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2020
वार्षिक प्रतिवेदन
ANNUAL REPORT

Fulfilling Nation's
Dairy Dreams

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

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.

भाकृअनुप
ICAR

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ICAR-NDRI initiated work to multiply the elite indigenous Sahiwal cows using OPU-IVF technology

CONTENTS

MILESTONES

1923	Established in Bangalore as Imperial Institute of Animal Husbandry and Dairying.
1936	Renamed "Imperial Dairy Institute".
1955	National Dairy Research Institute came into existence at Karnal, at the former Central Cattle Breeding Farm.
	Bangalore facilities became Southern Regional Station of the Institute.
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.
1983	IDD (DH) started at Bangalore.
1985	"Farm Advisory Bureau" and "Industrial Consultancy Cell" set up. The Institute recognised as Centre of Excellence in Animal Biotechnology.
1987	Embryo Biotechnology Centre established.
1989	The Institute granted "Deemed to be University" status.
	M.Sc. in Biotechnology started.
1990	Birth of Pratham, first IVF buffalo calf of the world.
1991	20 bedded Hospital Complex set up and made functional.
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.
1993-94	The ICAR award for outstanding KVK conferred on the KVK located at NDRI.
1997	A state-of-the-art Auditorium having seating capacity of 950 and 2 conference rooms and 2 meeting rooms made functional.
	A commercial Model Dairy Plant with a capacity of 60,000 lit./ day commissioned for providing practical training to the students of NDRI University and to serve as an interface between Institute and Industry.
1998	A Modern Cafeteria with a seating capacity of 150 constructed in front of the Institute Hostels.
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 introduction of 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.
2013	A Diploma in Dairy Technology started at Southern Regional Station, Bangalore.
2014	NDRI bagged the Sardar Patel Outstanding ICAR Institution Award presented by Hon'ble Prime Minister of India, Sh. Narendra Modi Ji.
	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.
	ICAR - NDRI ranked first among all Agricultural Universities and four Deemed Universities of ICAR (2016-17, 2017-2018 & 2018-19).
	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 National Accreditation Board for Testing and Calibration Laboratories (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 an 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.

प्रस्तावना PREFACE

भाकृअनुप–राडेअनुसं वार्षिक रिपोर्ट–2020 को पिछले एक वर्ष के दौरान संस्थान के अनुसंधान, शिक्षा और विस्तार के क्षेत्रों में इन कार्यक्रमों के सुदृढ़ीकरण हेतु सबसे महत्वपूर्ण उपलब्धियों और संबंधित गतिविधियों के एक सर्व–समावेशी खाते के रूप में प्रस्तुत किया जा रहा है। जानकारी को इस प्रकार व्यवस्थित किया गया है कि वह देश के इस प्रमुख डेरी संस्थान और इसकी कार्य पद्धति का समग्र दृष्टिकोण प्रदान करता है।

यह हमारे लिए गर्व एवं अपार संतुष्टि का विषय है कि वर्ष 2016–17, 2017–18, 2018–19 और 2019–20 में लगातार चार बार भाकृअनुप–राडेअनुसं को 4 मानद् विश्वविद्यालयों सहित भारत के सभी कृषि विश्वविद्यालयों में पहला स्थान प्राप्त हुआ है। राडेअनुसं की अनुसंधान और विकास गतिविधियों को इसके अधिदेश–उन्मुखी और सुसंरचित अनुसंधान कार्यक्रमों के माध्यम से और अधिक गति मिली है, जिसमें 85 इन–हाउस और 75 बाह्य वित्तपोषित अनुसंधान परियोजनाओं के साथ–साथ छह अंतरराष्ट्रीय सहयोगी अनुसंधान परियोजनाएं भी शामिल हैं।

राष्ट्रीय डेरी मेला–2020 का आयोजन 15 से 17 फरवरी, 2020 के दौरान किया गया था ताकि हितधारकों, विशेषकर किसानों को संस्थान के निष्कर्षों और प्रौद्योगिकियों का प्रदर्शन, प्रसार और विस्तार किया जा सके। इसमें उत्तर प्रदेश, हरियाणा, पंजाब, दिल्ली और राजस्थान जैसे विभिन्न राज्यों के 15000 से अधिक हितधारकों ने भाग लिया। इसके अलावा, 19 बन्ध्यता और पशु–चिकित्सा सहायता अभियानों और 19 किसान संगोष्ठियों का आयोजन किया गया ताकि किसानों को अच्छी पशुपालन प्रथाओं के बारे में जागरूकता प्रदान की जा सके। कृषि विज्ञान केन्द्र के द्वारा 5548 प्रतिभागियों को लाभान्वित करने के लिए फसलों, पशुधन, मछली पालन और मधुमक्खी पालन के विभिन्न पहलुओं को शामिल करते हुए लगभग 155 आवश्यकता आधारित ऑनलाइन एवं ऑफलाइन प्रशिक्षण कार्यक्रम आयोजित किए

ICAR-NDRI Annual Report-2020 is being presented as an all-inclusive account of the most significant achievements of the Institute in the areas of Research, Education and Extension, and related activities undertaken to strengthen these programmes during the last one year. The information has been so arranged that it provides a holistic view of this premier dairy Institute of the country and its functioning.

To our pride and immense satisfaction, ICAR-NDRI has been ranked first among all Agricultural Universities of India, including 4 Deemed Universities, consecutively for four times in the years 2016-17, 2017-18, 2018-19 and 2019-20. The research and development activities of NDRI got further impetus through its mandate-oriented and well-structured research programmes comprising 85 in-house and 75 externally funded research projects, which also included six international collaborative research projects.

National Dairy Mela-2020 was organized during 15 to 17 February, 2020 in order to demonstrate, extend and expand the findings and technologies of the Institute to stakeholders, especially farmers. More than 15000 stakeholders from different states like Uttar Pradesh, Haryana, Punjab, Delhi and Rajasthan participated. Further, 19 infertility and veterinary aid campaigns and 19 Kisan Sangosthies were organized to impart awareness among farmers on good animal husbandry practices. About 155 need based on-line and off-line trainings programmes covering various aspects of crops, livestock, fish farming and bee keeping were organised by KVK to

गए। इसी तरह, कोविड–19 की गंभीर महामारी के परिदृश्य में, कृषि विज्ञान केन्द्र ने 5 ऑनलाइन प्रशिक्षण–सह–वेबिनार भी आयोजित किए, जिससे कुल 1540 किसान लाभान्वित हुए।

पशु उत्पादन के क्षेत्र में, राडेअनुसं भैंस क्लोनिंग के मौलिक कार्य का संवर्द्धन कर रहा है। वर्ष 2020 के दौरान, राडेअनुसं ने श्रेष्ठ मुर्रा प्रजनन करने वाले सांडों के छह क्लोन बछड़ों का उत्पादन किया और श्रेष्ठ संतान पैदा करने के लिए कृत्रिम गर्भाधान के माध्यम से क्लोन किए गए बुल जर्म प्लाज्म का प्रसार किया गया। वैश्विक प्रतिलेख और miRNA विश्लेषण द्वारा कम क्लोनिंग दक्षता की पेचीदगियों का भी पता लगाया गया था। दिलचस्प बात यह है कि फील्ड की परिस्थितियों में बढ़ती भैंसों (8 से 10 महीने) के लिए बीटेन/25 ग्राम/दिन/पशु के संपूरकता के अध्ययन ने यौवन की आयु को 28 दिनों तक कम कर दिया। फील्ड में लागू मद का पता लगाने के लिए मद हेतु केंडीडेट प्रोटीन बायोमार्कर की भी पहचान की गई और एलसी–एमएस/एमएस विश्लेषण के साथ युग्मित लेबल मुक्त (एलएफक्यू) और लेबल (टीएमटी) मात्रा का उपयोग करके भैंस के लार और मूत्र में मान्य किया गया। इसी तरह, साहीवाल गायों के मूत्र में प्रारंभिक गर्भावस्था से जुड़े बायोमार्कर की खोज जारी रखी जा रही है, हालांकि गोमूत्र में नए पेप्टाइड्स ने दिलचस्प रूप से ई.कोलाई के विरूद्ध रोगाणुरोधी गतिविधि दिखाई है। साहीवाल गायों में उच्च प्लाज्मा ग्लूकोज, एनईएफए और कोर्टिसोल का स्तर अधिक पाया गया, जबकि साहीवाल गायों में लगातार स्तनपान कराने वाली गायों में वृद्धि हार्मोन, अल्फा–लैक्टलबुमिन और लैक्टोफेरिन अधिक थे। डेरी पशुओं को थनैला से बचाने के लिए डेरी पशुओं में उप–नैदानिक और नैदानिक थनैला का पता लगाने के लिए एंजाइम–सब्सट्रेट आधारित स्ट्रिप्स विकसित किए गए। सिद्ध मुर्रा और साहीवाल सांडों का चयन करने के लिए सतत् पारंपरिक प्रजनन दृष्टिकोण, संततियों की 3700 किलोग्राम से अधिक लेक्टेशन उपज, शुक्राणु प्रतिलेख विश्लेषण और संकर बैल के सेमिनल प्लाज्मा मेटाबॉलिक विश्लेषण किए गए। इसके अलावा, भैंसों के उत्पादन और प्रजनन लक्षणों से जुड़े आनुवंशिक मार्करों की पहचान करने के लिए जीनोम वाइड एसोसिएशन स्टडीज (जीडब्ल्यूएएस) आयोजित की गई।

संस्थान डेरी प्रसंस्करण के क्षेत्र में उत्पादों और प्रक्रियाओं को वितरित करने में सक्रिय है। कुछ प्रमुख नवाचार हैं: एक्वा–उत्पादों में एंटीबायोटिक समूहों का तेजी से पता लगाने के लिए एक बीजाणु आधारित तकनीक; दूध में भारी धातुओं का पता लगाने के लिए पेपर स्ट्रिप आधारित सेंसर; संदेश और दूध–बाजरा पूरक खाद्य पदार्थों के लिए ऑन–पैकेज ताजगी संकेतक; पारंपरिक भारतीय डेरी उत्पादों के लिए लैक्टिक एसिड बैक्टीरिया से रोगाणुरोधी चयापचयों युक्त कैसिनेट आधारित रोगाणुरोधी पैकेजिंग प्रणाली; गाय के दूध में भैंस के दूध का तेजी से पता लगाने के लिए एक कार्बन नैनोपार्टिकल आधारित लेटरल फ्लो इम्यूनोएसे; 5–6 लीटर क्षमता की ऑन–फार्म चिलिंग दुग्ध

benefit 5548 participants. Similarly, in the grim pandemic scenario of COVID19, KVK also organized 5 online training-cum-webinars, which benefited a total of 1540 famers.

In the domain of animal production, NDRI has been crafting seminal work on buffalo cloning. During the year 2020, NDRI produced six cloned calves of elite Murrah breeding bulls and the cloned bull germ plasm has been disseminated through artificial insemination to produce elite progeny. The intricacies for low cloning efficiency were also explored by global transcriptome and miRNA analysis. Interestingly, studies on the supplementation of betaine @ 25g/day/animal to growing buffaloes (8 to 10 months) under field conditions reduced the age of puberty by 28 days. To develop field applicable oestrus detection, the candidate protein biomarkers for oestrus were also identified and validated in saliva and urine of buffaloes, using both label free (LFQ) and labeled (TMT) quantification coupled with LC-MS/MS analysis. Similarly, the exploration of the early pregnancy associated biomarkers in the urine of Sahiwal cows is being continued, although novel peptides in cow urine interestingly showed an antimicrobial activity against *E. coli*. Higher plasma glucose, NEFA and cortisol levels were found higher in Sahiwal cows with the truncated lactation, while growth hormone, alpha-lactalbumin and lactoferrin were higher in Sahiwal cows of persistent lactation. To protect dairy animals from mastitis, enzyme-substrate based strips were developed for detection of subclinical and clinical mastitis in dairy animals. Continuing traditional breeding approaches to select the proven Murrah and Sahiwal bulls with more than 3700 kg lactation yield of daughters, sperm transcriptome analysis and seminal plasma metabolomic analysis of crossbred bulls were carried out. Further, genome wide association studies (GWAS) were conducted to identify the genetic markers associated with the production and reproduction traits of buffaloes.

The Institute is vibrant in delivering products and processes in the sphere of dairy processing. Some of the key innovations are: a spore based technology for rapid detection of antibiotic groups in aqua-products; a paper strip based sensor for detection of heavy metals in milk; on-package freshness indicators for Sandesh and milk-millet complementary foods; caseinate based antimicrobial packaging system containing antimicrobial metabolites from Lactic acid bacteria for traditional Indian dairy products; a carbon nanoparticle based lateral flow immunoassay for rapid detection of buffalo milk in cow

पात्रय दही के लिए पीएच–नियंत्रक आधारित स्वचालित एंडो–एक्सो इकाईय आरिल हाइड्रोकार्बन रिसेप्टर (एएचआर) उत्तरदायी जेनोबायोटिक्स का पता लगाने के लिए रिवर्स ट्रांसक्रिप्शन–लूप मध्यस्थता इजोटेर्मल एम्प्लीफिकेशन (आरटी–एलएएमपी) परख और दूध एक्सोसोम में siRNA के एनकैप्सुलेशन और इंटरसेलुलर डिलीवरी के लिए एक नवीन रासायनिक–मुक्त और गैर–यांत्रिक विधि उनके वृहद स्तर पर चिकित्सीय अनुप्रयोग हेतु पहली बार भैंस के दूध के एक्सोसोम से जीनोम–वाइड माइक्रो आरएनए को प्रोफाइल किया गया और ऊंट के दूध से पके पनीर के निर्माण की तकनीक विकसित की गई। इसी तरह, स्वदेशी प्रोबायोटिक एल. रमनोसस वीटीसीसीडीएम 179बी स्ट्रेन के पूरे जीनोम को डिक्रिप्ट किया गया है। दूध और घी पैकेजिंग पॉलिमर से संभावित माइग्रेंट्स की पहचान के लिए गैर–लक्षित जीसी–एमएस पद्धति को अनुकूलित किया गया और होल्स्टीन फ्रीजियन संकर गाय के दूध की तुलना में देवनी और मलनाड गिद्दा गाय के दूध की रासायनिक गुणवत्ता को स्पष्ट किया गया।

डेरी शिक्षा के क्षेत्र में, राडेअनुसं मानद् विश्वविद्यालय अपनी गतिविधियों को भारत सरकार की नई शिक्षा नीति (एनईपी–2020) के साथ–साथ उच्च शिक्षा के वैश्विक संस्थानों में रुझानों के साथ जोड़ने बावत् नए सुधार लाने के लिए सतत् अग्रसर है। संस्थागत विकास योजना (आईडीपी) के तहत शैक्षणिक कार्यक्रमों को सुदृढ़ करने, पूर्व छात्रों के नेटवर्क का लाभ उठाने, छात्रों के सॉफ्ट स्किल्स और इक्विटी कार्य योजना ग्रीन कैंपस को बढ़ावा देने के लिए विभिन्न पहलें की गईं। अंतर्राष्ट्रीय प्रशिक्षण के लिए सोलह संकाय सदस्यों का चयन किया गया, जिनमें से 7 संकाय सदस्यों को 2020 के दौरान संयुक्त राज्य अमेरिका और नीदरलैंड में स्थित 6 विभिन्न विश्वविद्यालयों में अग्रिम प्रशिक्षण प्राप्त करने के लिए प्रतिनियुक्त किया गया। भाकृअनुप–राडेअनुसं, करनाल में संभावनाशील उद्यमियों की मदद हेतु सामाजिक आउटरीच गतिविधि के अन्तर्गत 18–27 फरवरी, 2020 के दौरान "स्टार्टर कल्चर और किण्वित दूध उत्पाद" पर एक प्रमाणपत्र कोर्स आयोजित किया गया। 3 – 5 मार्च, 2020 के दौरान ''मेटाबॉलोमिक्स : मूल सिद्धांत एवं अनुप्रयोग'' विषय पर एक कार्यशाला आयोजित की गई । राडेअनुसं के पूर्व छात्रों की मदद से प्रतिबद्ध परियोजना गतिविधि और छात्रों की वर्चुअल मेंटरिंग के रूप में "प्रबंधन में उच्च शिक्षा के अवसर" विषयों पर एक वेबिनार और ''डेटा एनालिटिक्स'' पर कार्यशाला का आयोजन किया गया। इसी तरह, स्नातक छात्रों हेतु रोजगार के अवसरों को बढ़ाने के लिए ''व्यक्तित्व विकास'' और ''उद्यमी कौशल विकास'' विषयों पर वेबिनार आयोजित किए गए। आईडीपी–नाहेप परियोजना के तहत, छात्रों को भाषा कौशल प्रदान करने के लिए एक अत्याधुनिक ऑडियो–विजुअल उपकरणों से युक्त आधुनिक भाषा प्रयोगशाला स्थापित की गई।

इसके अलावा, विभिन्न उद्योगों और शैक्षणिक संस्थानों के साथ

milk; on-farm chilling milk pail of 5-6 lit capacity; pH-controller based automated endo-exo unit for dahi; reverse transcription-loop mediated isothermal amplification (RT-LAMP) assay for the detection of aryl hydrocarbon receptor (AhR) responsive xenobiotics and a novel chemical-free and non-mechanical method for the encapsulation and intercellular delivery of siRNA in milk exosomes for their wider therapeutic applications. For the first time, genome-wide microRNAs have been profiled from buffalo milk exosomes and the technology for ripened cheese manufacturing from camel milk has been developed. Similarly, whole genome of indigenous probiotic *L. rhamnosus* VTCCDM 179B strain has been deciphered. Non-targeted GC-MS method was optimized for identification of potential migrants from milk and ghee packaging polymers and the chemical quality of Deoni and Malnad Gidda cow milk was elucidated in comparison to Holstein Friesian crossbred cow milk.

In the area of Dairy Education, NDRI Deemed University is marching ahead to bring in new reforms to keep its activities aligned to the new education policy (NEP-2020) of the Government of India as well as the trends in global institutions of higher learning. Various initiatives were taken for strengthening academic programmes, leveraging alumni network, nurturing soft skills of the students and equity action plan plus green campus under Institutional Development Plan (IDP). Sixteen faculty members were selected for international training, out of which 7 faculty were deputed for availing advance training at 6 different universities located in USA and Netherlands during 2020. A Certificate course on "Starter Culture and Fermented Milk Products" was organized during 18-27 February, 2020 at ICAR-NDRI, Karnal as a part of society outreach activity to help prospective entrepreneurs. A workshop on "Metabolomics: Basic Principles and Application" was organized during 3 – 5 March, 2020. A Webinar on the topics "Higher Education Opportunities in Management" and Workshop on "Data Analytics" were organized with the help of NDRI alumni as a part of the committed project activity and virtual mentoring of students by Alumni. Likewise, webinars on the themes "Personality Development" and "Entrepreneurial Skill Development" were organized to enhance employment opportunities for the under-graduate students. Under IDP-NAHEP project, a Modern Language Laboratory with state-of-the-art audio-visual equipment was set up for imparting language skills to the students.

Furthermore, linkages were established with different industries and academic institutions. Three MoUs were

संबंध स्थापित किए गए। छत्तीसगढ़ कामधेनु विश्वविद्यालय(दुर्ग), डीबीटी–एनआईएबी (हैदराबाद) और एमपीयूएटी (उदयपुर) के साथ तीन समझौता ज्ञापनों पर हस्ताक्षर किए गए। वर्ष 2020 के दौरान, तीन पेटेंट प्रदान किए गए और सात पेटेंट दायर किए गए। संस्थान में विकसित नौ प्रौद्योगिकियों को कृषि–नवोन्मेष के माध्यम से पांच वाणिज्यिक घरानों में स्थानांतरित किया गया और 28 प्रौद्योगिकियों को व्यावसायीकरण के लिए अनुमोदित किया गया।

जिला करनाल (हरियाणा) के गांव खेरीमानसिंह में कृत्रिम गर्भाधान केंद्र का एक नया भवन बनकर तैयार हुआ और 7 फरवरी, 2020 को उसका उद्घाटन किया गया। जल संरक्षण के उद्देश्य से छात्रावास, खेल परिसर, गेस्ट हाउस और प्रशासनिक भवन परिसर में 13 एकड़ के कुल लॉन क्षेत्रों को कवर करने के लिए छिड़काव जल सिंचाई प्रणाली स्थापित की गई। संस्थान की ये उपलब्धियां भाकृअनुप–राडेअनुसं के कर्मचारियों के समर्पण, कड़ी मेहनत और सहयोग का परिणाम हैं। संस्थान डेरी अनुसंधान, शिक्षा और आउटरीच को बढ़ावा देने के लिए एक विश्व स्तरीय मॉडल परिसर बनने के लिए प्रतिबद्ध है, चूंकि डेरी उद्योग लाखों किसानों की सामाजिक–आर्थिक स्थितियों को बदलने के लिए एक प्रमुख गेम–चेंजर अर्थात् महत्वपूर्ण निर्णायक के रूप में उभर रहा है।

मुझे पूरी उम्मीद है कि राडेअनुसं वार्षिक रिपोर्ट 2020 देश के उच्च शिक्षा और डेरी विकास संगठनों के अन्य संस्थानों के पेशेवरों हेतु सूचना के एक मूल्यवान स्रोत के रूप में काम करेगी।

(एम.एस. चौहान)
निदेशक, भाकृअनुप–राडेअनुसं

signed with Chhatisgarh Kamdhenu Vishvidyalaya (Durg), DBT-NIAB (Hyderabad) and MPUAT (Udaipur). During the year 2020, three patents were granted and seven patents filed. Nine technologies developed at the Institute were transferred to five commercial houses through Agri-innovate and 28 technologies were approved for commercialization.

A new building of AI center at village Kherimansigh, district Karnal (Haryana) was completed and inaugurated on Feb. 7, 2020. Sprinkler water irrigation system was installed to cover total lawn areas of 13 acres in hostel, sports complex, guest house and administrative building premises with an aim to conserve water. These achievements of the Institute are the results of the dedication, hard work and cooperation of the staff of ICAR-NDRI. The Institute is committed to becoming a world-class model campus for promoting dairy research, education and outreach, as dairying is emerging as a major game-changer for transforming the socio-economic conditions of millions of farmers.

I sincerely hope that NDRI Annual Report 2020 would serve as a valuable source of information to the professionals of the other Institutions of Higher Learning and Dairy Development Organizations in the country.

(M.S. CHAUHAN)
Director, ICAR-NDRI

कार्यकारी सारांश EXECUTIVE SUMMARY

भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल देश में डेरी विकास कार्यक्रमों हेतु अनुसंधान और विकास और मानव संसाधन विकास (एचआरडी) सहायता प्रदान करने के लिए समर्पित देश का एक प्रमुख अनुसंधान संगठन है। सन् 1923 में बेंगलुरु में स्थापित, संस्थान के मुख्यालय को सन् 1955 में करनाल में वर्तमान स्थान पर स्थानांतरित कर दिया गया था। इसके दो क्षेत्रीय केन्द्र हैं, एक बेंगलुरु में और दूसरा कल्याणी में, जो उनके क्षेत्रों में कृषि–जलवायु परिस्थितियों के अनुकूल क्षेत्र–विशिष्ट सहायता प्रदान करते हैं। भाकृअनुप–राडेअनुसं को 1989 से अपने शैक्षणिक कार्यक्रमों को लागू करने के लिए एक मानद् विश्वविद्यालय होने का गौरव प्राप्त है। वर्ष 2016–17, 2017–18, 2018–19 एवं 2019–20 में लगातार चार बार संस्थान को 4 मानद् विश्वविद्यालयों सहित भारत के सभी कृषि विश्वविद्यालयों में प्रथम स्थान दिया गया है।

संगठनात्मक संरचना

भाकृअनुप की मानद् विश्वविद्यालय प्रणाली के प्रशासनिक स्वरूप के अनुरूप, विभिन्न नीति/निर्णय लेने वाले निकायों अर्थात् प्रबंधक मंडल, अनुसंधान सलाहकार समिति, अकादमिक परिषद, कार्यकारी परिषद और विस्तार परिषद के माध्यम से संस्थान का प्रबंधन होता है। निदेशक इसके मुख्य कार्यकारी अधिकारी होते हैं, जिन्हें संयुक्त निदेशकों के द्वारा अनुसंधान, अकादमिक और विस्तार कार्यों के प्रबंधन में सहायता प्रदान की जाती है। संस्थान में अनुसंधान एवं विकास गतिविधियों के तीन प्रमुख क्षेत्र अर्थात् i) डेरी उत्पादन, ii) डेरी प्रसंस्करण और iii) डेरी विस्तार/प्रबंधन हैं। सभी अनुसंधान एवं विकास गतिविधियों का तेरह अनुसंधान प्रभागों/अनुभागों के माध्यम से प्रबंधन किया जाता है, यथा पशु आनुवंशिकी एवं प्रजनन, पशुधन उत्पादन एवं प्रबंधन, पशु पोषण, चारा अनुसंधान एवं प्रबंधन, पशु शरीरक्रिया विज्ञान, पशु जीवरसायन, पशु जैव प्रौद्योगिकी, डेरी प्रौद्योगिकी, डेरी अभियांत्रिकी, डेरी रसायन, डेरी सूक्ष्मजीवाणु, डेरी विस्तार एवं डेरी अर्थशास्त्र, सांख्यिकी एवं प्रबंधन। संस्थान में कृषि प्रौद्योगिकी सूचना केन्द्र (एटिक), कृषि विज्ञान केन्द्र और डेरी प्रशिक्षण केन्द्र, कृत्रिम प्रजनन अनुसंधान केन्द्र, के.वी.के., पिपराकोठी, पूर्वी चंपारण, मोतिहारी, बिहार में कृषि व डेरी विकास केंद्र एवं मॉडल डेरी केन्द्र मुजफ्फरनगर, उत्तर प्रदेश के लालूखेड़ी में है। संस्थान में केंद्रीय सुविधाओं से युक्त बुनियादी ढांचा जैसे पशुधन अनुसंधान केंद्र, चारा अनुसंधान और प्रबंधन केंद्र, पशु स्वास्थ्य परिसर, मॉडल डेरी प्लांट, प्रौद्योगिकी व्यवसाय इनक्यूबेटर, व्यवसाय योजना व विकास इकाई, दूध की गुणवत्ता और सुरक्षा के लिए राष्ट्रीय रेफरल प्रयोगशाला, प्रयोगात्मक डेरी संयंत्र, परामर्श इकाई, पुस्तकालय और राष्ट्रीय जैवसूचना केंद्र, कंप्यूटर केंद्र, संपदा अनुभाग और अनुरक्षण अभियंता अनुभाग है। प्रशासनिक कार्य जैसे खरीद, भण्डार और सुरक्षा संयुक्त निदेशक (प्रशासन) और कुलसचिव के प्रशासनिक नियंत्रण में हैं जबकि

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 were 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 four times in the year 2016-17, 2017-18, 2018-19 and 2019-20.

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 Genetic & 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, Small Animal House, Forage Research and Management Centre, Animal Health Complex, Model Dairy Plant, Technology Business Incubator, Business Planning and Development Unit, National Referral Laboratory for Milk Quality and Safety,

वित्त विभाग नियंत्रक(वित्त) के प्रशासनिक नियंत्रण में है। संस्थान में वर्तमान में 146 वैज्ञानिक, 181 तकनीशियन, 131 प्रशासनिक कर्मचारी और 291 कुशल सहायक कर्मचारी हैं।

बजट परिव्यय

- वर्ष 2020–21 के दौरान वास्तविक व्यय के रूप में संस्थान का वित्तीय परिव्यय 22,614.31 लाख रुपये था एवं वर्ष 2020–21 के लिए स्वीकृत बजट 22,830.34 लाख रुपये था। इन आंकड़ों में क्षेत्रीय परिसरों के सुदृढ़ीकरण के लिए वित्तीय परिव्यय भी शामिल है। 2020–21 के दौरान क्षेत्रीय परिसरों सहित संस्थान की राजस्व प्राप्तियां 627.75 लाख रुपये थीं।

अनुसंधान

उत्पादन

- उत्तम सांडों की दाता कोशिकाओं का उपयोग करे छह क्लोन बछड़ों का उत्पादन किया गया।
- वैश्विक ट्रांस्क्रिप्टोन एवं miRNA विश्लेषण और भैंस में कम क्लोनिंग दक्षता के कारणों की पहचान की गई।
- संतान उत्पत्ति हेतु कृत्रिम गर्भाधान बावत् क्लोन्ड बुल सीमन का प्रयोग किया गया।
- साहीवाल गाय के मूत्र से गर्भावस्था के शुरुआती निदान से जुड़े प्रोटीन आधारित बायोमार्कर की जांच जारी थी।
- भैंस में गर्भावस्था के निदान हेतु एक संभावित प्रतिरक्षा परख के विकास के लिए पुनः संयोजक BuPAG-1 की खोज की गई।
- ई.कोलाई के विरूद्ध रोगाणुरोधी गतिविधि के लिए गोमूत्र में नए पेप्टाइड्स की खोज की गई।
- पॉली I:C को माइलोइड कोशिकाओं की तुलना में तंतुकोशिका में IFN- आधारित ऐंटीवायरल प्रतिक्रिया का बेहतर प्रेरक मिला।
- सेल कल्चर मॉडल में चयनित ऑलिगोन्यूक्लियोटाइड अनुक्रमों ने ऐंटीवायरल प्रतिरक्षा प्रतिक्रिया उत्पन्न की।
- थनैला गाय के दूध में एस्चेरिचिया कोलाई का तेजी से पता लगाने के लिए गोल्ड नैनोपार्टिकल–आधारित विस्तारण मुक्त दृश्य परख विकसित की गई।
- औसत उत्पादन लक्षण अर्थात् 305–दिनों का लेक्टेशन दुग्ध उत्पादन, कुल लेक्टेशन दुग्ध उत्पादन और मुर्रा भैंस की अधिकतम उत्पादन क्रमशः 2184.10, 2256.10 और 12.8 किलोग्राम था, जबकि पषु समूह का नम और शुष्क औसत 6. 7 किलोग्राम और 3.5 किलोग्राम था। मुर्रा भैंसों की सेवा अवधि और शुष्क अवधि 133 और 162 दिन थी।
- मुर्राह सांडों में संतान परीक्षण कार्यक्रम के 14वें सेट के सांड मूल्यांकन ने एनडीआरआई बुल 6044 को एक सिद्ध बैल घोषित किया और उसने भैंस सुधार पर भाकृअनुप–नेटवर्क परियोजना के सभी केंद्रों में दूसरा स्थान हासिल किया। अन्य परीक्षण किए गए सांडों की तुलना में 2.43 प्रतिशत श्रेष्ठता के साथ सबसे अच्छी मादा (पुत्री) उपज के रूप में सांड की 3837.75 किलोग्राम थी।

Experimental Dairy Plant, Consultancy Unit, Library and National Bio-informatic Centre, Computer Centre, Estate Section and Maintenance Engineering Section. The administrative functions viz. purchase, stores and security are under the administrative control of the Joint Director (Administrative) and Registrar, whereas finance division is under the administrative control of Comptroller (Finance). The Institute presently has strength of 146 scientists, 181 technicians, 131 administrative staff and 291 skilled supporting staff

BUDGET OUTLAY

The financial outlays of the Institute in terms of actual expenditure during the year 2020-21 was Rs. 22,614.31 lakhs and the budget sanctioned for the year 2020-21 was Rs. 22,830.34 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. 627.75 lakhs during 2020-21.

RESEARCH

Production

- Six cloned calves of Murrah buffalo were produced using donor cells of elite breeding bulls.
- Global transcriptome and miRNA analysis and reasons of low cloning efficiency in buffalo were identified.
- Cloned bull semen was used for artificial insemination to produce progeny.
- Screening for proteins based biomarkers associated with early pregnancy diagnosis from urine of Sahiwal cow was continued.
- Recombinant BuPAG-1 was explored for the development of an immunoassay for pregnancy diagnosis in buffalo.
- Novel peptides were explored in cow urine for antimicrobial activity against *E. coli.*
- Poly I:C showed better induction of the IFN- based antiviral response in fibroblast cells than myeloid cells.
- Selected oligonucleotide sequences generated antiviral immune response in cell culture model.
- Gold nanoparticle-based amplification free visual assay was developed for rapid detection of *E. coli.* in mastitis cow milk.
- The average production traits namely, 305-day lactation milk yield, total lactation milk yield and peak yield of the Murrah buffaloes were 2184.10, 2256.10 and 12.8 kg, respectively, whereas the wet and dry average of the herd were 6.7 kg and 3.5 kg. The service period and dry period of Murrah buffaloes were 133 and 162 days.

- मुर्रा भैंस के फील्ड संतति परीक्षण कार्यक्रम के तहत कुल 1532 ब्यांत ज्ञात हुईं थी जिनमें से 647 (42.2 प्रतिशत) मादाओं का जन्म हुआ। जन्मी सत्तासी (87) पुत्रियों ने इस अवधि के दौरान सफलतापूर्वक अपना स्तनपान पूरा कर लिया था।
- साहीवाल के समूह की संख्या बढ़कर 419 (मादा) और 37 (नर) हो गई है। 2126 किलोग्राम के झुंड के औसत के मुकाबले सात साहीवाल नरों को ईपीडी 5.18 प्रतिशत और डेम के औसत सर्वश्रेष्ठ लैक्टेशन उत्पादन (3725 किलोग्राम) के साथ चुना गया था। कुल 34 (प्रजनन योग्य मादाओं का 19 प्रतिशत) को श्रेष्ठ गायों के रूप में पहचाना गया।
- झुंड(1955–2020) में सभी साहीवाल पशुओं के लिए वंशावली आधारित अंतर्जनन गुणांक का अनुमान लगाया गया था।
- खंडित वंशावली ने प्रजनन मूल्यों के पूर्वानुमानों पर महत्वपूर्ण प्रभाव का खुलासा किया। पशुओं के एक छोटे से अनुपात का जीनोटाइपिंग नकली आंकड़ों में खंडित वंशावली के साथ भी प्रजनन मूल्यों के बेहतर अनुमान प्राप्त करने के लिए पाया गया था।
- मुर्रा भैंसों में जीनोम वाइड एसोसिएशन किया गया था और कुल 131 एसएनपी और 65 विशिष्ट जीनों को उत्पादन, लेक्टेशन दृढ़ता और प्रजनन लक्षणों के लिए पहचाना गया।
- इन–सिलिको जीनोम वाइड miRNA-QTL-SNPs के विश्लेषण से पता चला कि CUX1 जीन और miRNA bta-mir-2388 आमतौर पर गर्मी सहनशील, श्वसन दर और शरीर के तापमान से जुड़े होते हैं।
- डेरी उत्पादकता में सुधार के लिए निक्रा परियोजना के तहत संस्थान की गतिविधियों को गांवों तक पहुंचाया गया।
- निक्रा परियोजना के तहत बहु मौसमी आवास मॉड्यूल डिजाइन और निर्मित किए गए।
- मुर्रा भैंसों की त्वचा AQP1, AQP3 एवं AQP5 की अभिव्यक्ति मौसम से प्रभावित हुई थी।
- भैंस के स्तन उपकला कोशिकाओं में गर्मी तनाव प्रतिक्रिया और सूजन से संबंधित जीन को विनियमित करके करक्यूमिन ने खुराक पर निर्भर तरीके से सुरक्षात्मक प्रभाव प्रदर्शित किया।
- कोलोस्ट्रम की उपज, प्रोटीन प्रतिशत और न्यूट्रोफिल की फागोसाइटिक गतिविधि अधिक थी और विटामिन ई, ए, बायोटिन और डी संपूरक गायों के कोलोस्ट्रम में दैहिक कोशिकाएं कम थीं जो उनकी प्रतिरक्षा पर पूरकता के लाभकारी प्रभाव को दर्शाती हैं।
- खेत की परिस्थितियों में बढ़ती भैंसों (8 से 10 महीने) के लिए बीटेन/25 ग्राम/दिन/पशु के सप्लीमेन्टेशन ने यौवन की आयु को 28 दिनों तक कम कर दिया।
- प्लाज़्मा ग्लूकोज, एनईएफए, कोर्टिसोल का स्तर काटे जाने में काफी अधिक था जबकि विकास हार्मोन, अल्फा–लैक्टलबुमिन और लैक्टोफेरिन लगातार साहीवाल गायों के दूध में अधिक थे।

- The Bull evaluation of 14th set of progeny testing programme in Murrah bulls declared NDRI Bull #6044 as a proven bull, and he achieved 2nd rank among all the centres of ICAR-Network Project on Buffalo Improvement. The bull had 3837.75 kg as best daughters yield with 2.43% superiority over the other tested bulls.
- A total of 1532 calvings were reported under field progeny testing program of Murrah buffalo, out of which 647 (42.2%) females were born. Eighty seven (87) daughters born had successfully completed their lactation during the period.
- The herd strength of Sahiwal has been increased to 419 females and 37 males. Seven Sahiwal males with EPD 5.18%and greater Dam's average best Lactation Yield of 3725 kg than the herd average of 2126 kg were selected. A total of 34 (19% of the breedable females) cows were identified as elite cows.
- Pedigree based inbreeding coefficient was estimated for all the Sahiwal animals in the herd (1955-2020).
- Truncated pedigree revealed significant impact on the prediction of breeding values. Genotyping a small proportion of animals was found to yield better estimates of breeding values even with truncated pedigree in simulated data.
- Genome wide association in Murrah Buffaloes was done and a total of 131 SNPs and 65 characterized genes were identified for production, lactation persistency and fertility traits.
- In-silico genome wide miRNA-QTL-SNPs analyses revealed the association of the CUX1 gene and the miRNA, bta-mir-2388, with heat tolerance, respiration rate and body temperature.
- Institute activities under NICRA project were extended to villages for improving dairy productivity.
- Multi seasonal housing module was designed and fabricated under NICRA Project.
- Expression of AQP1, AQP3 and AQP5 in the skin of Murrah buffaloes was affected by season.
- Curcumin exhibited protective effect in a dose dependent manner by regulating the genes related to heat stress response and inflammation in buffalo mammary epithelial cells.
- The yield, protein percentage and phagocytic activity of neutrophils were higher, and the somatic cell count was lower in the colostrum of Vitamin E, A, Biotin and D supplemented cows than the control, indicating a

- bGH-Msp1 जीन के TT जीनोटाइप वाले पशुओं में अन्य bGH जीनोटाइप की तुलना में बेहतर लैक्टेशन यील्ड, लैक्टेशन की निरंतरता और लंबे समय तक लैक्टेशन की अवधि थी।
- प्रारंभिक गर्भावस्था के दौरान Indoleamine-2, 3-dioxygenase (IDO) अभिव्यक्ति में एक अप–विनियमन डेरी गायों में मातृ प्रतिरक्षा–दमन का कारण बनता है।
- किसपेप्टिन मद को शामिल करने में प्रभावी पाया गया और यह लंबे समय तक अंतर–ब्याने की अवधि को कम करता है, फॉलिकुलो–हार्मोनल में सुधार और पोस्टपार्टम अमदकाल में जीन अभिव्यक्ति की स्थिति में सुधार करता है।
- मद के लिए केंडीडेट प्रोटीन बायोमार्कर की पहचान की गई और एलसी–एमएस/एमएस विश्लेषण के साथ लेबल मुक्त (एलएफक्यू) और लेबल (टीएमटी) परिमाणीकरण दोनों का उपयोग कर भैंस के लार और मूत्र में मान्य किया गया।
- qRT-PCR विश्लेषण का उपयोग करते हुए कोशिका मुक्त ट्रांसक्रिप्ट विश्लेषण ने मद चरण के दौरान लार में HSPA1A, HSD17B1 और INBH जीन की उच्च अभिव्यक्ति का खुलासा किया, जो ओस्ट्रस चक्र के अन्य चरणों की तुलना में है और इसे भैंसों में ऑस्ट्रस के संभावित केंडीडेटों के रूप में माना जा सकता है।
- भैंस में प्रारंभिक भ्रूण के अस्तित्व को नियंत्रित करने वाले प्रासंगिक संबद्ध मार्गों को जानने की दिशा में COX-2 जीन के लिए CRISPR/Cas9 द्वारा लक्षित जीनोम संपादित किया गया।
- संपूर्ण एक्सोम सीक्वेंस विश्लेषण और एसएनपी विश्लेषण द्वारा देवनी और मलनाड गिद्दा बोस इंडिकस मवेशियों में दूध उत्पादन लक्षणों से जुड़े दुर्लभ आनुवंशिक रूपों की पहचान की गई।
- होल्स्टीन फ्राइजियन क्रॉसब्रेड गाय के दूध की तुलना में देवनी और मलनाड गिद्दा गाय के दूध की रासायनिक गुणवत्ता को स्पष्ट किया।
- क्रॉसब्रेड बुल पर्म ट्रांसक्रिप्ट का व्यापक विश्लेषण किया गया।
- उर्वरता पूर्वानुमान में उनके उपयोग की संभावित संभावनाओं के साथ उच्च और निम्न–उर्वर संकर सांडों के बीच शुक्राणु mRNA अभिव्यक्ति में गहन विसंगतियों का पता चला।
- संकर सांड के शुक्राणुओं की प्रोटीन प्रोफाइलिंग की गई और संभावित प्रजनन क्षमता से जुड़े शुक्राणु प्रोटीन की पहचान की गई।
- संकर सांड की वैश्विक उपापचयी रूपरेखा तैयार की गई और प्रजनन क्षमता की भविष्यवाणी के लिए पुटीय उपापचयी मार्करों की पहचान की गई।
- स्वदेशी और क्रॉसब्रेड ब्रीडिंग सांडों के तुलनात्मक चयापचय विश्लेषण से पता चला है कि बढ़े हुए लिपिड पेरोक्सीडेशन के साथ–साथ सेमिनल प्लाज्मा में ऐंटीऑक्सिडेंट की कम सांद्रता क्रॉसब्रेड सांडों में बांझपन/उप–प्रजनन की उच्च घटनाओं से जुड़ी हो सकती है।

beneficial effect of supplementation on the immunity of cows.

- Supplementation of betaine @25gm/day/animal to growing buffaloes (8 to 10 months) under field conditions reduced the age of puberty by 28 days.
- Plasma glucose, NEFA, cortisol levels were significantly higher in Sahiwal cows with the truncated lactation, while the growth hormone, alpha-lactalbumin and lactoferrin were higher in the milk of persistent Sahiwal cows.
- The animals with TT genotype of bGH-Msp1 gene had better lactation yield, persistency of lactation and longer lactation length than other bGH genotype.
- An up-regulation in Indoleamine-2, 3-dioxygenase (IDO) expression during early pregnancy causes maternal immune-suppression in dairy cows.
- The kisspeptin was found effective in oestrus induction, reduction of the prolonged inter-calving period, and an improvement in folliculo-hormonal and gene expression status in postpartum anestrus condition.
- Candidate protein biomarkers for oestrus were identified and validated in saliva and urine of buffaloes using both label free (LFQ) and labelled (TMT) quantification coupled with LC-MS/MS analysis.
- Cell free transcript analysis using qRT-PCR analysis revealed higher expression of HSPA1A, HSD17B1 and INBH genes in saliva during oestrus phase compared to other phases of oestrous cycle and could be considered as potential candidates for oestrus in buffaloes.
- Targeted genome editing was carried out by CRISPR/Cas9 for the COX-2 gene towards unravelling the relevant associated pathways governing early embryonic survival in buffalo.
- Identified rare genetic variants associated with milk production traits in Deoni and Malnad Gidda Bos Indicus cattle by Whole Exome Sequence Analysis and SNP analysis.
- The chemical quality of Deoni and Malnad Gidda cow milk was elucidated in comparison to Holstein Friesian crossbred cow milk.
- Comprehensive analysis of crossbred bull perm transcripts was carried out.
- Profound discrepancies in sperm mRNA expression were discovered between high- and low-fertile crossbred bulls, with potential possibilities for their use in fertility prediction.

- वृषण नमूनों में जीन अभिव्यक्ति डेटा के सामान्यीकरण के लिए उपयुक्त ICGs; Zebu के लिए ATPSF1, HMBS, PPIA, RPS15A एवं क्रॉसब्रेड के लिए ।TPSF1, RPL23, तथा PPIA के लिए क्रासब्रेड) के एक पैनल की पहचान की।
- देवनी और एचएफ क्रॉसब्रेड गायों में प्रसव से जुड़े व्यावहारिक बायोमेट्रिक्स और थर्मल हस्ताक्षर स्थापित किए गए थे।
- गायों के प्रसवोत्तर पोषण और चयापचय की स्थिति पर प्रसव पूर्व अवधि के दौरान कार्यात्मक पोषक तत्वों की खुराक के साथ ऊर्जा के विभिन्न स्रोतों को खिलाने का प्रभाव।
- सभी केसीन के बीच ट्रिप्सिन से उपचारित के–केसीन हाइड्रोलाइजेट्स में अधिकतम डीपीपी–चार निषेध गतिविधि देखी गई।
- कैटेचिन लोडेड निओसोम तैयार किए गए और दूध में मजबूती के लिए विशेषीकृत किए गए। विकसित निओसोम कैटेचिन की बेहतर जैवउपलब्धता और कार्यक्षमता के लिए आशाजनक डिलीवरी वाहनों के रूप में काम कर सकते हैं। गैसगासे पायसम के लिए सुविधा मिश्रण के लिए प्रक्रिया प्रौद्योगिकी विकसित की गई थी। रंग और स्वाद के संवेदी गुणों के मामले में ड्राई–क्रिस्टलीकरण दृष्टिकोण का उपयोग करके तैयार किया गया उत्पाद बेहतर था।
- चारा उत्पादन का हाइब्रिड नेपियर और मोरिंगा आधारित मॉडल पूरे वर्ष गुणवत्ता वाले चारे की उपलब्धता के लिए विकसित किया गया है। संकर नेपियर की चार कटाई से औसतन हरे चारे की उपज 1552 क्विंटल/हेक्टेयर शुष्क पदार्थ उपज 251 क्विंटल/हैक्टर के साथ दर्ज की गई है।
- बाईपास फैटी एसिड और टिनोस्पोरा की पूरकता से दूध की उपज में वृद्धि होती है, गुणवत्ता में सुधार होता है (दूध वसा और असंतृप्त फैटी एसिड) और नव ब्यांत मुर्रा भैंस की प्रजनन स्थिति में सुधार होता है।
- फीड में क्रमशः यूएमएमबी और पॉलीहर्बल मिश्रण की पूरकता के कारण दूध की औसत उपज में 26.95 और 21.53 प्रतिशत की वृद्धि हुई।
- शूलरहित कैक्टस गर्म और आर्द्र परिस्थितियों में स्वैच्छिक पानी की मांग को कम करते हुए फीड सेवन को प्रभावित किए बिना बकरियों (अल्पाइन बीटल) में मक्के के चारे का विकल्प हो सकता है।
- आहार में 10 पीपीएम स्तर पर निकेल (संभवतः आवश्यक ट्रेस तत्व) की पूरकता ने मुर्रा भैंस के कटड़ों में प्लाज्मा Fe, Hb, RBC, हेमेटोक्रिट, रक्त ग्लूकोज और कम प्लाज्मा, कुल कोलेस्ट्रॉल और कोर्टिसोल के स्तर के साथ उत्प्रेरित गतिविधि के उच्चतम मूल्यों को दिखाया।
- बी. मोनिएरी और एलोवेरा के अर्क के उत्पाद की सम्पूरकता, रुमेन किण्वन के हेरफेर के माध्यम से दूध के पोषक गुणों को बढ़ा सकता है।

- Proteomic profiling of crossbred bull spermatozoa was carried out and potential fertility associated sperm proteins were identified.
- Global metabolomic profiling of crossbred bull was carried out and identified putative metabolomic markers for fertility prediction.
- Comparative metabolomic analysis of indigenous and crossbred breeding bulls identified that increased lipid peroxidation coupled with low concentrations of antioxidants in seminal plasma might be associated with high incidence of infertility/sub-fertility in crossbred bulls.
- A panel of suitable ICGs (ATPSF1, HMBS, PPIA, RPS15A for Zebu and ATPSF1, RPL23, and PPIA for crossbred) was identified for normalization of gene expression data in testes samples.
- Behavioural biometrics and thermal signatures associated with parturition in Deoni and HF crossbred cows were established.
- Effect of feeding different sources of energy with functional nutrient supplements was studied during prepartum period on postpartum nutritional and metabolic status of cows.
- The maximum DPP-IV inhibition activity was observed in k-casein hydrolysates treated with trypsin amongst all the caseins.
- Catechin loaded proniosomes and niosomes were used as delivery vehicle for fortification in milk and milk-based beverages leading to improved bioavailability and functionality of catechins.
- Hybrid Napier and Moringa based model of fodder production was developed for quality fodder availability round the year. The average green fodder yield of 1552q/ha with a drymatter yield of 251q/ha has been recorded from four cuttings of hybrid Napier.
- Supplementation of bypass fatty acid and Tinospora leads to an increase in milk yield, improves quality (milk fat and unsaturated fatty acid) and also improves reproductive status of freshly calved Murrah buffaloes.
- Average milk yield increased by 26.95 and 21.53% due to UMMB and polyherbal mixture supplementation, respectively in feed.
- Spineless cactus could be a substitute for maize fodder in goats (Alpine × Beetle) without affecting feed intake while reducing the demand for voluntary water under hot and humid condition.

- एल.रयूटेरी बीएफ–एच9 एवं एल.सेलीवेरियस बीएफ–17 की पहचान मुर्रा भैंस के कटड़ों से अलग किए गए सर्वश्रेष्ठ प्रोबायोटिक्स के रूप में की गई थी।
- उन्नत गर्भवती मुर्रा भैंसों के आहार में ऊष्णकटिबंधीय समुद्री शैवाल उपोत्पादों के 2.5 प्रतिशत सांद्र मिश्रण की सम्पूरकता से नवजात बछड़ों के ऐंटीऑक्सीडेंट और प्रतिरक्षा स्थिति में सुधार हुआ।
- साहीवाल सांडों के आहार में 0.125 और 0.25 पीपीएम की खुराक दर पर आयोडीन की खुराक ऐंटीऑक्सीडेंट स्थिति और शुक्राणु प्रकिया परीक्षण में सुधार में फायदेमंद थी।
- साहीवाल और संकर सांडों में वीर्य उत्पादन प्रदर्शन में सुधार के लिए 890 पीपीएम की दर से सांडों के लिए विरल खनिज मिश्रण फायदेमंद साबित हुआ।
- राशन में 34.5 प्रतिशत एनडीएफ और 8.4 प्रतिशत एमपी के स्तर ने वर्तमान प्रायोगिक स्थितियों में गर्मी के तनाव को कम करने पर सकारात्मक प्रभाव दिखाया।
- सुनिश्चित सिंचाई स्थिति के तहत पूरे वर्ष गुणवत्तापूर्ण हरा चारा उत्पादन प्रणाली विकसित की। एनबीएच . लोबिया–बरसीम की इंटरक्रॉपिंग 2:3 पंक्ति अनुपात में प्रति वर्ष हरा चारा (177 टन/हेक्टेयर) और सूखा चारा (32 टन/हेक्टेयर) का उत्पादन किया।
- फसल प्रणाली में एक वर्ष में बेबी कॉर्न (दोहरे उद्देश्य के रूप में)–लोबिया (हरे चारे के रूप में)–चीनी गोभी (बीज उत्पादन)'' शामिल हैं, जिससे 3.17 के लाभ लागत अनुपात के साथ रु. 2.40 लाख/हेक्टेयर की शुद्ध आय हुई है।
- जई किस्म जेएचओ 851 ने उपज, गुणवत्ता और नाइट्रेट की मात्रा के संबंध में 100 प्रतिशत आरडीएफ और 90 किग्रा/हेक्टेयर बीज दर के साथ बेहतर प्रदर्शन किया।
- सभी मक्का–बरसीम–लोबिया में उर्वरक की 100 प्रतिशत अनुशंसित खुराक के उपयोग से अधिक हरा और चारा उपज प्राप्त हुई, दूसरे सर्वोत्तम उपचार में एफवाईएमपीजीपीआर मक्का में 3 प्रतिशत पंचगव्य स्प्रे के माध्यम से 100 प्रतिशत आरडीएन के साथ प्रयोग शामिल है। तीसरा सबसे अच्छा विकल्प पीजीपीआर बीज उपचार 3 प्रतिशत पंचगव्य स्प्रे का उपयोग बरसीम और लोबिया दोनों फसलों में करना है।
- मक्का में 100 प्रतिशत RDK+ PGPR+0.5 % Zn स्प्रे के प्रयोग से उच्चतम शुद्ध लाभ (5387.1 हेक्टेयर–1) और लाभ–लागत अनुपात (2.48) मिला और इसलिए, मक्का के बेहतर गुणवत्ता वाले हरे और सूखे चारे के उत्पादन के लिए किसानों को सिफारिश की गई।
- भैंस में पहली बार दूध एक्सोसोम के जीनोम–वाइड microRNAs की रूपरेखा तैयार की गई।
- दूध एक्सोसोम का उपयोग करके व्यापक चिकित्सीय अनुप्रयोगों के लिए siRNA के इनकैप्सुलेशन और अंतरकोशिकीय वितरण के लिए एक नए, रसायन–मुक्त और गैर–यांत्रिक विधि स्थापित की गई है।

- Nickel supplementation at 10 ppm level in the diet showed highest values of plasma Fe, Hb, RBC, haematocrit, blood glucose and catalase activity with decreased plasma total cholesterol and cortisol levels in Murrah buffalo calves.
- Supplementation of a product of B. monnieri and aloe vera extract can enhance milk nutraceutical properties through manipulation of rumen fermentation.
- The L. reuteri BF-H9 and L. salivarius BF-17 were identified as best probiotics isolated from Murrah buffalo calves.
- Supplementation of tropical seaweed byproducts at 2.5% of concentrate mixture in the diet of advanced pregnant Murrah buffaloes improved antioxidant and immune status of neonatal calves.
- Iodine supplementation at the dose of 0.125 and 0.25 ppm in the diet of Sahiwal bulls was beneficial in improvement of antioxidant status and sperm function tests.
- Trace mineral mixture for bulls @ 890 ppm proved beneficial to improve semen production performance in Sahiwal and crossbred bulls.
- A level of 34.5% NDF and 8.4% MP in the ration showed a positive influence on amelioration of heat stress in cattle.
- Developed round the year quality green fodder production system under assured irrigation condition. The production system consists of the intercropping of NBH + Cowpea-Berseem in 2:3 row ratio produced green fodder (177 t/ha and dry fodder (32 t/ha) per year.
- Cropping system consists of baby corn (as dual purpose)-cowpea (as green fodder)-chinese cabbage (seed production) in a year has generated net income ofRs. 2.40 lakh/ha with the benefit cost ratio of 3.17.
- Oats variety JHO 851 performed better with the application of 100% RDF and 90 kg/ha seed rate with respect to yield, quality and nitrate content.
- Application of 100% recommended dose of fertilizer yielded higher green fodder in all maize-berseem-cowpea crops, the second best treatment includes the application of 100% RDN through FYM+ PGPR+3% Panchagavya spray in maize, and the third best option is the application of PGPR seed treatment +3% Panchagavya spray in both berseem and cowpea crops.
- Application of 100% RDK+ PGPR+0.5 % Zn spray in maize gave highest net return (Rs. 5387.1 ha-1) and benefit-cost ratio (2.48), hence, this combination was

- रिवर्स ट्रांसक्रिप्शन–लूप मेडियेटेड इजोटेर्मल एम्प्लीफिकेशन (आरटी–लेम्प) परख को एरिल हाइड्रोकार्बन रिसेप्टर (AhR) रेस्पॉन्सिव जेनोबायोटिक्स का पता लगाने के लिए विकसित किया गया था।
- भैंसों में ओव्यूलेशन के पूर्वानुमान के लिए मूत्र में लेटरल फ्लो–आधारित ल्यूटिनाइजिंग हार्मोन का पता लगाने के लिए एक प्रूफ–ऑफ–कॉन्सेप्ट स्थापित किया गया है।
- कैसीन व्युत्पन्न पेप्टाइड सी, एंटी–ओस्टोजेनिक पोस्ट ट्रांसक्रिप्शनल रेगुलेटर, microRNA-300 (miR300). miR300 की अभिव्यक्ति को डाउन–रेगुलेटेड करता है, ऑस्टियोपोरोसिस में सांकेतिक बायोमार्कर के रूप में एक वैकल्पिक कार्य के साथ ओस्टोजेनिक Smad3/ -catenin/Runx2 सिग्नलिंग क्रॉसस्टॉक को नियंत्रित करता है।
- यांत्रिक और जैव रासायनिक परिवर्तनों के लिए नैनोकणों (एनपी) के लिए सेलुलर प्रतिक्रिया का पता लगाया जाता है और मेसोपोरस सिलिका नैनोपार्टिकल (MSN) के तीक्ष्ण प्रदर्शन मल्टीवॉल कार्बन नैनोट्यूब (MWCNTs)] और जिंक ऑक्साइड (ZnO) NPs के बाद कोशिका व्यवहार का अध्ययन करने के लिए चीनी हैम्स्टर ओवरी (CHO-K1) कोशिका श्रृंखला का व्यापक विश्लेषण प्रदान करते हैं।
- अध्ययनों ने स्थापित किया कि Rac-Rho सिग्नलिंग मार्ग के सक्रियण के लिए परिवर्तित साइटोस्केलेटन गतिकी है। परिणाम व्यापक रूप से नैनोसुरक्षा मूल्यांकन के लिए एक संवेदनशील प्रारंभिक आणविक रीडआउट के रूप में सहायता करेंगे।
- साहीवाल दूध Caco-2 कोशिकाओं और चूहे के मॉडल में पेप्टिडोग्लाइकन प्रेरित जलन प्रतिक्रिया को कम करने में प्रभावी है।

प्रसंस्करण

- संभावित प्रोबायोटिक लैक्टोबैसिलस रमनोसस (एमटीसीसी–5897) के सुरक्षात्मक प्रभाव को डेक्सट्रान सल्फेट सोडियम (डीएसएस) प्रेरित म्यूरिन अल्सरेटिव कोलाइटिस मॉडल में स्थापित किया गया था, जो रोग गतिविधि सूचकांक में महत्वपूर्ण कमी, बेहतर हेमटोलॉजिकल और हिस्टोलॉजिकल स्कोर, आंतों के उपकला अवरोध प्रकार्य के सुदृढीकरण के साथ मेंटेन्ड इम्यून होमियोस्टेसिस के माध्यम से स्थापित किया गया था।
- हिस्टोन एच–3 एसिटिलीकरण के मॉड्यूलेशन के माध्यम से आंतों के उपकला कोशिकाओं में चयनित प्रतिरक्षा जीन (IL-6, IL-8, hBD-2 and NF- B) के प्रोबायोटिक लैक्टोबैसिली मध्यस्थता वाले एपिजेनेटिक विनियमन एक तनाव–विशिष्ट तरीके से हुआ।
- बकरी कैसिन और मट्ठा प्रोटीन हाइड्रोयसेट क्रमशः बकरी कैसिन और मट्ठा प्रोटीन की तुलना में बेहतर अग्नाशयी लाइपेस निषेध प्रदर्शित करता है। तुलना करने पर, मट्ठा प्रोटीन पीटीसी हाइड्रोलाइजेट में कैसिन प्रोटीन पीटीसी

recommended to the farmers for superior quality green and dry fodder production of maize.

