**)	Rakesh Kumar
28.	C-71	Designing and development of continuous bioreactor for *in vitro* rumen studies **(Lead Division: Animal Nutrition)**	Raman Malik
29.	C-72	Potential of selected methane inhibitors under *in vitro* model and towards carbon neutrality in livestock sector **(Lead Division: Animal Nutrition)**	Goutam Mondal
30.	D-62	Profiling of milk constituents from indigenous breeds of cattle and buffalo **(Lead Division: Dairy Chemistry)**	Rajesh Kumar
31.	D-63	Utilization of paneer whey towards sustainable production of bioactive lactose-derived oligosaccharides **(Lead Station: Southern Regional Station, Bengaluru)**	Priyanka Singh Rao
32.	D-64	Development of spray dried probiotic direct vat set starters of *Lactiplantibacillus plantarum* strain(s) **(Lead Division: Dairy Microbiology)**	Chand Ram
33.	D-65	Characterization and bioprocess optimization for enhanced Vitamin B_{12} production by *Limosilactobacillus reuteri* NCDC 958 **(Lead Division: Dairy Microbiology)**	Manorama Kumari
34.	E-47	Development of mechanised feed and fodder distribution, and feeding system **(Lead Division: Dairy Engineering)**	Ankit Deep and Hima John
35.	E-56	Metabolomics-assisted elucidation of compositional and technological variations in milk of Beetal, Barbari and Jamunapari goats **(Lead Division: Dairy Technology)**	Heena Sharma
36.	E-57	Development of an energy efficient method for ghee preparation from butteroil **(Lead Division: Dairy Technology)**	Writdhama Prasad
37.	E-58	Development of thermic fluid based small scale mechanized process unit for rasogolla cooking **(Lead Division: Dairy Engineering)**	Priyanka
38.	E-59	Development of magnetic induction based milk heating system for paneer **(Lead Division: Dairy Engineering)**	Hima John
39.	E-60	Development of inline milk coagulation cum coagulum pressing unit for paneer manufacturing at small scale **(Lead Division: Dairy Engineering)**	P. Barnwal
40.	E-61	Improvement in functionality of buffalo milk protein concentrate (BMPC80) **(Lead Division: Dairy Technology)**	Ganga Sahay Meena
41.	E-62	Development of chest freezer attachment for small scale milk cooling application **(Lead Division: Dairy Engineering)**	P.S. Minz
42.	E-63	Monitoring and characterization of yogurt fermentation process on the basis of electrical properties **(Lead Division: Dairy Engineering)**	Khushbu Kumari
43.	E-64	Development of nutri-cereals based ready to reconstitute payasam mixes (**Lead Station: Southern Regional Station, Bengaluru)**	Menon Rekha Ravindra
44.	E-65	Densification of cattle dung-based composite torrefied biomass for bioenergy **(Lead Station: Southern Regional Station, Bengaluru)**	Vairat Amita Dinkar
45.	F-33	Development of analytical strategy for estimation of endogenous water-soluble vitamins in milk. **(Lead Division: Dairy Chemistry)**	Richa Singh
46.	F-34	Attenuated total reflectance-Fourier transform infrared spectroscopy coupled with chemometrics to detect foreign fats in ghee**. (Lead Division: Dairy Chemistry)**	Kamal Gandhi
47.	F-36	Detection of adulteration in milk and ghee using Raman Spectroscopy coupled with chemometrics **(Lead Division: Dairy Chemistry)**	Rajan Sharma

S. No.	Project No.	Title	PI
48.	F-37	Determining a safe alternative to Mercury for Dairy Glassware-Butyrometer Calibration **(Lead Station: Southern Regional Station, Bengaluru)**	Laxmana Naik, N.
49.	G-68	Fodder crop management interventions through bio-fertilizers and Bio-pesticide for sustainable dairy farming **(Lead Station: Eastern Regional Station, Kalyani)**	A. Mohammad
50.	G-71	Development of Climate Services for Murrah Buffalo Farmers of Haryana **(Lead Division: Dairy Extension)**	Sanjit Maiti
51.	G-73	Improving adaptive capacity of women farmers of Haryana through climate resilient dairy farming practices **(Lead Division: Dairy Extension)**	Sanchita Garai
52.	G-77	Dairy startups in Karnataka State: An ecosystem analysis (**Lead Station: Southern Regional Station, Bengaluru**)	S. Subash
53.	G-79	Livelihood augmentation of resource poor scheduled caste farm households in Western Dry Region of Rajasthan (SCSP Project) **(Lead Division: Dairy Extension)**	Gopal Sankhala
54.	G-80	Empowerment of tribal farmers through dairy interventions in Rajasthan **(Lead Division: Dairy Extension)**	B.S. Meena
55.	G-81	An appraisal of natural farming practices in different climatic cone of north India **(Lead Division: Dairy Extension)**	H.R. Meena
56.	G-82	Farmers' Participatory Assessment of "Salivascope for Estrus Detection" Method in Buffalo **(Lead Division: Dairy Extension)**	Sanjit Maiti
57.	G-83	Assessment of competitiveness and performance of Indian dairy export **(Lead Division: Dairy Economics, Statistics & Management)**	Gunjan Bhandari
58.	G-84	Impact assessment of selected interventions of NDRI-KVK **(Lead Division: Dairy Economics, Statistics and Management)**	Anil Kumar Dixit
59.	G-85	Consumer Behaviour and Demand–Supply Analysis of Dairy Based Functional Foods in India **(Lead Division: Dairy Economics, Statistics & Management)**	Ajmer Singh
60.	G-86	Levels and trends in income from dairy of agricultural households in major dairy states of India **(Lead Division: Dairy Economics, Statistics & Management)**	Udita Chaudhary
61.	G-87	Multimarket price determination of milk in India **(Lead Division: Dairy Economics, Statistics and Management)**	Biswajit Sen
62.	G-88	Women-Centric Vulnerability Mapping and Participatory Adaptation Planning to Climate Change for Dairy Farmers in Haryana **(Lead Division: Dairy Extension)**	Sanchita Garai
63.	G-89	Understanding the inclination of dairy entrepreneurs towards choosing dairying and related businesses as a means of employment in Haryana: A comprehensive study **(Lead Division: Dairy Extension)**	Raj Kumar
64.	G-90	Estimation of lifetime economics of Deoni cattle in organized and unorganized farms **(Lead Station: Southern Regional Station, Bengaluru)**	Shivaswamy GP

New Externally Funded Projects Sanctioned-2023

S. No.	Title	PI/CCPI	Co-PI	Funding Agency	Duration	Budget (Rs. in Lakh)
1.	Delineating the drug delivery potential of milk exosomes to combat intracellular pathogenic niche causing bovine mastitis	Dheer Singh	Suneel kumar Onteru	DBT	17.03.2023 to 06.03.2026	98.72520
2.	Evaluation of the impact of mitochondrial changes on milk production traits of indigenous cattle	Sadeesh E.M.		SERB-DST	15.02.2023 to 14.02.2025	29.53800

S. No.	Title	PI/CCPI	Co-PI	Funding Agency	Duration	Budget (Rs. in Lakh)
3.	Indian dromedary camel genome diversity analysis and development of customized low density SNP chip for camel.	Ved Prakash (AGB,NRCC, BIKANER	G.R.Gowane, Basanti Jyotsana and A.Sahoo, (NRCC)	NRCC Bikaner as part of coordinated research project IAEA Vienna	09.05.2023 to 08.05.2028	00.00
4.	Identification of heat stress- specific biomarkers to develop a biosensor for formulating mitigation strategies in high yielding dairy animals	A.K. Dang	-	DBT	March 2023 to March 2026	49.10480
5.	Profile analysis of farmer producer companies in India	K. Ponnusamy		KAU-ICAR-NAHEP-CAAST, Kerela Agricultural University Thrissur, Kerala	Jan 2023 to Dec 2023	40.00
6.	Building resilience model for the vulnerable hotspots to climate change in smallholder dairy production system of Indo-Gangetic Plain Region of India using GIS and fuzzy cognitive mapping approach	Sanjit Maiti	Dr. Rupak Goswami Howrah, Dr. Bishwa Bhaskar Choudhary Jhansi, Dr. Anirban Mukherjee Scientist Patna	NASF	Sept.2023-Aug.2026	54.94741
7.	Sensor based oestrus identification and health monitoring device in dairy animals	T. K. Mohanty	Mukesh Bhakat PS(LPM) Rubina Kumari Baithalu	DST (Collaborative project with IIT Delhi)	3 years 8.2.23 to 7.2.26	34.04592
8.	In-situ production of active vitamin B12 rich ready to use therapeutic composite dairy food and evaluation of its bioavailability and safety	Devraja H.C.	Monika Sharma, Rashmi H.M., Goutam kaul	ICMR New Delhi)	2023-2026 (01.07.2023 to 30.06.2026)	44.89
9.	Novel Nano purification technology for enrichment of super sperm population to improve fertility and skew sex ratio towards female in dairy animals.	A. Kumaresan		National Fellow ICAR	Jan 2023 to Dec 2027	376.59880
10.	The South Asia Agriculture Adaptation Atlas: Interconnections between climate risk, practices, technologies and policies	Sanjit Maiti	--	MOA&FW New Delhi (Collaborations) ICAR-CRIDA Hyderabad in collaboration with BISA	2023-2026	28.86580
11.	R & D project Affordable sustainable and nutritionally balanced milk millet protein ingredients	Yogesh Khetra		DST	2023-26	29.69327

S. No.	Title	PI/CCPI	Co-PI	Funding Agency	Duration	Budget (Rs. in Lakh)
12.	Global Centre of Excellence on Millets(Shri Anna) : Sub-component "Valorization of pearl millet strow for production of gut health caring nutraceuticals"	A. K. Samanta		ICAR-IIMR, Hyderabad	2023-2026	50.00
13.	Overexpression of recombinant linoleic acid isomerise/ desaturase on the surface of probiotice *Lactobacillus* spp. for enhanced in situ production of conjugated linoleic as acids in gastrointestinal tract of the host	Anita Kumari Garsa Mentor: J. K. Kaushik		DST under Women Scientists Scheme (WOS-A)	2023-2026	31.28
14.	Post Doc Fellow Bioinformatics approach for genomic insight for candidate genes for milk production and fertility traits in Indian cattle	Akinsola Oludayo Michael, Assistant Professor, Univ. of Jos, Nigeria C.V. Raman Fellow	Anupama Mukherjee (Mentor)	DST	29.11.23 to 29.05.2024	2.60
	Total					**870.2892**

Highlights of Major Activities of PME Unit

- In-house Research Projects (2023) : 64
- New Externally Sanctioned Projects (2023) : 14
- On- going Externally Funded Projects (National) : 59
- On- going Externally Funded Projects (International) : 03
- Externally Funded Projects Proposals Screened : 145
- Contract / Consultancy Projects : 03
- MoUs Screened / Signed : 07

Glimpses of Research Advisory Committee meeting held on June 27-28, 2023 at ICAR-NDRI, Karnal

5. EXTRA-MURAL FUNDING AND COLLABORATIONS

Externally Funded Projects

S. No.	Title of the Project	Name of PI/ CCPI	Name of Associates	Funding Agency	Duration	Cost (Lakh)
International Projects						
1.	Molecular markers for improving reproduction of cattle and buffaloes (MMIRCB)	Rakesh Kumar	Dheer Singh, Suneel Onteru, Rubina K. Baithalu, A. K. Mohanty, S. Kumar, T. K. Mohanty, J. K. Kaushik and M. Bhakat	Bill & Melinda Gates Foundation, USA	2018-2024	648.38
2.	Molecular markers for improving reproduction of cattle and buffaloes (MMIRCB)-Bill & Melinda Gates Foundation, USA	A. Kumaresan	A. Manimaran and K.P. Ramesha	Bill & Melinda Gates Foundation, USA	2018-2024	127.13
3.	Genome editing for improved location traits in Indian Buffalo.	Naresh Selokar Bhanu	Chi-hun- Park and Ravikant Reddy ponnuru	Bill & Melinda Gates Foundation, USA	2022-2027	98.53
National Projects						
4.	Network programme on veterinary type culture (VTC)-Rumen Microbes.	Sachin Kumar	Nitin Tyagi	ICAR	2009-2023	13.80
5.	Indigenous breed program (Sahiwal Cattle).	Anupma Mukherjee	Vikas Vohra, T. K. Mohanty, S. S. Lathwal and M. Bhakat	ICAR	2015-2026	8.35
6.	Study of fodder crop assessment for dairy industry and potential areas of intensification of state level.	Magan Singh	V. K. Meena and Sanji Kumar	Space Application Centre, Ahmedabad	2016-2023	34.00
7.	Capacity building of resource for farmers in paddy-wheat cum dairy production system through Farmer First Programme.	Gopal Sankhala	S. Meena, H. R. Meena, S.S. Lathwal, Rakesh Kumar, Ajmer Singh, A.K. Singh, V.K. Pandita (IARI), Nitin Tyagi, Sanket Borad, Heena Sharma, Sachin and Omvir Singh (CTO)	ICAR	2016-2023	33.62
8.	Enriching knowledge-integrating technology and institutions for holistic village development in horticulture based farming system.	B.Balakrishna, IIHR, Bengaluru	M.C.A. Devi and S. Subhash	ICAR	2016-2023	31.80
9.	Network project on buffalo Improvement-Institute herd-ICAR (CIRB Hisar-125001)	Vikas Vohra	Pawan Singh, G. R. Gowane and T. K. Mohanty and Mukesh Bhakat	ICAR	2017-2026	15.60
10.	Network project on buffalo Improvement-Field Unit (CIRB Hisar-125001)	Vikas Vohra	G. R. Gowane, Sabyasachi Mukherjee and S.K.Rathi	ICAR	2017-2026	30.70
11.	National Innovations in climate resilient Agriculture (NICRA) (Budget for 2020-21)	Ashutosh	Mahendra Singh PS & Head(AP), S.S. Lathwal (PS & I/C LRC), Nishant Kumar, Nitin Tyagi, Ashwani Roy, Anjali Aggarwal, M. K. Singh, Sunita Meena, Rani Alex, B. S. Meena, Ritu Chakravarty, Richa Singh, Sachin Kumar, Madhu Mohini and Biswa Bhaskar	CRIDA (ICAR)	2017-2025	91.50

S. No.	Title of the Project	Name of PI/ CCPI	Name of Associates	Funding Agency	Duration	Cost (Lakh)
12.	All India Network Programme on Livestock poultry product safety (AINP-LPPS)	Raghu H. V	Diwas Pradhan	ICAR	2023-2026	19.87
13.	Improving the livelihood through dairy farming in North Eastern region of India.	T. K. Dutta	M. K. Ghosh, S. K. Das, A. Santra, C. Bhakat, A. Mandal, A. Chatterjee, D. K. Mandal, Mohan Mondal, M. Karunakaran, A. Mohammad, S. Rai, R. Behera, Chander Dutt, S. Bandopadhyay (IVRI-ERS-Kolkata) Samiran Bandopadhyay (IVRI-ERS-Kolkata), S. Naskar (IVRI-ERS-Kolkata) and P. Dandapat (IVRI-ERS-Kolkata)	ICAR	2017-2026	20.00
14.	Incentivizing research in agriculture "Project-V Semen Sexing in cattle.	T. K. Mohanty PI of Component -A	Mukesh Bhagat, A. Kumaresan, Pawan Singh and Rubina K. Baithalu	ICAR	2017-2023	549.84
15.	Incentivizing Research in Agriculture Project-V Semen sexing in cattle.	Sudarshan Kumar of Component 'B'	Satish Kumar	ICAR	2017-2023	239.50
16.	Empowering farmers through selective interventions in salt affected agroecosystems of Ghaghar Plains(Farmers FIRST Programme, Funded by ICAR	Sohanvir Singh	K. Ponnusamy	ICAR	2018-2024	169.80
17.	Modulating the immune-cellular components and their signaling molecules in bovine colostrum and milk after micro-nutrient interventions and their functional validation under ex-vivo and in vivo animal models.	A.K. Dang	Sujata Pandita, S. S. Lathwal and Rajeev Kapila	DBT	2019-2022	76.39
18.	Scheme on Dairy Microbes under Network Mode.	P.V. Behare	A.K. Puniya	ICAR Network Project	2019-2024	95.00
19.	Exploring molecular basis of seasonal variation of seminal attributes and identification of potential biomarkers for selection of buffalo bulls with quality semen	Pawan Singh	Ranjit Singh Kataria-NBAGR, Karnal and Pardeep Kumar, CIRB, Hisar	DBT	2020-2023	193.00
20.	Characterizing milk colostrum of ladakhi Cows and Yak for identification of Biomolecules with therapeutic potential	Sudarshan Kumar	Jai Kumar Kaushik	SERB-DST	2020-2023	42.77
21.	Elecrohydrodynamic encapsulation of probiotics in prebiotic nanofibres for food applications	P. Heartwin Amaladhas	Sachin Kumar and Nitin Tyagi	DST	2020-2023	25.07
22.	Water budgeting and improving water productivity livestock based farming.	Ashutosh	Mahendra Singh, Sunita Meena and Satish Kumar	ICAR	2020-2025	90.00
23.	Development of flaxseed-rich probiotic dairy foods to address menopause symptoms	Sangita Ganguly	Neelam Upadhyay	DST	2020-2023	35.06
24.	Upliftment of socio-economic condition of tribal people through integrated livestock farming in north eastern hill region/eastern part of India –ICAR	T. K. Dutta	M. K. Ghosh, S. K. Das, A. Santra, C. Bhakat, A. Mondal, A. Chatterjee, D. K. Mondal, Mohan Mondal, M. Karunakaran, Asif Mohammad, S. Rai and R. Behera	ICAR	2020-2026	50.00

S. No.	Title of the Project	Name of PI/ CCPI	Name of Associates	Funding Agency	Duration	Cost (Lakh)
25.	Development of polarized angular scattering and microfluidics technology for bovine sperm sexing	Sharad Gupta	T.K. Mohanty and Mukesh Bhakat	DBT	2021-2023	157.0376
26.	Production of Double Muscled-Mass Farm Animal using CRISPR	Naresh Selokar	S. De, S.S. Lathwal and M.K. Singh	NASF	2021-2023	165.92
27.	Generation of milk somatic cell reference values and intelligent and predictive modelling for monitoring mammry profile and milk quality of indigenous dairy animals.	A. K. Dang,	Gourav Kr. Deshwal and Adesh Kr. Sharma	DBT	2021-2024	73.06
28.	Process for the preparation of lactose free skim milk powder with approaches to minimize maillard reaction	Sumit Arora	Vivek Sharma, Ashish Kumar Priyanka Singh Rao and Richa Singh	DBT	2021-2024	44.45
29.	Genomic based approaches for characterization of the microbial antibiotic resistance and resistome in Dairy production system	Rashmi H.M.	Diwas Pradhan and Saurab Kadyan and Sunita Grover	ICMR	2021-2024	49.32
30.	Development of quantitative molecular assays for rapid enumeration of viable probiotics from probiotic food products	Rashmi H.M.	Diwas Pradhan	ICMR	2021-2024	43.90
31.	Protein Based Optical sensors for detection of listeria monocytogenes in milk.	Raghu H.V.	Rashmi H.M. and Naresh kumar	ICMR	2021-2024	43.30
32.	ICAR Network programme on precision agriculture.	T.K.Mohanty	A.K.Mishra, S.S.Lathwal and Mukesh Bhakat	ICAR-NEPPA	2021-2026	332.00
33.	Development of phyto-immunobiotic for reduction of bovine intra mammary infections: comparative studies on bioactive compounds and whole extract effects	A. Manimaran	-	SERB	2021-2024	46.20
34.	Dairy entrepreneurship development among rural youth and women in aspirational districts of Karnataka State	S. Subash	K.P. Ramesha, S. Jeyakumar and H.C. Devaraja	RKVY	2021-2024	232.00
35.	Evaluation of bio functional attributes of extracellular components derived from probiotic lactobacilli as postbiotics.	Rajeev Kapila	Suman Kapila	SERB	2022-2025	40.00
36.	Unique innate-immunity genomic signatures identification in Sahiwal Gir, Tharparkar, Kangeyamm Karan Fries and Holstein Friesian cattle using immune informatics	Suneel Kumar	Ragothaman M.Yennamalli, Asstt. Prof. Sastra Deemed to be University, Thanjavur	NASF	2022-2025	95.40
37.	Enhancing post thaw quality of cryopreserved buffalo semen by using sperm-quiescent proteins of cauda epididymal plasma	R.K. Paul	-	SERB-DST	2022-2024	13.60000
38.	Establishment of AI network in Muzaffarnagar	Pawan Singh	B.S.Meena, Sohanvir Singh, Nishant Kumar and Indu Devi	DADF	2022-2025	859.10

S. No.	Title of the Project	Name of PI/ CCPI	Name of Associates	Funding Agency	Duration	Cost (Lakh)
39.	Antimicrobial resistance surveillance in view of one health concept	Prerna Aggarwal (Prof. & Head) Deptt. of Microbiology KCGMCH Karnal	Anupam Berwal and Sachinandan De	ICMR, New Delhi	2022-2024	57.34
40.	Evaluation of semen characteri-stics and fertility parameters of cloned bulls and performance of clones progenies –phase II	Prem Singh Yadav, ICAR-CIRB, Hisar	M.K.Singh	NASF	2022-2025	450.58
41.	Unraveling the genomic diversity and identifying Putative SNPs for Milk quality and production in Bilahi and crossberd population in Haryana State.	G.R.Gowane	Vikas Vohra and Rani Alex	DST (HSCSI&T)	2022-2025	40.00
42.	Development of climate resilient and sustainable agri based systems for better food, feed, nutritional and livelihood security potions to farming community of cold arid region– Ladakh	Anurag Saxena	Hardev Ram, P.N. Raju, Richa Singh, A.K. Mishra, M.S. Raghuwanshi, Shiraj Saleem Bhatt, Jagbir Tyagi and D. Namgyal	DST	2022-2025	272.00
43.	Utilization of paddy straw as complete fodder block by treating with Gomutra (Indigenous cow urine)	Ajayvir Singh Sirohi	Sanjeev Kumar Verma, Naimi Chand, Ahmad Fahim, CCPI: Nitin Tyagi , CC CoPI: Sachin Kumar	DST-SEED-SUTRA	2022-2024	70.68
44.	Development of Nano-Micro Matrices for the Delivery of Bioactives, Micro-nutrients and Therapeutics	Rajesh Kumar	Naveen K Navani, IIT Roorke Rajendran D., ICAR-NIANP, Bengalur P.Senthil Kumar, TANUVAS, Orathanad and P.Heartwin Amaladhas	NASF	2022-2025	401.63
45.	Comparative functional analysis of human bovine and goat milk based on modulation in the gut bacterial and metabolite composition	Rashmi H M	Diwas Pradhan, Suman Kapila, Rajesh Kumar and Heena Sharma	ICMR	2022-2025	90.00
46.	Electronic platform to monitor cattle health and milk quality	Ajoy Mandal	Chamapak Bhakat, and M. Karunakaran	MeiTY	2022-2024	60.88
47.	Characterization of native livestock and poultry population of West Bengal State.	Ajoy Mandal	S.M. Deb M. Karunakaran, Mohan Mandal	ICAR	2022-2027	27.50
48.	Controlling subclinical mastitis through NIFs indigenous medication farmers field in region of Haryana	K. Ponnusamy	A.K. Mishra, T.K. Mohanty and Chand Ram Grover	Vet/2022/138161 dt./21.10.2022	2022-2023	10.45
49.	Isolation of pro-rich poly peptides from colostrum of select indigenous cattle breed and evaluation of their neutraceutical potential.	Sathish Kumar, M.H.	Shaik Abdul Husain	NASF	2022-2025	100.55
50.	Delineating the drug delivery potential of milk exosomes to combat intracellular pathogenic niche causing bovine mastitis	Dheer Singh	Suneel Kumar Onteru	DBT	2023-2026	98.72520
51.	Evaluation of the impact of mitochondrial changes on milk production traits of indigenous cattle	Sadeesh E.M.	-	SERB-DST	2023-2025	29.53800

S. No.	Title of the Project	Name of PI/ CCPI	Name of Associates	Funding Agency	Duration	Cost (Lakh)
52.	Up gradation of methane emission factors for Indian livestock and prepration of inventory of GHGs emissions from Indian livestock	Goutam Mondal	Nitin Tyagi Sanjit Maiti	ICAR	2023-2027	70.15168
53.	Identification of heat stress-specific biomarkers to develop a biosensor for formulating mitigation strategies in high yielding dairy animals	A.K. Dang	-	DBT	2023-2026	49.10480
54.	Profile analysis of farmer producer companies in India	K. Ponnusamy	-	KAU-ICAR-NAHEP-CAAST, Kerela Agricultural university Thrissur, Kerala	2023-2023	40.00
55.	Sensor based oestrus identification and health monitoring device in dairy animals	T.K. Mohanty	Mukesh Bhakat and Rubina Kumari Baithalu	DST (Collaborative project with IIT Delhi)	2023-2026	34.04592
56.	In-situ production of active vitamin B12 rich ready to use therapeutic composite dairy food and evaluation of its bioavailability and safety	Devraja H.C., SRS	Monika Sharma,Rashmi H.M. and Goutam kaul	ICMR	2023-2026	44.89
57.	Novel Nano purification technology for enrichment of super sperm population to improve fertility and skew sex ratio towards female in dairy animals.	A. Kumaresan	-	Funded under national fellow ICAR	2023-2027	376.59880
58.	Overexpression of recombinant linoleic acid isomerise/desaturase on the surface of probiotice Lactobacillus spp. for enhanced in situ production of conjugated linoleic as acids in gastrointestinal tract of the host	Anita Kumari Garsa	Mentor: J. K. Kaushik	DST under Women Scientists Scheme (WOS-A)	2023-2026	31.28
59.	Building resilience model for the vulnerable hotspots to climate change in smallholder dairy production system of Indo-Gangetic Plain Region of India using GIS and fuzzy cognitive mapping approach	Sanjit Maiti	Dr. Rupak Goswami (RMVERI, Howrah), Dr.Bishwa Bhaskar Choudhary ,IGFRI -Jhansi, Dr.Anirban Mukherjee (R.Complex for Eastern Region, Patna)	NASF	2023-2026	54.94741
60.	The South Asia Agriculture Adaptation Atlas: Interconnections between climate risk, practices, technologies and policies	Sanjit Maiti	-	MOA&FW New Delhi (Collaborations) ICAR-CRIDA Hyderabad in collaboration with BISA	2023-2026	28.86580
61.	R & D project Affordable sustainable and nutritionally balanced milk millet protein ingredients	Yogesh Khetra	-	DST	2023-2026	29.69327
62.	Global Centre of Excellence on Millets (Shri Anna) : Sub-component " Valorization of pearl millet strow for production of gut health caring nutraceuticals	A. K. Samanta	-	ICAR-IIMR, Hyderabad	2023-2026	50.00
	Total					6908.05848

6. INTELLECTUAL PROPERTY MANAGEMENT

Institute Technology Management Unit (ITMU)

Institute Technology Management Unit at NDRI is managed by Institute Technology Management Committee (ITMC). ITMC is the highest body which takes important decisions for the intellectual property management at NDRI viz., filing of patents, approval of the technology for commercialization, pricing of the technologies ready for commercialization etc. ITMC is chaired by the Director.

In 2023, upto 12th September the following ITMC was in place

S. No.	Name of the officer	Position
1	Dr. Dheer Singh, Director	Chairman
2	Dr. A.K. Singh, Joint Director (Academic)	Member
3	Dr. S.K. Niranjan, Principal Scientist, NBAGR (IPR Expert)	Member
4	Dr. Naresh Kumar, Head, DM Division	Member
5	Dr. Sachinanadan De, Principal Scientist, ABTC	Member
6	Dr. Chand Ram, Principal Scientist, DM Division	Member
7	Dr. P. Narender Raju, Senior Scientist, DT Division& Co-Incharge-ITMU	Member
8	Dr. Rajan Sharma, Principal Scientist, DC Division	Member Secretary

After this, ITMC was reconstituted and since 13th September 2023 following ITMC is in place

S. No.	Name of the officer	Position
1	Dr. Dheer Singh, Director	Chairman
2	Dr. Rajan Sharma, Joint Director (Research) & Member Secretary, IRC	Member
3	Dr. Deep Narayan Yadav, Head, DT Division	Member
4	Dr. Sachinanadan De, Principal Scientist & Technical Expert	Member
5	Dr. Chand Ram, Principal Scientist & Technical Expert	Member
6	Dr. A.K. Puniya, Principal Scientist & Representative of PME Cell	Member
7	Ms. Shikha Singh, Managing Associate, M/S LexOrbis, New Delhi & IPR Expert	Member
8	Dr. P. Narender Raju, Senior Scientist and Office-in-charge, ITMU	Member - Secretary

During the period January 2023 – December 2023, three ITMC meetings were held as per following details

- 57th ITMC Meeting was held on 29.05.2023
- 58th ITMC Meeting was held on 07.07.2023
- 59th ITMC Meeting was held on 31.07.2023

At these meetings, pricing of technologies and examination of patent applications for their novelty and commercial applicability before filing patent applications were taken-up. Te details are as follows:

Technologies developed-2023 (04)

S. No.	Name of technology	Approved on	Inventors
1	BUPAG2 Based immunodiagnostic Elisa Kit for the quantitative estimation of PAG2 Isoform in cows and Buffaloes	07.07.2023 (58th ITMC)	A.K. Mohanty, Sudarshan Kumar, Sushil Kumar, Rubina Kumari Baithalu, T.K. Mohanty, Munna Yadav, Shweta Yadav
2	BuPAG-2 based immunodiagnostic methods and Kit (LFIA) for the early detection of pregnancy in cows and Buffaloes	07.07.2023 (58th ITMC)	A.K. Mohanty, Sudarshan Kumar, Sushil Kumar, Rubina Kumari Baithalu, T.K. Mohanty, Munna Yadav, Shweta Yadav
3	Additive combination for, improving quality and aerobic stability of Maize Silage	07.07.2023 (58th ITMC)	Nitin Tyagi, Neelam Kumari, Nutan chauhan, Pradeep Vishnu Behare, Sachin Kumar
4	Detection of sorbitol in milk using paper based discs	07.07.2023 (58th ITMC)	Vivek Sharma, Shailja Shinde, Sumit Arora, Priyanka Singh Rao, Richa Singh, Karra Madhavi Latha

Technologies commercialized - 2023 (05)

During the period January-December 2023, a total of 05 technologies were transferred to 04 commercial houses through 04 different License agreements thereby earning a total of **Rs. 20.60 Lakhs** (excluding Service Tax) for the Institute through technology licensing fee. The list of technologies licensed are given below:

S. No.	Name of technology	Inventor (s)	Technologies commercialize date	Price Fix (in Rupees)	Buyer
1	Indigenous probiotic *Lactobacillus rhamnosus* NCDC 610	Sudhir Kumar Tomar, Pradip V. Behare, Sandip Basu and Ashish Kumar Singh	20.01.2023 through Agrinnovate India Limited	4.00 Lakh + Tax	Vickro Biopharma Pvt. Ltd., Hyderabad
2	Native vitamin 12 producing *Lactobacillus reuteri* NCDC 958/vtcc610b for production Of vitamin B12 bio-fortified soy curd	S. K. Tomar, Manorama Kumari, Harshil Kumar Patel and Pradip V. Behare	20.01.2023 through Agrinnovate India Limited	5.00 Lakh + Tax	Vickro Biopharma Pvt. Ltd., Hyderabad
3	Misti Doi with fast acidifying high sugar tolerating lactic cultures	Surajit Mandal, Sudhir Kumar Tomar and Pradip V. Behare	20.03.2023 through Agrinnovate India Limited	1.60 Lakh + Tax	Terrestrial Foods Ltd., New Delhi
4	Spore based kit for detection of antibiotic residues in milk at dairy farm	Naresh Kumar, A. Khan, S. Arora, Raghu H.V., M. Balhara, P.K. Sharma and S. Shaikh	08.06.2023 Through Agrinnovate India Limited	4.00 Lakh + Tax	Beejapuri Dairy Pvt. Ltd., Haryana
5	Strip based technology for early detection of sub-clinical and clinical Mastitis	Naresh Kumar, Kriti Dua and Bhawani N	24.11.2023 through Agrinnovate India Limited	6.00 Lakh + Tax	Schreiber Dynamix Dairies Pvt. Ltd., Pune

Trademark registration

During the period, a trademark was registered for NDRI Signature (# 5261386) by the Office of the Controller General of Patents, Designs, and Trade Marks on September 13, 2023. Dr. Himanshu Pathak, Secretary DARE and Director General ICAR officially released it on 29th September 2023.

NDRI Trademark (Registration No. 5261386)

Patent Applications Filed

During the period, 02 patent applications are filed at Indian patent office. The details are:

S. No.	Title of Patent	Inventors	Date of Filing	Patent Application No.
1	A multi-enzyme based method for preparation of low lactose milk powder	Sumit Arora, Payal Singh, Priyanka Singh Rao, Richa Singh, Ashish Kumar Singh, Vivek Sharma, Deepika Kathuria	29.03.2023	202311023254
2	Modification of gene structure of buffalo genome and a method thereof"	Naresh Lalaji Selokar, M.K. Singh, S. De and M.S. Chauhan	03.08.2023	202311052265

Patents Granted

During the period, 06 patents were granted to ICAR-NDRI. The details are:

S. No.	Title of Patent	Inventor (s)	Grant No. and date of Grant
1.	A Strip for detection of neutralizers in milk (201811030055)	Rajan Sharma, Y.S. Rajput, Priyae Brath Gautam, and Bimlesh Mann	421478 on 13.02.2023
2.	A strip for detection of maltodextrin in milk and process for the same (2097/DEL/2014)	Rajan sharma, Y.S. Rajput, Bimlesh Mann, Prerna Narula and Rahul Thakur	427031 on 27.03.2023
3.	Microfluidic method for enrichment of live and motile spermatozoa of cattle (202011008229)	A.K. Mohanty, Vinod Kumar, Bhanu Prakash, Vibhav Katoch, Neeraj Yadav, Dharmendra Kumar gangwar, Sudarshan Kumar, T. K. Mohanty	436709 on 30.06.2023
4.	A preservative formulation for milk and milk products stored for analytical purpose (201911032383)	Richa Singh, Mitul Bumbadiya, Bimlesh Mann, Sumit Arora, Priyanka Singh Rao, Diwas Pradhan	446523 on 22.08.2023
5.	Rapid spores-enzyme based miniaturised assay (s) for detection of pesticide residues (3819/DEL/2015)	Dr. Naresh Kumar, Ms. Nimisha Tehri, Mr. Rajesh Gopaul, Mr. Pradeep kumar sharma, Mr. Brijesh Kumar, Ms. Spurti Morab, Mr. Raghu H.V.	450906 on 12.09.2023
6.	The preparation of buffalo milk casein hydrolysates with enriched antioxidative peptides and the process therof (201711023424)	Rajesh Kumar, Rajeev Kapila, Nichal Mayur Ashok Rao, Sowmya, Gulshan Dass, Bimlesh Mann, Suman Kapila,	460340 on 18.10.2023

Request for Examination for Patent Application filed

During the period, request for examination was filed for 01 patent application. The details are:

S. No.	Application/ Registration No.	Inventors of the Patent	Name of Innovation/ Technology/ Product/ Variety	Date of Filing/ Registration	Remark
1.	202111044603	Sachin Kumar, A.K. Tyagi, Nitin Tyagi, Rashmi H.M., Vinay V.V., Anukarna Singh	Novel probiotic formulations to improve the growth and health of buffalo calves	19.07.2023	Request Filed

Filing of reply of First Examination Report (FERs) of Patent Applications Filed

During the period, **reply of first examination report (FERs) of 03** patent applications have been filed at Indian patent office. The details are:

Sr. No.	Application/ Registration No.	Inventors of the Patent	Name of Innovation/ Technology/ Product/ Variety	Date of filing reply
1.	202111004590	P. Narender Raju, Rakesh Kumar Raman, Karpurapu Uma, Ashish Kumar Singh and Sangita Ganguly	Label for indicating freshness of Indian Dairy Products and preparation method thereof	20.07.2023
2.	201711036404	Y.S. Rajput, D.K. Nanda and Rajan Sharma	A crosslinked membrane with flow-line capable of arresting free-flowing gold nanoparticles and the process for the same	14.12.2023
3.	201711030808	Shilpa Vij, Arun Beniwal, Priyanka Saini, S. De	Construction of Mutant Strain of *Kluyveromyces marxianus* for Enhanced Galactose Utilization.	07.12.2023

Submission of NBA application

During the period, NBA application was submitted for 01 patent application. are filed at Indian patent office.

S. No.	Application/ Registration No.	Inventors of the Patent	NBA reference number	Name of Innovation/ Technology/ Product/ Variety	Date of filing
1.	806/DEL/2015	Dheer Singh, Onnureddy Kaipa, Suneel Kumar Onteru, Sriram Kannan	INBA3202305257	A PCR based method for detection of a field strain of urea plasma diversum	08.11.2023

Outreach Activities

During the period 05 outreach programmes were conducted. Firstly, organized the NDRI-Entrepreneurs Meet, gathering stakeholders from dairy, food, and allied industries. An exhibition displayed NDRI's technologies at an event for Farmer Producer Organizations (FPOs). Then, NDRI, with Agrinnovate India Ltd., held a Techno-Commercial Assessment & Expert Committee Meeting. NDRI also showcased its technologies at the 10th National Seminar on "Indian Dairy and Food Industry in Amrit Kaal: Opportunities and Challenges," hosted by the NDRI Graduates Association (NGA). Additionally, a Patent Workshop focused on drafting procedures for protecting various IPRs, led by Ms. Shikha Singh and Ms. Aprajita Nigam from M/s LexOrbis. The details are:

S.No.	Period	Name of Institute	Event / Programme Details	Number of Participants	Venue of Event	Remarks
1	March 15, 2023	ICAR-NDRI	NDRI-Entrepreneurs Meet commercialization of technologies	142	N.N. Dastur Auditorium, NDRI-Karnal	ICAR-NDRI invited the participant of the representatives/ entrepreneurs from "Dairy, Food and allied-industries" in One Day, "NDRI-Entrepreneurs Meet" on March 15, 2023 at the ICAR-National Dairy Research Institute, Karnal. NDRI-Entrepreneurs Meet – ICAR-NDRI, March 15, 2023
2	August 15, 2023	ICAR-NDRI	Exhibition of NDRI Technologies at an Exhibition for the FPOs of the country arranged by the Ministry of Agriculture and Farmers Welfare	2	Official Residence of Union Minister of Agriculture and Farmers Welfare	Exhibition of NDRI Technologies at an Exhibition for the FPOs of the country arranged by the Ministry of Agriculture and Farmers Welfare at the Official Residence of Union Minister of Agriculture and Farmers Welfare on 15th August 2023
3	August 28, 2023	ICAR-NDRI	Techno-Commercial Assessment & Expert Committee Meeting	30	Pinaki Hall, ICAR-NDRI, Karnal	ICAR-National Dairy Research Institute, Karnal along with Agrinnovate India Ltd., New Delhi organized Techno-Commercial Assessment & Expert Committee Meeting
4	September 28-30, 2023	ICAR-NDRI	Exhibition of NDRI Technologies at 10th National Seminar on "Indian Dairy and Food Industry in Amrit Kaal: Opportunities and Challenges" organized by NDRI Graduates Association (NGA) and held at ICAR-NDRI	6	ICAR-NDRI, Karnal	Exhibition of NDRI Technologies at 10th National Seminar on "Indian Dairy and Food Industry in Amrit Kaal: Opportunities and Challenges" organized by NDRI Graduates Association (NGA) and held at ICAR-NDRI during 28-30 September 2023.
5	December 06, 2023	ICAR-NDRI	A Patent Workshop on "Drafting procedure for protecting various IPRs with special reference to Animal Science"	150	N.N. Dastur Auditorium, NDRI, Karnal	A Patent Workshop on "Drafting procedure for protecting various IPRs with special reference to Animal Science" was organized. At this workshop, Ms. Shikha Singh and Ms. Aprajita Nigam, Managing Associates at M/s LexOrbis conducted sessions on the drafting procedures of patents, copyrights, and industrial designs.

Release of ICAR-NDRI trademark by the dignitaries

Launching of NDRI Technology Booklet on NDRI-Entrepreneurs Meet on 15th march 2023

7. ENTREPRENEURSHIP DEVELOPMENT, BUSINESS INCUBATION ACTIVITIES AND CONSULTANCY SERVICES

Consultancy Processing Unit

The consultancy processing unit facilitates and coordinates the professional service functions of the institute by offering different services to organization, individuals, industries and entrepreneur. The services include contract research, consultancy services, contract service and training programmes. Contract research comprises all research activities undertaken through specific contractual agreements with external agencies for the purpose. Consultancy shall mean professional services rendered to external agencies in terms of scientific, technical, engineering or other professional advice/assistance based on the expert knowledge and skill available at the institute. Contract services would mean services rendered to the external organizations/ clients/ customers, or assistance of minor nature based on available knowledge, expertise, skills and facilities of the institute.

Consultancy Projects

Institute is offering both general and advisory consultancy to individuals or organization on various aspects of dairy production, processing and management. The details of consultancy projects are given below:

Project Name	Firm Name	Name of Consultant
Consultancy on training of ice creams manufacture and its analysis	M/s Dev Ice Cream, Kavri Pathak, Panipat, Haryana	Dr. Shaik Abdul Hussain, Dairy Technology Divison
Evaluation of BovEasy/AniEasy early pregnancy diagnosis in cows.	M/s Prompt Equipments Pvt. Ltd, Navrangpura, Gujarat	Dr. Rubina K Baithalu, Livestock Production Management Divison
A Validation study on the milk screen for rapid assessment of the composition & Quality of Milk	M/s Indifoss Analytical Pvt. Ltd., Gujarat	Dr. Kamal Gandhi, Dairy Chemistry Division

Contract Research

Institute is engaged in active collaboration with industry, government agencies and other stakeholders for executing the research projects funded by them. In year 2023, one contract research project was received. The detail of contract research project is given below:

Project Name	Name of the Organization	Name of Consultant
The effect of slow release nitrogen feeding on nutrient utilization, microbial protein synthesis and milking performance in lactating cows.	M/S Alltech Biotechnology Pvt. Ltd, Bengaluru	Dr. Sachin Kumar, Animal Nutrition Division

Contract Services

Institute assisted stakeholders through offering the services of analysis, supply of testing kits, cultures and other services. Through contract services institute offered 53 services of analysis, 7 supplies of kit and culture to different organization, individuals and industries.

Training Programmes

A total number of 136 students from other universities and educational organization were imparted training from 1 to 6 months duration in various divisions and sections of the Institute.

National Referral Centre for Milk Quality and Safety

National Referral Centre for Milk Quality and Safety (NRCMQS) has been established at ICAR-National Dairy Research Institute, Karnal with a total area of 17000 square feet. The NRCMQS is accredited by National Accreditation Board for Testing and Calibration Laboratories (NABL) in accordance with ISO/IEC 17025-2017. Functioning as a commercial testing facility, NRCMQS is equipped with necessary instruments and techniques for qualitative and quantitative analysis of milk and milk products in both chemical and microbiological testing. At present, lab is doing 264 parameters in chemical testing and 89 parameters in microbiological testing. The laboratory also imparts scientific inputs to the national bodies like FSSAI and BIS.