- Genome-wide microRNAs of milk exosomes were profiled for the first time in buffalo.
- Using milk exosomes, a novel, chemical-free and non-mechanical method was established for the encapsulation and intercellular delivery of siRNA for wider therapeutic applications.
- Reverse transcription-loop mediated isothermal amplification (RT-LAMP) assay was developed for the detection of aryl hydrocarbon receptor (AhR) responsive xenobiotics.
- A proof-of-concept was established for lateral flow-based luteinizing hormone detection in urine for ovulation prediction in the buffaloes.
- -casein derived Peptide C down-regulated the expression of anti-osteogenic post transcriptional regulator, microRNA-300 (miR300), which regulates osteogenic Smad3/ -catenin/Runx2 signalling crosstalk with an alternate function as indicative biomarker in osteoporosis.
- The mechanical and biochemical responses of the cells were explored by the exposure of the Chinese Hamster Ovary (CHO-K1) cell line with the spiked mesoporous silica nanoparticle (MSN), multiwall carbon nanotubes (MWCNTs), and zinc oxide (ZnO) NPs.
- Studies established that there is an altered cytoskeleton dynamics for the activation of Rac-Rho signalling pathway, which would comprehensively assist as a sensitive early molecular readout for nanosafety assessment.
- Sahiwal milk is effective in ameliorating peptidoglycan induced inflammatory response in Caco-2 cells and rat model.

Processing

- Protective effects of potential probiotic Lactobacillus rhamnosus (MTCC-5897) fermented whey was established in dextran sulfate sodium (DSS) induced murine ulcerative colitis model through significant reduction in the disease activity index, improved hematological and histological scores, maintained immune homeostasis along with reinforcement of intestinal epithelial barrier function.
- Probiotic lactobacilli mediated epigenetic regulation of selected immune genes (IL-6, IL-8, hBD-2 and NF- B) in intestinal epithelial cells via the modulation of histone H-3 acetylation occurred in a strain-specific manner.

हाइड्रोलाइजेट की तुलना में बेहतर अग्नाशयी लाइपेस अवरोध क्षमता होती है।

- प्रोबायोटिक और सिनबायोटिक किण्वित दूध के लंबे समय तक सेवन ने एचएफडी फीडिंग के प्रतिकूल प्रभावों को कम किया और स्वास्थ्य स्पेक्ट्रम में सुधार करके नर और मादा चूहों के सामान्य शरीर क्रिया विज्ञान और बेहतर प्रजनन क्षमता से जुड़े मापदंडों को बहाल किया।
- ऊंटनी के दूध की एंटीडायबिटिक क्षमता को RIN-5F कोशिकाओं (अग्नाशयी बीटा कोशिकाओं) द्वारा ऊँट के दूध प्रोटीन हाइड्रोलाइजेट्स, विशेष रूप से पेप्सिन एंजाइम द्वारा व्हे प्रोटीन हाइड्रोलाइजेट्स के साथ उपचारित इंसुलिन स्राव में उल्लेखनीय वृद्धि को देखकर दर्शाया गया था।
- अपोलिपोप्रोटीन ए1 और सेरुलोप्लास्मिन एक इन–सिलिकोट्रांससक्रिप्टम–आधारित नेटवर्क विश्लेषण द्वारा भैंसों के प्रारंभिक प्रसवोत्तर के दौरान जिगर और वसा ऊतक के बीच प्रमुख क्रॉसस्टॉक कारकों के रूप में पाए गए थे।
- प्रोबायोटिक लैक्टोबैसिलस फेरमेंटम–400 का अनुप्रयोग और इसका संयोजन पशु के शारीरिक, शारीरिक और जैव रासायनिक प्रोफाइल को नियंत्रित कर सकता है।
- टॉरिन का ओवेरियन फॉलिक्युलर टेस्टोस्टेरोन के साथ सकारात्मक संबंध था और खेत की स्थितियों में प्रसवोत्तर अमदकाल में मुर्राह भैंसों में इसका सीरम स्तर कम दिखाई देता है।
- एक पायलट अध्ययन से पता चला है कि महामृत्युंजय मंत्र या वैदिक मंत्रों ने 3डी–संवर्धित भैंस ग्रैनुलोसा सेल स्फेरॉइड मॉडल सिस्टम में एरोमाटेज जीन अभिव्यक्ति को बढ़ाया है।
- भैंस में माइटोकॉन्ड्रियल प्रोटीन–कोडिंग जीन अभिव्यक्ति और OXPHOS गतिविधियों में भिन्नता का एक हैप्लोटाइप–विशिष्ट पैटर्न है
- भैंस में mtDNA जीनोमिक्स फुटप्रिंटिंग साइटों के ऊतक–विशिष्ट पैटर्न देखे गए।
- सेल ध्रुवीकरण मेसोपोरस सिलिका नैनोपार्टिकल, मल्टीवॉल्ड कार्बन नैनोट्यूब और जिंक ऑक्साइड नैनोपार्टिकल–प्रेरित सेलुलर साइटोस्केलेटन की कमी से जुड़ा हुआ है।
- लैक्टोबैसिलस फेरमेंटम एनसीडीसी 400 में शामिल सिनबायोटिक डेरी उत्पाद एंटीऑक्सिडेंट, मोटापा–रोधी और हेपाटो–सुरक्षात्मक गुणों का प्रदर्शन करता है।
- कच्चे और पाश्चुरीकृत दूध में बैक्टीरिया की कुल संख्या का पता लगाने के लिए एक PANI-PEC पेपर स्ट्रिप सेंसर विकसित किया गया है, जिसमें 4) hat 37°C के भीतर 4 लॉग सीएफयू/एमएल की पहचान सीमा होती है।
- संक्रमण के बाद पंचामृत का सेवन आईएल–10 और आईएल–8 जैसे एंटी और प्रो–इंफ्लेमेटरी साइटोकिन्स दोनों को नियंत्रित कर सकता है।
- Ogs मीडिया 1:1, 2:1 और 1:2 (कोलोस्ट्रम मट्ठाः पनीर मट्ठा) के विभिन्न अनुपातों में 12–48 घंटे के लिए इनोकुलेटिंग

- Goat casein and whey protein hydroysates exhibit better pancreatic lipase inhibition than goat casein and whey protein, respectively. On comparison, whey protein PTC (pepsin, trypsin and chymotrypsin) hydrolysates have better pancreatic lipase inhibition potential than the casein protein PTC hydrolysates.
- Prolonged consumption of probiotic and synbiotic fermented milk attenuated the adverse effects of HFD (high fat diet) feeding, restored the normal physiology and improved fertility parameters of male and female mice by improving their health spectrum.
- Antidiabetic potential of camel milk was depicted by observing a significant increase in insulin secretion by the RIN-5F cells (pancreatic beta cells) treated with camel milk protein hydrolysates, especially whey protein hydrolysates by the pepsin enzyme.
- Apolipoprotein A1 and Ceruloplasmin were found as the key crosstalk players between the liver and adipose tissue during early postpartum of buffaloes by an in-silicotranscriptome-based network analysis.
- Administration of probiotic Lactobacillus fermentum-400 and its combination may regulate the physical, physiological and biochemical profile of animal.
- Taurine had a positive correlation with ovarian follicular testosterone, and its serum levels appear to be lower in postpartum anestrus Murrah buffaloes in the field conditions.
- A pilot study revealed that the Mahamrityunjaya mantra or vedic chants enhanced the aromatase gene expression in 3D-cultured buffalo granulosa cell spheroids model system.
- There is a haplotype-specific pattern of variation in mitochondrial protein-coding genes expression and OXPHOS activities in buffalo
- Tissue-specific patterns of mtDNA genomics footprinting sites were observed in buffalo.
- Cell polarisation is linked to Mesoporous Silica Nanoparticle, Multiwalled Carbon Nanotubes and Zinc Oxide nanoparticle-induced reduction of cellular cytoskeleton.
- Lactobacillus fermentum NCDC 400 incorporated synbiotic dairy product exhibited antioxidant, anti-obesity and the hepato-protective properties.
- A PANI-PEC paper strip sensor was developed for the detection of total bacterial count in raw and pasteurized milk with a detection limit of 4 log cfu/ml within 4½ hat 37°C.

कल्चर (1–2 प्रतिशत एकाग्रता) द्वारा प्रोटीन युक्त किण्वित मट्ठा पेय तैयार करने के लिए 37 डिग्री सेल्सियस और चीनी सांद्रता (8–12 प्रतिशत) पर अनुकूलित विधि।

- दूध में लैक्टम एंटीबायोटिक दवाओं का पेपर स्ट्रिप आधारित पता लगाने के लिए अवधारणा का एक प्रमाण विकसित किया गया था, जो बेसिलस बीजाणुओं को अंकुरित करने में –लैक्टेमेस एंजाइम को शामिल करने पर काम करता है।
- 30 मिनट के भीतर उप–नैदानिक और नैदानिक थनैला का शीघ्र पता लगाने के लिए पेपर स्ट्रिप परीक्षण विकसित किया गया था जिसमें थनैला दूध में मौजूद दैहिक कोशिकाओं द्वारा जारी मार्कर एंजाइम का उपयोग किया गया था।
- एक्वा–उत्पादों में ऐंटीबायोटिक समूहों का तेजी से पता लगाने के लिए एक बीजाणु आधारित तकनीक विकसित की गई थी।
- दूध में भारी धातुओं का पता लगाने के लिए पेपर स्ट्रिप आधारित सेंसर विकसित किया गया।
- डेरी खमीर Kluyveromyces lactis NCDC 257 और स्वदेशी प्रोबायोटिक स्ट्रेन लैक्टोबैसिलस प्लांटारम MTCC 5690 की सह–प्रकृति का उपयोग करके प्राकृतिक रूप से कार्बोनेटेड मट्ठा आधारित प्रोबायोटिक पेय तैयार करने के लिए एक प्रक्रिया को अनुकूलित किया गया।
- स्वदेशी (गिर, साहीवाल और थारपारकर) और क्रॉसब्रेड (करण फ्रीज) मवेशियों के दूध के मेटाजेनोम और मेटाबॉलिक प्रोफाइलिंग ने उच्च माइक्रोबियल विविधता का खुलासा किया और चयापचय उंगलियों के निशान इन नस्लों के लिए अद्वितीय थे।
- स्वदेशी प्रोबायोटिक L. rhamnosus VTCCDM 179B विकृति के पूरे जीनोम को डीसाइफर कर दिया गया है।
- आयरन बाइंडिंग LAB strain L. rhamnosus Kar 1/ VTCCDM 314B ने उच्चतम (65.49±0.62%) फेरस सल्फेट जटिल क्षमता दिखाई।
- डेरी पशुओं में उपनैदानिक थनैला का पता लगाने के लिए एंजाइम सब्सट्रेट आधारित पट्टी विकसित की।
- डेरी पशुओं में उपनैदानिक थनैला का पता लगाने के लिए एंजाइम सब्सट्रेट आधारित पट्टी विकसित की।
- बहुऔषध ड्रग प्रतिरोधी थनैला के नियंत्रण के लिए पौधों के जैविक अणुओं की पहचान की गई, जो समय–समय पर रोगजनकों को मारते हैं।
- कैसिनेट आधारित रोगाणुरोधी पैकेजिंग प्रणाली विकसित की गई थी जिसमें लैक्टिक एसिड बैक्टीरिया के रोगाणुरोधी चयापचयों को शामिल किया गया था।
- कोलाइटिस चूहों के मॉडल में स्वदेशी प्रोबायोटिक लैक्टोबैसिलस उपभेदों से प्राप्त लिपोटेइकोइक एसिड के सूजनरोधी प्रभाव का प्रदर्शन किया गया था।
- गाय के दूध में भैंस के दूध का तेजी से पता लगाने के लिए एक कार्बन नैनोपार्टिकल आधारित लेटरल फ्लो प्रतिरक्षा

- Consumption of Panchamrit after infection may regulate both anti and pro-inflammatory cytokines like IL-10 and IL-8.
- Optimized method for preparation of protein rich fermented whey beverage by inoculating cultures (1-2% concentration) in different proportions of whey media 1:1, 2:1 and 1:2 (colostrum whey: cheese whey) for 12-48 h at 37°c and sugar concentration (8-12%).
- A proof of concept was developed for paper strip based detection of -lactam antibiotics in milk, which works on the induction of -lactamase enzyme in germinating bacillus spores.
- Paper strip test for early detection of sub-clinical and clinical mastitis within 30 min was developed employing a marker enzyme released by somatic cells present in mastitis milk.
- A spore based technology was developed for rapid detection of antibiotic groups in aqua-products.
- Paper strip based sensor was developed for detection of heavy metals in milk.
- A process was optimized for the preparation of a naturally carbonated whey based probiotic drink using a co-culture of dairy yeast Kluyveromyces lactis NCDC 257 and indigenous probiotic strain Lactobacillus plantarum MTCC 5690.
- Metagenome and metabolome profiling of milk from indigenous (Gir, Sahiwal and Tharparkar) and crossbred (Karan Fries) cattle revealed high microbial diversity and metabolic fingerprints unique to the breeds.
- The whole genome of indigenous probiotic L. Rhamnosusn VTCCDM 179B strain has been deciphered.
- Iron binding LAB strain L. rhamnosus Kar 1/ VTCCDM 314B showed highest (65.49±0.62%) ferrous sulphate complexing ability.
- Developed an enzyme-substrate based strip for the detection of subclinical mastitis in dairy animals.
- Developed a cost effective whey based formulation for Probiotic biomass production for direct vat starters.
- Identified plant biomolecules for control of multidrug drug resistant mastitis causing pathogens by time kill assay.
- Caseinate based antimicrobial packaging system was developed containing antimicrobial metabolites from Lactic acid bacteria for traditional Indian dairy products.

परीक्षण विकसित किया गया।

- विभिन्न संकेतकों का उपयोग करके शुद्ध प्रणाली में 1 प्रतिशत के स्तर पर सोर्बिटोल का पता लगाने के लिए एक गुणात्मक विधि विकसित की गई थी।
- संदेश के निर्माण हेतु उच्च दूध प्रोटीन पाउडर के निर्माण के लिए एक प्रक्रिया को अनुकूलित किया गया था।
- एक वॉश आरएम–प्रोटोकॉल को घी में आरएम–एडजस्टर का पता लगाने के लिए मानकीकृत किया गया था, जिसकी पहचान सीमा 1 प्रतिशत थी।
- स्किम दूध के कृत्रिम परिवेषीय (इन विट्रो) जठरांत्र पाचन में व्युत्पन्न पेप्टाइड्स के आरपी–एचपीएलसी प्रोफाइल ने मवेशियों की विभिन्न देशी नस्लों (साहीवाल, थारपारकर और गिर) के पाचन व्यवहार पर कोई महत्वपूर्ण अंतर नहीं दिखाया।
- उच्च प्रोटीन फैलाव में दूध प्रोटीन के बीच गर्मी प्रेरित अंतःक्रियाओं का मूल्यांकन करने के लिए एक प्रतिदीप्ति स्पेक्ट्रोस्कोपी–आधारित पद्धति को मानकीकृत किया गया था।
- दूध और घी पैकेजिंग पॉलिमर से संभावित विकल्पों की पहचान के लिए गैर–लक्षित जीसी–एमएस पद्धति को अनुकूलित किया गया था।
- भापा (स्टीम्ड) संदेश, भैंस के दूध से प्रोबायोटिक रिकोटा पनीर, बकरी के दूध पर आधारित कार्यात्मक पेय, अल्ट्राफिल्ट्रेशन रिटेंटेट से संसाधित पनीर, लस मुक्त मल्टीग्रेन सेंवई खीर और इसके तत्काल मिश्रण आदि जैसे उत्पादों के लिए विनिर्माण प्रोटोकॉल विकसित किया।
- हरे विलायक का उपयोग करते हुए, खाद्य अनुप्रयोग के लिए गाजर जैव–अपशिष्ट से कैरोटेनॉयड्स निकाले गए।
- दूध–बाजरा पूरक भोजन के लिए ऑन–पैकेज ताजगी संकेतक विकसित किया गया।
- संदेश के लिए ऑन–पैकेज वर्णमिति ताजगी संकेतक विकसित किया गया।
- पहली बार ऊंटनी के दूध से पके पनीर की तकनीक विकसित की गई है।
- गैसगासे पायसम के लिए सुविधा मिश्रण के लिए प्रक्रिया प्रौद्योगिकी विकसित की गई थी। रंग और स्वाद के संवेदी गुणों के मामले में ड्राई–क्रिस्टलीकरण दृष्टिकोण का उपयोग करके तैयार किया गया उत्पाद बेहतर था।
- खेत में दूध को ठंडा करने की सुविधा के लिए 5–6 लीटर दूध की हैंडलिंग क्षमता का एक पात्र डिजाइन और विकसित किया गया।
- दक्षिण भारत में संगठित और असंगठित डेरी उत्पादन स्थितियों के तहत रोगाणुरोधी के उपयोग पैटर्न का अध्ययन किया गया।
- डेरी संयंत्रों में सीआईपी के स्वचालन के लिए एक चल और

- Anti-inflammatory effect of Lipoteichoic acids derived from indigenous probiotic Lactobacillus strains was demonstrated in the colitis mice model.
- A carbon nanoparticle based lateral flow immunoassay was developed for rapid detection of buffalo milk in cow milk.
- A qualitative method for the detection of sorbitol at 1% level in pure system using different indicator was developed.
- A process for the manufacture of high milk protein powder for formulation of Sandesh was optimized.
- A wash RM- protocol was standardized for the detection of RM-adjustor in ghee with detection limit of 1%.
- RP-HPLC profile of peptides derived following in vitro gastrointestinal digestion of skim milk indicated no significant difference on digestion behaviour among different indigenous breeds of cattle (Sahiwal, Tharparkar and Gir).
- A fluorescence spectroscopy-based method was standardized to evaluate heat induced interactions between milk proteins in high protein dispersions.
- Non-targeted GC-MS method was optimized for identification of potential migrants from milk and ghee packaging polymers.
- Developed the manufacturing protocols for products such as Bhapa (Steamed) Sandesh, Probiotic Ricotta cheese from buffalo milk, goat milk based functional beverage, processed cheese from ultrafiltration retentate, gluten free multigrain vermicelli kheer and its instant mix etc.
- Carotenoids from carrot bio-waste extracted for food applications using green solvent.
- On-package freshness indicator developed for milk-millet complementary food.
- On-package colorimetric freshness indicator developed for sandesh.
- Technology of ripened cheese manufactured from camel milk for the first time.
- Process technology for convenience mix of Gasagase payasam was developed using the dry-crystallization approach.
- A pail of 5-6 lit milk handling capacity was designed and developed to facilitate the on-farm chilling of milk. .
- Antimicrobial's usage pattern was studied under

स्टैंडअलोन इलेक्ट्रोकेमिकल सेंसिंग सिस्टम विकसित किया गया था।

- ''दही के लिए पीएच–कंट्रोलर आधारित स्वचालित एंडो–एक्सो यूनिट का विकास'' पर एक पेटेंट आवेदन पेटेंट कार्यालय, नई दिल्ली (पेटेंट आवेदन संख्याः 202011046532; दिनांकः 26.10.2020) को प्रस्तुत किया गया था।
- विमन्दन कोण, स्थैतिक घर्षण के गुणांक और आंतरिक घर्षण के गुणांक के मापन के लिए प्रयोगात्मक सेटअपों को डिजाइन और गढ़ा गया। विमन्दन कोण, स्थिर घर्षण का गुणांक, थोक घनत्व और सांद्र मिश्रण (मवेशी चारा) की नमी की मात्रा निर्धारित की गई थी।

प्रबंधन

- देश के संगठित डेरी प्रसंस्करण उद्योग में, 1991–2017 के दौरान पूंजी के हिस्से में लगातार वृद्धि (1.8 प्रतिशत से 63.7 प्रतिशत तक) दिखाई दी।
- संगठित डेरी प्रसंस्करण उद्योग के एक अपघटन विश्लेषण से पता चला है कि भारत में डेरी उद्योग की लाभप्रदता 5.9 प्रतिशत प्रति वर्ष की दर से बढ़ी है, जो मुख्य रूप से उत्पादन (4.2 प्रतिशत) और कुल कारक उत्पादकता (टीएफपी)(2.8 प्रतिशत) में वृद्धि से अभिप्रेरित थी।
- डेरी उत्पादों के लिए लागत दक्ष उत्पादन प्रौद्योगिकियां और मूल्य वातावरण फर्मों को अपने उत्पादन और निवेश को बढ़ाने के लिए प्रोत्साहित करेगा।
- टीई 2016–17 के दौरान औसतन सकल फसली क्षेत्रों की प्रति हेक्टेयर कुल सब्सिडी 10467 रुपये थी, जो सालाना आधार पर 0.20 प्रतिशत की दर से बढ़कर टीई 2008–09(रु. 201791 करोड़) से टीई 2016–17(रू. 202628 करोड़) हो गई।
- इनपुट और सेवाओं पर सब्सिडी के कुल आवंटन में फसल क्षेत्र का बड़ा हिस्सा (98 से 99%) था, जबकि पशुधन क्षेत्र में कुल सब्सिडी का केवल एक से दो प्रतिशत हिस्सा था।
- पशुधन क्षेत्र में, पशु चिकित्सा और स्वास्थ्य सेवाओं पर सब्सिडी का हिस्सा सबसे अधिक था जबकि पशुधन बीमा पर सब्सिडी सबसे कम थी।
- फसल सब्सिडी उच्च कृषि विकास सूचकांक (एडीआई) वाले राज्यों के प्रति पक्षपाती थी जबकि पशुधन सब्सिडी का आवंटन राज्यों के बीच अधिक न्यायसंगत तरीके से किया गया था।
- दूध के उत्पादक मूल्य में एक प्रतिशत की वृद्धि के परिणामस्वरूप देश के उत्तरी क्षेत्र में दूध उत्पादन में 0.8 प्रतिशत की वृद्धि (107.2 मिलियन रुपये प्रति वर्ष) हुई, जिसमें हरियाणा, हिमाचल प्रदेश, जम्मू–कश्मीर, पंजाब, यूपी और उत्तराखंड जैसे राज्य शामिल थे।
- बटर_घी और चीज_पनीर पर जीएसटी में 50 प्रतिशत की कमी से घरेलू (एचएच) स्तर पर इन उत्पादों की मांग क्रमशः 1.99 फीसदी और 3.16 प्रतिशत बढ़ जाएगी।

organized and unorganized dairy production conditions in southern India.

- A movable and standalone electrochemical sensing system for automation of CIP in dairy plants was developed.
- A patent application on "Development of pH-controller based automated endo-exo unit for dahi" was submitted to Patents office, New Delhi (PATENT Application No.: 202011046532; Dated: 26.10.2020).
- The experimental setups for measurement of angle of repose, coefficient of static friction and coefficient of internal friction were designed and fabricated. The angle of repose, coefficient of static friction, bulk density and moisture content of concentrate mixture (cattle feed) was determined.

MANAGEMENT

- Organised dairy processing industry of the country was found capital intensive as the share of capital showed consistent increase (from 1.8 % to 63.7 %) during 1991-2017.
- Profitability of dairy industry in India grew at a rate of 5.9 per cent per annum, which was mainly driven by the growth in output (4.2%) and Total Factor Productivity (TFP) (2.8 %).
- Cost efficient production technologies and price environment for dairy products would incentivise the firms to scale up their production and investment.
- On an average, total subsidy per hectare of gross cropped areas was Rs.10467 during TE 2016-17, which grew at the rate of 0.20 per cent on yearly basis from TE 2008-09 (Rs. 201791 crores) to TE 2016-17 (Rs.202628 crores).
- Crop sector accounted for major share (98 to 99%) in total allocation of subsidies on inputs and services, while the livestock sector accounted only for one to two per cent of the total subsidy.
- In livestock sector, the subsidy on veterinary and health services had the highest share while the subsidy on livestock insurance was the least.
- Crop subsidy was biased towards states with high Agriculture Development Index (ADI) while the allocation of livestock subsidy was distributed in more equitable manner among states.
- One per cent increase in producer price of milk results into 0.8 per cent increase in milk production (Rs.107.2 million per annum) in states like Haryana, HP, J&K, Punjab, UP and Uttrakhand.

- दूध की मांग में कमी, अप्रैल से जून, 2020 में कोविड–19 महामारी लॉकडाउन के कारण भारतीय डेरी किसानों को प्रति दिन 1123 मिलियन रुपये की आर्थिक हानि हुई।
- भाकृअनुप–राडेअनुसं की 'दूध में मिलावट का तेजी से पता लगाने की प्रौद्योगिकी से 2018–19 में वार्षिक लाभ 174.44 करोड़ रुपये था।
- गुजरात में समूह के सदस्य बनने पर चर जैसे पशुधन स्वामित्व (आय का प्रमुख स्रोत), डेरी में अनुभव, शैक्षिक कार्यक्रम (ईपी), तकनीकी कार्यक्रम (टीपी), और ग्रुप मोबिलाइजेशन (जीएम) की विस्तार सेवाएं, और औसत दूध उपज (4.4 लीटर प्रति दिन)सकारात्मक और महत्वपूर्ण प्रभाव डालते हैं।
- राजस्थान में स्वयं सहायता समूह (एसएचजी) का डेरी पशुओं की उत्पादकता, घर की आय और महिला सशक्तिकरण पर सकारात्मक प्रभाव पड़ा।
- गोजातीय आबादी (43.47:) वाले तमिलनाडु के उत्तर पूर्वी और दक्षिणी क्षेत्र (30 में से 12 जिले) अत्यधिक सूखे की चपेट में पाए गए।
- अर्थमितीय परिणाम दर्शाते हैं कि भाकृअनुप–राडेअनुसं प्रशिक्षुओं ने डेरी मूल्य श्रृंखला में तुलनात्मक रूप से बेहतर लाभ अर्जित किया।
- डेरी आधारित एकीकृत कृषि प्रणाली (आईएफएस) से शुद्ध लाभ रु. 3.92 लाख/वर्ष डेरी घटक (59.89 प्रतिशत) के उच्चतम योगदान के साथ इसके बाद फसल घटक (गेहूं, चावल और जई) से 32.75 प्रतिशत और शेष सहायक उद्यमों (पोल्ट्री, मत्स्य पालन और वर्मिन–खाद, आदि) से 7.36 प्रतिशत था। लाभ लागत अनुपात 1.60 प्रणाली की वित्तीय व्यवहार्यता को दर्शाता है।

शिक्षा

- वर्ष 2020 के दौरान आईडीपी (एनएएचईपी) परियोजना के द्वारा चार व्यापक उद्देश्यों के तहत निम्नलिखित गतिविधियों अर्थात् अकादमिक कार्यक्रमों को मजबूत करना, पूर्व छात्रों के नेटवर्क का लाभ उठाना, छात्रों की सॉफ्ट स्किल का पोषण करना और इक्विटी एक्शन प्लान प्लस ग्रीन कैंपस पहल का संचालन किया गया।
- 16 संकाय सदस्यों को अंतर्राष्ट्रीय प्रशिक्षण के लिए चुना गया और जिनमें से 7 संकाय सदस्यों ने 2020 के दौरान संयुक्त राज्य अमेरिका एवं नीदरलैंड स्थित 6 विभिन्न विश्वविद्यालयों में प्रशिक्षण प्राप्त किया।
- भाकृअनुप–राडेअनुसं, करनाल में संभावित उद्यमियों की मदद के लिए सोसाइटी आउटरीच गतिविधि के एक भाग के रूप में 18–27 फरवरी, 2020 के दौरान ''स्टार्टर कल्चर और किण्वित दूध उत्पाद'' पर एक प्रमाणपत्र पाठ्यक्रम आयोजित किया गया।
- 20–24 जनवरी 2020 के दौरान ''डेयरिंग में कंप्यूटर विजन एप्लीकेशन'' पर एक कार्यशाला का आयोजन किया गया।

- ·The reduction in GST on butter_ghee and cheese_paneer will increase demand of these products at household (HH) level by 1.99% and 3.16%, respectively.
- The economic losses to the dairy farmers were to the extent of Rs.1123 million per day due to COVID-19 pandemic lockdown from April to June, 2020.
- The annual benefits from ICAR-NDRI technology 'Rapid Detection of Adulterants in Milk' were Rs.174.44 crore in 2018-19.
- The variables like livestock ownership, experience in dairying, extension services, Group Mobilisation (GM), and average milk yield (of 4.4 litres per day) have a positive and significant effect on becoming member of dairy farmer collectives in Gujarat.
- Self Help Group (SHGs) had positive impact on productivity of dairy animals, income of the household, and women empowerment in Rajasthan.
- North Eastern and Southern zones (12 districts out of 30) of Tamil Nadu having Bovine population (43.47%) were found highly drought vulnerable.
- The econometric results show that ICAR-NDRI trainees realised comparatively more profit than non-trainees in dairy value chain. Food safety score was also found positively and significantly associated with profitability.
- The net return from dairy based integrated farming system (IFS) was Rs. 3.92 lakh/ year with highest contribution from dairy component (59.89%) followed by 32.75% from crop component (wheat, rice and oat) and remaining 7.36% from subsidiary enterprises (poultry, fishery and vermin-compost, etc.). The benefit cost ratio was 1.60 indicating the financial viability of the system.

EDUCATION

- The following 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 2020:
- 16 faculty members were selected for international training and out of which 7 faculty members underwent training at 6 different universities located in USA and Netherlands during 2020.
- A Certificate course on "Starter Culture and Fermented Milk Products" was organized during 18-27 February, 2020 at ICAR-NDRI, Karnal as a part of Society outreach activity to help prospective entrepreneurs.

- 3–5 मार्च, 2020 के दौरान ''चयापचयः मूल सिद्धांत और अनुप्रयोग'' पर एक कार्यशाला का आयोजन किया गया।
- राडेअनुसं के पूर्व छात्रों की मदद से ''प्रबंधन में उच्च शिक्षा के अवसर'' विषय पर एक वेबिनार और ''डेटा एनालिटिक्स'' पर कार्यशाला का आयोजन किया गया था, जो पूर्व छात्रों द्वारा छात्रों की वर्चुअल मेंटरिंग की प्रतिबद्ध परियोजना गतिविधि के एक भाग के रूप में आयोजित किया गया।
- स्नातक के विद्यार्थियों हेतु रोजगार के अवसर बढ़ाने के लिए ''व्यक्तित्व विकास'' और ''उद्यमी कौशल विकास'' विषयों पर वेबिनार आयोजित किए गए।
- विद्यार्थियों एवं फैकल्टी के लाभ के लिए वर्चुअल माध्यम से एक कार्यशाला और नौ वेबिनार का आयोजन किया गया।

विस्तार

- खाद्य प्रसंस्करण उद्योग मंत्रालय, भारत सरकार सरकार की मध्यम और लघु उद्यम योजना (पीएम–एफएमई) योजना के तहत प्रधानमंत्री के तत्वावधान में डेरी प्रसंस्करण पर मास्टर प्रशिक्षकों के लिए ऑनलाइन प्रशिक्षण एवं भारतीय खाद्य प्रसंस्करण प्रौद्योगिकी संस्थान (आईआईएफपीटी), तंजावुर द्वारा इसे प्रायोजित किया गया। करनाल, पानीपत, सोनीपत जिले की संभावित महिला उद्यमियों को दूध और दूध उत्पादों के प्रसंस्करण (दही, पनीर, घी आदि) पर एक डीएसटी–वित्त पोषित परियोजना के तहत प्रशिक्षण दिया गया।
- विस्तार शिक्षा संस्थान (दक्षिणी क्षेत्र), कृषि और सहकारिता और किसान कल्याण विभाग, पीजेटीएसएयू परिसर, राजेंद्रनगर, हैदराबाद में डेरी उत्पाद और समग्र डेरी खाद्य पदार्थों के मूल्य संवर्धन और प्रसंस्करण के क्षेत्र में नवीनतम विकास पर हितधारकों के लिए आयोजित वर्चुअल प्रशिक्षण कार्यक्रमों के लिए फैकल्टी ने संसाधन व्यक्तियों के रूप में कार्य किया।
- फील्ड–फार्म तकनीशियन (एफएफटी) प्रयोगशाला के तहत कुल 19 इनफर्टिलिटी और पशु चिकित्सा सहायता अभियान आयोजित किए गए और इन अभियानों के दौरान कुल 1333 जानवरों का इलाज किया गया। इसके अलावा, अच्छी पशुपालन प्रथाओं के बारे में किसानों में जागरूकता फैलाने के लिए 19 किसान संगोष्ठियों का आयोजन किया गया।
- 15 से 17 फरवरी, 2020 के दौरान राष्ट्रीय डेरी मेला–2020 का आयोजन किया गया जिसमें उत्तर प्रदेश, हरियाणा, पंजाब, दिल्ली और राजस्थान जैसे विभिन्न राज्यों के 15000 से अधिक आगंतुकों ने भाग लिया।
- कृषि विकास केन्द्र के द्वारा फसलों, पशुधन, मछली पालन और मधुमक्खी पालन के विभिन्न पहलुओं को शामिल करते हुए लगभग 150 आवश्यकता आधारित प्रशिक्षण कार्यक्रम आयोजित किए गए। इनमें 50000 से अधिक प्रतिभागी लाभान्वित हुए।
- कृषि विकास केन्द्र ने कोविड–19 महामारी के दौरान 5 ऑनलाइन प्रशिक्षण–सह–वेबिनार का भी आयोजन किया और कुल 1540 किसान लाभान्वित हुए।

- A workshop on "Computer vision applications in dairying" was organized during 20-24 January 2020.
- A workshop on "Metabolomics: Basic Principles and Application" was organized during 3 – 5 March, 2020.
- A Webinar on the topics "Higher education opportunities in Management" and Workshop on "Data analytics" were organized with the help of NDRI alumnus as a part of the committed project activity virtual mentoring of students by Alumni.
- Webinars on the themes "Personality development" and "Entrepreneurial skill development" were organized to enhance employment opportunities for the UG students.
- One workshop and nine webinars were organized for the benefit of the students and the faculty in virtual mode.

EXTENSION

- Online Training for Master Trainers on Dairy Processing was organised under the aegis of Prime Minister's-Formulation of Medium and Small Enterprises (PM-FME) Scheme of MOFPI, Govt. of India and sponsored by Indian Institute of Food Processing Technology (IIFPT), Thanjavur.A training was imparted to potential women entrepreneurs from Karnal, Panipat, Sonepat district on milk and milk products processing (dahi, paneer, ghee etc.) under a DST-funded project
- Faculty served as resource persons for Virtual Training Programs conducted for stakeholders at the Extension Education Institute (Southern Region), Department of Agriculture & Cooperation & Farmer's Welfare, PJTSAU Campus, Rajendranagar, Hyderabad on latest developments in the area of Value Addition and Processing of Dairy Products and Composite Dairy Foods.
- A total of 19 infertility and veterinary aid campaigns were organized under Field-Farm Technician (FFT) Laboratory and a total of 1333 animals were treated during these campaigns. Besides, 19 Kisan Sangosthies were organized to impart awareness among farmers on good animal husbandry practices.
- National Dairy Mela-2020 was organised during 15 to 17 February, 2020, in which more than 15000 visitors from different states like Uttar Pradesh, Haryana, Punjab, Delhi and Rajasthan have participated.
- Around 150 need based trainings programmes covering various aspects of crops, livestock, fish farming and bee keeping were organised by KVK. More than 50000 participants were benefited.

आधारभूत संरचना

- आईडीपी–एनएएचईपी परियोजना के तहत, छात्रों को भाषा कौशल प्रदान करने में सहायता के लिए अत्याधुनिक श्रव्य–दृश्य उपकरणों के साथ एक आधुनिक भाषा प्रयोगशाला स्थापित की गई थी। प्रयोगशाला को विभिन्न आत्म–वृद्धि और सॉफ्ट स्किल विकास गतिविधियों के लिए छात्रों द्वारा प्रभावी ढंग से उपयोग किया जाना है। संस्थान की भाषा प्रयोगशाला हाई एंड एडवांस्ड कान्फिगुरेशन के साथ मास्टर कंप्यूटर, 75" स्क्रीन आकार के साथ एक इंटरैक्टिव टच डिस्प्ले, डिजिटल टच पैड, बिल्ट–इन माइक्रोफोन के साथ वीडियो कॉन्फ्रेंसिंग कैमरा, लैन आधारित डिजिटल इंटरएक्टिव के साथ 25 भाषाओं के लाइसेंस प्राप्त मॉड्यूल से सुसज्जित है। नवीनतम संस्करण का भाषा प्रयोगशाला सॉफ्टवेयर, जिसमें अंग्रेजी, फ्रेंच, जर्मन, स्पेनिश आदि सहित विभिन्न भाषा मॉड्यूल शामिल हैं। प्रयोगशाला 24 कंप्यूटरों और पर्याप्त संख्या में फर्नीचर के साथ स्थापित की गई है।
- जिला करनाल (हरियाणा) के खेरीमानसिंह गांव में कृत्रिम गर्भाधान(ए.आई.) केंद्र का एक नया भवन बनकर तैयार हुआ और 7 फरवरी, 2020 को इसका उद्घाटन किया गया।
- जल संरक्षण के उद्देश्य से छात्रावास, खेल परिसर, अतिथि गृह और प्रशासनिक भवन परिसर में कुल 13 एकड़ के लॉन क्षेत्र को कवर करने के लिए छिड़काव जल सिंचाई प्रणाली स्थापित की गई।
- यूजीसी अनुदान से स्वचालित नाइट्रोजन विश्लेषक खरीदा गया।
- भाकृअनुप–राडेअनुसं, करनाल में पुस्तकालय भवन का विस्तार।
- भाकृअनुप–राडेअनुसं, करनाल में कृषि विज्ञान केन्द्र साइड सीवेज संप कुएं से शॉपिंग कॉम्प्लेक्स तक सीवर लाइन की मरम्मत और प्रतिस्थापन।
- भाकृअनुप–राडेअनुसं, करनाल में आवासीय सड़क और कृषि सड़कों पर 25 मिमी मोटी प्रीमिक्स कारपेटिंग उपलब्ध कराना।
- भाकृअनुप–राडेअनुसं, करनाल के 'सी' टाइप आवासों की फ्लोरिंग की मरम्मत एवं नवीनीकरण, अंदर/बाहर की पूरी पेंटिंग।
- भाकृअनुप–राडेअनुसं, करनाल के पशु जैवरसायन/डेरी रसायन/डेरी प्रौद्योगिकी/डेरी अभियांत्रिकी/उत्पादन भवन में सीमेंट कंक्रीट रैंप प्रदान करना।
- बिजली के इंस्टालेशनों सहित पशुधन आश्रय, फीड मेन्जर, पाइप रेलिंग, पैडॉक फर्श, एमएस गेट, छत, पेंटिंग आदि की मरम्मत और रखरखाव।
- गेस्ट हाउस, भाकृअनुप–राडेअनुसं, करनाल के लिए पीवीसी वॉल पैनल उपलब्ध कराना।
- KVK also organized 5 online training-cum-webinar during COVID-19 pandemic and a total of 1540 famers were benefited

INFRASTRUCTURE

- Under IDP-NAHEP project, a Modern Language Laboratory with the state-of-the-art audio-visual equipment was set up to aid in imparting language skills to the students. The laboratory is to be effectively utilized by the students for various self-enhancement and soft skill development activities. The language laboratory of the institute is equipped with master computer with high end advanced configuration, an interactive touch display with 75" screen size, digital touch pad, video conferencing camera with built-in microphone, licensed modules of 25 languages with LAN based digital interactive language lab software of latest version, comprising of different language modules including English, French, German, Spanish, etc. The laboratory has been set up with 24 computers and adequate number of furniture.
- A new building of AI center at village Kherimansigh, district Karnal (Haryana) was completed and inaugurated on Feb. 7, 2020.
- Sprinkler water irrigation system was installed to cover total lawn areas of 13 acres in hostel, sports complex, guest house and administrative building premises with an aim to conserve water.
- Automatic nitrogen analyser was procured from UGC grant.
- Extension of Library Building at ICAR-NDRI, Karnal.
- Repair & Replacement of sewer line from KVK side sewage sump well up to shopping complex at ICAR-NDRI, Karnal.
- Providing 25mm thick premix carpeting on residential road & farm roads at ICAR-NDRI, Karnal.
- Repair and renovation of flooring of 'C type quarters complete inside/outside painting at ICAR-NDRI, Karnal.
- Providing of cement concrete ramp to the ABC/DC/DT/DE/ Production building at ICAR-NDRI, Karnal.
- Repair and maintenance of Livestock Shelter, Feed manger, pipe ralling, paddock flooring, MS gates, roofs, painting etc. including electric installations.
- Providing PVC Wall Panel for Guest House, ICAR-NDRI, Karnal.

- पशुधन अनुसंधान केन्द्र, भाकृअनुप–राडेअनुसं, करनाल के आईएफएससी परियोजना शेड की आंतरिक और बाहरी पेंटिंग।
- सभागार भवन, भाकृअनुप–एनडीआरआई, करनाल के टूटे शीशे और रबर गास्कैट को बदलना।
- भाकृअनुप–राडेअनुसं, करनाल के टाइप ई आवासों के पास के लॉन में पानी के फव्वारे का नवीनीकरण।
- पषु जैव प्रौद्योगिकी केन्द्र, भाकृअनुप–राडेअनुसं, करनाल में आईवीएफ लैब में आरसीसी स्लैब के तहत एल्युमिनियम अलमारी का पत्ता उपलब्ध कराना और लगाना।
- भाकृअनुप–राडेअनुसं, करनाल में मुख्य और मिनी सभागार में लकड़ी की पॉलिशिंग।
- ईटीटी भवन (पशुधन अनुसंधान केन्द्र), भाकृअनुप–राडेअनुसं, करनाल की एग्रो लैब में मरम्मत और पुनः–पेंटिंग।
- पशुधन अनुसंधान केन्द्र, भाकृअनुप–राडेअनुसं, करनाल के गरिमा शेड में सीमेंट कंक्रीट फर्श और दीवार प्लस्तर की मरम्मत और नवीनीकरण।
- पशुधन अनुसंधान केन्द्र, भाकृअनुप–राडेअनुसं, करनाल में पाइप ग्रिल/रेलिंग ग्राउंड पथ की पेंटिंग।
- पशुधन अनुसंधान केन्द्र, भाकृअनुप–राडेअनुसं, करनाल में क्लोन बछड़ा शेड में दीवार की टाइलें लगाना।
- निदेशक के आवास, भाकृअनुप–राडेअनुसं, करनाल में फाइबर ग्लास शीट 3 मिमी रूफ लाउंज और लॉन कैनोपी आदि की मरम्मत और प्रतिस्थापन।
- डेरी अभियांत्रिकी प्रभाग, भाकृअनुप–राडेअनुसं, करनाल की डिस्प्ले लैब का अर्थिंग कार्य।
- भाकृअनुप–राडेअनुसं, करनाल में ई और एफ टाइप के आवासों की सफेदी।
- ग्राम कमालपुर रोडन, करनाल में फसल अवशेष एवं फसल अवशेष प्रबंधन के विरूद्ध विज्ञापन के नारे की वॉल पेंटिंग।
- भाकृअनुप–राडेअनुसं, करनाल में निदेशक निवास के बरामदे के सामने टाइलें लगाना।

- Interior and exterior painting of IFSC Project Shed of LRC, ICAR-NDRI, Karnal.
- Replacement of broken glass and rubber gasket of Auditorium building, ICAR-NDRI, Karnal.
- Refurbishing of water fountain in the lawn near Type E Quarters at ICAR-NDRI, Karnal.
- Providing and fixing of Aluminum cupboard leaf under RCC slab at IVF Lab. ABTC, ICAR-NDRI, Karnal.
- Wooden polishing at main and mini auditorium at ICAR-NDRI, Karnal.
- Repairing and re-painting at AGRO Lab. in ETT building (LRC), ICAR-NDRI, Karnal.
- Repair and renovation of cement concrete flooring and wall plastering in Garima Shed at LRC, ICAR-NDRI, Karnal.
- Painting of pipe grills /railing ground path at LRC, ICAR-NDRI, Karnal.
- Fixing of wall tiles in clone calf shed at LRC, ICAR-NDRI, Karnal.
- Repair and replacement of fiber glass sheet 3mm of roof lounges and lawn canopy etc. at Director's residence, ICAR-NDRI, Karnal.
- Earthing work of Display Lab of DE division, ICAR-NDRI, Karnal.
- Whitewash of E and F type Quarters at ICAR-NDRI, Karnal.
- Wall painting of slogan for advertising against crop residue and crop residue management at village Kamalpur Rodan, Karnal.
- Fixing of tiles in front of porch of Director's Residence at ICAR-NDRI, Karnal.


राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल

INTRODUCTION

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. NDRI has the unique distinction of having been ranked first among all Agricultural Universities consecutively four times in the years 2016-17, 2017-18, 2018-19 and 2019-20. 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. 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. This centre was the first to initiate training in artificial insemination in cattle in the country.

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 north eastern India and to offer solutions through research and extension activities to these problems.

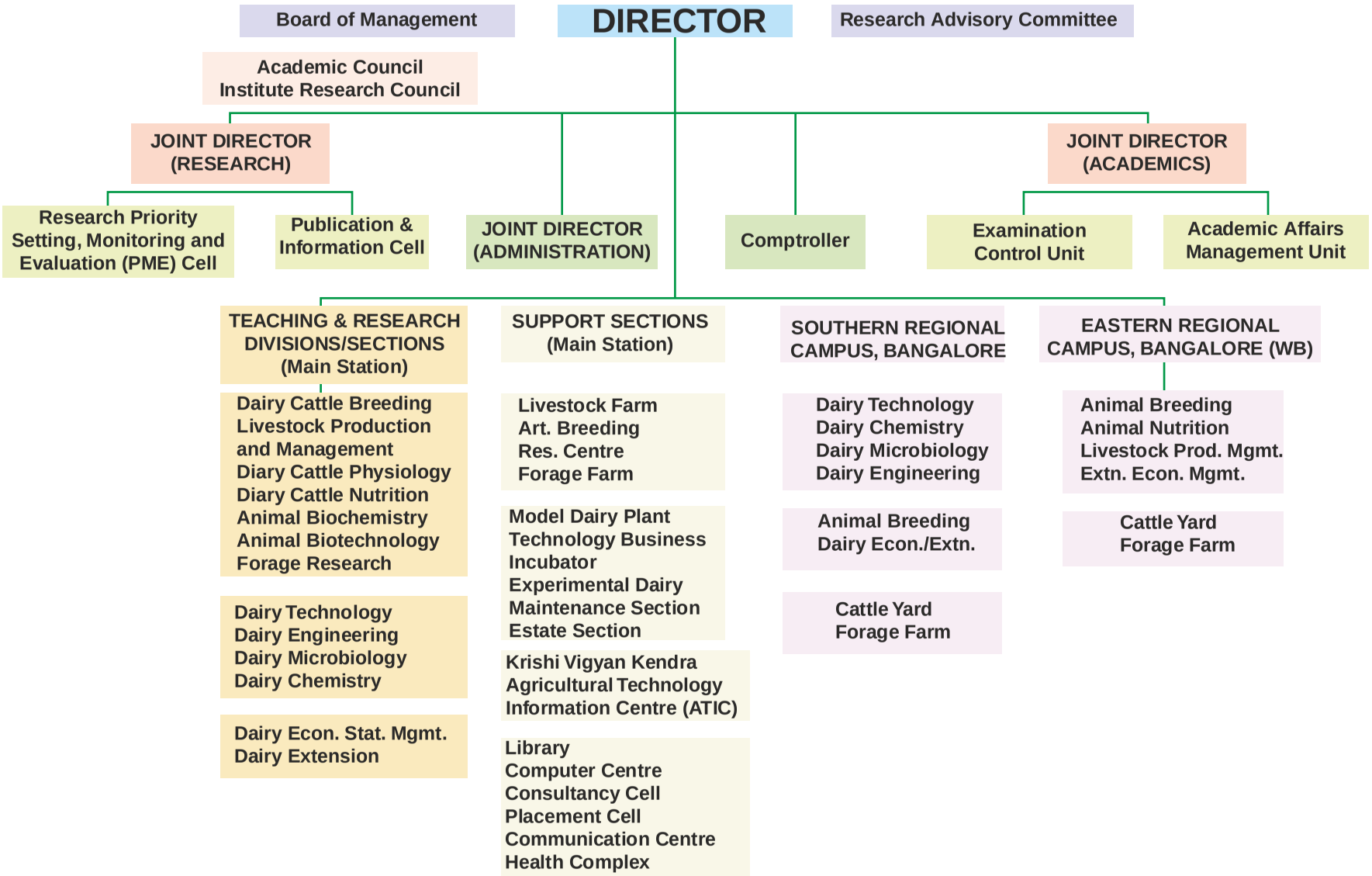
Krishi and Dairy Vikas Kendra, Piprakothi - Motihari

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



ORGANISATIONAL SETUP

The organizational structure of NDRI follows the Deemed University pattern of the ICAR. The policy making functions pertaining to 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 the education and training. The Academic Council, in turn, is supported by (i) Standing Committees, (ii) the Post Graduate Faculty, and (iii) the Board of Studies in the respective disciplines. The Extension Council is responsible for guiding extension programmes. 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 16 subject-matter disciplines.

BOARD OF MANAGEMENT

Chairman	**Dr. M.S. Chauhan, Director, NDRI**
Member Secretary	**Joint Director (Admn. & Registrar), NDRI**
Members	
Dr. Dheer Singh, Joint Director (Research), NDRI, Karnal	**Dr. R.R.B. Singh**, Joint Director (Academic), NDRI, Karnal
Dr. B.N. Tripathi, Deputy Director General (AS), ICAR, Krishi Bhavan, New Delhi-110001	**Dr. N.C. Gautam**, Vice-Chancellor, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidhyalaya, Chitrakoot, Satna (MP)
Dr. K.S. Kadian, Extension Division, ICAR-NDRI, Karnal	**Dr. G.K. Singh**, Vice-chancellor, U.P. Pt. Deen Dayal Upadhyay Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura (UP)
Dr. S.M. Deb, Head, ERS of ICAR-NDRI, Kalyani, Distt. NADIA (WB)	**Dr. Triveni Dutt**, Director, Indian Veterinary Research Institute, Izatnagar (UP)
Dr. P. Barnwal, Principal Scientist, Dairy Engineering Division, ICAR-NDRI, Karnal	**Sh. Jagdev Singh Padha,** Kothi No. 1920, Sector-13, Urban Estate, Karnal-132001
Dr. Sumit Arora, Principal Scientist, Dairy Chemistry Division, ICAR-NDRI, Karnal	**Sh. S. Ravinder Singh Dhillon,** 6-F, Model Town, Patiala-147001, Punjab
Dr. Naresh Kumar, Principal Scientist, Dairy Microbiology Division, ICAR-NDRI, Karnal	**Sh. Manish Wadhera,** Sr. F & AO, ICAR-, Krishi Bhawan, New Delhi-110001
Dr. T.K. Mohanty, Principal Scientist, Animal Breeding Research Centre, ICAR-NDRI, Karnal	**Dr. T.K. Datta,** Director, ICAR-CIRB, Hisar (Haryana)
Dr. Rakesh Kumar, Principal Scientist, Animal Breeding Research Centre, ICAR-NDRI, Karnal	**Dr. S.K. Jha,** Principal Scientist, ICAR-IIS&WC, Chandigarh

ACADEMIC COUNCIL

Chairman	**Dr. M.S. Chauhan, Director, NDRI, Karnal**
Vice-Chairman	**Dr. R.R.B. Singh, Joint Director (Academic), NDRI, Karnal**
Member Secretary	**Joint Director (Administration & Registrar), NDRI, Karnal**
Members	
Dr. Dheer Singh, Joint Director (Research), NDRI, Karnal	**Dr. S.S. Tomar,** Dean, College of Vet. Sci. Kuthulia, Rewa (MP)
Dr. S. Majumdar, Director, National Institute of Animal Biotechnology (Deemed University), Hyderabad	**Dr. Triveni Dutt,** Joint Director (Academics), Indian Veterinary Research Institute, Izatnagar-243122 (UP)
Dr. A.K. Rawat, Advisor, Department of Biotechnology, New Delhi	**Dr. Latha Sabikhi,** Head, DT Division
Dr. Dheer Singh, Head, ABC Division	**Dr. K. S. Kadian,** Head, Dairy Extension Division
Dr. Raman Seth, Head, DC Division	**Dr. P. Barnwal**, Head, DE Division
Dr. Parveen Kumar, Head, AP Division	**Dr. Madhu Mohini**, Head, AN Division
Dr. B. S. Chandel, Head, DES&M Division	**Dr. S. M. Deb,** Head, AG&B Division
Dr. A.K. Puniya, Head, DM Division	**Dr. Pawan Singh,** In-charge Livestock Production & Management
Dr. P. Palta, In-charge ABTC	**Dr. K. P. Ramesha,** Head, SRS, Bengaluru (Karnataka)
Dr. Magan Singh, In-charge FR&MC	**Dr. S. K. Tomar,** Academic Coordinator
Dr. Manoj Ghosh, Head, ERS, Kalyani, Nadia (WB)	**Dr. T.K. Datta,** PS, ABTC
Dr. A. P. Ruhil, COE	Representative from UGC
B.S. Meena, PS, Dairy Extension Division	Ph.D. 2nd year topper student
DDG Education / Nominee, New Delhi	M.Sc. 2nd year topper student

RESEARCH ADVISORY COMMITTEE

Chairman	**Dr. S. L. Goswami, Ex-Vice-Chancellor, Banda University of Agri. & Technology, ZC-590, Chd City, Karnal 132 001**
Members	
Deputy Director General (AS), ICAR, New Delhi	**Dr. M.S. Chauhan,** Director, ICAR-NDRI, Karnal
Dr. D. Kathiresan, Ex-Dean, College of Veterinary Science & Animal Husbandry, CVSc & AH, Aizawl, Director, TVCC, Apollo College of Veterinary Medicine, AGRA Road Near Chandrmahal Garden Hotel & Poultry Farm, Jaipur (Rajasthan)	**Dr. R. K. Sethi,** Former Director, Central Institute for Research on Buffaloes, Hissar
Dr. V.P. Reddy, Vice Chancellor, Sri Venkateswara Veterinary University, Administrative Office, Dr. YSR Bhawan, Tirupati, Andhra Pradesh	**Dr. Seema Bathla**, Professor (Agri. Economics), Centre for the Study of Regional Development, School of Social Sciences, Jawaharlal Nehru University, New Delhi
Sh. Mukesh Anand, Keshav Gaushala, Anand Ashram, Vill New Gothra, Khetri, Jhunjhunu, Rajasthan	**Sh. Rajumor,** VPO-Ludana, Jind, Haryana
Member Secretary **Dr. Dheer Singh**, Joint Director (Research)	

EXTENSION COUNCIL

Chairman	Dr. M.S. Chauhan, Director, ICAR-NDRI, Karnal
Member Secretary	**Dr. K. S. Kadian,** Head, Dairy Extension Division
Members	
Dr. R.R.B. Sngh, Joint Director (Academic), NDRI, Karnal	**Dr. Dheer Singh**, Joint Director (Research), NDRI, Karnal
DDG (Extension Education), ICAR, New Delhi or nominee	**Dr. S. S. Lathwal,** I/C, LRC
Dr. S. K. Tomer, PS, DM Division	**Dr. B. S. Chandel,** PS, DES&M Division
Dr. Ashutosh, I/C, Forage Production Section	**Dr. T. K. Mohanty,** PS & I/C, ABRC
Dr. A. K. Misra, PS & I/C, ATIC	**Dr. A. K. Tyagi,** Head, AN Division
Dr. A. K. Singh, PS & I/C, BPD Unit, DT	**Head, ERS** of NDRI, Kalyani
Agriculture Commissioner, Govt. of India, Ministry of Agriculture, Department of Agriculture & Cooperation, Krishi Bhawan, New Delhi	**Director General**, Department of Animal Husbandry & Dairying Govt. of Haryana, Pashudhan Bhawan, Sector-2, Panchkula
Director (Farm Information), Directorate of Extension, Govt. of India, New Delhi	

RESEARCH ACHIEVEMENTS

BIOTECHNOLOGICAL INTERVENTIONS FOR HIGHER PRODUCTIVITY

Production of Clones of Elite Bulls Using Cloning Technology

NDRI excelled at improving the developmental competence, quality and live birth rate of cloned buffalo embryos by treating them with Dickkopf 1 (DKK1), an inhibitor of canonical WNT signaling pathway. Following supplementation of the *in-vitro* culture medium on day 5 with DKK1 (100 ng/ml), that improved blastocyst, conception and live birth rate in buffaloes.

MU-7982 (TEJAS)

MU-8061 (SHAKTI)

Six live cloned calves were born, presently two - TEJAS and SHAKTI are alive and healthy.

Details of Cloned calves born at NDRI in 2020:-

Sl. No	Calf Number	Date of Birth	Birth weight	Dam No.	Donor Bull No.	Health Status	Age as on 31.12.2020
1)	MU-7982 (TEJAS)	20/06/2020	26 kg	MU-7664	MU-4354	Alive and healthy	6 months 11 days
2)	MU-8061 (SHAKTI)	06/12/2020	23 kg	MU-7343	MU-2558	Alive and Healthy	25 days
3)	MU-7960	06/01/2020	27 kg	MU-7690	MU-4354	Died on 24.01.2020	Survived for 18 days
4)	MU-7962	12/01/2020	23 kg	MU-7687	MU-4354	Died on 24.01.2020	Survived for 12 days
5)	MU-7964	16/01/2020	26 kg	MU-7688	MU-4354	Died on 03.02.2020	Survived for 18 days
6)	--	10/12/2020	54 kg	MU-7681	MU-2558	Died on 10.12.2020	--

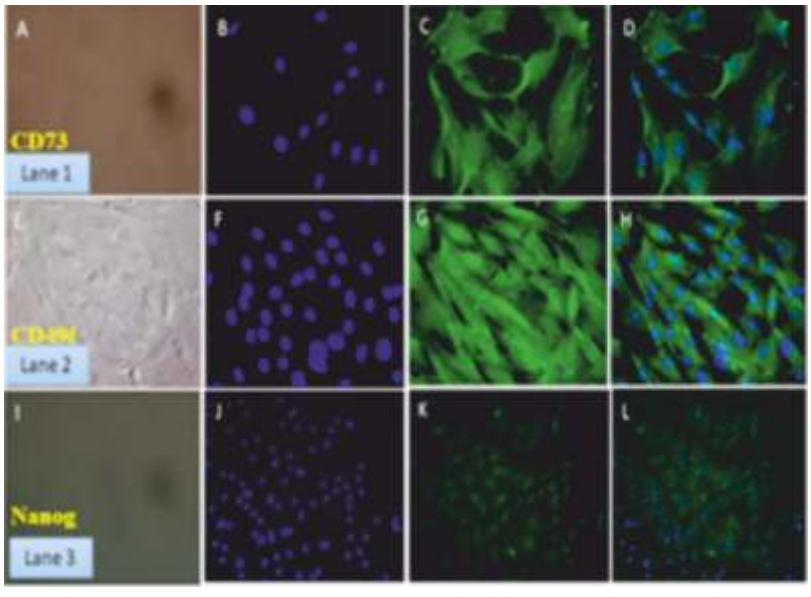
Global Transcriptome and miRNA Analysis for Deciphering Reasons for Low Cloning Efficiency in Buffalo

Reasons for low cloning efficiency with dynamics of global expression of transcriptome and miRNA profile in cloned and IVF pre-implantation embryos at different developmental stages using next-generation sequencing were explored. Embryos at 2-cell, 8-cell and blastocyst stages were produced by Hand-guided cloning and IVF techniques. RNA was sequenced on Illumina-platform and QC was made. High-quality reads were aligned to *Bos taurus* reference genome, UMD 3.1.1. Bioinformatics analysis was performed to compare the transcriptome, Gene Ontology and pathway analysis for cloned and IVF embryos revealed 3 transcripts (*FAU*, *PFN4* and *TNNC1)* up-regulated and 3 down-regulated transcripts (*AP3B2*, *HBQ1* and *OVCA2)* in cloned relative to IVF embryos at 2-cell stage. At 8-cell stage, the top 3 transcripts up-regulated were *MFAP5*,

PRKG2 and *ZNF33B*, and the top 3 down-regulated transcripts were *TIAM2*, *MX1* and *CCDC*. At the blastocyst stage, the top 3 transcripts up-regulated were *GRIN2C*, *TEKT2* and *ZAR1*, and the top 3 down-regulated transcripts were *CCDC80*, *MAP1LC3C* and *IFIT3*. Whereas, the top 3 miRNAs up-regulated in cloned relative to IVF embryos at 2-cell stage were bta-mir-136, bta-mir-1187 andbta-mir-431, and the top 3 miRNAs down-regulated were bta-mir-141, bta-mir-451 andbta-mir-340. At 8-cell stage, the top 3 miRNAs up-regulated were bta-mir-133a-2, bta-mir-431 and bta-mir-202, and the top 3 down-regulated miRNAs were bta-mir-139, bta-mir-214 andbta-mir-382. At blastocyst stage, the top 3 miRNAs up-regulated were bta-mir-1949, bta-mir-1692 and bta-mir-431, and the top 3 down-regulated miRNAs were bta-mir-1973, bta-mir-1839 and bta-mir-188. Treatment of reconstructed embryos with miR-21 or miR-29b and miR-145, improved the quality of cloned embryos without affecting their developmental competence. We conclude that the global transcriptome and miRNA profile undergoes major changes during the course of embryonic development, cloned embryos differ from IVF in the enriched GO terms, iii) a large number of pathways are affected in cloned relative to IVF embryos, among which, the major pathways related to embryonic development include apoptosis signaling pathway, Wnt signaling pathway, TGF-beta signaling pathway, PI3 kinase pathway, PDGF signaling pathway, Interleukin signaling pathway, Integrin signaling pathway, FGF signaling pathway, EGF receptor signaling pathway. The affected pathways may be corrected by using different miRNAs, or supplements so that the cloned embryos may behave like IVF counterparts, leading to improved pregnancy and live calf production rate.

Exploring the Use of Panchagavya and Mesenchymal Stem Cells for Treatment of Diabetes and Cancer in rats

Isolation and characterization of Mesenchymal stem cells (MSC) from adipose tissue of rats was standardised and was found that rat MSCs were growing very slow. Characterization of AD-MSC's was done through the following 3 methods: Immunofluorescence staining, alkaline phosphatase activity and RT PCR. Cells were fixed in 4% paraformaldehyde at room temperature for 20 min. Cells were then in 1% Triton X for 1 hour. Cells were then washed 4 times. Blocking solution (3% BSA) was the added for about 1 hour. Primary antibody CD73, CD90 and CD105, Oct 4, Nanog, Sox2 were then added (dilution 1:10-100 in 1% blocking solution) and incubated overnight at 4ºC. Secondary antibody (1:500 dilutions) was then added for 1-2 hrs at room temperature. Then Hoechst dye (1:1000-2000) was added for 2 min washed 4 times and visualized under microscope. *In-vitro* study of cancerous cells were carried out with MSCs, medium of MSCs and extracellular vesicles (EV) and observed medium of MSCs showing better preventive ability and continuing this work. Study on Panchagavya on cancerous cells was performed for preparation of Panchagavya and *in-vitro* was continuing.



Immunistaining photos of AD-MSCs of Rat : (A) Bright field, (B) Hoechst stain, (C) FITC, (D) Combined photo of Hoechst stain and FITC; Lane 1: CD73; Lane 2: CD 49f; Lane 3: Nanog.

Isolation and Characterization of Mesenchymal Stem Cells for Prevention of Mastitis and Metritis in Cattle

Mesenchymal stem cells (MSCs) were isolated from various tissues like adipose tissue, bone marrow, peripheral blood, umbilical cord blood (UCB), placenta, umbilical cords, amniotic fluid. UCB was collected from the umbilical cord vein of Cow just after delivery. First, blood samples were centrifuged followed by dilution of cells pellet at a ratio of 1:1 with phosphate buffered solution (PBS) and then applied to density centrifugation using Ficoll Hypaque. MSCs were cultured in DMEM containing 1% antibiotic-mycotic, 10 ng/mL epidermal growth factor (EGF), 10 ng/mL basic fibroblast growth factor (bFGF) and 10% fetal bovine serum (FBS) for the control. Cells reached 70–80% confluence and cell culture was sub-cultured and maintained. RT-PCR analysis of stem cell markers. RNA was isolated from UCB stem cells and subjected to cDNA synthesis. The cDNA was subsequently used for PCR using primers against genes- CD73, CD90, CD105, CD34, CD45 and CD79a. The cDNA was found to be positive for CD73, CD90, CD105 and negative for CD34, CD45 and CD79a. Immunostaining of UCB stem cells. The cells were then stained with anti-CD73-FITC, anti-CD90-FITC, anti-CD105-FITC, anti-CD34-PE, anti-CD45-FITC and anti-CD79a-FITC. The cells were found to be positive for anti-CD73-FITC, anti-CD90-FITC, anti-CD105-FITC and negative for anti-CD34-PE, anti-CD45-FITC, anti-CD79a-FITC. For adipogenic differentiation, cells were plated at 1 × 104 cells/well in 24-well plates. Adipogenic differentiation was evaluated by Oil Red O staining. For osteogenic differentiation, UCB-MSCs were plated at 1 × 104 cells/well in 24-well plates. At 70% confluence, the cells were cultured for 21 days in DMEM containing 10% FBS, 10-7 mol/L dexamethasone, 50 µmol/L ascorbic acid-2 phosphate, and 10 mmol/L β-glycerol phosphate. Osteogenic differentiation was confirmed by Alizarin red staining.

Bright field microscopic images of umnilical cord derived MSCs primary culture cells seeded on day 1 (A). Homogenous population of MSCs achieved at 3rd passaging and 90% confluency achieved at day 5 (B).

CRISPR/CAS9 Mediated Functional Analysis of Genes Regulating Early Embryonic Survival in Buffalo

Standardization of the protocol of superovulation was successfully completed in embryo culture of mice and non-surgical transfer of blastocyst in synchronized foster females was possible and produced pups first time in India. One-cell stage embryos were isolated from mice oviduct on the day of appearance of plug (.5 dpc) by microdissection under stereo-zoom microscope. Embryo recovery was 20±2 embryos per mice. Embryos were cultured to develop into morula or blastocyst at 37°C and 5% CO_2. An average of 19.5 blastocyst per mice and 20 zygotes (1-cell stage embryos) per mice and 34 oocytes per mice were recovered. Mouse endometrial epithelial cells were thus successfully isolated and cultured and total RNA was isolated followed by cDNA synthesis. The quality of cDNA was checked through GAPDH primers. Primers for amplification of the full coding region (open reading frame) of COX-2, PTGFS, PTGES and AKR1B5 genes were standardized. PTGES and COX2 ORF were amplified followed by ligation in GFP fusion TOPO expression vector (PcDNA 3.1CT-GFT TOPO) and transfected in TOP10 competent cells. The plasmid containing ORF of both genes PTGES and COX2 were isolated from the TOP10 bacterial cultures. The plasmids were confirmed for the presence and correct orientation of the inserted ORFs. Colony PCR of PTGES and COX2 genes cloned in TOPO GFP expression vector. Designing of sgRNAs for CRISPR/Cas9 mediated editing of COX-2, PTGFS, PTGES and AKR1B5 genes has been done by CRISPR designing software. Preparation of eukaryotic gene

constructs for overexpression studies of PTGES and COX-2 gene ORFs in GFP TOPO Fusion Expression Vector was successfully performed and sequence of the genes was corrected in order. We cloned, expressed and transfected to CHO cells of COX2 and PTGES genes and designed the primers of these genes for CRISPR/Cas9 technique optimization through micromanipulation and microinjection in different stages to mouse embryos and transfect to fibroblast cells for cloning of pup production.

Standardized the non-surgical embryo transfer into surrogate mice

Fig. A Sarrogate mice were pregnant by non-surgical embryo transfer method day 20.

Fig. B Sarrogate mice with pups were born by non-surgical embryo transfer 30th August 2020.

Fig. C Sarrogatte mice with pups were produced by non-surgical embryo transfer method (14 days old).

Discovery of Proteins Based Biomarkers in the Urine of Sahiwal Cows for Early Pregnancy Diagnosis

With the aim to developing early pregnancy diagnostic assay, through discovery of biomarkers from urine samples of pregnant and non-pregnant cattle was attempted. Sampling was done on 0, 10, 18, 35, 42 and 60 days post Artificial Insemination in Sahiwal cows. High throughput proteome analysis of urine by various methods of Quantitative proteomics including iTRAQ, TMT & LFQ revealed some of the potential urinary proteins which are highly up regulated in pregnant samples in comparison to the non-pregnant samples. Some of the significant and highly reproducible proteins which can be evaluated as potential biomarkers and which can further be assayed for the development of an easy to use diagnostic kit are i) Fibulin 1, ii) Mannan-binding protein, iii) IGFBP-2, iv) Sex hormone binding globulin, v) Nectin-2, vi) Fetuin B, vii) Glutaminyl-peptide cyclotransferase. We validated the expression of these proteins by Immunoblotting and ELISA using the 7 different antibodies raised against the selected proteins. In immunoblotting data we observed that Nectin-2 and Sex hormone-binding Globulin antibody correlated positively with pregnant samples and no interaction was observed in non-pregnant samples.

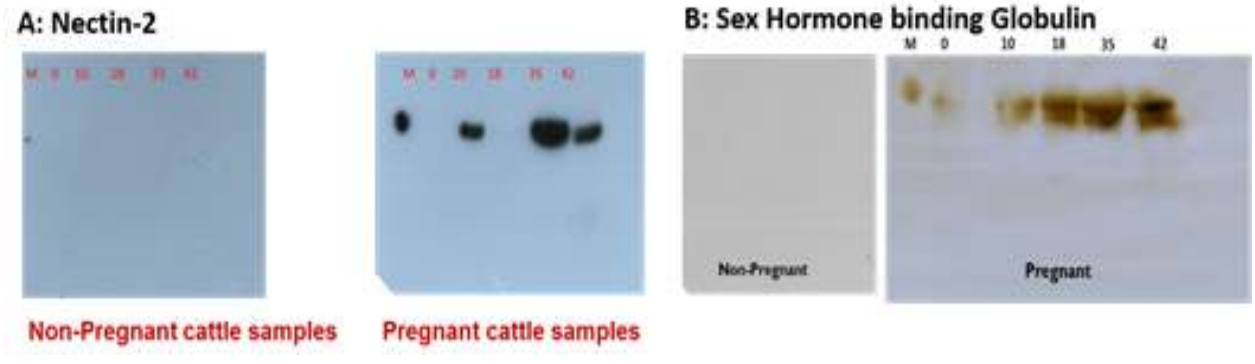


Fig. : Images of immunoblotting experiment of (A) Nectin-2 and (B) Sex hormone binging globulin in urine samples on different days of pregnancy- 0, 10, 18, 35 and 42.

The ELISA based assay in pregnant and non-pregnant urine samples also confirmed elevated level (5-16 fold) of Nectin-2 in pregnant samples in comparison to non-pregnant urine samples. Urine is subject to volumetric fluctuation and hence, the biomarkers concentration doesn't remain constant. To address the issue creatine was considered as normalizer.

Novel Peptides in Cow Urine with Potential Antimicrobial Activity against *E. coli*

Peptidomic surveillance of urine in Sahiwal cows to evaluate its antibacterial potential against *Staphylococcus aureus using* nano Liquid chromatography Mass spectrometry (nLC-MS/MS) experiments revealed 5239, 4774, and 5466 peptides in the heifer, pregnant and lactating animals, respectively. Using antimicrobial peptide prediction platform such as CAMPR3 and DPABBs we selected few sequences with possible antimicrobial activity. Beside antimicrobial activity several other bioactive functions were also predicted such as antihypertensive (n=1767), anticancer (n=724) and anti-inflammatory sequences (n=607). A total of 551 sequences were predicted with antimicrobial activity out of which 33 sequences deemed fit (based on overall high score across different predictive platforms) for synthesis and evaluation. The peptides scoring high on antimicrobial parameters as predicted by *in-silico* experiments, were selected for the synthesis and *in vitro* antimicrobial assays. Synthetic sequences FN-14, AY-16, RK-18, LL-14, RV-11 & NK-20 (sequence identity and feature undisclosed) were found active against the *Escherichia coli.* The growth was inhibited by the FN-14, RK-18 and AY-16. The preliminary confirmation of antimicrobial activity was done by disc diffusion assay where 30 µl of the test peptide (total 300 µg) was coated on the sterile disc from a stock solution of 10 mg/ml. Development of zone of inhibition confirms the antimicrobial activity of the test peptide

The synthetic peptides shows strong antimicrobial activity against E. coli

Production of Recombinant BuPAG-1 in *E. coli* and Development of an Immunodiagnositic Assays for the Early Detection of Pregnancy

Buffalo pregnancy associated glycoprotein-1 produced by foetal cells and subsequently released into the maternal circulation during onset till term of pregnancy. Thus, such proteins can be used as potential markers for early pregnancy diagnosis. An immunoassay was developed using BuPAG-1 recombinant protein. BuPAG-1 isoform protein and antibodies against this specific isoform are not available commercially that poses severe constraint in the development of the assay. BuPAG-1 was produced in BL21 (DE3) *E. coli* using pET22b+ expression vector in frame with His-tag at the C-terminal. High purity rBuPAG-1 protein was obtained by Cobalt column as confirmed by SDS-PAGE at molecular weight corresponding to recombinant BuPAG-1 protein i.e. 40.8kDa. 500 µg of recombinant BuPAG-1 protein was administered to two wistar rats following four booster doses one week apart. Hyper-immune serum was collected from the sacrificed rats after 35 days from the start of the immunization program. The IgG immunoglobulins were purified using Protein A column. The antibodies were found to be specific against the rBuPAG-1 protein. The dot blot and

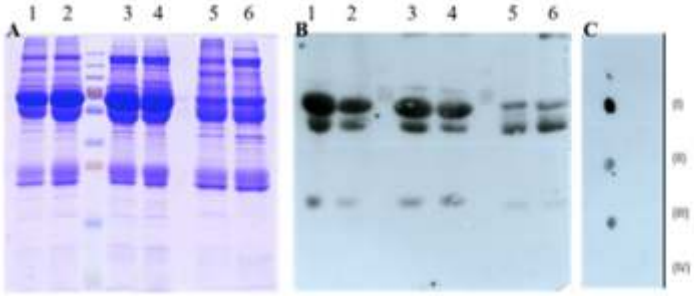
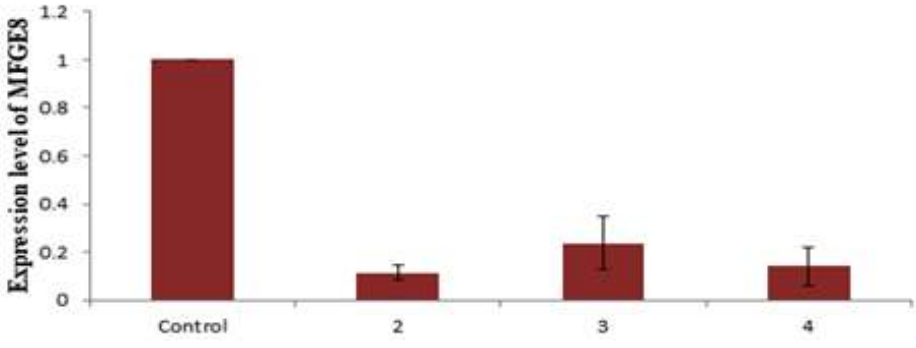


Fig.: Validation of Antibodies. A: The pure recombinant BuPAG protein isolated from Western Blot with serum; B: Western Blot image showing strong reactivity with pregnant samples. Dot blot result showing low intensity non-specific interaction of heifer samples with antibody as compared to rBuPAG-1. (I) PAG-1 purified fraction (positive control) (II) heifer sample (4ul) (III) heifer sample (2ul) (IV) BSA (negative control).

western blot with purified antigen (rBuPAG-1) and natural samples like pregnant and non-pregnant serum and urine confirmed that the antibody was generated against rBuPAG-1. The validation of the antibodies with the pregnant cow and buffalo serum samples (45 days) revealed that antibodies interacted strongly with the pregnant samples i.e native glycosylated BuPAG-1 of molecular weight 67kDa. It is therefore, concluded from the research that the recombinant BuPAG-1 can be used to generate hyperimmune sera in rats and the immunoglobulins so produced can be effectively used in the development of immunodiagnositic assays for the early detection of pregnancy in bovine.

Creation of a Genome Edited Buffalo Mammary Epithelial Cell Line with Reduced Expression of MFGE8

MFGE8 and S100 genes are differentially expressed in the Mammary epithelial Cells which is associated with regulation of milk yield and lactation persistency in cows. A MFGE8 knock out BuMEC cell line was developed. The sgRNAs against MFGE8 was designed using Chopchop and CRISPOR software and cloned into plasmid vectors pSpCas9 (BB)-2A-Puro (PX459) V2.0 (Addgene plasmid # 62988) and pSpCas9 (BB)-2A-GFP (PX458) (Addgene plasmid # 48138). pSpCas9 (BB)-2A-Puro plasmids containing MFGE8gRNAs were transfected into BuMEC by multiple transfections. The transfected cells were screened in the presence of puromycin (1-2 µg/ml) for the selection of possible knockouts. The Next Generation Sequencing (NGS) results confirmed that approximately 25% of sequences were edited with indels of ~1-10 bp, at position 3-4 base pairs upstream to PAM site of MFGE8. The Genome edited cells showed distorted morphology and showed a slower growth rate as compared to wild type cells. The expression of MFGE8 was found to be highly down regulated in the edited cells as revealed by the semi quantitative RT-PCR test.



MFGE8 gene expression in control vs transfected cells

Allelic Variations in BBD129 Gene vis-à-vis Fertility of Cattle Spermatozoa

Allelic variation in BBD129 gene were explored in high and low fertile cattle bulls, exonic regions of BBD129 gene from cattle spermatozoa were screened. The sequence analysis of BBD129 gene revealed four allelic variations haplotypes i) 169_T/G, ii) 329_A/G, iii) 329_T/G_169_A/G, and iv) 329_T/T_169_A/A. These allelic variations were significantly differentially distributed in high fertile and low fertile Karan Fries (KF) crossbred cattle bulls. Bioinformatics analysis of these variations revealed that BBD129 SNPs affect the glycosylation and phosphorylation pattern among the individuals. Further experiments confirmed the variation in phosphorylation in serine/threonine using anti-phoshoserine/threonine antibody assay and the results proved a significant correlation between the distribution of BBD129 haplotypes and phosphorylation in the high fertile vis-a-vis low fertile KF bulls.

Fig.: Allelic variations observed in BBD129 genes in HF and LF bull spermatozoa, (b) detection of an increased level of serine phosphorylation in low fertile sperm vis-a-vis high fertile KF bulls sperm ($p<0.05$).

Low fertile (LF) Spermatozoa of Crossbred Cattle exhibit Lower Abundance of the Lectin with a Poor Ability of Immunoprotection against Macrophages

Spermatozoa are considered to be an allogenic entity in female reproductive tract (FRT) and very strong immune response generate against them in FRT. Differential abundance of glycan moieties on the sperm surface may offer the vital immunoprotective ability to sperm in FRT. We hypothesize that mapping of sperm surface glycans from high fertile and low fertile Crossbred cattle bulls could provide the discrete immunoprotective ability of sperm in FRT. Seven lectins i.e. ABA, LEL, JAC, SNA, LCA, PNA and MAL-II were used in this study. We observed that four lectins are differentially abundant on the surface of distinct fertility spermatozoa. JAC, LCA, SNA, and MAL-II lectins were significantly varying in high fertile and low fertile KF bulls.

To further support that the glycan moieties on sperm can protect against immune cells, an *in-vitro* monocytes and macrophages culture model was developed for sperm-macrophage challenge. The rate of phagocytosis

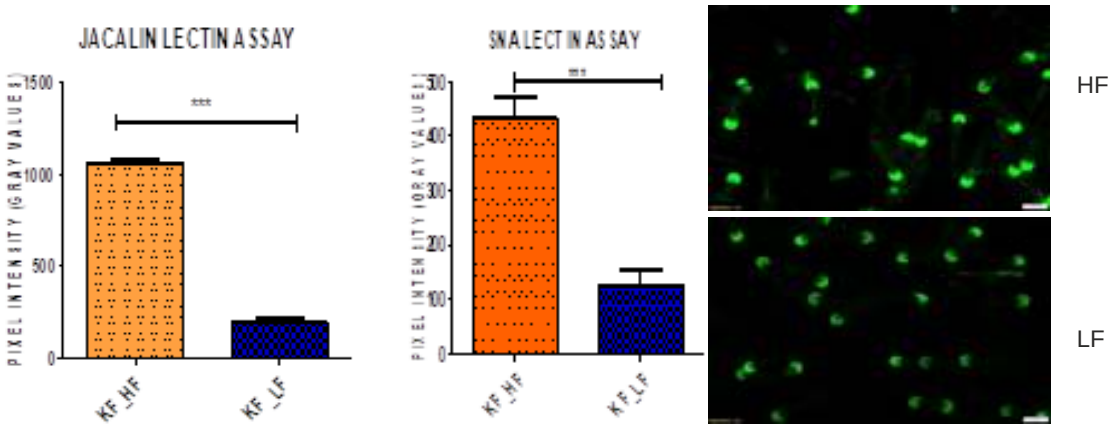


Fig.: Differential abundance of lectins (JAC, SNA) confirmed in high and low fertile (HF and LF) sperm from cattle bulls ($p<0.005$).

by macrophages was different in differential abundant glycan population of spermatozoa. The level of abundance of glycans on spermatozoa has shown a strong relationship with the rate of phagocytosis by the macrophage. The sperm of low fertile bulls were more phagocytosed by macrophages at a higher rate compared to high fertile spermatozoa.

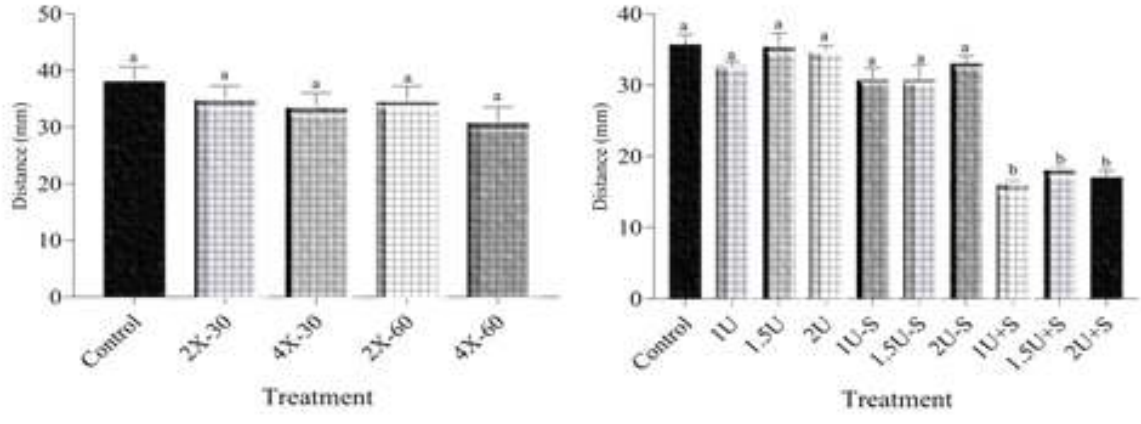


Fig.: Cervical mucus penetration assay exhibited no differences in the distance travelled after either treatments vis-à-vis controls. The samples treated with PI-PLC were either rendered free of the treatment medium (-S) or supplemented with supernatant of extracted proteins (+S) which brought a significant decrease in the distance travelled by the vanguard spermatozoon

Assessment of Cervical Mucus Penetration of Sperm Coated with Leach-out Protein Extract and IVF Rate of Sperm Blocked with Anti-BuBD129

Cervical mucus penetration (CMP) assays was performed to assess the effect of PIPLC and salt treatments on the penetration ability of the buffalo spermatozoa. Results revealed that the distances travelled by the vanguard spermatozoa in the treatment groups didn't differ from the distances covered by the sperm in the control sample. None of the treatment groups whether with the supernatant or without the supernatant varied *vis-à-vis* the distances travelled by the vanguard spermatozoon. Surprisingly, the travelled distance decreased significantly when the separated supernatant (-S) of these groups was added back (+S) to the treatment groups wherein the supernatant was earlier separated.

Blocking of ubiquitously distributed sperm surface proteins BuBD-129 affects the fertilizing ability of the spermatozoa. The addition of anti-BuBD-129 in the fertilization medium appeared to hamper not only the recognition of the oocyte by the buffalo spermatozoa but also affected the subsequent development of the embryo in a dose-dependent manner *vis-à-vis* the control samples wherein no antibodies were added. Overall, our data indicate that the masking of BuBD-129 could be the cause of fertility reduction in buffalo IVF model.

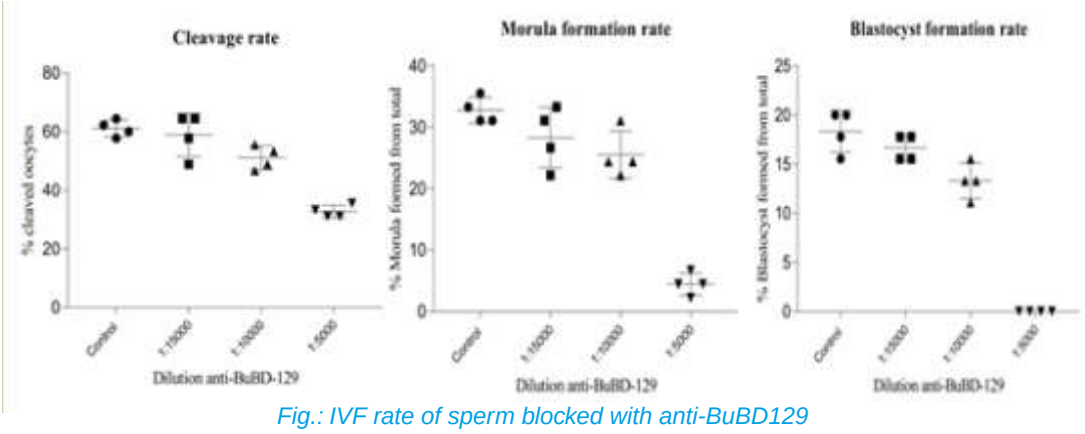


Fig.: IVF rate of sperm blocked with anti-BuBD129

Antibiotic Resistance Pattern (Karnal district) in Mastitis-causing Bacteria

The prevalence of antimicrobial resistance (AMR) in mastitis pathogens has been investigated (N=392) in milk samples of animals suffering from clinical mastitis from five city veterinary hospitals (Karnal city, Nilokheri, Gharaunda, Assandh and Nissing). Identification and isolation of resistant bacterial pathogens was completed using around 30 different antibiotics. The most commonly used injectable antibiotics showed high level of resistance compared to less commonly use ones. Gentamicin showed least resistance whereas, Cephalosporins and Penicillin, showed high resistance. Enrofloxacin showed higher resistance and Tetracycline showed moderate resistance. This information utilized to identify the prevalence of AMR pathogen in a specific area and use of suitable antibiotic therapy accordingly.

Genetic Variation in AS2 Casein (CSN1S2) of Indian Goats

Goat milk is easily digestibility and has unique fatty acid composition along with many unexplored components having health benefits in human. Genetic variability of Indian goat milk was explored for casein fractions: alpha casein 1 (AS1), alpha casein 2 (AS2), beta and kappa casein. Variations in AS2 (*CSN1S2)* gene were detected in six Indian goat breeds namely Bakarwali, Sirohi, Osmanabadi, Marwari, Jakhrana, Chegu and one non-descript goat of Jammu. Three common alleles A, B and C were found present in these breeds of goats which were reported earlier. Altogether seven new AS2 variants were identified from Marwari, Jakhrana, Bakarwali and Osmanabadi breeds of goat.

Poly I: C Found Better Inducer of Interferon (IFN)- based Antiviral Response in Fibroblast than Myeloid Cells.

The expression dynamics of RLR pathway genes and their impact on IFNβ expression in immune cells (alveolar macrophage and monocyte) and non-immune cells (Buffalo embryonic fibroblast, BEF) after poly I:C stimulation that is widely used to mimic and elicit an antiviral response. Analyzed different mRNA response

pattern were similar although there was difference in magnitude of responses between immune and non-immune cells. IFN pathway genes RIG-I and MDA5 were highest at all time point in BEF than monocyte and alveolar macrophage. In BEF, RIG-I and MDA5 mRNA expression was upregulated to 900 and 5000 times at, respectively. In monocytes, RIG-I and MDA5 were upregulated to 90-fold and 40-fold, respectively, while in alveolar macrophage, ~50-fold and ~ 25-fold fold change in mRNA level was observed, respectively. Differential expression of IFNβ influence the expression of Interferon Stimulating Genes (ISGs), which followed a similar expression pattern in all cell types. In BEF, ISG56 and ISG54 mRNA levels elevated highest to ~700 fold and ~30000, respectively. Whereas in monocyte, ISG54 & ISG56 were expressed to the fold change of ~90-fold and ~140-fold and in alveolar macrophage ~30-fold and ~120 fold, respectively. So, in BEF, poly I:C induce higher IFNβ expression (antiviral immunity) than in monocyte and alveolar macrophage. Therefore, these oligonucleotides can be used to induce antiviral immunity by injecting them intramuscularly in dairy animal

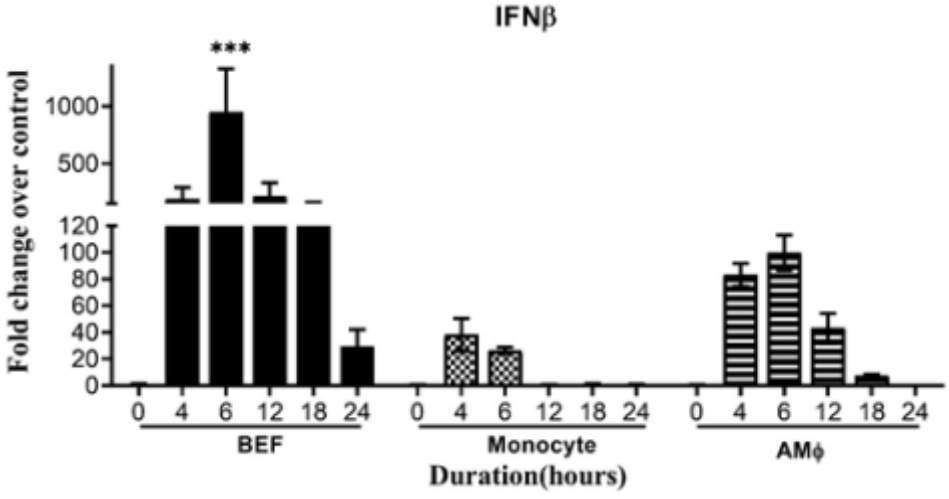


Fig.: In fibroblasts, IFN expression was ten and forty-fold higher when compared to A.M and monocytes, respectively. While among the two myeloid cells, IFN expression in A.M was four-fold higher than in monocytes.

Selected Oligonucleotide Sequences Generated Antiviral Immune Response in Cell Culture Model.

Differential responsiveness in three different cell types (Fibroblast, Monocyte and Macrophage) of Buffalo studied and identification of optimum pathogen oligonucleotide sequence as immunostimulatory ligand in cell culture model. This will help in inducing antiviral response in the face of any possible viral disease outbreak in dairy animals. RNA based therapeutics showed more promising results than the protein and DNA based therapeutics. Although, the recent COVID-19 pandemic speed up the RNA based pharmaceutical sector, for instance vaccine developed by Pfizer and Moderna. Seven new natural RNA motifs were tested transcriptionally and translationally in BEF cells for stimulation of RLRs (RIG-I & MDA5) as well as IFN-β. These RNA Motifs were differed in length, secondary structure and composition. Conclusively, out of the

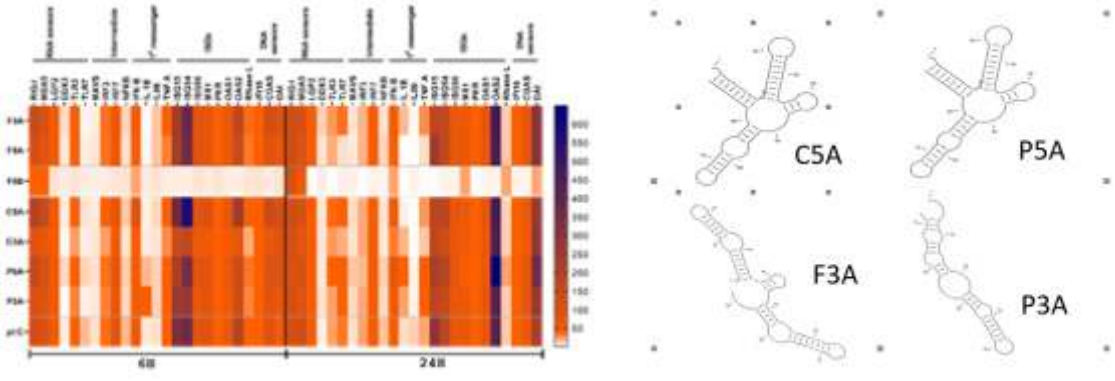


Fig.: Heat map showing variable expression profile

seven, C5A, P5A, F3A and P3A were found most potent immunostimulatory RNA motifs exclusively induced RLR pathway *in-vitro* in BEF cells leading to IFNβ expression which further modulate ISGs ((ISG15/54/56, MX1, OAS1 & 2)) expression in agonist specific manner that suggest antiviral state establishment. These findings demonstrate differential responsiveness of different cell type. Natural small RNA motifs are potent investigative tools for targeted modulation of the animal innate immune system.

Gold Nanoparticle-based Amplification Free Visual Assay Developed for Rapid Detection of *Escherichia Coli* in Mastitis Cow Milk

Developed amplification free visual assay which is simple, rapid, specific, sensitive, user-friendly and most importantly cost-effective Point-of care (POC) diagnostics for identification of *Escherichia coli* in mastitis cow milk samples. Test uses a novel methodology for capturing multiple gold nanoparticles (AuNPs) onto a magnetic microbeads surface using multiple sets of modified oligos. The assay is faster, can be completed within 1-1.5 h and can be visualized through naked eyes. The assay can be performed without the usages of any costly equipment. The estimated cost of the developed assay is only about INR 100-200 (1.37-2.74 USD) per reaction. The assay is able to specifically detect only *Escherichia coli* specific DNA in mastitis milk samples with the microbial detection limit as little as 1.11 $x10^2$ CFU/ml. Sensitivity testing revealed that the developed amplification free visual assay can identify bacterial DNA as low as 1 pg by simple visual inspection.

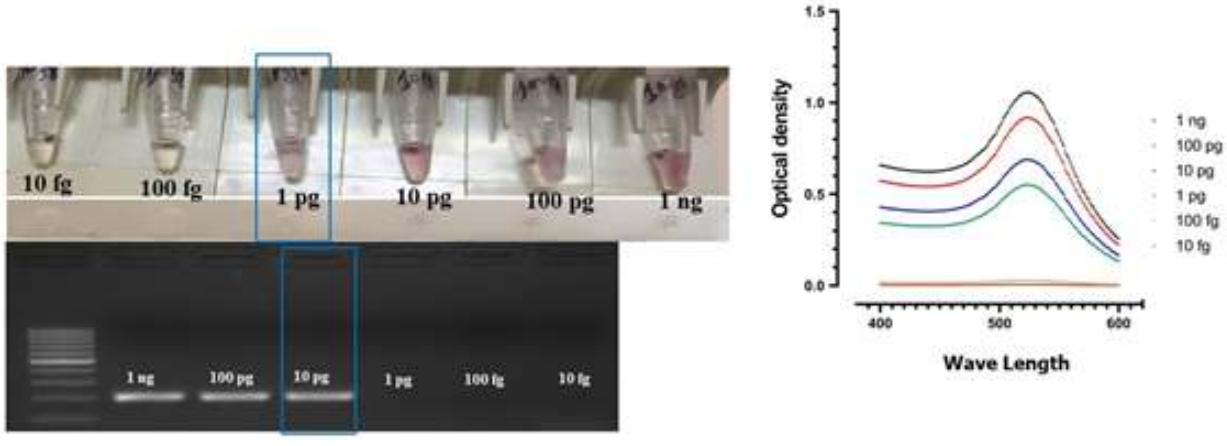


Fig.: A gold-nano particle captured based assay (detect as low as 1 pg of microbial DNA while traditional PCR can be able to trace up to 10 pg of DNA).

CRISPR/CAS9 Guided Functional Analysis of Genes Regulating Early Embryonic Survival in Buffalo

Targeted genome editing by CRISPR/Cas9 for COX-2 gene towards unravelling relevant associated pathways governing early embryonic survival in buffalo was carried out. Molecular cloning and characterization of COX-2 gene isolated from buffalo endometrial epithelial cells (EECs) completed. Nucleotide and protein sequence of the COX-2 gene in buffalo were compared with different species by BLASTn and BLASTp of NCBI data base which revealed 100 per cent similarity with *Bubalus bubalis*. For CRISPR/Cas9 mediated gene editing, a total of six sets of sgRNAs were designed against the coding sequence of COX-2 gene by e-CRISP software. Cloning was performed with the best sgRNAs. The pSpCas9(BB)-2A-Puro(px459) v2.0(Addgene plasmid #p62988) Cas9 vector (9175 bp) was selected for the purpose of Cas9 mediated genomic deletion. This plasmid contains Cas9 with an invariant sgRNA scaffold and cloning sites for inserting a guide sequence. For the backbone cloning construct, (2A-Puro) puromycin resistance gene was also fused with Cas9 to allow screening or selection of transfected cells with pSpCas9(BB)-2A-Puro.

Restriction digestion of Addgene plasmid vector was carried out using BbsI restriction enzyme (RE). Insertion of sgRNA into plasmid was confirmed by sequence analysis of CRISPR-Cas9 plasmid clones. The presence of the sgRNA in the plasmid was confirmed by PCR using U6 primers. All the plasmids displayed the 400 bp amplicon indicated the presence of sgRNA in the plasmid. Sequencing confirmed the presence of sgRNA3 and sgRNA4 in plasmids. Plasmid with sgRNA1 scaffold was transfected into the buffalo

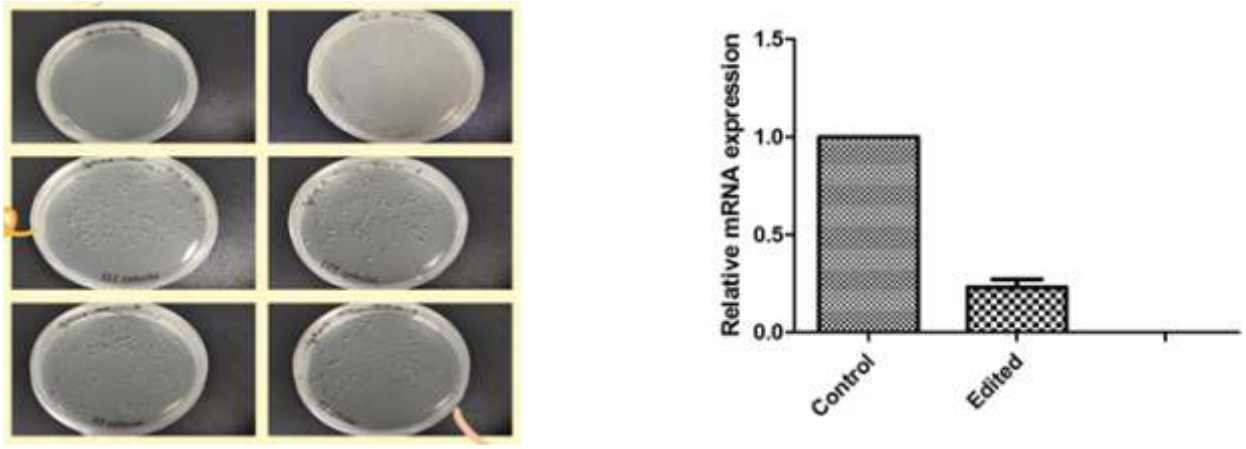


Fig.: Cloning of sgRNA-3 & sgRNA-4 (left) and results indicating decline (82 per cent) in mRNA Expression of CRISPR Cas9 edited COX-2 gene (right)

endometrial epithelial cells by Lipofectamine mediated transfection. mRNA expression was analyzed in the transfected EECs. Real Time PCR revealed that there was 82 per cent reduction in mRNA expression due to CRISPR/Cas9 editing of COX-2 gene.

Whole Genome Sequencing, *De-novo* Assembly and Integrated Annotation Reveals High Degree of Genetic Diversity among Malnad Gidda, Deoni and Hallikar Breeds of *Bos Indicus* Cattle

With an aim to identify and document the genetic diversity among Malnad Gidda, Deoni, and Hallikar breeds we assembled their whole genome and sequence variations with reference to UMD3.1.1 *Bos taurus* genome assembly. The short paired-end (70X) and mate-pair reads (20X) from Illumina HiSeq-2500 platform for all three breeds and further the long reads from PacBio (10X) for Malnad Gidda were used for genome analysis. A total of 24109, 23772, 24645 variations specific to Deoni, Hallikar and Malnad Gidda cattle breeds and 69,868 common variations to these 3 breeds were identified in protein coding genes. Unique/novel genes identified with reference to *Bos taurus* genome against the total genes predicted by Augustus was 171 (58,795), 132 (61,366) and 144 (62,198) in Malnad Gidda, Deoni and Hallikar, respectively. Integrating with a proteogenomics annotation pipeline, we have also refined the genome annotations and also report novel genes in these breeds. Based on the known QTL/SNV variant analysis for associations with milk production, fertility, and immunity traits, we also provide the current knowledge-based linkage and trait associations of these 3 breeds. The genome assembly, sequence variations and gene model annotations in this study would promote the efforts for both conservation of genetic diversity of *Bos indicus* breeds and also the genetic selection for diverse economic quality phenotypic traits in indigenous cattle.

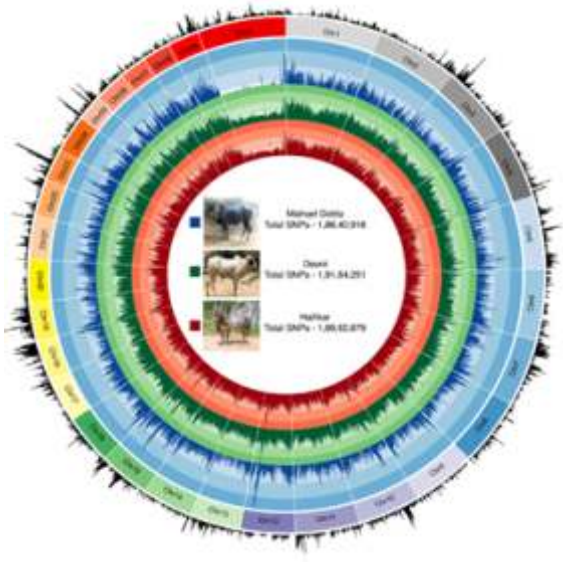


Figure depicting SNP density in Malnad Gidda (blue), Deoni (green), and Hallikar (red) breeds per 1Mb base pairs. The outer circle (black) represents the gene density per 1Mb base pairs. SNP density of chromosome X in Malnad Gidda is comparatively less with respect to the other two breeds, Deoni and Hallikar

Identification of Rare Variants Associated with Milk Production Traits in Maland Gidda and Deoni Breeds of Bos Indicus Cattle by Whole Exome Sequence Analysis

Indigenous cattle (Bos indicus) are an important livestock species in the rural economy of India. In the present study, we generated the exome data for Maland Gidda and Deoni breeds of Bos indicus cattle. The target capture sequencing approach was carried out in two important Bos indicus breeds viz. Malnad Gidda and Deoni cows with high and low milk yield category. Blood samples were collected and whole-exome sequencing was performed using the Illumina NovoSeq6000 platform. GATK version 4 was used for Variant Calling and identified high-quality Single Nucleotide Polymorphism (SNPs) specific to high and low milk yielders. Gene ontology and pathway annotation further showed that all shared genes in phenotypic differences participate in many biological processes related to milk production. The study indicated that any alteration in ABC transporter pathway and Glutathione metabolism could be the possible reasons for low milk yield in Malnad Gidda and Deoni cows. Variations observed in ABCG2, LPIN1, GSTM2 and PLCG2 genes were associated with milk yield trait and it could serve as potential candidate genes for identifying low milk yielders in indigenous cattle. The Circos plot was generated to highlight the SNPs reported in the Malnad Gidda high milk yield (MGHY), Malnad Gidda low milk yield (MGLY), Deoni high milk yield (DHY) and Deoni low milk yield (DLY) groups (Figure). The SNPs associated with all the four groups were taken into a matrix for identification of SNPs that were group-specific. It was found that MGHY had 184 SNPs which are represented in orange colour in Circos plot, similarly MGLY had 135 SNPs which are highlighted in Purple colour; in Deoni breed DHY group had 290 SNPs, and DLY had 369 SNPs. By exome analysis in indigenous breeds, we identified potential genes which effects milk production and also identified coding region variation associated with milk production traits which could serve as potential targets for selection of cows for milk yield.

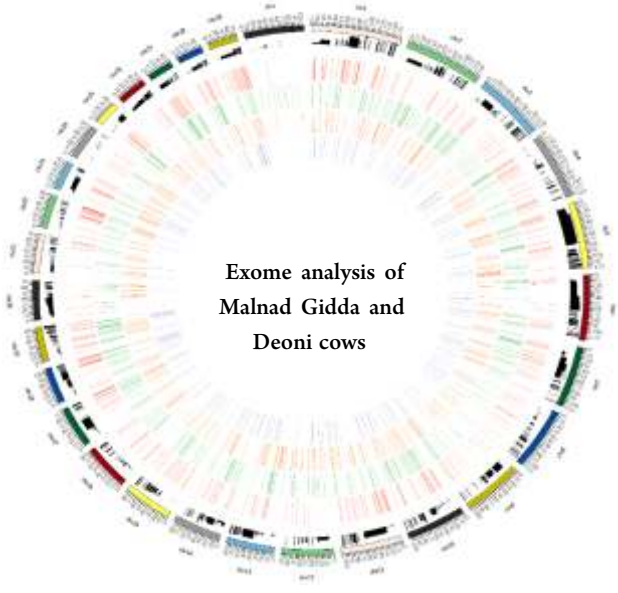


Fig.: Evaluating unique SNPs in Malnad Gidda and Deoni high yield and low yield group associated with milk yield QTLs. 1. The outermost ring represents different chromosomes of Bos taurus genome 2. From the outermost ring, the second ring QTLs from the cattle database 3. The SNPs of four different groups are highlighted in a ring from inside to outside, the innermost being MGLY in Purple colour, next is MGHY in orange colour, followed by DLY in green colour, and the fourth ring in red colour represents DHY

Functional Analysis of Urine of Indigenous *vis-a-vis* Crossbred Cows

Urine samples (n=410) collected from Deoni and HF cross cows were pooled in four physiological groups- non-lactating, early-lactation, mid-lactation and late-lactation from each breed. Pooled samples were characterized for composition, anti-oxidative and DNA protection properties. Albumin, protein, creatinine, bilirubin, uric acid, nitrogen, calcium and phosphorous were observed in the normal reference range in both breeds. Highly significant values were observed for protein and creatinine in non-lactating; for uric acid and nitrogen in mid-lactating while for phosphorous in late-lactating stages. DPPH free radical scavenging activity in Deoni and HF cross breeds was in the range of 15.9 to 16.5 (±0.2) trolox equivalent antioxidant capacity. Overall anti-oxidant activity was significantly high in mid and late-lactation groups. Cow urine distillate has shown DNA protection effect in an experiment in which plasmid DNA was exposed to extremely toxic hydroxyl free radicals. DNA was protected in presence of re-distilled cow urine distillate (RCUD). Anti-oxidant and DNA protection properties observed in cow urine append to the potential health benefits of cow urine.

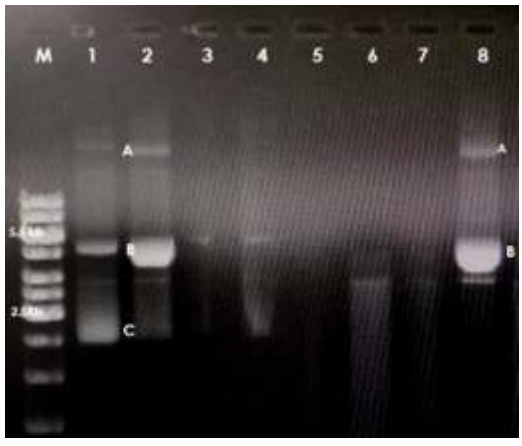


Fig.: Agarose gel electrophoresis analysis of Fenton mediated DNA oxidation. A= linear form, B= super coiled, C= circular single strand forms of plasmid DNA. Lane 1: plasmid DNA, Lane 2-4: partial Fenton reaction created, Lane 5: Fenton reaction showing DNA damage, Lane 6,7: DNA not protected in presence of 1 and 3µl RCUD, Lane 8: DNA protected in presence of 5µl RCUD.

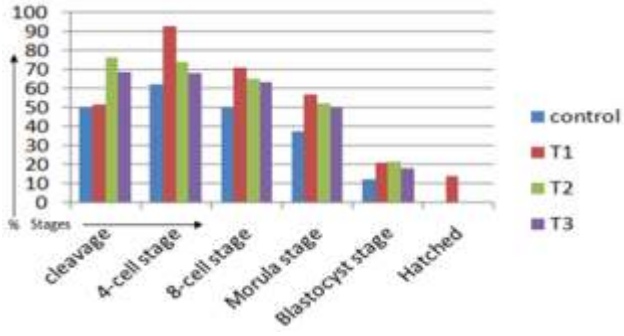


Fig. Combined effects of PDGF and FGF supplementation in IVM, IVF & IVC media on in vitro embryo development

Improvement of Developmental Competence of Immature Oocytes Supplementing with PDGF and FGF Growth Factors in Culture Media and *in vitro* Embryo Development

The purpose of the present study is to improve the developmental competence of immature cattle oocytes using fibroblast and platelet derived growth factor as media supplement. Cattle ovaries were collected from local abattoir in 0.9% saline (30-35°C) supplemented with antibiotics. Cumulus oocyte complexes were aspiratedusing aspiration media (TCM-199 + DPBS + 0.3% BSA + 50 µg /mlgentamicin sulphate), washed 5-6 times with washing media (TCM-199 + 10% FBS + 0.81 mM sodium pyruvate + 50 µg /mlgentamicin sulphate) and placed in maturation media supplemented with growth factors (TCM-199 + 10% FBS + 5µg / mlFSH-P + 0.33mM sodium pyruvate + 5% Follicular fluid + 50µg/mlgentamicin sulfate + in treatment group FGF or PDGF or both) and cultured in 5% CO_2 incubator at 38.5 °C with maximum humidity.After every 48 h half of the medium used to replace with fresh medium. At the end of 15-18 h of sperm-oocyte co-incubation, the presumptive zygotes were separated from the drop and cumulus cells were washed off from the oocytes by repeated gentle pipetting in washing medium. The zygotes were then washed 1-2 times with modified Charles Rosenkrans 2 amino acid (mCR2aa) medium and cultured in 100 µl of mCR2aa medium. After 48 h cleaved oocytes/embryos were shifted to 100 µl droplets of mCR2aa blastocyst medium and co-incubated with vibrant oviductal cells for 8 days. Cleavage was observed after 40-42 h and embryos were co-cultured with oviductal cells for 7-9 days. The cleavage rates were 50.00%, 51.85%, 76.66% and 68.65%, and blastocyst formation rates were 12.50%, 21.43%, 21.74% and 18.18% incontrol group and T1,T2 & T3 treatment group in combination of FGF and PDGF respectively. It can be concluded that T2 (5+5 ng/ml of FGF and PDGF) enhanced cleavage rate aT1(1+1 ng/ml of FGF and PDGF) and T2 produced highest blastocyst formation rate.

GENETIC IMPROVEMENT OF DAIRY ANIMALS

Indigenous Cattle Improvement Programme: AICRP-Sahiwal Cattle

The female herd strength was 492 including 181 breedable females as on 31.12.2020. A total of 37 growing males and breeding bulls were available at the Germplasm Unit. During the year 2020 there were a total of 112 normal calving out of which 59 males and 53 females were born. The average age at first calving was (1176.55 ± 28.96days), FLMY (2210.34 ± 126.50kg), Total Lactation milk yield (2219.83 ± 90.29 kg) peak yield (10.59 ± 0.54 kg) lactation length (288.0 ±14.13 days) dry period (140.18 ± 12.39days) and calving interval (377.42 ± 14.92 days) and service period (128.17 ± 7.62 days) was observed with wet average (7.87 kg) and dry average (3.12 kg) in the year 2020.

Males were initially selected on the basis of EPD, dam's best 305 days lactation yield, breed characteristics and physical conformity for selection of young male calves for future breeding. 10 out of 40 males were selected in Bull screening meeting. EPD % of the selected males was 5.18% and average of Dam's best Lactation Yield was 4299 kg against herd average of 2128 kg.

Based on Jan, 2020 EPA, a total of 47 out of 196 Sahiwal females were identified as elite cows (Either 305-FLY equal to greater than 2500 kg or Best 305-LY equal to or greater than 3000 kg). The Best 305-LY, average LY and average EPA were 4299 kg., 2219 kg and 1999 kg against herd average of 2128 kg and average EPA of 2083 kg. During the period (Jan-Dec, 2020) 7680 doses of frozen semen from 6 bulls of Set-III were produced. Semen doses were supplied to DRU units at GADVASU, Ludhiana, GBPUA&T, Pantnagar and LUVAS, Hissar for AI at those centres. Also 251 and 4385 doses of bulls of high genetic merit under Set II, III were supplied to farmers/ developmental agencies through sale in addition to supply of semen for Institute extension/ other activities.

Genome–wide Scan for Autozygosity, Selection Signature and Genomic Inbreeding in Karan Fries and Sahiwal Cows

The study based on G2P concept and has been undertaken. Pedigree based inbreeding coefficient (F_{PED}) was estimated for 3449 Sahiwal animals including 1737 males and 1712 females in herd since inception (1955-2020). The least squares mean was estimated on adjusted data for birth weight, weight at regular interval, first lactation milk yield, SNF yield and fat yield. The results suggested that the winter born claves had higher birth weight (19.95± 0.31 kg) as compared to other seasons, and calves born during 2000-2004 (20.29± 0.73 kg) having the highest birth weight as compared to other classes. The effect of both season (p 0.05) and period (p 0.01) of calving was found significant on most of the growth traits.

Assessment of Genetic Diversity and Trends for Performance Traits in Karan Fries Cattle

In the study pedigree data over a period of 54 years (1965-2018) was analysed to assess the population structure in terms of pedigree completeness measure, inbreeding coefficient (F_x), average relatedness (AR), generation interval, effective population size (*Ne*). The PCI (%) of the whole pedigree for the first, second, third, fourth and fifth generations was 90.03, 65.70, 41.17, 21.01 and 9.92. The maximum generations traced was 11 and mean maximum, complete and equivalent generations was found to be 4.43, 1.25 and 2.36 in Karan Fries cattle.

A total 217 (2.95%) mating between half sibs and 17 (0.23%) mating between parent-offspring occurred during the period. Out of 7348 individuals, 2716 were inbreeds with inbreeding range from 0.1 to 31.25%. The increase was substantially lower in recent years (2002 to 2018) as compared with the decade from 1981 to 1993 clearly indicated that average F_x had increased considerably until 1998, reaching a value of 2.50 in 1993 and then start decreasing slowly thereafter. The effective population size estimates for was found to be 119.50. The N_eC_i(78.56 ± 2.40) was lower in comparison to the N_eF_i(119.15 ± 23.16). The N_e estimates per year range between 01.44 and 217.90 with a mean of 119.15. There was a steady increase of N_e per year due to establishing phase of breed in the initial years. The ratio between N_eC_i/N_eF_i was found to be 0.65 in present study. The average Generation Interval of parent offspring pathway was 5.94 years in Karan Fries (KF) cattle. The maternal interval (5.70 years) was almost similar as that of paternal interval (6.18 years) this might be due to similar annual replacement rate among male and female subpopulation in KF breed. In present finding number of founders, effective founders and ancestors contributing to the reference population were 479, 88 and 61 in KF. The observed levels of inbreeding and the values of the Average relatedness (AR) are low within the recommended level and well defined pedigree structure of three breeds. Adoption of breeding policy like introduction of new reproductive individuals with the lowest possible *AR* is strongly recommend to minimize inbreeding with less intensive use of few bulls is desirable to maintain genetic variability in future generations.

Assessing Genetic Relationship among Production, Functional and Linear Type Traits for Selection of Elite Sires in Indigenous and Crossbred Dairy Cattle

Genetic evaluation of bulls based on multiple traits (production/yield traits, linear type traits and functional traits) may give better objectivity and balanced sire/animal selection procedure. Balanced selection of sires/animal will be very important for further propagation of these elite sires in the field for overall well-being of animals with better feet and udder traits and more economic return due to less involuntary culling. Production (300DMY, total yield) and breeding data of Sahiwal cattle were collected and a number of functional were generated. Genetic parameters (heritability and genetic correlations) between production and functional traits were estimated with a small data (N=111) set using two statistical computer packages (Harvery, 1990 and BLUPF90). Estimates through BLUPF90 were found to be more precise for estimation of genetic parameters.

Deciphering the Modifications in Mirna Binding Region of DNA Repair Genes in Concurrence with Thermal Stress in Tharparkar and Karan Fries Cattle

In-silico genome wide miRNA-QTL-SNPs analyses using modifications in the customized SNPtools-miRNAQTLsnp software revealed 13 SNPs in CUX1 gene and miRNA bta-mir-2388 commonly associated with heat tolerance, respiration rate and body temperature. Further, 60 genes Base excision repair, Nucleotide excision repair and mismatch excision repair pathways were scanned and 36 SNPs were identified in miRNA binding regions out of which 15 were in seed regions.

Genetic Improvement and Evaluation of Dairy Buffaloes (Murrah)

The NDRI center continued to practice breeding programme for buffalo improvement in Network Mode, in the Murrah herd, was followed for test mating of 18th set of bulls. Fifteen bull from 18th set were used. Semen was received/collected from 15 bulls of 18th set and two proven bulls (Bull no. 183 and 2195). The Dam's best lactation 305 day milk yield of 4 bulls of NDRI under 18th set ranged from 3018 to 3465 kg. The herd strength of breedable buffaloes was 156. Average age at first calving of buffaloes was 44.52 months. The average service period of buffaloes has been estimated as 133.5 days. The overall female conception rate in the herd was 37.09% for the buffaloes. The overall mortality during the year was only 18.6%. The wet and herd average were 6.7 and 3.5 kg, respectively. The average Milk Fat, SNF Total Solid, Protein and Lactose were estimated as 7.54 ± 0.14, 9.86 ± 0.02, 17.38, 3.76 and 5.25%, respectively.

On the basis of evaluation of 14th set the Bull no. 6044 from NDRI ranked second out of three top ranking bulls and was declared as proven bull and selected for nominated mating. The information on 305 days milk yield of daughters completing first lactation during 2019-20 were collected and compiled for genetic evaluation of Murrah bulls. Total 15 elite Murrah male calves were reserved on the basis of Expected Predicted Difference and Dam's best 305d or less lactation milk yield, breed characteristics and physical conformity for selection of young male calves for future breeding. Finally, three young bulls with their Dam's best 305 days lactation milk yield of ranged from 2799 kg in first lactation to 3158 kg were reserved.

The NDRI Centre has produced 17397 doses of frozen semen from 4 Bulls of 18th set. The centre has supplied 9500 doses of frozen semen to other centers and field units, out of which 950 doses were supplied to Field unit of NDRI Karnal. In addition, doses of semen were supplied from ABRC for research purpose in the institute, though sale to farmers and other dairy development organizations during the period.