A view of National Referral Centre for Milk Quality and Safety

National Collection of Dairy Cultures

National Collection of Dairy Cultures (NCDC) established at ICAR-NDRI functions as a specialized repository, catering to diverse sectors like the dairy and food industry, academic institutions, and research organizations within the country. Primarily, NCDC has effectively addressed the increasing demand for dairy cultures, which are crucial for producing fermented milk products in the Indian Dairy Industry. At present, NCDC boasts an impressive collection of over 800 cultures, spanning fungal cultures and cultures tailored for specific product preparations, such as Cheese, Dahi, Lassi, Misti Dahi, and Yoghurt starter culture. The centre is proactive in conducting specialized training programs that centre on the preservation, propagation, and effective use of dairy starter cultures in developing fermented milk and milk-based products.

Professional Service Functions at a Glance

S. No.	Services	Number	Revenue
1.	Contract Research Projects	1	20,06,887.00
2.	Consultancy Projects	3	19,44,151.50
3.	Contract Services		
	i) Analytical Services	53	4,78,728.00
	ii) Supply of Kits and Culture	7	2,36,000.00
4.	Training Programmes	136	21,87,337.00
		Grand Total	**68,53,103.50**

8. DAIRY EDUCATION

ICAR-National Dairy Research Institute is the premier Institution of International repute in Human Resource Development for the growing dairy industry in India. ICAR-NDRI which has been conferred deemed to be university status vide Govt. of India, Ministry of Human Resource Development, Department of Education, and Notification No. F. 9-15/85-U.3 dated 28.3.1989, is well equipped and staffed to meet emerging needs of the 21st Century of the Dairy Industry. The University offers academic programmes 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 2022-23. The courses have been so designed as to provide broad base as well as specialized training on different aspects of dairying.

B.Tech. (Dairy Technology)

This 4 Year degree programme offers intensive training in processing and quality control of milk and milk products; and engineering aspects of milk processing plants.

Master's and Doctoral Degree Programmes

The Institute offers Master's degree programme in the following disciplines:

S. No.	Discipline	S. N0.	Discipline
1	Dairy Microbiology	8	Livestock Production and Management
2	Dairy Chemistry	9	Animal Nutrition
3	Dairy Technology	10	Animal Physiology
4	Dairy Engineering	11	Agricultural Economics
5	Animal Biochemistry	12	Agricultural Extension Education
6	Animal Biotechnology	13	Agronomy
7	Animal Genetics and Breeding	14	Animal Reproduction Gynaecology and Obstetrics

The Institute offers Doctoral degree programme in the all the above disciplines.

Scholarship and Fellowships

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

Institute Scholarships

1.	Master's degree	:	Rs. 7560/- P.M. for two years plus Rs. 6000/- per annum as contingency
2.	Ph.D.	:	Rs.25000/- P.M. for first two years, Rs. 28000/- during third year and Rs. 10000/- per annum as contingency.
3.	Ph.D. (In-service)	:	Rs. 3000/- P.M. for three years and Rs. 10000/- per annum as contingency

ICAR Junior Research Fellowship

1.	Master's	:	Rs. 12640/- P.M. (For veterinarians) for two years and Rs. 6000/- per annum as contingency
2.	Ph.D.	:	Rs. 31000/- P.M. for first two years, Rs. 35000/- during third year and Rs. 10000/- per annum as contingency.

National Talent Scholarship

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

Career Guidance, Training and Placement Cell

The placement Cell provides career guidance, training and placement services for the passing out students in various disciplines of the Deemed University. B.Tech. (Dairy Technology) and Master in Dairying students were provided employment in reputed organizations through campus interviews. Passed out students of NDRI are getting employment in Dairy/ Food Industry (Govt./Cooperative/Multinationals). The average salary offered to UG students was above ₹6.06 lakh per annum while the average salary for PG students was more than ₹10.00 lakhs per annum during 2022-23. . In addition to employment a number of students also opt for higher studies in India and abroad. The major functions of the Cell are as follows:

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

Counselling for Admissions

Online Counselling for admission to UG/PG programmes was held by the Education Division of ICAR New Delhi.

Admissions

Admission for the academic session 2022-23 for B.Tech. (Dairy Technology), M.Sc./M.V.Sc./M.Tech. and Ph.D. programmes were made.

S. No.	Courses	No. of students admitted
1	B.Tech. (Dairy Technology)	39
2	Masters' programme	142
3	Ph.D. Programme	114

Meetings

- 96th meetings of the Standing Committee on Course Curricula and Academic Affairs was held on 02.01.2023
- 52nd and 53rd meetings of Academic Council were held on 06.01.2023 and 22.4.2023

To Celebration of Academic Month From 3rd Week of March Onwards

Date	Event
28th February, 2023	Dr. N.N. Dastur Memorial Oration by Dr. B.N. Tripathi, Deputy Director General (AS), ICAR, New Delhi.
2nd March, 2023	Presentation of Best Thesis (Master's Programme for 2020-21 and 2021-22). Parallel Sessions were conducted for Processing, Production and Social Science groups
03rd March, 2023	Presentation of Best Thesis (Ph.D. Programme for 2020-21 and 2021-22 . Parallel Sessions were conducted for Processing, Production and Social Science groups
14th March 2023	Dr. K.K. Iya Memorial Oration by Dr. M.S. Chauhan, Vice-Chancellor, GBPUA & T, Uttrakhand.
27th March, 2023	Dr. D. Sundaresan Memorial Oration by Dr, Himanshu Pathak, Secretary DARE & DG, ICAR, New Delhi
17th April , 2023	Presentation of innovations and significant achievements during 2020-21 and 2021-22 in education/ research/consultancy by different divisions.
22nd April, 2023	53rd Meeting of Academic Council
24th April, 2023	Nineteenth Convocation of NDRI (Deemed University)

Nineteenth Convocation of the ICAR-NDRI

19th Convocation of the ICAR-National Dairy Research Institute, Karnal was held on 24th April, 2023 in the he august presence of Hon'ble President of India Smt. Droupadi Murmu Ji. While chairing the 19th convocation ceremony, the Hon'ble President conferred degrees upon 544 students including gold medals. While congratulating the students receiving degrees, Hon'ble President, Smt. Droupadi Murmu said that with these degrees a new chapter had been started in their life and each one of them should continue the streak of learning new things along with making significant contributions for the welfare of the people. On this occasion, Chief Minister, Haryana, Sh. Manohar Lal Khattar also conferred honoris causa on Dr. Ramesh Chandra, Member, Planning Commission; Dr. B. N. Mathur, Former Director, ICAR-NDRI; and Dr. M. S. Chauhan, Vice Chancellor, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, for their outstanding contributions in the sphere of dairy science.

Hon'ble Governor of Haryana, Sh. Bandaru Dattatreya, Union Minister for Agriculture and Farmers Welfare, Sh. Narendra Singh Tomar; Union Minister of Fisheries, Animal Husbandry and Dairying, Sh. Parshottam Rupala,

Union Minister of State for Agriculture and Farmers Welfare, Sh. Kailash Choudhary and Secretary DARE and Director-General, Indian Council of Agricultural Research, Dr. Himanshu Pathak also graced the convocation ceremony.

We awarded degrees & Medals to the following eligible students the year 2021 & 2022.

DEGREE	Total	Boys	Girls
Ph.D. Programme	158	95	63
Master	308	193	115
B.Tech.	78	63	15
MEDALS			
Gold	12	7	5
Silver	6	1	5
Bronze	6	5	1

In addition to the above, the best thesis award to the Master's & Ph.D. students, best division award and three Memorial Oration Award; Dr. D. Sundaresan, Dr. N.N. Dastur and Dr. K.K. Iya awards were given during the convocation.

- Dr. Himanshu Pathak, Secretary DARE & DG, ICAR, New Delhi for Dr. D. Sundaresan Memorial Oration Award.
- Dr. M.S. Chauhan, Vice-Chancellor, GBPUA&T, Uttrakhand for Dr. K.K. Iya Memorial Oration Award.
- Dr. B.N. Tripathi, DDG (AS), ICAR, New Delhi for Dr. N.N. Dastur Memorial Oration Award.

Hon'ble President of India Smt. Droupadi Murmu during the 19th Convocation Ceremony of the ICAR-NDRI, Karnal

Key Initiative of ICAR-NDRI NEP-2020

- Courses & Curriculum Enrichment.
- As per NEP-2020, criteria for admitting students from the diverse field is permitted. Students from Biological science have been admitted in B. Tech. (DT) and UG (Agriculture) in Biochemistry & Microbiology.
- Seven certificate and Diploma courses have been finalized.
- One PG Diploma course on "Dairy Processing Operation & Management" for In-service candidates is under development.

- B. Tech. (Biotechnology) and B. Tech. (Food Technology) will be commenced from next academic session.
- In order to implement multiple exists & entry, B. Tech. (DT) course is restructured in consultation with expert committee constituted by ICAR.
- Organized Two Faculty Development Programmes (FDPs) on "New Education Policy-2020" to sensitize faculty and researchers of the university.
- Global Collaboration & Student Exchange.
- Four faculty members from 3 different universities of USA & 1 from Germany joined as Adjunct faculty for a period of 15 days.
- Signing of MOU for academic collaboration and offering Dual degree programme is in final stages with South Dakota University and Oklahoma State University.
- Out of 102 students deputed for overseas Internship, 21 have been selected for higher studies along with fellowships in USA & European Universities.
- Teaching & Learning Infrastructure Development.
- Created 17 classrooms: equipped with interactive panel along with dedicated internet connectivity for harnessing the expertise of faculty located in other ICAR institutes.
- One Virtual class room with provision of video recording of lectures is developed under the NAHEP to implement Blended Learning Programme (BLP).
- One language lab for improving the English and foreign language is created.

Institutional Development Plan Project (NAHEP)

Different activities under four broad objectives viz. strengthening academic programmes, leveraging alumni network, nurturing soft skills of the students, and equity action plan plus green campus initiatives were conducted by IDP (NAHEP) project during the year 2023. A total of 16 faculty members were deputed for international training in 6 different universities located in USA and Netherlands. A total 19 students have completed their overseas internship at 08 global universities. Six workshops on various topics viz. Overseas Prospects for Postgraduate Studies in Dairy and Food Science, Agro-climatology Data: Useful to Usability, Campus to Corporate , Stress Management and Conflict Resolution, CME on Good Laboratory Practice (GLP) , Safety and Quality Monitoring in the Food Industry, Big Survey Data Analysis, Genomic Analysis and Artificial Intelligence Applied to Animal Genetics and Breeding and Food Microbiology & Microbial Diseases were organized for the benefit of the faculty and students. Subject experts including two overseas professors' from USA were invited to deliver the lectures in these workshops. Two motivational lectures *From Impossible to I' am Possible: A Tale of Triumph and Psychosocial Wellbeing* were also organized for motivating and empowering students. A seminar on *Cyber Security and Traffic Rules* was also conducted to raise awareness about the importance of cybersecurity measures and adherence to traffic rules to ensure the safety and security of individuals and the community.

National Education Conclave on "New Education Policy-2020: Seeds of Hope and Action organized at ICAR-NDRI on December 23, 2023

9. TECHNOLOGY DISSEMINATION AND EXTENSION PROGRAMMES

DAIRY EXTENSION DIVISION

As per the mandate of the institute, ICAR-National Dairy Research actively engages in technology dissemination and extension program. A brief description about the various extension activities and outreach programs conducted during 2023 are mentioned here.

National Dairy Mela-2023

The ICAR-National Dairy Research Institute, Karnal, organized a three-day National Dairy Mela from April 8 - 10, 2023. The Mela was inaugurated by the Chief Guest Dr. B.N. Tripathi, DDG, Animal Science, ICAR, Dr. U.S. Gautam, DDG, Agril. Extension, ICAR, New Delhi and Dr. M.S. Chauhan, Vice Chancellor, G.B. Pant Nagar University, Agriculture & Technology, Pant Nagar. The mega event was a part of our Centenary Year Celebration and an opportunity to showcase the various technologies developed at NDRI and at other sister institutes located in and around Karnal. The mela attracted more than 37583 visitors from different states like Uttar Pradesh, Haryana, Punjab, Delhi, Rajasthan, Gujarat, Tamilnadu, and Karnataka etc. Further, there were 111 stalls displayed by government & private companies, Entrepreneurs, Progressive Farmers & Students involved in the production of livestock feed and medicines, and manufacturing of dairy machineries. All the stalls were well equipped to cater the information needs of the visitors.

Competition for animals

The 402 animals from different parts of the country were brought to the Mela ground for the competition under different categories, stole the show. Animals ccompetitions were organized in 11 categories including beauty, milk production. Highest milk production was recorded under different milk competition categories as follows: HF Cross- First=70.253 kg; Sahiwal=18.890 kg; Haryana=16.464 kg; Murrah=31.10 kg and Tharparkar=18.155 kg respectively.

Dignitaries releasing Smaarika during the inauguration of Nationa Dairy Mela-2023

Field/Farm Technician (FFT) Laboratory

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

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

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

Activities conducted in adopted villages

S. No.	Activities	No. of Cases
1	A.I. in Cows	1021
2	Conception rate	44.35%
3	A.I. in Buffaloes	645
4	Conception Rate	41.25%
5	No. of C.B. calves born	956
6	No. of buffalo calves born	563
7	General Treatment cases	213

Infertility and Veterinary aid Camps

A total of nineteen camps were organized in Kulweri, Daniyalpur, Subhri and Jhanjhari villages. During the campaigns, animals were treated for reproductive disorders and various other Vety. ailments. Ectoparasitic control campaign & Deworming programmes for control of endo-parasites were also conducted. Special attention was given to improve the productive & reproductive parameters of animals by diagnosis and proper treatment.

S. No.	Activities	Numbers
1	Repeat breeding cases	542
2	Anoestrus and late maturity	221
3	Metritis & Endometritis	27
4	Pyrexia	122
5	Wound	72
6	Indigestion	65
7	Diarrhea	162
8	Mastitis	102
9	Tick control	1523
10	Deworming (Endo-parasite)	2105
	Total	**4941**

Kisan Sangosthi

Twenty three Kisan Sangosthies were organized at village level and following topics were discussed in detail:- Role of mineral mixture in animal diet, Management of animals during extreme weather condition, Correct Time of Breeding of cow and buffaloes, Clean milk production practices in rural areas, Role of reducing inter-calving period in lactating animals, Preparation of value added milk products, Preventive measure of H.S. and FMD Disease, Awareness on endo & ecto-parasite infestation and management of dairy animals during transition period.

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

Dairy Education at Farmers Door (DEFD)

A new Extension Education Programme "Dairy Education at- Farmers' Door" is initiated 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 organize Dairy Education at Farmers' Door in various villages on 2nd Saturday of every Month. Scientists also obtained the feedback from the participating farmers. The farming community expressed happiness on this new Extension initiative of the Institute where the NDRI scientists devote their holiday for dairy farmers.

Farmers Farm School: A new initiative of NDRI for farmers

National Dairy Research Institute (NDRI) has started an ambitious programme wherein farmers of Haryana State are being provided formal Education in the field of Dairying, Horticulture and Agriculture through Farmers Farm School. In this School, farmers would interact with the scientists of the Research Institutes and there is class room teaching as well as practical classes. There is provision of enrolling 25 farmers in one batch on first come first basis and the course duration is for one year. The 7th batch consisting 23 farmers of village Deepo Janesaro is in progress.

Dairy Samachar

Quarterly Hindi Magazine "Dairy Samachar" were compiled, edited and published by Division Dairy Extension, NDRI, Karnal in following 4 quarters, in each quarter a total of 3000 copies were published.

Educational Visit and Tour (2023):

A total of 23976 visitors (students & Faculty) of 316 colleges/Institutions/Universities have visited the institute which were coordinated by the division. The groups have been sensitized about the different research, teaching and extension achievements and facilities available in the Institute.

Advisory Services

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

Technological interventions/demonstration at farmers field

Module	Intervention	Village covered	Area Covered (ha)/ Animal (No.)	Number of Households covered
Crop Based	Varietal Trial of Wheat DBW-327 DBW-332	7	20.24	100
	Varietal Trial of Paddy (PB-1847, PB-1885 & PB-1886)	7	74.41	173
	Crop diversification of Mustard (PM-32 & Pusa tarak)	4	9.71	48
	Crop Residue Management	7	128	285
Horticulture based	Vegetable Kit	4	2.53	50
	Fruit Plantation	2	0.20	10
Dairy Based	Minerals Mixture supplementation	7	593	551
	Ecto parasite	7	1624	962
	Theilariosis Vaccination & treatment	7	300	71
	Mastitis treatment	7	187	187
	Silage Demonstration	2	--	41
	SMS Portal	7	All households	1245
	Round the year green fodder	7	7.08	33
	Fodder kits	7	5.06	50
	Chinese cabbage	4	5.06	25
	Oats	2	2.53	25
Enterprise based	Processing of milk	2	15	15

Extension Activities under Farmers First Programme 2023

S. N0.	Activities	No. of villages	No. of activities	No. of Farmers/animals
1	Training Programmes	7	11	537
2	Kissan Sanghoshthi	7	04	124
3	Animal Heath camps	7	14	594
4	Crop health Camp	7	01	72
5	Field Visits	7	24	492
6	Place where Cams Organized	7	4	107
7	Exposure visits	7	4	77
8	Institute visits	7	04	124
9	Mastitis Testing	7	7	140
10	Theileriosis vaccination Camps	7	07	175
11	LSD Vaccination programme	7	07	2245

Digniteries inaugrating the Naitional Dairy Mela – 2023 organized at ICAR-NDRI

A view of Animal competition during Naitional Dairy Mela – 2023 organized at ICAR-NDRI

KRISHI VIGYAN KENDRA

For cultivation and promotion of science at farmers field, the KVK works at grass root level for (i) Showcasing the frontier technologies, (ii) Capacity development of farmers & other stakeholders, (iii) Front runner in technology application, (iv) Making available technological information and inputs to the farmers, (v) Practicing participatory approaches in planning, implementing, executing and evaluation and (vi) Pursuing assessment of technologies to suit different micro-climatic condition in close partnership with farmers.

Training programmes achievements of KVK: On-Campus and Off-Campus

KVK provides strong training support to disseminate need-based and skill-oriented technology for various target groups for achieving a production breakthrough in Dairying, Agriculture and allied subjects. Need-based short and long-term (on and off-campus) trainings on various disciplines, viz. Dairy Production, Dairy Processing, Agriculture, Horticulture, Vermi-culture, Bee-keeping, Fish Farming and Home Science are being organized for farmers, farm-women, rural youth, in-service personnel and rural leaders. The training programmes organized and achievements made by KVK during January 2023 to December 2023 have been summarized in the following table.

Training Achievements (2023)

Title of the course	On-Campus	Off-Campus	Total	Participants
Dairy production management & Dairy processing	20	12	32	1280
Crop Production & Crop residue management	5	12	17	304
Fisheries production & management	2	5	7	115
Home Science management	3	5	8	145
Natural farming	3	4	7	210
Horticulture production	1	2	3	105
Vermi-compost Production	4	-	4	133
Rural Youth (Bee keeping)	2	-	2	86
Rural & Agricultural Work Experience	1	-	1	33
Skill Development Training (ASCI)	2	-	2	60
Warehousing Development and Management	1			50
ARS FOCARS FET Training	1	-	1	6
NIFTEM (Institute Village adoption Programme)	1	-	1	8
Total	**46**	**38**	**85**	**2535**

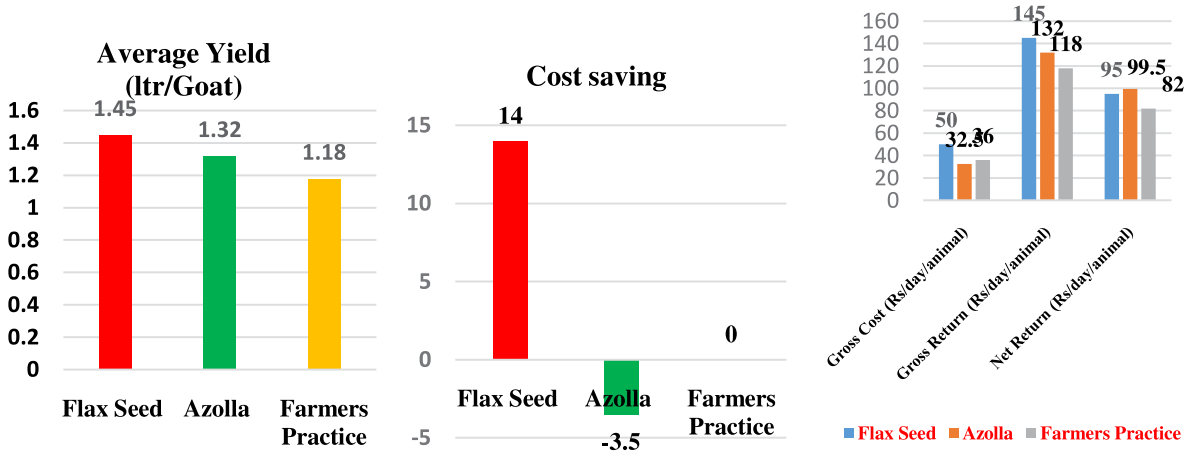
Exposure visits cum short training programmes organized

KVK being located in National Institute for Dairying and having live demonstration units that attracts the attention of various State governments, NABARD and NGOs which send various groups of farmers, farm women and youth on exposure and study visits to KVK. In total 84 visits were organized in which **3298** farmers and farm women participated from Haryana, Uttar Pradesh, Chhattisgarh, Gujarat, Uttarakhand, Rajasthan, Delhi, Punjab, Himachal Pradesh and Bihar.

On Farm Testing (OFT)

Assessment of Efficacy of Flaxseed and Azolla feeding on Productivity Lactating Goat

Title	Assessment of efficacy of Flaxseed and Azolla feeding on Productivity Lactating Goat
Problem	Low productivity of goat at field condition
Technology Selected	Feeding of Flaxseed Feeding of Azolla Use 1 month before kidding and after 3 month kidding
Source of Technology	ICAR-NDRI, 2021
Thematic area	Nutrition Management
Performance of the Technology	Azolla is a low cost fodder Flax seed improves the milk quality (Fat % increase)



Impact of Flaxseed and Azolla feeding on Productivity Lactating Goat

Assessment of efficacy of Poly herbal feeding in Dairy Animals

S.No.	Observation Parameters	किसान पद्धति में उत्पादन	पॉली-हर्बल मिश्रण खिलाने पर उत्पादन
1.	Average milk yield (kg)	10.5	13.4
2.	Increase milk yield (%)	-	27.6
3.	Average fat (%)	3.8	4.1
4.	Average SNF (%)	8.4	8.6
5.	Av. feed cost/animal/day (Rs):	190.34	211.34
6.	Total feed cost in 90 days	17130.6	19044.0
7.	Total milk yield in 90 days	945.0	1206.0
8.	Difference in milk yield	-	261
9.	Income from milk (Rs)	34492.5	45707.4
10	Increase income (%)	-	32.51
11	लागत-लाभ अनुपात B:C Ratio	1:1.98	1:2.4

Demonstrating efficacy of Poly herbal feeding in Dairy Animals

Front Line Demonstration (2023)

Popularization of Maize green fodder var. J-1007 for Dairy Animals

Crop/ Enterprise	Technology demonstrated	Demonstration Yield (Qt/Ha)			Yield of local Check	Increase in yield	Avg. Cost of Cultivn. (Rs/Ha)	Avg. Gross Return (Rs/Ha)	Avg. Net Return (Rs/Ha)	B:C Ratio
		H	L	A	(Qt/Ha)	%				
Fodder Maize	Var. J-1007	472.2	430.8	451.35	420.6	7.31	42053	135405	93352	1: 1.98

Frontline demonstration of maize green fodder var. J-1007 for Dairy Animals

Mastitis management technologies in milch animals (on-going)

Problem	Incidence of mastitis
Technology Selected	Feeding intervention in the form of mineral mixture @50g/ day/animal starting before 1 month and up to 3 months of calving Use of KMNO4 solution for milker's hand and animal's udder wash
Source of Technology	NDRI, 2017
Thematic area	Disease Management
Performance of the Technology	The technology was found to be 90% effective.
Farmers Feed back	Farmers adopted the technology.

Frontline demonstration of Mastitis management technologies in milch animals

Popularization of Nutri-Kitchen garden at domestic level

Name of the Village	Name of the Vegetables	No of Demonstration	Area under kitchen gardening (m2)	Yield (kg/unit)	Per capita consumption (g/d)	B:C ratio
Ghogdipur	Spinach, Coriander Radish, Tomato, Cauliflower, Brinjal, Carrot and Methi	3	300	101.67	308.00	1:4.12

In-situ Crop residue management Project: Demonstrations CRM scheme on promotion of agricultural mechanization for in-situ management of crop residue: 2023-24

S.No.	Village	Total	
		Area (acre)	No. of Farmers
1.	Kalron	139	45
2.	Nalvi Khurd	93.48	32
	Total	**232.48**	**77**

Demonstrations organized PUSA decomposer during 2023-24 under CRM

Technology	Village	Demonstration
PUSA Decomposer	Kalron and Nalvikhurd	35

Field Day at Vill- Picholia, Date: 30.05.2023

Field Day at Vill- Barsalu, Date: 23.05.2023

Field day demonstration to farmers

Out scaling of Natural Farming Project 2023

Awareness Programmes conducted

Name of NF Awareness programmes	Title topic	Venue of Programme	No. of Programmes	No. of Participants
Out scaling of Natural Farming	Natural farming of vegetables crop	Village- Padhana, Kunjpura, Kharajpur, mehmadpur	5	375
Out scaling of Natural Farming	Natural farming of pulse crops	Village- Kaimla, Phurlak, tikri, KudakJagir	6	292
Out scaling of Natural Farming	Natural farming of Oilseeds crops	Village- Nibhipur, Manchuri, KamalpurRoran, danchar	6	488
Out scaling of Natural Farming	Natural Farming of Cereal crop	Village- Kohand, Kalram, Gagsina, Barsalu, Picholia	6	556
	Total		**23**	**1711**

Sensitization of farmers on Natural Farming

Demonstration under natural farming project conducted on summer moong 2023

Crop/ Variety	NF demonstrated	Area (ha)	Place (Village) Demo.	No. of Demonstration laid out under NF	Observations Recorded		
					Name of parameter	Performance	
						Without NF practice	With NF practice
Moong (MH-1142)	Beejamrit, Jeevamrit, Neemastar, Deshparni	0.40	Vill- Kaimla	6	Plant Height (cm)	55	56
		0.40	Vill-Kudak Jagir		Yield (q/ha)	17.92	8.61
		0.25	Vill- Gheer		Soil OC (%)	0.70	0.94
		0.40	Vill-Phurlak		Soil pH	7.92	7.7
		0.40	Vill-Tikri		Soil EC (dSM)	0.56	0.44
					Soil Microbes (cfu)	-	-
		0.25	Vill- Stundi		Any other	No incidence of MYMV	Incidence of MYMV and poor plant growth
		Total=2.1					

AGRI-DRONE Project

Awareness Programme organized

Total 385 participants with 240 male and 145 female participants were sensitized on AGRI-DRONE project and demonstrations were organized.

Awareness on AGRI-DRONE

Evaluation of Agri-Drone demonstrations in different crop

Sprayer Machine	Agri-Drone	Farmer Practice	Comparison
Spraying Cost	Rs. 738/ha	Rs. 1180/ha	Rs. 442/ha
Water Requirement	24.6 litre/ha	400 litre/ha	375.4 litre/ha
Time Requirement	12.3 Minutes/ha	86.1 Minutes/ha	73.8 Minutes/ha
Efficiency (1 man power)	8.13 hour/ ha	3.25 hour/ha	4.88 hour/ha
Adaptability(terrain, crop growth stage, etc)	Strong	Weak (Can't work in orchard)	
Pesticide utilization efficiency	85%	30%	55%
Safety	High	Low	

Extension Education programme/Activities (2023)

As per the mandate, the KVK engaged actively on various extension outreach programs as listed below.

S. No.	Activity	Total No.
1	Field day	12
2	Kisan Ghosthi	15
3	Exhibition	25
4	Film Show	25
5	Method Demonstrations	16
6	Group meetings	25
7	Newspaper coverage	145
8	Radio talks /TV talks	4
9	Literature/ articles	15
10	Scientists visit to farmers field	42
11	Farmers visit to KVK	18110
12	Scientist farmers interactions	45
13	Soil/Water samples analysed	45
	Total	18524

Performance of Crop Demonstration Unit of KVK During 2023

Seed and other bio-products produced at KVK

The KVK is maintaining live demonstration units in fish farming, bee keeping, vermi-culture, horticulture and crop production for imparting practical training for skill development, demonstration of technologies and production of quality seed material of latest varieties for sale to farmers. The products from these units particularly seed are being sold through ATIC to farmers.

Projects/Schemes being implemented by KVK

This KVK implemented the following projects and schemes of DOAC&FW, ICAR and IMD during the year 2021 and continuing to carry out various assigned activities under these.

1. Promotion of Agricultural Mechanization for In-Situ Management of Crop Residue in the States of NCT Delhi and Haryana.
2. Cluster Front-line Demonstration (Pulses) under the scheme NFSM.
3. Cluster Front-line Demonstration (Oilseed) under the scheme NFSM.
4. Frontline Demonstrations (Vegetables)
5. Training for Skill Development in Vermiculture on behalf of ASCI.
6. Establishment of District Agro Meteorology Unit at KVK.
7. Nutri Sensitive Agricultural Resources and Innovation (NARI).
8. Farm Machinery & Equipments under submission on Agricultural mechanization.
9. Agri-Drone Project.

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

Agricultural Technology Information Centre at NDRI Karnal became operational in November 2004. This centre is engaged in disseminating information on dairying and allied agricultural fields. A large number of entrepreneurs, practicing farmers, extension workers and students are availing the facilities of ATIC together latest information related to dairying and allied fields. ATIC-NDRI is using following approaches for disseminating agricultural and dairy information to its intended users:

1. Personal interaction with visiting farmers
2. Display of Models etc; organizing /participating in Melas and Exhibitions
3. Audio/Video shows
4. Visits to Dairy farm
5. Information through toll free telephone number (1800-180-1199)
6. Selling publications
7. Providing input like improved seed varieties, vermicompost, etc.
8. Through emails

Services rendered in Agricultural Technology and Technology Products during 2023

SN	Detail of services	No. of Services	No. of Persons
1.	Dairy/Agriculture related information through Video show and Lecture	86	3896
2.	Personal Discussion with Subject-Matter-Specialist on Dairy Farming	206	528
3.	Information through Dairy/Agriculture Literature	145	272
4.	Information on Agriculture (Seed/Fertilizer/Compost etc)	2602	3644
5.	Information through telephone (Toll-free) on Agriculture & Dairying etc.	670	670
6.	Information through e-mail on Agriculture & Dairying etc.	112	112
7.	Information through what app group on Agriculture & Dairying etc.	54	965
	Total	3875	10087

Total sale at ATIC during 2023

SN	Item	Amount (Rs.)
1.	Agriculture Inputs (seeds, fertilizers etc) obtained from KVK NDRI, Farm Production Section NDRI.	18,66,134
2.	Books (NDRI Publications)	67,553
3.	Sale in Integrated Farmer System	700
4.	Sale of NICRA Products like Diya, Ganesh Idol, etc	3,750
5.	Charges from Visitors, etc.	8,000
	Total	19,71,587

Training cum exposure visits organised

Title of the course	Sponsor	Date	Participants
Management of Dairy Animals	CDTRI, Meerut	22-06-2023	46
Livestock Production	GYVM, Kaithal	04-09-2023	50
Livestock Production	GYVM, Kaithal	05-09-2023	29
Rearing of Dairy Animals	Ambuja Foundation, Roorkee	21-12-2023	20

Glimpses of training organized for farmers at ATIC

10. WOMEN EMPOWERMENT AND MAINSTREAMING OF GENDER ISSUES

The National Dairy Research Institute (NDRI) has been at the forefront of empowering farm women through its dedicated initiatives. Recognizing the critical role women play in dairy farming, NDRI provides extensive training programs aimed at enhancing their skills in dairy management, livestock care, and milk processing. The institute also promotes the adoption of modern dairy technologies and best practices, ensuring that women gain both knowledge and confidence. Through these efforts, NDRI helps improve the livelihoods of farm women, fostering economic independence and contributing to the overall development of rural communities.

Main Campus

A women empowerment lab was established in Dairy Extension division in 2013 for capacity building of different self-help groups of NDRI, DRDA and NGOs. This lab was established with the objective to create awareness and impart skills in the field of dairy processing and fruit and vegetable preservation and also mobilize these groups to take up vocation in these areas. For this lab., all items of Dairy Processing Unit viz. Eco Milk Testing Machine, Refractometer, pH Meter, Moisture Balance were procured. Regular women empowerment trainings and campaigns through this Women Empowerment laboratory were organized to create awareness among rural farm women 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.

On Campus Women Empowerment Training Programme-cum-Demonstrations

S. No.	Training Name	Date	Participants
1.	Training cum demonstration programme on value added milk product for rural women	October 18, 2023	17
2.	Training-cum-demonstration programme on homemade value-added milk products for trainees	February 25, 2023	15
3.	Exposure visit-cum-training programme on "Scientific Dairy Farming Practices" for the women dairy farmers of the Pithoragarh district of Uttrakhand	March 29-31, 2023	29
4.	Homemade value-added milk product	March 31, 2023	26

Women empowerment training

Regional Campus

On the occasion of International Women's Day 2023**,** a sensitization programme on milk and millets for health-nutrition and a training programme on scientific dairy management practices was organised by SRS under the Farmer FIRST Project for farm-women beneficiaries on 8th March, 2023 at BAMUL Mega Dairy, Shivanahalli, Kanakapura. The training programme comprised, series of technical sessions presented by the faculty to the farm-women, comprising, importance of millets in providing nutritional security, health and reproduction management of dairy cattle for enhanced milk production, quality raw milk production at farm level, cost of production of milk in indigenous and crossbred animals and sensitisation improved nutritional management practices for profitable dairying' to benefit the participant farmwomen. The technical sessions, were followed by awareness competition on identification of millets and a quiz on dairy products were arranged for farm-women to test their awareness of millets and milk value addition.

Women's participation in a sensitization cum training programme on milk and millets for health-nutrition and scientific dairy management practices on 8th March 2023

The farm women of the project villages were recognised for their active participation in dairying and highest milk pourers of the three DCS (Dairy Co-operative Societies), viz., Hosadurga, Yeremgere and VasappanaDoddi and were awarded with SS milk cans for encouraging them for quality milk production. The programme was well-attended by 170 participants, comprising 120 farm-women, scientists and students from institute and officials from BAMUL, KMF.

Women of Dairy Cooperative Society member is being felicitated for active participation in dairying and highest milk pourer of the society during Dairy Farm Women Training

ICAR-NDRI, ERS, Kalyani, West Bengal organized one day programme on Livelihood Improvement of tribal Farmers through Livestock Interventions at Muluk Kalitala village, Bolpur, Birbhum, West Bengal on 14.08.2023 under NDRI-TSP and SCSP Project Component. A *Scientists-Farmers' Interaction-cum-Training* (off-campus) programme was conducted. One hundred and fifty (150) beneficiaries from tribal women farmers and 50 from scheduled caste women farmers participated in the *Scientists-Farmers' Interaction-cum-Training* session. Dr. S. K. DAS highlighted the objective of this programme for empowerment of tribal farmers for increasing socio-economic status through duck farming based integrated farming and he urged all farmers for providing feedback in future. Different aspects of scientific livestock/poultry/duck farming like transportation stress, breeding, feeding practices, fodder production, housing and general management, reproductive management, deworming, vaccination, mortality issues etc. were discussed by Dr. A. Chatterjee, Dr. A. Mohammad and Dr. S. Datta in the off-farm training programme. On the occasion, health camp was also organized in which more than 90 goats and 60 cows were vaccinated against deadly diseases. Veterinary medicine was also distributed among the farmers. Some inputs were distributed in this programme. 4000 ducklings were distributed among 150 tribal farmers and 50 scheduled caste farmers. Apart from that, 100 feeders and waterer were also distributed among the farming communities. These initiatives would benefit the vulnerable section of the farming community to support their livelihood through creating nutritional and economic security.

A programme organized for the livelihood Improvement of women tribal Farmers

Feeder and drinkers distribution among tribal women farmers for backyard poultry development on 23.08.2023

11. HONOURS AND AWARDS

Team Award

- ICAR-National Dairy Research Institute has received Research Leadership Award - 2023. The award was presented to Dr. Dheer Singh, Director, ICAR-NDRI by Sh. Arjun Munda, Honourable Minister of Agriculture and Farmers Welfare at 14th Agriculture Leadership Conclave 2023 held at New Delhi on December 21, 2023. The award is given by Agriculture Today Group to institutes who have made noticeable contributions to research achievements, generated resources and established networks which accelerated the pace of research activities in that sphere.

*Dr. Dheer Singh, Director (NDRI, Karnal) receiving the **Research Leadership Award 2023** from the Honourable Minister of Agriculture and Farmer's Welfare, Shri Arjun Munda in the Agriculture Leadership Conclave 2023 in New Delhi on December 21, 2023*

- ICAR-National Dairy Research Institute has been recognized as a GATI Achiever by the department of Science and Technology (DST), Govt. of India among the identified 30 pilot institutions on July 3rd, 2023. This is prestigious and the first of its kind of recognition of ICAR-NDRI for its remarkable work done for women in STEMM through GATI program. This recognition would be valid for next five years.
- Selokar, N., Singh, M. K., Aswal, A., Lathwal, S. S., Chand, S., Verma, R., Patel, K. and Chauhan, M. S. Received appreciation letter for the production of India's first cloned cow, GANGA from Hon'ble Union Minister of Agriculture and Farmers' Welfare, Shri. Narendra Singh Tomar.

Fellows and other individual awards

- Rajan Sharma received Recognition Award for the Biennium 2021-2022 for his contribution in Animal Sciences from National Academy of Agricultural Sciences (NAAS), New Delhi during the Inaugural Function of the XVI Agricultural Science Congress at ICAR-CMFRI, Kochi on October 10, 2023
- Sachinandan De selected as the 'National Professor' by ICAR Agricultural Education Division.
- Sachinandan De selected as Fellow of the National Academy of Agricultural Sciences, New Delhi and National Academy of Veterinary Sciences, India.
- Sudarshan Kumar was selected for Fulbright-Nehru Academic and Professional Excellence Fellowship 2022-23.
- Chander Datt conferred with Fellow of Animal Nutrition Association, ICAR Bareilly, Izatnagar, UP, India.
- Chand Ram was conferred upon the Fellowship of Society for Advancement of Biological Sciences, Bangalore (Karnataka).
- Santanu Banik has been awarded Fellow of Indian Society of Animal Genetics and Breeding.

- Dhruba Malakar received the "Research Excellence Award" in recognition of his outstanding professional & research achievements in the fields of Animal Biotechnology from the Institute of Researchers, Wayanad, Kerala.
- Suman Kapila received "Women Scientist Award" in 2nd International Conference on Prospects and Challenges of environment and biological sciences in food production system for livelihood security of farmers (ICFPLS-2023) at ICAR-CIARI, Port Blair, A & N Islands.
- Bharati Pandey received "Young Scientist Award" on account of her overall achievements and accomplishment in the Agriculture & Allied Sector by Dr. Ram Awatar Shiksha Samiti (DRASS), 2023.
- Sachin Kumar acted as an Expert to the Food and Agriculture Organization (FAO) of the United Nations expert meeting on "Alternative and advanced feed practices to promote the responsible use of antimicrobials" at FAO Headquarters, Rome, Italy.
- Sachin Kumar received "International Travel Grant" from Science and Engineering Research Board, Department of Science and Technology, Government of India, New Delhi.
- Sachin Kumar received Dr. U. B. Singh Memorial Young Scientist Award at DUVASU, Mathura.
- Sachin Kumar received Dr. S. K. Sirohi Memorial Outstanding Young Researcher Award of ICAR-NDRI, Karnal.
- Sadeesh E.M. is honored with a nomination to the SMRM-India Executive Committee, serving as a Member (January, 2024 – December, 2027).
- Raghu H. V. Received 'Best Technology award' for the technology entitled "PANI-PEC paper strip sensor for detection of aerobic plate count in milk" during ICAR 95th foundation day and Technology day celebrations.
- Raghu H. V. Awarded 'Dr. S.K. Sirohi Memorial Outstanding Young Researcher Award of ICAR-NDRI, Karnal.
- Reenu Kashyap awarded 'Best thesis award' for outstanding research work on the topic entitled "Buffalo colostrum proteins and peptides derived formulation for diarrhoea management in weaning mice" in the 19th Convocation at ICAR-NDRI, Karnal held on 24th April 2023.
- Akash awarded with best thesis award for outstanding research work on the topic entitled "Isolation and characterization of antibiotic resistant bacteria from organized dairy production system" in the 19th Convocation at ICAR—NDRI, Karnal held on 24th April 2023.
- Yogesh Khetra Received Young Scientist Award by Swedish South Asian Network on Fermented Foods (SASNET-FF).
- Sharanabasava awarded Best PhD Thesis Award in International Conference at Malla Reddy University, Hyderabad during 21st -23rd June, 2023.
- Dr. A. Kumaresan awarded with Prof. Nils Lagerlof Memorial Award (2023) by the Indian Society for Study of Animal Reproduction in recognition of his meritorious contribution to the research in Animal Reproduction.
- Arindam Dhali awarded with G.B. Singh Memorial Award (2023) by the Indian Society for Study of Animal Reproduction in recognition of his contribution to the research in Animal Reproduction.
- Subash, S. Received 'Best Extension Scientist Award' during the International Conference on 'Global Insights on Research and Development in Agriculture, Horticulture and Allied Sciences' jointly organized by G.H. Raisoni University and Just Agriculture Education Group.
- Indu Devi received 'Shri S. Lakshmana Rao award' in National Livestock Conference and 29th Annual Convention - "Futuristic Approach to Viable Animal Production vis à vis Climate and Calamity Challenges" at C.V. Sc. & A.H., OUAT, Bhubaneswar, Orissa.
- K. Ponnusamy is recognised with Lifetime Achievement Award in 5th National Conference of Society of Veterinary & Animal Husbandry Extension (SVAHE) at Khalsa College of Veterinary and Animal Sciences, Amritsar.