Field Progeny Testing Programme (Murrah buffalo)

A total of 66 females and 82 males calves were born during the period. The average age at first calving of 44.39 months in buffaloes. The average service period of buffaloes was 139 days. The overall female conception rate in the herd was 43.71 % for the buffaloes. The Female calf (0-3 month) mortality was around 7% during. The wet and herd average were 7.4 and 3.9 Kg, respectively. The average milk Fat, SNF and total solid were estimated as 7.69, 9.85 and 17.53%, respectively. The Dam's best lactation 305 day milk yield of 6 bulls of NDRI under 17th and 18th set ranged from 3018 to 3533 kg. A total of 15 elite Murrah male calves were reserved for future breeding programme during the period (2018-19) on the basis of Expected Predicted Difference and Dam's best 305d or less lactation milk yield (2792 kg to 3570 kg). Average best lactation milk yield for elite buffaloes was 3103.9 kg (25.29% > herd average). The best lactation milk yield of elite Murrah buffaloes ranged between 3036 kg to 4024 kg in 305 days.

During the period a total of 4,571 artificial inseminations with overall conception rate of 46.96% were performed in 16 villages adopted by ICAR-NDRI, Karnal by Darar, Kheriman Singh, Rindal, Kamalpur, and Shekhupura centers under the Murrah buffalo field progeny testing program. The AI services, semen dose and liquid nitrogen were supplied to the field un-interrupted during nationwide lockdown period.

Genome-wide Association Studies (GWAS) to Identify SNPs for Lactation Persistency in Murrah buffalo

Chromosomal mapping of 131 unique and significant SNPs for production, reproduction traits and lactation persistency were identified in Murrah buffalo genome. Identified SNPs, genes and genomic regions associated with production in Murrah breed shall help in early selection of high yielding buffaloes through Genome wide selection methods. A panel of SNPs was identified, which has a direct application in developing a trait specific SNP array / DNA chip technology in buffalo.

GWAS in Production and Reproduction traits in Murrah buffalo

Table: SNPs, genes and uncharacterized loci for production and reproduction traits in Murrah buffaloes

Traits	Related SNPs	Genes affected	Uncharacterized Locus
Milk yield & its constituents	65	30	4
Lactation Persistency	36	17	0
Fertility	30	18	5

A total of 27,735 population-specific SNPs were identified using ddRAD approach in 96 Murrah buffaloes. GWAS was conducted using two different methods (Mixed Linear Model and single-step GBLUP). A total of 28 SNPs (25suggestive SNPs and 3 significant SNPs) were found to be associated with production and reproduction. Among them, 14 SNPs were present in intronic region of AK5, BACH2, DIRC2, ECPAS, MPZL1, MYO16, QRFPR, RASGRF1, SLC9A4, TANC1 and TRIM67 gene. Only one SNP was present in long non-coding region of LOC102414911. Out of these SNPs, 9 SNPs were found to have pleiotropic effect over milk production traits (First lactation 305 days or less milk yield, First lactation 305 days or less fat yield, First lactation 305 days or less SNF yield) were present in chromosome number BBU 1, 2, 4, 6, 9, 10, 12, 19 and 20. SNPs in intronic region of AK5, TRIM67 gene were found to be associated with first lactation length, first lactation 305days milk yield, fat yield and SNF yield. Eleven of associated SNPs were found to be in intergenic region. ssGBLUP method which takes advantage of phenotype, pedigree and genotype in a single step revealed chromosomal regions having a higher proportion of additive variance. A total of 145 genes were found to be present in all of the top 5 genomic regions associated with production and reproduction traits: PIK3C2G, RARB, TACR1 and PPA1 are important candidate genes. Two chromosomal segments present in BBU12 and BBU3 showed maximum additive variance for production and reproduction trait.

Genomic Diversity in Buffaloes

Genomic diversity between swamp and riverine buffalo; and to identify QTLs in Murrah buffalo breed through GWAS based on ddRAD approach. A total of 17k variants were identified in both Indian swamp and riverine buffalo. PCA and structure analysis revealed Manipur swamp is pure and distinct, whereas Nagaland and

Mizoram swamp buffaloes had an admixture with riverine buffalo. As both swamp and riverine are interfertile in north eastern part of India, the above proposed low cost genomic approach can be used to identify admixture.

Identification of Selective Sweeps for Performance Traits in Gir and Tharparkar Cattle

Selective sweep regions and gene pathways involved for performance traits in Gir and Tharparkar cattle were identified using ddRAD method. A total of 13.6 and 12.3 million reads were obtained upon sequencing in Gir and Tharparkar respectively. After quality control, 13.4 and 12.1 million reads were retained. Good quality processed reads showed an alignment of 99.7%, 93.5% and 91.6% with reference genome of *Bos taurus, Bos indicus* and Gir, respectively while 99.87% and 92.13% with reference assemblies of *Bos taurus* and *Bos indicus*. In Gir, a total of 198952, 182917 and 163349 SNPs while in Tharparkar, a total of 185682, 167092 and 144417 SNPs as compared to *Bos taurus* reference assembly were identified. A total of 19,127 SNPs, passed the quality control, were used for further analysis. Using SweeD and pStacks, a total of 191 Selective sweep regions were found by CLR approach in Gir, CLR approach in Tharparkar and F_{st} approach in top 1 percentile of the empirical distribution. Using BEDtools intersect, a total of 91, 80 and 100 genes were traced in Selective sweep regions. 86 and 73 genes annotated in these regions can be regarded as potential breed-specific selective sweeps in Gir and Tharparkar cattle, respectively. Wright's statistic (Fst) between Gir and Tharparkar was 0.055. This implies that a moderate part of variability i.e., 5.5% is shared between the breeds, as compared to the total variability. Gene pathway analysis using PANTHER portal revealed a likely involvement of genes in pathways related to nervous system, indicating probable selection for domestication in Gir and Tharparkar.

Identification of Insulin IGF pathway imply their role in production; Gonadotropin releasing hormone pathway and Oxytocin receptor mediated pathways for reproduction; chemokine and cytokine signaling pathway, Ras pathway and Wnt signaling pathways in immunity and adaptation. Almost 20 genes found in selective sweep regions by F_{st} approach were related to adaptation. QTL overlaps showed stronger signals for selection for milk production and growth in Gir cattle, exterior association in Tharparkar cattle and for reproduction in both the breeds.

Strategic Modeling of Reference Population for Effective Implementation of Advanced Selection Strategies.

Impact of truncated pedigrees on the prediction accuracy and bias was evaluated using simulation tool QMSim, selected out of other tools such as MTG2, GPopSim and QMSim. The data was simulated for 10 recent generations with 50 males and 500 females breeding each generation to produce 1000 progeny. The mating design was random, whereas selection and culling design was EBV. The simulation was done using gene dropping approach. It has been observed that only pedigrees for 10 generations can yield accuracy of 44.5% with minimum bias, however with truncated pedigrees, the prediction is less accurate and more biased (acc: 44.2% and bias:92.4% for 5 truncated pedigrees).

As genotyping all individuals is not practical solution therefore, top 25% males from generation 6 to 9 (N=500) were used and made a reference for genomic prediction. The accuracy was severely compromised to 28.1%. Increasing the reference to 1000 animals (top 50% males), the accuracy regained its pedigree level (43.5%) but bias increased by 32% (1.32). However using a Single Step approach and correcting for inbreeding of NRM could obtain the 44.7% accuracy and no bias even for truncated pedigree of 5 Generations if top 25% males from last 4 generation are genotyped. Hence truncated pedigrees can be useful for prediction if some top relatives are genotyped and used in Single Step approach.

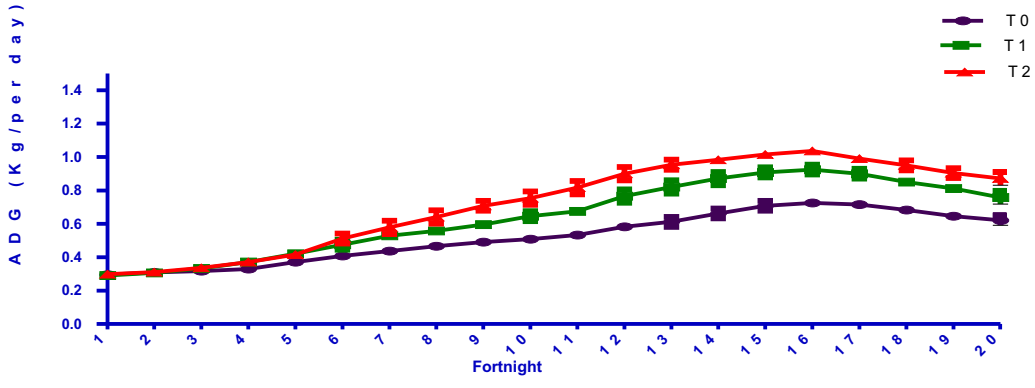
Fitness Black Box: Deciphering the Ovar-MHC Variability in Sheep Breeds of India

Project was transferred from CSWRI to NDRI along with PI. Breeds covered till now are nearly 20 that also include some crossbreds. The samples were collected from Malpura, Kheri, Patanwadi, Avikalin, Avishaan, Chokla, Marwari, Magra, Deccani, Madgyal, Sonadi, Madras Red, Garole, Kendrapara, Munjal, Harnali, 2 Crossbreds from CSBF, Poonchi, Bhakarwal. Three genes which are hypervariable are targeted for study, and these are DRB1 (301bp), DQA1 (269bp) and DQA2 (242 bp). The approach used is PCR-SBT for polymorphism study. Three genes of following breeds amplified: Malpura, Patanwadi, Avikalin, Magra, Marwari, Chokla, Kheri, Madgyal, Deccani, Poonchi, Bhakarwal, Munjal, Harnali. Evidence of duplication of DQA2 and also very huge diversity at DRB, DQA and loci in Malpura, Avikalin, Munjal and Patanwadi sheep have been found. The result will help in deciphering the overall fitness in Sheep breeds of India.

INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS

Effect of Bull Biostimulation on Growth, Puberty and Estrus Behaviour of Murrah Buffalo Heifers and Buffaloes

Pre-pubertal Murrah buffalo heifers were allotted to 3 groups of 8 each on the basis of age (15 months) and body weight (200 kg). In no bull exposure (NBE; T0) group, the heifers were not exposed to bull; in fenceline bull exposure (FBE; T1) group, the heifers were exposed to a bull through a fenceline contact and in direct bull exposure (DBE; T2) group, the heifers were exposed to direct contact in heifer paddock for a period of 6 hours daily. Heifers were confirmed to have attained puberty if P4 concentrations were >1 ng/ml. The estrus behaviours were recorded on day -3, -2 and -1 (prior to estrus), day 0 (on the day of estrus) and on day +3, +2 and +1 (post estrus) using 24 hours CCTV camera recording.



Daily Body wait gain of heifers over fortnights in no bull exposed (T0), fenceline bull exposed (T1) and direct bull exposed (T2) heifers.

Table: Average age and body weight at puberty under No bull exposure, Fence-line bull exposure and direct exposure of bull biostimulation in Murrah heifers

Parameter	No bull exposure	Fence-line bull exposure	Direct bull exposure
Daily weight gain (kg)	0.545a±0.02	0.678b±0.02	0.764c ±0.02
Age at puberty; first estrus (months)	25.61a±0.70	23.55b±0.85	21.50c±0.44
Body weight at puberty (kg)	330±12.45	342±13.46	348±8.53
No. of heifers reaching puberty	5	5	8

Table: Reproductive performance of buffalo heifers exposed to bull contact

Parameter	No bull exposure	Fence-line bull exposure	Direct bull exposure
Age at first service (months)	26.29 a±0.70 (4)	24.35b±0.60 (4)	22.28c±0.50 (7)
Services per conception (No.)	1.50±0.50	1.00±0.00	1.20±0.20
Conception rate (%)	50.0	75.0	71.4
Accuracy of estrus detection (%)	30	100	100

The mean frequencies of estrus behaviours viz., sniffing/licking, micturition, chin resting, and allowing mounting attempts were significantly higher ($p<0.01$) to the extent of 200-300% in both bull exposed heifers than non bull exposed heifers during first as well as second estrus. Theses frequencies of estrus behaviors in general increased in second estrus as compared to first estrus in all three groups.

It was concluded that the biostimulation of buffalo heifers through direct contact improved the growth and reduced age at puberty and sexual maturity by about 4 months. The bull contact either direct or through a fenceline promoted accuracy of estrus detection, reduced the number of services per conception or improved conception rates in buffalo heifers.

Reproductive Performance of Buffaloes Exposed to Bull Contact

Postpartum Murrah buffaloes were assigned to 3 groups (T0, T1 and T2) of 8 each based on their yield in previous lactation in pleuriparous buffaloes and expected producing ability of primiparous buffaloes.

Daily dry matter intake was similarly also higher (($p<0.01$) T2 buffaloes (15.74±0.27 kg) than in T0 (14.35±0.31 kg) and T1 (14.72±0.32 kg) buffaloes. This may be attributed to lower or no stress of calf separation in these buffaloes as evidenced by greater resting time and lower frequency of vocalization around milking time. The fat content in milk was however, lower in both calf suckled buffaloes (T1 and T2) as compared to calf weaned (To) buffaloes. The higher fat content in the milk suckled by the calf at the end of milking due to accumulation of fat globules at the top layer in the udder quarters due to continuous shaking action of hand milking may have resulted in lower fat content in the bucket milk.

It was concluded that the biostimulation of calf-suckled buffaloes with fenceline bull contact from about 30 days post-partum was effective in preventing the delay in onset of estrus cyclicity caused by calf suckling in buffaloes. The full time fenceline calf-contact, however, greatly improved the productive performance of these buffaloes

Effect of Direct Bull-Contact and Fenceline Calf-Contact on the Performance of Buffaloes

The effect of biostimulation through direct bull contact along with fenceline calf contact was studied on 24 freshly calved buffaloes divided into 2 groups of 12 each. In one group (FC) the buffaloes were exposed to an intact apronized bull from 6 hours daily after about 30 days of calving. The calves of these buffaloes were housed in a full time fenceline contact with their mothers right from their birth and allowed natural suckling. The buffaloes in the other group (RC) were not exposed to the bull but their calves were allowed suckling and limited mother contact twice daily only at milking time.

Table: Reproductive performance of buffaloes

Parameter	No bull contact No calf contact (n=8)	Fenceline-bull contact Restricted calf contact (n=8)	Fenceline-bull contact Fence-line-calf contact (n=8)
Days from calving to first estrous	67.62±6.74	62.28±6.69	60.37±5.41
Days from calving to first service	95.75±6.28	90.28±6.62	84.75±6.76
Number of buffaloes inseminated	8	7	8
Service period (days)	117.42±15.41	99±12.34	98±9.84
No of services per conception	2.14±0.55	1.40±0.40	1.28±0.18
Days from bull exposure to first estrous	--	25.37±5.41	27.28±6.69

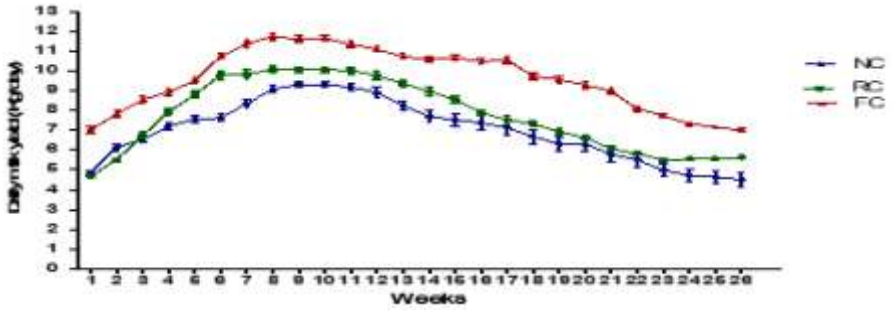


Fig.: Daily milk yield of buffaloes in no bull-no calf contact (To), fenceline bull contact+restricted calf contact (T1) and fenceline bull contact+ fenceline calf contact (T2) from calving to 26 weeks

Productive Performance

The average daily milk yield of buffaloes with fenceline calf contact was significantly ($p<0.01$) higher (11.8±0.1 kg) than that in restricted contact (7.9±0.1 kg). Greater secretion of prolactin hormone due to presence of calf full time in close vicinity of mother buffaloes, lower stress levels as evidenced by lower frequency of vocalization, longer resting, eating and rumination time may together have contributed to remarkably higher milk yield in FC buffaloes.

Table: Performance of buffaloes in no bull contact with restricted calf contact and direct bull contact with fenceline calf contact

Particulars	No bull contact Restricted calf contact	Direct bull contact Fenceline calf contact
Days to first heat	106.8±8.2b	51.5±3.1a
Number of animals AI	08	12
Days to first service	112.4±9.2b	74.8±3.4a
Service period (days)	118.8±8.3b	78.8±4.8a
Number of services per conception	1.16±0.11	1.33±0.23
Daily milk yield (kg/day)	7.9±0.1b	11.8±0.1a
DMI (kg/day)	14.92±0.25b	15.89±0.22a

In conclusion, the biostimulation of calf bonded buffaloes by direct exposure to a bull for a period of 6 hours daily after one month post-calving highly improved the reproductive performance of buffaloes. Further, full time calf contact to these buffaloes through a fence remarkably improved their productive performance.

National Innovations in Climate Resilient Agriculture (NICRA)

Under NICRA project two villages were adopted and in Chugawa village (District Karnal) 50 dairy farming families were selected for improving dairy productivity through scientific interventions, methodologies and technologies (mineral mixture, best quality semen, fodder seeds, health and deworming) developed by the NICRA team. Under SC-SP component the floor rubber mats were distributed among the dairy farmers who are keeping lactating animals.

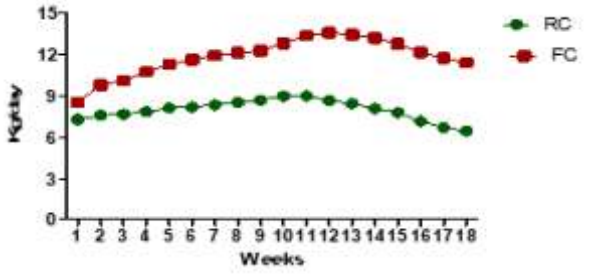


Fig. Daily milk yield (kg) of buffaloes with full calf contact (FC) and restricted calf contact (RC) from calving to 18 weeks

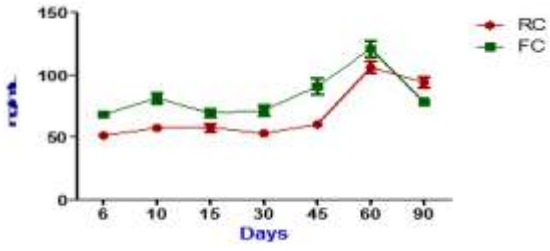


Fig. Plasma prolactin hormone concentration (ng/mL) in buffaloes with full calf contacts (FC) and restricted calf contact (RC) at different day after calving

Ramie (Boehmeria nivea), a feed forage grown in Northeastern region of the country is successfully grown at ICAR-NDRI, Karnal under NICRA project as an objective. This crop can be used in multiple ways like animal fodder, vermi composting, paper pulp and as a strongest natural fiber. Hence may prove beneficial to the farmers of North Indian plains. One multi seasonal housing module has been designed and fabricated under NICRA project considering the seasonal variations in environmental parameters. This module may help in mitigate the effect of external environment on different types of livestock dairy species.

One multi seasonal housing module has been designed and fabricated under NICRA Project considering the seasonal variations in environmental parameters. This module may help in mitigate the effect of external environment on different types of livestock dairy species. One study to observe the general and individual interaction behavior with other animals were recorded in experimental heifers. These heifers were kept stress free, so that to enable them to exhibit natural behavior. The animals were kept under stress free environment with minimum disturbances to these animals in terms of regular handling for blood collection or for any other purposes. These animals were also subjected to different types of soothing music at low volumes. After trying many music

Fig.: Dr. M.S. Chauhan, Director, ICAR-NDRI, Karnal distributing water filters under SCSP grants at villages in Distt.-Karnal

combinations, the Indian flute music at low volumes were found to be significantly effective for making animals stress free and calm. The feed intake and growth rates increased significantly after music therapy to these animals. The general behavior in terms of animal-to-animal interactions changed significantly. The observations on animal to human interactions, it was found that the animals were less repellent to the workers in comparison to the earlier periods.

Effect of Thermal and Nutritional Stress on Growth in Female Sahiwal Calves

Six months old Sahiwal female calves were selected to study the effect of different stressors on different physiological parameters during their early life and to access the compensatory growth rate. It was recommended that initial stage of growth the animal should be stress free in terms of Heat Stress (HS), Nutritional Stress (NS) and combined stress (CS). The HS during early life can be compensated in later stages but CS and NS if persists in early life the desired growth rate may not be achieved very soon even after following the best management, which further leads to financial loss to farmers.

Shelter Management

In winter season the animal shed temperature was maintained around 15-17 degree Celsius by using plastic cover around. This saved animals from harsh cold and maintained comfortable temperature for growing cattle. The custom designed shed in NICRA Complex was modified to maintained the inside temperature within the range of 14-18 °C, some additional material was arranged and existing shed was modified to maintain the comfortable environment inside. In this arrangement the suntrap sheet was arranged to fix all around the shed to break the wind/air entry in the shed when outside temperature was around 3-5°C. During this period from 08-01-2021 to 20-02-2021 during the winter season, the performance of experimental animals was recorded in terms of feed intake, water intake and daily weight gain.

Table: Mean ± S.E.M. Values of relative mRNA expression of AQP1, AQP2 and AQP3 in Urinary Bladder of goats during different seasons

Gene Expression	Winter	Spring	Summer
AQP1	0.51b ± 0.11	1.00a ± 00	1.2a ± 0.10
AQP2	0.69b ± 0.12	1.00b ± 00	2.6a ± 0.32
AQP3	0.77b ± 0.08	1.00b ± 00	2.9a ± 0.34

Agri-CRP on Water Budgeting and Improving Water Productivity in Livestock

Aquaporins (AQP1, AQP3 and AQP5) are transmembrane proteins, and were investigated for their role in thermoregulation of buffalo. The expression of the genes across different season viz. winter, spring and summer (N=12, sampled from neck region) were studied through RT-PCR and immunolocalization. The physiological responses including respiration rate, rectal temperature and neck skin temperature observed during summer were significantly higher than winter and spring seasons. The relative mRNA expressions of AQP1, AQP3 and AQP5 in skin relative to spring season were 1.41± 0.47, 1.95± 0.22 and 6.77± 1.02 folds during summer which were significantly higher than other seasons. The up-regulation of the expression of the studied AQPs were concomitant with the increase in physiological responses including skin temperature and sweating rate during summer. During summer season, AQP1 were mostly immunolocalized in the walls of skin blood capillaries, while AQP3 were observed mostly in the epidermal layer of the skin. The immunolocalization of AQP5 were mostly observed in the secretory glands of skin. The up-regulation of AQP1, AQP3 and AQP5 in skin during summer season indicates their role in thermoregulation of buffaloes.

Cellular Distribution of AQP1, AQP2 and AQP3 in Renal System of Goat

Aquaporins (AQP1, AQP2 and AQP3) plays a major role in water movement in kidney, especially in renal medulla where ADH acts to reabsorb water and it is positively correlated with ADH different environmental temperature. The fold change expression of AQP3 was found to be highest expressed in ureter and urinary bladder as compare to AQP1 & AQP2 in summer season. AQPs may play a regulatory role in urothelial cell volume, osmolality and in determining the composition of final urine. In the goat significant rise in the physiological reactions occurred during summer showing a positive correlation with the temperature and physiological responses so as to overcome the environment stress during different seasons of animals. The

variations in the haematological counts, circulatory electrolytes, blood biochemical components observed in the goats during summer seasons depicting its thermo tolerance. The significant increase in the ADH and cortisol concentrations was high during summer showing a direct relationship with efficient water balancing mechanism in the body.

Effect of Treated Effluent Water Intake on Physiological Status, Health and Growth Parameters in Cattle and Buffaloes

Effect of treated effluent water was studied when offered for drinking on physiological status (Rectal Temperature, Respiration Rate and Heart Rate) and hematological parameters (TEC, TLC, DLC, Hb and PCV), health and growth parameters in comparison to control group animals served with fresh tap water, in young and adults of cattle (Karan Fries and Tharparkar) and buffaloes of Murrah breed. The physio-chemical and microbial properties of water was in accordance with the different drinking water standards such as Dairy NRC, 2001, APHA, EPA 2002 and BIS, 1991. The growth parameters which included body weight, heart girth, paunch girth, height at wither and body length also remained non-significantly ($p<0.05$) different in treatment groups as compared to the control groups. Different levels of hormones (Cortisol, Aldosterone, ADH, Angiotensin II, T3, T4, Interleukin 2 and TNF α) was measured to see the difference in the animals of control and treatment group, but no significance ($p<0.05$) was seen. Further, prevalence of parasitic infestation in young calves of these breeds was studied, and presence of endoparasites was found. It is envisaged that the treated effluent water served for drinking did not had any deleterious effect on the physiological and health status of the animals, therefore, this treated effluent water used during the study can be recommended as drinking water to the animals in the water scarce areas.

Exploring the Effect of Curcumin on Heat Stressed Buffalo Mammary Epithelial Cells and Analysis of Associated Molecular Pathways

Curcumin is a dietary polyphenol, recognized for its strong antioxidant, anti-inflammatory and anti-tumor properties. RNA-Seq analysis in different groups of treatment in bovine mammary epithelial cells (BuMECs) was done. Present study in buffalo mammary epithelial cells was conducted in vitro to evaluate the effect of curcumin on heat stressed BuMECs and molecular pathways associated with it. Morphological study showed that control cells were well adhered, homogeneous in size and appearance showing typical morphology of BuMEC (cobblestone conformation). When moved to higher doses (20µM, 40µM and 60µM), treated cells showed distorted morphology, abnormal shape, lose cell to cell contact. Results showed the cells which were treated with curcumin decreased the apoptosis in BuMECs under heat stress condition. KEGG database was used to identify the pathways associated with DEGs and our study revealed that most of the DEGs were involved in metabolic pathways (Table). Other pathways such as cell cycle pathway, p53 signaling pathway and lysosome pathway was also found in our study. Curcumin exhibited protective effect in a dose dependent manner by regulating the genes related to heat stress response and inflammation in BuMECs under heat stress conditions. In vitro and transcriptome analysis indicated that BuMECs treated with lower concentration of curcumin (5µM and 10µM) under heat stress condition found the effective doses for the protection of cell from deleterious effect of heat stress.

Table: Enriched KEGG pathways for different expressed genes in BuMECs

Pathway	No. of DEGs
bta01100 Metabolic pathways	1071
bta04151 PI3K	242
bta04010 MAPK signaling pathway	222
bta04144 Endocytosis	201
bta04714 Thermogenesis	173
bta05166 Human T	169
bta04810 Regulation of actin cytoskeleton	166
bta05205 Proteoglycans in cancer	165
bta05163 Human cytomegalovirus infection	164
bta04014 Ras signaling pathway	163
bta05170 Human immunodeficiency virus 1 infection	154
bta04015 Rap1 signaling pathway	153
bta05206 MicroRNAs in cancer	152
bta04510 Focal adhesion	151

Empowering Farmers through Selective Interventions in Salt Affected Agro Ecosystems of Ghaghar Plains

NDRI adopted villages (Mundri, Geong, Kathwar, Sampli Kheri and Bhaini Majra of Kaithal district) under Farmers FIRST programme, major problems in livestock production system were identified through farmers participation, namely, repeat breeding, availability of good quality semen, low growth rate and milk production of buffaloes and cows specially during summer stress, balance ration etc. Fourteen growing buffaloes (8-10 months) were selected into two groups i.e. control and treatment. The treatment group of animals were supplemented betaine @25gm/day/animal. Blood samples were collected at fortnight intervals for biochemical parameters. The physiological responses, thermal imaging, morphological parameters, feed intake and body weight were also recorded at fortnight intervals. The environmental parameters i.e. dry and wet bulb temperature, relative humidity were recorded on the day of sampling and temperature humidity index (THI) was calculated. THI remained higher than normal threshold levels throughout the experiment period. The physiological parameters viz. respiration rate, pulse rate, rectal temperature and skin temperature were significantly lower in treatment group than control group. Infra red temperature (IRT) at different anatomical sites (forehead, neck, shoulder, ventral and flank) was found to be significantly lower in experimental animals than control. Plasma glucose was numerically higher in treatment compared to control, whereas plasma NEFA was lower (P 0.05) in treatment group than control. Plasma Glutathione peroxidase and Catalase levels were higher (P 0.05) in treatment than control. The plasma levels of IL-2 was lower (P 0.05), whereas IL - 10 was higher (P 0.05) in treatment compared to control. Plasma hormones i.e. cortisol and growth hormone were significantly higher and lower, respectively, in control group compared to treatment group. The values of morphological parameters viz. heart girth; body length and height at withers were higher in treatment group than control. The average daily gain (ADG) was significantly higher in treatment than control group of growing buffaloes. These growing buffaloes were monitored for above mentioned parameters even after the withdrawal/ end of supplementation of betaine. The results indicated the sustained beneficial effects of betaine supplementation even after one month withdrawal.

In another trial, 395 breedable bovine (Cattle - 73 and buffalo- 322) were inseminated at the proper time of estrus (heat) using the NDRI bull semen. These animals were also supplemented mineral mixture @50-60 g/day/ animal during the study. Inseminated cow and buffaloes were checked through rectal palpation after three months of insemination. The overall conception rate of the whole period was 51.14%. The awareness and interaction programmes were also organized in adopted villages. One to two saplings of Nirgundi (*Vitex negundo*) plants were distributed to 40 farmers and educated them to prepare polyherbal medication using neem leaves also to effectively control the ticks' infestation in dairy animals.

Modulating the Immune-Cellular Components and their Signalling Molecules in bovine Colostrum and Milk

Healthy multiparous cows were selected and randomly divided into five groups with seven cows in each group, i.e. control (Basal Diet, BD), T1 (BD+ vitamin A, 10^5 IU), T2 (BD+ zinc sulphate, 60 ppm), T3 (BD+ vitamin E, 2500 IU), and T4 (BD+ combination of T1, T2, and T3). Feeding was started one month before the expected days of calving till calving and blood samples were collected from cows at days -15, -7, -3, 0, +3, +7, and +15 relative to the day of calving. Blood samples from newborn calves and milk samples of cows were collected at days 0, +3, +7, and +15. Combined supplementation of micronutrients decreased the maternal blood and milk cortisol, milk SCC and increased total milk Ig concentration and the PA of blood neutrophils. Similarly, lower blood cortisol concentration and higher total Ig and PA of blood neutrophils were observed in the calves born to the supplemented cows. The highest positive effects of treatment were noticed in T4 followed by T3 and then T2. However, T1 didn't differ from the control group.

ANIMAL FERTILITY, REPRODUCTION AND DIAGNOSTICS

Genomic and Proteomics Approaches to Develop Specific Diagnostic Assay for Detection of Estrus/Silent Estrus in Buffaloes.

Accurate and efficient detection of estrus in dairy cows and buffaloes is an essential component to maintain their reproductive efficiency at optimum. Identification of potential candidate protein biomarkers will lead to development of non-invasive and on-spot tool for accurate and efficient detection of estrus in buffaloes.

Label free quantification (LFQ) and labeled quantization using TMT labels coupled with LC-MS/MS analysis identified 742 and 689 differentially expressed proteins (DEPs) in saliva during estrus stage compared to proestrus, metestrus and diestrus stage of estrous cycle. Functional analysis of DEPs confirmed stress response signalling (P=1.16E-07), salivary secretion (P=1.75E-07), estrogen signaling (P=0.00076), response to dehydroepiandrosterone (P=0.029), mucosal immune response (P=0.04), cell redox homeostasis (P=0.0000006), lactate dehydrogenase activity (P=0.0002), fatty acid binding (P=0.00001), glycolytic process (P=0.00), estrogen-dependent gene expression (P=0.00) as most enriched pathways. Four important proteins were validated using western blotting.

Expression Analysis of Salivary Transcripts during Different Phases of Estrous Cycle in Buffaloe

Expression analysis of three transcripts viz., HSPA1A, HSD17B1 and Inhibin (INBH) in saliva was quantified using quantitative Real-Time PCR (qRT-PCR). Saliva samples were collected from proestrus (-2 to -1), estrus (day 0), metestrus (Day+1 to +3) and diestrus (day +10) phases and total RNA was extracted, cDNA was synthesized and time-lapse gene expression was studied in a CFX96 Touch Real-Time PCR Detection System. The expression of INHBA, HSD17β1gene was highest (P<0.05) during estrus (22 and 11.9 fold) followed by day -1 (2.45 and 3.065 fold), metestrus (1.07 fold) and lowest expression was observed during day -2 (1.002 fold) as compared to diestrus phase. Similarly, HSPA1A expression was highest (P<0.05) during

Fig.: Network construction for protein–protein interaction using Cytoscape with ClueGO plug-in

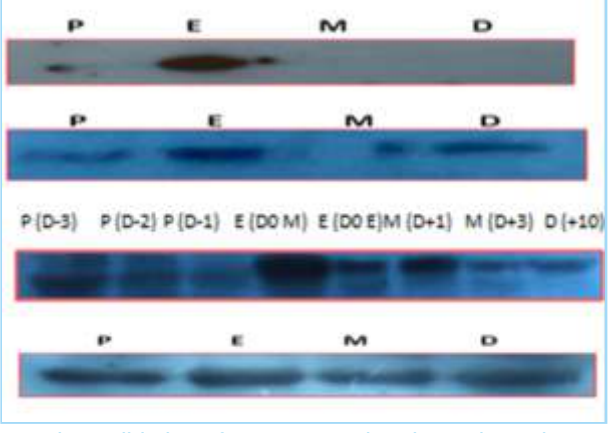
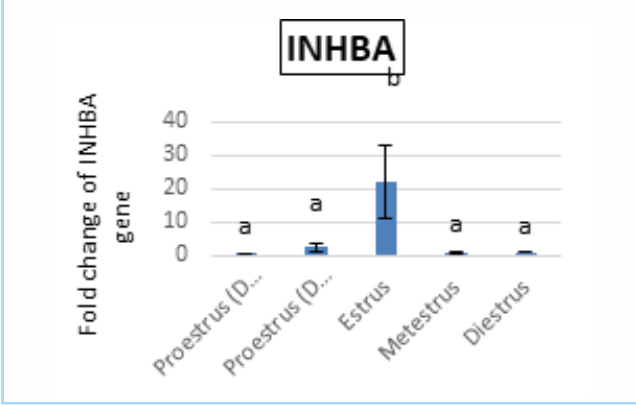


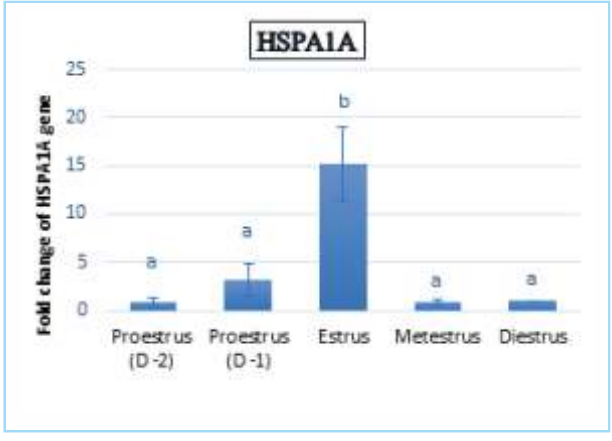
Fig.: Validation of estrus associated proteins using western blotting

estrus (15 fold), followed by day -1 (3.2 fold) and lowest expression was observed during day -2 (0.93 fold) and metestrus (0.86 fold) phase when compared to diestrus phase of the estrous cycle in buffaloes



Identification estrus biomarker in urine of buffaloes under research achievements of BMGF Project: Urine samples were collected from 4 different phases (proestrus, estrus, metestrus and diestrus) of estrous cycle and protein was extracted from urine samples using ammonium sulfate

Identification estrus biomarker in urine of buffaloes : Urine samples were collected from 4 different phases (proestrus, estrus, metestrus and diestrus) of estrous cycle and protein was extracted from urine samples using ammonium sulfate precipitation method and desalted using zeba-desalting columns. The concentration of protein in buffalo urine was in range of 140.8-900.2 µg/mL. Urinary proteins from 4 stages of estrous cycles were subjected to differential proteome



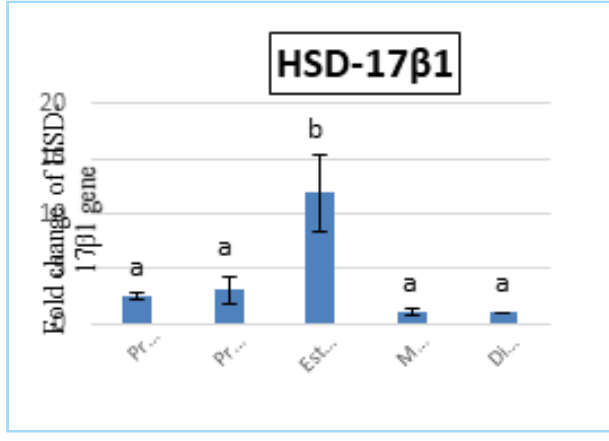


Fig.: Relative mRNA expression of INBH, HSD17B1 and HSPA1A gene in saliva during different phases of estrous cycle in buffaloes

profiling using in-sol digestion followed by TMT labeling and LC-MS/MS analysis using ThermoOrbitrap Fusion mass spectrometer and samples were run as technical duplicates. A total of 2455 proteins were identified as differentially expressed proteins (DEPs) at 1% FDR. Out of these, 238 proteins were up-regulated (fold change 1.5) and 411 proteins were down-regulated (fold change of 0.6) in urine during estrus compared to other non-estrus stages of the estrous cycle. Bioinformatics analysis revealed steroid dehydrogenase (P=0.001), oxidoreductase activity (P=0.00097), cellular hormone metabolic process (P=0.028), estrogen metabolic process (P=0.00012), oocyte meiosis (P=0.028), response to estradiol and estrogen (P=0.003), chaperone binding and unfolded protein binding as most enriched pathways.

Effect of Synthetic Kisspeptin-10 Administration on Postpartum Anestrus Management in Buffaloes

Postpartum anestrus is one of the foremost causes of meagre reproductive performance in buffaloes. It limits the life time productivity of animals by increasing the inter-calving period and incurs huge economic losses to farmers. A study was done with the aim (i) to standardize the dosage of kisspeptin-10 in postpartum anestrus buffaloes, (ii) to assess the effect of exogenous kisspeptin-10 in induction of estus in postpartum anestrus buffaloes, and (iii) to find out the effect of exogenous kisspeptin-10 on folliculo-hormonal and (KiSS1/R) transcript changes during induction of estus in control vs. treated group. To find out the effective dose, a study was carried out to access the effect of different doses of kisspeptin on the release of LH, for which 20 number of postpartum anestrus buffaloes were selected and divided into four groups (Control, T1, T2 and T3) and Kisspeptin-10 was injected at the dose rate of 10, 15 and 20 µg/kg body weight respectively in T1, T2, and T3 group, equal volume of NSS was injected in control group. Blood sampling was done on every 20 minutes interval beginning with zero minutes to till 2 hours and plasma was analysed for LH concentration. The LH

concentration was significantly higher ($p<0.05$) in T2 group. The peak level was recorded at 40 minutes post injection and comes to basal level after 60 minutes post injection. Therefore 15 µg/kg body weight dose of kisspeptin-10 was used further, for that 18 postpartum anestrus buffaloes were selected and divided into three groups (Control, Positive control and Treatment; n=6) with 2-4 parity and 520-530 kg body weight. KP-10 was administered weekly once in treatment group, equal volume of NSS to control group and OVSYCH+CIDR protocol used in positive control group. Five animals from positive control and three from treatment group showed estrus after treatment as compared to control (zero). Expression of KiSS1 gene and KiSS1R was increased significantly ($p<0.05$) at different days. The number of small, medium and large size follicles were significantly higher ($p<0.05$) in treatment group. Progesterone and LH concentration also vary significantly ($p<0.05$) at different days. It could be concluded that kisspeptin was found to be effective in induction of estrus and also reduces the prolonged inter-calving period in treatment group, improvement in folliculo-hormonal and gene expression status in postpartum anestrus buffaloes peak and it was selected for experiment 5 µg/kg BW dose of KP elicited highest LH.

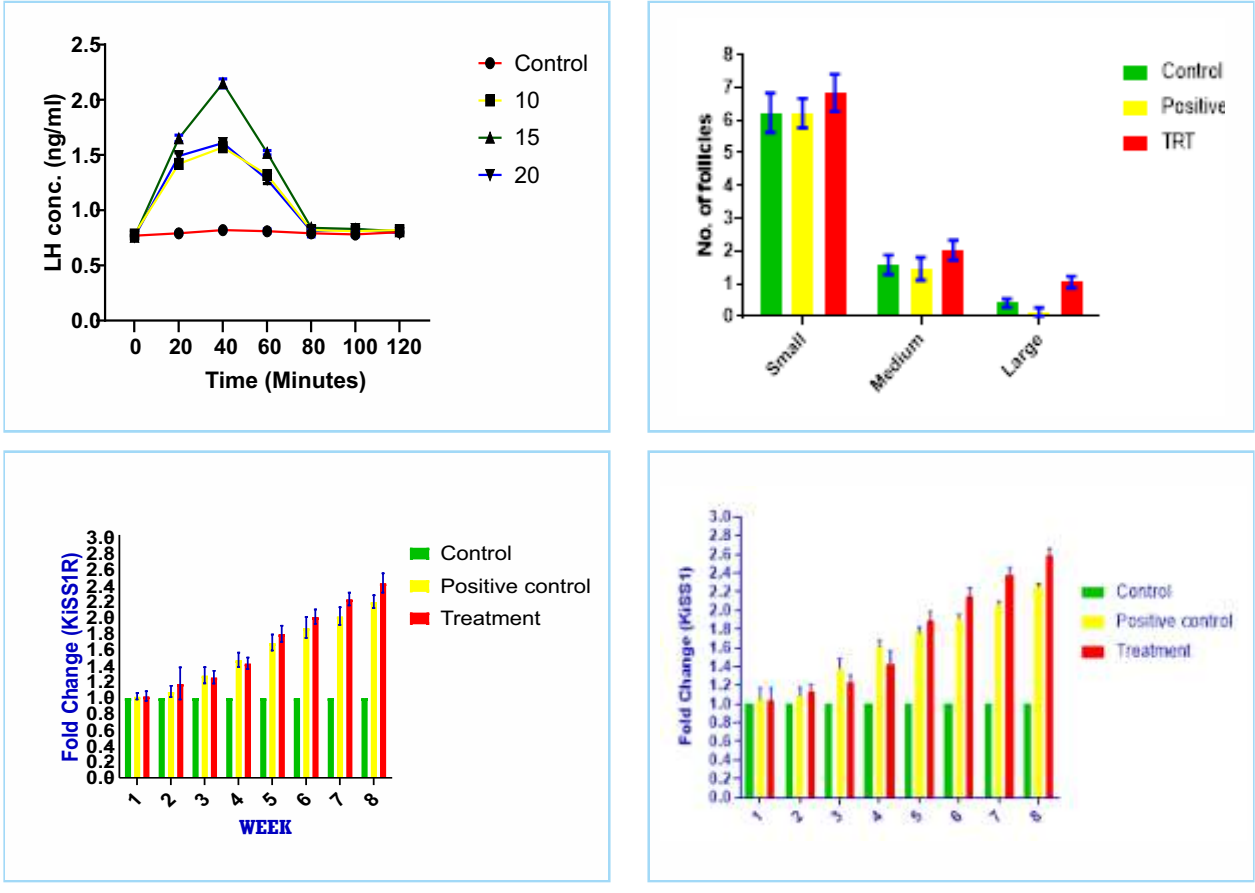


Fig.: Mean (±SE) fold change in mRNA expression of KiSS1/R gene in postpartum anestrus buffaloes of control and treatment group

Neutrophils as Potential Biomarkers/Predictors of Early Pregnancy in Cows

To study the role of IDO (Indoleamine-pyrrole 2,3-dioxygenase (IDO or INDO EC 1.13.11.52) during the critical period of implantation. Implantation associated immune-modulation and change in the expression profile of Th1-Th2 cytokines by indoleamine-2,3-dioxygenase (IDO) during early pregnancy establishment was studied in Karan Fries (KF) cows naturally coming to heat. Blood collection was done on days 0 i.e. day of Artificial Insemination (AI), 10, 18 and 36 post-AI in pregnant and non-pregnant cows. Neutrophils and peripheral blood mononuclear cells (PBMCs) were isolated by density gradient centrifugation method using Histopaque solutions 1077 and 1119. RNA isolation followed by gene expression analysis of IDO, Th1 cytokines (IFNɣ, TNFα) and Th2 cytokines (IL-4, IL-10, TGFβ) were performed. Relative mRNA expression of IDO was found to be significantly high ($P<0.05$) on 10^{th} and 18^{th} day in pregnant cows compared to non-pregnant animals. The mRNA transcript of IL-10 started to increase from day 10^{th} and was observed to be maximum on day 36 in pregnant cows compared to non-pregnant cows. The relative mRNA expression of IL-4

and IFNγ showed an increasing trend from day 10 and was highest on day 18 followed by a gradual decrease after 18th day in pregnant cows compared to non-pregnant animals. In case of TGFβ and TNFα the mRNA transcript was significantly high on 18th day in pregnant animals compared to non-pregnant cows.

A Rich Repertoire of Functionally Relevant Coding and Non-coding RNAs Identified in Crossbred Bull Spermatozoa

The sperm, which is believed to be transcriptionally and translationally inactive, does the duties by RNA and proteins which were pre-packed in it before the gradual disappearance of ribosome during chromatin compaction. Sperm transfers several functionally relevant transcripts to the oocyte, controlling maternal-zygotic transition and embryonic development. The present study was undertaken to profile and analyze the sperm transcripts comprehensively using Next Generation Ribonucleic acid sequencing technology in Holstein Friesian crossbred bulls. The global transcriptomic profiling of crossbred bull spermatozoa revealed the transcripts for 13,814 genes; of which 431 transcripts were expressed with >1 FPKM and 13,673 transcripts were expressed with >0 or <1 FPKM. *PRM1* and *HMGB4* were found to be the abundant protein coding RNAs of crossbred spermatozoa. Gene ontology of transcripts with >1 FPKM revealed their major involvement in structural constituent of ribosome and translation. Pathway enrichment exposed the connection between ribosome, oxidative phosphorylation and spliceosome pathways and the transcripts of crossbred sperm. Collectively, it may be inferred that the transcripts in crossbred bull spermatozoa were majorly involved in the functions such as structural constituent of ribosome and translation, and pathways such as ribosome, oxidative phosphorylation and spliceosome. The results of the present study can be used for generating reference crossbred bovine genome and opens up new avenues for understanding the etiology for compromised fertility in crossbred bulls.

Sperm Transcriptomic Analysis Identifies the RNA Level Alterations in Low-Fertile Crossbred Bulls

Presence of various forms of RNAs having roles in fertilization and early embryonic development is well documented in mammalian spermatozoa. Using Agilent microarray platform, we compared sperm mRNA expression profiles between high- and low-fertile crossbred bulls with normal semen parameters. Microarray data acquisition and analysis was performed using GeneSpring GX version software, wherein spermatozoa from high-fertile bulls were kept as control while spermatozoa from low-fertile bulls were considered as treatment group. A total of 6238 transcripts were detected in crossbred bull spermatozoa; 561 transcripts (>1.5-fold) were differentially regulated between high- and low-fertile bulls. Functional annotation has categorized these transcripts into biological process, cellular and molecular functions. It was observed that transcripts associated with oxidation reduction process (p=0.003), mitochondrial membrane potential (p=0.03) were significantly down-regulated while transcripts associated with apoptosis (p=0.04) were up-regulated in low-fertile spermatozoa. The dysregulated genes were involved in important cellular pathways including oxidative phosphorylation (p=0.002), estrogen signaling (p=0.002), Wnt signaling (p=0.035), cGMP-PKG signaling (p=0.007) and MAPK signaling (p=0.032) pathways. Collectively, the present study discovered profound discrepancies in sperm mRNA expression between high- and low-fertile crossbred bulls, with potential possibilities for their use in fertility prediction.

Metabolomics Fingerprinting of Bull Spermatozoa Identified Fertility Signature Metabolites

A study was undertaken to establish metabolomic profile of crossbred bull spermatozoa and to identify the fertility associated m etabolites. Spermatozoa from high- and low-fertile Holstein Friesian crossbred bulls were utilized for the analysis. Sperm proteins were isolated and protein-normalized samples were processed for metabolite extraction and LC-MS/MS analysis. Mass spectrometry data was processed using iMETQ software and metabolites were identified using Human Metabolome DataBase while, Metaboanalyst 4.0 tool was used for statistical and pathway analysis. A total of 3704 metabolites belonging to various chemical classes were identified in spermatozoa. After sorting the exogenous metabolites, 56 metabolites were observed to be common to both the groups while 44 and 35 metabolites were found unique to high- and low-fertile spermatozoa, respectively. Among the common metabolites, concentration of 19 metabolites was higher in high- compared to low-fertile spermatozoa (Fold change > 1.00). Spermatozoa metabolites with variable importance in projections of more than 1.5 included hypotaurine, D-cysteine, selenocystine. In addition, metabolites such as spermine, L-cysteine were identified exclusively in high-fertile spermatozoa. In

conclusion, we established the metabolic profile of bovine spermatozoa and identified the metabolomic differences between spermatozoa from high- and low-fertile bulls. Among the sperm metabolites, Hypotaurine, selenocysteine, L-malic acid, D-cysteine and chondroitin 4-sulfate holds potential to be recognized as fertility associated metabolites.

Comparative Metabolomic Analysis of Zebu and Crossbred Bull Spermatozoa

The incidence of infertility/sub-fertility is higher in crossbred bulls compared to zebu bulls; however, the etiology remains poorly understood. In the present study, we established the metabolomic profile of seminal plasma from zebu and crossbred bulls, and identified differentially expressed seminal plasma metabolites between these two breeds. Using high-throughput LC-MS/MS based approach, we identified 1002 and 990 metabolites in zebu and crossbred bull seminal plasma, respectively. After excluding the exogenous metabolites, it was found that 68 and 50 putative metabolites were unique to zebu and crossbred bull seminal plasma, respectively while 87 metabolites were common to both. In the normalized data, 63 metabolites were found to be dysregulated between zebu and crossbred bull seminal plasma. Observed pathways include inositol phosphate metabolism (observe d metabolites were Phospotidyl Inositol-3,4,5 triphospate/ Inositol 1,3,4,5,6 pentakishospate/ Myoinositol and hexakisphospate) in zebu, and Linoleic acid metabolism (observed metabolite was phosphatidylcholine) in crossbred bull seminal plasma. Abundance of Tetradecanoyl-CoA was significantly higher while abundance of Taurine was significantly lower in crossbred bull seminal plasma. In conclusion, the present study detailed the metabolomic profile of zebu and crossbred bull seminal plasma and suggest that increased lipid peroxidation coupled with low concentrations of antioxidants in seminal plasma might be associated with high incidence of infertility/sub-fertility in crossbred bulls.

Metabolomic Profiling of Seminal Plasma: A Comparative Analysis between Zebu and Crossbred Bulls

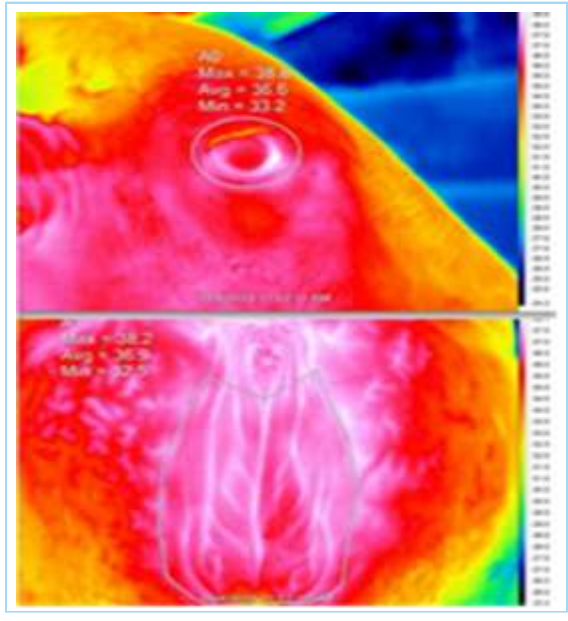
We investigated the comparative sperm metabolomic profile between zebu and crossbred cattle using LC-MS/MS based approach to understand etiology of high incidence of infertility in the later breed. Protein normalized mass spectrometry data was processed using iMETQ software and metabolites were identified using Human Metabolome DataBase while, Metaboanalyst 4.0 tool was used for statistical and pathway analysis. We observed the presence of 1732 and 1240 metabolites in zebu and in crossbred bull spermatozoa, respectively. After excluding the exogenous metabolites, it was found that 115 and 87 metabolites were unique to zebu and crossbred bull spermatozoa, respectively whereas 71 metabolites were common to both the groups. In the normalized data, 49 metabolites were found to be differentially expressed between zebu and crossbred bull spermatozoa. Taurine and Hypotaurine metabolism was the significant pathway ($P<0.05$) in zebu bull spermatozoa and Taurine and Hypotaurine were the observed metabolites. Glycerophospholipid metabolism ($P< 0.03$) was the significant pathway observed in crossbred bull spermatozoa, and phosphatidylcholine, phosphatidylethanolamine and phosphatidyl serine were the enriched metabolites in this pathway. Among different metabolites, Nitroprusside (VIP score>1.5) was downregulated while L- Cysteine, Acetyl-CoA and dUDP (VIP score>1.0) were upregulated in crossbred bull spermatozoa. In conclusion, the present study identified the metabolomic differences between zebu and crossbred bulls and suggest that aberrations in taurine, hypotaurine and glycerophospholipid metabolism might be associated with higher incidence of infertility/sub-fertility in crossbred bulls.

Identification of Stable Internal Control Genes for Accurate Normalization of Real-time Quantitative PCR Data in Bovine Testicular Tissue

Selection of stable internal control genes (ICGs) is an indispensable step in any real time quantitative PCR (qPCR) based gene expression studies. The present study evaluated the suitability of 10 candidate internal control genes (ICGs), namely *GAPDH*, *ACTB*, *RPL23*, *RPS15A*, *ATPSF1*, *GLUT5*, *HMBS*, *ATP2B4*, *PPIA*, and *BRP* to normalize the transcriptional data from testes samples of zebu and crossbred bulls. Total RNA was isolated from testicular tissue of zebu and crossbred bulls (n = 6 each) between 2-8 years of age, cDNA was

synthesised and quantitative Realtime PCR was performed. The Ct values were used for analysis of the stability of ICGs. Four different statistical algorithms, geNorm, Normfinder, BestKeeper and RefFinder were used to assess the stability of these genes. The comprehensive ranking by RefFinder showed that *ATPSF1*, *HMBS*, *PPIA*, and *RPS15A* were the most reliable and stable ICGs for zebu testes, and *ATPSF1*, *RPL23*, and *PPI A* for crossbred testes. Collectively, the present study identified a panel of suitable ICGs (*ATPSF1*, *HMBS*, *PPIA*, *RPS15A* for Zebu and *ATPSF1*, *RPL23*, and *PPIA* for crossbred) for normalization of gene expression data in testes samples, which could be helpful for researchers conducting functional genomic studies at testicular level in cattle bulls.

Behavioural Biometrics and Thermal Signatures Associated with Parturition in Deoni (*Bos indicus*) and HF Crossbred (*Bos taurus* x *Bos indicus*) Cows



A study was conducted to characterize behavioural and thermal biometric patterns around the calving process in Deoni and HF crossbred cattle. For this study, multiparous Deoni (n=6) and HF crossbred (n=6) cows of advanced gestation were chosen and allotted into individual calving pens 2 weeks prior to the expected date of calving. Behavioral studies were monitored by digital video recording system (DVRS) and digital infrared thermal imaging of eye and vulval region were captured using FLUKE thermal camera and was done at every 6 hours interval in both the breeds. Behavioural data were acquired through DVRS system 96 hours prior to calving and temperature profile were recorded from individual thermogram using FLUKE CONNECT software 48 hours before calving. Behavioural parameters like lying time (min/hour), rumination time (min/hour) was observed to decrease as the calving approached and differed significantly between both the breeds. Lying bouts differed significantly between breeds. Infrared thermographic (IRT) profile of eye and vulval temperature revealed that there was significant and sharp reduction in both eye and vulval skin temperature at 12 hours prior to onset of calving in both Deoni and HF crossbred cows. Temperature difference for eye at 12 hours and 6 hours was 0.39 and 0.32 and temperature difference of 0.55 for vulval region. In both the breeds the eye temperature significantly started increasing from 6 hrs till the completion calving process. In both the breeds the vulval skin temperature increased six hours prior to calving. It is suggested that behavioural parameters viz. lying time, lying bouts and rumination time can be a potential behavioural indicators for prediction of calving within 6 to 12 hours. It is concluded that thermal biometrics 48 hours prior to calving observed using digital infrared thermal imaging technology could be used as a non-invasive and non-contact technique to predict the onset of calving in cows.

Calving Alarm: A Wireless Remote Monitoring Sensor Device Prototype for Calving Prediction in Dairy Cattle

Calving time prediction, allowing the provision of human assistance when necessary, is thus of critical importance for dairy farm profitability and animal welfare. Many type of devices are currently in the market to detect imminent calving automatically. These devices operate on the same principle; once the predictive sign is detected by a sensor placed in or on the cow, a radio wave signal is generated and forwarded to a receiver that analyses the data and sends voice and/or text messages via Global System for Mobile communication (GSM) technology to the farmer's mobile phone, providing warning of the impending calving. A wireless remote monitoring sensor device prototype for calving prediction in dairy cattle has been developed and the current device works on the principle of electromagnetic wireless sensor with GPS communication system.

Cryopreservation of Black Bengal Buck Semen – Effect of Antioxidant Additives on Cryo-survivability

Non-enzymatic antioxidants such as alpha tocopherol, L-cysteine, methionine and hypotaurine were tested for their efficiency to reduce cryo-injury during preservation. 20 ejaculates were used for each antioxidant and

total of 80 semen ejaculates were used in the study. Each ejaculate was divided into three aliquots and treated with each one of antioxidants as control, T_1, and T_2 such as with alpha tocopherol (0,1 and 1.5mg/ml),L-cysteine(0, 1 and 2mM), methionine (0, 1 and 2mM) and hypotaurine (0, 5 and 10mM) respectively. The *in vitro* sperm characters were studied at immediately after collection and post freeze thaw of semen. Antioxidant additive alpha tocopherol @ 1mg/ml (T_1) and 1.5mg/ml (T_2) in the semen extender had significantly better values than the untreated control (C) in the following post thaw *in vitro* sperm characters such as motile sperm cells (T_1 43.5 ± 4.02 vs. C 34.4 ± 4.43%), functional membrane integrity ($T_1$42.2 ± 1.73; T_2 42.75 ± 1.61 vs. C 38.1 ± 1.43 %), sperm viability (T_1 41.5 ± 2.07; T_2 42.65 ± 1.98 vs. C 37.1 ± 1.72 %), acrosome integrity ($T_2$68.85 ± 1.95 vs. C 63.95 ± 2.24%), significantly low level of MDA ($T_1$0.769 ± 0.062 vs. C 0.509 ± 0.086 and T_1 0.769 ± 0.062 vs. $T_2$0.634 ± 0.022 µmol/ml) and reduced SOD activity ($T_1$0.125 ± 0.006 vs. T_2 0.125 ± 0.002 vs. C 0.339 ± 0.006 U/mg of protein). Inclusion of L-cysteine as antioxidant @ 0 mM (control), 1 mM (T_1 group), 2 mM (T_2group did not shown any significant difference between the groups in post thaw sperm motility, functional membrane integrity and sperm viability parameters. But T_2group (55.45±4.55) had significantly more population of sperm cells with acrosome membrane integrity (%) than the control (52.35±4.32). Further, there was significant reduction in MDA concentration (µmol/ml) between control (2.384±0.12) vs. T_1 (1.625±0.254) vs.T_2 (0.885±0.304) and in the SOD activity (U/mg of protein) between control (0.381±0.031) vs. T_1(0.223±0.01) vs. T_2(0.115±0.004).

Semen samples added with methionine @ 1mM (T_1) and methionine @ 2mM (T_2) had significantly better values than the untreated control (C) in the following post thaw *in vitro* sperm characters such as motile sperm cells (T_1 46.6 ± 4.18; T_2 43.95± 4.27 vs. C 34.55±3.52%),sperm viability (T_1 39.25±1.67; T_2 37.8±1.77 vs. C 34.7±1.66 %), acrosome integrity (T_1 68.9±1.82 vs. C 65.1±.211%), and significantly lower MDA concentration (T_1 1.385 ± 0.084; T_2 1.654 ± 0.053 vs. C 2.125 ± 0.046 µmol/ml) and SOD activity (T_1 0.191± 0.012;$T_2$0.208 ± 0.012 vs. C 0.382 ± 0.02 U/mg of protein). Semen samples treated with hypotaurine @ 5mM (T_1) and hypotaurine @ 10mM (T_2) had significantly better values than the untreated control (C) in motile sperm cells (T_1 48.15 ± 1.56; T_2 49.10 ± 2.35 vs. C 40.85 ± 2.69%), functional membrane integrity (T_1 42.3 ± 0.82; T_2 43.4 ± 0.92 vs. C 38.1 ± 0.94%), sperm viability (T_1 41.95 ± 0.9 ;T_2 43.6 ± 1.17 vs. C 37.5 ± 0.95%), acrosome integrity ($T_1$70.95 ± 1.01; $T_2$72.6 ± 1.01 vs. C 68.05 ± 0.86%), significantly lowered concentration of lipid peroxide compound MDA (T_1 0.673 ± 0.018 vs. T_2 0.644 ± 0.024 vs. C 0.981 ± 0.013 µmol/ml) and SOD activity (T_1 0.17 ± 0.007 vs. T_2 0.07 ± 0.002 vs. C 0.44 ± 0.037 U/mg of protein). It can be concluded that supplementation of alpha tocopherol, methionine and hypotaurine antioxidant additives were found to be more promising in terms of conserving *in vitro* sperm characters from cryo-damages during freezing of Black Bengal bucks semen.

Dynamics of Blood Kisspeptin and Phoenixin Concentrations during Different Days of Estrous Cycle and Pregnancy in Bengal Does

Keeping in view the importance of kisspeptin (KP) and phoenixin (PNX) in reproduction and non-availability of dynamics of these two peptides during caprine estrous cycle and pregnancy, the present study was carried out with the aim to elucidate the dynamics of blood Kisspeptin and Phoenixin concentrations during different stages of the estrous cycle and pregnancy in Bengal does. For the purpose, a total of 12 cyclic and 18 pregnant goats were selected from the Goat Farm of ICAR-NDRI, ERS, Kalyani. Cyclic goats were selected based on signs of behavioral estrus and through observation of standstill by buck introduction, which was further confirmed by ultrasonographic examination of the reproductive organs. Blood samples collected daily during entire estrous cycle and at every fortnight from pregnant animals were assayed for plasma KP and PNX.

Our results revealed that KP and PNX concentrations varied significantly ($P<0.05$) throughout the estrous cycle. A mean of four KP and PNX peaks of varying amplitudes were recorded during the entire estrous cycle. Peaks of both blood KP and PNX were found to be coincided with each other. The highest peak of KP and PNX was obtained on one day before the onset of estrus (day -1). On an average, the 2nd, 3rd and 4th peak of KP & PNX were found to occur on day 6, 12 and 17, respectively. Though the dynamicity of blood KP and PNX were qualitatively similar ($P>0.05$), but were found to be different ($P<0.05$) quantitatively. The number of peaks for blood KP and PNX was recorded to vary between three to four in individual goats. On the other hand, no definite pattern of secretion of phoenixin during different stages of pregnancy was found. Plasma kisspeptin concentrations increased significantly ($P<0.01$) with the advancement of pregnancy.

Abundance of Transcripts Encoding Kiss1/R and Smim20 Genes during Estrous Cycle and Pregnancy in Bengal Goats

Abundance of transcripts encoding KiSS1 and SMIM20 genes was found to be significantly different (P<0.01) during different stages of estrous cycle. The highest expression of KiSS1 and SMIM20 genes was found during proestrus stage of estrous cycle. Abundance of transcript encoding KiSS1R and GPR173 gene was similar (P>0.05) during different stages of estrous cycle. KiSS1 and SMIM20 genes expressed more abundantly as the pregnancy advanced and the maximum expression was found at late stage of pregnancy.

Follicular Dynamics in Bengal Does

Our results revealed the occurrence of four (66.67%; EC length: 22.87 days) and five (33.33%; EC length: 25.67 days) follicular wave patterns in Black Bengal goats. In four-waved cycle, average day of 1st, 2nd, 3rd and 4th follicular wave emergence was found at day 3±0.46, 9±0.63, 14.75±0.78 and 20.13±0.94 of the estrous cycle. Terminal wave was found to be ovulatory with a preovulatory follicle size of 7.35±0.11 mm. In five-waved cycle, average day of 1st, 2nd, 3rd, 4th and 5th follicular wave emergence was found on day 3.25±0.22, 7.75±0.74, 14.0±0.50, 19.75±0.89 and 24.5±1.44, respectively with preovulatory follicle size of 7.35±0.1mm in terminal wave. The co-dominant follicles that were observed during follicular dominance of a wave dictate the prolificacy of Black Bengal does. Peaks of FSH were found to be coincided with the day of follicular wave emergence.Blood supply to growing follicles was increased with the growth of follicles and decrease in the blood supply to the particular follicle was suggestive of onset of atresia. Diameter of CL was highly correlated with plasma progesterone levels (r=0.97).

Foetal Characteristics of Bengal goats

Certain fetal characteristics like embyonic vesicle, foetal movement, foetal heartbeat, outer placentomal diameter, C-R-L length and blood supply to the foetus and placentomes were characterized. For the first time, foetal heart rate was recorded in Black Bengal goats using ultrasonography. Blood supply to foetus and placentomes was found to increase with the increase in the length of foetus and diameter of placentomes, respectively. Outer placentomal diameter and C-R-L length during different days of gestation were found to be highly and positively correlated with a correlation coefficient of 0.98.

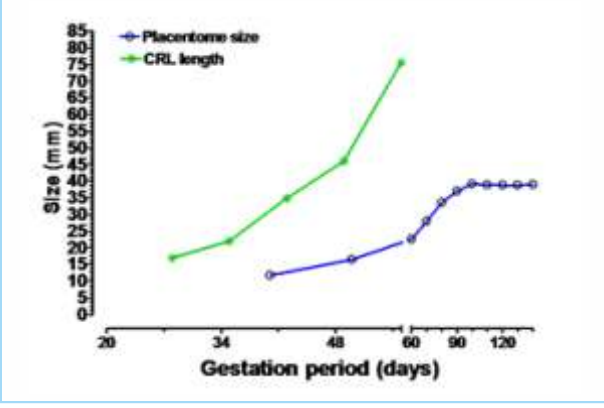


Fig.: Relationship between placentomal size and C-R-L length during different days of gestation in Black Bengal goats.

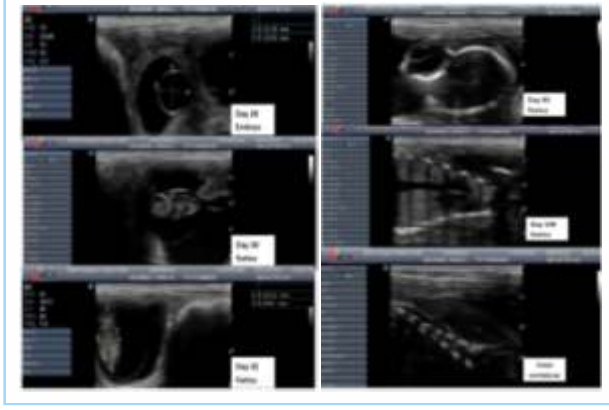


Fig.: Ultrasonographic images of foetus during different days of gestation in Black Bengal goat

Characterization of Ovarian Blood Flow and Kisspeptin/Kiss1 Gene during Reproductive Cyclicity in Crossbred Cows

Our results showed that blood supply to the follicle that is destined to be ovulated (dominant follicle) increased significantly (P<0.01) till the day it ovulated. On the other hand, blood supply to the CL increased (P<0.01) until it obtained the maximum size and decreased gradually thereafter and became the lowest till disappeared. Plasma kisspeptin concentrations exhibited three peaks during the entire estrous cycle i.e. one on one day before the onset of estrus, second being on day 6 and third on day 12 of the cycle. The relative abundance of

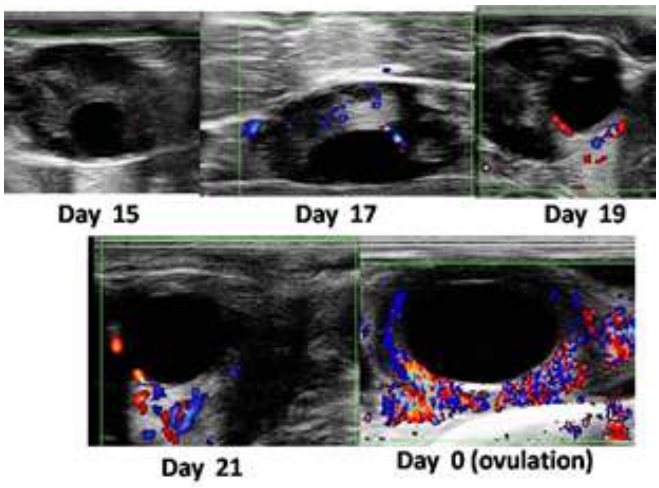


Fig.: Representative images of follicular growth and blood supply to the dominant follicle during different days of estrous cycle of crossbred cows as captured through CFM of ultrasonography

the transcripts encoding Kiss1 and Kiss1R genes were found to be higher on the days when plasma kisspeptin concentrations exhibited higher concentration i.e. day- (-) 1, 6 and 12 than day-18 (lower blood kisspeptin) of the estrous cycle in crossbred cows. Abundance of transcripts encoding KiSS1 and KiSS1R genes were more during proestrus and estrus stage than any other stages of estrous cycle in crossbred cows. Exogenous kisspeptin stimulates follicular growth of medium and large size and up-regulated the genes encoding KiSS1 and KiSS1R. Exogenous KP-10 potentially stimulates gonadotrphic-axis in crossbred cows. Plasma kisspeptin exhibited definite patterns of changes throughout the bovine estrous cycle. Expressions of KiSS1/R genes are differentially regulated during different phases of cyclicity in crossbred cows.

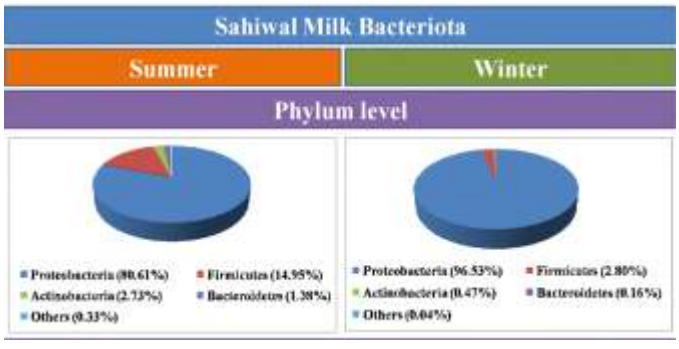
Efficacy of PNX, KP and GnRH in Amelioration of Anestrus in Crossbred Cows

In our next experiment, we induced estrus in cows that exhibit anoestrus/infertility using PNX, PNX + KP-10 and PNX+GnRH. The experiment was conducted in 30 crossbred cows (n=10 each). Efficacy of PNX alone or its combination with GnRH and KP in terms of induction of estrus in anestrus crossbred heifers/cows was found to be 89 to 97% with a good conception rate (57 to 62%). Efficacy of PNX alone and combination of PNX+KP-10 was found to better than PNX+GnRH group.

FEED, FODDER AND ANIMAL PRODUCTIVITY

Metagenome and Metabolome Profiling of Milk from Indigenous Dairy Cattle under Different Feeding Regimens

The metagenome analysis pertaining to bacterial taxonomics of milk from various indigenous (Gir, Sahiwal and Tharparkar) and cross bred (Karan Fries) cattle illustrated diversity higher than previously suspected. Proteobacteria (27.61 to 97.68 %) and Firmicutes (1.80 to 65.72 %) emerged as the predominant bacterial phyla followed by Actinobacteria (0.37 to 6.01 %) and Bacteroidetes (0.11 to 1.38 %) in all breeds and seasons. Further, the higher abundance of mesophiles and thermodurics (*Erwinia, Lactobacillus and Paracoccus*) was most significant in summer season, whereas psychrotrophs (*Ralstonia* and *Acinetobacter*) significantly dominated in winter season. It was evident that the microbial structure differed significantly in different seasons. Metabolomic profile of milk from indigenous and cross bred cattle revealed that the metabolic fingerprints were unique to the breeds. The metabolites such as Alpha-D-Lactose, Ribose, X-Xylose, Alpha-Mannose, Maltose and 2-Deoxygalactose varied between indigenous (Gir, Sahiwal and Tharparkar) and cross bred cattle (Karan Fries) which can be considered as potential biomarker candidates. The data on metabolomics from indigenous dairy cattle (desi cows) could serve as a baseline data for animal scientists of India or abroad to unearth the hidden benefits that are inherent in milk from *desi* cows considered as gold mine. Hence, the present multi-omics study to unravel the benefits of milk from indigenous cattle is vital.



Milk Microbiota of Sahiwal Explored through Metagenomics Approach

Effect of Bypass Fatty Acid and *Tinospora cordifolia* Supplementation on Production Performance and Milk Fatty Acid Profiling in Murrah Buffaloes

During early stage of lactation mostly high producing animals suffers from negative energy balance (NEB) due to imbalance between the needs and availability of energy and this NEB has negative impact on production and health of buffaloes. Taking this into consideration, a study was conducted on twenty freshly calved Murrah buffaloes. Buffaloes were grouped depending on their previous milk yield, body weight and parity as T_0 (control), T_1(fatty acids), T_2 (Tinospora) and T_3 (mix) groups having 5 animals each. Supplementation of 150g of bypass fatty acids in T_1group, 150g of Tinospora powder in T_2 group and combination of 150g of bypass fatty acid and 150g of Tinospora powder in T_3 group on over and above the standard feeding schedule was done for a duration of 90 days, whereas, no supplementation was provided to control (T_0) group.

Milk Yield and BCS

A significant (P<0.05) increase in average daily milk yield was observed in T_1 (10.06 ± 0.56 kg/d/h), T_2 (10.30 ± 0.53 kg/d/h), and T_3 (10.11 ± 0.48 kg/d/h) in comparison to control group (8.05 ± 0.38 kg/d/h). BCS of the animals was significantly improved in T_1 (2.74 ± 0.11) and T_3 (2.67 ± 0.09) group in comparison to T_2 (2.61± 0.04) and T_0 (2.40 ± 0.06).

Milk Composition and Properties

Significantly (P<0.05) higher milk fat percent and total solids were recorded in treatment groups over the control group. This can be possibly through availability of free fatty acids from supplemented bypass fatty acids and improved lipid metabolism by Tinospora. Due to increase in milk fat percentage, significant increase was observed in total solid contents of treatment group buffaloes. Other milk constituents like SNF, protein, lactose and ash were remained unaffected on supplementation. No significant changes were recorded in milk properties on supplementation of bypass fatty acids and Tinospora.

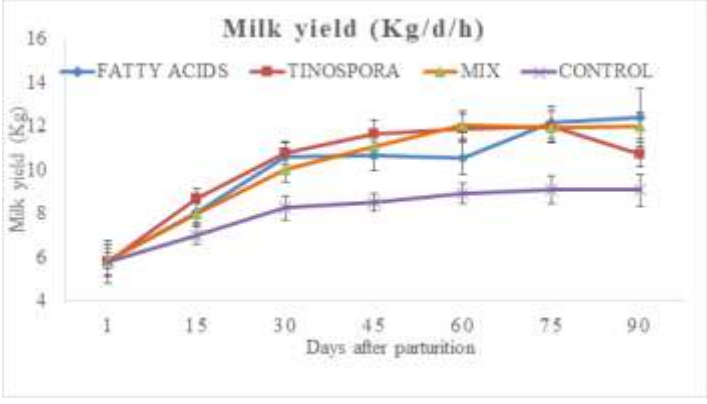


Fig.: Mean milk yield (kg/d/h) during different fortnights of experimental period in buffaloes

Table: Effect of bypass fatty acid and Tinospora supplementation on milk composition

Parameters (%)	Control (T0)	Fatty Acids (T1)	Tinospora (T2)	Mix (T3)	P Value
Fat	7.36axy ± 0.05	8.10cy ± 0.04	7.85bx ± 0.12	8.14cy ± 0.08	<0.001
SNF	9.36 ± 0.06	9.38 ± 0.06	9.31 ± 0.09	9.41 ± 0.04	0.750
Total solids	16.73ax± 0.09	17.48cy± 0.05	17.16bx± 0.07	17.55cxy± 0.06	<0.001
Milk protein	3.45 ±0.03	3.59 ±0.09	3.52 ±0.04	3.52 ±0.07	0.256
Milk lactose	4.87 ±0.03	4.88 ±0.03	4.85 ±0.06	4.86 ±0.05	0.644
Total ash	0.71±0.01	0.71±0.008	0.72±0.009	0.71±0.01	0.93

• The values are Mean ± SE of observations on five animals in each group.
• Values with different superscripts a,b,c and x,y differs significantly (P<0.05) in a row and column(between same parameter), respectively.

Somatic Cell Count

The SCC declines in all the groups with the advancement of lactation. But the rate of reduction was significantly higher in T_2 and T_3 as compared to T_1 and T_0. This may be attributed to immunostimulant property of *Tinospora cordifolia* which is due to the presence of different phytoactive compounds of Tinosporalike steroids, alkaloids, glycosides, diterpenoid lactones, sesquiterpenoid, aliphatic compounds and polysaccharides. Decreased SCC also proved that *Tinospora cordifolia* improved udder health of lactating buffaloes.

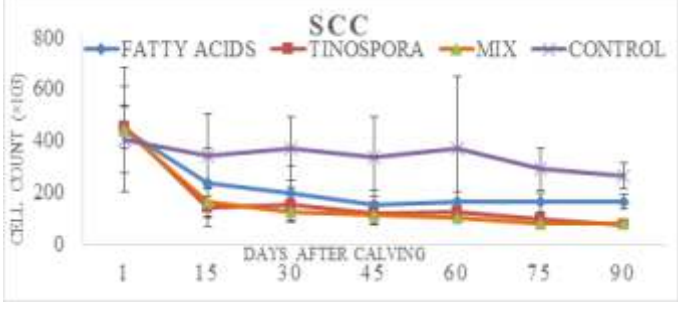


Fig.: Mean SCC (×103) of milk during different fortnights of experimental period in buffaloes

Fatty Acid Profiling of Milk

The results of fatty acid profiling of milk showed a significant increase in the unsaturated fatty acid content of treatment groups as compared to the control group. Overall saturated fatty acid values were not altered significantly between different groups but within saturated fatty acids changes were observed in composition i.e. values of butyric acid and palmitic acid increased in T_1 (fatty acid) and T_3 (mix) whereas values of stearic acid got significantly reduced in these groups. In unsaturated fatty acids both MUFA and PUFA contents were significantly elevated in treatment groups in comparison to control groups. The bypass fatty acids which used to supplement to buffaloes was containing higher amounts of saturated fatty acids (Myristic acid, Palmitic acid and Stearic acid) whereas in the milk of buffaloes there was no significant differences between saturated fatty acid content as these saturated fatty acids were utilized by the animals for energy metabolism and unsaturated fatty acids from the feeds were spared. Therefore, there was a significant difference in the values of unsaturated fatty acids in the milk of supplemented group buffaloes.

Table: Effect of bypass fatty acid and Tinospora supplementation on ssaturated fatty acids content in milk (mg/100mg)

Parameters	Control (T0)	Fatty Acids (T1)	Tinospora (T2)	Mix (T3)	P Value
C4:0, Butyric acid	2.02a ± 0.10	2.38bc ± 0.05	2.18ab ± 0.07	2.44a ± 0.06	0.003
C6:0, Hexanoic acid (Caproic acid)	1.17a ± 0.05	0.95a ± 0.09	0.99a ± 0.08	1.02a ± 0.08	0.222
C8:0, Octanoic acid (Cacprylic acid)	0.46a ± 0.05	0.45a ± 0.08	0.42a ±0.03	0.50a ± 0.02	0.726
C10:0, Decanoic acid (Capric acid)	0.94a ± 0.08	0.81a ± 0.19	0.81a ± 0.07	0.76a ± 0.15	0.782
C12:0, Dodecanoic acid (Lauric acid)	1.36a ± 0.13	1.23a ±0.14	1.19a ± 0.09	1.42a ± 0.09	0.441
C14:0, Tetradecanoic acid (Myristic acid)	8.77b ± 0.38	6.77a ± 0.27	7.02a ± 0.54	6.9a ± 0.19	0.004
C15:0, Pentadecanoic acid	0.60a ± 0.11	0.61a ± 0.03	0.51a ± 0.09	0.41a ± 0.10	0.355
C16:0, Hexadecanoic acid (Palmitic acid)	25.79a ± 0.42	29.42bc ±1.44	27.03ab ± 0.98	30.74c ± 1.25	0.023
C17:0, Heptadecanoic acid	0.63a ± 0.03	0.61a ± 0.09	0.71a ± 0.07	0.56a ± 0.04	0.387
C18:0, Octadecanoic acid (Stearic acid)	21.24b ± 0.48	17.74a ± 0.45	19.71b ± 0.69	17.61a ± 0.51	0.001
SFA	62.97a ± 1.11	60.97a ± 1.76	60.57a ± 0.87	62.37a ± 0.71	0.453

• The values are Mean ± SE of observations on five animals in each group.
• Values with different superscripts a,b,c differs significantly (P<0.05) in a row.

Table: Effect of bypass fatty acid and Tinospora supplementation on unsaturated fatty acids content in milk (mg/100mg)

Parameters	Control (T0)	Fatty Acids (T1)	Tinospora (T2)	Mix (T3)	P Value
C16:1 (Cis 9), (-Hexadecanoic acid (Palmitoleic acid)	0.23a ± 0.06	0.23a ± 0.06	0.28a ± 0.00	0.28a ± 0.01	0.800
C18:1 (cis 9) 9-Octadecenoic acid (Oleic acid)	0.82a ± 0.04	0.94a ± 0.06	0.84a ± 0.06	0.91a ± 0.03	0.313
C18:1 (cis 6) 6-Octadecenoic acid	24.42a ± 0.36	28.02ab ± 2.16	28.22ab ± 0.90	29.00b ± 1.12	0.102
C18:1 (cis 11) 11-Octadecenoic acid	0.52a ± 0.04	0.43a ± 0.04	0.43a ± 0.02	0.42a ± 0.02	0.119
MUFA	25.99a ± 0.37	29.62ab ± 2.10	29.77ab ± 0.93	30.60a ± 1.09	0.092
C18:2 (cis 9,12), 9,12-Octadecadienoic acid (Linoleic acid)	1.19a ± 0.04	1.34b ± 0.01	1.43c ± 0.02	1.42bc ± 0.04	0.000
C18:2 (cis 9, trans 11), 9-cis,11-trans-octadecadienoate (CLA)	0.50a ± 0.04	0.60b ± 0.02	0.62b ± 0.03	0.65b ± 0.02	0.008
C18:3 (cis 9,12,15) 9,12,15-Octadecatrienoic acid (Linolenic acid)	0.36a ± 0.02	0.41ab ± 0.02	0.41ab ± 0.02	0.46b ± 0.02	0.017
PUFA	2.05a ± 0.07	2.35b ± 0.02	2.46bc ± 0.06	2.52c ± 0.04	0.000
USFA	28.04a ± 0.35	31.97b ± 2.10	32.23b ± 0.90	33.12b ± 1.10	0.057

• The values are Mean ± SE of observations on five animals in each group.
• Values with different superscripts a,b,c differs significantly (P<0.05) in a row.

Dry Matter Intake and Digestibility of Nutrients

There was no significant difference (P>0.05) in DMI of different groups of buffaloes. However, the digestibility coefficients were significantly (P<0.05) varied between different groups. The digestibility of dry matter (DM), organic matter (OM), crude protein (CP) and non fibre carbohydrate (NFC) were significantly higher in Tinospora supplemented groups i.e. Tinospora (T_2) and mix (T_3) group in comparison to fatty acid (T_1) and control (T_0) group. The digestibility of ether extract was significantly (P<0.05) higher in the fatty acid supplemented groups i.e. T_1 and T_3, whereas no significant difference (P>0.05) was found in digestibility of neutral detergent fibre (NDF) and acid detergent fibre (ADF). Increase in the digestibility of DM, OM, CP, NFC in the Tinospora group may be attributed to the stomachic action of *Tinospora cordifolia* that may have

Table: Effect of bypass fatty acid and Tinospora supplementation on dry matter intake and digestibility of nutrients

Parameter	Control (T0)	Fatty Acids (T1)	Tinospora (T2)	Mix (T3)	PValue
DMI (Kg)	13.91 ± 0.21	14.23 ± 0.37	13.92 ± 0.23	13.65 ± 0.14	0.472
Digestibility coefficients (%)					
DM	62.84a ± 0.51	62.91a ± 0.60	64.72b ± 0.44	64.63b ±0.63	0.038
OM	64.28a ± 0.51	64.37a ±0.66	65.06ab ± 0.18	66.01b ±0.47	0.082
CP	61.36a ± 1.19	62.03a ± 1.04	65.98b ± 1.26	63.59ab ± 1.49	0.082
NDF	61.61 ± 1.22	62.25 ± 0.72	61.87 ± 0.73	62.09 ±1.22	0.971
ADF	37.55 ± 1.04	37.12 ± 1.82	39.55 ± 1.40	39.46 ± 2.37	0.664
EE	74.69a ± 0.39	82.22b± 0.58	76.21a ± 1.70	82.07b ± 0.22	0.000

•The values are Mean ± SE of observations on five animals in each group.
•Values with different superscripts a,b differs significantly (P<0.05) in a row.

increased the secretions of GIT and hence more is the absorption of nutrients. The increase in the digestibility of EE in fatty acid supplemented groups is due to feeding of bypass fatty acids which makes the availability of free fatty acids.

Significant reduction (P<0.05) was observed in Cortisol and NEFA values of the treatment groups. The IgG values were also significantly higher in the T_2 and T_3 as compared to T_1 and T_0. USG monitoring of cervix, uterus and ovaries revealed that rate of involution of cervix and uterus and size of follicles were significantly higher in the treatment groups. Buffaloes of supplemented groups had higher conception rate, and service period was significantly (P<0.05) reduced in comparison to control group with early onset of postpartum first cyclicity. The net returns per buffalo per day of the T_3 was highest followed by T_1, T_2 and T_0.

It can be concluded that supplementation of bypass fatty acid and Tinospora leads to increase in milk yield of freshly calved Murrah buffaloes. Milk quality was also improved as there is increase in milk fat and USFA because of the availability of free fatty acids and improved lipid metabolism. The combined supplementation of bypass fatty acids and *Tinospora cordifolia also* improves the reproduction and health status of lactating Murrah buffaloes, as SCC was decreased due to immunostimulant activity of Tinospora.

Development of Dairy Based Integrated Farming System for Income Enhancement of Small Farmers

India holds around 15% of the world's livestock population with 2% of world's geographical area, resulting in great pressure on land. Presently, India's livestock population is 536.76 million head, which is expected to grow at the rate of 0.55% in the coming years and to reach 780.7 million by 2050. The majority of farmers in India are small and marginal, having less than two hectares of land. It is difficult to achieve livelihood security and sustainability for these farmers with a single farm enterprise without turning to Integrated Farming Systems. These farms need multi-enterprise farming activities that are complementary and technically feasible in the interest of the productivity of the whole farming system. Integration of enterprises helps in ensuring not only food, nutrition and livelihood security but also social, economic and environmental sustainability. Keeping these facts in view, ICAR-NDRI has initiated the research work on “Developing dairy based integrated farming system model for income enhancement of small farmers”.

The project is 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-10), poultry farming (20 birds), fish pond and vermin-compost pits (0.2ha). The area of each enterprise is calculated based on the potential of the technologies realized by the farmers. Since the supply of green fodder throughout the year was a major challenge, hence emphasis was given on production of quality greed fodder and feeding strategies for dairy animals.

Hybrid Napier and Moringa based model of fodder production has been developed in 0.4 ha for round the year quality fodder availability. About 30 percent 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 during winter season as intercrop between moringa and napier rows. The average green fodder yield of 1552 q/ha with dry matter yield of 251q/ha has been recorded from four cuttings of hybrid Napier. The animals (three Sahiwal cattle, three Murrah buffaloes and 10 Alpine x Beetal crossbred goats) are maintained on fodder available from the system under cut and carry system and during summer months UMMBs were supplemented.

The total milk production was 7580 liters from buffaloes, 6308 liters from cattle and 6012 liters from goats. An average increase of 26.95 % in milk yield has been recorded due to UMMB supplementation with cost benefit ratio of 1: 8.23. Similarly, the supplementation of polyherbal mixture in cattle increased milk yield by 21.53%. The net return from the whole system was Rs. 3, 91, 760/year. The contribution of dairy component is 59.89%, crop component (wheat, rice and oat) as 32.75 % and subsidiary enterprises (poultry, fishery and vermin-compost, etc) as 7.36 % in total net farm income. Various nutrients viz., 119.8 kg N, 45.3 kg P and 71 kg K are also supplied by the recycling of farm waste, dung and urine in FYM/vermin-compost to the system.

Results revealed that dairy based integrated farming system model not only increases the production and profitability but also ensures the food and nutritional security through regular supply of milk and eggs round the year and has potential to increase resource use efficiency and overall resilience of the production system. Hence, emphasis needs to be given on development of dairy based IFS module for different situations to fit into socio-economic realm of small and medium famers.

Effect of Housing on Physiological Performance of Crossbred Goats

Eighteen adult healthy female crossbred (Alpine X Beetal and Saanen X Beetal) goats were selected from Livestock Research Centre (LRC) for the experiment and equally divided into three groups i.e. group-I (control- under existing conditions), group-II (inside shed with fan) and group-III (outside under natural conditions). The experimental trial was conducted during hot humid season being the most uncomfortable ambient conditions for animals. Environmental parameters like dry and wet bulb temperature and relative humidity were recorded and THI was calculated. The THI remained stressful throughout the experimental period even during forenoon (around 10.00AM) and varied from 81.90 to 85.53 being lowest inside and highest outside and 83.53 in existing shed (control). During afternoon the THI was increased in all three managemental conditions being highest outside, followed by existing shed and shed with fan. The respiration rate of goats were higher (76.11±1.03/ min) in control group followed by group-III (70.49±0.61/min) and group-II (67.22±0.06/ min). The values increased to 89.23±0.54/ min, 91.98±0.73/ min and 88.22±0.60/ min respectively in group-I, group-III and group-II respectively. Increase in RR showed the positive correlation with the increase in THI. The THI was lowest in the shed provided with fan and RR was lowest in this shed whereas highest THI was in outside and RR was also highest. During forenoon the rectal temperature was lower in group-II (38.57±0.03°C) followed by group-I (38.73±0.02°C) and group-III (38.68±0.03°C). Slight increase in RT was observed during afternoon in all groups of animals. Skin temperature was also increased with the increase in the THI in all the groups of animals at different anatomical sites viz. head, dorsal, ventral, upper and lower leg. The lowest surface temperature at different anatomical sites during forenoon and afternoon was observed in the shed provided with the fan. The results showed beneficial effect for providing comfort micro environment which showed lower physiological responses even in the heat tolerant breed of goats.

Livestock-Crop Based Technological Interventions for Empowerment of Scheduled Caste Farmers in Selected Districts of Himachal Pradesh, Uttarakhand and Haryana

The creation of livelihood opportunities through farm-based crop-livestock activities and skill development is crucial for empowerment of scheduled caste farmers. Keeping this in view, the present project is taken to improve the existing knowledge and skill in agriculture-based activities of targeted SC farm families in Haryana, Himachal Pradesh and Uttarakhand. From each state, one district selected purposefully having highest concentration of SC population. From each district, one block, and from each block, two villages, thus total sicx villages were selected.

Effect of Tri-sodium Citrate Supplementation on Management of Subclinical Mastitis in Jersey Crossbred Cows.

In order to investigate the effect of Tri-sodium citrate (TSC) supplementation on management of subclinical mastitis (SCM) an experiment was conducted on 187 lactating cows (Jersey crossbred) at “Dairy Bikas Kendra” of adopted village of ERS-NDRI. Animals were selected randomly and observed into two groups, viz., control (n=46) and treatment (n=141). Animals in treatment group were supplemented tri-sodium citrate (TSC) @ 30 mg/kg bw till 10 days. Milk samples were collected at initial period, 0 day (before supplementation) and after completion of supplementation (at 11 to 15 days). Statistically analyzed data revealed that milk yield significantly ($P < 0.01$) increased in treatment than control group. Milk somatic cell

count was significantly (P < 0.01) higher in control than treatment group. Significantly (P < 0.01) lower neutrophils% and higher macrophages%, lymphocytes% found in milk samples from treatment than control group. There were significantly (P < 0.01) higher milk MCMT, MWST, pH, EC, SFMT found in control than treatment groups. Significantly (P < 0.01) better milk quality was found in treatment than control group after completion of TSC supplementation. Milking time and MER variations were found to be non-significant between groups. There was significant (P < 0.01) difference in milk fat content but non-significant variations were recorded for protein, SNF, lactose and total solid between control and treatment group. The significant (P < 0.01) and negative correlations were found among milk SCC and total milk yield, MER and MBRT. However there was non-significant relationship was found between SCC and milking time. There was significantly (P < 0.01) negative correlations were recorded among SCC and milk fat, SNF, protein, lactose and total solid. The significant (P < 0.01) and positive correlations were found among SCC and milk pH, EC, MCMT, SFMT and MWST. The economic analysis revealed that BCR for treatment group was 0.88. The study can be concluded that management of subclinical mastitis by TSC supplementation (@ 30 mg/kg bw till 10 days) is found to be economical, safe and easy to practice which can arrest milk production losses of Jersey crossbred cows effectively for this region.

Optimizing the Performance of Crossbred Calves by Synbiotic Feeding in Existing Farm Conditions


Fermented Synbiotics

Synbiotic combination is known to be effective against diarrhea by reducing the adhesion of pathogens to the gut thereby, preventing infection and pathology. In the present study sixteen Jersey crossbred calves were randomly assigned to 2 groups (8/group), treatment (T) and control (C) and performances of the were observed when fermented synbiotic fortified in milk was fed up to weaning age (4 to 90 days). The performance during post synbiotic feeding period (90-120 days) was also noted observed. *Ad libitum* supply of concentrates and green fodder as basal diet was offered as early as one week of age to all the calves but treatment calves received an additional supply of synbiotics(*Lactobacillus rhamnosus* NCDC 298 and fructo-oligosaccharide) fortified in whole milk. Passive immunity (IgG) was found (P<0.05) to be better in calves fed synbiotics with notable increase (P<0.05) in body weight and heart girth post synbiotic feeding period. The synbiotic fed calves had higher appetite (P<0.05) reflected with better dry matter intake per animal/day. Occurrence of diarrhoea in synbiotic fed calves was reportedly fewer in days calculated. Also, *Lactobacillus* sp. populations was found to be abundant (P<0.01) with decrease (P<0.01) in diarrhoea causing pathogenic bacteria (*E. coli*) in the feces of the calves.

Though the calves in the study were fewer in number, the true potential of synbiotic supplements to calves cannot be concluded but results indicated successful colonization of beneficial bacteria in the gut of the young calves thereby, beneficial effects on health, immunity and growth of the neonatal crossbred calves.

Fodder Crop Management Interventions through Bio-fertilizers and Bio-pesticide for Sustainable Dairy Farming

Level of organic carbon percentage in soil sample collected from farmers' field of berseem fodder crop was .60, .40 and.36 in Chakdaha, Ranaghat- 1 and Shantipur blocks, respectively. Available N (kg/ha) level in Chakdaha, Ranaghat- 1 and Shantipur blocks was 516.48, 514.60 and 471.33, respectively. Organic carbon percentage in the soil sample analysis from the field of the farmers cultivating oats fodder crops was .35, .27 and .26 in Chakdaha, Ranaghat- 1 and Shantipur blocks, respectively. Available N (kg/ha) level in Chakdaha, Ranaghat- 1 and Shantipur blocks was found to be 562.24, 499.57and 516.50, respectively. The yield of the berseem fodder crop from the demonstration was as follows: in Chakdah block average yield was 499.40±74.12 quintal/ha, in Ranaghat-1 block average yield was 547.25± 30.64quintal/ha, in Shantipur block average yield was 552.17± 33.76 quintal/ha. The overall mean cost of cultivation of berseem fodder crop was Rs. 35687.00±385.97. The overall mean benefit accrued from cultivation of berseem fodder crop was Rs. 106653.33± 5589.43. The mean yield of oats fodder crop from the study area was 430.71± 21.55 quintal/ha. The overall benefit to cost ratio analysis for cultivation of oats fodder crop by using bio-fertilizer and bio-pesticide, suggested that the ratio was 2.01± .08.

Formulating Coping Up Strategies for Extreme Weather Events in Sundarbans Region through Livestock based Integrated Farming System: A Societal Perspective

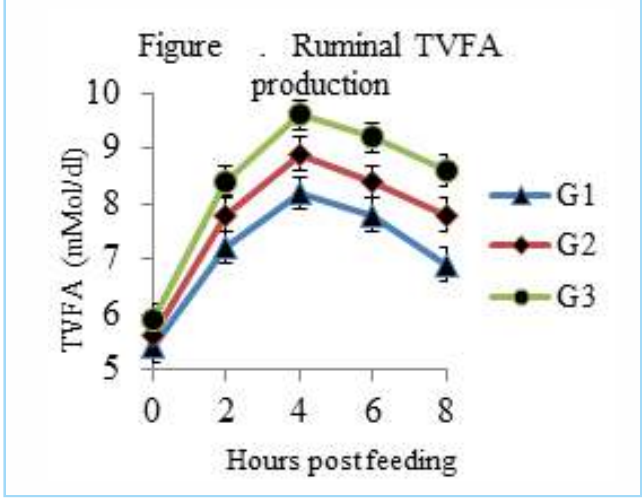
One 'livelihood security' index was developed under the project by involving parameters namely; Nutritional security (17 items under the parameter), Economic Security (21 items under the parameter), Health security (18 items under the parameter), Social Security (15 items under the parameter), Educational security (13 items under the parameter), Institutional Security (11 items under the parameter) and Infrastructural security (15 items under the parameter). One 'Perception index' was also developed under the project and perception level analysis suggested that, majority of the respondents felt that the incidences of extreme weather events have been enhanced manifold during the last decade. The farmers from general category were majorly engaged in cultivation of field crops and raising dairy animals for commercial purposes; whereas farmer who belong to tribal communities were not taking the animal husbandry from economic outlook rather than own family consumption. To enhance the income of the farming community it was felt that there was urgent need of diversification of farming activities like growing cash crops and un-conventional crops and including more agricultural enterprises in the farming system. Seasonality analysis of the study suggested that, the incidences of cyclonic storm were more during the period from May to October months, though in the last few years these storms are not maintaining any particular time of occurrence.

Evaluation of Eastern Himalayan Forest Tree Leaves as Herbal Feed Additives to Manipulate Rumen Fermentation for Improving Animal Productivity

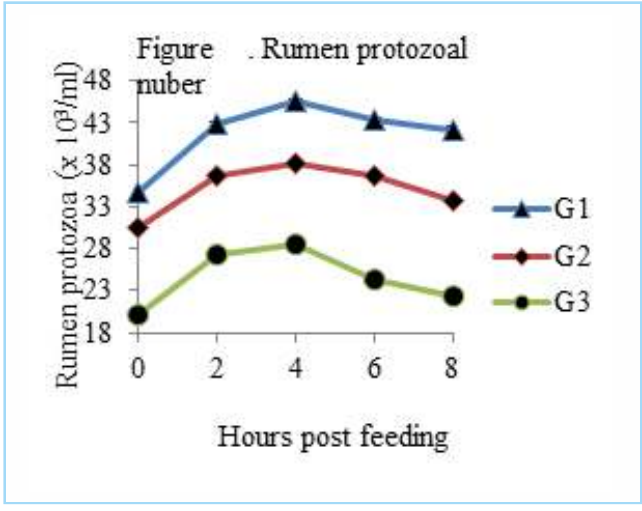
Attempts was made for using north-eastern Himalayan forest tree leaves as a herbal feed additives in the animals diet to improve its growth performances. Fifteen growing Jersey crossbred male calves of about 7-8 months age were divided into 3 groups (G1, G2 and G3) of 5 animals each. They were maintained on roughage (paddy straw) and concentrate based ration for 140 days. Roughage and concentrate mixture was offered separately and their ratio was maintained at 50:50 throughout the experimental period. 3 types of iso-nitrogenous concentrate mixtures (C1, C2 and C3) were prepared in which, C1, C2 and C3 concentrate mixture contained @ 00, 4 and 8% dried leaves (in powder form) of Lutekhanew (*Ficus clavata*) tree. Growth rate, nutrient digestibility, rumen fermentation pattern and feed conversion efficiency were studied in these animals. Lutekhanew (*Ficus clavata*) tree leaves were collected from Sikkim.

Fig.: Lutakhanew (Ficus clavata) tree leaves

Lutekhanew (*Ficus clavata*) tree leaves contained 11.9% CP, 3.3% EE, 28.6% NDF, 15.5% cellulose and 3.1% acid detergent lignin. The CP content of C1, C2 and C3 concentrate mixtures was 18.9, 18.7 and 18.6% on DM basis, respectively. Other nutrients content were also similar in all the three concentrate mixtures. On an average, offered concentrate mixture contained 93.9% OM, 18.7% CP, 70.9% T-CHO, 4.3% EE, 35.2% NDF, 12.8% ADF, 8.3% cellulose and 4.1% ADL, respectively. The paddy straw contained OM 86.8%, CP 3.2%, EE 1.7%, T-CHO 81.9%, NDF 70.8%, ADF 42.3%, cellulose 34.7% and ADL 6.9% on dry matter basis.



Daily dry matter intake per unit body weight was similar among the calves of three experimental groups and it was 3.3, 3.5 and 3.4 kg per 100g body



weight per day or 102.5, 107.7 and 104.2 g/kgW$^{0.75}$ per day in G1, G2 and G3 groups, respectively. Digestibility of DM, OM, CP and fibre fractions (NDF, ADF and cellulose) were higher (P<0.01) in G3 and G2 than G1 group. Moreover, digestibility of DM, OM, NDF, ADF and cellulose were higher (P<0.01) in the animals of G3 in comparison to G2 group. The ration of G1, G2 and G3 experimental groups contained 7.4, 7.4 and 7.6% DCP and 59.2, 60.9 and 62.8% TDN, respectively. The average value of pH in the rumen liquor of experimental animals was lowest (P<0.05) in G3 amounting to 6.53 followed by G2 (6.63) and G3 (6.72) groups. TVFA concentrations in the rumen liquorofthree experimental groups showed the reversed trend and it was highest (P<0.05) in G3 (8.4 mmol/dl SRL) followed by G2 (7.7 mmol/dl SRL) and G1 (7.1 mmol/dl SRL) groups. Lowest pH and highest TVFA concentration were recorded at 4 h post feeding in the calves of all three experimental groups. Concentration of NH3-N and total rumen protozoal numbers were lower (P<0.05) in the animal of G3 and G2 than G1 groups. Spirotrich protozoa constituted about 93.8% of total rumen protozoal population. Activity of caboxymthyl cellulase, xylanase and -glucosidase enzymes were higher in the rumen of the experimental animals in G3 and G2 than G1 groups. Blood glucose level was highest (P<0.05) in the calves of G3 group followed by G2 and G1 groups. However, concentration of plasma urea, total protein and albumin were similar in the calves of three experimental groups.

Initial body weight was similar among the calves of three experimental groups while finishing body weight was lower (P<0.01) in the calves of G1 than G2 and G3group. Similarly total body weight gain and average daily gain were also lower (P<0.01) in the calves of G1 group. Average daily body weight gain of the calves in G1, G2 and G3 groups were 525.7, 557.8 and 597.1 g, respectively. Feed conversion efficiency in terms of DM intake per kg body weight gain were also better (P<0.05) in the calves of G3 and G2 groups than G1 group. The DMI/kg body weight gain was 7.2, 6.8 and 6.3 kg in the calves of G1, G2 and G3 groups, respectively. On an average experimental calves consumed 104.8 g DM, 7.8 g DCP, 63.8 g TDN per kgW$^{0.75}$ per day and had a 560.2 g average daily body weight gain. On the basis of the results obtained in the present study it may be concluded that inclusion of dried powder of Lutekhanew (*Ficus clavata*) tree leaves as herbal feed additives @ 4% in the concentrate mixture or @ 2% of the total ration of growing calve improve its growth performances.

Formulation and Evaluation of Milk Replacers for Black Bengal Kids

Present experiment was conducted to investigate the effect of feeding developed milk replacerssolely as a supplement with milk on mortality in early age, growth performance(TDMI, Daily DMI, weight gain, average daily gain, feed conversion efficiency), bloodmetabolites (Hb, glucose, total protein, albumin, globulin, BUN), liver enzymes (SGPT,SGOT) in Black Bengal kids. For the experiment 04 day old growing kids were selectedrandomly. Total thirty animals were selected. All the kids were fed with their respective dams'milk for first 04 days of life. These kids were then divided in equally 5 groups as one control(T0) and four treatments groups (T1, T2, T3, T4). Each group was allotted 06 kids. The control(T0) group was fed with their dams milk as per the routine practice while two treatmentsgroups were fed exclusively with milk replacer devised for their group (T1 - SBMR and T2SMMR) and remaining two groups fed with milk and milk replacer both (T3 - Milk + SBMR and T4 Milk + SMMR). Present investigation revealed that where either dams' milk isunavailable or available but is insufficient quantity for kids both these formulations SMMRand SBMR can be used to save the life of kids. It also revealed that, though feeding SMMRand SBMR solely gives lower ADG than normal milk fed kid but their supplementation withmothers' milk gives higher ADG and which results in achieving higher final body weight thusgives better growth performance than milk fed kids. Treatment group T4and T3showedhigher Hb values than other treatments groups (T2, T1) and these values differed significantly (P<0.05) from them. While in T3 group Hb values are comparable to control group (T0) & inT4group it is higher than control but non-significant (P >0.05) in both cases. Thus presentstudy revealed

that supplementation of milk replacer with milk has positive effect on blood Hb values. In case of total protein level treatment group T4and T3recorded higher totalprotein values than all other treatments groups (T2, T1) and these values differ significantly (P<0.05) from their mean values. Mean albumin level in control (T0) group was 28.76 ± 28.76g/l. The corresponding values intreatments groups T1, T2, T3 and T4were21.86 ± 0.79, 24.43± 1.39, 29.37 ± 1.14and 32.42 ± 0.93g/l, respectively. Mean globulin level in control (T0)group was 35.99± 3.55 g/l. The corresponding values in treatments groups T1, T2, T3 andT4were 34.26 ± 4.37, 37.43 ± 2.42, 38.56 ± 1.56 and 42.08 ± 0.49 g/l, respectively. Meanblood glucose level in control (T0) group was 63.96± 2.59 mg/dl. The corresponding value intreatments groups T1, T2, T3 and T4were 61.52 ± 5.87, 62.53 ± 2.75, 65.06 ± 3.59 and 70.65 ±2.04 mg/dl, respectively. The present study revealed that glucose level in blood was similar inall groups though it was elevated in T3 and T4 groups but does not differ significantly (P >0.05) from other groups mean values. Though there was slight variation in average BUN values but none of the group differ significantly (P <0.05) from mean values of other groups.Mean SGPT level in control (T0) group was 21.58± 1.33 IU/L The corresponding values intreatments groups T1, T2, T3 and T4 were 29.9 ± 3.64, 28.44 ± 2.17, 29.48 ± 1.99 and 24.25 ±1.43, IU/L respectively. Mean SGOT level in control (T0) group was 71.77± 6.26 IU/L. Thecorresponding values in treatments groups T1, T2, T3 and T4 were 70.47 ± 9.5, 65.19 ± 5.73,69.47 ± 9.36 and 73.09 ± 1.59 IU/L, respectively. All groups show slight variation and noneof the group varies significantly (P>0.05) from either control (T0) or other treatments groupsmean values. The present study revealed that feeding SMMR and SBMR solely or itssupplementation with milk in Black Bengal kids gives positive effect on total protein,albumin, globulin and SGPT level in blood and feeding SMMR and SBMR solely or itssupplementation with milk in Black Bengal kids does not affect blood Hb, glucose, BUN andSGOT levels.

Improvement of Black Bengal Goats for Enhancement of Productivity in Eastern Region of India

Black Bengal is one of the important breed due to its high prolificacy, early maturity, low kidding interval as well as for their delicious meat and high quality black skin. The breed is widely distributed throughout West Bengal and adjoining parts of the neighbouring states, viz., Bihar, Jharkhand, Orissa, Assam and parts of Tripura. The breed is equally prevalent in Bangladesh. But the main home tract of the breed is throughout West Bengal. However, the main constrains for rearing of Black Bengal goats for commercial mutton production are lower body weight gain both in pre and post weaning phase, kid motility is very high due to lower milk production of mother particularly for twin and triplet, lower mature body weight, lack of knowledge regarding scientific feeding and housing under intensive or semi intensive management practices etc. Attempts were made to improve productivity of Blak Bengal goats through scientific intervention particularly on feeding and housing management.

Survey work was started to know the present status of goat rearing practices in the different villages. Interaction was made with 43 goat keepers at Chakdah and Haringhata block, Nadia, West Bengal to survey the goat rearing practices followed by the goat farmers. Out of 43 goat farmers, 23 goat framers having flock size 1-3 goats/farmer while 20 goat farmers having flock size mort ham 03 goats/farmer. Majority goat farmers (58.2%) rear their goats under semi intensive system of management and they fed their goats kitchen waste, wheat bran. 39.5 % farmers maintained their goats under intensive system of feeding management due to lack of grazing land and as they are living in highly densely populated area. However, they also fed their animal kitchen waste, wheat bran etc and do not fed balanced concentrate mixture to their animals. The work is under progress

Growth Performance of Black Bengal Goats on Dietary Supplementation of Zinc Nanoparticles

Nanotechnology bears a lot of promises for its application in nutritional science. Nanoparticles of minerals have been reported to have higher bioavailability due to their greater surface area, high catalytic efficiency and stronger absorption capability than its normal-sized particles. The present study was conducted to evaluate the effect of supplementation of nano zinc on growth performance, digestibility of nutrients and blood parameters in Black

Bengal goat kids.The growth experiment was done for 120 days on 24 growing Black Bengal goat kids (4-6 month) divided into four equal groups. The control group was fed basal diet (mixed forage + conc. Mixture @ 55:45 ratio) in which the mineral mixture used was devoid of zinc. The treatment groups were supplemented with 30 ppm Zn as ZnO (T1), and @ 30 and 15 ppm nano Zinc (30 nm size) in groups T2 and T3, respectively. The blood samples were collected at 0 and 120 day of experiment and different blood metabolites and serum enzymes were analyzed. A digestibility trial of seven days was also conducted at the end of the growth experiment. During growth trial there was no significant difference in intake parameters. The digestibility of most of the nutrients (DM, CP, EE, NDF, ADF, TCHO, and OM) was positively influenced by supplementation of zinc irrespective of source and level. Blood metabolites such as serum glucose, serum albumin, serum globulin and serum total protein were not affected by zinc supplementation. Blood enzyme (AST, ALT and ALP) profile also was not affected by zinc supplementation. Average daily gain (g/d/kid) was significantly higher ($P<0.05$) in both the nano-Zn supplemented groups (T_2 and T_3) than control group. There was no significant difference ($P>0.05$) among the treatment groups (T1, T2, T3), indicating that nano zinc supplementation @ 15 ppm is sufficient to sustain the growth rate and feed conversion efficiency obtained for

zinc supplementation @ 30 ppm. Total bodyweight gain was improved by around 12 percent in nano zinc supplemented groups (T_2 and T_3) and by 6 percent in case of T1 (inorganic zinc @ 30 ppm) compared to the control group. The Feed conversion efficiency was significantly ($P<0.01$) higher in case of zinc supplemented groups than the control group. Finally, it can be concluded that supplementation of nano zinc @ 15 ppm over the basal diet (having around 33 ppm zinc) can significantly improve the digestibility of nutrients, growth rate and feed conversion efficiency of Black Bengal kids without any adverse effect on intake and blood parameters.

Comparative Nutritional Evaluation of Wetland Plants Available in New Alluvial Zone of West Bengal

The wetland plants collected from Nadia, North 24 Parganas and Hooghly districts under New Alluvial Zone of West Bengal were nutritionally evaluated.The DM content of the wetland plants ranged from 5.52% to 14.82%. The mean DM content was 9.36 percent. The average CP content of rest sixteen plants was 14.17±0.91 percent, nine plants (around 70%) had more than 10% crude protein content and four plants (around 30%) had more than 15% crude protein content.Ether Extract content (%of DM) ranged from 1.39 to 4.78% with a mean value of 3.28±0.17, indicating that the aquatic plants were fair sources of Ether extract. High Total Ash content (17.16±0.63)and low AIA content (2.12±0.10) indicated these plants to be very good source of mineral elements.The average NDF, ADF and ADL content (% of DM) were 44.85±1.76, 32.94±1.90 and 3.75 ±0.49, respectively. The average cellulose and hemicellulose content (% of DM) was 29.19±1.82 and 11.90±0.80, respectively. As per CNCP system, average content of A and B1 fraction (% of CP), the source of RDP, were 18.68±0.51 and 17.49±0.37, respectively. B2 fraction (% of CP), which is intermediately degradable fraction and source of digestible UDP, was higher in almost all the wetland plants (mean 50.94±0.81).The mean C (undigestible fraction) value (% of CP) was 5.15±0.58. Most of the aquatic plants from new alluvial zone were found to be rich source of essential minerals like Ca, P, Mn, Zn and Fe. Five wetland plants namely, *Jussea repens,Enhydra fluctans, Spirodela Polyrhyza, Lemna minor* and *Azolla pinnata*were found to be better sources of essential nutrients and can also serve as potential alternative feed resource in ruminant ration in new alluvial zone of West Bengal.

INNOVATIVE APPROACHES IN MANAGEMENT OF DAIRY ANIMALS

Influence of Nickel Supplementation on Rumen Fermentation and Blood Metabolic Profile in Male Murrah Buffalo Calves

Nickel (Ni) is one of the probably essential elements. Its roles in animals particularly ruminants are not well defined. Eighteen Murrah buffalo male calves of similar age (8.7 months) and body weight (125 kg) were selected from Livestock Research Centre, ICAR- National Dairy Research Institute, Karnal, Haryana, India and divided into 3 groups of 6 animals each. All the animals were fed to meet their nutrient requirements (ICAR, 2013), however, animals in groups T1, T2 and T3 were supplemented with 0, 5 and 10 ppm of Ni, respectively. Supplementation of Ni at 0, 5.0 and 10.0 ppm to the basal diet (ICAR, 2013) was not found to affect rumen fermentation parameters like pH, total volatile fatty acids, ammonia-N, TCA precipitable-N. The urease activity in rumen liquor was the highest ($P<0.05$) in group T_3. The propionate level increased ($P<0.05$) while that of butyrate decreased in group T_3 as compared to groups T_1 and T_2 showing no significant effect on acetate concentration. Supplementation of Ni at 5 and 10 ppm level of dietary DM did not show any significant effect on excretion, absorption and retention patterns of Ca, Mg, Cu, Zn and Mn and their levels in blood plasma were also similar in different groups. The retention of Ni and its level in blood plasma increased linearly with the level of nickel in diet and it was the highest ($P<0.05$) in group T_3. The retention of Fe was higher in groups T_2 and T_3 in comparison to group T1 while plasma concentration of Fe was the highest ($P<0.05$) in group T_3 followed by groups T_2 and T_1. The concentration of WBC was not affected by Ni addition in diet but the levels of Hb, RBC and haematocrit were higher ($P<0.05$) in group T_3 as compared to groups T_1 and T_2. The values of blood metabolites like plasma total protein, albumin, globulin, triglycerides, nonesterified fatty acids, creatinine and blood urea nitrogen were similar in three groups, however, plasma glucose concentration was the highest ($P<0.05$) and that of total cholesterol lowest ($P<0.05$) in group T3 in comparison to groups T1 and T2. The activities of AST and ALT were not affected by Ni supplementation. The values of total anti-oxidant status, activity of SOD and GPx were similar in all 3 groups, however, catalase activity was higher ($P<0.05$) in group T_3 compared to other 2 groups. Plasma IGF-1 level was similar in 3 groups but concentration of cortisol was the lowest ($P<0.05$) in group T_3. In conclusion, dietary Ni supplementation at levels of 5 and 10 ppm did not affect feed intake, growth rate, apparent digestibility of nutrients and N balance in Murrah buffalo male calves, however, there was increase in urease activity and propionate level with a decreased butyrate concentration in rumen fluid at 10 ppm level of supplementation. Nickel retention and its plasma level was higher in buffalo calves supplemented with 10 ppm Ni.

Evaluation of Edible Spineless Cactus (*Opuntia ficus-indica*) Cladodes as Alternative Forage Source in Goat Kids

Eighteen (Alpine × Beetal) male kids were selected from Livestock Research Centre of ICAR-National Dairy Research Institute, Karnal and distributed randomly into 3 groups of 6 animals each based on their body weight and age. In the control group (T1), maize green fodder and concentrate mixture were supplied in the ratio of 40: 60 (on DM basis) to meet the requirements (ICAR, 2013). In group T_2 and T_3, the maize fodder was replaced by edible spineless cactus accessions No. 1270 and 1280, respectively. Two accessions of spineless cactus (*Opuntia ficus-indica*) *i.e.*, 1270 and 1280 used for animal feeding (90 days) were provided by ICAR-

Fig.: Plant of spineless cactus (accession No. 1270)

Fig.: Plant of spineless cactus (accession No. 1280)

Central Soil Salinity Research Institute, Karnal. Feed intake, fortnightly body weight, average daily gain and feed conversion ratio were found to be similar in 3 groups. However, voluntary water intake in the groups fed with spineless cactus waslower (P<0.05) than the control group. Digestibility of nutrients and N balance were similar in all the groups. Also, there were no significant differences in rumen parameters like pH, ammonia nitrogen, total volatile fatty acids and proportion of individual fatty acids among 3 groups. Spineless cactus could fully replace maize fodder in goats (Alpine × Beetle) without affecting feed intake while reducing the demand for voluntary water supply under hot and humid conditions.

Evaluation of Functional Characteristics of Murrah Buffalo Calves Origin Lactic Acid Bacteria for Autochthonous Probiotics Feeding Application

The present study aimed to isolate, characterize, and examine the prospective LAB from Murrah buffalo calves' faecal samples as potential species-specific probiotics. Accordingly, 96 lactobacilli strains were isolated; out of which 55 isolates were Gram-positive, catalase-negative and vancomycin-resistant. These isolates had been presumptively identified as Lactobacillus species and further confirmed by genus-specific PCR. Seventeen were shortlisted based on cell surface hydrophobicity (CSH) and auto-aggregation properties and identified by 16S rDNA sequencing. Cluster analysis from the phylogenetic tree revealed four different groups comprising of *L. reuteri* (11), *L. salivarius* (4), *L. mucosae* (1) and *L. agilis* (1). Whereas, seven isolates were non-hemolytic and showed better resistance to adverse GIT conditions viz. tolerance to pH, bile salts and phenol. The selected isolates also exhibited significant ($P < 0.05$) co-aggregation abilities with antimicrobial activity against the pathogenic strain of E. coli. All the selected LAB were susceptible to all antimicrobial taken except three isolates. BF-17 was resistant to cefadroxil, BF-26 against amikacin and cefadroxil, and BF-J17 to ciprofloxacin and norfloxacin. Also, these isolates showed optimal enzymes secreting activities (amylase and protease) except for BF-14 strain. Finally, principal component analysis (PCA) on probiotic phenotypic data selected *L. reuteri* BF-H9 and *L. salivarius* BF-17 as most promising novel probiotic candidates and requires further in vivo evaluation. These Lactobacillus isolates could be used as probiotics by adding them into premix, mineral blends, and concentrates after lyophilization, or they could be used to produce fermented milk for calves.