12. PUBLICATIONS

Research papers:

Animal Biotechnology

S. No.	Research Papers	Impact Factor	NAAS Score
1.	Choudhary, R., Singh, K. S., Bisht, S., Kumar, S., Mohanty, A. K., Grover, S., & Kaushik, J. K. (2023). Host-microbe interaction and pathogen exclusion mediated by an aggregation-prone surface layer protein of Lactobacillus helveticus. *International Journal of Biological Macromolecules*, 244:125146.	8.025	14.20
2.	Sharma, P., Mishra, S., &Pandey, B. (2023). Genome-wide identification and expression analysis of the NHX gene family under salt stress in wheat (Triticum aestivum L). *Frontiers in Plant Science*, *14*, 1266699.	6.6	11.60
3.	Karanwal, S., Pal, A., Chera, J. S., Batra, V., Kumaresan, A., Datta, T. K., & Kumar, R. (2023). Identification of protein candidates in spermatozoa of water buffalo (Bubalus bubalis) bulls helps in predicting their fertility status. *Frontiers in Cell and Developmental Biology*, *11*, 1119220.	5.5	11.50
4.	Behera, M., Parmanand, Roshan, M., Rajput, S., Gautam, D., Vats, A., Ghorai, S.M. & De, S. (2023). Novel aadA5 and dfrA17 variants of class 1 integron in multidrug-resistant Escherichia coli causing bovine mastitis. *Applied Microbiology and Biotechnology*, *107*(1), 433-446.	5.0	11.00
5.	Pal, A., Karanwal, S., Chera, J. S., Batra, V., Kumaresan, A., Sarwalia, P., Datta, T.K. & Kumar, R. (2023). Circulatory extracellular vesicle derived miR-195-5p promotes cellular apoptosis and suppresses cell proliferation in the buffalo endometrial primary cell culture. *Scientific Reports*, *13*(1), 16703.	4.6	10.60
6.	Chhillar, S., Batra, V., Kumaresan, A., Kumar, R., Pal, A., & Datta, T. K. (2023). Acute exposure to organophosphorus pesticide metabolites compromises buffalo sperm function and impairs fertility. *Scientific Reports*, *13*(1), 9102.	4.6	10.60
7.	Bhaskar, V., Saini, S., Ansari, S., Ghai, S., Thakur, A., Chopra, S., Verma, V.& Malakar, D. (2023). Allogenic adipose derived mesenchymal stem cells are effective than antibiotics in treating endometritis. *Scientific Reports*, *13*(1), 11280.	4.6	10.60
8.	Mishra, S., Chaudhary, R., Pandey, B., Singh, G., & Sharma, P. (2023). Genome-wide identification and expression analysis of the GRAS gene family under abiotic stresses in wheat (Triticum aestivum L.). *Scientific Reports*, *13*(1), 18705.	4.6	10.60
9.	Rajput, S., Gautam, D., Vats, A., Rana, C., Behera, M., Roshan, M., ... & De, S. (2023). Adaptive Selection in the Evolution of Aquaglyceroporins in Mammals. *Journal of Molecular Evolution*, 91: 441-457.	3.973	9.97
10.	De, A. K., Sawhney, S., Sunder, J., Muthiyan, R., Ponraj, P., Sujatha, T., Malakar, D., Mondal, S., Bera, A.K., Kumar, A. and Chakurkar, E.B.& Bhattacharya, D. (2023). Peeping into Mitochondrial Diversity of Andaman Goats: Unveils Possibility of Maritime Transport with Diversified Geographic Signaling. *Genes*, *14*(4), 784.	3.9	9.50
11.	Deb, R., Chaudhary, P., Pal, P., Tomar, R. S., Roshan, M., Parmanand, Ludri, A., Gupta, V.K. & De, S. (2023). Development of an on-site lateral flow immune assay based on mango leaf derived colloidal silver nanoparticles for rapid detection of Staphylococcus aureus in milk. *Journal of Food Science and Technology*, *60*(1), 132-146.	3.117	9.10
12.	Kashyap, P., Solanki, S., Datta, T. K., & Kumar, R. (2023). Buffalo sperm membrane glycan-binding proteins reveal precise and preferential binding signatures with specific glycans targets on oviduct epithelium and zona pellucida-an implication in fertilization. *Theriogenology*, *207*, 96-109.	2.8	8.80
13.	Kumar, R., Kaushik, J. K., Mohanty, A. K., & Kumar, S. (2023). Identification of bioactive components behind the antimicrobial activity of cow urine by Peptide and metabolite profiling. *Animal Bioscience*.36:1130-1142.	2.72	8.72
14.	Singh, I., Roshan, M., Vats, A., Behera, M., Gautam, D., Rajput, S., Rana, C. & De, S. (2023). Evaluation of Virulence, Antimicrobial Resistance and Biofilm Forming Potential of Methicillin-Resistant Staphylococcus aureus (MRSA) Isolates from Bovine Suspected with Mastitis. *Current Microbiology*, *80*(6): 198.	2.242	8.60

S. No.	Research Papers	Impact Factor	NAAS Score
14.	Khan, R., De, S., Dewangan, R., Tamboli, R., & Gupta, R. (2023). Potential status of A1 and A2 variants of bovine beta-casein gene in milk samples of Indian cattle breeds. *Animal Biotechnology*, 34 (9):4878-4884	2.141	9.70
15.	Bajwa, K. K., Punetha, M., Kumar, D., Yadav, P. S., Long, C. R., &Selokar, N. L. (2023). Electroporation-based CRISPR gene editing in adult buffalo fibroblast cells. *Animal Biotechnology*, 23:1-12.	2.14	9.70
16.	Verma, D., Chauhan, M. S., Mishra, S. K., Babu, K. R., Singh, K. P., Rani, S., Kumar, P., Singh, M.K., Gurao, A. & Kataria, R. S. (2023). Sequence characterization and comparative expression profile of buffalo WNT10B gene in adult and fetal tissues. *Animal Biotechnology*, 22:1-9.	2.14	9.70
17.	Sandhu, A., Mohapatra, S. K., Singh, M. K., Singla, S. K., Chauhan, M. S., & Manik, R. S. (2023). Effects of epigenetic modifier on the developmental competence and quantitative expression of genes in male and female buffalo (Bubalus bubalis) cloned embryos. *Zygote*, *31*(2), 129-139.	1.818	7.70
18.	Dua, S., Bansal, S., Gautam, D., Jose, B., Singh, P., Singh, M. K.,De, S., Kumar, D., Yadav, P.S., Kues, W.&Selokar, N. L. (2023). Production of MSTN Gene-Edited Embryos of Buffalo Using the CRISPR/Cas9 System and SCNT. *Cellular Reprogramming*.25(3):121-127	1.6	7.60
19.	Selokar, N. L., Singh, M. K., Lathwal, S. S., Chand, S., Verma, R., Patel, K., Tripathi, G., Meena, R., Chauhan, M.S. & Aswal, A. (2023). Ganga: India's first cloned cow that belongs to indigenous Gir breed. *Current Science*, 125 (1): 10	1.16	7.00
20.	Chera, J. S., Kumar, S., Bairagi, A. K., Kumar, A., Chandra, P., Vats, A., ... & De, S. (2023). Poly (I: C), a double stranded RNA analog, activates the anti-viral DNA sensors in buffalo fibroblasts. *Veterinary Vaccine*, *2*(1), 100016.		

Animal Genetics & Breeding

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Chhotaray, S., Vohra, V., Uttam, V., Santhosh, A., Saxena, P., Gahlyan, R. K., &Gowane, G. (2023). TWAS revealed significant causal loci for milk production and its composition in Murrah buffaloes. *Scientific Reports*, *13*(1), 22401.	4.60	10.60
2.	Worku, D., Gowane, G., & Verma, A. (2023). Genetic variation in promoter region of the bovine LAP3 gene associated with estimated breeding values of milk production traits and clinical mastitis in dairy cattle. *Plos one*, *18*(5), e0277156.	3.75	9.70
3.	Kour, A., Deb, S. M., Nayee, N., Niranjan, S. K., Raina, V. S., Mukherjee, A., Gupta, I.D. & Patil, C. S. (2023). Novel insights into genome-wide associations in Bos indicus reveal genetic linkages between fertility and growth. *Animal Biotechnology*, *34*(1), 39-55.	3.70	9.70
4.	Gowane, G. R., Sharma, P., Kumar, R., Misra, S. S., Alex, R., Vohra, V., Chhotaray, S., Sharma, N., Chopra, A., Kandalkar, Y. &Magotra, A. (2023). Population-wide genetic analysis of Ovar-DQA1 and DQA2 loci across sheep breeds in India revealed their evolutionary importance and fitness of sheep in a tropical climate. *Animal Biotechnology*, 34 (9): 4645-4657	3.70	9.70
5.	Jaglan, K., Ravikumar, D., Sukhija, N., George, L., Alex, R., Vohra, V., & Verma, A. (2023). Genomic clues of association between clinical mastitis and SNPs identified by ddRAD sequencing in Murrah buffaloes. *Animal Biotechnology*, 3499):4538-4546	3.70	9.70
6.	Kumar, M., Vohra, V., Ratwan, P., & Kumar, A. (2023). Comparative analysis of various methods for estimating expected genetic gain of production and reproduction traits in Murrah buffaloes. *Animal Biotechnology*, 34 (8): 3599-3608	3.70	9.70
7.	Raja, T. V., Alex, R., Singh, U., Kumar, S., Das, A. K., Sengar, G., & Singh, A. K. (2023). Genome wide mining of SNPs and INDELs through ddRAD sequencing in Sahiwal cattle. *Animal Biotechnology*, 34 (9): 4885-4899	3.70	9.70
8.	Tan, S., Alex, R., & Unver, T. (2023). Transcriptional and post-transcriptional regulations in agricultural species after stresses. *Frontiers in Genetics*, *13*, 1127832.	3.70	9.70
9.	Uttam, V., Vohra, V., Chhotaray, S., Santhosh, A., Diwakar, V., Patel, V., &Gahlyan, R. K. (2023). Exome-wide comparative analyses revealed differentiating genomic regions for performance traits in Indian native buffaloes. *Animal Biotechnology*, 1-16.	3.70	9.70
10.	Ranjan, A., Jain, A., Verma, A., Sinha, R., Joshi, P., Gowane, G. R., & Alex, R. (2023). Optimization of test day for milk yield recording and sire evaluation in Murrah buffaloes. *Journal of Animal Breeding and Genetics*, *140*(4), 400-412.	3.27	8.60

S. No.	Research Articles	Impact Factor	NAAS Score
11.	Kumari, N., Vasisth, R., Gurao, A., Mukesh, M., Vohra, V., Kumar, S., & Kataria, R. S. (2023). ASIP gene polymorphism associated with black coat and skin color in Murrah buffalo. *Environmental and Molecular Mutagenesis*, *64*(5), 309-314.	2.80	8.80
12.	Yadav, N., Mukherjee, S., & Mukherjee, A. (2023). Comparative genetic analysis of frequentist and Bayesian approach for reproduction, production and life time traits showing favourable association of age at first calving in Tharparkar cattle. *Animal Bioscience*, *36*(12), 1806.	2.2	-
13.	Bhardwaj, S., Togla, O., Mumtaz, S., Yadav, N., Tiwari, J., Muansangi, L., Illa, S.K., Wani, Y.M., Mukherjee, S. & Mukherjee, A. (2023) Comparative assessment of the effective population size and linkage disequilibrium of Karan fries composite cattle revealed viable population dynamics. *Animal bioscience*.	2.2	-
14.	Yadav, N., Mukherjee, S., & Mukherjee, A. (2023). Comparative genetic analysis of frequentist and Bayesian approach for reproduction, production and life time traits showing favourable association of age at first calving in Tharparkar cattle. *Animal Bioscience*, *36*(12), 1806.	2.2	-
15.	Raina, A. A., Patel, M., Somagond, A., Jeyakumar, S., Selvan, R. P. T., Gowane, G. R., ... & Dutt, T. (2023). Effect of foot-and-mouth disease vaccination on acute phase response and milk production in the Holstein-Friesian crossbred cow. *Journal of Applied Animal Research*, *51*(1), 495-500.	2.0	7.40
16.	Sahoo, S., Alex, R., Vohra, V., Mukherjee, S., & Gowane, G. R. (2023). Estimation of genetic parameters and genetic change of first parity reproductive traits in Alpine× Beetal goats. *Reproduction in Domestic Animals*, *58*(9), 1188-1198.	1.858	7.70
17.	Singh, U., Alex, R., Chaudhary, A., Deb, R., Raja, T. V., Rathod, B., & Das, A. K. (2023). Genetic variants in 5 UTR and e xonic region of NPY gene alter the reproduction performance in Indian cattle breeds. *Reproduction in Domestic Animals*, *58*(2), 246-252.	1.858	7.70
18.	Sahoo, S., Alex, R., Vohra, V., Mukherjee, S., &Gowane, G. R. (2023). Elucidating genetic diversity and population structure of Alpine x Beetal goats using pedigree analysis. *Small Ruminant Research*, *227*, 107060.	1.83	7.80
19.	Vyas, J., Pannu, U., Saran, R. K., Narula, H. K., Chopra, A., &Gowane, G. R. (2023). Performance evaluation of Marwari lambs for growth traits and impact of inbreeding. *Zygote*, *31*(3), 288-295.	1.818	7.70
20.	George, L., Alex, R., Sukhija, N., Jaglan, K., Vohra, V., Kumar, R., & Verma, A. (2023). Genetic improvement of economic traits in Murrah buffalo using significant SNPs from genome-wide association study. *Tropical Animal Health and Production*, *55*(3), 199.	1.70	7.70
21.	Yadav, N., Illa, S. K., Mukherjee, S., Gujar, G., & Mukherjee, A. (2023). Bayesian estimates for genetic and phenotypic parameters of growth traits in Sahiwal cattle. *Tropical Animal Health and Production*, *55*(1), 30.	1.70	7.70
22.	Sahoo, S., Alex, R., Vohra, V., Mukherjee, S., &Gowane, G. R. (2023). Explicating the genetic diversity and population structure of Saanen× Beetal goats using pedigree analysis. *Tropical Animal Health and Production*, *55*(6), 392.	1.70	7.70
23.	Jegaveera-Pandian, S., Kumar, J., Sonawane, G. G., Gowane, G. R., Swarnkar, C. P., & Sharma, S. R. (2023). Soil-borne septicaemic colibacillosis in neonatal lambs: Salient observations. *Indian Journal of Animal Research*, *57*(5), 662-665.	0.50	6.50
24.	Patel, B. M., Raina, A. A., Jeyakumar, S., Selvan, R. P., Gowane, G. R., Krishnaswamy, N., Dechamma, H.J., Vijayapillai, U., Somagond, A., Sanyal, A. Gaur, G.K & Dutt, T. (2023). Effect of breeding during the peri-vaccination window against foot-and-mouth disease on the pregnancy rate in the cow: A retrospective study. *The Indian Journal of Animal Sciences*, *93*(12), 1187-1189.	0.4	6.40
25.	Santhosh, A., Vohra, V. & Alex, R. (2023). Comparative Assessment of De Novo Genome Assemblers for Generating Eukaryotic Primary Genome Assembly from Short Reads. *Journal of Computational Systems Biology*. 6(1):1-10	-	-
26.	Pandey, D., Mukherjee, A., Gowane, G., Kamboj, M. L., Lathwal, S. S., Malhotra, R., Rathi, S.K. & Mukherjee, S. (2023). Comprehensive genetic analysis of linear type traits for characterization of the Sahiwal cattle in an organized herd.*Indian Journal of Dairy Science*. 76(1): 1-6.	-	5.24

S. No.	Research Articles	Impact Factor	NAAS Score
27.	Dhakad, G. S., Saini, S., Mallick, P. K., Jatav, P. K., Gowane, G. R., & Sharma, P. C. (2023). Non-genetic factors affecting lifetime body weights in Malpura Ram lambs. *Indian Journal of Small Ruminants (The)*, *29*(1), 11-16.	-	5.11
28.	Mumtaz, S., Mukherjee, A., Pathak, P., & Parveen, K. (2023). Study on Population Dynamics and Effects of Inbreeding on Performance Traits in Indian Murrah Buffalo. *Asian Journal of Dairy and Food Research*, *42*(1), 38-45.	-	5.44

Animal Physiology

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Alhussien, M. N., Dang, A. K., & Bu, D. (2023). Strategies for mitigating the transition period stress in dairy cattle. *Frontiers in Veterinary Science*, *10*, 1157526.	3.2	9.2
2.	Kumar, P., & Singh, S. (2023). Effect of melatonin implantation on productive performance in post-partum murrah buffaloes (Bubalus bubalis) during summer season. *The Pharma Innovation Journal,*12(12), 33-35	-	-
3.	Kumar, P., Singh, S. V., Mishra, D.B., Ali, S., Yadav, D.K., & Singh B. (2023) Infrared thermography as a Potential Non-Invasive Tool for the assessment of skin surface temperature of buffalo heifers supplemented with cumin and molasses during hot dry and hot humid seasons under field conditions. *AMA, Agricultural Mechanization in Asia, Africa and Latin America* 54 (11): 16157-16167.	0.3	6.3
4.	Kumar, P.,Singh,S. V., Singh, B., Mishra, D.B., Yadav, D. K., &Bhalakiya, N. (2023). Use of Infrared thermography to monitor the skin temperature of lactating buffaloes supplemented with cumin and molasses during summer season under field conditions. *AMA, Agricultural Mechanization in Asia, Africa and Latin America,* 54(11), 16145-16156.	0.3	6.3
5.	Loat, S., Kumari, N., Saini, S., Dige, M. S., Kumar, A., Dhilor, N., Dang, A.K., Lathwal, S.S., Sodhi, M. & Kataria, R. S. (2023). Allelic diversity at BoLA DRB3 locus and association with predisposition to clinical mastitis in indicus and crossbred cattle. *Animal Biotechnology*, *34*(4), 1030-1039.	3.7	9.7
6.	Mohapatra, S. K., Chaudhary, D., Panda, B. S., Kamboj, A., Kapila, R., & Dang, A. K. (2023). Indoleamine 2, 3-dioxygenase 1 mediated alterations in the functionality of immune cells, deciphers the pregnancy outcomes in crossbred dairy cows. *Journal of Reproductive Immunology*, *158*, 103972.	3.4	9.4
7.	Pal, P., Aggarwal, A., Rajput, Y. S., Deb, R., Joshi, V. G., Verma, A. K., Haldar, A., Singh, I., Grewal, S. & De, S. (2023). Development of B cell epitopes-based enzyme linked immune sorbent assay for detection of bovine anti-Mullerian hormone. *3 Biotech*, *13*(7), 241.	2.8	8.8
8.	Rautela, A., KUMAR, A., & ASHUTOSH, M. (2023). Effect of treated waste water intake on physiological, growth and hematological parameters in Karan-Fries, Tharparkar and Murrah female calves. *The Indian Journal of Animal Sciences*, *93*(8), 806-810.	0.4	6.4
9.	Senthamilan, S., Aggarwal, A., Grewal, S., Rani, S., Vats, P., Pal, P., Jaswal, S., Arya, A. &Alhussien, M. N. (2023). Pre-treatment but not co-treatment with vitexin alleviates hyperthermia induced oxidative stress and inflammation in buffalo mammary epithelial cells. *Journal of Reproductive Immunology*, *158*, 103979.	3.4	9.4
10.	Shashank, C. G., Prashant, R. G., Kumar, P., Kulkarni, N. A., Tiwari, M., Jayakumar, S., &Sejian, V. (2023). Comparative assessment of growth performance of indigenous and cross-bred calves subjected to combined stressors (heat and nutritional). *International Journal of Biometeorology*, *67*(9), 1435-1450.	3.2	9.2
11.	Singh, S. V., & Singh, S. (2023). Resilience of livestock production under varying climates. *Journal of Agrometeorology*, *25*(2), 183-184.	1.2	4.98
12.	Singh, S. V., Misra, A. K., Kumar, G., &Ukey, A. Thermal imaging and physiological responses of crossbred goats under different housing system during hot humid season. *Indian Journal of Dairy Science*, *76*(3).	3.5	5.24
13.	Somagond, Y. M., Alhussien, M. N., & Dang, A. K. (2023). Repeated injection of multivitamins and multiminerals during the transition period enhances immune response by suppressing inflammation and oxidative stress in cows and their calves. *Frontiers in Immunology*, *14*, 1059956.	7.3	13.3
14.	Vaidya, M. M., Singh, S. V., Dhenge, S. A., Dongre, V. B., &Gadegaokar, G. M. (2023). Status of Plasma Heat Shock Protein-72 in Peri-parturient dairy cows during thermal and metabolic Stress. *Journal of Livestock Science (ISSN online 2277-6214)*, *14*, 246-250.	1.8	4.53

Livestock Production & Management

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Dewry, R. K., Mohanty, T. K., Nath, S., Bhakat, M., Yadav, H. P., &Baithalu, R. K. (2023). Comparative RNA isolation methods from fresh ejaculated spermatozoa in Sahiwal cattle (Bos indicus) and Murrah buffalo (Bubalus bubalis) bulls for high quality and enhanced RNA yield. *Animal Biotechnology*, *34*(9), 5180-5191.	3.7	9.7
2.	Dewry, R. K., Mohanty, T. K., Nath, S., Bhakat, M., Yadav, H. P., &Baithalu, R. K. (2023). Comparative RNA isolation methods from fresh ejaculated spermatozoa in Sahiwal cattle (Bos indicus) and Murrah buffalo (Bubalus bubalis) bulls for high quality and enhanced RNA yield. *Animal Biotechnology*, *34*(9), 5180-5191.	3.7	9.7
3.	Tiwari, S., Srivastava, R., Kulkarni, N. A., Raval, K., Patidar, P., Fernandes, A., Bhakat, M. & Mohanty, T. K. (2023). Filtration techniques are advantageous over colloidal centrifugation in improving freezability of low-quality buffalo bull (Bubalus bubalis) ejaculates. *Animal Biotechnology*, *34*(7), 2835-2845.	3.7	9.7
4.	Gayathri, S. L., Bhakat, M., & Mohanty, T. K. (2023). Short-milking-tube thermograms: An alternative to udder thermograms for mastitis detection in Sahiwal cows. *Research in Veterinary Science*, *165*, 105056.	2.4	8.4
5.	Gayathri, S. L., Bhakat, M., & Mohanty, T. K. (2024). Seasonal assessment of mastitis using thermogram analysis in Sahiwal cows. *Research in Veterinary Science*, *166*, 105083.	2.4	8.4
6.	Joshi, M., Chandel, R., Kumar, V., Sharma, S., Baithalu, R. K., Singh, D., &Onteru, S. K. (2023). Detection and quantification of TIMP1 and miR-141 through RT-LAMP and TT-LAMP in serum samples during estrous cycle in buffalo. *Reproductive Biology*, *23*(4), 100820.	2.1	8.1
7.	Dubey, P., Batra, V., Sarwalia, P., Nayak, S., Baithalu, R., Kumar, R., & Datta, T. K. (2023). miR-1246 is implicated as a possible candidate for endometrium remodelling facilitating implantation in buffalo (Bubalus bubalis). *Veterinary Medicine and Science*, *9*(1), 443-456.	1.7	-
8.	Gayathri, S. L., Bhakat, M., & Mohanty, T. K. (2024). Short milking tube thermogram analysis: an indicator of mastitis in Murrah buffaloes. *Tropical Animal Health and Production*, *56*(1), 5.	1.7	7.7
9.	Sahu, J., Misra, A. K., &Baithalu, R. K. (2023). Moringa oleifera leaf meal supplementation improves nutrient digestibility, milk yield, and reproductive performances in dairy cows during early lactation. *Tropical Animal Health and Production*, *55*(6), 396.	1.7	7.7
10.	Nain, D., Mohanty, T. K., Dewry, R. K., Bhakat, M., Nath, S., Gupta, V. K., &Parray, M. A. (2023). Butylated hydroxytoluene (bht) improves the post-thaw semen quality in low-dose sperm cryopreservation in murrah buffalo bull. *CryoLetters*, *44*(1), 57-65.	1	7
11.	Kalwani, D.S., Misra, A.K. and Rao, S.B.N. (2023). Impact of Feeding Biofortified Wheat (WB 2) Straw-based Diet on Immunity of Lactating Murrah (Bubalus bubalis) Buffaloes. *Indian Journal of Animal Research*. DOI: 10.18805/IJAR.B-5244	0.5	6.5
12.	Kerketta, S., Mohanty, T. K., Kumaresan, A., Bhakat, M., Gupta, R., Malhotra, R., Baithalu, R., Mohanty, A.K., Singh, S.R.K. & Rahim, A. (2023). Moosense pedometer for oestrus detection and ovulation time prediction for artificial insemination in Karan fries cows. *Indian Journal of Animal Research*, *57*(1), 18-23.	0.5	6.5
13.	Adhana, M., Lathwal, S. S., Singh, P., Devi, I., Baithalu, R. K., & Kumar, A. (2023). The effect of a herbal anthelmintic (garlic and neem) on the production performance of Karan Fries cows. *Veterinarskiarhiv*, *93*(2), 159-168.	0.5	6.5
14.	Kumar, A., Lathwal, S. S., Devi, I., Misra, A. K., & Singh, P. (2023). Assessment of body conformation traits and their relationship with production performance of Sahiwal cows. *The Indian Journal of Animal Sciences*, *93*(8), 836-840.	0.4	6.4
15.	Dutt, S., & Kamboj, M. L. (2023). Identification of most motivating resource for estimation of social hierarchy in water buffaloes. *RevistaCientifica de la Facultade de Veterinaria*, *33*.	0.2	-
16.	Singh, N. P., & Kamboj, M. L. (2023). Effect of calf mother contact and summer protective measures on growth performance, physiological and health status of Murrah buffalo calves during summer season. *Journal of Experimental Zoology India*, *26*(1).	-	4.78
17.	Devi, I., Dudi, K., Sinha, R., & Vikram, R. (2023). Association of Bio-acoustic Features of Vocal Signals with Age and Semen Quality in Sahiwal Bulls. *Asian Journal of Dairy and Food Research*, *42*(4), 465-470.	-	5.44

S. No.	Research Articles	Impact Factor	NAAS Score
18.	Gayathri, S., Bhakat, M., & Mohanty, T. (2023). Assessment of antibacterial efficacy of Moringa oleifera extracts–a comparative study on mastitic and nonmastitic cultures. *Pharma Innov J*, *12*, 3733-3742.	-	-
19.	Jose, E., Ponnusamy, K., & Kamboj, M. L. (2023). Index based assessment of factors affecting farm diversification in Haryana. *Indian Journal of Extension Education*, *59*(3), 97-101.	-	4.48
20.	Kamboj, M. L., Vishwakarma, V. K., Dutt, S., Kumar, N., & Kamboj, S. (2023). Influence of Pre-partum Habituation Training to Milking Routine on Post-partum Milking Behaviour and Performance of Primiparous Sahiwal cows. *Indian Journal of Animal Production and Management*, *37*(3), 194-203.	-	2.51
21.	Mahajan, S., Devi, I., Chand, N., Kumar, S., Pande, M., Sirohi, A. S., & Tyagi, S. (2023). Dynamics of lipid mobilization and other serum metabolites during transitional period in Frieswal dairy cattle. *Haryana Veterinarian*. 62. (SI-2), 123-127.	-	4.5
22.	Praveen, S., Chandra, R., Kumar, N., & Tiwari, S (2023). Effect of Boron Supplementation During Peripartum Period on Colostrum Yield andComposition and Carry Over Effect on Calf Health in Crossbred Karan Fries CowsDuring Hot Humid Season. *Indian Journal of Animal Nutrition*, *40*(3).	-	5.19
23.	Regar, P. C., Kamboj, M. L., Shinde, K. P., & Kumar, S. (2023). Effect of selected management interventions on growth and production performance of goats in tribal areas of Rajasthan. *Pharma Innov J*, 12(5): 4315-4316.	-	-
24.	Sahu, J., & Misra, A. K. (2023). Effect of dietary inclusion of Moringa oleifera leaf meal and herbal galactogogues on haematological attributes of Sahiwal cows. *Pharma Innov J*, 12(6): 3249-3252.	-	-
25.	Sahu, J., Misra, A. K., Biswal, S., & Yadav, A. (2023). Moringa (Moringa oleifera) as an alternative feed supplement for dairy animals. *Indian Journal of Animal Nutrition*, *40*(2), 98-108.	-	5.19
26.	Singh, N. P., & Kamboj, M. L. (2023). Influence of Maternal Contact on Hormonal, Growth, and Behavioral Responses of Murrah Buffalo Calves in Winter. *International Journal of Environment and Climate Change*, *13*(11), 1635-1645.	-	5.16
27.	Tomar, D. S., Lathwal, S. S., Singh, P., & Devi, I. (2023). Evaluation of productive and reproductive performance of dairy animals in district Muzaffarnagar of Uttar Pradesh. *Indian Research Journal of Extension education,* 23 (3): 60-65.	-	4.99
28.	Tomar, D. S., Lathwal, S. S., Singh, P., & Devi, I. (2023). Impact of Ration Balancing on Productive Performance and Economics of Milk Production in Field Conditions. *Indian Journal of Veterinary Sciences & Biotechnology*, *19*(3).	-	5.25
29.	Tomar, D.S., Lathwal, S.S., Singh, P & Devi, I. (2023). Socio-economic Factors Influencing the Adoption of Scientific Dairy Animal Feeding and Breeding Practices: A Case of Muzaffarnagar in Uttar Pradesh. *Biological Forum*, 15 (2):768-773.	-	4.96

Animal Nutrition

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Nair, P. M., Srivastava, R., Chaudhary, P., Kuraichya, P., Dhaigude, V., Naliyapara, H. B., Mondal, G. & Mani, V. (2023). Impact of zinc, copper, manganese and chromium supplementation on growth performance and blood metabolic profile of Sahiwal (Bos indicus) male calves. *BioMetals*, *36*(6), 1421-1439.	3.5	9.5
2.	Srivastava, R., Nair, P. M., Dewry, R., Kulkarni, N., Mani, V., Bhakat, M., & Mondal, G. (2023). Semen characteristics, nutrient utilization and immuno-endocrine status in response to dietary supplementation of a novel trace mineral mixture in crossbred bulls. *Journal of Trace Elements and Minerals*, *5*, 100088.	-	-
3.	Sharma, A. N., Chaudhary, P., Kumar, S., Grover, C. R., & Mondal, G. (2023). Effect of synbiotics on growth performance, gut health, and immunity status in pre-ruminant buffalo calves. *Scientific Reports*, *13*, 10184.	4.6	10.6
4.	Reddy, R. D., Chaudhary, P., Tyagi, N., Mohini, M., & Mondal, G. (2023). Evaluation of rumen methane emission in Sahiwal and Gir calves supplemented with combination of methanogenic inhibitors. *Methane*, *2*(2), 241-251.	-	-
5.	Leitanthem, V. K., Chaudhary, P., Maiti, S., Mohini, M., & Mondal, G. (2023). Impact of Moringa oleifera Leaves on Nutrient Utilization, Enteric Methane Emissions, and Performance of Goat Kids. *Animals*, *13*(1), 97.	3.0	9.00

S. No.	Research Articles	Impact Factor	NAAS Score
6.	Thamizhan, P., Datt, C., Shambhvi, Mani, V., Mondal, G., & Malik, R. (2023). Influence of supplementary nickel on feed intake, nutrient utilization and growth performance in Murrah buffalo calves. *Indian Journal of Dairy Science,* 76, 144-149.	-	5.24
7.	Datt, C., Thamizhan, P., Chauhan, P., Dudi, K., & Mani, V. (2023). Effects of nickel supplementation on nutrient utilization, mineral balance, haematology and antioxidant status of crossbred dairy calves. *Journal of Trace Elements in Medicine and Biology*, *79*, 127250.	3.5	9.5
8.	Chauhan, N., Kumari, N., Mishra, D. B., Mani, V., & Tyagi, N. (2023). Dynamic changes in microbial succession and fermentation profiles of sugarcane tops silage treated with exogenous enzymes and lactic acid bacteria following various duration of ensiling. *Sugar Tech*, *25*(3), 592-602.	1.9	7.9
9.	Singh, D., Johnson, T. A., Tyagi, N., Malhotra, R., Behare, P. V., Kumar, S., & Tyagi, A. K. (2023). Synergistic effect of LAB strains (lb. fermentum and *Pediococcusacidilactisci*) with exogenous fibrolytic enzymes on quality and fermentation characteristics of sugarcane tops silage. *Sugar Tech*, *25*(1), 141-153.	1.9	7.9
10.	Chauhan, N., Kumari, N., Mani, V., Pradhan, D., Gowane, G. R., Kumar, S., & Tyagi, N. (2023). Effects of Lactiplantibacillus plantarum, Limosilactobacillus fermentum, and propionic acid on the fermentation process of sugarcane tops silages along with variations in pH, yeast and mould count after aerobic exposure. *Waste and Biomass Valorization*, 15, 2215-2230	3.2	9.2
11.	Kumar, S., Chauhan, N., Tyagi, B., Yadav, P., Samanta, A.K. and Tyagi, A.K. (2023). Exploring bioactive compounds and antioxidant properties of twenty-six Indian medicinal plant extracts: A correlative analysis for potential therapeutic insights. *Food and Humanity*. 1: 1670-1679.	-	-
12.	Sharma, A.N., Chaudhary, P., Grover, C.R., Kumar, S. and Mondal, G. (2023). Impact of synbiotics on growth performance and gut health in Murrah buffalo calves. *Veterinary Research Communications*, 48, 179-190.	2.2	8.20
13.	Singh, M., Varada, V.V. and Kumar, S., 2023. Synbiotic supplementation influence select antioxidants markers and immune response of Murrah buffalo calves. *Emerging Animal Species*, *7*, p.100026	-	-
14.	Varada, V.V., Panneerselvam, D., Pushpadass, H.A., Mallapa, R.H., Ram, C. and Kumar, S. (2023). In vitro safety assessment of electrohydrodynamically encapsulated *Lactiplantibacillus plantarum* CRD7 and *Lacticaseibacillusrhamnosus* CRD11 for probiotics use. *Current Research in Food Science*, p.100507.	6.3	-
15.	Hu, Y., Zhao, T., Guo, Y., Wang, M., Brachhold, K., Chu, C., Hanson, A., Kumar, S., Lin, R., Long, W. and Luo, M., 2023. 100 essential questions for the future of agriculture. *Modern Agriculture,* 1:4-12	-	-
16.	Kumar, S., Pattanaik, A.K., Jadhav, S.E. and Jangir, BL. (2023). *Lactobacillus johnsonii* CPN23 vis-à-vis *Lactobacillus acidophilus* NCDC15 improves gut health, intestinal morphometry, and histology in weaned Wister rat. *Probiotics and Antimicrobial Proteins*, 16(2), 474-489.	5.4	10.90
17.	Chouraddi, R., Kumar, S., Kumar, B., Bhatia, M., Varada, V.V., Tyagi, N. and Mallapa, R.H. (2023). Techno-functional characterization of fecal lactobacilli isolates of Bos indicus calves for probiotic properties, *Veterinary Research Communications*. 47, 1285-1302.	2.2	8.20
18.	Parsana, Y., Yadav, M. and Kumar, S. (2023). Microencapsulation in the chitosan-coated alginate-inulin matrix of *Limosilactobacillusreuteri* SW23 *and Lactobacillus salivarius* RBL50 and their characterization. Carbohydrate Polymer Technologies and Applications. 5, 100285.	5.5	-
19.	Kumar, S., Varada, V.V., Banakar, P.S., Tyagi, N., Chouraddi, R., HogarehalliMallapa, R. and Tyagi, A.K. (2023). Screening and characterization of Sahiwal cattle calves-origin lactic acid bacteria based on desired probiotic attributes for potential application. *Animal Biotechnology*, 34(4): 1612-1625.	3.7	9.70
20.	Banakar, P.S., Kumar, S., Varada, V.V., Dixit, S., Tyagi, N. and Tyagi, A.K. (2023). Dietary supplementation of Aloe vera extract modulates rumen microbes and improves the functional food value of milk by altering phenolic content, antioxidant capacity, and fatty acid profile in lactating goats. *Animal Biotechnology,* 34(7): 3187-3205.	3.7	9.70

Agronomy

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Bhattacharjee, S., Panja, A., Kumar, R., Ram, H., Meena, R. K., & Basak, N. (2023). Municipal solid waste compost: a comprehensive bibliometric data-driven review of 50 years of research and identification of future research themes. *Environmental Science and Pollution Research*, *30*(37), 86741-86761.	5.8	11.8
2.	Dutta, S., Singh, M., Begam, A., Bhattacharjee, S., Meena, B. L., & Kumar, S. (2023). Improvement of Growth, Yield and Soil Fertility in Wheat through Tillage and Nutrient Management Practices. *Journal of Soil Science and Plant Nutrition*, *23*(4), 5374-5388.	3.9	9.9
3.	Kumar, H., Kumar, R., Dutta, S., & Singh, M. (2023). Google's Cloud Computing Platform-Based Performance Assessment of Machine Learning Algorithms for Precisely Maize Crop Mapping Using Integrated Satellite Data of Sentinel-2A/B and Planetscope. *Journal of the Indian Society of Remote Sensing*, *51*(12), 2599-2613.	2.5	8.50
4.	Kumar, D., Singh, M., Kumar Meena, R., Kumar, S., Meena, B. L., Yadav, M. R., Makarana, G. & Kushwaha, M. (2023). Productivity and profitability improvement of fodder maize under combined application of indigenously prepared panchagavya with organic and inorganic sources of nutrient. *Journal of Plant Nutrition*, *46*(14), 3519-3534.	2.1	8.1
5.	Meena, R. K., Singh, Y. V., Shivay, Y. S., Kumar, D., Kumar, R., Ram, H., & Ram, M. (2023). Rice performance as influenced by crop establishment methods, green organic mulches and rates of nitrogen fertilization along with liquid *Azotobacter chroococcum*. *Journal of Plant Nutrition*, *46*(3), 401-422.	2.1	8.1
6.	Yadav, M. R., Singh, M., Kumar, R., Kumar, D., Ram, H., Meena, R. K., &Makarana, G. (2023). Productivity, quality, and land use efficiency of cereal-legume forages under monocropping and intercropping systems with integrated use of organic and inorganic nutrient sources. *Journal of Plant Nutrition*, *46*(10), 2231-2245.	2.1	8.1
7.	Kumar, D., Singh, M., Kumar Meena, R., Kumar, S., Meena, B. L., Yadav, M. R., Makarana, G. & Kushwaha, M. (2023). Productivity and profitability improvement of fodder maize under combined application of indigenously prepared panchagavya with organic and inorganic sources of nutrient. *Journal of Plant Nutrition*, *46*(14), 3519-3534.	2.1	8.1
8.	Kumar, H., Kumar, R., Dutta, S., Singh, M., &Karwariya, S. K. (2023). Utilizing machine learning algorithm, cloud computing platform and remote sensing satellite data for impact assessment of flood on agriculture land. *Current Science*, *125*(8), 886.	1.0	7
9.	Meena, R. K., Hindoriya, P. S., Kumar, R., Ram, H., Singh, M., & Kumar, D. (2023). Quality, productivity and profitability of diversified fodder-based cropping systems for year-round fodder production in Indo-gangetic plains of India. *Range Management and Agroforestry*, *44*(1), 152-159.	0.8	6.8
10.	Singh, K., Ram, H., Kumar, R., Meena, R. K., Saxena, A., Kumar, R., Kumar, A., Praveen, B.R & Kumar, P. (2023). Yield and seed quality of summer green gram as influenced by weed management under zero tillage. *Legume Research-An International Journal*, *46*(1), 69-74.	0.8	6.8
11.	Singh, K., Ram, H., Kumar, R., Meena, R. K., Saxena, A., Kumar, R., Praveen, B.R. & Kumar, P. (2023). Yield and seed quality of summer green gram as influenced by weed management under zero tillage. *Legume Research-An International Journal*, *46*(1), 69-74.	0.8	6.8
12.	Meena, R. K., Hindoriya, P. S., Kumar, R., Ram, H., Singh, M., & Kumar, D. (2023). Quality, productivity and profitability of diversified fodder-based cropping systems for year-round fodder production in Indo-gangetic plains of India. *Range Management and Agroforestry*, *44*(1), 152-159.	0.8	6.8
13.	Kumar, R., Ram, H., Kumar, R., Meena, R. K., Meena, B. L., & Kumar, D. (2023). Proximate composition and fibre fraction of pearl millet fodder as influenced by different nutrient management practices. *Indian Journal of Animal Research*, *57*(3), 334-339.	0.5	6.5
14.	Mahanta, R. K., Meena, R. K., Kumar, R., Ram, H., Singh, M., Bhakar, A., Kumar, D. & Bhattacharjee, S. (2023). Proximate principles and dry matter digestibility of fodder maize and sugargraze in response to potassium management. *The Indian Journal of Animal Sciences*, *93*(04), 384-388.	0.4	6.4
15.	Mahanta, R. K., Meena, R. K., Kumar, R., Ram, H., Singh, M., Bhakar, A., Kumar, D. & Bhattacharjee, S. (2023). Proximate principles and dry matter digestibility of fodder maize and sugargraze in response to potassium management. *The Indian Journal of Animal Sciences*, *93*(04), 384-388.	0.4	6.4

S. No.	Research Articles	Impact Factor	NAAS Score
16.	Meena, M. R., Perumal, G., Meena, R. K., Raja, A. K., Kumar, R., Chhabra, M. L., Pandey, S.P. & Govind, G. H. (2023). Genetic variability for fodder quality traits among high biomass energy cane feedstock under rainfed conditions. *Journal of Sugarcane Research*, *12*(1), 103-111.	-	4.54
17.	Raghuvanshi, M. S., Sawal, R. K., Landol, S., Dorje, N., Pandey, L., Enoch, S., Raza, M. & Saxena, A. (2023). Invasive Common Reed (Phragmites australis (Cav.) Trin. ex Steud.): A Serious Ecological Threat to Ladakh Tethys Himalayan Biodiversity in Changing Climate. *American Journal of Climate Change*, *12*(3), 321-334.	1.51	-
18.	Kumar, D., Singh, M., Kumar, S., Meena, R. K., Kumar, R., Yadav, M. R., Kushwaha, M., Makarana, G., Bhattacharjee, S., Kashyap, S. & Kumar, P. (2023). Energy budgeting and carbon footprints estimation of fodder maize varieties sown under different nutrient management practices in Indo-Gangetic plains of India. *Agronomy*, *13*(4), 981.	3.7	9.7
19.	Reddy, M.B., Singh, U P., Upadhyay, A., Verma K., Singh, N.K., Mahapatra, D. 2023. Evaluation of aclonifen 600 SC a broad-spectrum herbicide molecule to control canary grass (*Phalaris minor* (Retx) Pers.) in wheat crop. *Environment and Ecology,* 41 (3D):2193-2202	-	4.87
20.	Babu, R. T., Mavarkar, N. S., Praveen, B. R., Singh, M., & Dileep, R. (2023). Effect of Water-Soluble Fertilizers and PGPR on Soil Microbial Population, Nodule Count and Economics of Black Gram. *Indian Journal of Ecology*, *50*(1), 95-98.	-	5.38
21.	Kumar, D., Singh, M., Kumar, S., Meena, R. K., Kumar, R., Yadav, M. R., Kushwaha, M., Makarana, G., Bhattacharjee, S., Kashyap, S. & Kumar, P. (2023). Energy budgeting and carbon footprints estimation of fodder maize varieties sown under different nutrient management practices in Indo-Gangetic plains of India. *Agronomy*, *13*(4), 981.	3.7	9.7
22.	Rundan, V., Singh, M., Praveen, B. R., & Yadav, M. (2023). Soil fertility status and nutrient uptake pattern in fodder maize and ricebean intercropping at varying nutrient levels. *Indian Journal of Ecology*, *50*(2), 372-377.	-	5.38
23.	Rundan V., Magan Singh, Praveen B. R. and M. Bhargava Narasimha Yadav (2023). Bio-Economic Assessment of Fodder Maize (*Zea Mays*) Intercropped with Ricebean (*Vigna Umbellata*) Under Different Spatial Arrangements and Nutrient Management Practice. *Forage Research* 48(4): pp. 507-512 (2023).	-	4.76
24.	Kumar, B., Prasad, S., Singh, M., Kumar, D., Kumar, R. and Chetan, B.R. (2023). Effect of crop geometry and nitrogen doses on crop growth and nutrients uptake in transplanted rice. *Annals of Plant and Soil Research*, *25*(3), 488-493.	-	4.61
25.	Rundan, V., Singh, M., Praveen, B., Yadav, M. B. N. and Chethan, B. R. (2023). Proximate Composition Assessment of Fodder Maize with Ricebean Intercropping under Different Nutrient Management Practices. *Annals of Plant and Soil Research*, *25*(4), 641-648.	-	4.61