Effect of Supplementation of Product of *B. monnieri* and *Aloe vera* Extract on Beneficial Fatty Acids and Antioxidant Status in Milk

A study was conducted for duration of 90 days, to examine the effects of aloe vera plant extract supplementation on rumen bio-hydrogenation and nutraceutical value of goat milk. Twenty four lactating goats were selected and divided into 3 experimental groups. The control (T1) was fed with basal diet comprising of berseem and concentrate mixture (70:30) without any supplementation. The second (T2) and third (T3) groups were supplemented with aloe vera plant extract @ 2% and 4% of dry matter, respectively, along with the basal diet. The aloe vera supplemented group presented a greater amount of unsaturated fatty acids, including gamma linoleic acid in milk than the control fed with basal diet without supplementation. There was reduction in the amount of palmitic acid and stearic acid further leading to decreased total saturated fatty acids and thus, decline in the saturation index. The milk from goats fed with aloe vera containing diet displayed

a greater antioxidant capacity than milk from lactating goats fed with control diet. The mRNA expression of Stearoyl CoA Desaturase, Acetyl CoA Carboxylase and Lipoprotein lipase remained unchanged by aloe vera extract supplemented groups, however expression of Fatty acid synthase, showed increasing tendency as compared to control. Overall, the study concluded that supplementation of aloe vera extract can enhance milk nutraceutical properties through manipulation of rumen fermentation.

Twenty-four lactating goats were selected and divided into four groups. The control group (C) was fed with basal diet comprising of berseem and concentrate mixture (60:40). The second (T-I), third (T-II) and fourth (T-III) groups were supplemented with *B. monnieri* @ 1%, Aloe vera extract @ 2% and combination of *B. monnieri* (1%) and aloe vera (2%), respectively, along with the basal diet. Aloe vera is consistently better than *B. monnieri* in total phenols, flavonoids, tannin content. Aloe vera also showed higher total antioxidant capacity and ferric reducing antioxidant potential. Findings suggest that product of *B. monnieri* and aloe vera extract have the potential to modify rumen biohydrogenating microflora and positively affects the profile of fatty acids in milk without significantly affecting parameters of digestibility in lactating goats. Milk obtained from the aloe vera supplemented groups was found to have higher phenolic content and antioxidant potential than other groups.

Table: Principle components and the antioxidant potential of the extracts

Plant Extract	Phenols (µg/mg)	Flavonoid(µg/mg)	Total Tannins(µg/mg)	TAC*	FRAP**	IC50
B. monnierie	26.84	9.49	93.40	4.86	19.71	221.70
Aloe vera	38.80	23.91	199.90	8.12	20.43	142.71

**TAC- Total Antioxidant capacity [Ascorbic acid equivalent (mg/gm of dry wt.)]*
***FRAP- Ferric reducing antioxidant potential (mmole of ferrous ion equivalent)*

Table: The qualitative and quantitative assay of milk

Parameters	C	TI	TII	TIII
Total PhenolicsA	34.45b±0.72	39.15a±2.17	35.15b±0.62	40.95a±1.17
FRAPB	108.09b±6.26	155.14a±2.82	110.91b±3.15	162.44a±5.82
DPPHC	50.24b±4.54	76.1a±2.13	50.24b±4.54	74.5a±4.54

***T0-** Control; **TI** @ 1% B. monnierie, **TII** @ 2% Aloe vera extract and **TIII** B. monnierie and Aloe vera at 1 and 2% respectively. @; A- µg Gallic acid Eq./mL; B- µM $FeSo_4$ Equivalents; C- % inhibition*

Dietary Supplementation of Tropical Seaweed Based Formulations Increased Antioxidants, Immunity and Milk Yield in Murrah Buffaloes

This study was conducted with an objective to investigate the supplementary effects of combination of seaweed based formulation (SWBF) on the production performance, antioxidant and immune status of lactating Murrah buffaloes. Eighteen lactating Murrah buffaloes were divided into 3 groups based on their body weight, parity, days in milk and milk yield following randomized block design. All the animals were fed a basal diet as per their requirements based on ICAR, 2013. Whilst, animals in control group (T_0) did not received any supplementation, diets of animals in T_1 and T_2 groups were supplemented with SWBF-I (combination of two red seaweed species- *Kappaphycus alvarezii* and *Gracilaria salicornia*) and SWBF-II (combination of two red seaweeds and a brown seaweed species- *Kappaphycus alvarezii*, *Gracilaria Salicornia, Turbinaria conoides*) respectively at 2.5% of the concentrate feed. The intake and apparent digestibility of various nutrients and N balance were not affected by supplementation of SWBP formulations. Supplementation of SWBP formulations did not have any impact on hematological parameters, blood metabolites (blood glucose, total protein, plasma albumin, globulin, total cholesterol, triglycerides), plasma enzymes (AST and ALT) concentrations, all the related parameters studied were within the normal range. Plasma concentration of hormones like Insulin, IGF, T_4, T_3 were similar among the groups, but concentration of cortisol showed a decreasing tendency (P=0.060) with lower concentration in treatment groups. Total antioxidant activity was improved and the maximum response was reported in T_2 followed by T_1 (P=0.001). Concentration of LPO decreased (P<0.004) due to SWBP supplementation and the values were similar between the treatment groups. Supplementation of SWBP- I and SWBP-II augmented cell mediated immune response (P= 0.002) with maximum response in T2 followed by T_1. Humoral immune response was more (P<0.001) in treatment groups as compared to control group and was similar between the treatment groups. Milk yield (kg/d) and the 6% FCM yield (kg/d) were higher in T_2 followed by T_1 and the minimum milk yield and FCM yield was recorded in group T0. As compared to control, milk yield improved by around 9% (8.74±0.207 vs

9.57±0.290) in T_2 group. Supplementation of both the seaweed by-products improved antioxidant status, cellular and humoral immunity, and milk yield, the best response was obtained when SWBP II (*Kappaphycus alvarezii*, *Gracilaria Salicornia* and *Turbinaria conoides*) was incorporated at 2.5 % in the concentrate mixture of lactating Murrah buffaloes. Thus, supplementation of SWBP II at 2.5% in the concentrate mixture. of lactating Murrah buffaloes would be beneficial in terms of improved antioxidant and immune status and milk yield.

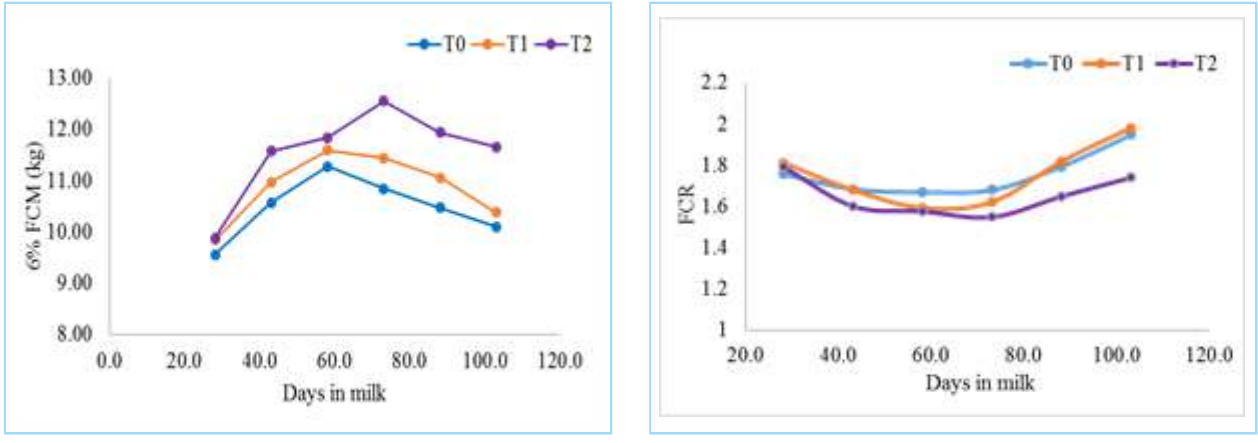


Fig.: Effect of dietary supplementation of different combination of seaweed based formulations in lactating Murrah buffaloes 6% FCM (kg/day) and FCR for milk production

Effect of Supplementation of Seaweed Based Formulations in Maternal Diet on Performance of Neonatal Murrah Buffalo Calves

This study was carried out in two phases. In phase-1, twelve Murrah buffaloes (~60d prepartum) were assigned to three groups (Control, T_1 and T_2) with 4 animals each. All the buffaloes were fed basal diet (wheat straw, green fodder and concentrate mixture) as per ICAR, 2013 requirements with additional supplementation of SWBF-1 (*Kappaphycus alverazii* and *Gracilaria salicornia*) in T_1 and SWBF-2 (*Kappaphycus alverazii, Gracilaria salicornia* and *Turbinaria conoides*) in T_2 at 2.5% of concentrate mixture. Supplementation period started from 60d prepartum and continued till calving. A digestibility trial of 7 days was also conducted in phase-1. *T. conoides* had highest CP (%) (7.84) followed by *K. alverazii* (5.87) and G. salicornia (4.20). The highest TA (%) was found in *G. salicornia* (77.97) and in other two seaweeds the values were comparable. The results of phase-1 revealed that there was no significant (P>0.05) difference in DMI (kg/d), CPI (kg/d) and TDNI (kg/d) among the three groups. Digestibility of nutrients (%) was not affected due to supplementation of SWBF. There was no significant (P>0.05) difference in fortnightly body weight (kg) and BCS among treatments. Haematological and plasma biochemical parameters were not affected due to supplementation of SWBF, however these were in normal physiological range. Plasma SOD (ng/mL) and TAC (mM FeSO4/l) were significantly (P<0.05) different among the three groups. Total antioxidants and phenolic content (mg GAE/100g) in colostrum were significantly higher in T2 (61.17) followed by T_1 (57.43) and control (52.14) however, in milk, these were not altered due to SWBF supplementation. In phase 2, effect of maternal supplementation was studied on the performance of neonatal calves till 3 months of age. The results of phase-2 revealed no significant difference in birth weight (kg) and fortnightly body weight (kg) among the three groups. Fortnightly ADG (g/d) in calves was not affected due to maternal supplementation of SWBF. Maternal supplementation of SWBF improved faecal score in calves. Also, T_2 group had lowest incidences of diarrhoea followed by T_1 and control. Haematological and plasma biochemical parameters in calves were in normal physiological range and there was no significant difference among the three groups. Plasma SOD concentration and TAC was higher in T_1 and T_2 as compared to control. Plasma total immunoglobulins (ng/mL) were higher (P <0.01) in SWBF supplemented group as compared to control. Also, cell mediated immune response (DTH against PHA-P antigen) was higher in T_1 and T_2 group calves. Hence, maternal supplementation of SWBF did not affect ADG of calves, however, improved the faecal score, plasma antioxidant profile and immune status.

Flavour and Taste Ingredient as Feed Additives and their Effect on Feed Intake and Growth Performance of Cattle Calves

A total of ten flavours was evaluated in Phase 1 of the trial. There were two sets having five flavours each. Thirty-six (36) growing calves were divided into six groups having six (6) animals in each group, keeping one group as a control (without flavour supplementation) in each set. In first set, green grass, pudina, neem, til and fresh flavours were fed to animals. In second set, mango, banana, coconut, milk and hing flavours were fed to animals. Feeding of each set continued for minimum 21 days. Based on the analysis of their respective TDMI, two most promising flavours *i.e.* Green grass and milk flavour were selected long term feeding trial. Green grass flavour feeding showed significant difference in the DMI (3.20±0.10) % BW) where the parameters were observed to be slightly higher as compared to other treatment groups. From the second trial, milk flavour showed significant difference in the DMI (3.29±0.09) per 100 kg body weight of animals and was slightly higher as compared to both control and treatment groups.

Table: Dry matter intake per 100 kg BW

Group	DMI (First trial)	Group	DMI (Second trial)
Control	2.74ab±0.20	Control	2.71a±0.11
Green grass	3.20c±0.10	Mango	2.87a±0.15
Pudina	3.09bc±0.09	Banana	2.87a±0.06
Neem	2.91abc±0.09	Coconut	2.78a±0.08
Fresh	2.79ab±0.16	Milk	3.29b±0.09
Til	2.67a±0.09	Hing	2.72a±0.10
a,b,c Mean values within a column differ significantly (p<0.05)		a,b Mean values within a column differ significantly (P<0.05))	

Optimizing Dietary Fiber and Protein Levels for Amelioration of Heat Stress in Lactating Murrah Buffalo

The objective of study was to assess the outcome of feeding six total mixed rations (TMR) differing in NDF and protein content for their synergistic effect on ameliorating heat load of lactating Murrah buffaloes evident through improved physiological and production performance. Thirty six lactating Murrah buffaloes were arranged in a 3×2 factorial design with three levels of dietary NDF (30, 34.5 and 37%) and two levels of metabolizable protein (MP; 7.0 and 8.4 %). Buffaloes were fed either of six dietary treatments: 30% NDF; 7.0% MP, 34.5% NDF; 7.0% MP (M1), 37% NDF; 7.0% MP (HF1), 30% NDF; 8.4% MP CF2), 34.5%NDF; 8.4% MP (MF2) and 37% NDF; 8.4% MP (HF2). Throughout the trial, THI level (79.7 to 83.8) denoted that buffaloes were exposed to stressful environment. Higher MP in diet reduced pulse rate in buffaloes as compared with lower MP diet. Rectal temperature was lower in Murrah buffaloes fed MF2 diet, whereas , minimum breathing rate was recorded for high protein fed group. The MF2 diet increased dry matter intake (kg/d) by 2.7%, milk yield (kg/d) by 8.3% and feed efficiency (milk/DMI) by 7.2% as compared with CF1 group indicating reduced heat load. Increase in protein intake along with improved protein digestibility in MF2 group was recorded. Measured 6%FCM and ECM (kg/d), milk fat (%) and total solid (%) were higher in MF2 treatment group. Thereore, 34.5% NDF and 8.4% MP have a positive influence on amelioration of heat stress in present experimental conditions.

Effect of Various Additives on Production of Cost-effective Sugarcane Tops Silage

The experiment was conducted to evaluate the effect of adding common additives (Urea, Molasses), exogenous enzymes (cellulase and xylanase) and bacterial inoculants (*Lactobacillus plantarum* NCDC- 344 and *Lactobacillus fermentum* NCDC-412) for improving the quality of sugarcane tops silage. In phase1 sugarcane, tops were ensiled after adding different additives and analyzed for their chemical parameters, *in vitro* parameters, and microbiology count. In phase 2, silage additive product was developed by using a spray dryer of the best treatment which was selected based on Fleig point (based on pH and DM loss) and the cost. For this, a total of 20 treatments were prepared which were divided into two major categories including controls (C1) and 19 combinations of various additives (exogenous fibrolytic enzyme, cellulase and xylanase and LAB inoculants, *Lb. fermentum*, NCDC-412, and *Lactobacillus plantarum*, NCDC -344). As compare to SCT silage control, all treatments had a higher (P<0.05), acetic acid (%DM) and LAB count (P <0.05), but lower (P <0.05) butyric acid, yeast and mould counts and C+X+LP+LF had higher IVDMD and IVOMD as compared to (P<0.05) other treatments.

Supplementation of Bull Specific Trace Mineral Mixture to Bulls

Twelve Murrah and Karan Fries bulls each were grouped as T1 and T2 based on their semen volume and mass activity and were fed as per ICAR (2013). Bulls in T1 were fed basal diet while those in T2 were supplemented with a trace mineral mixture, which was formulated on the basis of results of earlier experiments conducted at Animal Nutrition Division, NDRI, Karnal. The sexual behaviour and antioxidant status in blood and semen were improved by supplementation of the trace mineral mixture. Further, testosterone and thyroxine hormone levels were improved in supplemented groups. Results revealed that semen quality parameters *viz*., volume, sperm concentration, live sperm count, mass activity, intact acrosome count were found to be better by supplementation. Advanced *in-vitro* sperm function tests by fluorescent staining also showed better results in the group supplemented with trace mineral mixture. Trace mineral mixture for bulls @ 890 ppm proved beneficial to improve semen production performance in bulls.

Supplementation of Iodine to Breeding Bulls

The dietary supplementation of iodine by 1.5 and 2 times higher than ICAR (2013) recommendations improved ($p<0.05$) testosterone and thyroxine hormone levels in iodine supplemented groups. Blood and seminal iodine content was increased at both levels of supplementation. While, iodine did not alter ($p<0.05$) body weight, dry matter intake and digestibility of nutrients. Sperm function tests *viz.,* livability, membrane integrity, acrosomal integrity, motility and mitochondrial membrane potential were found to be improved by iodine supplementation. LPO and capacitation-related membrane destabilisation in spermatozoa were reduced in supplemented bulls. Blood and seminal antioxidant status (total antioxidant activity and glutathione peroxidase activity) was improved ($p<0.05$) by supplementation of iodine. Sexual behaviour was also improved ($p<0.05$) in iodine supplemented groups. Hence, iodine supplementation at the dose rate of 0.125 and 0.25 ppm in the diet of Sahiwal was beneficial in improvement of antioxidant status and sperm function tests.

Green House Gas Emission (GHGs; Methane & Nitrous Oxide) from Indian Livestock

Population data were extrapolated based on 2012 and 2019 census data to calculate the methane emission. Digestibility of nutrients data was taken from various experiments conducted at AN Division and other ICAR Institutes located in various parts of the country. Except cattle buffalo goat and sheep, tier 1 (IPCC 2006) have been adopted as country specific data is not available. Total enteric methane emission was increased 10.57 Tg in 2013 to 10.603 in 2016. Total methane emission was 10.69 to 10.72 Tg per year while when expressed on milk production for milch animals the value has decreased from 73.32 g methane per kg milk yield to 61.16g/kg milk yield. The decrease of 16.6% per kg milk yield was recorded. Total emissions in terms of CO_2 equivalent were increased from 249.08 to 249.88 Tg from 2013 to 2016. There is only 0.32% increase in four years. There is only 1.4% increase in total population of livestock and 0.21% in total GHGs emission major contributors being cattle and buffalo from 2013 to 2016. Indigenous cattle and buffaloes have shown a decrease by 4.4 and 0.14%, respectively. While there was 11.8% increase in crossbred cattle. There was increase in goats (2.4%), sheep (6.89%) and Mithun (12.18%) population while there was decrease in all other types of animals. Population of male animals decreased and that of female animals of cattle and buffalo increased. Number of male animals and number of unproductive animals may also be reduced further to reduce total enteric methane emission from livestock.

Deciphering the Role of miRNAs Induced by Milk Derived Peptide in Regulation of Osteoblast Differentiation and Osteoporosis

To decipher the function of miRNAs (induced by PepC) in osteoblast differentiation by decrypting their targets via, computational homology or target prediction tools, accompanied by experimental validations with osteoblast cultures and characterization in an osteoporotic rat model was carried out. The observations were initially focused on several parameters (high homology scores, fold change, p values, novelty) for screening a repository of 191 profiled miRNA in response to PepC. Five miRNAs were eventually shortlisted (miR300, miR592, miR381, miR369, miR10a). For, rno-miR300 (miR300), target identification was executed based on validated miRNA targets from its homologous miRNA; mmu-miR381 (miR381). Smad3 was recognized as best interactors for miR300 among 291 validated targets of miR381 *in silico* through RNAhybrid and Sfold tool.

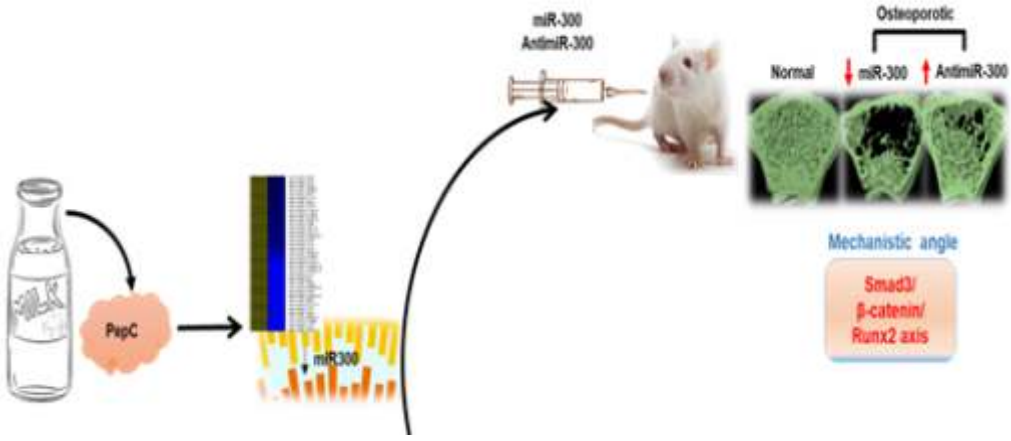


Fig.: miR300 intervenes Smad3/β-catenin/RunX2 crosstalk for therapy with an alternate function as indicative biomarker in osteoporosis

miR300 downregulation in response to PepC was confirmed by *in vitro* validations. Besides, miR300 excess was shown to decrease osteogenic gene and protein expression in rats osteoblasts for 4 days at 50 nM, whereas AntimiR300 (miR300 inhibitor) showed the opposite effect. Smad3 was a validated miR300 target, activating -catenin and potentiating Runx2.

The Anti-Inflammatory Potential of Milk from Different Breeds of Cow

The anti-inflammatory potential of milk from different breeds of cow studied in inflammatory bowel disease model created in rats using peptidoglycan (PGN). PGN treatment resulted in significant increase in gut permeability, but feeding of milk from Sahiwal (SG), GIR, Karan Fries (KF) and Karan Swiss (KS) brought about significant reduction in gut permeability. Gastric acidity was found to decrease significantly in different milk treated groups in comparison to PGN (Positive control). Likewise, significant increase in intestinal Glucagon like peptide-2 (GLP-2) in GIR and Holstein Friesian (HF) compared to PGN treated rats was found. TNF-α and IFN-γ reduced in Tharparkar (TP) and GIR milk treated rats, but IgA level increased in TP and GIR group as compared to positive control.

Role of *Lactobacillus* fermented Sweet Whey on Reinforcement of Intestinal Epithelial Function

The fermented foods provide essential nutritional components and bioactive molecules that have beneficial effects on several gastrointestinal disorders. Under present investigation potential protective effects of whey fermented with probiotic *Lactobacillus rhamnosus* (MTCC-5897) and *L. fermentum* (MTCC-5898) on reinforcement of intestinal epithelial barrier function were evaluated. In order to understand the protective role of probiotic *Lactobacillus* fermented whey, DSS-induced colitis mice were used as *in-vivo* model. The impact of consumption of *Lactobacillus* fermented whey was assessed on disease activity index, hematological and histological scores, release of cytokines and expression of other inflammatory markers as well tight junctional genes (*occludin*, *claudin-1*, *ZO-1* and actin) along with their cellular localization respectively. Pre-consumption of whey fermented with probiotic *L. rhamnosus* and *L. fermentum* before colitis induction to mice significantly reduced ($p<0.01$) the disease activity index and improved ($p<0.05$) the hematological and histological scores.

Deciphering the Role of Probiotic Lactobacilli on DNA and Histone Modifications as Epigenetic Regulation

The gut is the largest immunological organ of the body and its microbiota has an important role in the maturation and maintenance of the immune system. Probiotics are well documented for their role in the maintenance of gut homeostasis which is imperative for a healthy immune system. Probiotic-mediated immunomodulation occur through the mediation of cytokine secretion which can also affect proliferation and differentiation of immune cells. Epigenetic machinery plays a significant role in the modulation of both innate and adaptive immune systems. Various environmental factors including nutrients, microbes as probiotics or pathogens may have profound effects on epigenetic signatures of the intestinal epithelium to mediate their

either health-promoting effects or increase susceptibility to diseases. Based upon this information, the present study was aimed to investigate DNA and histone modifications in intestinal epithelial Caco-2 cells by two indigenous probiotic strains *Lactobacillus fermentum* (MTCC: 5898) and *Lactobacillus rhamnosus* (MTCC: 5897) in comparison to inflammatory agent *E. coli* (ATCC; 14849).

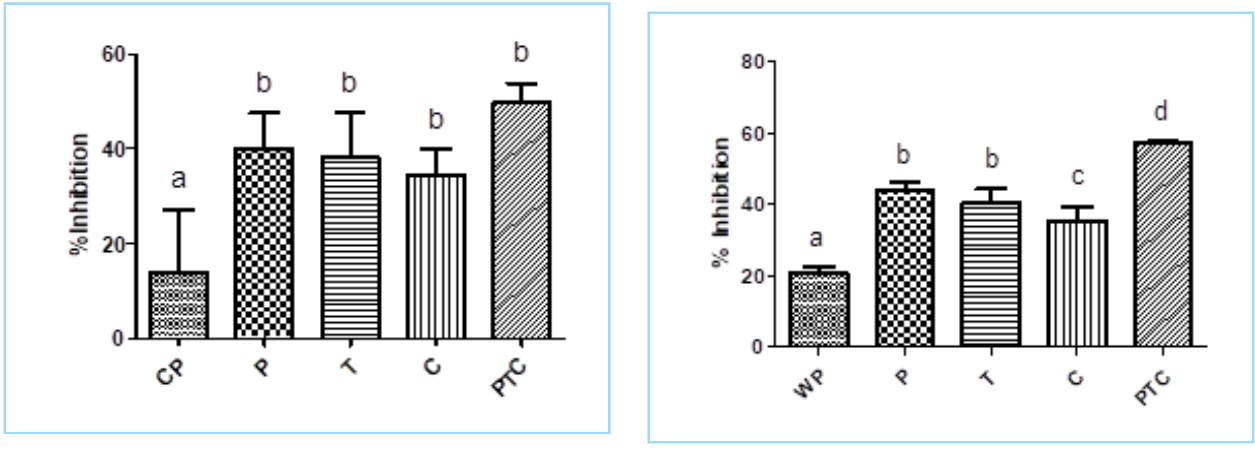


Fig.: Pancreatic lipase inhibitory activity of (a) goat casein protein (CP) and (b) whey protein (WP) and its hydrolysates prepared by pepsin (P), trypsin (T), chymotrypsin (C) and PTC enzymes

Role of Goat Milk Protein Hydrolysates in Controlling Obesity by Inhibiting the Activity of Pancreatic Lipase Enzyme

Pancreatic lipase is an important enzyme in hydrolyzing triglycerides in intestine. Inhibition of the activity of pancreatic lipase is one of the strategy to control obesity. Goat casein protein (CP) and whey protein (WP) was hydrolysed by pepsin (P), trypsin (T) and chymotrypsin (C) and PTC. These goat casein protein hydrolysates were assessed for their pancreatic lipase inhibitory activity. Casein protein exhibited 13.93% inhibition. <10k Da fraction of P, T, C and PTC hydrolysates exhibited 40%, 38.18%, 34.54% and 49.69% inhibition respectively. PTC hydrolysate exhibited highest pancreatic lipase inhibitory activity. Inhibition percentage of pancreatic lipase activity of goat whey protein hydrolysates are shown in fig.. It is shown that goat whey proteins upon hydrolysis demonstrated significantly higher pancreatic lipase inhibitory potential compared to unhydrolysed goat WP. WP exhibited 20.7% inhibition, <10kDa fraction of PTC generated hydrolysates with highest pancreatic lipase inhibitory activity (57.25%) as compared to P, T and C hydrolysates which exhibited 43.73%. 40.42% 35.38% inhibition respectively.

Role of Camel Milk Protein Hydrolysate in Controlling Diabetes by Increasing the Insulin Secretion by Pancreatic Bets Cells

Camel milk derived proteins, casein protein (CP) and whey protein (WP) hydrolysates were prepared by using pepsin (P), trypsin (T), chymotrypsin (C) and their combinations PT, PC, CT and PTC. Pancreatic beta cells

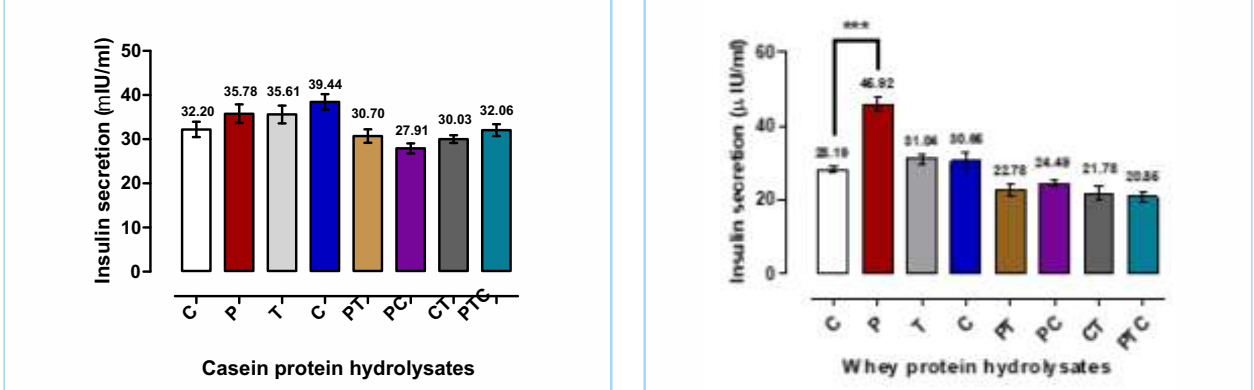


Fig.: Insulin secretion by Pancreatic beta cells (RIN-5F) on treatment with (a) casein protein and (b) whey protein hydrolysates

(RIN-5F) were treated with CP and WP hydrolysates and insulin secretion was measured. It was found that treatment of RIN-5F cells with hydrolysates caused increase in insulin secretion and significant increase was observed in case of WP-pepsin hydrolysate as compared to control.

Global MicroRNA Profiling of Buffalo Milk Exosomes

For the first time in India, the exosomal miRNAs have been profiled in the buffalo milk. The study provided interesting insights into the physiological functionality of bovine milk microRNA in humans. Primarily, small RNA sequencing identified 351 microRNA and 17 previously unannotated microRNA in the buffalo milk exosomes. Among them, bta-miR-148a, bta-miR-30a-5p, bta-miR-21-5p, bta-miR-99a-5p, bta-miR-27b, bta-miR-200a, bta-miR-26a, bta-miR-26c, bta-let-7g and bta-let-7i were the 10 most abundant microRNA. Out of 5 validated microRNA, bta-miR-148a and −30a-5p were differentially expressed, and the bta-miR-21-5p, bta-miR-200a and bta-let-7g were consistently expressed across different stages of lactation. Gene targets of the 10 most abundant microRNA identified using TargetScan taking *Homo sapiens* as the reference genome. *In silico* network analyses of the miRNA targets predicted 9 significant gene clusters involved in important cellular processes.

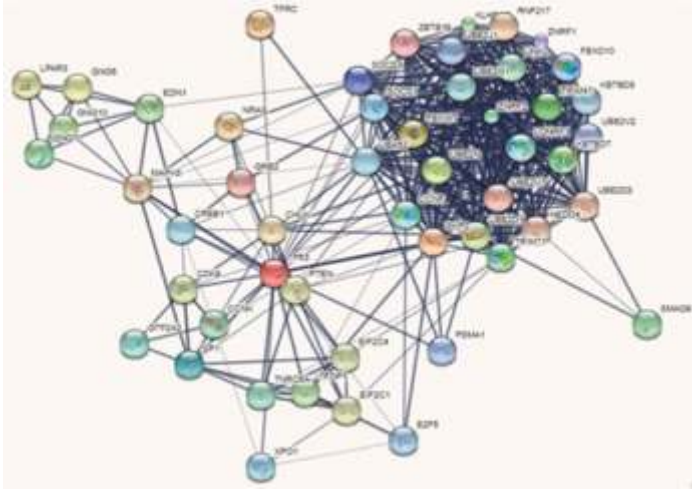


Fig: Protein–protein interactions network analysis among the target genes of the top 10 most abundant microRNAin buffalo milkexoxomes

Reverse Transcription-Loop Mediated Isothermal Amplification (RT-LAMP) Assay for Detection of AhR Receptor Responsive Xenobiotics

The most aryl hydrocarbon receptor (AhR)recognizes many xenobiotics. One of the model xenobiotics is dioxins. Dioxins are a group of highly toxic and lipophilic environmental persistent organic pollutants. Among several dioxins, 2, 3, 7, 8- tetrachlorodibenzo-p-dioxin (TCDD) is the most toxic representative of this class. TCDD causes several human health effects like endocrine disruption, carcinogenesis and reproductive toxicity mediated by aryl-hydrocarbon receptor. Current detection methods of dioxins like gas chromatography-mass spectrometry, liquid chromatography-mass spectrometry are costly and time consuming. Therefore, a study developed a relatively faster and cheaper technique called reverse transcription-loop mediated isothermal amplification **(**RT-LAMP) assay to detect dioxins. In this study, cultured buffalo granulosa cells were used as a model system.

An *In-Silico* Transcriptome based Network Analysis

High-energy demand occurs in female buffaloes during early postpartum because of milk production for the survival of new offspring. It is well known that ruminant milk contains high amount of lactose, a disaccharide of the glucose and galactose, which determines the milk yield. In ruminants, the liver majorly supplies glucose after obtaining energy from non-hepatic tissues such as the adipose tissue during energy demands. Therefore, there should be an intricate crosstalk between these two tissues for efficient maintenance of energy to meet the needs of normal physiology and milk production. To understand the crosstalk players between the liver and adipose tissue during early postpartum, transcriptome data obtained from the buffalo

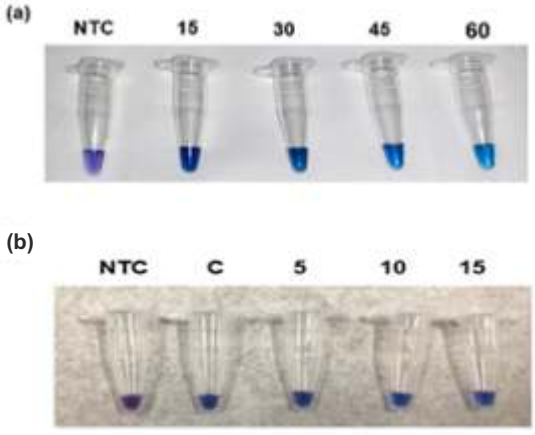


Fig: Development of RT-LAMP assay for detection of cells exposed to TCDD. Change in color from violet to blue represents the change in gene expression (CYP1A1) due to exposure of TCDD. (A) Dose dependent change in the color by TCDD treatment (5pg, 10pg and 15pg), (B) Change in color at different time period (15, 30 and 45),

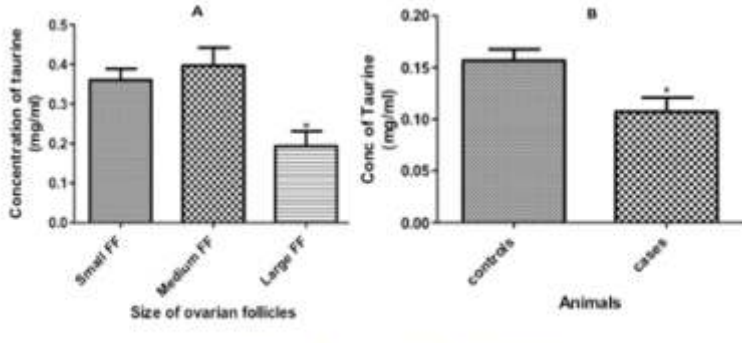
liver and adipose tissue on the lactation day 15 and 30 were analyzed by using several bioinformatics tools such as PANTHER, Secretome-P, STRING and CPDB. A total of 24 signaling molecules were found as interactive players between the liver and adipose tissue during early postpartum of buffaloes. Among them, the liver majorlyappears to interact with the adipose tissue and itself through an endocrine/autocrine molecule, APOA1 (apolipoprotein 1).

Correlation between Taurine and Ovarian Follicular Testosterone

Taurine, an abundant intracellular beta-amino acid, is majorly synthesized in the liver and transported through plasma to other organs.It was reported to be involved in various physiological functions, including the enhancement of testosterone levels, the major estradiol precursor. Therefore, a correlation was established among taurine, estradiol, and testosterone levels in the ovarian follicular fluid. Our studies showed thattaurine and testosterone levels were significantly ($P < 0.05$) higher in the follicular fluid of small and medium follicles than large ovarian follicles. On the contrary, the estradiol levels were significantly ($P < 0.001$) higher in the large follicles than small and medium follicles.

Mahamrityunjaya Mantra Enhanced Aromatase Gene Expression in 3D-cultured Buffalo Granulosa Cell Spheroids Model System

Music is known for reducing stress, anxiety and depression, improving cognitive performance, and enhancing oestrogen levels. However, its effect on non-auditory mammalian cell system and the molecular events leading to higher oestrogen levels is less explored. Therefore, this study targeted to know the direct effects of a peaceful Vedic music on 3D cultured buffalo granulosa cell spheroids. The spheroids were daily exposed to the Mahamrityunjaya mantra, a kind of Vedic chants, for 1.5 hr for 6 days. After 6 days, the music effect was analysed by the expression analysis of steroidogenic (*CYP19A1, STAR* and *HSD17 1)* and proliferative marker (*PCNA)* genes.



Concentration of taurine in the buffalo ovarian follicular fluid (A) and in the serum samples of postpartum anestrus (cases) and normal cyclic (control) animals (B).

Mitochondrial Protein-Coding Genes Expression and OXPHOS Complexes Activities in Haplotype-specific Ovarian Tissues of Buffalo

This study investigated whether mitochondrial DNA (mtDNA) variation preferentially modifies the expression of *mtDNA-encoded protein genes* and OXPHOS complexes activities in buffalo. The mitochondria were isolated from haplotype-specific different ovarian tissues (i.e. Haplotype 2, 5, 18, 23, 25, 35, 44, and 60). Further, the total RNA purified from the mitochondria has been used for the expression analysis of mitochondrial-encoded 13 protein-coding genes (PCGs) namely NAD1, NAD2, NAD3, NAD4L, NAD4, NAD5, NAD6, COX1, COX2, COX3, ATP8, ATP6, and COB by qRT-PCR using gene-specific primers. Subsequently, the functional activity of individual OXPHOS complexes (I, II, III, IV, and V) were measured in isolated mitochondrial suspensions from different haplotype-specific ovarian tissues. The results revealed that there were no differences ($P > 0.05$) between haplotypes in expressions of NAD1, NAD2, NAD4L, NAD4, NAD6, COX1, and COB. Relative abundance (RA) of NAD3 transcript in Haplotype 60 was greater ($P < 0.05$) than that of Haplotype 2, Haplotype 23, and Haplotype 25. Although a similar pattern of NAD5 expression was observed between haplotypes, transcription levels of NAD5 were higher ($P<0.05$) from Haplotype 2 as compared to Haplotype 23. Significant differences ($P = 0.0123$ to $P<0.0001$) were found in COX2 and COX3 mRNA transcript expression amongst different Haplotypes.

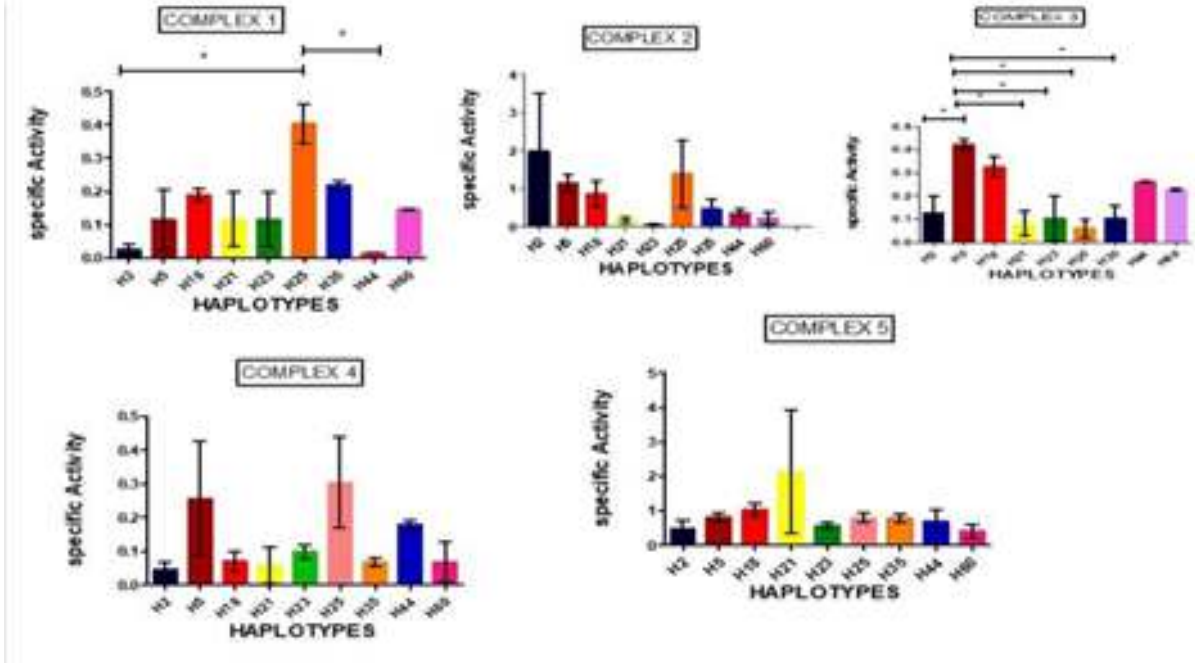
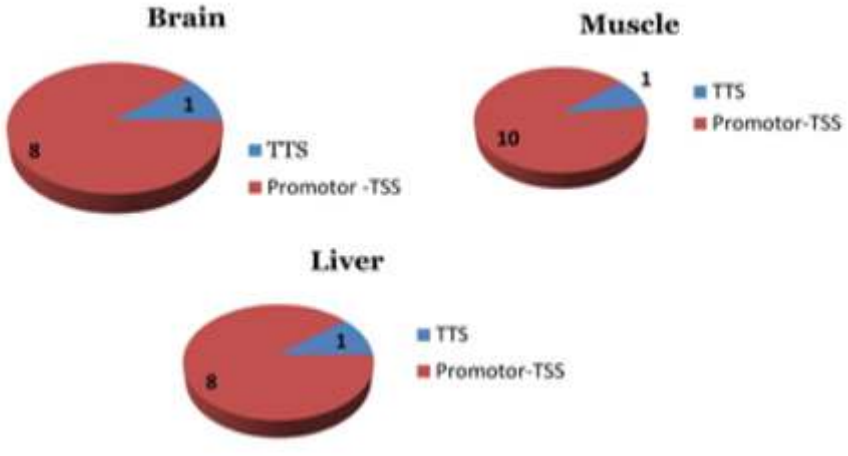


*Fig.: Complex I, Complex II, Complex III, Complex IV and Complex V Specific Activity measurements in haplotype-specific different ovarian tissues. The data are presented as the mean ± SEM. Asterisks indicate the level of statistical significance of differences (*P< 0.05).*

Identification and Analysis of Mitochondrial DNase1 Hypersensitive Regions in Buffalo Tissue Samples

Buffalo mitochondrial DNA (mtDNA) is believed to lack chromatin and histones. We asked whether buffalo mtDNA showed any tissue-specific pattern of genomic footprinting sites, to address this question we analyzed mtDNA DNase-I seq experiments in three different buffalo tissue types. The mitochondrial pellet from the liver, brain, and muscle tissues was subjected to DNase I digestion. The digested DNA was analyzed on genomic DNA screen tape on 2100 Agilent tape station as well as 1.2% agarose gel. Library preparation was performed using NEXTflex Rapid DNA Library Prep Kit (Bioo Scientific, Austin, TX, U.S.A.). The libraries were paired-end sequenced on Illumina HiSeq X Ten sequencer (Illumina, San Diego, USA) for 150 cycles following the manufacturer's instructions. A total of 8781240, 17704291, and 17120907 raw reads were



Number of Peaks and their annotations

obtained from sequencing of mtDNA from muscle, brain, and liver tissues respectively. The Illumina raw reads were quality-checked and were further processed for removal of adapters and low-quality bases in order to obtain high-quality data. The high-quality reads of 7862466 (89. 54 %), 15528248 (87.71 %), and 15915060 (92.96 %) from mtDNA of muscle, brain, and liver, respectively were aligned against the reference buffalo mitochondrial genome.

Cell Polarisation is Linked to Mesoporous Silica Nanoparticle, Multiwalled Carbon Nanotubes and Zinc Oxide Nanoparticle-Induced Reduction of Cellular Cytoskeleton

Nanotechnology has emerged as a multidimensional discipline getting utilised extensively in everyday life and biomedical field. It raises an urgent need to understand the safety of new-age materials in biological systems (liver, kidney, and lungs). High binding affinities of nanoparticles (NPs) leads to their accumulation in the target cell or organ. It is not apparent how various NPs accumulation influences cell morphology, organelle shape, protein localisation, and interactions. However, their uptake, accumulation, and degradation are indulged with the plasma membrane, endoplasmic reticulum (ER), mitochondria, and lysosomes are incredibly dynamic. The cellular response to nanoparticles (NPs) for the mechanical clue and biochemical changes are unexplored. Here, we provide the comprehensive analysis of the Chinese Hamster Ovary (CHO-K1) cell line to study cell behaviour following the exposure of mesoporous silica nanoparticle (MSN), multiwall carbon nanotubes (MWCNTs), and zinc oxide (ZnO) NPs. Through the high-throughput proteomic study, we observed that the effect of NPs is alone not restricted to cell viability but also on cell polarisation. In the case of MSN, no drastic changes were observed in cellular morphology, but it upregulated chaperons that might prevent protein aggregation. However, MWCNT showed elongated cell appearance with numerous cytoplasmic vacuoles, and induce lamellipodia formation through actin polymerisation. The cytoskeleton remodelling was accompanied by the increased expression of Dlc-1, cofilin and Rac1 proteins. While ZnO NPs resulted in the rounded cell morphology along with nuclear abnormalities. The proteome analysis revealed that UBXN11 control cell roundness and DOCK3 leads to actin stress fibre formation and finally, loss of cell adhesion. It enhances the expression of catastrophic DNA damage and apoptotic proteins, which was unrecoverable even after 72 h, as confirmed by the colony formation assay. All three NPs trigger over-expression of the endocytic pathway, ubiquitination, and proteasomal complex proteins. The data indicate that ZnO and MSN entered into the cells through clathrin-mediated pathways; whereas, MWCNT invades through ER-mediated phagocytosis. Based on the incubation and concentration of NPs, our work provides evidence for the activation of Rac-Rho signalling pathway to alter cytoskeleton dynamics. Our results assist as a sensitive early molecular readout for nanosafety assessment. The current study reports that NPs interactions with cells can alter biophysical parameters (morphological, cell spreading and migration) in correction with the cytoskeleton network's involvement. Changes expression levels of Dlc-1, UBXN11, DOCK3, and Rac1 are essential to control their morphology, proliferation, and migration in different type of NPs microenvironments.

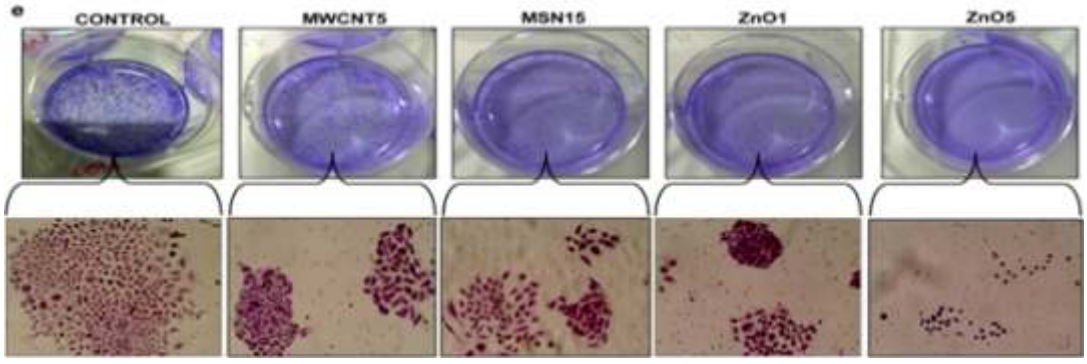


Fig.: Effect of MSN, MWCNT, and ZnO NPs on the CHO-K1 cell line: Cytotoxicity was measured by MTT (a), WST-8 (b), LDH release assay (c), and Trypan blue uptake (d) after treatment with ZnO, MSN, and MWCNT. CHO-K1 cells were cultured in Ham's-F12 culture medium for 24 h and then treated with different concentrations of NPs for 24 h. Nanoparticles induced colony formation inhibition of CHO-K1 cells: CHO-K1 cells were seeded in 6-well culture plates for 3 days and exposed with MWCNT5 (5 µg/mL), MSN15 (15 µg/mL), ZnO1 (1 µg/mL) and ZnO5 (5 µg/mL) for 24 h.

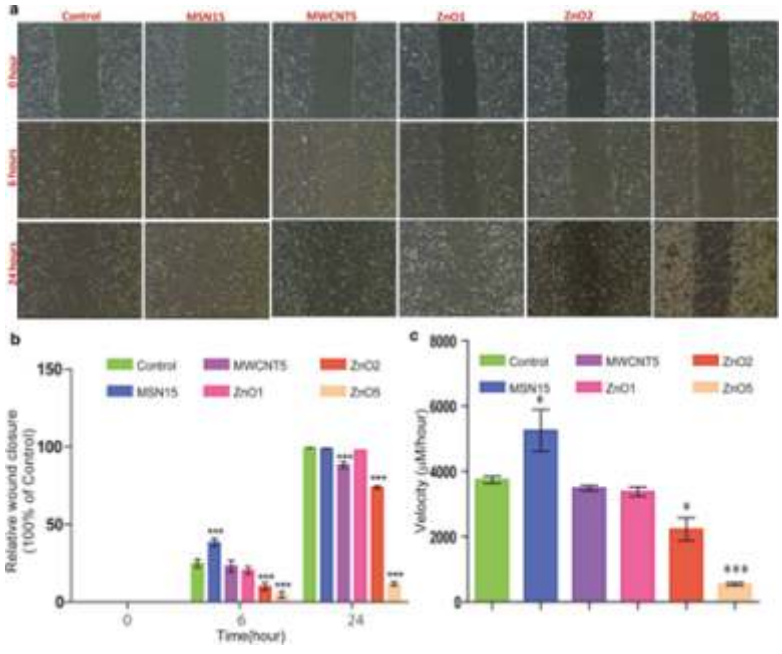


*Fig.: Effect of nanoparticles on cell migration of CHO-K1 cells: CHO-K1 cells were cultured in 6-well plates and wounding on the after 48 h. CHO-K1 cells treated with MSN15 NPs (5 µg/mL) MWCNT5 (5 µg/mL), ZnO1, ZnO2, ZnO5 NPs (1, 2 and 5 µg/mL) and control cells. The images were captured at hour 0, 6, and 24 h, respectively, after the wound was created. b The results are expressed as relative wound closure and velocity (mean ± SD) were calculated by one-way ANOVA with Tukey'sposthoc test (*p < 0.05, **p < 0.01,***p < 0.001) from three independent experiment.*

Nutrient Utilization, Milk Production and Accretion of Acetamide in Milk of Cows Supplemented with Ammoniated Paddy Straw Pellets

Urea treatment of straw is one of the popular technologies introduced about 50 years ago and numerous reports, including the present study, highlighted increased diet intake, digestibility of nutrients and nutritive value of the ration fed to dairy cattle. Feeding paddy straw treated with 4% ammonia source as per the Michigan technology 'Ammonia Fiber Expansion' or AFEX- PS resulted in increased fat yield in the milk (P< 0.001) from 3rd week hence, there was significant (P< 0.001) increase in 3.5% fat corrected milk yield. But, the feeding of AFEX-PS spiked acetamide accretion in milk to 6000 PPB compared to 400 PPB in control. Unlike, non-ruminants, ruminant appears to metabolize the acetamide because of fermentative digestion and its secretion was 10 folds lesser than a few reports available on rats. Acetamide content in milk soon after withdrawal of AFEX-PS feeding to lactating cows return to normal levels of 450 PPB that was comparable to control.

Effect of Feeding Different Sources of Energy with Functional Nutrient Supplements during Prepartum Period on Postpartum Nutritional and Metabolic Status of Cows

Novel supplementation based with an intermediary element in the intermediary metabolism of glycolysis, glycogensis or lipolysis was prepared after comparing its efficacy with jaggery as readily soluble disaccharide (replica of molasses) or maize grain polysaccharides along with selective functional nutrients viz., minerals,

vitamins and fatty acids. Serum NEFA concentration in cows was less than the threshold levels in prepartum (<0.5mmol/L) and postpartum (<1.0mmol/L). RBC and hemoglobin concentration increased significantly (P< 0.01). serum Ca^{2+}, P^{3-}, Mg^{2+}, Mn^{2+}, Cu^{2+} and Zn^{2+} on the day of calving phenomenally declined because of colostrum, but reversed to normal after calving in the first week that was confirmative to healthy cow tendency. The objective feeding supplement to prepartum cows 3 weeks prior to calving to improve the appetite and reduce the ketone bodies was successfully achieved besides improved birth weight of the calves (P< 0.001), expulsion of fetal membrane (P< 0.08) and colostrum quality (P< 0.001). The improvement was observed in indigenous breed of Deoni cows and Holstein Friesian crossbred cows but, breed difference in the calf birth weight and production exists.

Influence of Optimized Protein and Energy Diet Supplemented with Protected B-complex Vitamins on Nutrient Utilization, Immunity and Growth in Deoni Heifers

Gokul mission in India is dedicated for development of indigenous cattle in India and a complete study was conducted to determine their protein and energy requirements to optimize their growth which is major filed limitation leading to delayed age at puberty in indigenous cattle. Relative intake of DM, CP and ME were compared with NRC (2001) and ICAR (2013) recommendation for optimization besides marginal change in their efficiency terms. Optimized CP was 10% and ME was 10% more than NRC (2001) with consideration to DCP/ME intake, energy efficiency or MBP production. Even the nutrient requirements suggested by ICAR (2013) were also found short of 30% CP but energy was less by 10% only. The requirements given by NRC (2001) or ICAR (2013) for the specific body weight gains were impractical to apply for indigenous cows because the maximum average daily gain was shielded at maximum of 300 g/d with 74% efficiency of CP and only 30 to 35% efficiency of ME irrespective of enhanced CP or ME in the diets. ADG (g/d) was further reduced to 220 g/d after 24 mo of age. Phenotypically their nutritional performance had less plasticity and only genetic improvement may answer all the growth limitations in the indigenous breeds of cows.

Therapeutic Efficacy of Trisodium Citrate (TSC) and its Combined Supplementation with Nanominerals (Cu, Zn and Mn) on Subclinical Mastitis Affected Cows

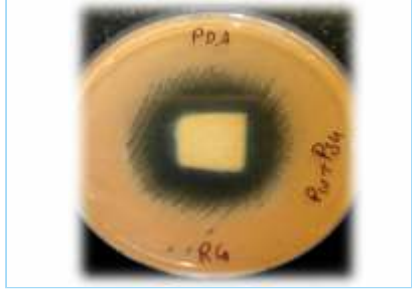
Nanominerals were synthesized by chemical reduction methods and characterized by using Dynamic Light Scattering Spectrometry (DLS), Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDS) and X-Ray Powder Diffraction (XRD) methods. Lactating HF crossbred cows diagnosed with SCM [milk somatic cell count (SCC) >200×10^3 cells/ml as a cut off value; n=8) were supplemented with TSC (30 mg/kg/day) and nanomonerals (Cu @ 13 ppm, Mn @ 17.5 ppm and Zn @ 60 ppm/kg DMI/day) for 28 days and compared with non-supplemented- SCM cows (n=6) and-apparently healthy cows (SCC < 200×10^3 cells/ml; n=8). Characterization of nanominerals by TEM, SEM. EDS and XRD methods revealed the size of < 100 nm. Combined supplementation of TSC and nanominerals had no significant effects on milk yield its composition and milk SCC. Plasma Zn and Cu levels were significantly (P<0.05) higher in supplemented cows and also favored for more bacteriological cure rate in SCM affected cows.

NOVEL APPROACHES IN VALUE ADDITION AND FUNCTIONAL FOODS

Development of Edible Antimicrobial Packaging Films for Traditional Dairy Sweetmeats Using Metabolites of Lactic Acid Bacteria

A total number of 89 fungi isolates, earlier isolated from the 3 traditional dairy products were identified by ITS (Internal Transcribed Spacer) region gene sequencing. The sequences were cleaned, aligned and a phylogenetic constructed. The 89 fungal sequences were deposited in NCBI database with the Gene Bank Accession No. MT443892-MT443966, MT448644-MT448657. GC-MS analysis of the fermentate of *W. cibaria* P6 and *L. plantarum* P10 along with the raw MRS broth elaborated a host of metabolites in the fermentate. A total of 78 metabolites were detected in the three samples (44 in MRS broth, 39 in *W. cibaria* P6 and 46 in *L. plantarum* P10) which could be grouped into organic acids, fatty acids, alcohols, acid derivatives, sugars, amino acids etc. Among the detected metabolites, 16 metabolites in *W. cibaria* P6 and 15 in *L. plantarum* P10 showed antimicrobial activity, which explained the increased activity in *W. cibaria* P6 as compared to *L. plantarum* P10. Finally, packaging films was developed with caseinate system that contained live bacterial cells supplemented with concentrated antifungal metabolites from *L. planatarum* P10 and pediocin bacteriocin. The developed active caseinate film was able to inhibit both the antifungal targets as well as bacterial target as identified in the TIDPs.

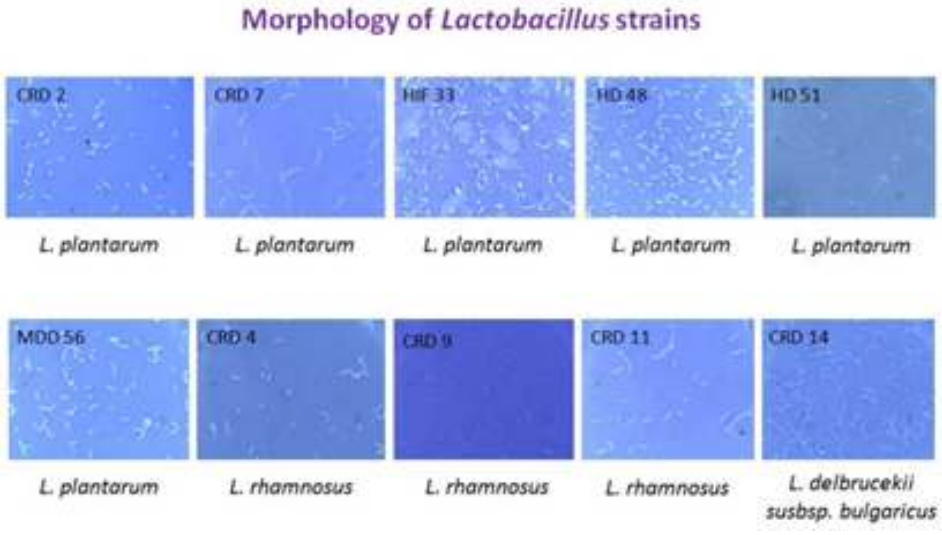
Phylogenetic tree of spoilage fungi from 3 products



Antifungal activity of the developed P10 + P34 containing antimicrobial packaging materil against 2 fungal indicator (Rhototorula glutinis and Candida spp.)