Animal Biochemistry

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Akram, M., Ali, S. A., & Kaul, G. (2023). Probiotic and prebiotic supplementation ameliorates chronic restraint stress-induced male reproductive dysfunction. *Food & Function*, *14*(18), 8558-8574.	6.1	12.10
2.	Puri, B., Meena, S., Kumar MH, S., Shelke, P. A., Sabikhi, L., & Ashutosh. (2023). Encapsulation and Assessment of Antidiabetic Potential of α-Lactalbumin-Derived Hydrolysates. *Journal of Agricultural and Food Chemistry*, *71*(14), 5547-5553.	6.1	12.10
3.	Bhawal, S., Kumari, A., Rana, S., Kapila, S., & Kapila, R. (2023). Scope of bacterial surface effector molecules beyond probiotics. *Food Bioscience*, 103180.	5.2	11.20
4.	Sharma, D., Lande, A. G., Sameni, D., Yadav, D. N., Kapila, R. and Kapila, S. (2023). Comparative evaluation of milk proteins and oil-seed cake derived-proteins extracted by chemical and biological methods for obesity management in mice. *Journal of the Science of Food and Agriculture.*https://doi.org/10.1002/jsfa.12920	4.13	10.10
5.	Kumar, L. K., Verma, S. K., Chandel, R., Thumar, M., Singh, D., &Onteru, S. K. (2023). Aflatoxin M1 decreases the expression of genes encoding tight junction proteins and influences the intestinal epithelial integrity. *Mycotoxin Research*, *39*(4), 453-467.	4.082	10.00
6.	Kumari, A., Bhawal, S., Kapila, S., & Kapila, R. (2023). Probiotic lactobacilli mediate their immunoregulatory functions in intestinal cells via modulation of H3 histone acetylation. *Journal of Applied Microbiology*, *134*(2), lxac045.	4.0	10.00

7.	Mohapatra, S. K., Chaudhary, D., Panda, B. S., Kamboj, A., Kapila, R., & Dang, A. K. (2023). Indoleamine 2, 3-dioxygenase 1 mediated alterations in the functionality of immune cells, deciphers the pregnancy outcomes in crossbred dairy cows. *Journal of Reproductive Immunology*, *158*, 103972.	3.4	9.4
8.	Thakur, K., Goud, E. S. K., Jawa, Y., Keswani, C., Onteru, S., Singh, D., Singh, S.P., Roy, P. & Tyagi, R. K. (2023). Detection of endocrine and metabolism disrupting xenobiotics in milk-derived fat samples by fluorescent protein-tagged nuclear receptors and live cell imaging. *Toxicology Mechanisms and Methods*, *33*(4), 293-306.	3.2	10.00
9.	Sadeesh, E. M., Singla, N., Lahamge, M. S., Kumari, S., Ampadi, A. N., & Anuj, M. (2023). Tissue heterogeneity of mitochondrial activity, biogenesis and mitochondrial protein gene expression in buffalo. *Molecular Biology Reports*, *50*(6), 5255-5266.	2.8	8.8
10.	Sansi, M. S., Iram, D., Vij, S., Kapila, S., & Meena, S. (2023). In vitro biosafety and bioactivity assessment of the goat milk protein derived hydrolysates peptides. *Journal of Food Safety*, *43*(5), e13061.	2.4	8.40
11.	Joshi, M., Chandel, R., Kumar, V., Sharma, S., Baithalu, R. K., Singh, D., &Onteru, S. K. (2023). Detection and quantification of TIMP1 and miR-141 through RT-LAMP and TT-LAMP in serum samples during estrous cycle in buffalo. *Reproductive Biology*, *23*(4), 100820.	2.1	8.1

Dairy Microbiology

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Pradhan, D., Gulati, G., Avadhani, R., Rashmi, H. M., Soumya, K., Kumari, A., Gupta, A., Dwivedi, D., Kaushik, J.K. & Grover, S. (2023). Postbiotic Lipoteichoic acid of probiotic Lactobacillus origin ameliorates inflammation in HT-29 cells and colitis mice. *International Journal of Biological Macromolecules*, *236*, 123962.	8.2	14.2
2.	Ranveer, S. A., Harshitha, C. G., Dasriya, V., Tehri, N., Kumar, N., & Raghu, H. V. (2023). Assessment of developed paper strip-based sensor with pesticide residues in different dairy environmental samples. *Current Research in Food Science*, *6*, 100416.	6.3	12.3
3.	Kumari, M., Kumari, R., Nataraj, B. H., Shelke, P. A., Ali, S. A., Nagpal, R., &Behare, P. V. (2023). Physicochemical and rheological characterizations of a novel exopolysaccharide EPSKar1 and its iron complex EPSKar1-Fe: Towards potential iron-fortification applications. *Current Research in Food Science*, *6*, 100478.	6.3	12.3
4.	Nataraj, B. H., Gowda, B. S., Kapila, S., Arora, S., Puniya, A. K., Nagpal, R., &Behare, P. V. (2023). Influence of exopolysaccharide EPSKar1–iron complexation on iron bioavailability and alleviating iron deficiency anaemia in Wistar rats. *Food & Function*, *14*(10), 4931-4947.	6.1	12.10
5.	Kumari, M., Haranahalli Nataraj, B., Prasad, W. G., Ali, S. A., &Behare, P. V. (2023). Multi-Faceted Bioactivity Assessment of an Exopolysaccharide from *Limosilactobacillus fermentum* NCDC400: Antioxidant, Antibacterial, and Immunomodulatory Proficiencies. *Foods*, *12*(19), 3595.	5.2	11.20
6.	Nataraj, B. H., Kumari, M., Nagpal, R., Ali, S. A., &Behare, P. V. (2023). Safety evaluation of indigenous probiotic *Limosilactobacillus fermentum* NCDC 400 using whole genome sequences and in vitro approaches. *Food Bioscience*, *56*, 103101.	5.2	11.2
7.	Behare, P. V., Ali, S. A., Mishra, V. S., Gómez-Mascaraque, L. G., & McAuliffe, O. (2023). Fructose-induced topographical changes in fructophilic, pseudofructophilic and non-fructophilic lactic acid bacterial strains with genomic comparison. *World Journal of Microbiology and Biotechnology*, *39*(3), 73.	4.1	10.10
8.	Verma, S. K., Iram, D., Sansi, M. S., Pandey, K. K., Vij, S., & Sood, S. K. (2023). Sustainable utilization of dairy waste paneer whey by Pediococcuspentosaceus NCDC 273 for lactic acid production. *Biocatalysis and Agricultural Biotechnology*, *47*, 102588.	4.0	10.0
9.	Chaudhary, V., Katyal, P., Puniya, A. K., Panwar, H., Arora, M., Kaur, J., Rokana, N., Wakchaure, N., Raposo, A., Raheem, D. &Poonia, A. K. (2023). Pilot-scale process to produce bio-pigment from Monascuspurpureus using broken rice as substrate for solid-state fermentation. *European Food Research and Technology*, *249*(7), 1845-1855.	3.3	9.3
10.	Iram, D., Sansi, M. S., Meena, S., Puniya, A. K., & Vij, S. (2023). In vitro antimicrobial and synergistic effect of fermented Indian zebu (Sahiwal) cow colostrum whey derived peptides with *Lactobacillus rhamnosus* against pathogenic bacteria. *Journal of Food Science and Technology*, *60*(10), 2568-2580.	3.1	9.1
11.	Kashyap, R., Narayan, K. S., & Vij, S. (2023). Evaluation of the antimicrobial attribute of bioactive peptides derived from colostrum whey fermented by Lactobacillus against diarrheagenic *E. coli* strains. *Journal of Food Science and Technology*, *60*(1), 211-221.	3.1	9.1

S. No.	Research Articles	Impact Factor	NAAS Score
12.	Pal, U., Pal, S., & Vij, S. (2023). *Kluyveromycesmarxianus* MTCC 1389 Augments Multi-stress Tolerance After Adaptation to Ethanol Stress. *Indian Journal of Microbiology*, *63*(4), 483-493.	3.0	9.0
13.	Choudhury, P. K., Jena, R., Puniya, A. K., & Tomar, S. K. (2023). Isolation and characterization of reductive acetogens from rumen fluid samples of Murrah buffaloes. *3 Biotech*, *13*(8), 265.	2.8	8.8
14.	Iram, D., Sansi, M. S., Puniya, A. K., Meena, S., & Vij, S. (2023). Draft genome sequence of methicillin-resistant *Staphylococcus aureus* strain D1418m22 isolated from human wound pus. *Microbiology Resource Announcements*, *12*(11), e00409-23.	0.303	6.30
15.	Manju, G., & Grover, C. R.(2023). Assessment of components of essential oils for antimicrobial activity in the dairy food matrix. *Indian Journal of Dairy Science*, *76*(3), 252-258	-	5.24
16.	Manju G.; Ram C. and Kumar H. (2023) Essential oils in vapour and direct contact treatments for controlling mold growth on Cheese. *Asian Journal of Dairy and Food Research*. DR-2076 [1-6]	-	5.44
17.	Talan, S., Pushpalatha, K., & Raghu, H. V. (2023). Evaluation of raw and pasteurized milk samples for prevalence of Listeria monocytogenes. *The Pharma Innovation Journal,* SP-12(11): 818-820	--	5.23
18.	Pushpalatha, K., Talan, S., & Raghu, H. V. (2023). Evaluation of milk samples for detection of mastitis. *The Pharma Innovation Journal,* SP-12(11): 814-817	--	5.23
19.	Vishweswaraiah, R., Sharma, D., Mehta, M., Jaswal, A., Dua, K., Mallappa, R., Pradhan, D., Divanshi, A.M., Kaur, G., Kumar, N. & Puniya, A. K. (2023). Prevalence of extended spectrum β-lactam, methicillin, and vancomycin resistant zoonotic bacterial pathogens in milk. *Food and Humanity*, *1*, 1503-1510.	-	-
20.	Iram, D., Sansi, M. S., Meena, S., Puniya, A. K., & Vij, S. (2023). *In vitro* antimicrobial and synergistic effect of fermented Indian zebu (Sahiwal) cow colostrum whey derived peptides with Lactobacillus rhamnosus against pathogenic bacteria. *Journal of Food Science and Technology*, *60*(10), 2568-2580.	3.1	9.1
21.	Iram, D., Sansi, M. S., Puniya, A. K., Meena, S., & Vij, S. (2023). Draft genome sequence of methicillin-resistant Staphylococcus aureus strain D1418m22 isolated from human wound pus. *Microbiology Resource Announcements*, *12*(11), e00409-23.	0.303	6.30

Dairy Chemistry

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Sharma, R., Sehrawat, R., Ahlawat, S., Sharma, V., Thakur, M. S., Mishra, A. K., Arora, R. &Tantia, M. S. (2023). Functional Quality Characteristics of the Meat from a Dual-Purpose Poultry Crossbreed Suitable for Backyard Rearing in Comparison to Commercial Broilers. *Foods*, *12*(13), 2434.	5.2	11.2
2.	Gawande, H., Arora, S., Sharma, V., Meena, G. S., & Singh, A. K. (2023). Effect of milk protein standardisation using buffalo milk protein co-precipitates on the texture, composition and yield of paneer. *International Journal of Dairy Technology*, *76*(3), 650-658.	4.4	10.4
3.	Deshmukh, U., Arora, S., Kathuria, D., Singh, A. K., Hussain, S. A., & Singh, R. (2023). Influence of variation in calcium content on casein micelle stability and techno-functional properties of buffalo milk. *International Journal of Dairy Technology*, *76*(3), 533-543.	4.4	10.4
4.	Singh, R., JM, H., & Kishore, A. (2023). Evaluation of nutritional quality of fat obtained from different breeds of cow and buffalo with respect to fatty acids and in vitro digestibility. *International Journal of Dairy Technology*, *76*(3), 683-694.	4.4	10.4
5.	Dhale, M., Singh, R., Sharma, R., & Arora, S. (2023). Quantification of all B vitamins in a single run using ion-pair modified liquid chromatography with UV detection. *Journal of Food Composition and Analysis*, *123*, 105602.	4.3	10.3
6.	Naik, Y. K., Sharma, V., Arora, S., & Seth, R. (2023). Development and application of DPPH impregnated paper based color sensor disc to detect vegetable oils addition in cow ghee. *Journal of Food Science and Technology*, *60*(12), 3014-3023.	3.1	9.1
7.	Gautam, P. B., Sharma, R., Atbhaiya, Y., Gandhi, K., & Mann, B. (2023). Activities of indigenous proteases in cow, buffalo and goat milk of Indian subcontinent and their correlation with somatic cell count. *International Dairy Journal*, *139*, 105567.	3.1	9.10
8.	Harshitha, C. G., Sharma, N., Singh, R., Sharma, R., Gandhi, K., & Mann, B. (2023). Interaction study of aflatoxin M1 with milk proteins using ATR-FTIR. *Journal of Food Science and Technology*, *60*(1), 64-72.	3.1	9.10

S. No.	Research Articles	Impact Factor	NAAS Score
9.	Parvatam, R., Singh, R., & Sharma, R. (2023). Comparison of different derivatising reagents in identification of milk metabolites using GC–MS. *International Dairy Journal*, *138*, 105535.	3.1	9.10
10.	Gawande, H., Arora, S., Mittan, R., Lule, V., Sharma, V., & Singh, A. K. (2023). Effect of milk protein standardization using high milk protein ingredients on texture, composition and yield of paneer. *Applied Food Research*, *3*(1), 100286.	2.48	-
11.	Maji, S., Rao, P. S., Ramu, N., Arora, S., & Sharma, V. (2023). Standardization of Methodology to Determine Nitrogen, Total Reducing Sugar, Crude Lipid and Urea Content in Panchgavya Formulation. *International Journal of Bio-resource and Stress Management*, *14*(Apr, 4), 600-610.	-	5.4
12.	Atbhaiya, Y., Sharma, R., Gandhi, K., Mann, B., & Gautam, P. B. (2023). Detection of cotton seed oil in cow ghee using triglyceride profiling. *Indian Journal of Dairy Science*, *76*(6), 515-521.	-	5.24
13.	Gandhi, K., Sharma, R., Seth, R., Ramani, A., & Mann, B. (2023). Mineral oil detection in ghee using attenuated total reflectance-fourier transform infrared spectroscopy (ATR-FTIR) in conjunction with chemometrics. *Food and Humanity*, *1*, 1523-1530.	-	-

Dairy Technology

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Dularia, C., Meena, G. S., Hossain, S., Khetra, Y., & Arora, S. (2023). Effect of emulsifying salts on functional, textural and rheological properties of milk protein concentrate 80 (MPC80) based processed cheese product. *Food Hydrocolloids*, *142*, 108842.	10.7	16.70
2.	Hossain, S., Khetra, Y., Dularia, C., Meena, G. S., & Arora, S. (2023). Symbiotic fermentation study of Acetobacter orientalis and lactic acid bacteria for lactobionic acid enriched yoghurt production. *Food Bioscience*, *53*, 102612.	5.20	11.20
3.	Sharma, H.,& Ramanathan, R. (2023). GC–MS-based metabolomics approach reveals metabolic variations between probiotics incorporated cow and goat milk yoghurt. *International Journal of Dairy Technology*, *76*(3), 521-532.	4.4	10.4
4.	Manik, S., Meena, G. S., Singh, A. K., Khetra, Y., Singh, R., Arora, S., &Vishweswaraiah, R. H. (2023). Valorization of Sour Buttermilk (A Potential Waste Stream): Conversion to Powder Employing Reverse Osmosis and Spray Drying. *Membranes*, *13*(9), 799.	4.20	10.2
5.	Navaf, M., Sunooj, K. V., Saji, H., Aaliya, B., Akhila, P. P., Mir, S. A., Yadav, D. N., Lackner, M., George, J., &Nemţanu, M. R. (2023). Ultrasound and gamma-irradiation assisted development of starch-fatty acid complex: Impact of palmitic acid and stearic acid on structural, functional properties of Coryphaumbraculifera L. starch. *Biomass Conversion and Biorefinery*, 1-13.	4.0	10.0
6.	Thomas, E., Panjagari, N. R., Ganguly, S., Rashmi, H. M., DamodharanPulikodenVeettil, S., & Singh, A. K. (2023). Effect of flaxseed lignan on the dynamics of Lactiplantibacillus plantarum and starter cultures in fermented milk. *International Journal of Food Science & Technology*, *58*(12), 6698-6707.	3.612	9.30
7.	Sharma, H., Singh, A. K., Rao, P. S., Deshwal, G. K., Singh, R., & Kumar, M. D. (2023). A study on incorporation of giloy (Tinospora cordifolia) for the development of shelf-stable goat milk based functional beverage. *Journal of Food Science and Technology*, *61*(3), 503-515.	3.3	9.10
8.	Chaudhary, D., Suresh, C. T., Khetra, Y., Meena, G. S., & Hossain, S. (2023). An assessment of the intact casein content in natural cheddar cheese to determine its suitability in processed cheeses with desired properties. *Journal of Food Science and Technology*, *60*(2), 600-608.	3.1	9.10
9.	Guru, P. N., Kumar, V., Nancy, M., Sharma, A., & Yadav, D. N. (2023). Microwave assisted disinfestation of green gram (Vigna radiata L.) infested with pulse beetle, Callasobruchus maculatus (F.). *Journal of Food Science and Technology*, 1-8.	3.1	9.1
10.	Tushir, S., Yadav, D. N., Kapoor, R. K., Narsaiah, K., Bala, M., & Wadhwa, R. (2023). Low temperature desolventization: effect on physico-chemical, functional and structural properties of rice bran protein. *Journal of Food Science and Technology*, *61*(3), 516-527.	3.1	9.1
11.	Sharma, H., & Ramanathan, R. (2023). Differences and correlation among various fatty acids of cow milk and goat milk probiotic yoghurt: Gas chromatography, PCA and network-based analysis. *Food Chemistry Advances*, *3*, 100430.	-	-
12.	Thomas, E., Ritika, Panjagari, N.R.(2023). Effect of Njavara Rice Bran on Physico-chemical, Sensory and Textural Properties of Sweetened Yoghurt. *Indian Journal of Dairy Science* (Accepted & In-Press)	-	5.24

S. No.	Research Articles	Impact Factor	NAAS Score
13.	Uma, K., Panjagari, N.R., Ramana, R.K., Singh, A.K., Sharma, L.C., Ganguly, S., Sharm, R., Sharma, V. (2023). Headspace volatile markers of Sandesh, a chhana-based delicacy stored at elevated temperatures, *Indian Journal of Dairy Science* (Accepted & In-Press)	-	5.24
14.	Rathod, G., Khamrui, K., & Prasad, W. (2023). Storage stability evaluation of conventional and reduced calorie peda (a dairy dessert) under different packaging conditions. *Food and Humanity*, *1*, 1449-1457.	-	-
15.	Wani, A. D., Prasad, W., Khamrui, K., Hussain, S. A., & Deep, A. (2023). Evaluation of green solvent as an environment friendly alternative for milk fat extraction from ghee residue (clarified butter sediment waste). *International Journal of Food Science & Technology*, *58*(4), 2085-2091.	-	-
16.	Deep, A., Sarkar, M. Prasad, W. and Khamrui, K. (2023). Quality evaluation of ghee obtained using different Methods. The Pharma Innovation Journal 2023; 12(4): 423-426.	-	-
17.	Viji, P. C., Chawla, R., Sivakumar, S., Yadav, D. N., Goel, N., & Anurag, R. K. (2023). Characterization of ultrasonicated assisted encapsulated omega 3 fatty acids and inulin for food applications. *Carbohydrate Polymer Technologies and Applications*, *6*, 100336.	-	-
18.	Sharma, K., Singh, A. K., Maddipatla, D. K., Deshwal, G. K., Rao, P. S., & Sharma, H. (2023). Eggnog: Process optimization and characterization of a dairy-based beverage. Journal of Dairy Research, 90(2), 205-212.		

Dairy Engineering

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Juneja, A. K., Barnwal, P., Sharma, A. K., Naskar, B., &Ammu, V. K. (2023). Energy, exergy and exergoeconomic analyses of single stage spray drying plant in the northern region of India for skim milk powder production. *Journal of Thermal Analysis and Calorimetry*, *148*(20), 11081-11091.	4.4	10.40
2.	Kumari, K., Chakraborty, S. K., Sudhakar, A., & Kishore, A. (2023). Dielectric spectroscopy-based characterisation of different types of Paneer (Indian cottage cheese) in terms of texture, microstructure and functional groups. *International Journal of Dairy Technology*, *76*(1), 4-14.	4.4	10.40
3.	Juneja, A. K., Barnwal, P., Sharma, A. K., &Naskar, B. (2023). Thermodynamic and exergoeconomic analyses of two-stage spray drying plant for skim milk powder production. *Drying Technology*, *41*(13), 2105-2118.	3.3	9.30
4.	Chavhan, B. B., Barnwal, P., Raju, P. N., & Singh, A. K. (2023). Influence of in-package microwave treatment and geometry on selected characteristics of Paneer. *Indian Journal of Dairy Science,* 76(2): 105-113.	-	5.24
5.	Chavhan, B. B., Barnwal, P., Adil, S., Bhagat, P. &Kele, V. (2023). Chemical changes of in-package microwave-treated *dhapkhoa* during storage. *The Pharma Innovation Journal* 12(8): 244-247.	-	-
6.	Deep, A., Sarkar, M., Prasad, W. &Khamrui, K. (2023). Quality evaluation of ghee obtained using different methods. *The Pharma Innovation Journal* 12(4): 423-426	-	-
7.	Deep, A., John, H., Barnwal, P., Kamboj, M. L., & Lathwal, S. S. (2023). Determination of engineering properties of selected animal feed and fodder materials. *Indian Journal Dairy Science* 76(2): 133-139.	-	5.24
8.	Kumawat, A., Minz, P.S. &Solanki, K.K. (2023). Design and Development of Milk Flake Formation System for Production of Rabri. *Frontiers in Crop Improvement*, 10:250-255	-	4.20
9.	Kumawat, A., Minz, P.S. &Solanki, K.K. (2023). Physicochemical & Sensory evaluation for optimization of rabri made through milk flake formation system. *The Pharma Innovation Journal* 12(2): 2529-2535.	-	-
10.	Kumawat, A., Solanki, K.K. Minz, P.S. &Panwar, P.S., (2023). Chemical evaluation of rabri optimized through milk flake formation system. *The Pharma Innovation Journal* 12(3): 1791-1795.	-	-
11.	Rohit, H.K., Chitranayak, P.S. Minz, J.K. Dabas&Kumari, K. (2023) Estimation of Freezing Point of Ternary Coolant Mixture, *Material Science Research India*, 19(3): 161-169	-	-
12.	Rohit, H. K., Minz, P., Dabas, J., & Ray, A. (2023). Characterization of multi-component antifreeze liquids for sub-zero cooling applications: Antifreeze liquids for sub-zero cooling applications. *Journal of AgriSearch*, *10*(4), 259-265.	-	4.95
13.	Sharma, V. K., Barnwal, P., Deep, A., &Bhagat, P. N. (2023) Evaluation of Selected Characteristics of Market *DhapKhoa.Indian J Dairy Sci* 76(5): 433-437.	-	5.23
14.	Priyanka, Narsaiah, K., &Ghodki, B. M. (2023). Thermal and physico-chemical properties of ghee used for frying.*The Pharma Innovation Journal*, 12(10): 1861-1865	-	-

Dairy Economics, Statistics and Management

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Mandal, S., Sendhil, R., & Goswami, R. (2023). Socio-economic evaluation of cropping systems for smallholder farmers–challenges and options. *Frontiers in Sustainable Food Systems*, *7*, 1310448.	4.7	10.70
2.	Adhav, C.A., Sendhil, R. and Bhandari, G. (2023). Determinants of farm household socio-economic vulnerability induced by climate change in Maharashtra: Regression Tree Approach. *Indian Journal of Economics and Development,19*: 272-279. DOI: https://doi.org/10.35716/IJED-21249.	0.20	6.20
3.	Arti, Chauhan, A. K., Dixit, A. K., Mondal, B., & Rai, C. K. (2023). Capturing Economic Incentives through Innovations: An analysis of Commercial Dairy Farms in Trans-Gangetic Plains in India. *Journal of Community Mobilisation and Sustainable Development*, *18*(3):959-963.	-	5.02
4.	Asha, D.S.S., Chandel, B. S., Malhothra, R., Dixit, A. K., & Franco, D. Performance of dairy processing firms in India-An empirical analysis across size and experience categories. *Indian Journal of Dairy Science*, *76*(3).	-	5.24
5.	Kerketta, A., Sen, B., Chaudhary, U. and Verma, A. (2023). Consumption of dairy-based functional foods influenced by socio-economic conditions: Study in Ranchi city. *Biological Forum – An International Journal*, *15*: 13-18.	-	4.96
6.	Kumar, A., Chandel, B. S., Dixit, A. K., & Singh, A. (2023). Water Use Efficiency in Milk Production of Selected Dairy Breeds in Central Region of Bihar: A Lifetime Analysis. *Agricultural Research*, *12*(3), 339-345.	1.40	7.40
7.	Kumar, A., Chandel, B. S., Dixit, A. K., Tiwari, S., Haritha, K., & Kumar, M. (2023). Distribution and Preference of Selected Dairy Breeds among Farmers of Bihar: A Socio-economic Analysis. *Indian Journal of Extension Education*, *59*(3), 85-89.	-	4.48
8.	Kumar, M., Malik, D. P., Singh, A., & Kumar, A. (2023). Economic Analysis and Resource use Efficiency of Sunflower Cultivation in Haryana. *Indian Journal of Ecology*, *50*(5), 1812-1815.	-	5.38
9.	Mohapatra, S., Sainath, B., KC, A., Lal, H., K, N. R., Bhandari, G., & Nyika, J. (2023). Application of blockchain technology in the agri-food system: a systematic bibliometric visualization analysis and policy imperatives. *Journal of Agribusiness in Developing and Emerging Economies*.	2.4	8.40
10.	Naresha, N., & Dixit, A. K. (2023). Value Chain Mapping of Standardized Milk in Cooperative and Private Dairy Plants in Andhra Pradesh. *Journal of Krishi Vigyan*, *11*(2), 388-392.	-	4.95
11.	Bhandari, G., Lal, P. and Kumari, B. (2023). Impact of COVID-19 pandemic on household consumption pattern of dairy products in India. *Indian Journal of Dairy Science*. 76 (1): 84-90. https://doi.org/10.33785/IJDS.2023.v76i01.012	-	5.24
12.	Mohapatra, S., Malhotra, R., Dixit, A.K., Choudhary, U., & Bhandari, G. (2023), Modelling food loss and waste management strategies in agri-food supply chains in India using analytical hierarchical process, *Agricultural Economics Research Review*, *36*(Conference No.), 19-31, DOI: 10.5958/0974-0279.2023.00012.5.	-	5.15
13.	Bijla, S., Birthal, P.S., Malhotra, R., Dixit, A.K., Sankhala, G., Singh, P., & Maiti, S. (2023), Livestock and transitional poverty in rural India, *Agricultural Economics Research Review*, *36* (2):155-168. DOI: 10.5958/0974-0279.2023.00029.0	-	5.15

Dairy Extension

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Leitanthem, V. K., Chaudhary, P., Maiti, S., Mohini, M., & Mondal, G. (2022). Impact of Moringa oleifera Leaves on Nutrient Utilization, Enteric Methane Emissions, and Performance of Goat Kids. *Animals*, *13*(1), 97.	3.0	9.0
2.	Singh, R., Maiti, S., & Garai, S. (2023). Sustainable Intensification–Reaching Towards Climate Resilience Livestock Production System–A Review. *Annals of Animal Science*, *23*(4), 1037-1047.	1.90	7.90
3.	Tengli, M. B., Meena, B. S., Paul, P., Dixit, A. K., & Sivakumar, P. S. (2023). Dairy tourism model for enhancing farmers' income: a niche tourism product from the Trans-Gangetic Plains of India. *Current Science*, *125*(4), 401.	1.0	7.0

S. No.	Research Articles	Impact Factor	NAAS Score
4.	Singh, R., Maiti, S., Garai, S., Jha, S.K., Bhakat, M., Dixit, A.K. and Aggarlwal, A.(2023). Exploring the Relationship between socioeconomic attributes and resilience capacity of Murrah buffalo-based livestock production system in changing climatic scenario.*Indian Journal of Animal Research*, 57(7), 943-950	0.50	6.50
5.	Meena, D. C., Garai, S., Maiti, S., Bhakat, M., Meena, B. S., & Kadian, K. S. (2023). Ethno-veterinary practices for camel diseases: A participatory assessment by the Raika pastoralist of Rajasthan. *The Indian Journal of Animal Sciences*, *93*(1), 45-50.	0.40	6.40
6.	Das, A., Raju, R., Malhotra, R., Singh, A., Maiti, S., Kumar, R., & Patnaik, N. M. (2023). Optimizing farm plan in saline and normal areas of West Bengal-a lexicographic goal programming approach. *J. Indian Soc. Coastal Agric. Res,* 40(2), 107-119.	-	5.45
7.	Reddy, D. A. K., Garai, S., Maiti, S., Manjunath, K. V., Panja, A., & Sahani, S. (2023). Construction of Scale to Measure Women Farmers' Attitude towards Climate Resilient Dairy Farming Practices. *Indian Journal of Extension Education*, *59*(3), 141-144.	-	4.48
8.	Manjusree, R. V., Maiti, S., Garai, S., Manjunath, K. V., Jha, S. K., & Kadian, K. S. (2023). Farmers' feedback associated with accessibility and usability of agromet advisory services disseminated in Thiruvananthapuram district. *Journal of Community Mobilization and Sustainable Development*, 18(4),1229-1233.	-	5.02
9.	Reddy, D. A., Garai, S., Maiti, S., Panja, A., Manjunath, K. V., & Sahani, S. (2023). Development of a test to measure knowledge level of women farmers towards climate resilient dairy farming practices. *Journal of Community Mobilization and Sustainable Development*, 18(4), 1229-1233, 1194-1199.		5.02
10.	Niranjan, D. A., Jha, S. K., Dominic, D. M., Maiti, S., & Kadian, K. S. (2023). Constraints Associated to Geographical Indication Usage: Experts and Producers Perspective. *Indian Journal of Extension Education*, *59*(2), 128-131.	-	4.48
11.	Veldandi, A., Zade, S., Panja, A., Garai, S., & Maiti, S. (2023). Effectiveness of the adaptation strategies to climate change followed by the livestock rearers of the eastern coastal region, India. *Indian J Anim Health*, *62*(2), 118-131.	-	5.01
12.	Meena, D. C., Meena, B. S., Sankhala, G., Garai, S., Meena, H. R., & Madhu, L. C. (2023). Wildlife conflict and prevention strategies adopted by farmers and forest officials. *Indian Journal of Extension Education*, 59(2),132-134.	-	4.48
13.	Pandey, S., Ponnusamy, K. and Saini, H.. (2023). A test to measure knowledge of dairy farmers about improved dairy farming practices. *Gujarat Journal of Extension Education*, 36 (2), 120-125.	-	5.30
14.	Jose, E., Ponnusamy, K., & Kamboj, M. L. (2023). Index based assessment of factors affecting farm diversification in Haryana. *Indian Journal of Extension Education*, *59*(3), 97-101.	-	4.48
15.	Jose, E., & Ponnusamy, K. (2023). SWOT analysis of three agro ecological zones of Haryana.*Indian Research Journal of Extension Education*, 23 (3), 81-85.	-	4.99
16	Jose, E., & Ponnusamy, K. (2023). Farm Diversification in Haryana, India: Case Studies. *Asian Journal of Agricultural Extension, Economics & Sociology*, *41*(9), 503-512.	-	4.73

Southern Regional Station (SRS), Bengaluru

S. No.	Research Articles	Impact Factor	NAAS Score
1.	Nataraj, B.H, Behare, P. V., Yadav, H., & Srivastava, A. K. (2023). Emerging pre-clinical safety assessments for potential probiotic strains: A review. *Critical Reviews in Food Science and Nutrition*, 1-29.	10.2	16.20
2.	Nataraj, B. H., Gowda, B. S., Kapila, S., Arora, S., Puniya, A. K., Nagpal, R., &Behare, P. V. (2023). Influence of exopolysaccharide EPSKar1–iron complexation on iron bioavailability and alleviating iron deficiency anaemia in Wistar rats. *Food & Function*, *14*(10), 4931-4947.	6.1	12.10
3.	Puri, B., Meena, S., Kumar MH, S., Shelke, P. A., Sabikhi, L., & Ashutosh. (2023). Encapsulation and Assessment of Antidiabetic Potential of α-Lactalbumin-Derived Hydrolysates. *Journal of Agricultural and Food Chemistry*, *71*(14), 5547-5553.	6.1	12.10
4.	Nataraj, B. H., Kumari, M., Nagpal, R., Ali, S. A., & Behare, P. V. (2023). Safety evaluation of indigenous probiotic Limosilactobacillus fermentum NCDC 400 using whole genome sequences and in vitro approaches. *Food Bioscience*, *56*, 103101.	5.2	11.20
5.	Lavanya, M., Jeyakumar, S., Veerappa, V. G., Pushpadhas, H. A., Ramesha, K. P., Kumaresan, A., ... & Emerald, F. M. E. (2024). Fabrication and characterization of progesterone loaded pullulan nanofibers for controlled release. *Journal of Drug Delivery Science and Technology*, *91*, 105193.	5.0	11.0

S. No.	Research Articles	Impact Factor	NAAS Score
6.	Teja, A., S. Jeyakumar., Ananda Rao, K., Kumaresan, A., Ramesha, K. P., Krishnaswamy, N., &Rajbangshi, N. (2023). Digital infrared thermal imaging of udder skin surface temperature: a novel non-invasive technology to monitor calving process in Murrah buffalo (Bubalus bubalis). *Scientific Reports*, *13*(1), 13207.	4.6	10.60
7.	Kumaresan, A., Sinha, M. K., Paul, N., Nag, P., Ebenezer Samuel King, J. P., Kumar, R., & Datta, T. K. (2023). Establishment of a repertoire of fertility associated sperm proteins and their differential abundance in buffalo bulls (Bubalus bubalis) with contrasting fertility. *Scientific Reports*, *13*(1), 2272.	4.6	10.60
8.	Prakash, R., Mutharayappa, M., Guruvanna, M. K., Pushpadass, H. A., Ravindra, M. R., & Battula, S. N. (2023). Energy storage and milk chilling performance of metal oxide nanofluids. *Food and Bioproducts Processing*, *140*, 46-59.	4.6	10.60
9.	Datir, R. P., Ravindra, M. R., Manjunatha, M., & Sharma, M. (2024). Optimizing quality and mixing performance of processed cheese spread using a mechanical universal disperser. *International Journal of Dairy Technology*, *77*(1), 224-233	4.4	10.40
10.	Krishnegowda, R., Sharma, M., & Ravindra, M. R. (2023). Green extraction of phospholipids from ghee residue using pulsed electric field processing: Process optimisation and analysis of structural and compositional parameters. *International Journal of Dairy Technology*, *76*(4), 987-999.	4.4	10.40
11.	Sonarthi, H., Kumar MH, S., Rajani, C. S., Sharma, A., Kumaresan, A., & Sabikhi, L. (2024). Production of DPP-IV inhibitory peptides-rich beta casein hydrolysates from milk of Gir (Bos indicus) cow and their evaluation for potential antidiabetic effect through in vitro assay. *International Journal of Dairy Technology*, *77*(1), 94-104.	4.4	10.40
12.	Tellabati, R., Ravindra, M. R., & Rao, K. J. (2023). Optimisation of consolidation and whey drainage during the process of Paneer pressing. *International Journal of Dairy Technology*, *76*(1), 200-213.	4.4	10.40
13.	Rao, S. B. N., Elangovan, A. V., Madiajagan, B., Rajendran, D., Franklin, M. E. E., Gopi, M., ... &Awachat, V. B. (2023). Production and Evaluation of Encapsulated Zinc Oxide on Performance, Ileal Digestibility and Zinc Transporter Gene Expression in Broiler Chicken. *Biological Trace Element Research*, *201*(12), 5774-5785.	3.9	9.90
14.	Raj S, R., DN, D., Mondal, S., Ashokan, M., Thota, L. N., Karuthadurai, T., & Ramesha, K. P. (2023). Expression analysis of pro-apoptotic BAX and anti-apoptotic BCL-2 genes in relation to lactation performance in Deoni and Holstein Friesian crossbred cows. *Animal Biotechnology*, *34*(4), 1354-1361.	3.7	9.7
15.	Sinha, M. K., Kumaresan, A., Rao Talluri, T., Ebenezer Samuel King, J. P., Prakash, M. A., Nag, P., ... & V, A. (2023). Single nucleotide polymorphisms cumulating to genetic variation for fertility in crossbred (Bos taurus× Bos indicus) bull spermatozoa. *Animal Biotechnology*, *34*(7), 2875-2886.	3.7	9.7
16.	Mech, A., Devi, G. L., Sivaram, M., Sirohi, S., Dhali, A., Kolte, A. P., ... & Bhatta, R. (2023). Assessment of carbon footprint of milk production and identification of its major determinants in smallholder dairy farms in Karnataka, India. *Journal of Dairy Science*, *106*(12), 8847-8860.	3.5	9.50
17.	Saunshi, Y. B., David, C. G., Pushpadass, H. A., Emerald Franklin, M. E., Awachat, V. B., &Kadakol, V. R. (2023). Characterization of withanolides and bacoside A-loaded proniosomes: effect on oxidative stress and survival under hypergravity in rodent model. *Drug Development and Industrial Pharmacy*, *49*(12), 748-758.	3.4	9.40
18.	Ashwitha, A., Ramesha, K. P., Ramesh, P., Kootimole, C. N., Devadasan, M. J., Ammankallu, S., ... & Prasad, T. S. K. (2023). Quantitative proteomics profiling of spermatozoa and seminal plasma reveals proteins associated with semen quality in Bos indicus bulls. *Journal of Proteomics*, *273*, 104794.	3.3	9.30
19.	Devadasan, M. J., Ramesha, K. P., Ramesh, P., Kootimole, C. N., Jeyakumar, S., Ashwitha, A., ... & Prasad, T. S. K. (2023). Exploring molecular dynamic indicators associated with reproductive performance of Bos indicus cattle in blood plasma samples through data-independent acquisition mass spectrometry. *Journal of Proteomics*, *285*, 104950.	3.3	9.30
20.	Tripathi, U. K., Kumaresan, A., Saraf, K. K., Golher, D. M., Chhillar, S., Nayak, S., ... & Mohanty, T. K. (2023). Seasonal and climatic factors have a significant influence on fertility associated sperm phenomic attributes in crossbred breeding bulls (Bos taurus× Bos indicus). *International Journal of Biometeorology*, *67*(2), 311-320.	3.20	9.20

S. No.	Research Articles	Impact Factor	NAAS Score
21.	Manoj Kumar, C.T., Supreetha, S., & MH, S. K. (2024). Preparation of nano-immobilised β-galactosidase using mesoporous silicon dioxide nanoparticles and its efficiency in production of galactooligosaccharides. *International Dairy Journal*, *150*, 105847.	3.1	9.10
22.	Rajunaik, B., Franklin, M. E. E., Seethu, B. G., Pushpadass, H. A., Battula, S. N., & Naik, N. L. (2023). Fabrication and characterization of electrospun catechins-loaded nanofibres for fortification of milk. *Journal of Food Science and Technology*, 1-14.	3.1	9.1
23.	Geethambika, S. B., HarthikoteVeerendrasimha, V. S., Prakash, A. K., Pasagadi, A. S., Franklin, M. E. E., Ambrose, R. P. K., &Pushpadass, H. A. (2023). Effect of moisture content on physical and flow properties of milk-millet powders. *Journal of Food Process Engineering*, *46*(10), e14198.	3.0	9.0
24.	Pasagadi, A. S., Prakash, A. K., HarthikoteVeerendrasimha, V. S., Geethambika, S. B., Franklin, M. E. E., &Pushpadass, H. A. (2023). Shelf-life prediction of milk-millet powders. *Journal of Food Process Engineering*, *46*(10), e14204.	3.0	9.0
25.	Krishnegowda, R., Sharma, M., Ravindra, R. M., & Naik, L. N. (2023). Process optimization and kinetics for ultrasonication assisted extraction of phospholipids from ghee residue. *Journal of Food Process Engineering*, *46*(6), e14260.	3.0	9.0
26.	Elango, K., Karuthadurai, T., Kumaresan, A., Sinha, M. K., Ebenezer Samuel King, J. P., Nag, P., ... & Talluri, T. R. (2023). High-throughput proteomic characterization of seminal plasma from bulls with contrasting semen quality. *3 Biotech*, *13*(2), 60.	2.8	8.80
27.	Niribili, R., Jeyakumar, S., Kumaresan, A., Lavanya, M., Sinha, M. K., Kausik, M., ... & Ramesha, K. P. (2024). Prolonged follicular dominance is associated with dysregulated proteomic profile of the follicular fluid in Bos indicus cows. *Theriogenology*, *213*, 34-42.	2.8	8.80
28.	Teja, A., Jeyakumar, S., Rao, K. A., Kumaresan, A., Ramesha, K. P., Narayanan, K., ... & Das, D. N. (2023). Pre-and peri parturient behaviour as an indicator of onset of the calving process in Murrah buffalo (Bubalus bubalis). *Applied Animal Behaviour Science*, *263*, 105936.	2.3	8.30
29.	Preeti, B., Ravindra, M. R., Shivaram, M., Gajanan, D. P., & Singh, A. M. (2023). Effect of pulsed electric field treated on quality of curd. *Food Science and Technology International*, 10820132231193479.	2.3	8.30
30.	Chavan, N. B., Kumaresan, A., Chhillar, S., Nayak, S., Prakash, M. A., Lathika, S., ... &Kimothi, S. P. (2023). Salivary crystallization pattern: a possible unconventional tool for timing of insemination and early pregnancy diagnosis in zebu cows. *Journal of Dairy Research*, *90*(1), 21-25.	2.1	8.10
31.	Sharma, D., Kaniamuthan, S., Manimaran, A., Kumaresan, A., Sivaram, M., Rajendran, D., ... & Banu, S. (2023). Seasonal, physiological and bacteriological risk factors for subclinical mastitis in dairy cows maintained under different farming conditions. *Journal of Dairy Research*, *90*(2), 164-172.	2.1	8.10
32.	Prakash, R., Ravindra, M. R., Battula, S. N., & Sivaram, M. (2024). Chilling of the agitated milk using nano-enhanced phase change materials. *Journal of Food Engineering*, *366*, 111852.	1.6	7.6
33.	Talluri, T. R., Kumaresan, A., Paul, N., Elango, K., Raval, K., Nag, P., ... & Pal, Y. (2024). Heterologous seminal plasma reduces the intracellular calcium and sperm viability of cryopreserved stallion spermatozoa. *Biopreservation and Biobanking*, *22*(1), 82-87.	1.6	7.60
34.	Raina, A. A., Patel, M., Somagond, A., Jeyakumar, S., Selvan, R. P. T., Gowane, G. R., ... & Dutt, T. (2023). Effect of foot-and-mouth disease vaccination on acute phase response and milk production in the Holstein-Friesian crossbred cow. *Journal of Applied Animal Research*, *51*(1), 495-500.	1.4	7.40
35.	Sathiyabarathi, M., Jeyakumar, S., Ayyasamy, M., Pushpadass, H. A., Muniyandi, S., & Ramesha, K. (2023). Influence of circadian rhythm, breed, stage of lactation, milk yield and parity on body and udder skin surface temperature of lactating cows monitored by infrared thermography. *Journal of Applied Animal Research*, *51*(1), 406-413.	1.4	7.40
36.	Lokesh Babu, D.S., Jeyakumar, S., Manimaran, A., Pushpadass, H. A., Sivaram, M., Sathiyabarathi, M., ... & Ramesha, K. P. (2022). Digital infrared thermal imaging of body and hoof skin surface temperature profile in Murrah buffaloes (Bubalus bubalis): A preliminary report. *Buffalo Bulletin*, *41*(4), 623-639.	0.2	6.20
37.	PATEL, B. M., RAINA, A. A., Jeyakumar, S., Selvan, R. P., Gowane, G. R., Krishnaswamy, N., ... & Dutt, T. (2023). Effect of breeding during the peri-vaccination window against foot-and-mouth disease on the pregnancy rate in the cow: A retrospective study. *The Indian Journal of Animal Sciences*, *93*(12), 1187-1189.	-	6.40

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38.	Polekkad, A., Franklin, M., Pushpadass, H. A., Dhotre, A. V., & Rao, S. N. Application of Taguchi orthogonal array design to optimize microencapsulation of zinc by spray-drying. *Indian Journal of Dairy Science*, *76*(3).	-	5.24
39.	Akash J. Rathod and Bandla Srinivas (2023) Nature of Carbohydrates in Agro-industrial By-products (AIBP) Scarcely Support Rumen Microbial Protein Production but Sustain Milk Composition. *Asian Journal of Dairy and Food Science*.	-	-
40.	Boopathi, V., Prasad, S., Kumaresan, A. and Manimaran, A. (2023). Impact of incorporating Asparagus racemosus (Shatavari) into the diet on the growth performance of Murrah buffalo heifers (Bubalus bubalis). International Journal of Veterinary Sciences and Animal Husbandry. 8(6): 160-164.	-	4.61
41.	Jagadeesh, N. K., Devi, M. A., Sushmita, R. Y., Abhishek, K. M., & Suresh, C. T. (2023). Role of dairying in livelihood security of dairy farmers in aspirational districts of Andhra Pradesh. *The Pharma Innovation Journal*, 12(8), 2302-2305.	-	-
42.	Shivanagouda Patil, Veeramani Aranganathan (2023) MXL1 could be a potential candidate gene for semen quality in Holstein Friesian bulls. *The Pharma Innovation Journal*, 12(11), 1923-1927.	-	-
43.	Joseph, K., & Rao, K. J. (2023). Evaluation of sensory and textural profile of lemongrass flavoured paneer during storage and its utilization in preparation of dairy products. *The Pharma Innovation Journal*, SP-12(7), 467-473.	-	-
44.	Kumar, C. M., Supreetha, S., Kumar, M. S., Rao, P. S., & Rao, K. J. (2023). Assessing the production of galactooligosaccharides in batch and continuous mode by using β-galactosidase immobilized on mesoporous silicon dioxide nanoparticles. *International Journal of Food Science & Technology*	-	-
45.	Methai, A., Kumaresan, A., Ansari, MR., & Kataria, Meena (2023) Antioxidant profile of oviductal fluid from Tarai Buffaloes. Agricultural Mechanization in Asia, Africa and Latin America 54 (9); 15599 - 15605	-	6.30
46.	Methai, A., Kumaresan, A., Ansari, MR., & Kataria, Meena (2023) Immunoassay of cow, buffalo and goat oviductal proteins indicate antigenic similarities among the species. Agricultural Mechanization in Asia, Africa and Latin America 54 (8); 14973 – 14979	-	6.30
47.	Methai, A., Kumaresan, A., Ansari, MR., & Kataria, Meena (2023) Incorporation of buffalo epididymal proteins in semen extender improves sperm freezability and post-thaw semen quality in crossbred bulls. Agricultural Mechanization in Asia, Africa and Latin America 54 (10); 15989 – 15998	-	6.30
48.	Oso, O. A., GB, M. R., Malik, P., Pushpadass, H. A., & Awachat, V. (2023). Serum biochemistry, meat quality and oxidative stability in broiler chicken supplemented with a novel phytogenic feed additive formulated from P. betle, P. nigrum, A. lanata and C. dactylon. *The Indian Journal of Animal Sciences*, *93*(6), 617-625.	-	6.40
49.	Sahu, C., Manimaran, A., & Kumaresan, A. Role of Trisodium Citrate and Nanominerals in Mastitis Management in Dairy Animals: A Review.*Agricultural Reviews*, R-2612, 1-8.	-	4.84
50.	Sangama, A. A., Sharma, M., Ravindra, M. R., & Rao, K. J. (2023). Quality attributes of ghee residue prepared using Deoni and Holstein Friesian crossbred cow milk as influenced by method of preparation: Quality attributes of ghee residue. *Indian Journal of Dairy Science*, *76*(1).	-	5.24
51.	Kunnath, S. K., Ramesha, K. P., Kataktalware, M. A., Kumaresan, A., Jeyakumar, S., Das, D. N., ... & Keshava Prasad, T. S. (2022). Exome sequencing identifies variants associated with semen quality in Holstein Friesian and Hallikar bulls. *bioRxiv*, 2022-11.	-	-
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13. TRAINING AND CAPACITY BUILDING

A Human Resource Management (HRM) unit has been established at NDRI to effectively coordinate and implement training programmes following the Govt. of India National Training Policy 2012 based on the tenet of competency-based training for all. The training plan of NDRI addressed the gap between the existing and the required competencies and provides opportunities for the employees to develop their competencies.

(A) Deputations Abroad

- Dr. A. K. Puniya, Principal Scientist attended the International Gut Microbiology Symposium, 13th, Aberdeen, Scotland, UK as Invited Speaker for Gateway to Global Enteric Methane Reduction during June 13-15, 2023.
- The information on training attended by Scientists abroad during 2023 is as under: -

S. No.	Employee Name and Designation	Details of the training programme	
		Project Name & Location	Duration
1	Dr. Sanchita Garai, Scientist	NAHEP Project at UK	19-09-2022 to 15-02-2023
2	Dr. Naresh L Selokar, Senior Scientist	NAHEP Project at Germany	25-09-2022 to 23-02-2023
3	Dr. A. Manimaran, Senior Scientist	NAHEP Project at USA	12-10-2022 to 28-02-2023
4	Dr. Sangita Ganguly, Scientis	NAHEP Project at New Zealand	22-11-2022 to 20-04-2023
5	Dr. Kaushik Khamrui, Principal Scientist	NAHEP Project at Thailand	01-02-2023 to 30-03-2023
6	Dr. Suman Kapila, Principal Scientist	NAHEP Project at New Zealand	20-02-2023 to 06-03-2023
7	Dr. Jai Kumar Kaushik, Principal Scientist	NAHEP Project at USA	16-03-2023 to 31-03-2023
8	Dr. Sunil Kumar Onteru, Principal Scientist	BMGF Project at USA	07-05-2023 to 30-06-2023
9	Dr. A. Kumaresan, Principal Scientist	BMGF Project at Canada	01-06-2023 to 31-07-2023
10	Dr. Pawan Singh, Principal Scientist	NAHEP Project at UK	13-12-2023 to 27-12-2023
11	Dr. Anil Kumar Puniya, Principal Scientist	NAHEP Project at UK	13-12-2023 to 27-12-2023
12	Dr. Chitranayak, Principal Scientist	NAHEP Project at Australia	14-12-2023 to 30-12-2023
13	Dr. Rajesh Kumar Meena, Scientist	NAHEP Project at Australia	15-12-2023 to 30-12-2023

(B) Trainings

S. No.	Name and Designation	Title	Date
Scientific Staff			
1	Dr. G. R. Gowane, Senior Scientist	Training programme on Genomic Selection at NDDB, Anand	1-3 March, 2023
2	Dr. P.S. Minz, Senior Scientist	Training programme on Multivariate Data Analysis (online) at ICAR-NAARM, Hyderabad	20-27 March, 2023
3	Dr. Rani Alex, Senior Scientist		
4	Dr. Shaik Abdul Hussain, Scientist	Advanced User training Programme for water Activity Meter and Texture Analyser at Scientific and Digital Systems (SDS), New Delhi	3-4 May, 2023
5	Dr. Manoj Kumar Singh, Senior Scientist	Genome Analysis and Artificial Intelligence Applied to AGB at ICAR-NDRI, Karnal	21 August - 1 September, 2023
6	Dr. K. Ponnusamy, Principal Scientist	Training programme at the National Institute of Advanced Studies (NIAS), Bengaluru	11-15 September, 2023
7	Dr. Magan Singh, Senior Scientist	Training Programme (online) on Design Thinking in Agricultural Research and Education through Online Mode organised by NAARM, Hyderabad	9-13 October, 2023
		Onsite Training on Laboratory System and Internal Audit as per ISO/IEC 17025:2017 at Indian National Science Academy (INSA), New Delhi	2-4 December, 2023

S. No.	Name and Designation	Title	Date
8	Dr. Sachin Kumar, Scientist	Onsite Training on Laboratory System and Internal Audit as per ISO/IEC 17025:2017 at Indian National Science Academy (INSA), New Delhi	4-6 December, 2023
9	Dr. Monika Sharma, Senior Scientist	CAFT training programme on Agri-derived Nutrients and Nutraceuticals for Innovative Health Foods: Tools and Strategies at ICAR-IARI, PUSA, New Delhi	15 December 2023 to 04 January 2024
10	Dr. M. Sivaram, Principal Scientist	Training programme on Systems Dynamics Modeling at ICAR-NIVEDI, Bengaluru	28-29 December, 2023.
Technical staff			
11	Dr. Vijendra Kumar Meena, CTO	Agri-preneurship development in Seed Sector for sustainability of Agriculture & Rural Economy at ICAR-Indian Institute of Wheat & Barley Research, Karnal	01-10 February, 2023
12	Dr. S. Raju, CTO	Advance Diagnostics and Therapeutic Approaches of Emerging, R-emerging and Metabolic Diseases of Livestock, Poultry and Companion animals at State Level diagnostic Laboratory, Sri Venkateswara Veterinary University, Tirupati, Andhra Pradesh	14 February, 2023 - 06 March, 2023
13	Mrs. Sneh, TA	Online Short Course training Programme on E-Governance Applications in ICAR for Technical personnel at ICAR-IASRI, New Delhi	22 – 28 February, 2023
14	Dr. Ran Jeet Verma, STO		

(C) Participation in Conferences/ Symposiums/ Conventions/ Seminars/ Workshops within India

Name and Designation	Conferences/ Symposiums/ Conventions/ Seminars/ Workshops etc.	Duration
Scientific Staff		
Dr. Sachin Kumar, Scientist Dr. Nitin Tyagi, Principal Scientist Dr. Pradip Behare, Senior Scientist	New Horizons of Animal Nutrition Research: Combating the Challenges of Productivity, Health and Welfare of Animals at DUVASU, Mathura.	16-18 February, 2023
Dr. Sumit Arora, Principal Scientist Dr. Vivek Sharma, Principal Scientist	National Workshop on "Enhancing the functionality of dairy foods through fortification-Quality and Challenges at WBUA&FS, Kolkata, Mahanpur Campus, Nadia, West Bengal.	10-12 August, 2023
Dr. Pankaj Kumar Saraswat, Principal Scientist	National Symposium on Enhancing Agricultural Sectors Income through Integration, Diversification and Commercialization of Technologies (NSEAI-2023) at Agriculture University, Jodhpur.	1-2 September, 2023
Dr. A. K. Sharma, Principal Scientist Dr. Chitranayak, Principal Scientist Dr. (Mrs.) Khushbu Kumari, Scientist	Online Hindi workshop at IASRI, New Delhi.	08-13 September, 2023
Dr. Pawan Singh, Principal Scientist	Online Workshop on Biological Data Exploration and Visualization Using R	27-28 October, 2023
Technical Staff		
Sh. Rakesh Kumar Raman, Technical Assistant	Expo during the 49th Dairy Industry Conference at Gandhi Nagar Gujarat by Indian Dairy Association	16-18 March, 2023
Sh. Munish Leharwan, Technical Assistant	National Symposium on "Enhancing Agricultural Sectors Income through Integration, Diversification and Commercialization of Technologies (NSEAI-2023)" at Agriculture University Jodhpur	1-2 September, 2023

Name and Designation	Conferences/ Symposiums/ Conventions/ Seminars/ Workshops etc.	Duration
Sh. Bindeshwari Pratap Singh, CTO, Library Sh. Narender Singh, STO, Library	Agricultural Libraries and Sustainable Development Goals: The Way Forward at Mohinder Singh Randhawa library Punjab Agricultural University Ludhiana & Association of Agricultural librarian and Documentalists of India.	05-06 October, 2023
Dr. P. Barnwal, Principal Scientist Dr. Chitranayak, Principal Scientist Dr. Ankit Deep, Scientist Dr. Khushbu Kumari, Scientist Dr. Priyanka, Scientist Dr. J.K. Dabas, CTO, ME, Section Er. Sunil Kumar, ACTO, DE, Division Er. Pardeep TO, DE, Division Er. Sachin, TA, DE Division	13th IDEA Convention & International Conference on "Recent Advance in Engineering Applications for Sustainable Dairying" IDEA, at Collage of Dairy Technology GADVASU, Ludhiana.	13-14 October, 2023
Sh. Ishu Dhiman, TA, ABTC, Division Sh. Mukesh Onkar, TA, Dairy Chemistry Division,	Laboratory System & Internal audit as per ISO/ IEC17025:2017 (NABL Accreditation), at INSA, Bahadur Shah Zafar Marg, Mata Sundari Railway Colony, Mandi House, New Delhi	04-06 December, 2023
Administrative Staff		
Sh. Sanjay Kumar Smt. Alpana Sh. Sahil Sh. Shailender Kumar Sh. Dharmendra Singh Smt. Sushma Rani Sh. Ram Dhari Smt. Pinki Devi Smt. Meena Kumari Sh. Ravinder Kumar Ms. Sonika Yadav Sh. Pardeep Kumar Gupta Sh. Chatar Pal Sh. Naresh Chauhan Sh. Kuljit Singh Sh. Annu Mann Sh. Narendra Kant Sharma Sh. Vinod Kumar Sh. Prabhjit Singh Behl Sh. Babu Lal Meena Sh. Jatin Verma Sh. Rajesh Sh. Raj Kumar Sh. Suraj Bhan Sh. Subhash Chander Sh. Jalam Singh Sh. Rajesh Kumar Smt. Simranjeet Kaur Lall Sh. Sagar Sh. Ankit Kaushik	Workshop for Administrative Staff working at ICAR-NDRI, Karnal and its Regional Stations organised by NDRI, Karnal	25-29 October, 2023

14. MAJOR EVENTS

Date	Title of the Event
January 4, 5, 10, 2023	Midterm appraisal of the ongoing research project - Institute Research Committee (IRC) meetings
January 02-06, 2023	Training on "Chemical and Microbiological testing of Milk and Milk Products to meet FSSAI requirements"
January 16-20, 2023	Training on "Laboratory Assessor's Training course as per ISO/IE 17025: 2017 for ICAR scientists"
February 01-10, 2023	National Training Programme on "Climate Smart Livestock Production under Changing Climate Scenario"
February 08, 2023	48th Extension Council Meeting
February 23, 2023 to March 15, 2023	Winter School on "Molecular Diagnosis of AMR (Anti-Microbial Resistant) Pathogen causing Mastitis in Cattle and Buffalo"
February 28, 2023	National Science Day-International Year of Millets-2023
March 03, 2023	Workshop on "Genome Editing in Farm Animals"
March 04, 2023	Innovative Millet Food Ideas Competition
March 07, 2023	World Women Day 2023
March 15, 2023	NDRI-Entrepreneurs Meet
March 18-19, 2023	Workshop on 'Personal Brand Building & Self-Management'
April 03, 2023	Lecture on "From Impossible to I' amd Possible: A Tale of Triumph"on"From Impossible to I' am Possible: A Tale of Triumph"
April 08-10, 2023	National Dairy Mela
April 24, 2023	19th Convocation of ICAR-NDRI Organized
May 29, 2023 to June 23, 2023	Short Term Training Programme on "Machine Learning & Artificial Intelligence"
June 01, 2023	World Milk Day
June 05, 2023	World Environment Day
June 05-06, 2023	Workshop on "Overseas Prospects for Postgraduate Studies in Dairy and Food Science"
June 14, 2023	World Blood Donor Day
June 22, 2023	International Workshop on "Agro-climatology Data: Useful to Usability"
June 27-28, 2023	Research Advisory Committee Meeting Organized
July 03-12, 2023	SCSP Training Programme on "Preparation of Functional Fermented Dairy Products"
July 12-21, 2023	SCSP Training Programme on "Preparation of Functional Fermented Dairy Products"
July 10-19, 2023	SCSP Training Programme on "Conventional and Rapid techniques for the quality and safety assessment of milk"
July 14-15, 2023	Faculty Development Programme on "NEP-2020: Curtain Raiser and New Opportunities"
July 19-21, 2023	जलप्रबंधन एवं पर्यावरण संरक्षण हेतु तीन दिवसीय प्रशिक्षण कार्यक्रम (अनुसूचित जाति महिला प्रतिभागियों हेतु)
July 19-26, 2023	SERB, DST, GoI sponsored National Workshop on "Analytical Approaches for Social Science Dimensions of Climate Resilient Agriculture"
July 08-09, 2023	Training programme on "FoSTaC Advance Manufacturing (Milk & Milk Products)"
July 21, 2023	Workshop on "Campus to Corporate"
July 28-29, 2023	Workshop on 'Stress Management and Conflict Resolution'
July 26, 2023 to August 08, 2023	Workshop on "Application of advanced and sophisticated instrumentation in the development and characterization of functional dairy foods"
August 01-09, 2023	Workshop on "Safety and Quality Monitoring in the Food Industry"

August 09, 2023	Workshop "CME on Good Laboratory Practice (GLP)'
August 07-13, 2023	Workshop on Genome Editing Technologies in Livestock
August 18, 2023	Sensitization Workshop on National Education Policy
August 21-23, 2023	देसी गोमय उत्पादों के निर्माण एवं मूल्य संवर्धन द्वारा रोज़गार सृजन हेतु प्रशिक्षण कार्यक्रम
August 23, 2023	Workshop on "NARES-Blended Learning Platform (BLP)"
August 24, 2023	Workshop on "Roadmap for Increasing Targeted Milk Production in India during Amrit Kal"
August 25, 2023	Workshop on "Big Survey Data Analysis"
August 21, 2023 to September 01, 2023	International Workshop on "Genomic Analysis and Artificial Intelligence Applied to Animal Genetics & Breeding
September 04-15, 2023	National Workshop cum Training Programme on "Food Microbiology and Microbial Diseases"
September 04-08, 2023	Orientation programme on "Ice cream and frozen desserts business incubation"
September 06, 2023	Motivational programme on 'Scientific research and research project writing"
September, 08, 2023	Seminar on "Good Food and Good Health"
September, 09-12, 2023	ICAR Inter-Zonal Sports Tournament- 2022
September 12, 2023	Workshop on "Artificial Intelligence in Livestock Farming"
September 13, 2023	Lecture on "Psychosocial Wellbeing"
September 19, 2023	Brainstorming session on "Harnessing the Potential of Non-Bovine Milk: Collaborative Research Initiatives and the Road Ahead"
September 20, 2023	Seminar on "Cyber Security and Traffic Rules"
September 21, 2023	Hindi workshop on "Official Hindi and technical terminology"
September 29-30, 2023	National Seminar on "Indian Dairy & Food Industry in Amrit Kaal: Opportunities and Challenges"
October 07, 2023	फसल अवशेष प्रबंधन चेतन यात्रा सह क्षेत्रीय मेला
October 03-06, 2023	Midterm appraisal of the ongoing research project - Institute Research Committee (IRC) meetings
November 21, 2023	National Workshop on "Atlas on Climate Change Adaptation in South Asian Agriculture (ACASA)" with a special session on the Livestock Sector
November 26, 2023	National Milk Day
December 06, 2023	Workshop on "Innovation in Animal Feeding Technologies for Sustainable Animal Production"
December 06, 2023	Workshop on "Drafting Procedures for Protecting various IPRs with Special Reference to Animal Science"
December 07, 2023	Interface Meeting Between Feed Industry and Academia on "Livestock Feed and Feeding for Future Dairy Animals"
December 19, 2023	Workshop on "GM crops and their derivatives for the livestock sector"
December 23, 2023	A conclave on "National Education Policy-2020: Preparedness of Dairy & Animal Science Higher Education Institutes (HEIs)" under the IDP-NAHEP

Hon'ble Governor of Haryana, Sh. Bandaru Dattatreya visited ICAR-NDRI (August 09, 2023)

OTHER SIGNIFICANT ACTIVITIES OF STAFF & STUDENTS

Celebration of Republic Day and Independence Day

ICAR-NDRI, Karnal, celebrated the 74th Republic Day and the 77th Independence Day with joy and enthusiasm. The events saw active participation from all staff, family members, and students. Dr. Dheer Singh, Director of ICAR-NDRI, Karnal, highlighted the glorious heritage of our country and reminded everyone of their duties and responsibilities as citizens. The celebrations included an NCC parade during the flag hoisting, as well as various sports activities and cultural events.

Celebration of Republic Day, 2023

Celebration of Independence Day, 2023 by NDRI Family

Celebration of National Science Day

During National Science Day and International Year of Millets-2023 celebrations, various research divisions from the Institute set up Exhibition stalls for School Students. Subject matter experts educated visitors on the significance of milk and composite dairy products, as well as the vital role of millets in our diet.

Digniteries interacting with students during National Science Day (February 26, 2023)

Celebration of Milk Day

ICAR-NDRI, Karnal celebrated both World Milk Day and National Milk Day on 1st June and 26th November 2023, respectively at the Milk Parlour of the Institute. During these celebration, new innovative dairy products developed by the students were launched by the Director of the institute. Exhibitions based on the different value-added milk products were also organized to make awareness among the masses regarding the utility of milk and composite dairy products in our healthy life.

Scientists and students during the celebration of World Milk Day (June 1, 2023) at ICAR-NDRI

Launching of newly developed composite dairy products during National Milk Day (November 26, 2023)

Innovative Millet Food Ideas Competition

An "Innovative Millet Food Ideas Competition" was organized under the aegis of Institute Development Plan (IDP) sub-project of NAHEP on March 4, 2023 among the UG, PG and PhD students. A total of 104 (86 in offline and 18 in online mode) students had participated in this event and presented their idea regarding innovative millet-based food products.

Students displaying Millet based Food Products during Innovative Millet Food Ideas Competition on March 4, 2023

Celebration of World Blood Donor Day

ICAR-NDRI celebrated World Blood Donor Day on June 14, 2023, emphasizing the importance of blood donation. In collaboration with Kalpana Chawla Government Medical College and Indian Red Cross Society, 72 donors participated. The event honored Karl Landsteiner's (architect of the modern blood transfusion) birthday and promoted the campaign slogan "Give blood, give plasma, share life, share often."

NDRI students donating blood during Blood Donation Day (June 04, 2023)

Celebration of World Environment Day & Tree Plantation Drive

ICAR-NDRI celebrated World Environment Day on June 5, 2023, focusing on the Mission LiFE (Lifestyle for Environment). The event included a cycle rally involving faculty and students and a tree plantation. Participants took pledges to support Mission LiFE. The program aimed to promote sustainable living and concluded with poster displays for LiFE slogans for awareness campaign. In NDRI a special drive was organized for the tree plantation.

Harela celebration plantation at NDRI (July 26, 2023)

Organization of ICAR Inter-Zonal Sports Tournament

The ICAR Inter-Zonal Sports Tournament- 2022, was organized at ICAR-NDRI, Karnal from September 9th - 12th, 2023. This event featured the active participation of 49 ICAR institutes, representing five zones - East, West, Central, North, and South. A total of 520 participants, comprising 446 male and 74 female athletes, graced the tournament. These dedicated individuals showcased their talents across various sporting events, including Athletics, Cycle Racing, Chess, Carom, Table Tennis, Badminton, Basketball, Volleyball (Smashing & Shooting), Kabaddi, Football, and Cricket T-10, all hosted at three distinct venues: NDRI Sports Complex, Kalki Bhawan, and Staff Club.

Glimpses of ICAR-Zonal Sprots tournament-2022 held on September 9-12, 2023 at ICAR- NDRI, Karnal

Participation to the ICAR Zonal Sports Tournament 2023 (West Zone)

ICAR-NDRI Staff sports contingent participated in ICAR Zonal Sports Tournament 2023 (West Zone) organized at ICAR-Indian Grassland and Fodder Research Institute, Jhansi from December 16-19, 2023. NDRI Staff Team Won in Basketball, Cricket, Football, Kabaddi, Volleyball Shooting, 4 x100 meter Relay Race, Cycle Race and Other Athletic Events.

Director ICAR-NDRI alongwith Staff sports contingent

Celebration of International Day of Yoga (IDY-2023)

ICAR- National Dairy Research Institute, Karnal celebrated the 9th International Yoga Day on 21st June 2023. This event was organized at Kalki Bhawan Indoor Sports Complex of the institute from 6:00 AM onwards. The employees and their family members, students of the institute, trainees and members of Yoga club actively participated in this event. The Yoga experts of "Patanjali Yog Samati and Bharat Swabhiman Trust" assisted the Yoga Session as per the Protocol and Guidelines of Ayush Department.

Celebrational of International Yoga Day (June 21, 2023) at ICAR-NDRI

Foundation Programme for newly admitted students

Foundation Programme for newly admitted students (20 days) including motivational lectures, sessions on soft skills, Entrepreneurships & Learning sessions on literary, Fine arts, Dance, Music, dramatics etc. was organized for overall development students.

Activities during Foundation Day Programme of newly joined students at ICAR-NDRI

15. DISTINGUISHED VISITORS

Date	Name & Designation of the Visitors
February 09, 2023	Dr. R.S. Paroda, Chairman, Trust for Advancement of Agricultural Sciences (TAAS) (Former Secretary, Department of Agricultural Research and Education (DARE) & Director General (ICAR), New Delhi
March 27, 2023	Dr. Himanshu Pathak, Secretary, Department of Agricultural Research and Education (DARE) & Director General (ICAR), New Delhi
April 10, 2023	Sh. Meenesh Shah, Chairman & Managing Director, National Dairy Development Board (NDDB), Anand, Gujarat
April 24, 2023	Smt. Droupadi Murmu, Hon'ble President of India Sh. Bandaru Dattatreya, Hon'ble Governor of Haryana Sh. Manohar Lal Khattar, Chief Minister, Haryana Sh. Narendra Singh Tomar, Union Minister for Agriculture and Farmers Welfare Sh. Parshottam Rupala, Union Minister of Fisheries Animal Husbandry and Dairying Sh. Kailash Choudhary, Union Minister of State for Agriculture and Farmers Welfare Dr. Ramesh Chandra, Member, Planning Commission Dr. M. S. Chauhan, Vice Chancellor, GBPUA&T, Pantnagar Dr. Himanshu Pathak, Secretary DARE and DG ICAR
June 27-28, 2023	Dr. Nagendra Sharma, Former Vice Chancellor, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-Jammu), Jammu Dr. P.S. Birthal, Director, ICAR-National Institute of Agricultural Economics and Policy Research (ICAR-NIAP), New Delhi Dr. Anandharamakrishnan, Director, CSIR- National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram. Dr. Kusumakar Sharma, Ex- Assistant Director General (Human Resource Development), ICAR Mr. Sukhbir Singh Mann, Founder Mann Ventures, Faridabad Prof. Chaitnya Joshi, Director, Gujarat Biotechnology Research Centre (GBRC), Gandhinagar, Gujarat Dr. V.K. Saxena, Director (Research), Bihar Animal Sciences University (BASU), Patna, Bihar Dr. Amrish Tyagi, Assistant Director General (Animal Nutrition and Physiology), ICAR
July 03, 2023	Dr. Anupam Mishra, Vice-Chancellor, Central Agricultural University, Imphal, Manipur Dr. Manmohan Singh Chauhan, Vice-Chancellor, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand Dr. Ashok Kumar, Assistant Director General (Animal Health)
July 07, 2023	Dr Doohong Min, Associate Professor (Forage Management), Kansas state University, USA
August 09, 2023	Sh. Bandaru Dattatreya, Hon'ble Governor of Haryana
September 4-15, 2023	Dr. Arun Bhunia, Purdue University, USA
September 19, 2023	Dr. Manmohan Singh Chauhan, Vice-Chancellor, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand Dr. Manish K Chatli, Director, ICAR- Central Institute for Research on Goats (ICAR-CIRG), Makhdoom, Uttar Pradesh Dr. A. Sahoo, Director, ICAR-National Research Centre on Camel (ICAR-NRCC), Bikaner, Rajasthan Dr. Girish Patil, Director, ICAR-National Research Centre on Mithun (ICAR-NRC on Mithun), Medziphema, Nagaland Dr. A.K. Dixit, ICAR- Central Institute for Research on Goats (ICAR-CIRG), Makhdoom, Uttar Pradesh Dr. Anuradha Bhardwaj, ICAR-National Research Centre on Equines (ICAR-NRCE), Hisar, Haryana Dr. Basanti Jyotsana, ICAR-National Research Centre on Camel (ICAR-NRCC), Bikaner, Rajasthan Dr. Jyoti, ICAR-National Research Centre on Mithun (ICAR-NRC on Mithun), Medziphema, Nagaland Dr. Shubham Loat, ICAR-National Research Centre on Yak (ICAR-NRC on Yak), Dirang, Arunachal Pradesh

September 20, 2023	Dr. R.C. Mishra, IPS, Managing Director, Haryana Police Housing Corporation (HPHC), Panchkula, Haryana
September 25, 2023	Dr. Sanjeev Kumar Balyan, Hon'ble Minister of State for Fisheries, Animal Husbandry & Dairying, Govt. of India.
October 07, 2023	Dr. Wazir Singh, Deputy Director of Agriculture, Karnal, Haryana Sh. Kshitij Shandilya, IOCL Chandigarh Dr. Anuj Kumar, ICAR-Indian Institute of Wheat and Barley Research (ICAR-IIWBR), Karnal, Haryana Dr. Amit Kumar sharma, ICAR-Indian Institute of Wheat and Barley Research (ICAR-IIWBR), Karnal, Haryana Dr. R.K. Goyal, Maharana Pratap Horticultural University, Karnal, Haryana Dr. V. K. Arora, former Principal Scientist, Chaudhary Charan Singh Haryana Agricultural University (CCSHAU), Regional Research Station, Karnal, Haryana Dr. R.N. Yadav, IARI Regional Research Centre, Karnal, Haryana
November 02, 2023	Sh. Vinay Kumar Sharma, Independent Director, Indian Railway Catering and Tourism Corporation (IRCTC)
November 08, 2023	Dr. Samjhana Kumari Kafla, Director General, Department of Livestock Services, Lalitpur, Nepal Dr. Jagadish Pandaya, Chief Veterinary Officer, National Livestock Breeding Office, Pokhara, Kaski, Nepal Mr. Shiva Nath Mahato, Chief Veterinary Officer, National Livestock Breeding Office, Lahan, Siraha, Nepal Dr. Rajesh Yadav, Senior Officer, Department of Veterinary Livestock Services, Lalitpur, Nepal
November 21, 2023	Dr. P. K. Aggarwal, Regional Programme Leader (Climate Change), Borlaug Institute for South Asia, New Delhi Dr. Paresh Shirsath, Associate Scientist, Borlaug Institute for South Asia, New Delhi Dr. Kaushik Borah, Agricultural Economist, Borlaug Institute for South Asia, New Delhi Dr. V Sejian, Dean, Rajiv Gandhi Institute of Veterinary Education and Research Puducherry Dr. NH Mohan, ICAR-National Fellow & Principal Scientist, ICAR-NRC on Pig, Guwahati Dr. C. A. Rama Rao, Principal Scientist & PI, ACASA, India, ICAR-Central Research Institute for Dryland Agriculture, Santoshnagar, Hyderabad, Telangana
December 06, 2023	Ms. Aprajita Nigam, Managing Associate, M/s LexOrbis, Delhi
December 07, 2023	Dr. Amaresh Chandra, Director, ICAR-Indian Grassland and Fodder Research Institute (ICAR-IGFRI), Jhansi, Uttar Pradesh Dr. C.S. Prasad, former Assistant Director General (Animal Nutrition and Physiology), ICAR, New Delhi; former Vice Chancellor, Maharashtra Animal & Fishery Science University (MAFSU), Nagpur; and former Director, ICAR- National Institute of Animal Nutrition and Physiology (ICAR-NIANP), Bangalore Dr. S.P. Sharma, Kamdhenu Feeds, Uttar Pradesh Dr. V. Sreedhar, Senior General Manager, National Dairy Development Board (NDDB), Anand, Gujarat
December 19, 2023	Dr. Ani Bency Jacob, Animal Nutritionist, Department of Animal Husbandry and Dairying Dr. Vibha Ahuja, Chief General Manager, Biotech Consortium India Limited Dr. Sanjeev Kalia, Senior Manager, Government Affairs and Advocacy Executive, BASF India Limited Mr. Amit Sachdev, Regional Consultant – South Asia, U. S. Grains Council Mr. Jaison John, Team Lead, U. S. Soybean Export Council

Visit of Dr. Martin William Behbahani Counsellor, Agriculture and Food Embassy of Denmark, New Delhi to LRC, SRS of ICAR-NDRI on 13.04.2023

16. PERSONNEL

INSTITUTE STAFF

As on December 31, 2023

Director's Office	
Dheer Singh, PhD	Director
Santra Devi, BA	Principal Private Secretary
Joint Director (Academics) Office	
A. K. Singh, PhD	Joint Director (Academic)
Academic Affairs Management Unit	
B. D. Phansal, MA	Joint Director (Admn.) & Senior Registrar
Anjali Aggarwal, PhD	Principal Scientist & Academic Coordinator
Bhagwan Dass, BA	Assistant Administrative Officer
Joint Director (Research) Office	
Rajan Sharma, PhD	Joint Director (Research)
Ranjana, BA	Private Secretary
Research Prioritization, Monitoring and Evaluation Unit	
Gopal Ramdas Gowane, PhD	Senior Scientist
Varij Nayan, PhD	Senior Scientist
Braj Kishor, MA, B. Lib. Sc.	Chief Technical Officer
Lakshman, B. Com.	Technical Officer
Consultancy Processing Cell	
Biswajit Sen, MSc	Scientist & Officer-in-Charge
Veenu, BSc, MCA	Technical Officer
Information Technology Management Unit	
P. N. Raju, PhD	Senior Scientist & Officer-in-Charge
National Referral Lab	
Rajan Sharma, PhD	Joint Director (Research) & CEO
Rajesh Kumar, PhD	Principal Scientist & Nodal Officer
Kamal Gandhi, PhD	Scientist & Technical Manager
Raghu H.V., PhD	Senior Scientist & Technical Manager
Richa Singh, PhD	Scientist (SS) & Deputy Quality Manager
Rakesh Kumar, PhD	Assistant Chief Technical Officer
Administrative Wing	
B. D. Phansal, MA	Joint Director (Admn.) & Senior Registrar
Dinesh Nagpal, AMIE (Civil Eng.)	Chief Administrative Officer

Gajanand Yadav, MSc	Senior Administrative Officer
Ravinder, BE (Mechanical)	Senior Administrative Officer
Karambir Malik, MA	Principal Private Secretary
Rajbir, BA	Administrative Officer
Sukhdev Singh, BA	Administrative Officer
S. S. Meena, BA	Assistant Administrative Officer
Bhagwan Das, BA	Assistant Administrative Officer
Subhash Chand, BA	Assistant Administrative Officer
Ajit Singh, BA	Assistant Administrative Officer
Ram Pal, BA	Assistant Administrative Officer
Gurjeet Singh, BPharma	Assistant Administrative Officer
Subhash Chander, Senior Secondary	Assistant Administrative Officer
Ram Dhari Singh, MA	Assistant Administrative Officer
Chiranjee Lal, M. Lib. Sc.	Assistant Administrative Officer
B. L. Meena, Senior Secondary	Assistant Administrative Officer
Subhash Kumar, BA	Assistant Administrative Officer
Santosh Kumary, BA	Assistant Administrative Officer
Sonika Yadav, M.Tech.	Assistant Administrative Officer
Dharmendra Singh, BSc.	Assistant Administrative Officer
Meera Rani, Senior Secondary	Assistant Administrative Officer

Finance Wing

Naresh Kumar Arora, MBA (Finance)	Comptroller
Jagdish Chander, Higher Secondary	Senior Finance & Account Officer
Pradeep Malik, BA	Assistant Administrative Officer
Avnish Kumar, BCom	Private Secretary

Animal Genetics & Breeding Division

Vikas Vohra, PhD	Principal Scientist & Head
Sabyasachi Mukherjee, PhD	Principal Scientist
T. V. Raja, PhD	Principal Scientist
Gopal Ramdas Gowane, PhD	Senior Scientist
Rani Alex, PhD	Senior Scientist
Satish Kumar Rathee, PhD	Scientist
Uttam Kumar, PhD	Chief Technical Officer
Vinod Kumar, ITI diploma	Technical Officer

Livestock Production & Management Division

Pawan Singh, PhD	Principal Scientist & Head
A. K. Misra, PhD	Principal Scientist
T. K. Mohanty, PhD	Principal Scientist
M. L. Kamboj, PhD	Principal Scientist
S. S. Lathwal, PhD	Principal Scientist
Ramesh Chandra, PhD	Senior Scientist
Nishant Kumar, PhD	Senior Scientist

Rubina Kumari Baithalu, PhD	Scientist
Indu Devi, PhD	Scientist
Shiv Kumar, MSc	Chief Technical Officer

Animal Nutrition Division

Ashis Kumar Samanta, PhD	Principal Scientist & Head
Raman Malik, PhD	Principal Scientist
Ram Singh, PhD	Principal Scientist
Chander Datt, PhD	Principal Scientist
Nitin Tyagi, PhD	Principal Scientist
Goutam Mondal, PhD	Principal Scientist
Sachin Kumar, PhD	Scientist (SS)
Gyan Singh, MSc	Assistant Chief Technical Officer
Sumit Narayan, MSc	Senior Technical Officer

Animal Physiology Division

A. K. Dang, PhD	Principal Scientist & Head
Sohanvir Singh, PhD	Principal Scientist
Anjali Aggarwal, PhD	Principal Scientist
Ashutosh, PhD	Principal Scientist
Sahadev Singh, MSc	Chief Technical Officer
Yogender Pratap Singh, BSc	Senior Technical Officer
Narender Kumar, BA	Technical Officer
Dheeraj Kumar, MSc	Technical Officer
Anita Behl, BA	Private Secretary

Animal Biotechnology Division

J.K. Kaushik, PhD	Principal Scientist & Head
S. De, PhD	National Professor
D. Malakar, PhD	Principal Scientist
Satish Kumar, PhD	Principal Scientist
Rakesh Kumar, PhD	Principal Scientist
M.K. Singh, PhD	Senior Scientist
Sudarshan Kumar, PhD	Senior Scientist
Naresh Selokar, PhD	Scientist
Bharati Pandey, PhD	Scientist
Ranjit Verma, MVSc	Senior Technical Officer

Animal Biochemistry Division

Suneel Kumar Onteru, PhD	Principal Scientist & Head
Gautam Kaul, PhD	Principal Scientist
Rajeev Kapila, PhD	Principal Scientist
Suman Kapila, PhD	Principal Scientist
Varij Nayan, PhD	Principal Scientist
Rajani Kumar Paul, PhD	Senior Scientist

Sunita Meena, PhD	Senior Scientist
Sadeesh E.M., PhD	Senior Scientist
Ravikant Saini, PhD	Chief Technical Officer
Meenu Rani, MA	Private Secretary

Dairy Technology Division

Deep Narayan Yadav, PhD	Principal Scientist & Head
Kaushik Khamrui, PhD	Principal Scientist
P. Narender Raju, PhD	Senior Scientist
Ganga Sahay Meena, PhD	Senior Scientist
Yogesh Khetra, PhD	Senior Scientist
S.A.Hussain, PhD	Scientist (SS)
Writdhama G. Prasad, PhD	Scientist (SS)
Sangita Ganguly, PhD	Scientist (SS)
Heena Sharma, PhD	Scientist (SS)
Pratik Sharma, Scientist, PhD	Scientist
Gurvant Singh Rathod, MTech	Scientist
Gourav Kumar Deshwal, MTech	Scientist
Sunita Chaudhary, MA	Principal Private Secretary

Dairy Chemistry Division

Vivek Sharma, PhD	Principal Scientist & Head
Raman Seth, PhD	Principal Scientist
Sumit Arora, PhD	Principal Scientist
Rajesh Bajaj, PhD	Principal Scientist
Richa Singh, PhD	Scientist (SS)
Kamal Gandhi, PhD	Scientist (SS)
Sonu, K.S., PhD	Scientist
Rajni Bala, BA	Private Secretary

Dairy Microbiology Division

Shilpa Vij, PhD	Principal Scientist & Head
Anil Kumar Puniya, PhD	Principal Scientist
Chand Ram, PhD	Principal Scientist
Pradip V. Behare, PhD	Senior Scientist
Raghu H.V, PhD	Senior Scientist
Diwas Pradhan, PhD	Scientist (SS)
Saurabh Kadyan, MTech	Scientist
Manorama Kumari, PhD	Scientist
Yogita Sharma, MSc	Technical Officer

Dairy Engineering Division

P. Barnwal, PhD	Principal Scientist & Head
Chitranayak, PhD	Principal Scientist
P. S. Minz, PhD	Senior Scientist

Ankit Deep, MTech	Scientist (SS)
Khushbu Kumari, PhD	Scientist (SS)
Priyanka, PhD	Scientist
Hima John, PhD	Scientist
Sunil Kumar, MTech	Assistant Chief Technical Officer
Manju Bala, Diploma	Technical Officer
Pardeep, MTech	Technical Officer
Sneh, M.Tech	Technical Assistant
Sachin, M. Tech	Technical Assistant

Dairy Economics, Statistics & Management Division

S. Mandal, PhD	Principal Scientist & Head
R. Malhotra, PhD	Principal Scientist
A. K. Sharma, PhD	Principal Scientist
Ajmer Singh, PhD	Principal Scientist
A. K. Dixit, PhD	Principal Scientist
Udita Chaudhary, PhD	Senior Scientist
Gunjan Bhandari, PhD	Scientist
Biswajit Sen, MSc	Scientist
Santosh, BA	Private Secretary

Dairy Extension Division

Gopal Sankhala, PhD	Principal Scientist & Head
K. S. Kadian, PhD	Principal Scientist
K. Ponnusamy, PhD	Principal Scientist
B. S. Meena, PhD	Principal Scientist
Raj Kumar, PhD	Senior Scientist
Sanjit Maiti, PhD	Senior Scientist
Sanchita Garai, PhD	Senior Scientist