Development of Direct Vat Set (DVS) Probiotics for Preparation of Fermented Milk Products

Presently, fermented dairy products are prepared by regular maintenance and propagation of dairy starters that are prone to contamination and quality problems. These problems can be overcome by application of direct vat set starters (DVS) that would lead to consistent quality in fermented dairy products. Probiotic lactic acid bacteria play a vital role in human health and nutrition. Thus, based on our earlier *in-vitro* and *in-vivo* investigations, 14 native probiotic lactobacilli strains (*Lactobacillus rhamnosus, L. plantarum* and *L. delbrucekii subsp. bulagricus*) were evaluated for purity by Gram's and negative staining and biochemical activity. These were also evaluated for their compatibility by spot and well assays with each other for formulation of multiple strain probiotic direct vat starters. Observations on purity revealed all cultures as



Grams' positive and catalase negative indicative of their purity. Compatibility observations showed no zone of inhibition around the spot and wells revealing their compatibility to each other. Preliminary investigations of selected strains on effect of growth media on biomass production showed whey based formulation was most effective followed by MRS and Elliker broths.

Identification of Functional and Immunomodulatory Exopolysaccharide

Twenty eight EPS from lactic acid bacteria strains were extracted and freeze dried. The viscoelastic measurements were performed for all the EPS using high end viscometer, which were showing non-newtonian behavior. Viscoelastic properties of different EPS were evaluated which indicated that the extracted EPS shows pseudoplastic behaviour and thermal stability. Most prevalent viscous behaviour was shown by EPSWHW1, EPSVIS2, EPSVIK2 and EPSVIS4, EPSIND17 at 20 °C. The cell viability analysis by

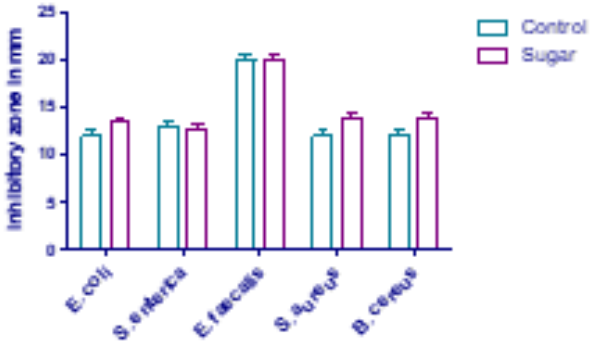
MTT and NRU assay revealed top five EPS (WHW1, VIS2, IND17, SHU3 and 399) that maintained the viability to more than 90 % at lowest dose of 10 µg/ml. EPSSHU3, EPSIND17, EPSWHW1, EPSKRI3, EPSGOV5 and EPSMC1 produced the highest nitric oxide in macrophages. EPSSHU3 and EPSIND17 were showing better viscoelastic characteristics and maintained the cell viability in addition to significant immunomodulatory properties. HPLC analysis revealed that EPSSHU3 and EPSIND17 were heteropolysaccharides.

Development of a Naturally Carbonated Whey Based Probiotic Drink

A process was optimized for the preparation of a naturally carbonated whey based probiotic drink using a co-culture of dairy yeast *Kluyveromyces lactis* NCDC 257 and indigenous probiotic strain *Lactobacillus plantarum* MTCC 5690. The developed drink was mildly acidic, slightly alcoholic and sweet in taste with a tingly sensation due to carbon dioxide (CO_2) production. The drink exhibited antioxidative activity as measured by TPC (111.19 ± 3.48 % mg GAA/100 mL), FRAP (196.47 ± 0.50 % mol/mL $FeSO_4$) and DPPH (85.47 % inhibition). Besides, the drink showed antimicrobial activity (in mm inclusive of 5.0 mm well dia) against tested pathogens viz. *Salmonella typhi* ATCC 19430 (20.33 ± 3.77), *Escherichia coli* ATCC 25922(28.0 ± 0.41), *Listeria monocytogenes* ATCC 19112(22.0 ±0.82) and *Staphylococcus aureus* MTCC 1144 (16.67 ± 3.86). After 21 day of refrigerated storage (6±2°C) the drink still maintained an overall acceptability score of 5.25 ± 2.48 on 9 point hedonic scale and viable probiotic count of 8.08 ± 0.032 log CFU/mL. The developed drink is a ready-to-serve (RTS) beverage which could be an effective means of utilisation and value addition to dairy by-product 'whey' which is routinely generated in huge amounts during paneer manufacturing and puts burden on environment in case of its inadequate disposal.

Preparation and Evaluation of Bio-Functional Fermented Goat Milk Using Native Lactic Acid Bacteria

Out of a total of 45 lactic acid bacterial strains isolated from goat milk, 12 isolates were *Streptococcus thermophilus* and 33 isolates were of Lactobacillus species. Two Streptococcus isolates namely SS5 and NST2 showed antimicrobial activity. Whereas, Lactobacillus isolates viz., SLBF2, OSLB1, OSLB2, OSLB3 and OSLB5 showed the highest antimicrobial activity with a zone of inhibition 12mm. The selected LAB isolates were identified using API 50CH system. Out of 8 Lactobacillus isolates, 6 isolates were identified as Lactobacillus rhamnosus and 2 isolates were Lactobacillus plantarum on the basis of API tests. SS5 and NST2 were confirmed as Streptococcus thermophilus, SLBF2 and OSLB3 were confirmed as Lactobacillus rhamnosus and Lactobacillus plantarum, respectively by PCR reactions using species-specific primers. After initial screening with the above 3 isolates, SS5 and SLBF2 combination was selected and the product was optimized with an inoculation rate of 2 % (1:1), 18 h incubation time at 42 ^{0}C. Overall acceptability of freshly prepared product-2 (with sugar) was higher than the product-1 (without sugar). Fermented goat milk had fat (3.42±0.0088), protein (3.82±0.0088), lactose (4.35±0.0088), total solids (12.73±0.0033), moisture (87.42±0.0057), acidity (0.92±0.0057 % LA), ash (0.77±0.0066), pH (4.22±0.0057) and peptide content (780.18±3.98 µg serine/ml). Total lactic counts were 8.71±0.31 log CFU/mL and proteolytic counts were 6.69±0.65 log CFU/mL in the product.



Antimicrobial activity of fermented goat milk

Active Packaging Material Coated with Colostrum Whey Derived Antimicrobial Bioactive Peptides

Antimicrobial bioactive peptides were produced by microbial fermentation using *Lactobacillus rhamnosus* C25, enzymatic hydrolysis using pepsin enzyme and combination of both (fermentation followed by pepsin treatment) in cow colostrum whey. The peptide fractions were separated using ultrafiltration membranes of 10 and 50 kDa molecular weight cut off (MWCO) and named as fermented permeate (FP), Fermentate retentate (FR), combination permeate (CP) and combination retentate (CR). The peptide samples exhibited antibacterial and antifungal activity. Higher antibacterial activity was exhibited by FP, CP and CR samples. Among all the peptide fractions, highest antibacterial activity as a zone of inhibition of 23.3± 0.57mm was seen by FP against *E.coli.* 50 kDa peptide fractions exhibited antibacterial and antifungal activities. The bacterial samples were sensitive to 50 kDa FP and 50kDa FR. Fermentate retentate and combination permeate showed similar antifungal activity against *Candida guilliermondii* and *Kluyveromyces marxianus.* Highest antifungal activity (21.33 ± 0.57 mm) was exhibited by CP against *Candida guilliermondii.* The 10 kDa FP and 50 kDa FR exhibited maximum antibacterial and antifungal activity. Therefore, both the peptide fractions 10 kDa FP having 0.43mg/ml peptide content and 50 kDa FR having 1.35 mg/ml peptide content were used to prepare 5 formulations by varying ratio of the two peptides fractions. All the tested bacterial and fungal culture was sensitive to 5^{th} formulations (1:5)

Procedure Developed for Preparation of Cow Milk Protein Powder Based *Sandesh*

A process for the manufacture of cow milk protein powder has been developed. The process parameters with respect to powder manufacture and its further use in *sandesh* preparation have also been optimized. This technology includes standardized amount of ingredients (cow milk protein powder, cream, acidic ingredient) and processing conditions required for preparation of *sandesh*. The developed process has many benefits over the traditional process of Sandesh preparation such as lower cost, greater consumer convenience and time saving and easily adoptable processing steps Further the developed product has consistent quality and calcium content is higher vis-à-vis conventional process.

Control sandesh

Cow milk protein powder sandesh

Technology of Ripened Cheese from Camel Milk

Camel milk and its products are gaining attention worldwide, owing to their nutritional value. There are no research reports available on ripened camel milk cheese, most of them being confined to soft unripened varieties. Ripened camel milk cheese was prepared after optimising the casein to fat ratio, levels of starter culture, $CaCl_2$ and camel rennet, type of heat treatment, cooking temperature, salting level and pressing duration. The compositional, sensory, textural, rheological, microstructural, proteolytic, glycolytic, lipolytic, colour and microbial changes of the resultant cheese was monitored over a period of 90 days at an interval of 15 days. The hardness, gumminess, springiness, chewiness & resilience reduced significantly while adhesiveness (stickiness) and cohesiveness increased. The casein fractions degraded extensively after 30 days of ripening, with the maximum degradation observed in s_1 casein. The fatty acid composition showed no significant difference up to 60 days though free fatty acid increased significantly. The cheese which initially had a curdy body, crumbly texture and salty flavour showed moderate bitterness after 75 days of storage. The overall acceptability of camel milk cheese was high during the entire ripening period.

Technology of Gluten Free Multigrain Vermicelli *Kheer* and its Instant Mix

The technology for instant gluten free multi grain vermicelli (GFMV) *kheer* mix powder was developed by spray drying of a mixture of concentrated (35 % TS) milk with 3 % fat and 9 % SNF added with 0.03 % multigrain flour followed by drying blending of powdered sugar and BHA. Reconstituted GFMV *kheer* was standardized by solubilizing the spray dried powder with water in a ratio of 1:5, addition of vermicelli @ 10 % of reconstituted milk and cooking for 7 min. Gluten free multigrain vermicelli contained high amount of protein (14.32 %), fat (2.64 %), iron (7.11 mg), calcium (120.81 mg), magnesium (180.72 mg) and zinc (1.49 mg/100 g) which were found to be much higher as compared to commercially available wheat-based vermicelli. Shelf life of instant *kheer* mix powder packed in paper laminated HDPE pouches was observed to be six months and when packed in metallized polyester LDPE pouches was seven months at 30 °C. Consumer acceptance study revealed that maximum number of consumers (36 %) rated the developed product as "very good", 32 % as "excellent" and 24 % consumers rated as "good" and 8 % rated as "fair" degree of liking. Cost of production per kg of instant GFMV *kheer* mix packed in metallized polyester LDPE pouches was estimated to be Rs. 295.

Technology of *Bhapa* (Steamed) *Sandesh*

The process for preparation of "Steamed (*Bhapa*) *Sandesh* **was** standardized. Steamed (*Bhapa*) *Sandesh* is a low sugar, soft variety of *chhana* based traditional sweet. Initially standardization of cow milk was conducted for preparation of good quality *chhana* which could be used for the preparation of best quality steamed *Sandesh*. Highest sensorial score was obtained at 3.5 % fat, 8.5 % SNF level and pH of coagulation 5.3 at 80 °C. Further, for standardization of production process of steamed *Sandesh*, three different levels of sugar, *chhana* and steaming time were tried. Among them the highest sensorial score was obtained at sugar level of 9.8 %, *chhana* 90 % and steaming timing of 20 min at 96 °C. Chocolate flavour was tried for increasing palatability of the product. Addition of 6 % of chocolate syrup in the final product was found optimum with maximum sensory score than other combinations. The cost of the final product was found to be Rs. 247.42/ Kg.

Development of an On-Package Freshness Indicator for Milk-Millet Complementary Food

An attempt was made to develop an on-package colorimetric indicator label that can detect the headspace volatiles, interact and indicate real time quality status of milk-millet complementary food (Nutrimix) by visual colour change without opening the package. Nutrimix was stored in PET jars at 30±1°C and 45±1°C and changes in quality attributes and headspace volatile compounds were monitored. In the SPME-GC-MS analysis, 111 and 117 compounds were identified in the product stored at 30 °C and 45 °C, respectively. Acids, aldehydes and ketones were selected as key chemical groups for fabrication of freshness indicator for milk-millet complementary food. Five labels (Label 1, Label 2, Label 3, Label 4 and Label 5) were developed using suitable formulations and their sensitivity was tested against selected volatile compounds. All five labels were mounted on the lid of the PET jar from inside and the changes in the colour of indicator label were monitored from outside during storage. The highest change in colour (E) was found with Label 2. Correlation coefficients between colour values of Label 2 and TBA and FFA values were determined. It can be concluded that Label 2 was suitable to detect oxidative changes in milk-millet complementary food non-destructively and may help in knowing the real-time quality status of the product.

Studies on the Development of an On-Package Colorimetric Freshness Indicator for *Sandesh*

Freshness indicator was developed for *sandesh*, a milk-based confection based on headspace volatile compounds liberated during storage. Samples were stored in clear (CG) and dark/amber colored glass containers (DG) and polystyrene trays (PS) at 6 °C, 30 °C and 45 °C. Quality changes and concentration of headspace volatiles in *sandesh* were determined at definite intervals. During storage, the dynamics of volatile organic compounds belonging to different chemical classes were monitored using SPME-GC-MS. Among these classes, acids, alcohols, alkanes, ketones and aldehydes were found to be predominant in the product at the end of shelf life. Based on the statistical analysis, the key VOCs responsible for the spoilage were selected and used for the fabrication of freshness indicator. Five freshness indicator labels were developed (L-1, L-2, L-3, L-1A and L-1B) and exposed to selected key volatile markers. Among all, label L1B was selected based on sensitivity and reactivity with the selected volatile compounds. Selected indicator was mounted on lids of the packages of freshly prepared samples and stored at 6 °C, 30 °C and 45 °C. At 30 °C and 45 °C, colour values were found to be significantly correlated with quality changes.

Development of Processed Cheese from Ultrafiltration Retentate

Processed cheese (PC) is versatile dairy products manufactured from ripened cheeses which are costly and not easily available to the small-scale manufacturers and start-up companies. Scientific information pertaining to the production of ultrafiltration (UF) retentate based PC is scanty. Therefore, work was undertaken to select the UF retentate, type and level of emulsifying salt and heating time-temperature combination to standardize the production process of UF retentate based PC. Physico-chemical, functional properties and textural attributes of control and optimized PC samples were compared. Pasteurized cow skim milk was concentrated employing UF. The total solids, protein, calcium and ash contents of UF retentates significantly increased ($P<0.05$) with an increase in degree of concentration. Selected UF retentate was used as a base material in this investigation. Based on pH, intact casein and calcium contents; meltability, free oil content and hardness; level, type of emulsifier and heating time-temperature condition were selected and used for the manufacturing of optimized PC. Different properties of control and optimized PC were compared using t-test. Statistically, meltability, oiling off index and textural attributes of control and optimized processed cheeses were at par ($P>0.05$) with each other, however, differences were observed in pH, intact casein and calcium contents.

Extraction of Carotenoids from Carrot Bio-waste using Green Solvent for Food Application

Carrot (*Daucus carota* L) is one of the most important root vegetables and is significant source of dietary carotenoids around the globe. In India, Haryana is major carrot producing state with the annual production of 265.47 tonnes and percent share of 27.41 (APEDA, 2014-15). Carrot pomace, an important by-product from carrot juice processing industry, contains about 50 % of -carotene. However, it is generally discarded as waste or used as animal feed. Therefore, a technology was developed for extraction of carotenoids from this bio-waste using vegetable oil as green solvent instead of hazardous organic solvents. The extracted colour showed yellow hue with the tinge of red and could be used as a natural colouring agent and also as an ingredient on account of high omega-3 alpha-linolenic acid and beta-carotene pro-vitamin A. The recovery of natural colourant (in terms of total carotenoid content) was >85 %. The extract being non-polar in nature was used as an ingredient for preparation of table spread (optimized using three-way ANOVA of Proc GLM of SAS9.3) on basis of organoleptic and textural profile analysis. The optimized product showed very good sensorial attributes and spreadability and could be easily spread on a slice of bread, on toast/ snack/ paratha/ with chapatti owing to its very good sensory appeal.

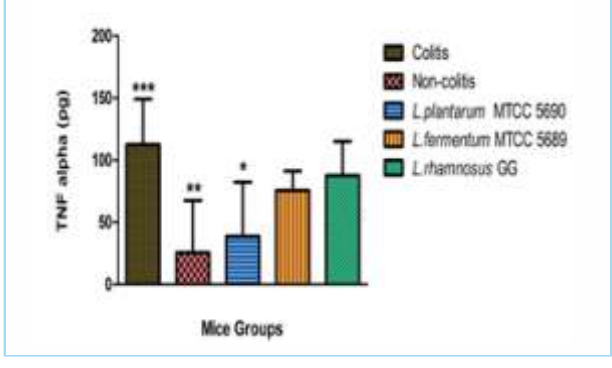
Development of Probiotic Ricotta Cheese from Buffalo Milk

Probiotic Ricotta cheese (PRC) was developed from buffalo milk. Survival of probiotic organism was evaluated in simulated gastrointestinal conditions of Ricotta matrix for estimating its shelf life.. Ricotta cheese was prepared by acid coagulation of heat-treated mozzarella cheese whey and buffalo milk mixture. Lactobacillus acidophilus La-05 (NCDC-291) was inoculated into Ricotta cheese matrix to maintain the respective count (~8 log CFU/g) of product. The product had 25 % total solids and 11 % proteins. Scanning Electron Microscopy (SEM) analysis showed that rod- shaped lactobacilli were embedded into protein matrix which may provide added protection to the organism. The product received a high overall acceptability score (9.0). The sensory panelists characterized the product as white, shiny, consistent and uniform in terms of appearance. However, the product had a flat flavour with high spreadability. Probiotic NCDC-291 showed better survival under simulated gastrointestinal (GI) conditions in Ricotta matrix (89 %) as compared to free cells (72 %). The product had 12 days of shelf life at refrigerated storage on sensory basis, during which the probiotic counts remained stable. The cost of probiotic Ricotta cheese had been estimated as Rs. 162.42 per Kg of product.

DEVELOPMENT AND VALIDATION OF HEALTH PROMOTING DAIRY FOODS

Cell Wall Components of Probiotic Lactobacilli as Therapeutics for Amelioration of Inflammatory Gut Diseases- ICMR Project (ICMR Project)

Ameliorative effect of Lipoteichoic acid (LTA) of 3 probiotic strains *viz.L. plantarum* MTCC5690, *L fermentum* MTCC5689 and *L. rhamnosus* GG on DSS induced colitis mice was carried out. LTA was extracted and evaluated for integrity, quantity and toxicity. FTIR and NMR were used to analyse the structural variation. Finally, the efficacy of extracted LTA was tested in DSS induced colitis mice and the extent of inflammation was measured using different indicators e.g., feed indices, weight loss etc. The endotoxins in LTA from the three probiotics were detected in safe limits. Purified form of LTA from LGG showed a thick band in 14-20 kDa range (SDS-PAGE), however, lower concentration of LTA from MTCC5690 and MTCC5689 was obtained on purification. FTIR and NMR analysis showed significant substitution of D-Alanine in the LTA from LGG compared to other strains. In the colitis mice study, no variation was observed in feed indices between the groups, however, DSS colitis group showed comparatively lower weight gain and higher DAI score. Similarly, the gut permeability (plasma FITC-Dx level) significantly increased in DSS group, however no differences in colon length were observed between the groups. Further, the MPO levels and TNF- were also clearly suppressed in the LTA treated group compared to the DSS control group. Similarly, LTA administration could also differentially increase the expression of IL-10, although, no groups showed any visible damages in colonic histopathology. LTA from the tested probiotic strains may offer a safer alternative therapy in place of live probiotics in amelioration of inflammatory conditions like inflammatory bowel diseases.

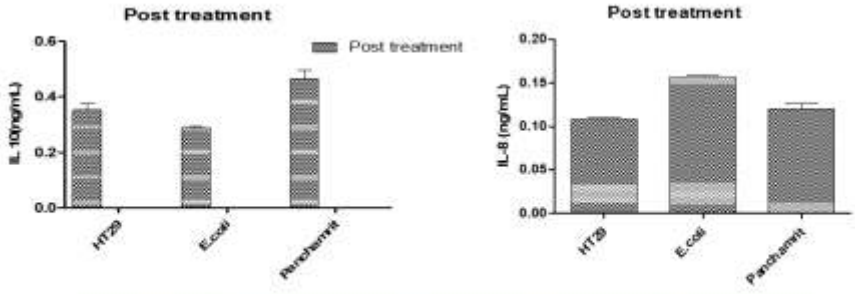


TNF-α expression in different mice groups

Preparation and Evaluation of Panchamrit for Immunomodulation

Panchamrit is traditionally prepared by mixing a right proportion of milk, curd, ghee, honey and sugar. Three formulations of Panchamrit i.e., I, II and III with varying concentrations of cow *dahi* and cow milk were prepared with the addition of honey 2.5-5 %, ghee 5 % and sugar 3 %. Total plate count, total lactic count, proteolytic counts were 9.197±0.040 log CFU/g, 9.162±0.027 log CFU/g, 8.372±0.034 log CFU/g. Panchamrit II formulation had high overall acceptability scores. Panchamrit II was having antimicrobial activity against both Gram-positive and Gram-negative bacteria mainly *Bacillus cereus*, *Escherichia coli*,

Enterococcus faecalis, *Salmonella enterica* ssp. *enterica serovar* Abony and *Staphylococcus aureus.* Panchamrit also showed antioxidant activity (88.074±0.028 %). The product was stable for three weeks at 4 ^{0}C. *In vitro* immunomodulatory activity was determined by quantifying the induction of IL-10, IL-8 and TNF cytokines with pre (6 and 24 h) and post-treatments of HT29 cell line with Panchamrit and then challenged with *E.coli.* The post-treatment (*E.coli* treated HT-29 cells) significantly increased the induction of IL-10 to 0.463±0.031 ng/mL. IL-8 secretion also decreased in post-treatment of HT-29 cell line with Panchamrit. However, prior infection with *E. coli* stimulated IL-8 secretion. In post-treatment, no significant difference was observed in the TNF- induction in HT-29 on challenging with *E. coli.* Thus, consumption of Panchamrit after infection may regulate both anti and pro-inflammatory cytokines like IL-10 and IL-8.



Induction of cytokines by post treatment of Panchamrit

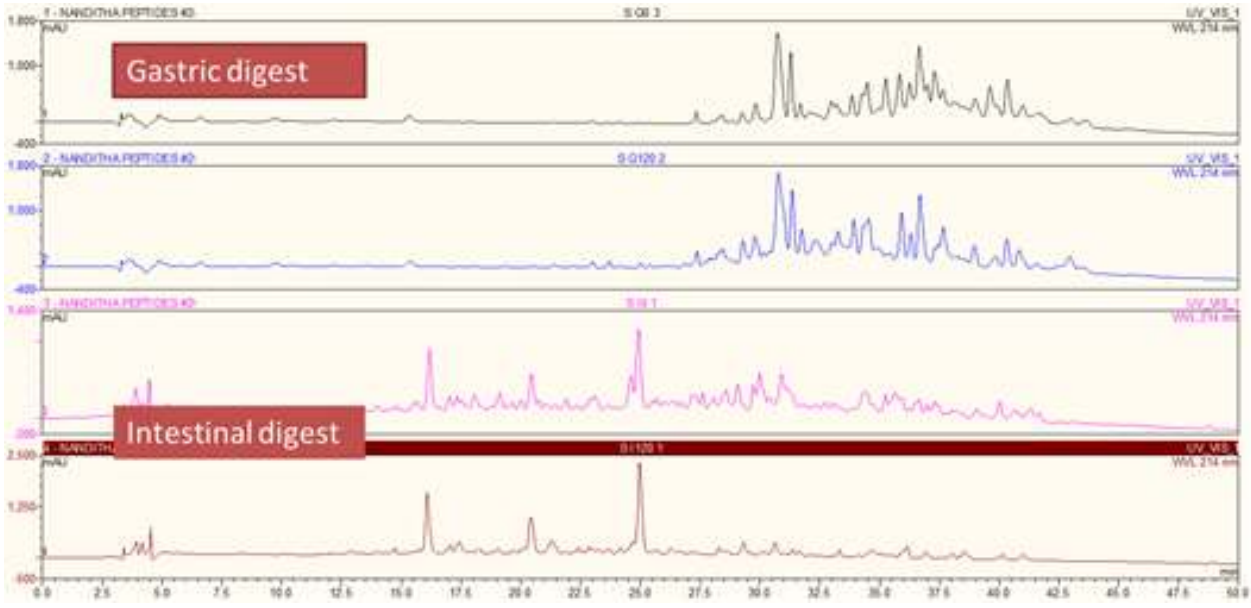
Development of Colostrum Whey-derived Bioactive Peptide Ingredients and Preparation of Protein-Rich Fermented Whey Beverage

Cow and buffalo colostrum was collected from LRC, NDRI. Whey was separated from colostrum using rennet and passed through 0.45µm filter. SDS-PAGE of colostrum whey showed clear bands of major whey proteins. Colostrum whey was fermented by proteolytic *L.rhamnosus* C25 for 48 h at 37 ^{0}C for the production of bioactive peptides. Bioactive peptide fractions of 10, 5 and 3 kDa were separated using ultrafiltration membrane. Protein content of colostrum whey were 5.7± 0.06 (mg/ml) and peptides in 10 kDa Permeate were 2.95 ± 0.01 µg/ml and in retentate were 3.38 ± 0.065 mg/ml. Approximately 50 % degree of hydrolysis was achieved in 48 h. All the fractions were having antimicrobial activity against all the test organisms. MIC of 10 kDa fractions was between 0.26-0.43 mg/ml for permeate and 0.28-0.63 mg/ml for retentate. The antioxidative activity was more in 3kDa permeate fraction of the whey fermentate. Cow and buffalo colostrum whey fermentate fractions had more antioxidative activity than colostrum whey and whey fermentate.

Colostrum | Colosrum whey | *E.coli*

In vitro Digestion of Skim Milk Derived from Milk of Indigenous Breeds of Cattle

Profiling of peptides obtained from digesta of skim milk following in vitro gastrointestinal digestion using RP-HPLC RP-HPLC profile of peptides derived following in vitro gastrointestinal digestion of skim milk indicated no significant difference on digestion behaviour among different indigenous breeds of cattle (Sahiwal, Tharparkar and Gir). Other parameters like free amino group, Tricine SDS-PAGE profile, peptide profile, particle size and zeta potential also indicated no significant difference between digestion behaviour of skim milk among different indigenous breeds of cattle.



Development of Goat Milk Based Functional Beverage

Cordifolia (*Giloy*), a herbal plant, exhibits various health benefits such as immunomodulation, antihypertensive, anti-diabetic and anti-carcinogenic. In view of 'green milk' concept, therapeutic benefits of herbal ingredients could be conveyed through milk owing to their higher bioavailability and milk's mass consumption. However, its bitter taste due to furanoid, diterpenoid and lactone compounds requires interventions for effective incorporation in milk base. Therefore, in order to potentiate the therapeutic benefits of *giloy* and goat milk, goat milk based functional beverage was developed and therapeutic claims were also validated in animal model. *Giloy* juice could be successfully debittered using ultrasonication. The storage stability of pasteurized and sterilized beverage was around 5 days and 90 days at 4 °C and 25 °C, respectively in glass bottles. Developed beverage exhibited retention of most bioactive components and antioxidant activity. Better anti-diabetic properties and immuno-modulatory activity were observed upon consumption of beverage as compared to goat milk alone in the animal model.

Process for the preparation of functional goat milk beverage

MECHANIZATION AND PROCESS ENGINEERING

Development of Mechanised Feed and Fodder Distribution and Feeding System

The experimental setup for measurement of angle of repose, coefficient of static friction and coefficient of internal friction were designed and fabricated. Determination of angle of repose, coefficient of static friction, bulk density and moisture content of concentrate mixture were carried out.

Table : Various frictional properties concentrate mixture

Frictional properties	Value	Replications
Moisture content, M (%)	9.18 ± 0.22 %	n = 7
Angle of repose (θr)	25.64 ± 0.16°	n = 3
Coefficient of static friction on structural surface		
• Mild steel MS)	0.6302 ± 0.0257	n = 56
• Stainless steel SS)	0.4779 ± 0.0265	n = 56
• Aluminium Al)	0.5754 ± 0.0228	n = 56
Bulk density (ρbd), kg/m3	503.87 ± 1.36	n = 3

Development of Automatic Endo-exo Thermal Unit for Dahi

Detailed engineering drawing of the insulated endo-exo cooling cabinet was prepared in CAD. Input design parameters of the automatic endo-exo thermal unit for *dahi* were evaluated for designing of heating and air-circulating components. Design and selection of refrigeration components were accomplished on the basis of external cooling load and internal thermal capacity of the cabinet itself. The oversized refrigeration capacity was utilized for fast cooling process. Development and fabrication of the proposed endo-exo automated thermal unit for *dahi* were successfully accomplished. Performance evaluation and analysis of the developed endo-exo automated thermal unit for *dahi* were carried out after conducting trials on incubation and transient cooling of *dahi.* The endo-exo thermal unit of *dahi* designed and developed in this project is unique equipment with special features of heating and cooling at one place with automatic process control.

Development of Low Cost Mechanized Stretching and Portioning Unit for Mozzarella Cheese Production at Small Scale

The proposed mechanized portioning unit (batch type) was designed and fabricated, using SS-304 as material of construction for product direct contact parts. Performance of the mechanized portioning unit with varying process parameters i.e. outer water jacket temperature (80-90 ºC) and conveyor screw speed (50-300 rpm) was evaluated. The process parameters of portioning unit were optimized using response surface methodology where quadratic model was used. With the analysis of various responses, throughput, flavour and overall acceptability were found to differ statistically. The optimized process parameters were screw speed 300 rpm and outer jacket temperature 81.04 ºC. Predicted values were compared with experimental values by student's t-test and found non-significant (p>0.05)

Development of Electrochemical Sensing System for Automation of CIP in Dairy Plants

Arduino Mega was selected to be utilised for the design attempt. The logging system was tested while in program mode for errors/malfunctions, if any and then after testing mounted back on to the control panel. After rigorous testing of the logging system on programming station, it was then tested by removing SD card from module and loading it into computer to read contents recorded to the log file created by the store mode only system. It was found that logging was taking place correctly with the values of date, time, logging interval and other parameters. Data log was getting appended after each power on of the store mode only system. Data file which was saved in the memory card could be easily accessed by various data analysis softwares for further analysis. After design and testing of store mode only system attempts for design of retrieval system was sought so that the data could be captured in real-time with the help of a computer. An attempt was made to make available real-time data accessible to a computer connected through a USB cable so that all process parameters are available at both memory card along with real-time transmission to a PC for real-time trend studies and display.

Determination of Engineering Properties of Ghee in Relation to Frying Oil Quality Management

Capacitive sensing system was designed and developed by simulating capacitive plate area and plate gap for parallel plate type electrode. Rheological, electrical and chemical properties were determined during thermal treatment of ghee during prolonged heating. Capacitive sensing technique showed positive significant correlation with chemical quality indicator and viscosity of ghee and can be useful to check deterioration of oil due to heating and frying. Transmission based Colour measurement system was designed and developed. Separate calibration and colour measurement protocol was developed and was integrated into the system. Results of Colour value for heated ghee sample shows uneven change with negative slope in lightness of ghee with heating time. Initially, CIE b value decreased when ghee was exposed to heat treatment after that it showed more or less constant trend. Yellowness index of ghee was initially higher when it was exposed to heat treatment and after 8 h of heating, YI showed an increasing trend. Simultaneously, Colour Desk reflectance type colour measuring system was also evaluated to measure changes in ghee colour during frying operations. Both reflectance and transmission type system were found effective to detect colour changes of ghee during deep fat frying operation of different food and dairy products viz. French fries, *gulabjamun* and *jalebi*. Among CIE L*a*b* values and YI, the potential markers for colour based changes were b* and YI.

Development of Dewatering Mechanism for Intermediate Indian Dairy Product-*Chhana* and *Chakka*.

Whey dewatering mechanism for intermediate Indian dairy product - *chhana* and *chakka* was designed and fabricated. The performance of the developed whey dewatering mechanism evaluated during manufacturing of *channa* with different process parameters i.e. spin speed (80 to 200 rpm) and time (7 to 20 min). The performance evaluation of developed system for whey removal showed a high desirability of 0.894 at 80 rpm, 9.5 min for 5-20 kg milk. The developed equipment for rapid whey removal for *chhana* reduces the production time (approximately 95%) and yields *chhana* with optimum moisture content and soft body.

Fig. Fabricated set-up for whey dewatering mechanism

The developed system modified for whey removal during manufacturing of *chakka*. Performance of developed mechanism was evaluated with varying process parameters i.e. spin time (30 to 90 min), temperature of curd (5 to 15 ^{0}C) and quantity of curd (2- 6 kg). Different types of controllers were evaluated for best performance. Solid state variable speed controlled was found best. Optimized solution obtained was: quantity of milk: 2-6 kg, Spin time: 60 min, temperature of curd before draining: 5 ^{0}C. Reduction in whey removal time from (approximately) 600 -720 min to 60 min (i.e. 90-92 % reduction) was observed during manufacturing of *chakka*.

Development of Low Cost Farm Level Milk Cooling System

Experimental setup of Farm Milk Cooler (FMC) for 40-80 L capacity was evaluated using secondary coolant medium (SCM). SCM comprised of composite component liquids to avoid freezing of the medium and to improve the cooling performance. Different ratios of the medium was evaluated 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7 and 1:8. Significant difference in cooling time of SCM was observed with respect

to its composition. The lowest cooling time for 40 L milk (37 to 4°C) was 55 min in case of 1:10 solution. For 80 L milk capacity time required for cooling from 37 to 4 °C was 95 min in with 1:10 solution. Time required for cooling was highest in case of water as medium for 40 L (97 min) and 80 L (111 min) milk capacity. The SCM was evaluated both for unfrozen and frozen condition to allow it to store thermal cooling energy. The primary objective for using SCM was to solve the problem of power cuts and to continue the process of milk cooling.

Development of Automatic Integrated Hybrid Solar System for Fermented Dairy Products

Experimental setup of Farm Milk Cooler (FMC) for 40-80 L capacity was evaluated using secondary coolant medium (SCM). SCM comprised of composite component liquids to avoid freezing of the medium and to improve the cooling performance. Different ratios of the medium was evaluated 1:1, 1:2, 1:3, 1:4, 1:5, 1:6, 1:7 and 1:8. Significant difference in cooling time of SCM was observed with respect to its composition. The lowest cooling time for 40 L milk (37 to 4°C) was 55 min in case of 1:10 solution. For 80 L milk capacity time required for cooling from 37 to 4 °C was 95 min in with 1:10 solution. Time required for cooling was highest in case of water as medium for 40 L (97 min) and 80 L (111 min) milk capacity. The SCM was evaluated both for unfrozen and frozen condition to allow it to store thermal cooling energy. The primary objective for using SCM was to solve the problem of power cuts and to continue the process of milk cooling.

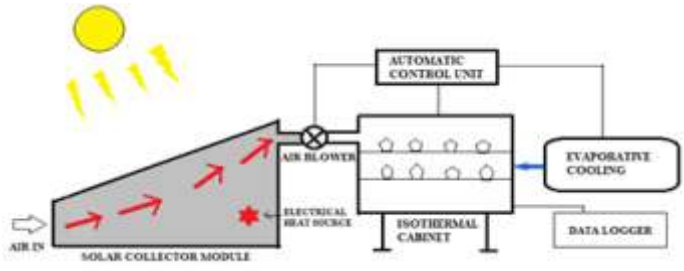


Fig: The conceptual diagram of automatic integrated hybrid solar system for yoghurt

Development of Multipurpose Automatic Controlled Rate Heating System for Production of Dairy Products

Study of heating pattern of milk in different systems was carried out to analyse the rate of change in temperature. Milk heating experiments were carried out with three different systems (1. Milk boiler (with water) + coil heater, 2. Milk pan +coil heater, 3. Electric rice cooker). The temperature sensors were placed at different locations to observe the rate of change of temperature and to analyse the temperature distribution within container during milk heating. Rate of change of temperature during heating at different locations was observed and recorded in data logger. Temperature distribution during heating was found more uniform in milk boiler followed by electric rice cooker and milk pan. The approximate time required to boil the milk was observed as; 14-15 min for milk pan directly heated on coil heater, 20-22 min for electric rice cooker and 30-32 min for milk boiler (with water) heated on coil heater. Less fouling was observed when milk was heated in milk boiler (with water) on coil heater as compared to electric rice cooker and milk heated in milk pan directly on coil heater. On the basis of volumetric capacity design calculations were carried out for designing the heating system of 20 lit milk capacity.

Development of Improved Bioreactor Prototype for Cattle Waste Management

Corrosion characteristics of different materials used for storage of cattle waste slurry was carried out. Square sheet (5x5 cm^2) of GI/Iron/SS304/SS202 were dipped in mixed cow manure slurry (dung to water ratio = 1:1) in an airtight container with 15 % headspace. The containers were maintained at a temperature of 45 $^{\circ}C$ for 90 days. The sheets exposed to slurry under anaerobic conditions were analysed for corrosion at every 15 days intervals. Colour Desk equipment was used for image acquisition of both sides of the exposed metal sheet and the corrosion was characterized using image analysis technique. A total of 22 Gray-Level Co-Occurrence Matrix (GLCM) parameters were extracted from the image and evaluated to determine the extent of corrosion. The method was developed to evaluate difference in properties of the treated and untreated sheet. Among various GLCM parameters, sum of average, sum of variance, sum of entropy and difference in variance were found to be better measure of corrosion than other properties

Risk Assessment and New Generation Methods to Access the Quality and Safety of Milk and Milk Products

Shotgun Metagenome Sequencing for Functional and Safety Analysis of *Dahi*, a Traditional Indian Fermented Milk Product

Shotgun metagenome sequencing of the Traditional *Dahi* samples was carried out in the present study to assess its safety and functionality. *Dahi* samples were collected from 2 rural regions of 2 districts of Haryana. Metagenomic DNA was isolated by chemical process and sequenced using Illumina sequencing HiSeq platform, generating a total of 18 M and 17.5 M paired-end reads, respectively. *De novo* assembly of Illumina paired end read was performed using metaSPAdes assembler, after which the filtered contigs were used for gene prediction using MetaGeneMark tool and CARD database for antimicrobial gene prediction. At the taxonomic level, the bacterial kingdom was the most predominant (avg. 83.59%) with a total of 1212 and 1047 bacterial species in the two samples, respectively. The major bacterial phyla was Proteobacteria (50.38%) followed by Firmicutes (37.62%). Lactic acid bacteria formed 19.89% of the bacterial population detected. At the resistome level, a total of 26 antibiotic resistance genes (ARG) each were identified in the two samples that belonged to 15 drug classes. Among the ARGs, genes against Penam (avg. 55.88%) and Aminoglycoside (avg. 12.30 %) drug class were detected in highest abundance. In both the samples, the dominant resistance mechanisms detected was the antibiotic efflux pumps. In addition, as high as 43 different metabolic functional pathways that belonged to different biosynthesis, metabolism, degradation etc. were also detected.

Unveiling the Microbial Diversity of Traditional Indian Fermented Milk Product '*Dahi* 'through Culturomic and Metagenomic Approaches

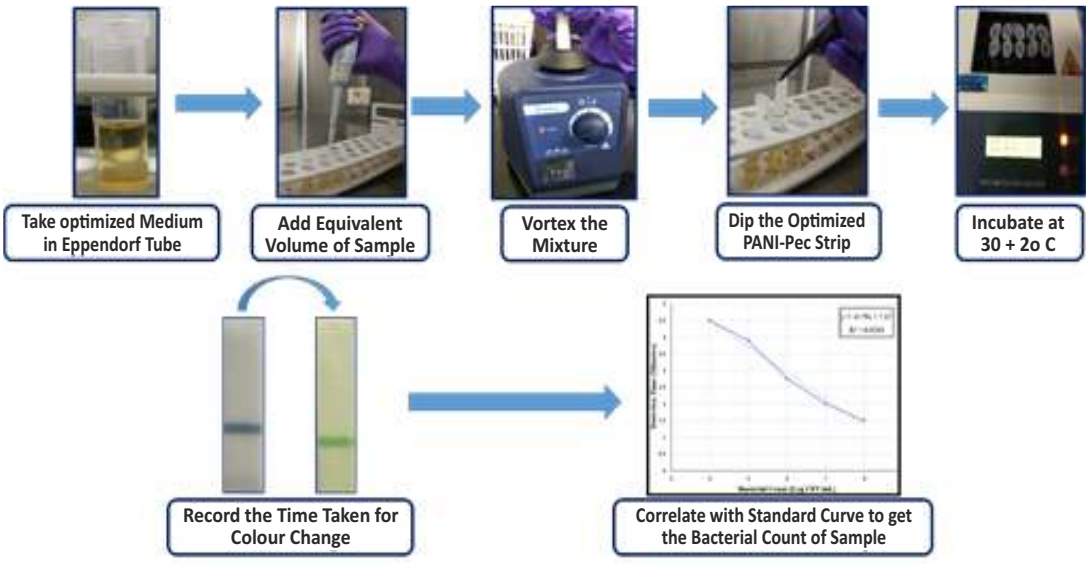
Advanced metagenomics and culturomics have been used as complementary approaches to evaluate the bacterial composition of traditional Indian fermented milk product '*Dahi*' prepared by traditional back slopping method in Haryana region of India. In metagenomics study, DNA from 12 individual samples of *Dahi* were extracted, pooled (4:1) and sequenced using Oxford Nanopore technology platform. The bacterial taxonomics clearly indicated *Firmicutes* as the major phyla (88.32–92.48% abundance) followed by *Proteobacteria* (1.37-5.38 %). Further analysis revealed *Streptococcus, Lactobacillus, Bacillus, Enterococcus, Lactococcus, Staphylococcus, Pseudomonas, Oscillospira, Cupriavidus, Bacteroides*, *Clostridium*, *Serratia and Prevotella* as the major bacterial genera which nearly constitutes >80 % of total bacterial genera of *Dahi* samples. Sankey plot of *Dahi* metagenomic data from the three regions revealed the prevalence of lactic acid bacteria genera such as *Lactobacillus*, *Streptococcus*, *Lactococcus,* and *Enterococcus* along with the environmental bacteria like *Bacillus*, *Staphylococcus* and *Pseudomonas*. In culturomics study of *Dahi* samples, out of ten culture media three commercial media viz. TGA, CA and LA were able cultivate maximum number of *Dahi* bacteria. A total of 179 isolates cultivated using these media were selected for Polyphasic identification. The collected samples were found to have higher abundance of cocci arranged in chains (Strepto), followed by higher abundance of bacilli arranged in either in pairs (diplobacilli) and chains (streptobacilli). Similar results were observed in case of metagenomics as abundance of Streptococci and Lactobacilli was observed in *Dahi* samples from Haryana region.

Prevalence of Antimicrobial Resistance in Zoonotic Bacterial Pathogens under Field Conditions

Among 194 samples analyzed for bacterial pathogens, 32 *E. coli*, 37 Coagulase positive *staphylococcus aureus* (CPSTA), and 50 *Enterococcus* sp. were identified by culture based methods followed by PCR methods, wherein 30, 31, and 50 isolates were confirmed as *E. coli* CPSTA and *Enterococcus* species, respectively. Confirmed isolates were further evaluated for antimicrobial resistance using phenotypic methods. Among 30 *E. coli* isolates, eleven isolates were showing resistance towards ESBL by AST method and these 11 isolates were further confirmed for ESBL by double disc diffusion method wherein only 5 of the isolates were confirmed as ESBL positive. Among these, all isolates *are harboring blaCTX* and blaTEM genes but no isolates were found to be positive for blaSHV and carbapenam resistance genes. In case of CPSTA, 31 isolates among 37 CPSTA were carrying 'nuc' gene by genotypic method and remaining 6 isolates were further confirmed as *S. intermedius* and *S.schleiferi.* Thirteen isolates of CPSTA have shown resistance towards oxacillin (OX) and cefoxitin (CX) antibiotics, respectively by AST method. Out of 13 isolates, only seven isolates were carrying 'mecA' gene (MRSA) by species specific PCR and one of the isolate was also carrying β-lactamase producing gene by BD phoenix. In case of *Enterococcus* species, only one isolate showing resistance towards vancomycin, ampicillin and chloramphenicol, 4 isolates to tetracycline, 5 isolates to erythromycin and 15 isolates to trimethoprim by AST method. Further, vancomycin resistance in enterococcus species was identified as *Enterococcus faecium* by BD Phoenix.

Conducting Polymer Based Rapid Detection Microbial Quality of Milk

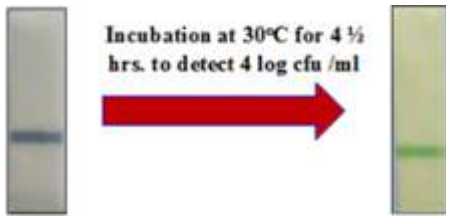
The colorimetric PANI-PEC strip sensor was constructed by immobilizing optimized concentration and volume of glucose activated PANI-PEC solution on the Whatman filter paper 04 by using easy printer device for sharp and uniform colour development. The response surface methodology (RSM) was used to evaluate statistical significance of the medium constituents on bacterial growth. The growth medium (GM-12) was selected as the optimized growth medium for the assay on the basis of pH, OD, sensitivity and colour intensity of PANI-PEC strips in different growth mediums. The effect of sample volume and growth medium on the detection time of developed assay was evaluated and it was observed that increasing the sample volume results in significant reduction in assay detection time. Incubation time for the developed assay was optimized at lowest bacterial count i.e. ~10^4 log CFU/mL, in accordance with FSSAI standards for aerobic count of milk and milk products and the colour change in PANI-PEC strips was observed within 4.5 h of incubation at 30 ± 2 ºC. Thus, 4.5 ± 0:15 h was considered as optimized incubation time for the developed colorimetric PANI-PEC strip-based assay. The sensitivity of developed PANI-Pec colorimetric strip-based assay for determination of bacterial count in milk was examined in the range of 10^8 to 10^4 log CFU/mL. It was observed that the developed PANI-PEC strips can detect 8.0 ± 0.15 log CFU/mL and 4.0 ± 0.15 log CFU/mL of microorganisms in milk within 1.50 ± 0:07 h and 4.50 ± 0:15 h of incubation, respectively



PANI-PEC paper strip sensor for detection of Total plate count in milk

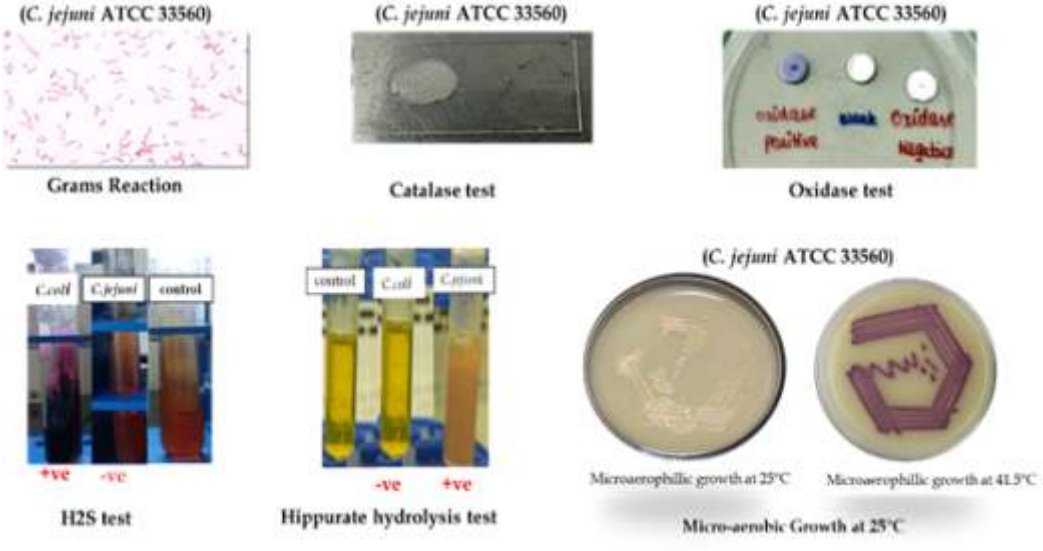
Development of Conducting Polymer Strip Based Assay for Determination of Bacterial Count in Milk

Total bacterial load is a vital factor in determining the milk quality as it indicates the hygiene practiced during milking, transportation and processing. Initially glucose activated Polyaniline-Pectin (PANI-PEC) solution was synthesized and its characterization (particle size analysis, average zeta potential and electrical conductivity) was carried out. The growth medium for the assay was optimized statistically by using response surface methodology (Box-Behnken Design), on the basis of the effect of medium constituents on optical density (600 nm) and pH value of the medium. The effect of sample volume on detection time was examined and it was observed that increasing the sample volume significantly reduces the assay detection time. In accordance with the regulatory standards for milk and milk products, the incubation time for developed assay was optimized to 4.5 h at 30 ± 2 ºC for the lowest bacterial count in milk i.e. ~10^4log CFU/mL. The developed PANI-PEC colorimetric sensor strips can detect 4.0 ± 0.15 log CFU/mL of microorganisms in milk within 4.50 ± 0:15 h of incubation at 30 ± 2 ºC. Semi-quantitative determination of bacterial count in milk was carried out using the developed assay. Standard calibration curve of assay detection time (hours) v/s bacterial count (log CFU/mL) was drawn. It can be concluded from the results obtained that the developed colorimetric PANI-PEC strip-based assay is a sensitive, cost effective and user-friendly method for semi-quantitative determination of bacterial count in milk.



Isolation and Identification of *Campylobacter* from Dairy Supply Chain

A total of 175 samples comprising of raw milk, fecal, freshwater, dairy wastewater, human handler and milk filter sample was collected from the Livestock research center and Experimental dairy (NDRI) for isolation of *Campylobacter* spp. Out of 175 samples, 53 samples grew in Bolton broth and showed characteristics of grey, flat colonies on mCCD agar. From 53 positive samples, 91 suspected colonies were selected for further biochemical confirmation. Among 91 isolates selected, 41 isolates showed pink-coloured curved rods/s-shaped rods/cocci's. Out of 41 Gram's negative screened isolates, 3 isolates were found to be Catalase positive, Oxidase positive and negative for Micro-aerobic growth at 25 °C. Based on these observations these isolates were suspected as *Campylobacter* species. Later, all 3 isolates were evaluated for the H_2S production and Hippurate hydrolysis test wherein 2 isolates showed positive Hippurate hydrolysis test and negative H_2S production and another isolate showed negative Hippurate hydrolysis test and positive H2S production. Overall, 1.71 % prevalence of *Campylobacter* was observed in raw milk and fecal swab samples among 175 samples screened along with 0.57 % *C. coli* and 1.14 % *C. jejuni* prevalence was observed based on phenotypic methods Further, it was also concluded that the prevalence of *C. jejuni* was found more in as compared to *C. coli*.



Proof of Concept for Detection of ß-Lactam Group Based on Induction Principle:

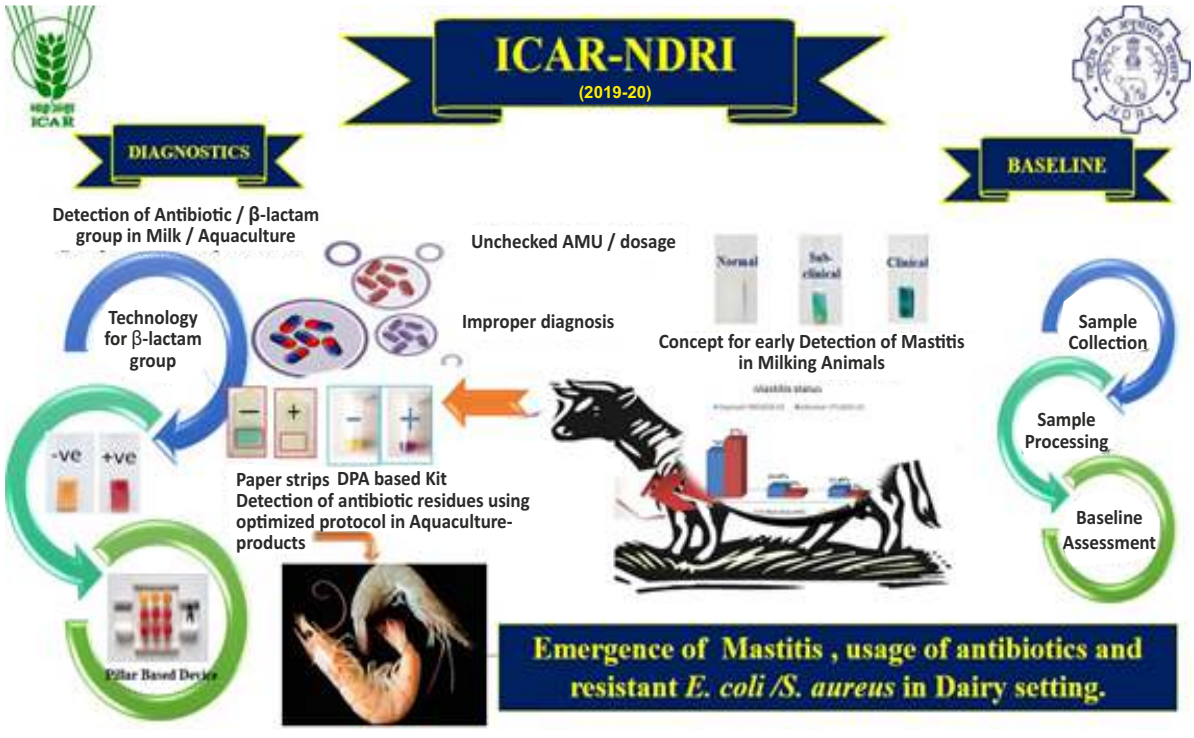
A proof of concept was established for the detection of β-lactam group of antibiotics in milk which works on the induction of β-lactamase enzyme in germinating bacillus spores. The concept was transformed on paper strip for specific detection of β-lactam group of antibiotics as specified in FSSAI standards. The strip making process and other assay parameters like spore concentration (20 µl), incubation and exposure time (30 min), substrate conc. (10 µl), incubation temperature (37 ˚C) were optimized.

Strip Based Test for Early Detection of Sub-Clinical and Clinical Mastitis

Enzyme based assay on paper strip for detection of mastitis in milk has been developed employing a marker enzyme which is released by somatic cells present in mastitis milk. The assay has been developed by functionalizing marker enzyme substrate on paper strip. The test involves enzyme substrate reaction in presence of activator and milk by incubation at 45 °C for 15 and 30 min. Development of deep blue colour on paper strip within 15 min indicates clinical mastitis, whereas, development of blue colour in 30 min indicates subclinical mastitis. No colour appearance after 30 min indicates normal milk. Test has been evaluated and validated under field conditions.

Spore Based Technology for Rapid Detection of Antibiotic Groups in Aqua-Products

Usage of antibiotics in milk and other sectors like aqua-products is one of the serious issues leading to antimicrobial resistance in pathogenic bacteria. To address the growing concern of antimicrobial use and resistance development in bacteria, FSSAI and other regulatory agencies have set standards for antimicrobials in different food matrices of animal origin. Spore based kit for detection of antibiotics in aqua-products like fish, shrimp, prawn, feed powder has been developed. The technology works on the principle of spore germination and its inhibition in presence of antibiotic residues. In case when antibiotic residues are absent, marker metabolites are released during spore's germination which changes the colour of the indicator. However, in presence of antibiotic residues in aqua-products, the spore germination process is inhibited at ≥ MRL level and no change in colour indicates the presence of drug residues when incubated at 64 ˚C for 3.h.



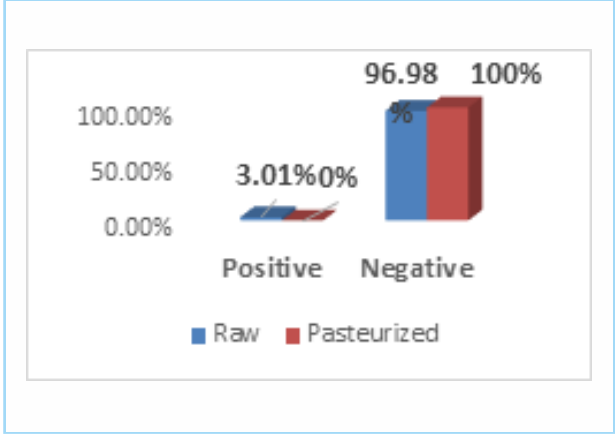
Progressive info graphics of DOSA project

Baseline Data on Surveillance of Mastitis, Antibiotic, ID and AST of *E. coli* and *Staph. Aureus* in Dairy Setting

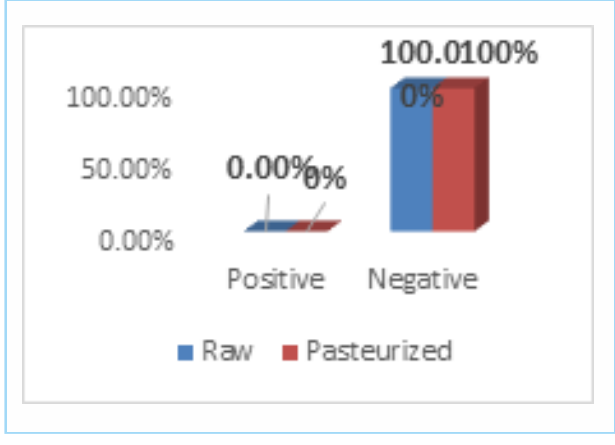
The prevalence of mastitis in dairy animals is one of the growing concerns in dairy setting. A baseline data was generated for the un-organized sector by collecting 175 raw milk samples from small dairy farms of Ambala and Karnal districts of Haryana. 87 % of the samples were found normal while 5.0 % were infected with clinical mastitis and 8.0 % with subclinical mastitis. These samples showed contamination with antibiotics in 4 % of the samples, excluding infected samples with a pre-dominance of Chloramphenicol, Enrofloxacin and Sulfa drugs. The prevalence of *E. coli* and *S. aureus* was 9.14 % and 28.57 %, respectively. The AST pattern using BD system was also studied. The presence of ESBL producing *E.coli* was 19 %, whereas, 14 % MRSA and 18 % BLACT was detected in *S. aureus* isolates. None of the samples showed Carbapenem resistance in *E.coli.* AST profile of samples collected in the previous year from organized sector was also carried out. The results showed ESBL in 9 %, KPC 2.56 %, MRSA 13.79 % and BLACT 2 0% isolates. The comparative data from the two years indicated that the infection in un-organized sector appears to be higher with *S. aureus* in contrast to *E. coli* in infected animals from organized sector.

Qualitative Screening of Antibiotic/ Pesticide Residues in Milk Using Strip Based Tests Developed at NDRI

Milk samples comprising of 398 raw and 191 pasteurized procured from Haryana were initially screened using developed strip based test and **3.01 %** samples of raw milk were found contaminated with antibiotic residues. 2.76 % samples showed the presence of antibiotics ≥MRL with predominance of Chloramphenicol and β- lactam. 191 nos. of pasteurized milk samples were also screened but none of them were found to be contaminated. Samples were also tested for pesticide residues, wherein none of the samples were found positive.