Forage Research & Management Centre

Anurag Saxena, PhD	Principal Scientist & Officer-in-Charge
Magan Singh, PhD	Senior Scientist
Hardev Ram, PhD	Senior Scientist
Sanjeev Kumar, PhD	Senior Scientist
Rajesh Kumar Meena, PhD	Scientist
Anil Kumar Dagar, MSc	Chief Technical Officer
Vijendra Kumar Meena, PhD	Chief Technical Officer
Ravi Rawat, MSc	Assistant Chief Technical Officer
Kamal Garg, PhD	Senior Technical Officer

Agricultural Technology Information Centre

Arun Kumar Misra, PhD	Principal Scientist & Officer-in-Charge
Jitender Singh Rana, PhD	Chief Technical Officer

Krishi Vigyan Kendra/ TTC	
Pankaj Kumar Saraswat, PhD	Principal Scientist & Head
Kulvir Singh, MSc	Chief Technical Officer
Ashwani Kumar, MSc	Assistant Chief Technical Officer
Deepa Kumari, MA	Senior Technical Officer
Raj Kumar, BCom	Assistant Administrative Officer

Livestock Research Centre	
Pawan Singh, PhD	Principal Scientist & Coordinator
S.S. Lathwal, PhD	Principal Scientist & Officer-in-Charge
Gopal R. Gowane, PhD	Senior Scientist
Rubina Kumari Baithalu, PhD	Scientist
Pramod Kumar, MSc	Chief Technical Officer
S. Raju, MVSc	Chief Technical Officer
Santosh Kumar, PhD	Assistant Chief Technical Officer
Amar Pal Singh, PhD	Assistant Chief Technical Officer
Neha Gupta, MVSc	Senior Technical Officer
Rajbir, Senior Secondary	Technical Officer
Har Kishan Meena, Senior Secondary	Technical Officer
Puneet Pal Singh, MVSc	Technical Officer

Artificial Breeding Research Centre	
Nishant Kumar, PhD	Senior Scientist & Officer-in-Charge
Subhash Chand, BVSc & AH	Assistant Chief Technical Officer
Kaushal Kumar, BVSc & AH	Technical Officer
Ghan Shyam Meena, BSc	Technical Officer
Ramesh Kumar, Matriculation	Technical Officer

National Library in Dairying	
A.K. Puniya, PhD	Principal Scientist & Head
B.P. Singh, MA, MLib	Chief Technical Officer
Sunil Sharma, MA	Senior Technical Officer
Narendra Singh, MSc	Senior Technical Officer

Computer Centre	
Udita Chaudhary, PhD	Senior Scientist & Officer-in-Charge
Vivek Kumar, MSc	Senior Technical Officer
Des Raj, Senior Secondary	Technical Officer
Atul Gupta, MTech	Technical Officer

Communication Centre	
B. S. Meena, PhD	Principal Scientist & Officer-in-Charge
Sourav Singh, Diploma (Instrumentation)	Technical Officer
Paramjeet, Diploma (Electronics-Telecom)	Technical Officer

Official Language Unit	
Dhiraj Sharma, MA, PGJMC	Joint Director (OL)
Agri-Business Incubator	
S. A. Hussain, PhD	Scientist (SS) & Officer-in-Charge
SINED- Technology Business Incubator	
Kaushik Khamrui, PhD	Principal Scientist & Officer-in-Charge
Guest House	
Chiranjee Lal, M Lib Sc.	Assistant Administrative Officer & Officer-in-Charge
Estate Section	
P. M. Meena, MSc	CTO & Officer-in-Charge
Human Health Complex	
A. K. Misra, PhD	Principal Scientist & Officer-in-Charge
Richa Walia, Course (Nurses)	Technical Officer
Saroj Kathuria, Sr. Secondary, Course	Technical Officer
Saroj Bala, BA, Diploma (Pharmacy)	Technical Officer
Deepak, Matric	Technical Officer
Anuradha, Diploma in Gen Nursing	Technical Officer
Hospitality Cell	
Navdeep Singh, MTech	Technical Officer & Officer-in-Charge
Chiranjee Lal, MLISC	AAO & In-charge (Guest House)
Sudesh Kumar, Matriculation	Technical Officer (D)
Pawan Kumar, ITI	Technical Officer (D)
Umed Singh	Technical Officer (D)
Atam Parkash	Technical Officer (D)
Ramesh Kumar	Technical Officer (D)
Vehicle Maintenance Section	
Sanjeev Kumar, MSc	Assistant Chief Technical Officer
Sports Cell	
Pradip Vishnu Behre, PhD	Senior Scientist & Officer-in-Charge
Sandeep Deswal, MPhil	Chief Technical Officer
Maintenance Engineer	
J.K. Dabas, PhD	Chief Technical Officer & Officer-in-Charge
Sanjeev Kumar, MSc	ACTO & Officer-in-Charge (Central Workshop)
Balbir Singh, ITI	Technical Officer
Mohan Lal Sharma, MTech	Technical Officer
Namo Narayan Meena, Diploma	Technical Officer

Ravinder Singh, BTech, Diploma	Technical Officer
Prabhjit Singh,BA	Assistant Administrative Officer

Hostel Office

Nitin Tyagi, PhD	Principal Scientist & Chief Hostel Warden
Hardev Ram, PhD	Principal Scientist & Warden, Sutlej Hostel
Sanchita Garai, PhD	Senior Scientist & Warden, Kaveri Hostel
Bharati Pandey, PhD	Scientist & Warden, Kaveri Hostel
M. K. Singh, PhD	Senior Scientist & Warden, Krishna Hostel
Yogesh Khetra, PhD	Senior Scientist & Warden, Brahmaputra Hostel
Sachin Kumar, PhD	Scientist (SS) & Warden, Narmada Hostel
Rani Alex, PhD	Scientist & Warden, Alaknanda Hostel
Sanjit Maiti, PhD	Senior Scientist & Warden, Married Hostel
Indu Devi, PhD	Scientist & Warden, Alaknanda Hostel
Sanjeev Kumar, PhD	Scientist & Asstt. Hostel Warden
Ravi Rawat, MSc	ACTO & Asstt. Hostel Warden
Deepa Kumari, MA	Technical Officer & Asstt. Hostel Warden
Hardev Singh, BSc	Technical Officer

Experimental Dairy

Deep Narryan Yadav, PhD	Principal Scientist & Officer-in-Charge
Lehri Singh, MSc	Chief Technical Officer
Sanjiv Kumar, MA	Chief Technical Officer
Gurpartap Singh, MTech	Senior Technical Officer
Jagdish Singh, BA	Technical Officer

SRS, Bengaluru

Arindam Dhali, PhD	Principal Scientist & Head
M.C. Arunmozhidevi, PhD	Principal Scientist
D.N. Das, PhD	Principal Scientist
P. Heartwin Amala Dhas, PhD	Principal Scientist
M.A. Kataktalware, PhD	Principal Scientist
Bandla Srinivas, PhD	Principal Scientist
K. Jayaraja Rao, PhD	Principal Scientist
Menon Rekha Ravindra, PhD	Principal Scientist
F.M.E. Emerald, PhD	Principal Scientist
S. Jeyakumar, PhD	Principal Scientist
M. Sivaram, PhD	Principal Scientist
Kumaresan, PhD	Principal Scientist
S. Subash, PhD	Senior Scientist
Mamta Chauhan, PhD	Senior Scientist
A. Manimaran, PhD	Senior Scientist
H.C. Devaraja, PhD	Senior Scientist
M.H. Sathish Kumar, PhD	Senior Scientist
Rashmi, H.M., PhD	Senior Scientist

Monika Sharma, PhD	Senior Scientist
N. Laxman Naik, PhD	Scientist
G.V. Vedamurthy, PhD	Scientist
Priyanka Singh Rao, PhD	Scientist
Manoj Kumar C.T., PhD	Scientist
Shivaswamy G.P., PhD	Scientist
Amita Dinakar Vairat, PhD	
Basavaprabhu, PhD	Scientist
S. Varalakshmi, MVSc	Scientist (on study leave)
P. Muruganantham, BSc, MLib	Chief Technical Officer
B.K. Rajashekariah, BSc	Chief Technical Officer
V.R.V.S. Naik, MBBS, MD	Chief Technical Officer
P.G. Sathish, BVSc	Chief Technical Officer
Siddaramanna, PhD	Chief Technical Officer
Janakshi, MSc, MCA	Assistant Chief Technical Officer
K. Ningaraju, PhD	Assistant Chief Technical Officer
M.S. Nagarajaiah, Diploma (CE)	Chief Technical Officer
R. Muthuraju, BCA, MCA	Assistant Chief Technical Officer
K. Ramakrishna Prasad, MSc	Senior Technical Officer
Ahmed Hussain, PhD	Senior Technical Officer
ERS, Kalyani	
S. Banik, PhD	Principal Scientist & Head (since 27.07.2023)
T. K. Dutta, PhD	Principal Scientist
S. K. Das, PhD	Principal Scientist
A. Santra, PhD	Principal Scientist
C. Bhakat, PhD	Principal Scientist
A. Mandal, PhD	Principal Scientist
D. K. Mondal, PhD	Principal Scientist
A. Chatterjee, PhD	Principal Scientist
M. Karunakaran, PhD	Principal Scientist
M. Mondal, PhD	Senior Scientist
A. Mohammad, PhD	Senior Scientist
Sanjay Ray, PhD	Senior Scientist & Head, KVK (Add.)
S. Rai, PhD	Scientist (SS)
Amitava Ghosh, MVSc	Chief Technical Officer
Somnath Dutta, MVSc	Chief Technical Officer
P.P. Chaudhuri, MSc	Assistant Chief Technical Officer
Annu Mann, BTech	Assistant Administrative Officer
Debabrata Basantia, MSc	ACTO, Subject Matter Specialist

Joining/Appointments/Promotions

- Dr. Rajan Sharma, Principal Scientist & Head Dairy Chemistry Division, ICAR-NDRI, Karnal joined TO the post of Joint Director (Research), ICAR-NDRI, Karnal as on August 3, 2023.

- Dr. Santanu Banik, Principal Scientist, ICAR-NRC on Pig, Rani, Guwahati, Assam joined the post of Head, ICAR-NDRI-ERS, Kalyani as on July 27, 2023.
- Dr. Arindam Dhali, Principal Scientist, ICAR-NIANP, Bengaluru joined the post of Head, ICAR-NDRI-SRS, Bengaluru as on July 19, 2023.
- Dr. Manorama Kumari has joined as Scientist, Dairy Microbiology Division at ICAR-NDRI, Karnal on April 11, 2023.
- Dr. Sonu, K.S. has joined as Scientist, Dairy Chemistry Division at ICAR-NDRI, Karnal on April 11, 2023.
- Dr. Basavaprabhu H.N. joined as Scientist, Dairy Microbiology at SRS, NDRI, Bengaluru on April 11, 2023.
- Dr. Varij Nayan, Senior Scientist joined the Animal Biochemistry Division, ICAR-NDRI, Karnal on December 22, 2023.
- Dr. Sanjay Ray joined as Senior Scientist & Head KVK (Additional), ERS, ICAR-NDRI on August 21, 2023.
- Mrs. K. Jayalakshmi, Personal Assistant, promoted to the post of Private Secretary in the pay level 8 of the 7th CPC Pay matrix and she was relieved from SRS, ICAR-NDRI on November 22, 2023.
- Sh. S. Thulasi, Skilled Supporting Staff superannuated from service on November 30, 2023.
- Sh. Braj Kishor, Assistant Chief Technical Officer (P&E), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (P&E) on 04.05.2023.
- Sh. Shiv Kumar, Assistant Chief Technical Officer(F/FT), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (F/FT) on 27.01.2023.
- Sh. Anil Kumar, Assistant Chief Technical Officer(F/FT), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (F/FT) on 19.02.2023.
- Sh. Pooran Mal Meena, Assistant Chief Technical Officer(F/FT), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (F/FT) on 27.04.2023.
- Sh. Promod Kumar, Assistant Chief Technical Officer(F/FT), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (F/FT) on 24.05.2023.
- Sh. Sh. Siddaramanna, Assistant Chief Technical Officer(F/FT), SRS of ICAR-NDRI Bengaluru promoted to the next higher grade of Chief Technical Officer (F/FT) on 07.06.2023.
- Dr. Jitender Singh Rana, Assistant Chief Technical Officer(L/T), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (L/T) on 01.05.2023.
- Sh. Sahadev Singh, Assistant Chief Technical Officer(L/T), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (L/T) on 21.08.2023.
- Sh. Sandeep Deswal, Assistant Chief Technical Officer(F/FT), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (F/FT) on 11.11.2022 (Office Order issued on 15.02.2024).
- Sh. Sanjiv Kumar, Assistant Chief Technical Officer (F/FT), ICAR-NDRI Karnal promoted to the next higher grade of Chief Technical Officer (F/FT) on 19.01.2023 (Office Order issued on 15.02.2024).

Transfer/ Retirement/ Relieving

- Dr. Rakesh Kumar, Principal Scientist (Agronomy) transferred from NDRI, Karnal to ICAR-NRM-ICARHQ, New Delhi and relieved from ICAR-NDRI, Karnal on October 9, 2023.
- Dr. Mukesh Bhakat, Principal Scientist appointed the Head, Division of Animal Physiology and Reproduction at ICAR-CIRG Makhdoom, Mathura (UP) and relieved from ICAR-NDRI, Karnal on October 31, 2023.
- Dr. Archana Verma, Principal Scientist, AG&B Division, NDRI, Karnal superannuated from Council's service in the afternoon of October 31, 2023.
- Smt. Simita Roy Deb, PS to Head, ERS retired from ICAR service on superannuation on January 31, 2023 (AN) from ICAR-NDRI-ERS, Kalyani.
- Sh. Deen Dyal Kumar, Technical Officer(Lib) transferred from ICAR-NDRI Karnal to ICAR HQ on 13.01.2023

- Sh. Arun Kumar, Technical Officer (W/S), ICAR-NDRI Karnal retired from ICAR service on superannuation on 31.01.2023.
- Dr. Jitender Kumar, Chief Technical Officer(F/FT), ICAR-NDRI Karnal retired from ICAR Services on superannuation on 31.03.2023.
- Sh. Sonu K.S., STO (L/T), SRS of ICAR-NDRI Bengaluru resigned from his post on 10.04.2023.
- Sh. Kirpal Singh Khanna, Technical Officer(L/T), ICAR-NDRI Karnal retired from ICAR Services on superannuation on 31.05.2023.
- Dr. Satish Kumar, Chief Technical Officer (F/FT), ICAR-NDRI Karnal retired from ICAR Services on superannuation on 30.06.2023.
- Dr. Manoj Kumar, Chief Technical Officer (M&PM), ICAR-NDRI Karnal retired from ICAR Services on superannuation on 30.06.2023.
- Dr. Sanjay Kumar Ray, ACTO/SMS (Soil Science), ERS of ICAR-NDRI, Kalyani resigned from his post on 21.08.2023.
- Sh. Meghanathan, Assistant Chief Technical Officer (W/S), SRS of ICAR-NDRI Bengaluru retired from ICAR Services on superannuation on 30.06.2023.
- Dr. S. M. Deb, Principal Scientist (AGB) retired from ICAR service on superannuation on September 30, 2023 (AN) from ICAR-NDRI-ERS, Kalyani.
- Mr. Alokes Goswami, Chief Technical Officer retired from ICAR service on superannuation on October 31, 2023 (AN) from ICAR-NDRI-ERS, Kalyani.
- Sh. Shyam Lama, PPS transferred to ASRB, New Delhi and relieved from ICAR-NDRI, Karnal on November 2, 2023.
- Sh. Vishal Acharya, AF&AO transferred to CSSRI, and relieved from ICAR-NDRI, Karnal on November 28, 2023.
- Sh. Alokesh Goswami, Chief Technical Officer (F/FT), ERS of ICAR-NDRI Kalyani retired from ICAR Services on superannuation on 30.11.2023.
- Sh. Surinder Kumar Gupta, Chief Technical Officer (F/FT), ICAR-NDRI Karnal retired from ICAR Services on superannuation on 30.11.2023.
- Dr. K. Ponnusamy, Principal Scientist appointed as Head, Division of Social Science at ICAR-CPCRI, Kasaragod, Kerala and relieved from ICAR-NDRI, Karnal on December 21, 2023.
- Sh. Surinder Pandey, Technical Officer (W/S Driver), ICAR-NDRI Karnal retired from ICAR Services on superannuation on 30.12.2023.

Ariel view of the institute

17. MAIN CAMPUS, ICAR-NDRI, KARNAL

RESEARCH DIVISIONS

ANIMAL GENETICS & BREEDING

The Division of Animal Genetics and Breeding was established in the 1960s on the Main Campus of ICAR-NDRI, Karnal. This Division is part of the chequered history of dairy cattle crossbreeding in India to increase milk production at the national level which was started in the early 1970s, and as a result of which, India became a milk-sufficient state from the milk-deficient one. The development of two high-yielding dairy cattle crossbreds Karan Fries and Karan Swiss was the signature of this glorious achievement. Division has been actively involved in conducting research in the areas of animal genetics and breeding including cytogenetics and molecular genetics. The research thrust areas of the division are genetic improvement of indigenous and crossbred cattle and Murrah buffaloes by progeny testing of breeding males, faster multiplication of indigenous cattle, development of sustainable breeding plans, part and complete characterization of genes and their association with production/reproduction traits, disease resistance, screening of young breeding males for genetic disorders and assessment of reproductive efficiency of cattle and buffaloes. The division also fulfils the mandate of extension in the area of Animal Genetics and Breeding through training programs in KVK, Technology Business Incubator (TBI) and Dairy Extension Division, Consultancy services to farmers and various dairy stakeholders, supply of superior germplasm in the form of frozen semen and surplus breeding males to farmers, livestock developmental agencies, state governments and other stakeholders involved in dairy development in the country. The organizational structure for research consists of Animal Breeding Lab., Biometrical Genetics Lab., Buffalo Breeding Lab., Molecular Genetics Lab., DNA Bank for cattle and buffaloes, Livestock Record Cell and besides this, breeding herds of cattle (Karan Fries, Sahiwal, Tharparkar & Gir) and Murrah buffaloes is also the integral part of the research component of Animal Genetics and Breeding Division. The Divisional Library has 436 books, 253 M.Sc./ M.V.Sc. and 152 Ph.D. theses.

LIVESTOCK PRODUCTION AND MANAGEMENT

The Livestock Production and Management (LPM) section came into being in June 2009 after being carved out of the Dairy Cattle Breeding Division of the Institute. The separate faculty of LPM along with the board of studies has been in existence since 1976 and post-graduate and doctorate 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 developing of package of practice 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 Artificial Breeding Research Centre of the Institute besides supporting the training and extension activities of the institute. The mandate of the division includes, (i) To maintain an elite germplasm repository of dairy animals of the identified breeds, ii) Development of state-of-the-art dairy animal management facilities and infrastructure for high-yielding dairy animals, (iii) To carry out research, in collaboration with different divisions, in the upstream areas of dairy animal production, (iv) To standardize the package of management practices and to demonstrate the state of the art dairy animal production system to clients and (v) To provide consultancy to the needy farmers and entrepreneurs for establishment of commercial dairy farms. The organizational structure for research consists of Sensor and Animal Behaviour Lab, Molecular Reproduction lab, Artificial Breeding Research Center (ABRC), Andrology and Semen Preservation Lab, Milk Analysis Lab, Animal Reproduction, Gynaecology and Obstetrics (ARGO)Lab and Livestock Research Centre.

ANIMAL BIOTECHNOLOGY

Biotechnology was initiated at NDRI, Karnal during the mid-eighties under a UNDP 'Centre of Excellence on Biotechnology' programme. After that this facility was recognised as Animal Biotechnology Centre in 1997-98. During the year 2023, it was upgraded as Animal Biotechnology Division. The urgent need for the application of recent biotechnological advances in reproduction and production of superior females of dairy breeds of ruminants for improving animal productivity in our country formed the basis for the establishment

of a state-of-the-art Embryo Biotechnology Centre (EBC) with financial support from the Department of Biotechnology. Biotechnology was further strengthened by the establishment of the Livestock Genome Lab and Molecular Biology Unit. Animal Biotechnology Centre was reorganized in June 1999 by consolidating all the infrastructure facilities created under various programmes on biotechnology. Besides research on areas relevant to biotechnology in dairy production and processing, the Centre also offers M.Sc./M.V.Sc./M.Tech and Ph.D. (Animal Biotechnology) programmes. The objectives of the proposed Division are 1) To undertake biotechnology-oriented basic and applied research programmes for improving animal productivity and for developing innovative dairy processes for producing superior quality, safe and wholesome dairy products, 2) To train manpower in the application of Biotechnology in Dairy Production and Dairy Processing and 3) To organize Masters and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

ANIMAL PHYSIOLOGY

Animal Physiology used to function as a section of the erstwhile Dairy Husbandry Division and subsequently as Dairy Cattle Nutrition and Physiology Division till the end of the 6th Five Year Plan. The discipline of Animal Physiology received the status of an independent division in 1984. The scientists of the division have contributed to the development of infrastructural facilities to initiate research in the area of Embryo Biotechnology centre and now the same has been established as Animal Bio-Technology Centre. The division has been committed to conduct Research, Teaching, and Extension activities in Environmental and Stress Physiology, Lactation and Immuno Physiology, Growth and Reproductive Physiology, and Endocrinology. The division has developed certain useful technologies like induction of lactation, rBST to augment milk production, milk SCC for udder health and CMP and application of mist and fan to alleviate summer stress, which have been adopted several progressive farmers of the area. A large Animal Treadmill was indigenously developed for the draft evaluation system and work-rest cycle in working bullocks. Somatic Cell Counts as an index of clean milk production and udder health in milch animals have been a major focus for a package of practices. A modern custom-designed shelter with automatic control systems has been installed in Livestock Research Centre to ameliorate the heat stress. Water-saving/ purification demonstration units have been installed at the animal farm and are ready to use by the dairy farmers. Modern state-of-the-art facilities are available at National Innovations on Climate Resilient Agricultural Research Centre (NICRA).

ANIMAL NUTRITION

Dairy Cattle Nutrition Division was established in the year 1972, as Dairy Cattle Nutrition and Physiology Division. It was bifurcated into independent divisions as Dairy Cattle Nutrition and Dairy Cattle Physiology in 1978. The Dairy Cattle Nutrition Division was renamed as Animal Nutrition Division in the year 2016. The Division undertakes basic and applied research in the field of post-graduate programmes of education and participates in the process of extension education through various training programmes and field-level technology development and refinement in the discipline of animal nutrition and forage production. Milk replacers and calf starters based on locally available sources were developed along with their feeding schedule. Work was also done on nutrient requirements of cattle, buffalo and goats. Utilization of Zn, vitamin A and iodine was studied. Degcure mixture was developed as a cure for degnala disease. Sulphur requirements with NPN compounds were also standardized. Sources of minerals were evaluated for their availability and chelated minerals were prepared and evaluated. Surveys have been carried out to find the prevalence of pesticides and toxic metals as well as essential trace minerals. With the emergence of one health concept, more focus has been diverted to value addition of milk and meat products, probiotics and prebiotics application in animal nutrition, mineral nutrition, and methane emission and its mitigation strategies. This Division offers Ph.D. and Master's Program in Animal Nutrition discipline. The research laboratories are equipped with modern analytical instruments for chemical and physical analysis. The Division has developed excellent central facilities for research and education, not only for the Institute but also for various sister organizations seeking such support from time to time. The central facilities include a central fine instrumentation laboratory, laboratory for anaerobic rumen microbial work, laboratory for environment-related studies including methanogenesis, quality control laboratory, feed processing unit and nutritional biotechnology laboratory. Some of the sophisticated instruments available include atomic absorption spectrophotometer, gas-liquid chromatography, HPLC system, ^{15}N-Analyzer methane

analysis equipment using SF6-technique, spectrophotometer, PCR machine etc. Research on precision nutrition has been undertaken in the past few years.

FORAGE RESEARCH & MANAGEMENT

The Agronomy Section (Forage Research and Management Centre) was established as a sister section of the forage production section in 2013 to strengthen the research, teaching and extension activities related to round-the-year forage production and quality improvement of forages through agronomic manipulations. The mandate of this section includes generating human resources in Forage Agronomy, developing the agro-techniques for enhancing fodder productivity and quality through efficient management of resources and disseminating the knowledge about new agro-techniques for forage crop production and management to the dairy farmers/extension functionaries. The section has facilities for quality analysis of forages and about 10 acres of land for conducting research experiments of a total of five scientists and 19 students' trials.

ANIMAL BIOCHEMISTRY

Established in September 1984, the Animal Biochemistry Division emerged through the amalgamation of the Animal Biochemistry discipline from the Dairy Chemistry Division and the Division of Human Nutrition and Dietetics. Since its inception, this division has played a pivotal role in advancing three key facets of Indian Dairying: dairy animal production, dairy products processing, and the health attributes of milk and its derivatives. The mandates of the Division include: (i) To conduct cutting-edge research, foster academic excellence, and provide scientific leadership in the realms of biochemistry and dairy sciences, (ii) To offer Master's and Doctoral degrees in Animal/Veterinary Biochemistry and Biochemistry. The division has well-equipped labs for each scientist in addition to the common facilities such as a seminar room, central instrumentation room, divisional library, committee room, PG lab and small animal house. These facilities are equipped to conduct research in areas of molecular biology, endocrinology, functional genomics, biomarkers, mitochondrial genetics, semen extenders, milk bioactive peptides, probiotics, prebiotics, and nutraceutical potential of milk components towards bone health, anti-ageing, anti-diabetic, anti-inflammatory, anti-cancerous properties, and drug delivery potential. The recent highlights of the division include: Novel mechanism of regulation of Cyp19A1 gene in cow and buffaloes; Salivary fern patterns based estrus identification method; Genetic and epigenetic factors associated with postpartum anestrus in Murrah Buffaloes; Mitochondrial DNA-based approaches for effective biomarkers to predict reproductive and productive efficiencies in buffalo and cattle; Milk-derived peptides for improving bone health; Characterization of milk exosomal miRNA; RT-LAMP assays for xenobitoics in Milk; Non-bovine milk health attributes; Functional Validation of Probiotics for overall health and safety of nanomaterials.

DAIRY CHEMISTRY

The mandate of the Division is to conduct fundamental and applied research to understandthechemistry 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. Credited with nearly 32 industrial licenses of different technologies in the last five years, the Division's work on the detection of adulteration in milk and milk products and low-cholesterol ghee has won wide national and international acclaim. Dairy Chemistry Division has generated a significant quantum of intellectual property (more than 17 in the last five years) in addition to quality research publications of high impact factor. The impact of scientific contributions is reflected through recognitions to its faculty which include Fellowships of the National academies, prestigious awards byICAR, NAAS, NRDC, Professional Societies and research funding from national and international agencies. The faculty from the division is also managing the activities of the Chemical Section of the National Referral Centre of Milk Quality and Safety. This facility is ISO 17025:2005 accredited and has been accredited for more than 175 analytical parameters for chemical testing of milk and milk products.The Division has a state-of-the-art air-conditioned Seminar room, Lecture room equipped with an interactive board, LCD projectors, a Visualizer, Podium etc., a Quality control Lab, Undergraduate and Postgraduate labs, Instrument room (equipped with HPLC, GLC, Mastersizer, Ultrafiltration Unit, Electrophoresis, Imaging system, Refrigerated water bath, Dual-beam digital Spectrophotometer, Water purification on system, BOD incubator, Sonicator etc.), Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ nutraceuticals and quality assurance).

DAIRY TECHNOLOGY

The Dairy Technology Division is one of the oldest Divisions of the Institute. The Division contributes significantly to the teaching, research, training and consultancy activities of the Institute. The educational programmes include the flagship programme of B.Tech. (Dairy Technology), Masters and Ph.D. (Dairy Technology). The research efforts of the Division faculty are brought to fruition through sponsored as well as in-house projects including dissertations of postgraduate students. Basic and applied studies to refine processing and packaging technologies for traditional, composite, western and dried dairy products constitute the major focus of research activities. The Division has developed strong expertise in the area of membrane processing, biotechnological applications, fermented dairy products, composite dairy and food products and their packaging. It has successfully organized 40 National Training Programs under the ICAR-sponsored Centre for Advanced Faculty Training in Dairy Processing (earlier, Centre for Advanced Studies in Dairy Technology) since 1994, for teaching faculty of State Agricultural Universities and other institutions. The Division of Dairy Technology has received several awards in recognition of the outstanding scientific contributions made by the scientists, students and staff, such as Fellow of the National Academy of Agricultural Sciences (NAAS), Fellow of the Indian Dairy Association (IDA), Best Employee Award from ICAR, Best Teacher Awards, Rafi Ahmed Kidwai Awards, Jawaharlal Nehru Award, DAAD Fellowships, Humboldt Fellowships and several other awards etc.

DAIRY MICROBIOLOGY

Dairy Microbiology Division is engaged in research, teaching, consultancy, training and technology transfer in the specialized field of Dairy Microbiology. Broadly, the research work of the division covers the areas related to starter cultures and fermented milk products; direct vat starters (DVS); indigenous probiotics, their functional efficacy and gut microbiota, prebiotics and synbiotics; bioactive peptides, microbial metabolites and biopreservatives; biosensors, quality assurance and food safety; rumen micro-organisms etc. The division has played a leading role in establishing the National Collection of Dairy Cultures (NCDC) with the current repository of more than 800 cultures and a national referral centre for milk quality and safety. The Division has recently transferred technologies on two indigenous strains of probiotics, Misti Dahi, rapids kits for antibiotic residues, *Listeria monocytogenes* and *Enterococci*to potential stakeholders in our country for their industrial application. A few more such products like carbonated lassi, vitamin B_{12}-rich propioni-yoghurt, blueberry fortified probiotic dahi, real time test for detection of E. coli and antibiotic residues in milk have been developed and are under process of validation for their commercialization. The Division offers M.Tech. and Ph.D. programmes in Dairy Microbiology. The Division offers contractual and consultancy / training services such as supply of starter cultures, freeze-drying of cultures, microbiological analysis and setting standards for regulatory compliance of dairy products in the country.

DAIRY ENGINEERING

The mission of the Dairy Engineering Division includes, (i) To develop engineering database required in design of dairy process equipments/ instruments; (ii) Process mechanization for Indian dairy products. (iii) To design and develop the equipments/instruments to meet the requirement of dairy industry; (iv) Teaching/ Training to UG/ PG students. (v) Transfer of technology, technical training, and consultancy services etc. It has been established as one of the major research divisions since the inception of the institute. It has been contributing to teaching, research, training and industrial consultancy since the inception of the Institute. The Division has research laboratory facilities to cater to the needs of specific areas and programmes such as process engineering, process equipment design, thermal, electronics and instrumentation. In addition to this, there are post-graduate teaching laboratories, a Research & Development workshop and an equipment testing hall to support both research and teaching activities. During the past three decades, the Division has achieved breakthroughs in developing several process equipment for manufacturing indigenous milk products. Many of these equipment have been patented and efforts are being made to transfer them to the equipment manufacturers. The Division has tie-ups with equipment manufacturers and users for their collaboration in the development or adoption of the research efforts. The Division has developed equipment for the manufacture of Khoa, Burfi, Basundi, Ghee etc. on an industrial scale. Recent research achievements include the development of a weight-based filling system for Kheer, a machine vision system for colour measurement of dairy products, turbo-assisted scraped surface heat exchanger (SSHE) etc.

DAIRY ECONOMICS, STATISTICS & MANAGEMENT

A Division of Dairy Economics, Statistics and Management (DES&M) was created in 1972 from the erstwhile Statistics Section which was constituted at NDRI in 1960. The Division is an amalgamation of three disciplines, that is, Agricultural Economics, Agricultural Statistics and Computer Application. The Division offers post-graduate programs at Master's and Doctoral levels in Agricultural Economics. Our faculty members teach a variety of courses at the undergraduate level also, that is, B. Tech. (DT). The alumni of the Division are well-placed in academia, banking and the development sector. The Division provides unique opportunities for aspiring post-graduate students by offering an ambient academic environment, professional learning and analytical skills. Apart from conducting research on various economic aspects of the dairy sector at the national and international levels, the Division attempts to understand the complex array of forces that influence the level and behaviour of agricultural products. In the present context, the Division endeavours to further advance the knowledge in economic and statistical analysis techniques pertinent to research work and to assess technologies, programs and policies to make informed judgments about the trade-offs in allocating scarce resources and predicting resulting changes or their economic consequences. The Division harnesses the emerging tools, techniques and research methods in econometrics and statistics to provide direction in designing policies & programs, developing institutional mechanisms and facilitating the decision-making process of the stakeholders at micro, meso and macro levels.

DAIRY EXTENSION

The Dairy Extension Division was established at NDRI, Karnal in May 1961 to undertake extension activities, besides teaching and research in Extension Education. Research endeavours of the division are in the areas of Information and Communication Technologies, organizational behaviour, information management, participatory technology development and impact studies of dairy innovations. The faculty has also been engaged in human resource development through postgraduate and doctoral programmes of NDRI. The main extension programmes of the institute such as Dairy Mela and demonstrations, field days, etc. are organized by the Division. Research-Extension-Industry-Farmer Interface is also organized by the Division to provide an opportunity for the convergence of all stakeholders working together for dairy development. Interface not only helps 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 Sangosthi and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, help in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers. A new Extension Education Programme "Dairy Education at Farmers' Door" is initiated onFebruary 09, 2009 to strengthen the effective dissemination of dairy production and processing technologies among the farming community. A new Extension Approach "Farmers Farm School" in the village was initiated in August 30, 2014to updatefarmers' knowledge in the field of dairy farming in particular and agriculture in general.

SUPPORT SECTIONS

ARTIFICIAL BREEDING RESEARCH CENTRE (ABRC)

The Artificial Breeding Research Centre (ABRC) with 138 breeding bulls (Sahiwal-45, Tharparkar-08, Karan-Fries- 25, Karan Swiss -01, Murrah – 56, Gir-3), is involved in advanced research on bull management, Breeding soundness evaluation standards for the indigenous bull, semen cryobiology, early bull fertility assessment and dissemination of quality germplasm to the farmers. It is also engaged in progeny testing programme for Sahiwal and Murrah bulls. The Artificial Insemination Laboratory under ABRC is also developing strategies for fertility improvement in dairy cows and buffaloes.

Production of superior germplasm

The centre is involved in production and conservation of superior male germplasm of cattle and buffaloes. During year 2023, a total of **141879 doses of frozen semen** were produced.

Month	MU	SW	TP	GIR	KF	KS	Total
January	5744	4050	700	0	1380	0	14874
February	6204	6048	840	180	1420	0	14692
March	8945	480	0	0	0	0	9425
April	4934	0	240	0	600	0	5774
May	5164	9720	2740	1160	1640	0	20424
June	1600	1620	460	0	200	0	3880
July	7146	5140	720	240	1370	0	14616
August	8224	7000	1320	0	960	0	17504
September	7320	1000	1460	0	540	0	10320
October	6160	960	580	0	0	0	7700
November	13290	3980	700	480	1480	0	19930
December	2740	0	0	0	0	0	2740
Total	**77471**	**42998**	**9760**	**2060**	**9590**	**0**	**141879**

Dissemination of superior germplasm

The centre is disseminating superior male germplasm for genetic improvement programme of cattle and buffaloes. During year 2023, ABRC disseminated 141490 ml dose of liquid semen of Sahiwal, KF and Murrah bulls to local farmers and also disseminated/ supplied 113363 doses of frozen semen of Sahiwal, Tharparkar, KF and Murrah bulls to farmers, students and various development organizations/Institutes/ Gaushalas of different states.

Month-wise dissemination of semen doses in year 2023

Month	Liquid semen doses (ml) to Farmers	Frozen semen doses disseminated to Farmers/Institutes/Dairy Development Agencies/Project students Research
January	11640	6936
February	10800	12479
March	10845	9047
April	10715	5526
May	12080	5032
June	9925	5251
July	10380	19453
August	9860	4470
September	14160	11955
October	15045	17413
November	13515	9584
December	12525	6217
Total	**141490**	**113363**

FORAGE PRODUCTION SECTION

The primary responsibility of the Forage Production Section is to ensure the consistent production of a sufficient quantity of high-quality green fodder to fulfill the nutritional needs of the Institute's herd. This is particularly more crucial during the lean periods of May to June and November to December when there is a peak in green fodder scarcity. To achieve this, the center focuses on adopting perennial grasses and high-value dual-purpose crops that offer year-round fodder supply with comparatively lower maintenance and costs, promoting a sustainable approach.

Beyond addressing the immediate daily fodder requirements, certain areas are allocated for the production of fodder seeds and other grain crops. This serves a dual purpose: supporting the Institute's technology transfer programs by providing necessary resources and contributing to the feeds component, while also generating revenue. This multifaceted approach ensures the effective management of forage resources, meeting both immediate needs and contributing to the long-term sustainability and financial viability of the Institute.

Fodder/ Feed Production and Supply

In the year 2023, the Forage Production Section achieved significant milestones in fodder production. A total of 243092.00 quintals of high-quality green fodder, 10,778.00 quintals of dry fodder, and 1009.65 quintals of straw successfully produced. This accomplishment was made possible through the cultivation of high-yielding varieties of fodder crops such as Maize, Sorghum, Napier Grass, Cowpea during the *Kharif* season, and Berseem, Oats, Mustard, Chinese cabbage, and winter Maize during the *Rabi* season.

In addition to fodder crops, the section also focused on the cultivation of seed/grain crops including Maize, Oats, Wheat, Mustard, Sorghum, Bajra, and Berseem, resulting in a total production of 5,630.93 quintals of grains. The produced fodder played a vital role in sustaining the Institute's cattle herd and other sections. Throughout the period, a total of 253,870 quintals of fodder, comprising 243092 quintals of green fodder, 1,009.65 quintals of straw, and 10,778 quintals of dry fodder, supplied to the cattle yard, ABRC, and other sections. This consistent and substantial supply contributes to meeting the nutritional requirements of the Institute's livestock while supporting various sections and activities within the organization.

LIVESTOCK RESEARCH CENTRE

The total milk production of the herd during the current year was 695696.1 kg. The production performance of the crossbred strain developed by the NDRI Karan Fries was 12.4 kg per head per day, respectively. The milking average of Sahiwal cows 5.6 milking average of Gir Cows and Murrah buffaloes was 3.9 and 7.7 kg per animal per day, respectively. One Sahiwal cow (SW-2288) produced best milk yield of 20.5 kg in peak lactation. Best yield in Murrah buffalo (MU-6846) was 16.0 kg per day during the current year. The peak milk yield by the KF crossbred cow was 25.5 kg (KF-7737), respectively

Month-wise Milking Average (Kg.) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal 2023 (01.01.2023 to 31.12.2023)

Months	Cows Buffaloes Goats													
	Sahiwal		Tharparkar		Gir		Karan Fries		Murrah		Alpine x Beetal		Sannen x Beetal	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
January	68	4.6	16	3.7	29	3.2	54	11.3	98	7.9	95	1.2	28	1.1
February	63	6.3	19	3.1	26	4.0	51	12.1	93	8.1	91	1.2	26	1.1
March	68	6.1	18	3.9	19	3.4	53	11.6	86	7.6	59	1.3	20	1.4
April	71	6.5	09	7.2	20	3.3	48	13.3	79	7.8	48	1.3	18	1.4
May	78	6.3	14	7.1	22	3.8	36	15.9	71	7.2	47	1.3	18	1.3
June	75	5.8	17	6.9	19	4.2	37	14.3	64	6.8	45	1.0	17	1.0
July	73	5.5	22	5.7	17	4.0	40	13.8	57	6.4	33	0.7	12	0.8
August	72	5.1	24	5.2	18	3.5	47	12.5	60	6.3	11	0.7	06	0.7
September	69	5.0	24	5.0	18	3.5	55	11.2	74	7.1	09	0.8	05	0.9
October	72	5.5	21	5.2	14	4.3	60	11.0	79	8.1	21	1.2	12	1.2
November	74	5.0	20	5.0	16	4.3	62	11.2	83	8.7	24	1.5	12	1.6
December	73	5.1	21	4.0	15	5.0	59	12.5	85	9.0	24	1.3	10	1.5
Average	**71**	**5.6**	**19**	**5.0**	**19**	**3.9**	**50**	**12.4**	**77**	**7.7**	**42**	**1.2**	**15**	**1.2**

(1)= Av. No of animals in milk per day, (2)= Milk Yield Av. (kg) per Animal per day

Bovine Strength of Cattle and Buffaloes as on 31-12-2023

Age group	Cattle						Buffaloes	Total Bovines
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total	Murrah	
Male up to 6 months	16	7	3	-	13	39	31	70
Female up to 6 months	25	4	7	-	17	53	33	86
Heifers	141	65	72	7	70	355	124	479
Cows/ Buffaloes	171	44	45	1	112	373	138	511
Young Male Stock	37	11	21	-	9	78	14	92
Bulls	35	9	11	-	14	69	-	69
Teaser Bull	-	-	-	-	-	-	2	2
Total	**425**	**140**	**159**	**08**	**235**	**967**	**342**	**1309**

Flock Herd Strength of Goats as on 31-12-2023

Age Group	Alpine x Beetal	Sannen x Beetal	Total
Female			
Kids upto 12 months	12	10	22
Yearling	73	24	97
Goats	32	15	47
Male			
Kids upto 12 months	17	05	22
Bucks	64	27	91
Total	**198**	**81**	**279**

Total milk production during the year - 695696.1 kg

Average No. of animals in milk per day cattle - 159

Buffaloes - 77

Goats - 57

Performance of Dairy Animals during the year 2023 (01-01-2023 to 31.12.2023)

Particulars	Genetic Groups							
	Sahiwal	Tharparkar	Gir	Karan Fries	Total cattle	Murrah	AXB Goats	SXB Goats
Average number of animals in milk per day	71	19	19	50	159	77	42	15
Average number of dry animals per day	97	35	31	50	213	58	12	05
Milking average (kg) per day	5.6	5.0	3.9	12.4	7.5	7.7	1.2	1.2
Overall average (kg) per day	2.4	1.8	1.5	6.2	3.2	4.4	0.9	0.9
Best yield (kg) in a day	20.5	14.5	12.5	25.5		16.0	2.7	2.5
Animal Number	**2288**	**1362**	**32**	**7737**		**6846**	**490**	**308**

EXPERIMENTAL DAIRY

Experimental Dairy was setup in this Institute in 1961 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 requirement of research and teaching, the plant is used for converting the surplus milk into variety of dairy products. During the year 2023, 553634 kg of milk was supplied to Experimental dairy from LRC, from which Experimental dairy manufactured and sold Skimmed Milk Powder (Roller)-17900.0 kg., Pasteurized table butter (200 gm) – 1003 pkt, Ghee 14079 kg, Paneer 34035.25 kg, Kalakand – 29149.0 kg, Ice–cream (100 ml) – 68021 cups, Flavoured Dairy Drink (200 ml) - 265107 pkts, Processed Cheese Slices (200 gm) – 808 pkt, Gulab Jamun Mix 4812.5 kg. Pizza Cheese (200 gm) – 1915 pkt, Cheddar Cheese 9.5 kg, Khoa – 653.5 kg, Table cream (20%fat) – 28 kg, and Cooking Butter – 6.0 kg.

Experimental Dairy provides facilities for practicals, teaching and training to students and research facility to scientists of NDRI Deemed University. It also provides training facility to outside students of various universities/ colleges and entrepreneurs from across the country in the dairy field. Six students from several institutions were provided practical training during the year 2023 in the experimental dairy.

COMPUTER CENTRE

The Computer Centre was established in 1982 with the aim to provide scientific data processing facilities to scientists and research scholars of the Institute. Over the years, the Centre has expanded its activities in line with the rapid advancements in ICT field to face the new challenges. The Centre has by now successfully inculcated Computer culture in the Institute by organizing training programmes/ workshops. The activities of Computer Centre are being carried out through three units, namely, Data Processing Unit; Teaching & Training Unit, and Computer maintenance Unit besides AKMU Cell and BTIS Sub Centre. The Centre also includes an ASRB Lab and a PC Lab where more than 130 systems are currently working and well equipped with an i3/i5, heavy duty Line Matrix Printer and software like MATLAB, SYSTAT, etc. NKN Connectivity 1 GBPS link with more than 300 Mbps speed is provided at NDRI offices and library. The network is utilized for various official purposes. Apart from this, the library is providing Internet/ Email Services to students, faculty members and other staff members of the institute. For this purpose there are 40 work-stations available in the library, so that students may have easy access to current information in the area of their interest and communicate with the researchers of their interest immediately. Our Kaveri, Alaknanda, and Narmada hostels are now fully Wi-Fi enabled, allowing students to conduct research-related work from their hostels. This upgrade has significantly enhanced the academic environment by providing seamless internet access for studies, research, and other educational activities. A dedicated mail server with the domain *ndri.res.in* has been created for the students. This server is maintained by the Computer Centre and it is ensured that all students have reliable and secure email communication for academic and administrative purposes. The servers' maintenance includes regular updates, security checks, and support to ensure uninterrupted service. Server room, web server and mail server for smooth internet functioning of NDRI are also maintained by the Computer Centre.

NATIONAL LIBRARY IN DAIRYING

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 36 scientific periodicals were subscribed to keep track of the current scientific/technical developments. There are 98,447 volumes which include books, bound journals, theses, standards and annual reports. In addition of that 1687 e-books of different foreign and Indian publishers were made available for perpetual access at NDRI Campus. Library has an excellent computer section having fifty workstations for students and staff of the institute. Students use these to get current information in the advanced research areas and for communication.

The library provides Internet, Email, Documentation, Reference, Current Awareness Services, CD- ROM Literature scanning through CD-ROM of CAB Abstract, Food Science Technology Abstract, AGRIS, Derwent Biotechnology Abstract, Indian Standards and ISO Standards on food products including milk and dairy products on CD-ROM. The library also provides Photocopying, Document Scanning, Printing and Computerised Issue-Return and reservation facilities.

The library is an active partner CeRA (Consortium for e-Resources in Agriculture) and provides single point search for consortia subscribed, Library subscribed and open access journals to its users under institute's IP addresses.

CeRA Usage Report-2023

1.	Total Hits	28003
2.	Total Logins/ Sessions	2215
3.	Searches	12943
4.	Full Text/ Abstract Views	4063
5.	ILL Requests/Enquiries	60
6.	TOC Browsing	4253
7.	Profiles Created	5
8.	Others Usage	3283

Provides instant Document Delivery Services to users of ICAR sister Institutes, State Agricultural Universities and other participating Institutions on their request.

The Library is also an active partner of Agricat (a sub-portal under WorldCat). Presently 53,341 catalogue records of Library, NDRI available on Agricat/ WoridCat and all the users worldwide participating institution may access catalogue records of national Dairy Research Institute though URL: http://www.worldcat.org or www.agricat.worldcat.org.

Presently ~ 7172 digitized records, which includes valuable books, institutional publications, M.Sc. and Ph.D. Dissertations, reports, conference proceedings and ~ reprints etc. on Krishi Kosh-Institutional Repository of Indian National Agricultural Research System. In addition of above complete online library catalogue is also available on URL: library.ndri.res.in by using Koha-Library Management System.

COMMUNICATION CENTRE

Video Lab: The Video and Photo Lab works as a Central facilities of the Institute, it provide the facilities of audio video editing, recording of audio, video clipping, dubbing & mixing were extended to the students; staff, scientists. The video coverage was done during 11 events of the Institute consisting of National dairy Mela, Convocation, National seminars, Workshops, meetings, conferences, cultural programme, Kisaan Sangoshties, Exhibition, Swachhta Pakhwada, Educational visits of farmers and students. The Re-edit NDRI song that is being shown to the various visitors, farmers, National and International dignitaries, trainees from KVK during their visit to NDRI Karnal.

Photo Lab: The Photo Lab works related to digital photography, cataloguing of photographs. Photographic coverage of National / International workshops, seminars, symposium, extension activities, KVK activities, visit of VIPs high dignitaries, CD / DVD preparing, scanning of photographs, maintenance of photo laboratory including; management of colour photography printing, consultancy of photography to the scientists / students of the Institute and preparation of album, provide photographs for NDRI publication/website ICAR and VIP visits during. The photography was done covering 210 events during the reported period.

Exhibition Unit: This unit provides the hall to organize various programs like cultural activities of students, Hindi cell meeting, NAHEP programme, official meeting of ICAR-NDRI officials and training purposes from time to time.

It displays models of all breeds of cows and buffaloes, posters of the latest research of the institute and also shares the latest research information about our institute with the visitors. A total of 316 groups with 23976 visitors visited the exhibition unit during Jan. to Dec. 2023.During this period, the unit organizes 16 exhibitions all over in India.

MAINTENANCE ENGINEERING SECTION

In the year 1979, the Institute took over the maintenance works from CPWD and UHBVNL. The Institute created an in-house centralized maintenance facility named as Maintenance Engineering Section to operate the essential services of electric supply, water supply and sewerage water disposal. This section provides maintenance services of all kinds to the whole institute.

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE

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

Mandate of ATIC

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

Dissemination of Technological Information:

ATIC-NDRI is using following approaches for disseminating agricultural and dairy information to its intended users:

1. Personal interaction with visiting farmers
2. Display of Models etc; organizing /participating in Melas and Exhibitions
3. Audio/Video shows
4. Visits to Dairy farm
5. Information through toll free telephone number (1800-180-1199)
6. Selling publications
7. Providing input like improved seed varieties, vermicompost, etc.
8. Through emails

Services rendered in Agricultural Technology and Technology Products during 2023

S. No.	Detail of services	No. of Services	No. of Persons
1.	Dairy/Agriculture related information through Video show and Lecture	86	3896
2.	Personal Discussion with Subject-Matter-Specialist on Dairy Farming	206	528
3.	Information through Dairy/Agriculture Literature	145	272
4.	Information on Agriculture (Seed/Fertilizer/Compost etc)	2602	3644
5.	Information through telephone (Toll-free) on Agriculture &Dairying etc.	670	670
6.	Information through e-mail on Agriculture & Dairying etc.	112	112
7.	Information through what app group on Agriculture & Dairying etc.	54	965
	Total	**3875**	**10087**

Training cum exposure visits organized

Title of the course	Sponsor	Date	Participants
Management of Dairy Animals	CDTRI, Meerut	22-06-2023	46
Livestock Production	GYVM, Kaithal	04-09-2023	50
Livestock Production	GYVM, Kaithal	05-09-2023	29
Rearing of Dairy Animals	Ambuja Foundation, Roorkee	21-12-2023	20

MODEL DAIRY PLANT

A state-of-the-art commercial Dairy Plant was established in 1996 at ICAR-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 initially and is presently handling 1,40,000 – 1,50,000 liters per day. Model Dairy Plant is presently certified under the Food Safety Management System ISO 22000:2018.

Model Dairy Plant at ICAR-NDRI, Karnal

Special Features

Model Dairy Plant provides Six Months 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 I.C.A.R., is independently managed by a committee, whose Chairman is the Director of NDRI.

Procurement of Milk

MDP does not have its own infrastructure for milk procurement and is receiving milk on behalf of Mother Dairy Fruit and Vegetable Ltd. from the new generation cooperatives of Punjab, Rajasthan etc. The average milk procurement is 1.40 lacs liters per day, which is sufficient to meet day to day demand of different milk variants like Full Cream Milk (Premium), Full Cream Milk, Toned Milk, Double Toned, Super T, Cow Milk being packed at MDP.

Liquid Milk Processing and Packaging

Model Dairy Plant is currently engaged in processing and packaging of milk for Mother Dairy in different variants (Full Cream(Premium), Full Cream, Toned Milk, Double Toned Milk, Super T and Cow Milk). MDP is presently processing and packing 1,50,000 LPD of polypack Milk in all the varieties for Mother Dairy Fruit and Vegetable Pvt Ltd, Delhi. The plant is running in three shifts and the supplies from MDP are dispatched in the evening and morning to Delhi market and nearby cities thereby utilizing the plant to more than its full capacity.

Ghee Manufacturing

MDP manufactures Cow Ghee from Cow Butter purchased from different State Federations and its production is taken as per demand. The average production/sale of ghee is 45-50 metric tons per month. All the Ghee manufactured at MDP is being sold through the MDP Sale Counter.

Cheese and Paneer

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.

Pinni Manufacturing

Pinni launched in the thirteenth Convocation of N.D.R.I. Deemed University on 14th February 2015 and developed by the students of batch 2010-14. Total Sale of Pinni was 64.6 metric tons from January 2023–December 2023.

Training to the Students

Model Dairy Plant provides In-plant training to the 4th B.Tech. (DT) students of NDRI Deemed University. The students are provided with In-plant Training Manual comprising of unit wise operation covering all the sections of the Dairy Plant. Since its inception in 1996, Model Dairy Plant has provided training to twenty five batches of B.Tech. (DT) students. The student trainees are provided Rs.1500/- per month as stipend. So far, 632 students have been trained at MDP. Students are given hands on experience for plant operations and are trained to manage the shift activities of the plant under the guidance of trained technical staff. In addition to the above, students are also made to involve in other activities like KAIZENs, Small Group Activities etc. The feedback regarding Inplant Training, from the student's trained at MDP and now working in different capacities with different organizations is quite positive and encouraging.

Highlights of MDP in the year 2023

1. New High Speed Packing machine of capacity 12000 pouches per hour installed.
2. New product Elaichi Kulfi launched.
3. New product multi grain Pinni launched.
4. New Appointment of General Manager. Cleaning Cream Separator of 10 KL installed.
5. High Speed Milk Packing Machine installed.

18. REGIONAL CAMPUSES

Southern Regional Station, Bengaluru

Southern Regional Station of National Dairy Research Institute (NDRI) is located at Bengaluru, Karnataka. Southern Regional Station of NDRI has the distinction of being the origin of this great institute. NDRI was established as Imperial Institute of Animal Husbandry and Dairying in the year 1923 as a Centre for training and research in dairying in the country. This Centre was the first to initiate training in artificial insemination in cattle in the country and research in different fields of dairy production and processing in India. A two-year course leading to Indian Dairy Diploma (IDD) was started as back as in 1923 and it is a matter of pride that the Alumni of the Institute served at various capacities for the development of dairy sector in the country. One of the memorable events of the Imperial Institute was the visit of Mahatma Gandhi in 1927 who got acquainted with scientific dairy farming. After independence, Imperial Dairy Research Institute was renamed as Indian Dairy Research Institute. The activities of the institute were further strengthened during 1952-54 by locating a Central Artificial Insemination Centre, Key Village Scheme and Southern Regional Animal Nutritional Research Centre at Bangalore. Indian Dairy Research Institute was reorganized in 1955 and renamed as National Dairy Research Institute with headquarter at Karnal. The establishment at Bangalore was re-designated as Southern Regional Station of NDRI. With a total strength of 25 scientific faculties, the station is engaged in teaching, research, training, and extension in the field of dairy production, dairy engineering, dairy processing& technology, dairy extension, economic and statistics. This natural green campus is endowed with necessary infrastructure in terms of farmland of about 21 ha, dairy herd of about 300 animals comprising Deoni, Malnad Gidda cattle & HF Crossbred cattle, laboratories are supported with basic and modern equipment, experimental dairy plant, library, staff dispensary, and students hostel & guest house facilities.

The Station functions with the mandates focused on the region issues viz. 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 and establish centers of advanced studies for R & D and HRD with the Station as the Southern Campus of NDRI Deemed University. This station caters the needs of southern states of India through the following objectives viz. i) Faster multiplication of superior germplasm of region-specific breeds of cattle and buffaloes through interventions, ii) Process up-gradation for the industrial production / packaging of region-specific dairy products, iii) Establishment of the regional referral Centre for quality assurance of dairy products, v) Economic analysis of various aspects of dairying and establishment of data bank for strategic development of dairying in the region, v) Establishment of model villages with integrated development focused on dairying, vi) Transfer of technologies suitable for the crop-livestock production systems prevalent in agro-climatic conditions of the region, viii) Training of farmers and industrial entrepreneurs at technology development centers, and viii) Undertake advanced HRD programmes to meet the needs of the industry.

EXTENSION

Resource Generation in terms of Consultancy Services provided and sponsored research projects

- Contract research project 2022-24: Efficacy of rumen protected choline and methionine in crossbred cows on health and milk production. M/s Indian Herbs Pvt. Ltd., Chandigarh/Pune/Sahranpur (Rs. 9, 54,000 + Product supply)

Extension programmes of Dairy Extension

- Awareness camp on Animal Health and Mastitis Management under the Farmer FIRST project (Lead Centre: ICAR-NIANP, Bengaluru) at Gangasandra village, Rural Bengaluru district on 09.06.2023.
- New product "Ragi Choco Spread" - Ragi incorporated convenient food containing 15% of milk protein and 7% Ragi flour was launched at SRS of ICAR-NDRI milk parlour on 16th June 2023 on "by the Director, ICAR-

NDRI, Karnal in the presence of Head, SRS, faculties and other staff. The Technology/product was developed by: Dr. Devaraja, H.C., Dr. Jayaraj Rao, K., Dr. Monika Sharma, Dr. F. Magdaline Eljeeva Emerald.

Launching of new dairy product "Ragi Choco Spread" by the Director, ICAR-NDRI at Milk Parlor of SRS of ICAR-NDRI, Bengaluru on 16th June 1923

MOOCs on Commercial Dairy Farming

The MOOCs was developed under ICAR-NDRI- NAHEP project on "Incentivizing Dairy Education through Innovative Learning Approaches". ICAR-NDRI and ICAR-NAARM partner together in developing digital content for offering MOOC on 'Commercial Dairy Farming' for the benefit of dairy farmers and entrepreneurs. The digital content was offered to the farmers/entrepreneurs and students during February 01–March 31, 2023.

Advisory services

- Advisory services were rendered to 358 clienteles during their personal visits to the institute and also through the digital media, phone and mail enquiries. The profile of the advisory services comprised, technical advice on scientific dairy farming, management of indigenous dairy cattle, hydroponic green fodder production, improvised cattle feed and preparation of milk & milk products, consultancy for establishing dairy farm, scientific management of crossbred dairy cows and Murrah buffaloes, scientific feeding of dairy cows and training programme on processing of milk & milk products.

Visitors

- The profile of visitors to the institute comprised 1299 visitors in 31 batches of 962 students, and 337 farmers, from various Districts of the State and neighbouring States. The visitors were briefed about the on-going research and extension activities and were taken around the institute as per their needs.

Training programmes organized

- An Exposure cum training programme was organized for 80 farmer trainees comprising farmers, farm women and farm youth from Sholapur, Maharashtra under 'Support to State Extension Programs for Extension Reforms' (SSEPERS) under Agricultural Technology Management Agency (ATMA) scheme. The farmer trainees were sensitised about quality milk production, clean milk production and dairy animal health care through lecture presentations in local language by the faculties. A demonstration was done on use of CMT kits for Mastitis Management. Visits were organized to Livestock Research Centre and Experimental Dairy Plant for the benefit of farmer trainees.
- Training programme / Student Ready Dairy Work Experience was organized for the benefit of B. Tech II Year Students from College of Food & Dairy Technology, TANUVAS at SRS of ICAR-NDRI during 10.4.2023 to

15.5.2023. A total of 20 students, in four batches underwent, practical work experience training on dairy processing & production aspects and exposure visit to diary industry.

Student participants from College of Food & Dairy Technology, TANUVAS at SRS of ICAR-NDRI during 10.4.2023 to 15.5.2023

- Sensitization program on 'Milk and Millets for Health and Nutrition, as a part of International Year of Millets (IYM 2023), was organized for four batches of undergraduate students of Biotechnology, Veterinary Sciences, Food & Dairy Sciences, on exposure visits to the institute. The students were sensitized by the faculties on the importance of millets, milk and milk products for human health and nutrition and were advised to disseminate the information to their peer and clientele groups.
- The Sessions were well-attended by 145 students in four batches. Importance of milk and millets for balanced nutrition of farm families was sensitized among the women self-help groups (SHGs) on Exposure visit (50 no.) to the institute.

ON-FARM OUTREACH PROGRAMS

SCSP project

Farmers Meet and input distribution to the SC farmer beneficiaries of Kolar district of Karnataka

- During the period, various technical inputs were distributed to beneficiary-SC farmers in the adopted villages of Kolar District, Karnataka State, under DAPSC project. Farmers were provided with various critical inputs including feed supplements viz., Concentrated feeds, improved hybrid fodder crop seeds viz., Sorghum CoFs-31 to enhance their animal productivity and income from livestock farming. Further, extension literature depicting monthly advisories on various aspects of improved dairy farming practices were also distributed for the benefit of the farmers.
- Cattle Health cum Infertility Camp was organized in collaboration with KMF officials for the benefit of SC farmers in the adopted villages of Kolar District under SCSP funded IRC project on 2.2.2023.

Dairy Education at Farmers' Door

- The Dairy Education at Farmers' Door was organized in the selected clusters of villages of Bangalore Rural, Ramanagara and Kolar Districts of Karnataka State. During the period organized visits were made by the multidisciplinary team on Second Saturdays to the selected villages. Necessary technical advice was rendered on scientific dairy farming, green fodder production, clean milk production and animal health care to the farmers and farm women at their doorsteps. Focused farm household visits in the adopted villages and interactive sessions with farm families, concerned extension officers, field veterinary officers' and DCS secretaries revealed the problems and issues to be addressed which included, poor milk quality, mineral deficiency, malnutrition, reproductive disorders, repeat breeding, mastitis, bloat, calf mortality, indiscriminate feeding and sub-clinical rumen acidosis. Based on the observed and expressed problems, suitable strategies as institute interventions are being formulated for systematic addressing and solving the problems for the benefit of the farm families.

Outreach programs

- A Guest lecture on, 'Low-cost feed formulation for dairy animals' was provided by the subject matter specialist, to 200 dairy farmers of Tumkur District of Karnataka, in the Training program organized by DAH&VS, Govt. of Karnataka on 13.1.2023.
- A Guest lecture on, 'Nutritional Interventions for Profitable Production in Dairy Farming' was delivered online by the subject matter specialist, to 180 participants comprising, Dairy Extension Officers, Veterinary Officers, Entrepreneurs and Faculties from SAUs for the Online Collaborative Training program on 'Dairy Farming: A Profitable Venture', organized by Veterinary College, Hassan, KVAFSU and MANAGE, Hyderabad from 20th to 22nd June, 2023.

Exhibition participation

- Participated in the exhibition of G20 Technical Workshop on One Health: Challenges and Opportunities, organized in Bengaluru during 29-31 August 2023, for displaying the technologies developed by SRS ICAR-NDRI.

Exhibition stall of SRS ICAR-NDRI during the G20 Technical Workshop on One Health: Challenges and Opportunities, 29-31 August 2023, Bengaluru

- Participated in the National Horticultural Fair 2023, from 22nd to 25th February 2023 at ICAR-IIHR Campus, Hessaraghatta, Bengaluru. NDRI stall depicted updated technical know-how from dairy production & processing for the benefit of the farming community, with participation of farmers, entrepreneurs, research scholars and students from the State.
- Participation in Skill & Innovation Expo organised by Garden City University, Bangalore held on 11th Aug 2023
- Participated in the Dairy Tech India 2023, an International exhibition on Dairy products, Veterinary, Feed & Packaging Machinery, Cold-Chain and Allied Industries held during 25th to 27th August 2023, (3 days) at Bangalore International Exhibition Centre (BIEC), Bangalore.

Participation and Stall of SRS-ICAR-NDRI at Dairy Tech India 2023: an International Exhibition, Bangalore

- Participated in the Krishi Mela 2023 organised by University of Agricultural Sciences, at GKVK Campus, Bangalore during November 17-20, 2023. NDRI Stall depicted key focus areas of improved green fodder production; indigenous breeds of Southern region, quality milk production and profile of milk products of SRS, to benefit the visiting farming community. The event was well-attended by farmers, farm women and farm youth, progressive farmers, entrepreneurs, extension officials, students of schools and colleges, research scholars and general public with a visit profile of more than 10,000 farmers and hundreds of entrepreneurs and during their visit need-based advisory services were rendered to the clientele, with regard to dairy production, processing and management aspects.

Extension literatures prepared

- Extension literature comprising monthly advisories on various aspects of improved dairy farming practices in Kannada language was prepared and distributed to 107 beneficiary SC dairy farm families under SCSP Project.

Dr. Arindam Dhali and Dr. A Kumaresan receiving award during the 38th ISSAR Annual Convention held at College of Veterinary Science, Mannuthy, Kerala, 06.12.2023

Training and Capacity Building (2023)

- **Visit/ Training Abroad**
- Dr. A. Kumaresan, Principal Scientist (Animal Reproduction) underwent two months international training in the lab of Prof. Jonathan LaMarre, Department of Biomedical Sciences, Ontario Veterinary College, University of Guelph, Guelph, Ontario, Canada from 01.06.2023 to 31.07.2023 under the Bill and Melinda Gates Foundation funded Project "Molecular markers for Improving Reproduction of Cattle and Buffaloes.
- Dr. A. Manimaran, Senior Scientist, underwent four months International training for faculty under approved project of IDP-programme of National Higher Education Project (NAHEP) at Department of Animal Sciences, College of Agricultural, Consumer, and Environmental Sciences (ACES), University of Illinois Urbana-Champaign (UIUC), 1207, W Gregory Dr, Urbana, IL 61801, USA during 12-10-2022 to 28-02-2023

Training programmes attended

Name and Designation	Name of training programme attended	Duration	Organizing Institute
Dr. M. Sivaram, Principal Scientist **Dr. Menon Rekha Ravindra,** Principal Scientist **Dr. Sathish Kumar, MH,** Senior Scientist **Dr. Devaraja, HC,** Sr. Scientist **Dr. Shivaswamy,** Scientist	Training programme on "Creating High Performance Organisations"	20th-24th November, 2023	Indian Institute of Management, Bangalore
Dr. S. Jeyakumar Principal Scientist **Dr. Vedamurthy, GV** Scientist	Training programme on "Artificial Intelligence (AI) and Analytics based business strategies: creating business value"	23rd-25th November, 2023	Indian Institute of Management, Bangalore
Dr. D.N. Das, Principal Scientist **Dr. S. Jeyakumar,** Principal Scientist **Dr. Mukund A. Kataktalware** Principal Scientist **Dr. Vedamurthy, GV,** Scientist **Dr. Vairat Amita Dinkar,** Scientist (Sr. Scale)	Online training programme on "Prospectus and Applications of Artificial Intelligence in Livestock Sector"	19th -21st July, 2023	Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana and MANAGE, Hyderabad
Dr. Manoj Kumar C.T. Scientist	National level faculty development programme on "innovative teaching strategies and tools in the digital age"	01st-14th March, 2023	ICAR-NDRI, Karnal
Dr Vedamurthy G V Scientist	21-day online training Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management ECOBASM-2023.	10th-30th Aug, 2023	Organized by Astha Foundation, Meerut (U.P.) India in collaboration with ICAR- Institutes and State Agriculture Universities (SAUs)
Dr. S. Jeyakumar Principal Scientist **Dr. Vedamurthy, GV** Scientist	Training on Electrospinning for Nanofibre Production	18 to 20th December, 2023	ICAR-Central Institute for Research on Cotton Technology (CIRCOT), Mumbai.
S. Subash Senior Scientist	14 days National Level Faculty Development Programme on 'Innovative Teaching Strategies and Tools in Digital Age'	01st-14th March, 2023	Organized by M/s. Scrollwell, Noida in collaboration with MoE's Institution innovation Council
Dr. Basavaprabhu H N Scientist	113th Foundation Course for Agricultural Research Service (FOCARS)	17th July-18th October, 2023	ICAR-NAARM, Hyderabad
Dr. Basavaprabhu H N Scientist	Institutional Orientation Training	19th November-18th December, 2023	SRS-NDRI, Bengaluru

Participation in Workshop/ Seminar / Conferences etc

Name and Designation	Title of workshops, conferences/ symposium/ seminars etc./	Date
Dr. Arindam Dhali Head of the Station	G20 Technical Workshop on One Health: Challenges and Opportunities, ICAR-NIANP, Bengaluru	29-31 August 2023
Dr. D.N. Das Principal Scientist **Dr. Mukund A. Kataktalware** Principal Scientist **Dr. Mamta Chauhan** Senior Scientist	National workshop (online) on 'Lumpy Skin Disease in India: Current Scenario and Future Challenges' organized by ICAR-NIVEDI, Bengaluru	27th January 2023
Dr. D.N. Das Principal Scientist **Dr. Mukund A. Kataktalware** Principal Scientist	State Level Workshop on 'Role of Veterinarians in Augmenting the Rural Economy through Animal Husbandry Practices' organized by Karnataka Veterinary Association, Bengaluru at the University of Agricultural Sciences, Bengaluru.	28th to 29th January 2023
Dr. Monika Sharma Senior Scientist	National Virtual Conference on Food & Health Sciences: The Futuristic Outlook (FHS-23) Online mode	9- 10 February 2023
Dr. P. Heartwin Amaladhas Principal Scientist **Dr. Menon Rekha Ravindra** Principal Scientist **Dr. F. Magdaline Eljeeva** Principal Scientist **Dr. Vairat Amita Dinkar** Scientist (Sr. Scale)	National Level Faculty Development Programme on "Innovative Teaching Strategies and Tools in the Digital Age " Organized by SCROLLWELL in collaboration with the MoE's Institution Innovation Council and Gulzar Group of Institute's Ludhiana (Punjab).	1st March, 2023 to 14th March, 2023
Dr. Laxman Naik N, Senior Scientist	Workshop on SPS-TBT Issues in Export of Milk, Fruits & vegetables Products, Rice, Peanut, Spices and Other Products, Organized by Export Inspection Agency, Chennai, Tamil Nadu	12th April 2023
Dr. Basavaprabhu H N, Scientist	International Conference on Clinical and Applied Microbiology Organized by BioLEAGUES. Online mode	27th and 28th April 2023
Dr. A. Kumaresan Principal Scientist	Annual Meeting of Society for the Study of Reproduction (SSR) and Seminar on "Reproductive Sciences: From Innovation to Impact" held at Ottawa, Canada	11-14, July 2023
	Kerala Veterinary Science Congress & International seminar on "Exploring the boundless Horizons of Veterinary Profession- Unleashing a New Era Worldwide"	18-19 November 2023
Dr. A. Manimaran Senior Scientist	International Conference on "Global Perspective in Ethno Veterinary Herbal Research for Production of Residue Free Animal Products" & first annual convention of Indian Society of Ethno Veterinary Herbal Research at Veterinary College and Research Institute (VCRI-TANUVAS), Orathanadu, Tanjavur, Tamil Nadu.	19-21st July, 2023
Shivaswamy GP Scientist	National Seminar on 'Indian Agriculture @ 75 – Achievements, Challenges, and Way Forward' held at Pondicherry University, Pondichery	July 20-21, 2023
Dr. Vedamurthy G V Scientist	21-day online training Emerging Challenges and Opportunities in Biotic and Abiotic Stress Management ECOBASM-2023. Organized by Astha Foundation, Meerut (U.P.) India in collaboration with ICAR- Institutes and State Agriculture Universities (SAUs)	10-30th Aug, 2023
Dr. Bandla Srinivas, Principal Scientist **Dr. Mukund A Kataktalware** Principal Scientist **Dr. A. Manimaran,** Senior Scientist	International conference on "Feeding the Future through Sustainable Eco-friendly Innovations in Rangeland, Forages and Animal Sciences" at University of Agricultural Sciences, GKVK, Bangalore, India	2-4th December, 2023

Dr. M. Sivaram, Principal Scientist **Dr. A. Kumaresan,** Principal Scientist **Dr. Shivaswamy,** Scientist	XVI Agricultural Science Congress on the theme "Transformation of Agri-Food Systems for Achieving Sustainable Development Goals" Organized by National Academy of Agricultural Sciences and Central Marine Fisheries Research Institute at Kochi, Kerala	October 10-13, 2023
Dr. D.N. Das, Principal Scientist **Dr. P. Heartwin Amaladhas** Principal Scientist **Dr. Menon Rekha Ravindra** Principal Scientist **Dr. F. Magdaline Eljeeva** Principal Scientist **Dr. Vairat Amita Dinkar** Scientist (Sr. Scale) **Dr. S. Jeyakumar,** Principal Scientist **Dr. Vedamurthy, GV,** Scientist **Dr. Manoj Kumar C.T.,** Scientist **Dr. Monika Sharma,** Senior Scientist **Dr. Mamta Chauhan,** Senior Scientist **Dr. S. Subash,** Senior Scientist	One day Sensitization Workshop on " New Education Policy", Organized by SRS of ICAR-National Dairy Research Institute, Bengaluru.	18th August, 2023
Dr. S. Subash Senior Scientist	National Seminar on "Evolving Extension Science towards Secondary Agriculture for Sustainable Development" organized at GKVK, UAS-Bengaluru	22-24th June 2023
	Online mode in the International Conference on 'Global Insights on Research and Development in Agriculture, Horticulture and Allied Sciences' organized by G. H. Raisoni University and Just Agriculture Education Group.	05th-07th October, 2023
	International Conference on 'Dairy Products in Human Health and Nutrition: Innovations and Opportunities' jointly organized by Indian Dairy Association - Tamil Nadu Chapter, and Department of Nutrition and Dietetics, Periyar University, Salem, Tamil Nadu, India.	14th December 2023
	Workshop on 'NARES-Blended Learning Platform (BLP)' Organized by ICAR-NDRI, Karnal on 23.8.2023.	
Dr. MCA Devi, Principal Scientist **Dr. S. Subash,** Senior Scientist	Continuous Education Program series Webinar on 'Open Network for Digital Commerce (ONDC) applications in Dairying'. Organized by IDA-South Zone, Bengaluru.	27th October 2023
Dr. MCA Devi Principal Scientist	Webinar on 'Orienting FPOs on Agri-Infrastructure Fund Scheme (AIF). Organised by Centre for Secondary Agriculture, FPO's and Monitoring & Evaluation, National Institute of Agricultural Extension Management (MANAGE).	21st June 2023
	Webinar on 'Scale up Your Startup with Startup India Seed Fund Scheme (SISFS) by Startup India'. Organised by MANAGE-Centre for Innovation and Agripreneurship.	14th October
	Webinar on 'International Trade opportunities for Indian Dairy Industry'. Organized by IDA (South Zone).	7th November 2023
	Webinar on 'Pradhan Mantri MUDRA Yojana (PMMY) scheme for Micro Entrepreneurs'. Organized MANAGE-Centre for Innovation and Agripreneurship.	25th November 2023
	Webinar on "NABARD Support in Incubation and Agri-Startups" Organised by MANAGE-Centre for Innovation and Agripreneurship (CIA)	2nd December 2023

Dr. D.N. Das Principal Scientist **Dr. Vairat Amita Dinkar** Scientist (Sr. Scale) **Dr. S. Subash** Senior Scientist	Workshop on "Drafting Procedures for Protecting various IPRs with Special Reference to Animal Science" Organized by Institute Technology Management Unit, ICAR-National Dairy Research Institute, Karnal-132001	6th December, 2023
Dr. Sathish Kumar M H. Sr. Scientist **Dr. Priyanka Singh Rao** Scientist	Global Traditional Foods Summit Jain Global Campus, Bengaluru	27- 29 April 2023
	9th International Food Convention AFSTI, CFTRI, Mysore	7-10, December 2023
Dr. Manoj Kumar C.T. Scientist	Innovative smart and safe solutions for agro and marine food processing to achieve sustainable nutritional security '5S', AFSTI, Mysore	5-7th January, 2023
Dr. Arindam Dhali Principal Scientist and Head **Dr. A. Kumaresan** Principal Scientist **Dr. S. Jeyakumar** Principal Scientist **Dr. Vedamurthy, G V** Scientist	38th Annual Convention of The Indian Society for Study of Animal Reproduction and International Symposium on "Frontiers in Theriogenology: Research and Practice" Organized by ISSAR at College of Veterinary Sciences, KVASU Mannuthy, Thrissur, Kerala	6 – 8 December 2023
Dr. P. Heartwin Amaladhas Principal Scientist **Dr. Menon Rekha Ravindra** Principal Scientist **Dr. F. Magdaline Eljeeva** Principal Scientist **Dr. Vairat Amita Dinkar** Scientist (Sr. Scale) **Dr. S. Jeyakumar** Principal Scientist **Dr. Vedamurthy, GV** Scientist **Dr. S. Subash** Senior Scientist	KK Iya memorial lecture on "Global Food Security: Role of Dairying" delivered by Dr. Dheer Singh, Director & Vice Chancellor, ICAR-NDRI, Organized by Indian Dairy Association (South Zone)	4th August, 2023
Dr. Menon Rekha Ravindra Principal Scientist	Brainstorming Session on "Greening of Livestock and Poultry Sector: Policy Options for Developing Sustainable Approaches" Attended and presented a paper on *Energy and water consumption in dairy value chain and sustainable practices*. Organized by National Academy of Agricultural Sciences	1st September, 2023
	International conference on Recent Advances in Engineering Applications for Sustainable Dairying. Attended and presented a lead paper on Engineering Approaches to Make Dairying Sustainable. Organized by College of Dairy Science and Technology, GADVASU, Ludhiana	October 13th-14th, 2023
Dr. F. Magdaline Eljeeva Principal Scientist	57th Annual Convention of Indian Society of Agricultural Engineers on 'Agri-Food Systems' Transformation through Engineering Innovations' & International Symposium on 'Engineering Interventions for Making Millets a Global Food' Organized by ISAE, New Delhi & UAS, Raichur at UAS, Raichur	6-8th November, 2023
	Webinar on Wiley online library: How can it help researchers? Organized by CeRA Consortium	3rd August, 2023

Major Events (Workshops/ Seminars/ Summer Institutes/ Farmers' Day etc. organized at the Institute

- One day Sensitization Workshop on "New Education Policy", Organized by SRS of ICAR- National Dairy Research Institute, Bengaluru, on 18th August, 2023. Organizing Secretaries: Dr. Sathish Kumar M.H. and Dr. Priyanka Singh Rao.
- Workshop on "Drafting Procedures for Protecting various IPRs with Special Reference to Animal Science" Organized by Institute Technology Management Unit, ICAR-National Dairy Research Institute, Karnal-132001.
- Training Programme on "Dairy animal management and value addition to milk at farm level: ways to earn profits" for FPO members (NABARD supported) conducted between Feb. 9-11, 13-15, 20-22, Feb 27 – March 01, 2023. Course Director: Dr. K. Jayaraj Rao, Course Co-Director: Dr. Jeyakumar and Dr. Sathish Kumar M.H.
- Training Programme on "Orientation on Ice cream and Frozen Desserts Business Incubation" AIC-SRS-ICAR-NDRI Foundation supported). September 04–08, 2023. Course Director: Dr. Sathish Kumar M.H., Course Co-Directors: Dr. Devaraja, H. C. and Dr. Manoj Kumar, C.T.
- NAHEP sponsored EDP Training programme on Startup Opportunities in the Dairy Sector December 13-22, 2023. Course Director Dr. Arindam Dhali. Course Co-ordinators: Dr. Sathish Kumar M.H. and Dr. Priyanka Singh Rao.

Faculties and participants of the NAHEP sponsored EDP Training programme on Startup Opportunities in the Dairy Sector December 13-22, 2023

- Organized World Intellectual Property (IP) Day at SRS, Bengaluru and arranged a Lecture on "IP filing at faster speed: How to Proceed" April 26th , 2023 (Wednesday) at 3:00 PM at ICAR-NDRI SRS, Bengaluru. Coordinator: Dr. D. N. Das as I/C Consultancy and Patent Cell, member ITMU ICAR-NDRI.

Celebration of Hindi Week at SRS, ICAR-NDRI from 14-20th September, 2023

- Organized one day programme on Motivational Skills and lecture on 'Psychosocial wellbeing' conducted at Southern Regional Station of ICAR-NDRI, September 13, 2023 for the staff and students of SRS.
- Organized Kisan Diwas and on Farm-Sensitization Program on Scientific Dairying and Swachhata Initiatives for the benefit of dairy farmers in Nayanhalli, Chikkaballapur District of Karnataka State on 21.12.2023.

Swachh Bharat Abhiyan: Clean & Green NDRI initiative

- Under the rural extension programme, Mera Gaon Mera Gaurav, the selected cluster villages in Ramanagara and Bangalore Rural Districts were visited by the scientific team to respective adopted villages and need-based technical advice on various farming aspects and general health and hygiene aspects were rendered to the needy clientele by the multi-disciplinary team. Follow-up visits were made to the adopted villages by the team members to monitor the interventions of the dairy animals treated for reproductive disorders and improved green fodder production.

Education and Training Section at SRS

The coursework for M.Tech. (Dairy Technology) are being conducted at the Campus. The students in the disciplines of Dairy Technology, Dairy Chemistry, Dairy Engineering, Animal Genetics & Breeding, Animal Nutrition, Veterinary Gynaecology and Obstetrics, Livestock Production Management, Animal Biochemistry Agricultural Economics and Agricultural Extension Education are being guided for their Doctoral and Masters dissertation work. Besides, PG students from other Universities are also guided to carry out their internship training. Further, the Station serves as Study Centre for the Post Graduate Diploma in Food Safety and Quality Management (PGDFSQM) of the Indira Gandhi National Open University (IGNOU). During 2023-24, **17** students have registered for their PGDFSQM at SRS-NDRI, Bengaluru.

Scholarships and Fellowships

Scholarship/fellowship	Ph.D. students	Masters students
NDRI Fellowship	27	35
ICAR-SRF/JRF	05 (SRF)	05 (JRF)
UGC fellowships	05	-
Prime Minisiter Fellowship for Doctoral Research	01	-
National Fellowship of Higher Education for ST students	01	

Organized the training program/Student Ready Dairy Work Experience for B.Tech II Year Students from College of Food & Dairy Technology, TANUVAS held during 10.4.2023 to 15.5.2023 at SRS of ICAR-NDRI, Bengaluru.

Organized the in plant training of B.Tech (DT) II Year Students from College of Dairy Science and Technology, Thiruvananthapuram held during 10.4.2023 to 15.5.2023 at SRS of ICAR-NDRI, Bengaluru.

Livestock Research Centre of SRS

The Livestock Research Centre at SRS, ICAR-NDRI is home to a diverse herd comprising Deoni, Malnad Gidda, and HF crossbred cattle. In the year 2023, the collective milk production was 173,621.3 kg. Breaking down the contributions, HF crossbred cattle led the production with 153,825.1 kg, followed by Deoni cattle at 18,498.2 kg, and Malnad Gidda cattle contributing 1,294.2 kg. The average number of milking cows in the herd per month stood at 44 for HF crossbred, 17 for Deoni, and 3 for Malnad Gidda. The total green fodder production, encompassing varieties such as Paragrass, Hybrid Napier, Guinea grass, Fodder Maize, Jowar, and miscellaneous crops like cowpea, Hedge lucerne, and Sudan grass, amounted to an impressive 2,113.85 tonnes for the year 2023. The Parthenium Awareness Campaign was conducted at LRC on August 17, 2023.

Eastern Regional Station, Kalyani

Eastern Regional Station, Kalyani

Eastern Regional Station of National Dairy Research Institute (NDRI) is located at Kalyani, Nadia District, West Bengal. The Eastern Regional Station was established at the Central Dairy in Calcutta. in 1964 and was shifted during 1966 to Kalyani, Nadia district; about 50 km north of Calcutta and was located in the Administrative Building of Kalyani University. The Regional Animal Nutrition Research Centre of the ICAR till then located at Haringhata, West Bengal, was merged with the Eastern Regional Station of NDRI with effect from June 1, 1968. In 1978 the Government of West Bengal granted 100 acres of land at Kalyani where cattle sheds, forage unit, staff quarters etc. were gradually built up. The Station built its own laboratory building and the entire station started functioning within the same campus from May, 1987.

The main objective of establishing the Eastern Regional Station is to identify the major constraints of dairy production in eastern and north eastern India and to offer solutions through research and extension activities to these problems. It serves as a vital link between the NDRI, Karnal and the far-flung areas of the eastern and north eastern regions of the country for transfer of technology developed at the institute and provides appropriate feedback after trial for perfection. The research work undertaken at this station is mainly strategic and applied in nature and the thrust of research is to improve the socio-economic condition of dairy farmers of this region.

EXTENSION ACTIVITIES ORGANIZED UNDER TSP AND SCSP

Health camp for livestock development programme under TSP project

One day programme was organized on Livelihood Improvement of tribal Farmers through Health camp for livestock development programme at A-5 tribal area, Kalyani, Nadia, West Bengal on 03.05.2023 under NDRI-TSP Project Component. Scientists of ERS-NDRI, namely Dr. T. K. Dutta, Dr. S. K. Das, Dr. C.Bhakat and Technical Officer Dr. S. Datta actively participated in the programme. Few intern B.V.Sc&A.H students also actively participated the health camp in full spirit. A Scientists-Farmers' Interaction session was conducted as well. Total 68 tribal farmers benefited through this health camp for rearing their animals. In the camp total 313 goats including kids and 214 poultry were vaccinated and treated to help tribal farmers to rear goat, poultry scientifically and 24 kg of mineral mixtures were distributed among needy farmers. It is expected for higher economic gain by the practicing and resource poor farmers.

Glimpses of Health camps

Development of backyard poultry for increasing tribal farm family income in Nadia district, West Bengal

One day programme was organized to encourage tribal Farmers for development of scientific backyard poultry through Direct Benefit Transfers (DBTs) in ERS-NDRI, Kalyani campus, Nadia district, West Bengal on 23rd August, 2023 under NDRI-TSP Project Component. Beneficiary Tribal farmers of Bir Sidhu Nagar, A/5, Kalyani, A/14, Kalyani and Barajaguli, Nadia district attended the programme. Scientists of ERS-NDRI, namely Dr. Santanu Banik, Head; Dr. T.K. Dutta, PS, Dr. S.K. Das, PS and Dr. A. Mondal, PS, DR. A. Chatterjee, PS, Dr. A. Mohammad, Sr. Scientist actively participated in the input distribution programme. 1600 chicks (40 chicks/farmers, Banaraja variety) along with feed, plastic feeders and waterers were distributed among 40 tribal farmers. 2600 kg of goat feed was

also distributed to 52 tribal old beneficiary tribal farmers in order to increase the production potential of their animals. The initiatives taken by ERS-NDRI would be beneficial for the resource-poor tribal farmers to develop backyard poultry based integrated farming.


Group of Beneficiary Tribal farmers

Development Programme at Tripura for adopting duck farming in scientific way to increase livelihood security

Eastern Regional Station of NDRI A programme on "Livelihood Improvement of NEH Farmers through Livestock Interventions" through Scientist-farmer's interaction meet cum training programme, Input distribution activities and awareness programme was organized on 11-12 July'23 at the Salema KVK, Dhalai, Tripura. The team members Dr. S. K. Das, Dr. A. Santra, Dr. C. Bhakat and Dr. S. Dutta organized the programme in collaboration with KVK, Dhalai, Tripura. During scientist-farmer interaction cum training programme on livestock rearing at the area Dr. S. K. Das had given an overview of the objectives of the NEH programme for upliftment of the socio-economic conditions of the farmers through livestock improvement, Dr. A. Santra and Dr. C. Bhakat discussed about dairy farming on scientific way, their nutritional management and delivered overall management aspects about scientific duck/poultry rearing and Dr. S. Dutta highlighted on diseases aspects of livestock in this programme. Different animal husbandry inputs *viz.* 28 days old Khaki Campbell ducklings, feed, Feeder & Waterer, Vitamin supplements, antibiotic, medicines and mineral mixture were distributed among farmers. All these inputs were distributed to beneficiary farmers of dhalai district of Tripura to help them to rear duckling more scientifically and it is expected for higher economic gain by the practicing and resource poor farmers.


Scientist-farmer's interaction meet at the Salema KVK, Dhalai, Tripura


সালেমায় কৃষকদের নিয়ে কর্মশালা

NDRI, ERS trains, farmers on livelihood

জেলার

সালেমা কৃষিবিজ্ঞান কেন্দ্রে কৃষকদের নিয়ে দুদিনের কর্মশালা অনুষ্ঠিত

2-day prog for 100 poor farmers of Dhalai district held

Ducks and chickens distributed

Newspaper coverage of extension programmes conducted by ERS, Kalyani

ICAR-KVK (ADDITIONAL), NADIA, NDRI-ERS, KALYANI

At present, KVK, Nadia is operating in 64 villages spread across nine blocks including Chakdah, Ranaghat-I, Santipur, Nabadwip, Kaliganj, Krishnanagar-1, Krishnanagar-2, Tehatta-2, and Nakashipara in Nadia districts. During the period of July and October of 2023, more than 5000 farmers benefited from KVK's training, OFT, FLD, and input distribution programs. Additionally, KVK(Addl), Nadia has been serving as a as knowledge resource centre for agricultural innovations, assisting farmers with aiming to enhance the district's agricultural economy.

Glimpses of KVK activities

On Farm Testing (OFT) Conducted:

Following technologies has been tested/ongoing to find out location specific suitability under various farming system.

Date	Crop/Enterprise	Title of OFT	No. of farmers involved
4/1/2023	Rice	Performance evaluation of zinc fertilization and green manuring in rice cultivation	45
11/11/23	Mustard	Performance trial of no-till (utera) mustard cultivation with foliar nutrient application under rice-based cropping sequence	26
12/1/23	Bhindi	Performance trail of Early and Late seasonal Bhindi cultivation with INM practice	22
15/10/23	Coriander	Varietal evaluation of new Coriander varieties under Nadia agro-ecological condition (Acr-1, Acr-2, and AgCr-1)	32
4/4/23	Papaya	Evaluation of highly Productivity & Superior Papaya varieties (Arka Prabhat, Ranchi Selection & Red Lady)	15
10/11/23	Garden pea	Varietal evaluation of garden pea (Arka Chitra, Arka Uttam Arka Ajit and Pusa Pragati)	50
5/5/23	Tuberose	Performance trail of highly fragrance tuberose variety (Bidhan-singdha and Bidhan Ujjal)	15
2/2/23	Sorghum	Cultivation of fodder sorghum for augmenting milk production	17
11/10/23	Maize	Effect of Bio-fertilizers and bio-pesticides on yield potentiality of Maize	15
10/10/23	Tomato	Varietal evaluation of late seasonal tomato	15
5/6/23	Chilli	Varietal evaluation leaf curl resistant chilli	15
		Total	267

Front Line Demonstration (FLD) Conducted:

Following technologies has been popularized successfully among the farming communities of Nadia district.

Date	Crop/Enterprise	Title of FLD	No. of farmers involved
12/2/23	Maize	Cultivation of maize fodder crop through improved package of practice	60
25/6/23	Rice	Promotion of Bio-fortified Rice varieties through improved package of practices	60
12/8/23	Blackgram	Promotion of Black gram (PU-31) through improved package of practices	185
14/11/23	Mustard	Promotion of Indian mustard (DRMR 150-35) through improved package of practice	150
10/4/23	Jute	Promotion of Jute through integrated crop management practices	500
4/4/23	Colocasia	Popularization of Short duration & high yielded Colocasia Cv. Telia	20
10/11/23	Bottle gourd	Popularization of New variety of Bottle Gourd Cv. *Pusa Santusti*	32
6/5/23	Marigold	Popularization of round year production marigold variety Bidhan marigold -1 and Bidhan marigold -2	40
6/4/23	IFS	Promotion of Integrated Faming System for Small & Marginal Farmers of Nadia	10
4/3/23	Elephant Foot Yam	Popularization of Elephant foot yam "Bidhankusum"	15
4/5/23	Pointed gourd	Promotion of Pointed gourd	15
12/11/23	Sweet potato	Popularization of Biofortified sweet potato variety (Bhukrishna)	120
		Total	1207

Training programme

Training programme conducted in agriculture &allied sector for farmer, farm women & rural youths of the district.

S. No.	Title of Training	No. of farmers/youth involved
1	Production techniques of plant propagation & nursery management	18
2	Scientific cultivation of rainy season vegetable crop	36
3	Cultivation of Fruit cultivation under IFS model	35
4	Disease & Pest Management of Plantation crop	32
5	Scientific cultivation of seed spices	35
6	Scientific disease management of Banana crop	32
7	Benefits of enriched straw feeding	38
8	Livelihood improvement of tribal farmers through IFS	27
9	Training cum demonstration programme on use of accelerated jute retting material by using CRIFAF SONA	412
10	Training cum demonstration programme on use of accelerated jute retting material by using NINFET SATHI	517
11	Nutrient management technique by using Liquid fertilizer	110
12	Celebration of Parthenium awareness week	112
13	Scientific cultivation of Black gram	185
14	Techniques of Liquid fertilizer application	50
15	Role of zinc fertilizer in rice cultivation	55
16	Scientific cultivation techniques of fodder oats	84
17	Disease management for livestock farming	266

S. No.	Title of Training	No. of farmers/youth involved
18	Scientific Goat farming	123
19	Weed management	73
20	Scientific cultivation practices of different crops	8
21	Scientific fodder cultivation	360
22	Water management	178
23	Soil health management	63
24	Scientific dairy farming	372
25	Scientific Piggery farming	30
26	Scientific Bee farming	21
27	Scientific cultivation practices of different crops	85
28	Training on Cultivation Technique of Tropical Fruits (Banana, Mango, Guava	40
29	Protective of Cut Flowers Verbena & Orchids	35
30	Training on Scientific Fodder Farming	50
31	Training on Scientific Dairy Farming & Vaccination Camp	44
32	Training on Scientific Plantation Crop Management (Arecanut, Coconuts)	41
33	Training on Exotic Vegetable Cultivation	40
34	Oyster mushroom cultivation	57
35	Scientific Bee-Keeping	37
36	Cultivation of Tuber Crops (Sweet Potato)	36
37	Training on Rejuvenation of old fruits orchards through Pruning	40
38	Training Programme on Scientific Cultivation of Black Gram	88
39	Technique of Fertilizer Application for Enhancing NUE in Kharif Rice	35
40	Training on Nana Urea Use in Kharif Rice Cultivation in Nadia Dist.	20
41	Scientific Goat Farming	20
42	Elephant foot yam Cultivation	36
43	Training Program on Scientific Lintel Cultivation	
44	Training programme on Jal Shakti Abhiyan	40
45	Plant propagation methods	31
46	Natural Farming	37
47	Scientific lentil cultivation	37
48	Cultivation of tuber crops	27
49	Scientific cultivation of bio-fortified rice	30
50	Organic inputs and mushroom	100
51	Commercial Banana cultivation	25
52	Scientific goat farming	25
53	Scientific cultivation techniques of Chickpea	50
54	Preparation techniques of Nutrient enrich rice straw	33
55	Scientific cultivation of mustard	39
56	Cultivation techniques of bio-fortified rice	35
	Total	4485

Livestock Farm

Production & Reproductive Performance of Cattle at ERS- NDRI Herd during Jan-Dec 2023

Particulars	Jersey Cross (2023)
Herd Strength as on 31-12-2022	205
Total Milk Production (Kg)	179776.0
Av. no of Cows in Milk/Day	66
Av. no of Cows In Dry/Day	18
Wet Average (Kg)/Day	7.50
Herd Average (Kg)/Day	5.90
Age at First Calving (Month)	44.0
No. of Inseminated	254
No. of Pregnant	89
Conception Rate (%)	35.0
Service Period (Days)	105
Inter Calving Period (Days)	468
Mortality (%)	4.4

Milk Production Performance at ERS-NDRI, Kalyani Herd (Jan-Dec' 23)

Months	Milk Production (Kg.)	Wet Average (Kg.)	Herd Average (Kg.)	Average FAT %	Average SNF %
January	15767.5	8.20	6.52	5.17	8.94
February	16615.0	8.53	7.15	5.03	8.95
March	17577.5	8.18	6.25	4.67	8.86
April	15493.5	7.40	5.98	4.58	8.84
May	16523.0	8.02	5.93	4.42	8.78
June	15344.5	7.60	5.60	4.47	8.84
July	14359.0	7.57	5.41	4.49	8.74
August	13619.0	7.43	5.74	4.52	8.79
September	13630.5	6.86	5.75	4.53	8.82
October	13711.0	6.61	5.50	4.49	8.86
November	13615.5	6.85	5.60	4.59	8.84
December	13520.0	6.76	5.37	4.86	8.85
Total Milk	179776.0				
Overall Average	14981.333	7.50	5.90	4.65	8.84

Forage Farm

Forage Farm section is engaged in cultivation of quality fodder crops in about 27-30 hectares area and manages harvesting and supply of fodder crops either chaffed or unchaffed to the Cattle Yard. Besides cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machineries including tractors, chaff-cutter etc. There is a small vermi-compost unit used for training and demonstration purpose. There is an agri-meteorological observatory where regular observations are taken for various meteorological parameters like relative humidity, max. and min. air temperature, soil temperature at different depth, wind speed and direction, Rainfall etc. There are more than 1000 plants of teak, sheesham, mango, coconut etc. growing around the Institute premises. Mango and guava based agro-forestry have been developed in the ERS campus. Every year staff of ERS used to plant several saplings of different useful species in the campus. Besides, there is a fodder herbarium for training and demonstration purpose. The Forage Section has necessary facility for covering the theoretical and practical part of training on fodder crop production.

Fodder production and supply to the Institute Farm, ICAR-NDRI-ERS, Kalyani, during 2023 (Jan-Dec.)

S. No.	Particulars of fodders	Quantity (Qtl.)
1.	Maize/Maize+Cowpea/Maize+Guinea	2721.66
2.	Sorghum/Sorghum+Cowpea/Sorghum+Ricebean/Sorghum+Guinea	5465.55
3.	Oats/Oats+Mustard/Oats+Guinea	3264.45
4.	Berseem/Berseem+Mustard	1554.30
5.	Cowpea/Cowpea+Guinea, Bajra	2042.50
6.	Hybrid Napier Grass/Guinea Grass/Para Grass/Hybrid Napier Grass+Guinea	1145.15
	Total	16193.61

Academic Cell

M.Sc. / M.V. Sc. and Ph. D. students of different disciplenes like Animal Nutrition, Livestock Production & Management, Animal Physiology, Animal Reproduction, Animal Biotechnology, Animal Genetics & Breeding and Dairy Extension are alloted to pusue ther disseration/ research work at Eastern Regional station, Kalyani. During the year 2023, six Master degree students and six Ph.D. students have successfully completed their thesis works and awarded the respective degrees. Presently,six Master degree students and eighteen Ph.D. students are pursuing their research work. Other than academics, some sports and literary acivities were organized in which students took keen interest.

Scientists'/Officers' participation in Trainings/Seminars/Conferences

A. Trainings

S. No.	Name & Designation	Name of training programme attended	Duration (days)	Organizing Institute
Scientific Staff				
1.	**Dr. A. Santra** Pr. Scientist	Training on, "Design thinking in agricultural research and education"	October 9-13, 2023	ICAR-NAARM, Hyderabad (online)
2.	**Dr. C. Bhakat** Pr. Scientist	Participated in Hindi online training on "Application of statistical software for analysis of agricultural and survey data"	September 6-13, 2023	IASRI, New Delhi-12

B. Participation in Conferences/Seminars/Workshops/Symposium/webinar within India

S. No.	Name & Designation	Title of the conference/seminar/workshop	Period	Organizing Institute
1.	**Dr. S. Banik** Head	National Conference on "Advances in Genetics and Genomics for Sustainable Livestock Transformation" organized by Indian Society of Animal Genetics & Breeding (ISAGB)	November 16-17, 2023	ICAR-NBAGR, Karnal
		NAHEP International Conference On "Sustainable Innovation in Food Safety, Health & Nutrition" (SInFoCoN-23)	December 22-23, 2023	ICAR-World Bank funded NAHEP & Faculty of DT, WBUAFS
		International Conference on "Sustainable Innovation in Food Safety, Health&Nutrition" under NAHEP project	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS
		One day conclave on "National Education Policy-2020: preparedness of dairy and animal science higher education institutes (HEIs).	December 23, 2023	ICAR-National Dairy Research Institute, Karnal
2.	**Dr. T.K. Dutta** Pr Scientist	NAHEP International Conference on "Sustainable Innovation in Food Safety, Health and Nutrition-SInFoCoN-2023)	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS
3.	**Dr. S.K. Das** Pr. Scientist	Attended the NAHEP International Conference On "Sustainable Innovation in Food Safety, Health & Nutrition" (SInFoCoN-23)	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS

4.	**Dr. A. Santra** Pr Scientist	Attended the International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023)	December 19-20, 2023	CDAC, Kolkata and University of Calcutta
		2nd International conference on, "Prospects and challenges of environment and biological sciences in food production system for livelihood security of farmers	September 18-20, 2023	ICFPLS-2023 at ICAR-CIARI, Port Blair, Andaman and Nicobar Islands.
5.	**Dr. C. Bhakat** Pr. Scientist	Attended National symposium on "Challenges to animal resource development keeping in view the increasing need of animal produce to resolve protein hunger".	January 10-11, 2023	WBUAFS Kolkata (WB)
		Attended the International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023)	December 19-20, 2023	CDAC, Kolkata and University of Calcutta
		Attended the International Conference On "Sustainable Innovation in Food Safety, Health & Nutrition" (SInFoCoN-23)	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS
6.	**Dr. A. Mandal** Pr. Scientist	National Conference on "Advances in Genetics and Genomics for Sustainable Livestock Transformation" organized by Indian Society of Animal Genetics & Breeding (ISAGB)	November 16-17, 2023	ICAR-NBAGR, Karnal
		International Conference on "Systems and Technologies for Smart Agriculture (ICSTA 2023)"	December 19-20, 2023	CDAC, Kolkata & University of Calcutta, Kolkata
		International Conference on "Sustainable Innovation in Food Safety, Health& Nutrition" under NAHEP project	December 22-23, 2023	West Bengal University of Animal & Fishery Sciences, Mohanpur, Nadia, West Bengal
7.	**Dr. D.K. Mandal** Pr. Scientist	International conference on "Sustainable innovation in food safety, health and Nutrition"	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS
		International Conference on "Systems and Technologies For Smart Agriculture (ICSTA 2023)" at Biswa Bangla Convention Centre, Newtown, Kolkata,	December 19-20, 2023	Centre for Development of Advanced Computing (C-DAC) Kolkata, in association with the University of Calcutta,
8.	**Dr. A. Chatterjee** Pr. Scientist	Webinar on Use of GM crops and derivatives for dairy industry	January 31, 2023	ANSI and BCIL
		Attended the International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023)	December 19-20, 2023	CDAC, Kolkata and University of Calcutta
		Attended the International Conference on 'Sustainable Innovation in Food Safety, Health & Nutrition' (SinFoCon-23)	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS
		International conference on "Sustainable innovation in food safety, health and Nutrition"	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS

9.	**Dr. M. Karunakaran** Pr. Scientist	National Steering Committee (NSC) on "National programme on Electronics and ICT Applications in Agriculture and Environment (AgriEnIcs)"	January 17, 2023	MEITY, New Delhi
		National Steering Committee (NSC) of "National programme on Electronics and ICT Applications in Agriculture and Environment (AgriEnIcs)",	December 07, 2023	CDAC, Kolkata at at Sher-e-Kashmir University of Agricultural Science and Technology (SKUAST), Kashmir (on line)
		International conference on systems and technologies for smart agriculture	December 19-20, 2023	CDAC, Kolkata
		International conference on "Sustainable innovation in food safety, health and Nutrition"	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS
10.	**Dr. M. Mondal** Sr. Scientist	Attended the International Conference on Systems and Technologies for Smart Agriculture (ICSTA 2023)	December 19-20, 2023	CDAC, Kolkata and University of Calcutta
		International conference on "Sustainable innovation in food safety, health and Nutrition"	December 22-23, 2023	organized by Faculty of Dairy Technology, WBUAFS,
		31st SAPI Annual Conference & National Symposium (SAPICON-2023) on "Technology Driven Physiological Capacity Building in Livestock for Food Security and Sustainability"	May 3-5, 2023	Organized by Division of Veterinary Physiology, FVSc& AH Shuhama Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir
11.	**Dr. A. Mohammad** Sr. Scientist	Attended the InternationalConference on 'Natural Farming forRevitalizing Environment and ResilientAgriculture (NF-RERA – 2023)'	March 17-19, 2023	College of Agriculture, Iroisemba, Central Agricultural University, Imphal, Manipurwhich wasorganized byCentralAgricultural University, Imphal.
		Attended the International Conference on 'Systems and Technologies for Smart Agriculture (ICSTA,2023)',	December 19-20, 2023	Biswa Bangla Convention centre, New Town, Kolkata, West Bengal which wasjointly organized by C-DAC, Kolkata and University of Calcutta.
12.	**Dr. S. Rai** Scientist	Attended the International Conference on 'Systems and Technologies for Smart Agriculture (ICSTA,2023)',	December 19-20, 2023	Biswa Bangla Convention centre, New Town, Kolkata, West Bengal which wasjointly organized by C-DAC, Kolkata and University of Calcutta.
		International conference on "Sustainable innovation in food safety, health and Nutrition"	December 22-23, 2023	ICAR- World Bank funded NAHEP & Faculty of DT, WBUAFS

19. BUDGET AND EXPENDITURE

The financial outlays in terms of actual expenditure for Grants for the year 2023-2024 was Rs. 27309.92 lakhs and the sanctioned budget for Grants in 2022-2023 was Rs. 27354.02 lakhs. These figures include the financial outlays for regional stations.

Financial Outlays & Expenditure during 2023-2024

Rs. in lakhs

Particulars	Re/Budget (2023-24)	Expenditure (2023-24)
Grant-in-Aid Capital	464.00	420.69
Grant-in-Aid General	4350.00	4349.21
Non Scheme GIA-General	0.00	0.00
Total (Capital+ General)	**4814.00**	**4769.90**
Grant-in-Aid Salary	9790.02	9790.02
Grant-in-Aid Pension	12750.00	12750.00
Total (Salary+ Pension)	**22540.02**	**22540.02**
Grand Total	**27354.02**	**27309.92**

Resource Generation

The revenue receipts of the Institute and the Regional Stations for the year2023-24 were Rs. 1135.89 lakhs.

S. No.	Head of Account	Amount in lakhs
1.	Sale of farm produce	279.31
2.	Sale of Livestock	65.12
3.	License Fee	97.96
4.	Interested earned on loans and Advances	16.68
5.	Leave Salary and Pension Contribution	5.15
6.	Analytical and Testing Fee	8.32
7.	Application fee from candidates	209.41
8.	Interest earned on short term deposits	91.40
9.	Income generated from internal resource generation	72.56
10.	Recoveries of loans and advances	22.39
11.	Miscellaneous Receipts	267.59
	Grand Total	**1135.89**

Position of Manpower at NDRI, Karnal and its Regional Stations with KVKs as on December 31, 2023

Type of Posts	Sanctioned/ Approved Posts	In-Position Posts	Vacant Posts
Director	1	1	0
Joint Director	2	2	0
Scientific	192	137	55
Administrative (Group: A&B)	48	36	12
Technical	237	157	80
Administrative (Group: Non-Gazetted)	94	72	22
Supporting	374	228	146
Total	**948**	**633**	**315**

20. राजभाषा गतिविधियां

भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की वर्ष 2023 की राजभाषा की विभिन्न गतिविधियां

भारत सरकार की राजभाषा नीति के अनुपालन में राजभाषा हिंदी के प्रचार, प्रसार एवं कार्यान्वयन हेतु संस्थान में वर्ष 1979 में राजभाषा एकक की स्थापना की गई। राजभाषा एकक द्वारा संस्थान के अधिकारियों, वैज्ञानिकों, मंत्रालयिक स्टाफ, तकनीकी स्टाफ आदि को राजभाषा हिंदी में कार्य करने के लिए प्रोत्साहित करते हुए हर संभव प्रयास/सहयोग प्रदान किया जा रहा है। संस्थान के द्वारा वर्ष 2023 में निम्नलिखित गतिविधियों का आयोजन किया गया।

संस्थान राजभाषा कार्यान्वयन समिति की बैठकें

1. डा. धीर सिंह, निदेशक, भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति की 01 जनवरी से 31 मार्च, 2023 तक की 98वीं तिमाही समीक्षा बैठक दिनांक 31.03.2023 को अपराह्न 03.30 बजे के साथ संस्थान के डा. एन.एन.दस्तूर सभागार में आयोजित की गयी। बैठक में संस्थान के 32 पदाधिकारी शामिल हुए और उन्होंने उन सभी बिन्दुओं पर चर्चा की जहां हिन्दी के कार्य में गति लाने की आवश्यकता थी।
2. डा. धीर सिंह, निदेशक, भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति की 01 अप्रैल से 30 जून, 2023 तक की 99वीं तिमाही समीक्षा बैठक दिनांक 26.06.2023 को पूर्वाह्न 10.00 बजे के साथ संस्थान के पिनाकी कक्ष में आयोजित की गयी। बैठक में संस्थान के 26 पदाधिकारी शामिल हुए। बैठक में हिन्दी के कार्य में गति लाने वाली बिंदुओं पर चर्चा की गई।
3. डा. धीर सिंह, निदेशक, भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति की 01 जुलाई से 30 सितंबर, 2023 तक की 100वीं तिमाही समीक्षा बैठक दिनांक 04.09.2023 को अपराह्न 3.30 बजे के साथ संस्थान के डा. एन.एन.दस्तूर सभागार में आयोजित की गयी। बैठक में संस्थान के 36 पदाधिकारी शामिल हुए एवं उन्होंने बैठक में राजभाषा हिन्दी से संबंधित सभी महत्वपूर्ण बिंदुओं पर चर्चा की गई।
4. डा. ए.के. सिंह, संयुक्त निदेशक (शैक्षणिक), भाकृअनुप-राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल की अध्यक्षता में संस्थान राजभाषा कार्यान्वयन समिति की 01 अक्तूबर से 31 दिसंबर, 2023 तक की 101वीं तिमाही समीक्षा बैठक दिनांक 14.12.2023 को अपराह्न 3.30 बजे के साथ संस्थान के डा. एन.एन.दस्तूर सभागार में आयोजित की गयी। बैठक में संस्थान के 32 पदाधिकारी शामिल हुए। बैठक के दौरान समिति ने उन सभी बिन्दुओं पर चर्चा की जहां हिन्दी के कार्य में गति लाने की आवश्यकता थी।

हिन्दी कार्यशालाएं, संगोष्ठियां एवं प्रशिक्षण

1. संस्थान के डा.एन.एन.दस्तूर सभागार में दिनांक 21.02.2023 को पूर्वाह्न 11.30 बजे से ''राजभाषा कार्यान्वयन एवं छमाही समीक्षा के आंकड़े भरने संबंधी'' विषय पर आयोजित की गई। एक दिवसीय हिंदी कार्यशाला में संस्थान एवं नराकास कार्यालयों के तकनीकी एवं प्रशासनिक श्रेणी के अनेक अधिकारी एवं कर्मचारी सम्मिलित हुए। इस अवसर पर अपने व्याख्यान श्री धीरज शर्मा उप निदेशक (राजभाषा) ने छमाही प्रपत्र कैसे भरें विषय पर विस्तार से चर्चा की।
2. संस्थान के डा.एन.एन.दस्तूर सभागार में दिनांक 19.05.2023 को अपराह्न 03.00 बजे से ''राजभाषा कार्यान्वयन तथा हिन्दी की तिमाही रिपोर्ट भरने में आने वाली समस्याओं के निराकरण'' विषय पर आयोजित की गई एक दिवसीय हिंदी कार्यशाला में संस्थान के प्रशासनिक और तकनीकी श्रेणी के अधिकारी एवं कर्मचारी सम्मिलित हुए। इस अवसर पर अपने व्याख्यान श्री धीरज शर्मा ने तिमाही रिपोर्ट कैसे भरें (कैसे यथेष्ट सूचना उपलब्ध करायें) पर विस्तार से चर्चा की।
3. संस्थान के डा. एन.एन.दस्तूर सभागार में दिनांक 03.08.2023 को "राजभाषा कार्यान्वयन, समस्याएँ एवं समाधान'' विषय पर तिमाही हिन्दी कार्यशाला का आयोजन किया गया जिसमें संस्थान के 55 अधिकारी एवं कर्मचारी शामिल हुए।

4. संस्थान के डा. एन.एन.दस्तूर सभागार में दिनांक 13.10.2023 को राजभाषा हिंदी एवं उसका कार्यान्वयन, शब्द रचना एवं शब्दावली विषय पर हिन्दी कार्यशाला का आयोजन किया गया जिसमें संस्थान के 121 वैज्ञानिक, अधिकारी एवं कर्मचारी सम्मिलित हुए।

हिन्दी दिवस/हिन्दी उल्लास महोत्सव 2023 एवं वार्षिक पुरस्कार वितरण समारोह

संस्थान में हिन्दी दिवस से प्रारंभ कर दिनांक 19.09.2023 से 13.10.2023 तक की अवधि में राजभाषा हिन्दी उल्लास महोत्सव का आयोजन किया गया। इस महोत्सव के दौरान वैज्ञानिकों, कर्मचारियों तथा विद्यार्थियों के लिए हिन्दी श्रुतलेखन प्रतियोगिता (20.09.2023), हिंदी शोध पत्र पोस्टर प्रदर्शन प्रतियोगिता (22.09.2023), हिन्दी निबंध लेखन प्रतियोगिता (25.09.2023), हिन्दी टंकण प्रतियोगिता (27.09.2023) का आयोजन किया गया।

वर्ष 2023 के दौरान संस्थान की राजभाषा संबंधी प्रमुख गतिविधियां

- संस्थान की हिन्दी की चारों तिमाही बैठकें प्रत्येक तिमाही में एक-एक कर आयोजित की गयीं।
- नराकास, करनाल का सचिवालय होने के कारण नगर राजभाषा कार्यान्वयन समिति की 07 जून, 2023 तथा 07 नवंबर, 2023 में छमाही समीक्षा बैठक आयोजित की गयी।
- संस्थान में वर्ष के दौरान चार हिन्दी कार्यशालाओं का आयोजन किया गया।
- वर्ष 2022-23 के दौरान ''सरकारी कामकाज में मूल हिन्दी टिप्पण/आलेखन योजना'' के अन्तर्गत संस्थान के 15 विजेताओं को नकद पुरस्कार व प्रमाणपत्रों से सम्मानित किया गया।
- संस्थान की ''वैज्ञानिक तथा तकनीकी लेखन प्रोत्साहन योजना'' का नियमित रूप से प्रत्येक वर्ष आयोजन कर विजेताओं को नकद पुरस्कार एवं प्रमाण पत्रों से सम्मानित किया जा रहा है।
- संस्थान में वैज्ञानिकों व विद्यार्थियों के द्वारा हिन्दी में शोधपत्र व पोस्टर बनाने के लिए उन्हें प्रोत्साहित करने के लिए प्रत्येक वर्ष हिन्दी पखवाड़ा/माह के दौरान "*हिन्दी शोधपत्र व पोस्टर प्रदर्शन*" प्रतियोगिता का आयोजन कर सभी प्रतिभागियों को प्रतिभागिता प्रमाणपत्र व विजेताओं को नकद पुरस्कार एवं प्रशस्ति प्रमाणपत्र से सम्मानित किया जाता है।
- संस्थान की राजभाषा गृह पत्रिका 'दुग्ध गंगा' का प्रकाशन किया गया।
- संस्थान के सभी वैज्ञानिकों, अधिकारियों एवं कर्मचारियों के नाम से निदेशक के हस्ताक्षर उपरांत व्यक्तिशः आदेश जारी किए गए।
- संस्थान के 100 से अधिक शोधकर्ता विद्यार्थियों के थीसिस एब्सट्रेक्ट का हिन्दी अनुवाद किया गया।
- संस्थान के लगभग 60 विद्यार्थियों को सप्ताह में तीन दिन हिन्दी संबंधी बुनियादी जानकारी प्रदान की गयी।

हिंदी दिवस समारोह दिवस के दौरान पोस्टर पुरस्कार प्रमाण पत्र प्राप्त करते हुए एक प्रतिभागी

हिंदी दिवस के अवसर पर आयोजित पोस्टर समारोह का एक दृश्य

21. SWACHH BHARAT ABHIYAN: CLEAN & GREEN NDRI

ICAR-NDRI is consistently pursuing vigorous initiatives in order to keep its campus clean and green. It always inspires the rural farming community also to maintain hygienic and healthy environment of their locations under the novel programme, Swachchh Bharat Abhiyan (SBA) led by the Union government. This covers organizing cleanliness campaigns, motivational talks, publications, awareness camps, cycle rally, tree plantation etc. in the Institute campus, places of public importance and as well as in the adopted villages of NDRI. The residents of the Institute's campus and the villagers were also engaged as participants to make the planned interventions as effective and successful. All the scientists, students and staff of the Institute contributed to the mammoth sanitation drive to instil a sense of responsibility among people of all walks of life. Further, in order to inculcate the value of maintaining health and hygiene at household- level, especially among the residents of the campus of the Institute, several eco-friendly dustbins and display boards depicting environmental themes were kept at multiple locations inside the premises of the Institute.

Dr. Dheer Singh and Dr. A. K. Singh with students during cleanliness campaign on 02.10.2023

Awareness Campaigns

Awareness campaigns become regular activities in the adopted villages of the Institute as well as prominent public places. The team of scientists educated the villagers about the wider adoption of the bio-waste management towards processing of bio-wastes into clean and environment-friendly bio-fuels and organic manures. Further, when scientists, technical officers, staff and students of the Institute visited the nearby villages for programmes like field oriented research programmes (Farmers FIRST, DST, NICRA, DAPSC, ICMR, NIF etc); Azadi Ka Amrit Mahotsav; Dairy Education at Farmers' Doors, Farmers' Farm School and Mera Gaaon Mera Gaurav, they gave full emphasis about significance of Swachchh Bharat Abhiyan, in order to inculcate a sense of responsibility for cleanliness among them.

Scientists, students and villagers at Nagla Roron village of Karnal district on 11.10.2023

Faculty and students undertaking campus cleaning

Observation of 18th Parthenium Awareness Week

ICAR-National Dairy Research Institute, Karnal organised a number of activities in connection with '18th Parthenium Awareness Week' during 16-22 August, 2023 to commemorate 75th Anniversary of Indian Independence (Azadi ka Amrit Mahotsava) and in order to create awareness among the residents of NDRI campus and maintain cleanliness. The activities include Parthenium uprooting, releasing Mexican beetles, spraying herbicides, composting of uprooted biomass, students' rallies, demonstrations, exhibitions, etc. During the occasion, the faculty, students, trainees, student visitors were also actively involved in uprooting of parthenium in the campus. It was emphasised that the strategies for control of this obnoxious weed include community mobilization involving all sections of the society, organising regular meetings and demonstrations for awareness creation, uprooting the weed before flowering and making compost by pit method, spraying herbicides like glyphosate (1.0 to 1.5 %) or 2, 4-D (1.0 to 1.5 %) and releasing bio-control agents such as Zygogramma biocolorata in infested areas during rainy season.

Observance of Vigilance Aawareness Week

ICAR- National Dairy Research Institute, Karnal has organized vigilance awareness and farmer interaction meet in Khwaja Ahmedpur Village of Nilokheri Block on 30-10-2023. Dr. K. Ponnusamy, Nodal Officer, Swachh Bharat Abhiyan explained the programme in detail. While welcoming the villagers, and farmers, Dr. Gopal Sankhala, Head, Dairy Extension emphasized the vigilance in every aspect of life including the maintenance of personal integrity and honesty. The vigilance pledge was administrated to all the participants. Dr. T. K. Mohanty advised the dairy farmers to follow the proper timing of Artificial Insemination and quality of semen. He emphasized the compulsory vaccination of dairy animals against brucellosis disease. It is given free of cost at Government Veterinary hospitals. Dr. Chander Datt Sharma prescribed the balanced feeding of animals incorporating carbohydrates, protein, minerals and vitamins along with good quality drinking water. Dr. Magan Singh guided the farmers about new fodder varieties and cultivation techniques. Dr. Virendra Kumar, Veterinary Surgeon of local hospital highlighted the schemes and advisories of Animal Husbandry Department, Government of Haryana. He exhorted the farmers to avail the benefits of cattle insurance and sex semen technology. Mr. Ajit Singh, Assistant Administrator Officer thanked all the participants. The scientists along with villagers participated in the cleanliness campaign in the temple and other public premises.

Vigilance awareness and farmer interaction meet in Khwaja Ahmedpur Village of Nilokheri Block

Special Swachhta campaign

Every division/section/unit in main campus Karnal in Haryana and regional stations at Bengaluru in Karnataka and Kalyani in West Bengal carried out the cleaning, rearranging and other innovative practices involving all

the faculty, staff and students on every day. An innovative approach of maintaining an oxygen park at the NDRI premises could inspire many inmates of campus as well as outsiders after thoroughly cleaning the space.

NDRI carried out 16 special Swachhta campaign with a total participation of 1300 stakeholders. The faculty educated the villagers and farmers about cleanliness, non-use of single use plastics, non-spitting on the road and public places, putting the water bottles and other wastes in dust bins, wearing face masks while going out and in public places and adhering to all Covid-19 guidelines.

Swachhta Pakhwada activities of NDRI

ICAR-National Dairy Research Institute, Karnal has organized Swachhta Pakhwada from 16.12.2023 to 31.12.2023. Various activities including display of banner at prominent places, stock taking and briefing of the activities were organized during the Pakhwada, apart from plantation of trees, taking pledge, organising farmers interaction meets, celebration of Kisan Diwas, competition for school children and college students, campaign on crop residue management. Cleaning of tourist places, disposal of pending files, stock taking of solid waste management, selection of clean division, sections and residential quarters have been organized on daily basis. Awareness was created about the clean India campaign among the visiting students. In addition, the students and faculty have been exposed to the technologies and products of ICAR-NDRI, Karnal. They have been taught on maintaining cleanliness in their own localities and surrounding areas.

Celebration of Swachhta Pakhwada

Meanwhile, the administration and audit wings of NDRI have been motivated to undertake digitization of office records / e-office implementation as well as cleanliness drive like cleaning of offices, corridors and premises. Review of progress on weeding out old records, disposing of old and obsolete furniture's, junk materials and white washing/painting were also conducted. Promoting clean & green technologies and organic farming practices in kitchen gardens in villages under Farmer FIRST Project were given priority on 20.12.2023. Campaign on cleaning of sewerage & water lines, awareness on recycling of waste water, water harvesting for agriculture/ horticulture application / kitchen gardens in villages of Gharunda block were conducted on 21.12.2023.

To comply with date wise Action Plan for Swachhta Pakhwada, 16-31 Dec., 2023 at ICAR-NDRI, a debate programmewas organized in ICAR-NDRI at 11.00 AM on 22.12.2023 on the topic "Swachh Bharat: as mission or mentality". Students from different divisions of ICAR-NDRI, Karnal participated in the debate and presented their views for and against the debate motion. The debate created an opportunity to the students to present their views on the mentioned topic and helped to create awareness among them. Participants highlighted the success of the swachhta programme and its larger penetration in the society by changing group attitude which is beneficial for the society.

Glimpse of the debate on on the topic: "Swachh Bharat: as mission or mentality".

MERA GAON MERA GAURAV (MGMG)

Mera gaon Mera Gaurav (MGMG) is a flagship programme being implemented by ICAR-NDRI as per the guidelines of ICAR since its inception in 2015. At present, 21 teams comprising of 4 to 5 Scientists each from multiple disciplines of the Institute are involved in carrying out the MGMG activities in 124 villages. The major objective of this innovative field oriented extension approach is to promote the 'Direct Interface' of Scientists with the farmers to step up the lab-to-land dissemination process, while providing the farmers with the required information, knowledge and advisory services on a regular basis via adoption of villages. In NDRI, the technical staff and students along with research scholars of different sponsored projects are also being involved as they support the scientists in the field and learn the issues of farmers and solutions. A total of 475 field activities including messages / advisories were conducted in 120 villages benefitting 7258 farmers.

The approach lies in identifying the key resource persons of the village, facilitation of interaction with the villagers though them and taking the feedback from the interaction meetings to the concerned stakeholders for addressing them. Every MGMG team created a Whastsapp group for regular communication with key resource persons. Meanwhile, the field oriented research projects are also linked with MGMG villages for enhancing the visibility of the activities and the institute. Many farm centric interventions have been popularised among the farmers in the MGMG villages.

Although institute centric interventions were given prominence in the interaction meetings, often other stakeholders are also invited for responding to the queries of farmers so that every participant will get satisfied with the MGMG activities. In addition, linkages were developed with 20 organisations from the various streams of rural development.

Activities Organised under MGMG

S. No.	Name of activity	No. of activities conducted	No. of farmers benefitted
1	Visit to village by all teams	73	1625
2	Interface meeting/ *Goshthies*	35	1600
3	Training organized	22	658
4	Demonstrations conducted	25	1200
5	Mobile based advisories	31	300
6	Literature support provided	245	900
7	Awareness programmes	34	975
	Total	475	7258

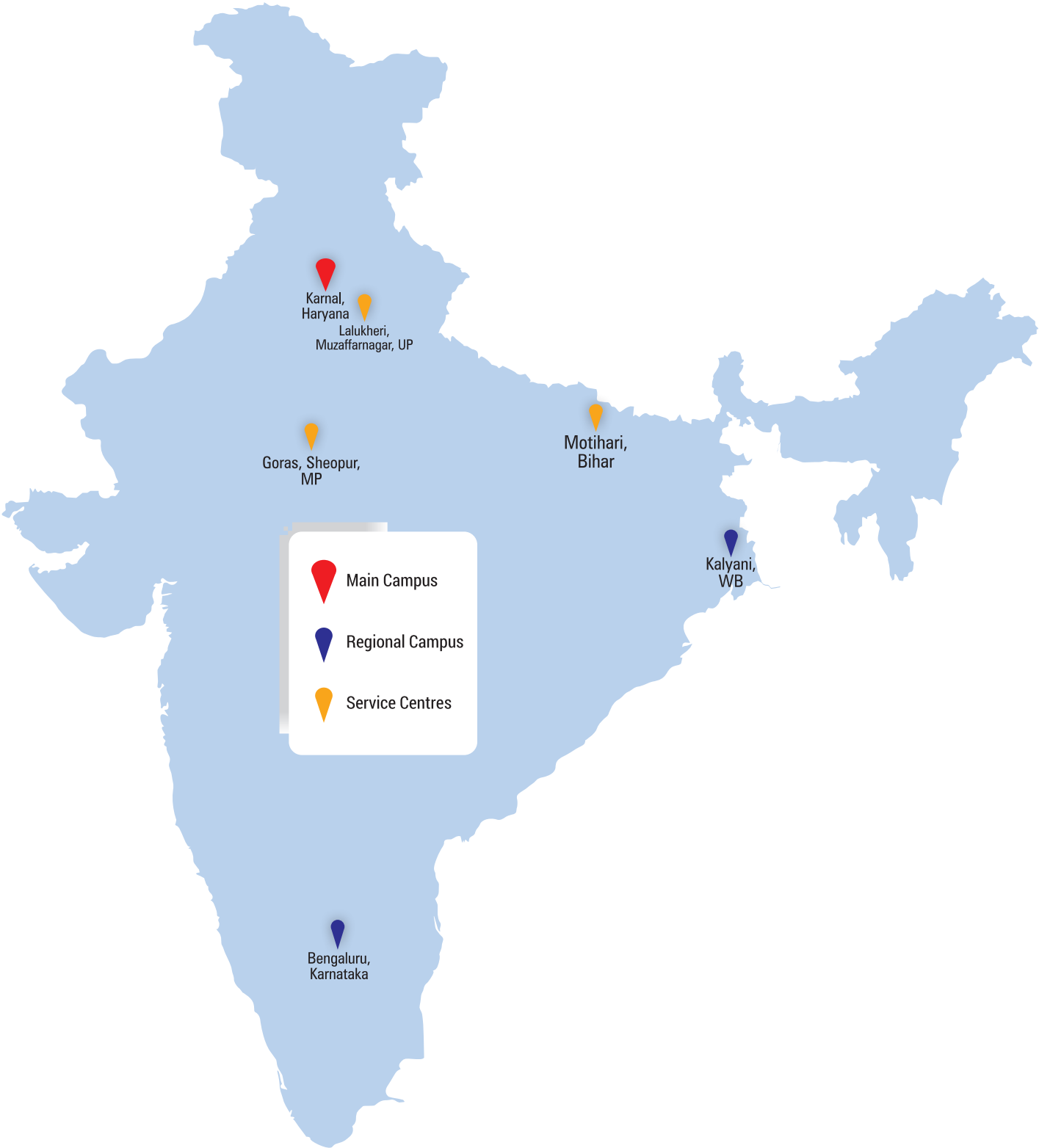
Distribution of inputs to farmers in a MGMG village

Facilitation under MGMG

	Crop	Variety	Seeds provided in quintal/ No.	Farmers Benefitted (No.)
i) Seeds	Wheat	HD 187 HD 2967 PBW 222 DBW 327 &332	45 Q 22 Q 40 Q 18 Q	18 20 22 85
	Paddy	PB 1509 PB 1718	52 Q 35 Q	15 10
	Vegetable kits	Packets of multiple crops	5 kg	220
ii) Seedlings	Fodder crop	Bajra Napier cuttings	500 No	145
	Maize	J1006	2.55 Q	31
	Oat	Kent	2.5 Q	23
a) Fertilizer				
b) Bio-fertilizer	Paddy	Azospirillum		55
	Numbers	**Name of technology**		**Farmers Benefitted (No.)**
iv) Technology (No)	20 8 950 450 kg 35 kg 925	Storage bin Rubber mat Dewormer mineral mixture Calcium powder Albendazole		20 8 490 450 35 540
v) Livestock / poultry / fisheries	**Numbers**		**Farmers Benefitted (No)**	
a) Livestock	40		2500	
b) Poultry chicks	-		-	
c) Fingerlings	-		-	

NDRI scientist discussing the problems of villagers in a MGMG village

ICAR-NATIONAL DAIRY RESEARCH INSTITUTE



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