Incidence of antibiotic residues in milk samples



Incidence of pesticide residues in milk samples

Paper Strip Based Sensor for Detection of Heavy Metals in Milk

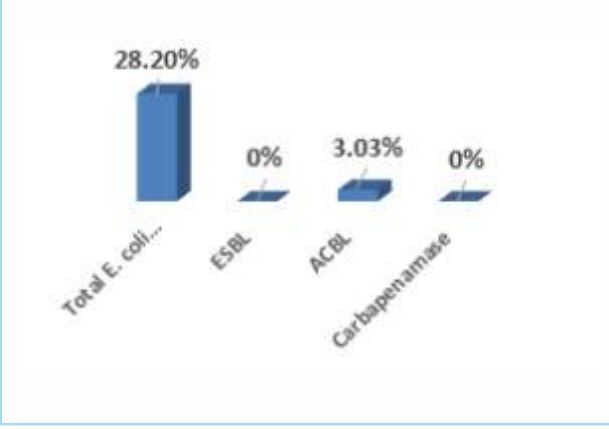
Paper based sensors was used for detecting heavy metals in milk with with a novel approach of employing spores as bio recognition molecule as a source of marker enzyme E-2. The developed assay exhibited remarkable characteristics of high sensitivity against lead, cadmium, arsenic and mercury that are nowadays prominently present in milk above its permissible limits. The assay is completed within 3 hours which includes extraction of heavy metals from milk and detection principle based on enzyme inhibition on strip. The sensitivity obtained with lead, cadmium and mercury in buffer system is in compliance with the regulatory standards. However, in spiked milk samples the limit of detection (LOD) for heavy metals is slightly higher than the requirements established by regulatory bodies. Therefore, slight optimization of extraction protocol, with higher recovery rate will help to enhance sensitivity of the method in spiked milk samples so that the method could be used for primary screening at various stages in dairy food chain like at milk collection points or at front door step for routine monitoring/regulatory compliance of milk. The novel features of the developed strip based assay have been filed in the form of an Indian patent with title "Paper strip based sensor for detection of heavy metals in milk" and Application Number **202011006420**.

ID and AST of *E. coli* and *Staph. Aureus* in Cow & Buffalo Milk and Rectal Swab

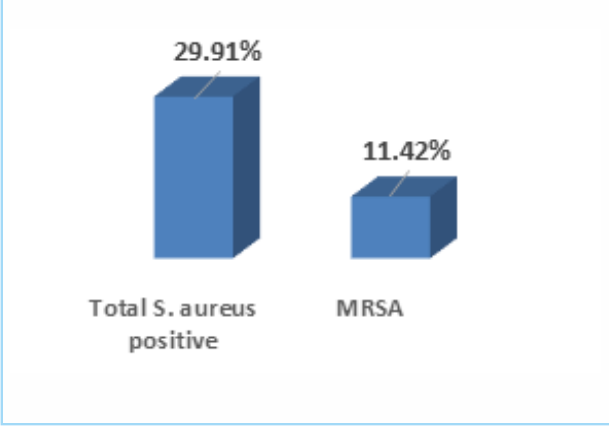
A total of 117 raw milk and rectal swab samples were collected from two districts of Haryana state i.e. Karnal and Kurukshetra. Selection of dairy farms and cows were random. These samples were tested for *E. coli*, *S. aureus* and their antibiotic susceptibility/ resistance profile. The prevalence of *E. coli* and *S. aureus* was 28.20 % and 29.91 % , respectively. Out of 117 samples, the presence of AmpC beta lactamase producing *E.coli* was 3.0 3%, whereas, 11.42 % MRSA was detected in *S. aureus* isolates. None of the samples showed Carbapenamase and ESBL producing *E.coli.*

Rapid Antimicrobial Susceptibility Assay for Rapid Detection of Extended - Spectrum β-Lactamase, Ampicillinase C - Lactamase and Carbapenem Resistance in *E. coli*

Current innovation was designed for development of "Rapid AST assay" for the detection of Extended-Spectrum-β-Lactamases (**ESBL)**, Ampicillinase C-β-Lactamase (**ACBL**) and Carbapenemases (**Carbapenem**) resistance in *E.coli* directly form colonies without going for multiple enrichment and processing steps like culture washing, cell lysis and centrifugation. In the development of assay, antibiotic disc were functionalized with ECSM and chromogenic substrate and were added in the tube containing 1.8 ml of distilled water and vortexed to dissolve the media. Cell concentration @ 1.5 x 10^8 CFU/mL was added and incubated at 37 C for 5.0 h. Subsequently, change in colour from light yellow to bluish green was observed, which indicated the bacterial resistance within 5 h of incubation



Prevalence of E. coli and its resistant markers in raw milk and rectal swab samples



Prevalence of S. aureus and its resistant markers in raw milk and rectal swab samples

Isolation and Functional Characterization of Lactic Acid Bacteria from Dairy Samples

A total of thirteen LAB isolates were obtained from 6 homemade curd samples collected from Dehradun and Jind district., Nine were rod shaped while 11 were cocci shaped bacteria based on the phenotypic characters. Phenotypic identification indicated that the LAB isolates belongs to *Lactobacillus* and *Streptococcus* genus. These cultures have exhibited promising technological properties of curd. The whole genome of indigenous probiotic *L. rhamnosus* VTCCDM 179B strain has been deciphered. In an attempt to screen iron binding LAB strains, *L. rhamnosus* Kar 1/VTCCDM 314B showed highest i.e. 65.49±0.62 % ferrous sulphate complexing ability.

Isolation of Dairy Spoilage Causing Bacilli and their Phages

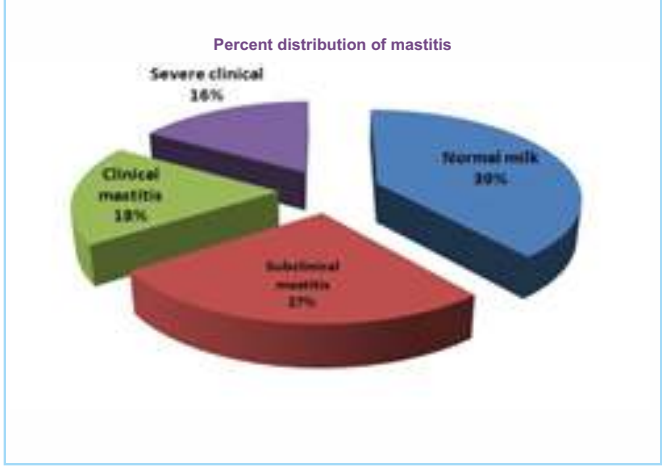
Fourteen samples comprising of milk powder, rinse water from dairy equipment and ETP were ascetically collected from ICAR-NDRI, Karnal. These samples were processed and plated on nutrient and MYP agar media to isolate mesophilic and thermophilic bacilli. A total of 48 tentative mesophilic and four thermophilic bacilli isolates were obtained from experimental dairy samples and transferred to nutrient broth. These isolates are being evaluated for morphology, biochemical and genotypic tests for their identification. Citrate utilization test was positive for mesophiles.

Evaluation and Validation of Enzyme Substrate Based Strip Test for Detection of Subclinical Mastitis.

Conventional mastitis detection methods have certain limitations *i.e.* sensitivity, cost and skilled manpower requirement. A simple and rapid strip assay for detection of subclinical mastitis was developed based on

visual color differentiation. Performance of developed assay was validated using subclinical, clinical and normal milk samples from Sahiwal cattle. Milk samples were collected from individual quarters and assessed for its mastitis status by conventional tests (CMT, SCC and pH). Prevalence of disease was recorded in 27, 18 and 16 percent quarters for subclinical, clinical and severe clinical mastitis. Quarter wise distribution of mastitis indicated higher % of infection in rear quarters as compared to front quarters. Correlation of developed assay was also established with conventional tests (CMT, SCC and pH) as well as with CIELAB values for different colour intensity. Colour intensity developed on functionalized paper strips exhibited linear correlation with convention methods. Sensitivity and specificity of developed assay was 93.13 and 94.73 %, respectively indicating its excellent reproducibility. Functionalized paper strips can be stored safely at -20±1 °C for up to eight months. Developed assay can be used an alternative to conventional tests for early detection of subclinical mastitis infection to avoid economic losses to both milk producers and processors.

Qualitative detection of sorbitol in pure system (water) was standardized. Different indicators were evaluated for colour development in 1 % sorbitol solution in presence of 1 % boric acid. Indicator 1 and 2 showed distinct colour differences between negative and positive samples in pure system in presence of boric acid. Further, to optimize the level of boric acid with selected indicator, concentration of boric acid was standardized in absence and presence of 1 % sorbitol. Marked difference in colour was obtained at 1 % level of boric acid in pure system. To evaluate the effect of increasing level of sorbitol in pure system, 1-10 % sorbitol solution was used. Intensity of developed colour remained unaffected as the concentration of sorbitol was increased. The concept developed was also tried in milk samples spiked with different concentration of sorbitol. It was observed that in the milk system, level of sorbitol detected was 5 %.



Indicator 1 with increasing concentration of sorbitol in water + 0.5% boric acid n=8

Indicator 1 with increasing concentration of sorbitol in water + 0.5% boric acid n=8

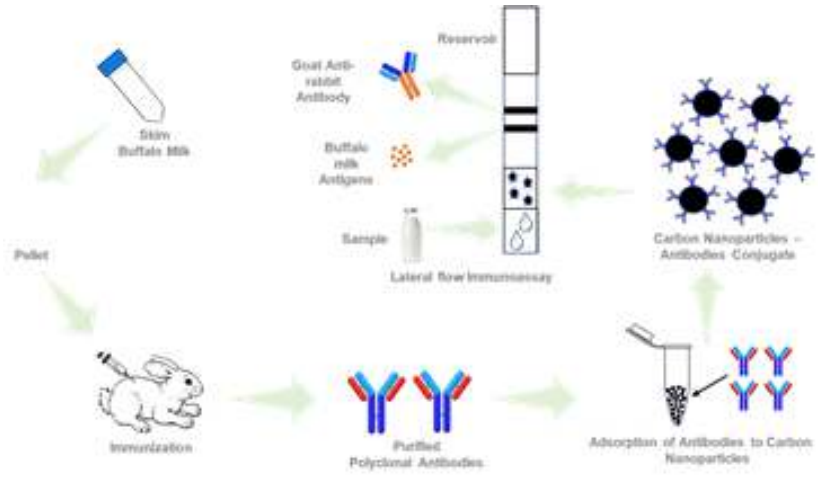


Fig. 1. Summary of development of lateral flow immunoassay for detection of buffalo milk in cow milk

Development of a Method to Detect Adulteration in RM- Adjusted Ghee

A wash RM- protocol was standardized for the detection of RM-adjuster in ghee. The optimum condition leading to minimum difference in RM- value of pure ghee samples prior to and after washing was standardized. Double washing with neutralized ethanol followed by removal of traces of ethanol from the sample by heating on boiling water bath for at least 55 min was used. On adding RM- adjuster @1 % to pure cow ghee a significant ($p \leq 0.05$) difference in RM- values using the standardized protocol was observed before and after washing the ghee samples with neutralized ethanol. The observed difference was found to be 1.91 unlike pure ghee samples (0.44 - 0.45), which increased further as the level of addition of RM- adjuster was increased in ghee. Similar trend was observed in case of buffalo ghee samples.

A Lateral Flow Assay was Developed for Rapid Detection of Buffalo Milk in Cow Milk

A competitive lateral flow immunoassay using amorphous carbon nanoparticles (CNPs) has been developed for rapid detection of buffalo milk added to cow milk. The quality of polyclonal antibodies raised against specific buffalo milk protein fraction was ascertained by ELISA. Protein A purified antibodies (175 g ml^{-1})were conjugated to CNPs and were sprayed on conjugate pad. Test line consisted of buffalo milk whole protein (1.6 g cm^{-1}) while control line contained (250 ng cm^{-1}) anti-rabbit antibodies raised in goat. The test comprises of placing the milk sample mixed with running buffer at sample-cum conjugate pad followed by visualization of test and control line. Due to competition between buffalo milk protein in sample and test line for limited number of antibodies conjugated to CNPs, the intensity of test line decreases with increasing concentration of buffalo milk and limit of detection of with naked eye was less than 5 %.

A Fluorescence Spectroscopy-based Method Standardized to Evaluate Heat Induced Interactions Between Milk Proteins in High Protein Dispersions

The casein-whey protein interactions were investigated in high-protein dispersions (5% protein w/w) during heating at 90 °C for 1.5 to 7.5 min at different pH (6.5, 6.8, and 7.0). The conventional (gel electrophoresis, physico-chemical parameters) methods were able to confirm the presence of milk protein aggregates and correlate with denaturation and aggregation of milk proteins as a function of heat treatment. However, the results from the conventional methods were greatly affected by batch-to-batch variations and therefore, differentiation could be drawn only in non-heated samples and samples heated to longer duration. The similarity map of principal component analysis (PCA) plots applied on fluorescence data were able to differentiate and classify samples on the basis of degree of denaturation and aggregation of milk proteins as a function of pH and heat exposure .

Front-face fluorescence spectroscopy was found to be a useful, rapid and non-destructive tool that helped in understanding differences between non-heated, low, and high-heated samples along with heating pre-history (sample derived from liquid or powder MPC).

Non-Targeted GC-MS Analysis for Identification of Potential Migrants from Milk and Ghee Packaging Polymers

Food packaging has acquired distinct consideration from the food safety viewpoint as it could be a possible cause of contamination via migration of chemical additives from packaging material into packaged foods. Non-targeted screening using gas chromatography coupled to mass spectrometry (GC-MS) was performed for the recognition of migrants in multilayer co-extruded packaging films being used for milk and ghee. Samples were analyzed after extraction with optimized chloroform and methanol solvent mix (1:1). Several compounds including phthalates, N-alkanes, stearamide, acetyl tributyl citrate, 2- carboxy-benzophenone, etc. were identified using GC-MS. Around 20 % of the compounds detected in packaged material samples forms a part of the positive list of approved substances (*IS* 16738: 2018 (R), *IS* 12248: 2015 (R) & *IS* 9833: 2018 (R). Few non-intentionally added substances (NIAS) like, tris (2,4-di-tert-butylphenyl) phosphate, 7,9-Di-tert-butyl-1-oxaspiro (4,5) deca-6-9-diene-2,8-dione, etc. were also detected which are the degradation products of the added chemical additives. The method serves as a suitable approach for identification of potential migrants present in dairy packaging materials.

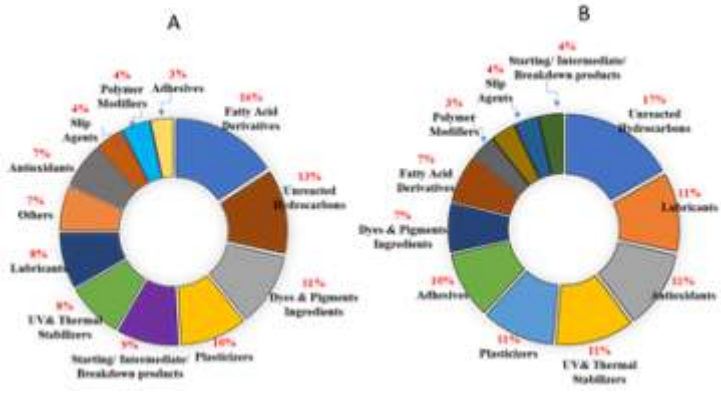


Fig.: Types of polymer additives extracted from Milk (A) and Ghee (B) packaging samples

DAIRY DEVELOPMENT: POLICY ANALYSIS, STRENGTHENING DATABASE & IMPACT ASSESSMENT

Decomposing the Profitability Change of Organised Dairy Processing Industry in India

The study investigated the profitability of organised dairy processing sector in India using secondary data collected from Prowess database of Centre for Monitoring Indian Economy Private Limited, Mumbai. The study was based on firm level panel data of 138 dairy processing firms for the period 1991-2017. Analysis of trend in profit margin and other performance indicators revealed that there was significant increase in profit margin (0.16 %) and labour productivity (2.36 %) in the industry while the change was insignificant in the case of cost per unit sale and capital output ratio. The return to scale (RTS) in dairy industry was more than one in most of the cases exhibiting the scope of enhancing production by investing more on capital and labour in the industry.

The share of capital ( ) showed consistent increase (from 1.8 % to 63.7 %) during the study period while share of labour (1-) has decreased from 98.2 per cent to 36.3 per cent that indicates increase in capital intensity over the years. The decomposition analysis revealed that the profitability of dairy industry in India grew at a rate of 5.9 per cent per annum, which was mainly driven by the growth in output (4.2 %) and Total Factor Productivity TFP (2.8%). In all cases, rate of technical change was found to be increasing while the technical efficiency was declining even though the growth remained positive. In the past, real prices of both output and input have reduced. Hence, in order to make dairy industry more profitable, firms should focus on cost efficient production using modern technologies, while an increasing price environment for products would incentivise the firms to scale up their production and investment.

Spatio-Temporal Distribution of Subsidy in Crop and Livestock Sectors

As a measure to support and incentivise large section of farmers to adopt new technology and inputs, the government started giving subsidy on various inputs and services. But the role of subsidies has changed from complementarities to competitive due to limited capital and resources where government had to draw a trade-off between invest in infrastructural development and subsidisation. In this context, the present study was conducted with objectives as to estimate the allocation of crop and livestock subsidies, its trends with public investment and effects at farm household level. The study was conducted using both secondary and primary data. The subsidies in crop and livestock subsectors were estimated by considering both direct financial transfers under different schemes and the indirect subsidy by way of unrecovered costs of providing inputs and services to the farmers. In order to study the spatio-temporal allocation of subsidy, the techniques used were growth rates and rank correlation. The relationship between public investment and subsidies was estimated using co-integration and panel data regression. While the primary data was collected from 300 farm households of three states Haryana, Rajasthan and Odisha to analyse the effect of subsidy on production and demand of farm household by using separable Household (HH) model.

The estimates of subsidies showed that there was Rs. 201791.39 crores of total agriculture subsidies in TE 2008-09 which increased to Rs. 202628.02 crores in TE 2016-17 registering a meagre growth rate of 0.20 per cent on yearly basis. On an average, total subsidy per hectare of gross cropped areas was Rs. 10467 during TE 2016-17. Crop sector accounted for major share (98 to 99%) in total allocation of subsidies on inputs and

services while the livestock sector accounted only for one to two per cent of the total subsidy. In component-wise allocation; the subsidy on fertilizer, irrigation and electricity was for more the 80 per cent of the total subsidy. In livestock sector, the subsidy on veterinary and health services had the highest share while the subsidy on livestock insurance was the least. Relationship between subsidies and Agriculture Development Index (ADI) of a state depicts that total and crop subsidies per hectare was found to be allocated more in states which were having high index values while allocation of livestock subsidies was found to be high for states having low ADI scores. There by, showing the allocation of livestock subsidy towards more equitable manner among states.

The co-integration analysis between gross capital formation (GCF) and the subsidies revealed that there exists a long run relationship between the two. In states, the results of panel regression between the capital expenditure as dependent variable and the subsidies exhibited that the amount of subsidy in a state positively influences its capital expenditure in agriculture. The household level analysis showed that the total agriculture input subsidy received at farm household level was Rs. 37279 per year with per hectare allocation of Rs. 8730. The consumption functions estimates show that the one per cent change in price of agricultural commodities leads to less than one per cent change in demand of agricultural commodities. The removal of subsidies on inputs and services is likely to decrease demand for inputs like electricity, concentrate and irrigation to the extent of 80 per cent, 73 per cent and 70 per cent, respectively. The removal of subsidies on all inputs led to more than 39 per cent decrease in production, consumption and marketed surplus of agricultural commodities while there was increase in labour supply in order to earn more. Thus, the subsidies in crop and livestock sub-sectors need to be phased out in stages and re-allocating the same either on area or product basis in order to avoid the adverse effects.

Effect of Change in Producer Price and GST Reduction on Indian Dairy Stakeholders

As one of the thrust areas, the effect of policy interventions on stakeholders of Indian dairy sector was analysed using a multi-market model. In this study, two important policy interventions, namely:(i) change in producer price of milk and (ii) reduction of GST on milk products were simulated in an integrated model of crop and livestock sectors comprised of 665 variables in 47 blocks and 600 equations in 40 blocks.

Table : Region wise economic welfare losses per day in Indian dairy sector

(Rs in crore per day)

Milk producing regions	Change in Producer surplus/ welfare	Change inconsumer surplus/ welfare	Total economic
losses			
Northern Region	-34.19	13.88	-20.32 (30.44)
Southern Region	-12.76	5.18	-7.58 (11.36)
Eastern Region	-12.80	5.19	-7.60 (11.39)
Western and Central Region	-52.59	21.34	-31.24 (46.81)
Total	-112.33	45.58	-66.75 (100.00)

Figures in parenthesis are percentage of the total.
Source: Authors' estimations from the Economic Surplus Model

Regarding first policy intervention, it was observed that one per cent increase in producer price of milk results into 0.8 per cent increase in milk production in northern region of the country (states ofJ&K, HP, Punjab, Haryana, UP and Uttrakhand). If the milk production of the region is approximately 59 million tones, the effect of increase in producer price resulted into 0.42 million tone increase in milk production. In value terms, the additional income generated was to the extent of Rs 107.2 million which was translated into an increase in income of Rs 89 and Rs 184 per landless and large households, respectively.

The model was run to estimate the effect of reduction in GST on butter_ghee and Cheese_paneer to the extent of 50%. The effect of policy change was estimated on demand and supply of processed dairy products which further affects the income of the dairy plants and expenditure of the consumers. The reduction in GST resulted into decrease in consumer price (CP) and increase in producer price (PP) of these products. This happens because of the theory of sharing of tax between producer and consumer depending on elasticities. Accordingly, it was estimated that the reduction in GST, which is a sort of sales tax, would be shared in the ratio of 1:4 between producer and consumer. The results showed that reduction in GST on butter_ghee and cheese_paneer, will increase demand of these products at HH level by 1.99% and 3.16%, respectively. While

the demand of raw milk and, yoghurt and other fermented dairy products (YOFDPs) will decrease to the extent of 2-4% due to substituting nature of dairy products. Due to higher price elasticity of poor HH, the increase in demand of the former products was obviously higher i.e. 4.44% (butter_ghee) and 5.68% (cheese_paneer) among Urban poor households (UHP). Nevertheless, the increase in demand was lesser than the decrease in prices, consequently the total monthly expenditure on MMPs decreased from Rs 2355 to Rs 2305 per HH (-2%). On the other hand, increase in PP led to increase in supply of butter_ghee and cheese_paneer by 8.70% and 11.96%, respectively. This led to increase in the demand of raw milk for processing by 1.54%. In this process, the monthly turnover of small and medium plants increased by about 10% with overall growth of 9.38%.

Impact of COVID-19 Lockdown on Indian Dairy Sector

This study examines losses from the angle of decrease in demand for milk and milk products (MMPs) due to closing down of sweet shops producing traditional dairy products, hotels, restaurants and other catering services due to COVID-19 pandemic lockdown. The period in reference was from 24th March to 30th June, 2020, i.e., more than three months. During these three months, economy passed through different phases of close down in order to avoid spread of corona virus. Economic surplus model (closed economy) was applied to measure the impact of decrease in demand on the economic welfare of producers and consumers. The information regarding extent of reduction in demand and prices have been discerned from various news articles as it was difficult to conduct any field survey during lockdown. While applying the model, state level milk demand was calculated taking differential marketed surplus and the amount of milk procured by organised sector. The milk demand and supply elasticities taken were -1.035 and 0.42, respectively.

The reduction in demand for milk was the major factor of economic losses to the Indian dairy sector. It is quite understandable that demand for milk has reduced due to closing down of sweet shops, hotels/dhabas, creameries and tea shops round the corner. During, first lockdown of twenty one days from 25th March to 14th April, 2020, the initial reduction in demand was to the extent of 25 to 30 per cent which has settled at 10 to 12 per cent in the second phase of lockdown because of enhanced procurement of surplus milk by the dairy cooperatives.

To the estimated decrease in demand by 10 per cent, the price of milk reduced by about 24 per cent. A decrease in price is a loss to the producers and benefit to the consumers. The economic loss to the producer was estimated to be Rs. 1123 million (112.3 crores) per day during the reference period. On the other hand, the reduction in prices benefited consumers to the extent of Rs 456 million (Rs. 45.6 crores) per day. This way, the total losses in the economic welfare of producers and consumers in the Indian dairy sector has been estimated to be Rs. 667 million (Rs. 66.7 crores) per day. When the total value of output from milk group was Rs. 701530 crore at current prices in 2017-18 (GOI, 2019), the estimated welfare losses figured at 3.5 per cent of the total value of output per day from the milk group.

These losses were not uniformly distributed across India. The aggregate losses per day were the highest in the Western and Central Region (WCR) with a value of Rs. 312 million followed by Northern Region (NR) with a loss of Rs 203 million which was 47 per cent and 30 per cent, respectively of the total economic welfare losses in the country as a whole. The economic losses in each of the Eastern Region (ER) and Southern Region (SR) were approximately Rs. 76 million per day (11% of the total losses in the country).

The averaging of total losses among producers (Rs. 1123.33 million per day) stands at Rs. 899 per month per livestock holding on an average. While dividing the total economic losses with marketed surplus of milk, it comes around Rs. 5 to Rs. 6 loss per litre of marketed surplus milk. As cited above, if an average household produces only 2.75 litre of milk per day, it may be purported that the total losses in the welfare of 63 per cent of the producers had been about Rs. 400 to Rs. 500 per month on an average during the lockdown period.

Around 75 per cent of the total economic losses to the dairy farmers are concentrated in nine states namely Uttar Pradesh (15.35%), Rajasthan (12.59%), Madhya Pradesh (8.47%), Andhra Pradesh (8.01%), Gujarat (7.71%), Punjab (6.34%), Maharashtra (6.20%), Bihar (5.51%) and Haryana (5.40%).

Impact of NDRI Technology 'Rapid Detection of Adulterants in Milk'

The impact of NDRItechnology, viz., 'Rapid detection of adulterants (maltodextrin and detergent) in milk was assessed. The technologies of these tests have been transferred to industries, viz., Mother Dairy, Sanchi Milk Industry, Punjab State Cooperative Milk Producers' Federation Limited, Haryana Dairy Development

Cooperative Federation Limited, Rajasthan Cooperative Dairy Federation Ltd, Thirumala Dairy, Heritage Foods, Havmor Ice Cream, Mahanand Dairy. The key benefits are: (i) Results of the test kits are reliable and available in short-time, (ii) Quality testing of milk has become extremely easy, (iii) These tests are 50% more sensitive and 60% cheaper than existing methods. Significant and tremendous reduction in incidences of maltodextrin/sucrose/glucose adulteration of milk from 39% to 3.7%, and detergent from 8% to 0.1% as evident from two rounds of FSSAI surveys conducted during 2011 and 2018, respectively. This success can be attributed mainly to adoption of this detection technology (90%) and remaining to surveillance and administrative control (10%).

The economic benefits to the society from the reduction in the adulterants (maltodextrin and detergents) accrued through the saving of the cost of milk testing and ensuring the quality of milk. The cost-saving to the dairy industry is estimated as Rs. 3.8 crore, annually. The annual benefits from the technology are estimated at Rs. 174.44 crore in 2018-19. However, the benefits to society from ensuring milk quality could be even much higher than what is indicated here. It was also found that the consumers are willing to pay a higher price (15%) for the quality tested milk.

Inter-Regional Differences in Production and Utilisation Pattern of Milk and Milk Products

There are significant inter- and intra-regional variations in production and utilisation patterns of milk and milk products across the country which cause approaches for dairy development to vary from state to state and region to region or even within the region. The present study was conducted in three important regions of Rajasthan namely, N&N-W plains, T&E plains and S&S-E plains. The overall milk production was highest from crossbred cow followed by buffalo and lowest from local cow. The return per litre of milk from indigenous cow was highest in S&S-E plains. In case of crossbred cow, it was highest in N&N-W plains.

The overall marketed surplus was 73.43 per cent. Surplus milk produced was disposed off directly to consumers, milk vendors, halwais, creameries and co-operatives. Co-operatives were dominated in procuring the surplus milk (59%) among all the categories. There were three major milk-based industries, namely, Bikaji Food International Limited, Navhari Food Private Limited and Sethia Sweet Products involved in exporting Rasgulla and Gulabjamun. Major importing countries of these products were the USA, UK, Canada and Arab countries.

Evaluation and Impact of Dairy Farmer Collectives in Gujarat

This study funded by the VergheseKurien Centre of Excellence (VKCoE) at Institute of Rural Management Anand (IRMA), was initiated in December 2019. Data were collected from 416 members (members of AMUL, which is a milk co-operative and Maahi, which is a milk producer company) and non-member dairy farming households in Saurashtra and Kutchh regions of Gujarat. In both members and non-members of farmer collectives, majority were medium farmers with 2-4 ha land. On an average, the non-members were more educated than the members. Nearly 20% of the farmer collective members reported livestock as their principal source of income. Among non-members, livestock was the main source of income for only 12 per cent of the households. 29% of non-members possessed BPL cards.

The corresponding percentage for members was 21%. Variables like years of dairy farming experience, extension services of Educational Programme (EP), Technical Programme (TP), and Group Mobilisation (GM), owning TV, having livestock as principal source of income, and milk yield (of 4.4 litres or more) were found to have a positive and significant affect on membership. Age, holding a BPL card, extension service of Input Supply (IS), participation in Panchayat and religious activities, and herd size in SAU were found to have a negative and significant affect on membership. In financial performance, the producer company was found to be faring better than the co-op union.

Modeling Production and Reproductive Performance in Dairy Cattle

Auto Regressive Integrated Moving Average (ARIMA) models with different values of p, q and d have been developed for different lactations on average monthly milk yield of Karan Fries and Sahiwal cattle; and Murrah buffaloes in different years (1984–2018).On the basis of Akaike's Information Criterion (AIC), Bayesian Information Criterion (BIC) and Root Mean Square Error (RMSE), the best ARIMA model was chosen. The best fitted models for the KF's first, second, third, fourth, fifth and sixth & above lactations were found to be (1,1,2),(2,1,2),(2,1,2),(2,1,2),(1,1,2) and (2,1,2), respectively. In case of Sahiwal cattle, ARIMA (2,1,2) was

the best fitted model for all the lactations. In case of Murrah buffaloes, the best fitted models for first, second, third, fourth, fifth and sixth & above lactations were found to be (2,1,2),(2,1,2),(2,1,1),(2,1,1),(1,1,2) and (2,1,2), respectively.

Different machine learning (ML) models, viz., Additive Regression, Multi-Layer Perceptron (Recurrent Neural Network), Random Forest (RF), and Support Vector Regression models have been developed and validated for aforementioned lactations of Karan Fries and Sahiwal cattle; and for Murrah buffaloes as well. ML models exhibited fairly well predictive potential to forecast time-series data vis-à-vis the conventional ARIMA models.

In Karan Fries cows, the life time milk production is positively and significantly influenced by third, fourth, sixth and seventh lactation lengths. Whereas, the age at first calving and fourth calving interval negatively affected the life time milk production in Karan Fries cattle. In Sahiwal cows, the life time milk production is positively and significantly affected by fourth, fifth and sixth lactation lengths. It is also influenced positively by first lactation length but second and fifth dry period had negative impact on life time milk production. In Murrah buffaloes, fourth, fifth, sixth and seventh lactation lengths positively and significantly affected the lifetime milk production; whilesecond, fourth and fifth dry periods negatively influenced the life time milk production.

Performance of Women Dairy Self-help Groups in Rajasthan

Self-help groups play an important role in improving the livelihoods of rural poor, and in women empowerment. SHGs not only provide credit to poor women but also make them self-reliant by generating employment. Keeping in view the importance of self-help groups, this study was carried out with the objectives to evaluate performance of women dairy self-help groups, to assess the determinants of participation of members and repayment performance of SHGs, and to analyse the impact of the SHGs on socio-economic status of members. Rajasthan state was chosen for the study and two districts (Baran and Jhalawar) having the highest number of dairy SHGs were selected. Two blocks from each district and from each block 20 women dairy self-help groups were selected. Two members were selected randomly from each of the selected women dairy SHGs, making a sample of 160. Besides, 160 non-members were selected from the selectedvillagesas control. The study applied Principal Component Analysis, TOBIT regression, Double Hurdle and Heckman two-stage regression models to analyze the data.The results of the study revealed that women dairy SHGs in the study area were performing well in terms of institutional performance, saving performance, internal and external loaning performance and external repayment rate. The tenure of establishment of SHG had positive impact on economic performance of SHGs, which indicates that SHG-based microfinance fulfils its objectives in the long-run. Distribution of SHGs based on composite performance index revealed that out of total 80 SHGs, 37 SHGs (46.25%) were in average performance category, followed by 28 SHGs (35%) in poor and rest 15 SHGs (18.75%) in good performance category.Overall repayment rate of SHGs was worked out to be 0.8083, which shows that 80.83 per cent of the total loan amount was repaid on the due date. The variables 'group size', 'total dependents in a household' and 'loan amount' had significant and negative effect, while 'years of experience of SHG' had positive and significant effect on the repayment rate of SHGs. The decision of women to become member of an SHG was found to be positively affected by 'number of dependents per household', 'involvement in off-farm activities' and 'prior indebtedness' but negatively affected by 'yearly income'. 'Number of dependents per household' and 'prior indebtedness' had positive and significant influence, while 'yearly income' and 'involvement in off-farm activities' had negative and significant influence on the extent of participation of members in an SHG.Net income from each dairy animal for member households (Rs.10,314 per annum)was relatively higher as compared to non-members (Rs.7,164 per annum). Milk productivity of dairy animals of members was significantly higher (4.21 litre per day) as compared to non-members (3.76 litre per day).. Woman empowerment index in dairy was estimated as 0.71 and 0.64 for women in member and non-member households, respectively. It can be concluded from results that participation in SHGs had positive impact on productivity of dairy animals, income of the household, employment generation of women, and women empowerment.

Vulnerability of Rural Households to Drought in Tamil Nadu

The study developed a new composite drought vulnerability index (CDVI) comprising of both crop and dairy indicators for 30 districts of Tamil Nadu based on the Intergovernmental Panel on Climate Change (IPCC) approach using exposure, sensitivity and adaptive capacity. The districts were classified as high, moderate

and less vulnerable on the basis of magnitude of the index. The CDVI was highest in Kanchipuram district (0.88), lowest in Erode district (0.45) and moderate in Thanjavur district (0.73). Vulnerability mapping showed 12, 8 and 10 districts as high, moderate and less drought vulnerable. Geographically, districts in north eastern and southern zones were highly vulnerable. Post estimation analysis of CDVI showed that shares of gross sown area (37.13%) and bovine population (43.47%) were highest in high vulnerable category districts. The household drought vulnerability index (HDVI) was estimated for 300 rural farm households selected from Ramanathapuram, Nagapattinam and Erode districts representing high, moderate and less vulnerable category, respectively. The results of HDVI revealed that about 117 (39%), 69 (23%) and 114 (38%) households were categorised as high, moderate and less vulnerable to drought, respectively. The district wise mean value of HDVI was highest in Ramanathapuram (0.86), followed by Nagapattinam (0.60), while it was lowest in Erode (0.34). The vulnerability mapping also showed that more households in Ramanathapuram (82%) were highly vulnerable to drought, whereas more households in Erode (84%) were less vulnerable. This may be due to high exposure and sensitivity along with low adaptive capacity in Ramanathapuram, whereas Erode has high adaptive capacity coupled with low exposure and sensitivity. The study also analysed extent of adoption and determinants of drought management strategies. Among district wise overall mean value of intensity of adoption, the highest value was observed in Erode (0.52), followed by Ramanathapuram (0.51) and Nagapattinam (0.44). Age, education, farm size, herd size, number of family members employed in farming and dairying, access to credit, membership in organisations and extension contact were some of the important socio-economic variables, which influenced probability and intensity of adoption in different districts. It was also estimated the effect of management strategy on crop and dairy output and constraints faced by farmers. In case of paddy crop, seed drill sowing, direct (line) sowing and System of Rice Intensification (SRI) methods were the most important drought management strategies in Ramanathapuram, Nagapattinam and Erode, respectively. In case of dairy, mineral mixture supplementation was the most vital management strategy in all the districts. Change in income was mainly due to technological change, followed by change in inputs.. Efficient use of inputs leads to increase gross income and reduce costs in both paddy and dairy farming. Lack of adequate irrigation facilities during drought and decline in product sale price were major constraints in paddy, whereas lack of availability of feed and fodder was major constraint in dairy. There is a need to develop regional level adaptation strategies such as direct (line) sowing and water conserving techniques/ farm pond in both high and moderate vulnerable districts, whereas SRI in low and moderate districts as well as mineral mixture supplementation to dairy animals in all vulnerable districts. Vulnerability can be further reduced by increasing irrigation sources, crop diversification and livestock rearing.

Correlates of Commercial Dairy Farms' Choice of Value Chain and its Impact on Performance

We used a multinomial treatment effects model to simultaneously estimate correlates of commercial dairy farms' choice of value chain and the impact of this choice on their performance. The coefficient value of locality in formal value chains is positive and significant. This means relatively more chance of a commercial dairy value chain to be formal, if it is located in an area implying higher presence of formal buyers. Dairy farms situated in pre-urban areas, particularly in the outskirt of National Capital Region (NCR),wereapplying innovative marketing strategiesand targeting premier consumers directly. These dairy farms are addressing consumer concerns of food safety and quality of milk/ milk products. The coefficient of education level of the entrepreneur is negative and significant in both formal and informalvalue chains over base (consumer-household). The coefficients of training and food safety score are positive and significant in case of formal value chains. This indicated that the dairy entrepreneurs who have participated in formal training in dairying – follow the food safety protocols – are more likely to be in the formal chains. Higher profit realisation is evident for maintaining milk quality across selected value chains. Finally, the coefficient value of commercial dairy farms in the high milk producing states (Uttar Pradesh, Rajasthan, Gujarat, and Andhra Pradesh) among the sample farms is positive and significant. The commercial dairy farms in these states are more likely to be in the formal chain possibly because of the organised market already available in these states. In the second stage of multinomial treatment effect model, the estimates show the effect of choice of value chain on the profit of commercial dairy farm. The inverse mills ratios (Lambda) are found to be non-significant clearing all the suspicions about presence of any selectivity bias.

Our econometric results show that dairy entrepreneurs operating in any value chains other than selling to consumer-household realise comparatively lesser profit. The positive and significant coefficient of village dummy is indicating the greater prospect of dairy enterprise in rural areas. The study implies that training/ EDP in dairying need to be promoted with more emphasis on food safety and quality throughout the value chain.

EXTENSION APPROACHES FOR SOCIO-ECONOMIC UPLIFTMENT THROUGH DAIRYING

Livelihood Vulnerability to Climate Change among the Changpa Pastoral Nomads of Leh-Ladakh

An attempt was made to understand the perception of *Changpa* pastoral Nomads of Leh-Ladakh towards climate change and they reported seven features of changing climatic scenario. More than 90 percent of them perceived increased in summer and winter temperature, heavy decline in snow fall pattern and rapid melting of glaciers. Half of the respondents perceived that season cycle of Ladakh was gradually changing and increased in extreme climatic events like cloudburst etc. The *Changpa*pastoral nomads perceived direct and indirect impact of climate change on the nine aspects of livelihood security which were mainly sources of drinking water, pastures land and quality of *Pashmina* wool. More than 90 percent of the respondents perceived that mid altitude streams are drying up and increased in wildlife -livestock conflict due to reduction in area of pastures. About 42 per cent of the *Changpa*pastoral nomads were moderately vulnerable. But, 32.50 per cent and 25.50 per cent of them were having extreme and lower level of vulnerability, respectively. It was also found that 7.5 per cent of the sampled *Changpa*pastoral nomads were having negative vulnerability value which is a matter of serious concern and these households are under threat to any types of shocks related to climate change. Hence, necessary efforts may be undertaken to improve their adaptive capacity as well as to reduce their sensitivity to climate-led disaster. Wool production was perceived as the most sensitive to climate change. Whereas, herd size of the bovine and the market infrastructure wereconsidered as the most important indicators of the adaptive capacity.. Majority of the *Changpa*pastoralists were modifying their migration pattern i.e., early migration, extended period of migration and change in migration routes. Interestingly, 83.33 percent of the respondents started cultivating fodder production and conservation. The *Changpas*are shifting towards small ruminant (particularly *Pashmina* goat) from large ruminant. Few of them were doing inter species hybridization between yak and cattle to cope up changing climatic scenario.

District wise Thermal-Humid Index Map of the Haryana and Associated Climatic Stress on Milk Production

District wise monthly Thermal-Humid Index Map of the Haryana was developed for the last 61 years since 1958 to 2019 as an indicator to appraise the impact of climate change on the milk production. It was found that mild to severe stress was observed during April to October in a year across the districts of Haryana. A fixed effect panel data regression was applied to understand the impact of climate change on the district wise and season wise milk production of the different bovine spp i.e., buffalo, crossbred cow, and indigenous cattle. It was found that climatic parameters like Thermal Humid Index (THI) and Potential Evapotranspiration (PET) had significant impact on the significant impact on the milk production of crossbred cattle and buffalo. Sensitivity of the Murrah buffalo based livestock production system to climate change was assessed with the help of psycho-mathematical model i.e., Analytical hierarchy process (AHP) among the 320 Murrah buffalo rearers. They perceived that that among five parameters of productive performance, average daily milk yield was highly sensitive followed by lactation length, peak yield, stage of lactation and dry period. In case of reproductive performance, the most sensitive indicator was conception rate followed by estrous cycle, age at the first calving, service period and calving interval.

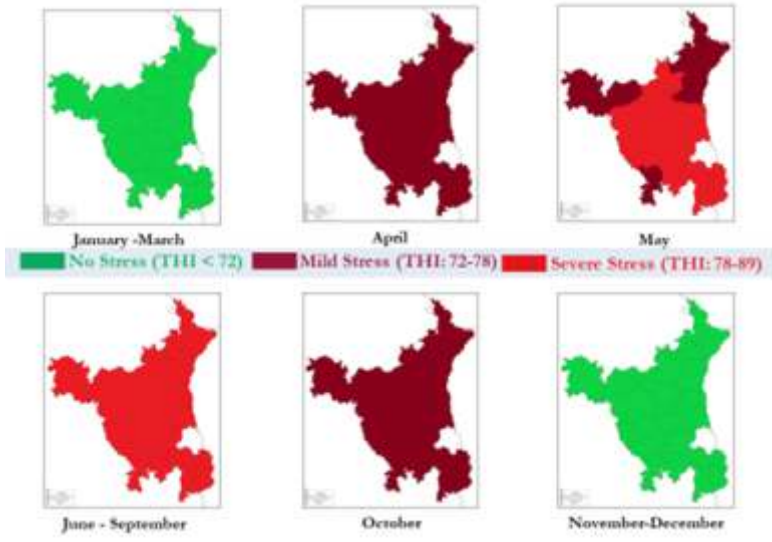


Fig. 1: Thermal Humid Index map of Haryana at the district level during 1961-2019

Assessment of Farmer-led Adaptation Strategies to Climate Change in Eastern Uttar Pradesh

The study on assessment of farmer-led adaptation strategies to climate change in eastern Uttar Pradesh was conducted in three districts viz., Azamgarh, Varanasi and Ghazipur. The study revealed that majority (81.67 %) of the farmers perceived changing climatic scenario and its impact on crop-farming as well as livestock-rearing. Total 9 and 15 farmers-led adaptation strategies were documented for crop-farming and livestock-rearing, respectively. In all three districts, 'crop diversification' and 'use of shed for cattle and buffaloes' were the most preferred adaptation strategies in crop-farming and livestock-rearing, respectively. It was found out that 35.66 per cent of the farmers were in higher level of adoption category of adaptation strategies related to crop-farming, whereas 41.26 per cent of the farmers were in medium level of adoption category of adaptation strategies related to livestock-rearing. The findings of the study exhibit an alarming difference between the perception with regard to impact climate change and adoption of adaptation strategies to cope up with the impact of climate change on crop-farming and livestock-rearing. Farmer-led adaptation strategies in crop-farming and livestock rearing were appraised in terms of their effectiveness to cope up with the changing climatic scenario. In crop-farming, 'search for alternate sources of income' was chosen as most effective one in Azamgarh district. But, 'preparation of bunds to control water flow' was most effective in Varanasi and Ghazipur district. In livestock-rearing, the most effective adaptation strategies were 'proper sanitation practices for animals', 'regular vaccination' and 'use of jute cloth to cover animals' in Azamgarh, Varanasi and Ghazipur district respectively.

Impact of Mineral Mixture on Performance of Dairy Animals

The mineral mixture technology of NDRI, Karnal was highly perceived by the dairy farmers to tune of 78.31 percent and they explained that 'Mineral mixture can solve the anestrus problem of dairy animals (88.50%) and increase the conception rate in dairy animals up to 86.25 percent. It can also solve the repeat breeding problem of dairy animals up to 85.25 percent. Further, farmers' feedback on feeding of mineral mixture to dairy animals was analysed and it was found that about 96.77 percent farmers explained that by feeding of mineral mixture, service period was reduced about 23 days, lactation length was increased about 30 days and milk yield of dairy animal was increased about 0.76 litres/animal.

Capacity Building of Resource Poor Farmers in Paddy-Wheat cum Dairy Production Systems through Farmer FIRST Programme under Irrigated Agro-Eco. Region of Haryana

A total of 24 interventions (crop, dairy and horticulture based) were given to one thousand selected small and marginal farmers of five villages (i.e., KamalpurRoran, GarhiGujran. NagalaRoran, Churni and Samora) of Karnal District. The study found that the knowledge of stakeholder farmers under crop, dairy and horticulture based interventions were significantly increased (88.59%) and farmers willing to adopt different technology like

improved seed of crop, seed production, diversification toward commercial crop, IFS, feeding mineral mixture, anionic and cationic mineral mixture to animals, estruses synchronization, balances feeding, by pass fat, mastitis control and scientific dairy farming practices. The interventions were found to be economically viable with benefit cost ratio greater than one in all the cases. FFP project developed a VIREN dairy enterprise and the annual returns of this enterprise were found to tune of Rs.14, 34,400. These interventions were found to help inimprove the socio-economic conditions of small and marginal farmers and contributing towards doubling farmer's income.

Impact Assessment of Selected Interventions under Farmer FIRST Programme of NDRI

The present study was conducted in the five adopted villages of Karnal district of Haryana on 250 respondents which were selected proportionately under 14 advocated interventions. The study revealed that majority of the respondents (44.80%) were middle aged with middle level education(40.40%) , had medium sized family (86.00%), medium level of family education status (54.00%) and membership in one organization(61.60%). They had agriculture as primary occupation (97.20%), having medium size land holding (37.60%), small herd size(41.60%) with medium level of milk production (55.60%), milk consumption(40.80%) and milk sale (51.20%), belonged to medium income group (43.20%) with medium level of experience in dairying (58.00%) with high level of extension contact (52.40%) and medium level of mass media exposure(66.00%). The highest knowledge was seen in Mastitis control (98.21%) followed by SMS portal (96.67%) and round the year fodder production (95.71%).Under the economic impact assessment the Benefit Cost Ratios of different interventions were as follows; IPM in Paddy(2.69),INM in Wheat (2.54),IWM in Wheat (2.35) , fodder maize production (2.80),Cucumber cultivation (4.88) and in case of dairy based interventions; balanced feeding (1.83),Bypass fat supplementation (2.99), Mineral mixture supplements (5.37),Theileriosis vaccination (74.88), Theileriosis treatment (10.19), Mastitis diagnosis (41.20) and Mastitis treatment (85.75), respectively. The major positive feedback in case of crop interventions was increase in crop yields and returns, reduced weed infestation due to IWM practices, and reduced pest infestation due to IPM practices and improvement in soil health due to Dhainchacultivation. In case of dairy intervention, these were increase in milk yield and returns, improvement in animal health and reproductive efficiency and better control and management of diseases.

Development of Dairy Business School Model for Farmers

Dairy Business School (DBS) has been taken up by ICAR- National Dairy Research Institute Karnal& National Institute of Agricultural Marketing, Jaipur. Dairy Business School is evolved from the concept of Farm Business School by FAO. The main aim of Dairy Business School is capacity building, transfer of technological innovations in the area of milk production and processing, and linking farmers with markets and financing instutions. Under Dairy Business School, 180 dairy farmers from 6 adjoining districts of NDRI, Karnal were selected in order to study entrepreneurial behavour. The Entrepreneurial Behaviour Index (EBI) was developed and pre-tested in field. Finally, 30 dairy farmers were selected for DBS based on the criteria such as interest in dairy business, possession of atleast1 to2 dairy animalsandEBI scores.

An appraisal of Dairy Based Farmer Producer Companies in India.

The study was conducted in Uttar Pradesh, Rajasthan, and Madhya Pradesh on randomly selected four farmer producer companies (FPCs) from each state. In FPCs, twelve stakeholders, viz., primary stakeholders (04 Nos), secondary (05) and external stakeholders (03) were involved.The linkage among stakeholders was found medium to strong. The institutional performance of FPCs was average with a mean index score of 0.65. Further, all FPCs were categorized into three categories i.e. low, medium, and high based on the performance. 41.66 per cent of the FPCs were found under the medium level of institutional performance category followed by 33.33 per cent and 25 percent belonging to low and high institutional performance categories of FPCs, respectively. In the case of business performance, three FPCs were in the yellow zone (average performance) followed by one in the red zone (poor performance). Overall business performance of industries was average with a score of 122. The study found that FPCs play a significant role in the capacity building of stakeholders and have a significant impact on the overall socio-economic development of member farmers and enhanced their livelihood wellbeing. The priority weight of each SWOT factor was calculated through AHP. The most important factor among SWOT was a strength (0.415) followed by threats (0.293), weakness (0.185), and opportunity (0.107); respectively. The study concluded that, more than fifty percent of the dairy-based FPCs under the incubation stage in India (< 5 years old). The institutional and business performances of these FPCs were low which affect the sustainability and viability of FPCs.

Automation on Commercial Dairy Farm in North India: Farmers Perspective

The data on automation/ mechanization in commercial dairy farms were ascertained and found that majority (48.66%) use Bucket milking machine followed by milking parlor (35.33%) and remaining hand milking. The study indicated that majority (67%) of the farmers considered public funded agencies as the major sources of information. Intial investment (cost of equipment) and benefits (interms of reduction in labour and efficiency in milking and other farm operations) were considered for decision making on automation/ mechanisationof dairy farm. About half of the respondents (54.44%) were having a high perceptual level followed by moderate perceptual level (35.56%) towards dairy automation/ mechanisation. Only 10.00 per cent of the respondents were in the category of low perceptual level towards dairy automation/ mechanisation technologies. Dairy units were classified into small (20 to 30 milch animals and 1 unit of two bucket milking machine), medium (30 to 50 milch animals and 2 units of two bucket milking machine)and large (50 to 70 milch animals and one unit of 6 bucket milking machine) categories. Payback period of semi automatic milking machine was one year in case of small and 3 years each for medium and large categories of dairy farms.

Mitigation of Stubble Burning through Custom Hiring Centres for Agricultural Machinery in Trans-Genetic Plain Region of India

Most of the farmers were aware about government approaches and schemes such as crop diversification (>99%), subsidy on farm implements (90%) and other command and control mechanism like imposing plenty (>95%) to mitigate crop residueburning. However, economic persuit and labour scarcity continue to burn residue, although there is decrease in aboulute number of cases.

Out of 180 respondents only 22.77 per cent of the farmers had low perceptionaboutcrop residual burning. Otherwise, respondents were well aware of negative effect of residue burning on human–animal–plant–-soil health, biodiversity and air quality.

Farmers showed willing to adopt crop residual management technologies and practices, that are, (i) super straw management system (SMS) at least cost, (highest weighted mean of 94.89 %); (ii) technology for utilization of cropbiomass into for power generation (94.44 %). School and college students were identified as potential social stars to convey the message for in-situ residue management.

Nurturing Latent Agro-animal based Entrepreneurship among the Youth in Mewat District of Haryana

The challenges and prospects of agro-animal based entrepreneurship in Mewat district were identified through personal interview and Group discussion of selected 250 youths from Nuh, F.P. Jhirka, Punhana, Taoru and Nagina blocks of the Nuh district. Need based interventions required for capacities building among the youth were explored. A total of 50 potential youth for nurturing entrepreneurship were selectedand need based interventions (Milking machine, Juice machine and tea coffee soup machines, etc) were introduced in the study area.

Improving Livelihood of Rural Women through Dairy Based Secondary Agriculture

The project was implemented in ten villages comprising of seven villages in Karnal district, one village in Panipat and two villages in Sonepat district. The aim of the project isto promote women entrepreneurship in processing and value added of dairy products.. Forty demonstrations were organized to build their capacity on value added dairy products at Women Empowerment lab and project villages. The Project since its inception in 2017 covered 25 villages, organized 70 trainings/gender sensitization meetings and 60 demonstrations, thereby training 1023 farm women.Women were earning Rs. 5000 to Rs 8000 per member per month depending upon the nature and volume of venture. Women were facilitated to sell their products in canteens of school, college as well as restaurants.The partnership with Haryana State Rural Livelihood Mission (HSRLM) played a critical role in selling products in the canteens of Grain market run by Haryana State Agricultural Marketing Board (HSAMB). The success story of women groups was uploaded in ICAR website in July 2020.

Farmer participatory Assessment of Cost Effective Solution for Management of Ticks and Mites in Dairy Animals: An action Research in Haryana

The project was implemented in eight villages of Haryana, representing all agro-climatic zones to treat ticks using NIF poly-herbal medication. Demonstrations were conducted covering 47 farmers and 203 dairy animals in Karnal, Jind and Bhiwani districts. The relevance and efficacy of polyherbal medication was shared in 15 farmer interaction meets in the respective villages in collaboration with officials of LUVAS and Department of Animal Husbandry.

The indigenous polyherbal medicine was prepared and administered only for first three days in all the six villages. The treatment solution (*Azadirachtaindica*+ *Vitexnegundo*) wasadministrated two times in a day (morning and evening) to the dairy animals for three days to treat the ticks and mites. After providing treatment, observations were recorded after 7th day, 14th day, 21st day and 28th day. The percent efficacy of this preparation over infested animals was found to be 92.97 percent by 28th day of observation. About 2000 nirgundi (*Vitexnegundo*) seedlings were distributed to 600 farmers covering 30 villages in Haryana. A success story was also uploaded in ICAR website for wider dissemination of the polyherbal medication.

Aspirations and Training Needs of Rural Youth for Entrepreneurship in Crop and Dairy Farming in Cuttack District of Odisha

Aspirations and training needs of rural youth for entrepreneurship in crop and dairy farming were analysed in Cuttack district of Odisha. Most of the respondents had medium level of livelihood aspiration (46.67 %) while.lifestyle aspiration (46.11%) and entrepreneurial aspiration(46.67%) was found to be low Livelihood had a significant negative relationship withlifestyle aspiration (P<0.01). On the other hand, there was a significant positive relationship between livelihood aspiration and entrepreneurial aspiration of the respondents (P<0.01)significant negative relationship between lifestyle aspiration and entrepreneurial aspiration (P<0.01). Among entrepreneurial training needs, 1st rank was given by the rural youth to "Identification of business opportunities in their locality and region", followed by "Improving communication skills" (2ndrank), "Development of achievement motivation" (3rd rank).

Adaptive Capacity to Climate Change among the *Chilika* Buffalo Rearers of Odisha

The present study was designed to assess the adaptive capacity of the *Chilika* buffalo reares. So, the study was purposively conducted at the *Chilika*lake region of Odisha as it is the breeding tract of *Chilika* buffalo. A total 150 *Chilika*buffalo rearers were selected randomly from the cluster villages of the adjacent districts of *Chilika* lake. Sustainable Livelihood Approach (SLA) was used to develop *Adaptive Capacity Assessment Index.*. They were having physical capital (0.55) followed by social capital (0.48), financial capital (0.47), human capital (0.45) and natural capital (0.35). The average adaptive capacity of the *Chilika* buffalo rearers was found to be as 0.46, which was quite unsatisfactory.Majority of them (62.67%) were having a medium level of adaptive capacity to cope up with climatic change scenarios. Adaptive capacity of the *Chilika* buffalo rearers were having a strong positive and significant (p<0.01) relationship with its every componentTherefore, the status of each and every capital needto be improved so as to strengthen adaptive capacity of *Chilika* buffalo rearers.

Improving Adaptive Capacity of Women Farmers of Haryana through Climate Resilient Dairy Farming Practices

Inventory on climate resilient dairy farming practices with intended use and scientific rationality was prepared and validated for their suitability to be used as the climate resilient dairy farming practices in Haryana. Deworming (Albendazole tablet twice in a year) followed by supplementation of essential mineral mixture (60gm/ day), copper ad cobalt supplement (02 Cu-Co tablets/ day for ten days),vitamins in non-pregnant anestrus dairy cattle were identified as the most suitable healthcare and management related climate resilient dairy farming practices. "Adoptive capacity of women farmers can be boosted through diversification of income sources and preparation of value-added milk products.

RESEARCH PRIORITIZATION, MONITORING AND EVALUATION

Intensification of R&D activities at ICAR-NDRI Karnal in recent years has necessitated introduction of professional management approach for managing research functions. PME Cell has been created at ICAR-NDRI to coordinate and manage research activities and facilitate 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 under the Chairmanship of Dr S. L. Goswami, Ex-Vice-Chancellor, Banda University of Agriculture & Technology, Banda and Former Director, NAARM, Hyderabad 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.

Institute Research Committee (IRC)

The key functions of Institute Research Committee (IRC) are to critically review the on-going and completed research projects, to consider the new research proposals and to advise on fostering of linkages between the groups/divisions of the Institute in respect of multi-disciplinary/multi-locational projects. The IRC meetings to evaluate the outcome of the completed research projects and to consider new research projects proposals were held on-line on May 26-30, 2020 for ICAR-NDRI, Karnal, and June 10, 2020 for SRS, Bengaluru and June 12 and July 13, 2020 for 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 on December 1-4, 10-11, 2020 at ICAR-NDRI, Karnal, The virtual 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. Besides PME Cell meetings held on 7th, 24th January, 13th, 25th February, 3rd, 9th, 11th March and 31st December, 2020, a total of 88 no Externally Funded/ Contract/ Consultancy research proposals were considered, screened and evaluated online due to the Pandemic Covid-19 and forwarded them 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; RKVY-RAFTAR; HSPCB ;Ministry of Health (Grant-in-Aid Scheme); SERB-Power Grant; National Gender Resource Centre New Delhi and DST SERB Power Grant.

PME also processed and prepared the papers for an International Grant–proposal submission to the Council for obtaining donation funding from Illumina Agricultural Greater Goods Initiative Grants.

Besides, 34 proposals submitted by the scientists of ICAR-NDRI and its regional stations for funding under National Agriculture Science Fund (NASF) were screened and submitted.

Review of the Externally Funded Projects

PME Unit coordinated the Review Meetings for Externally Funded Projects under the chairmanship of Director ICAR-NDRI, Karnal held on 21.11.2020 and 23.11.2020. The major purpose of the meeting was to identify the constraints faced by the PIs of the externally funded projects and offer viable solutions to the problems being faced by them.

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.

- ICAR-NDRI and Chhatisgarh Kamdenu Vishvidyalaya Durg on 25.02.2020
- ICAR-NDRI and DBT-NIAB, Hyderabad on 01.09.2020
- ICAR-NDRI and MPUAT, Udaipur on 16.12.2020

Besides, draft MoUs of ICAR-NDRI with Agriculture Skill Council of India (ASCI), WBUAFS, Kolkata, GBPUA&T, Pantnagar, Kamdhenu University, Gandhinagar (Gujrat), CAU, Imphal, GADVASU, Ludhiana and Sh. Venkateswara Veterinary University, Tirupati were taken up for scrutiny during the period under report.

Project Information Management System (PIMS)

The PME Unit implemented on-line database/computerization of research projects under PIMS introduced in collaboration with IASRI. The unit acted as a nodal agency to facilitate and coordinate with PI of the project at IASRI, New Delhi and PIs of all the on-going and completed research projects at ICAR-NDRI for smooth functioning of PIMS activity.

Research Projects Database Management

A database through PIMS package of research projects was updated for all the research projects in operation during the year 2020. The database of research projects containing the targets and achievements of the preceding half yearly and targets fixed for the next six months was updated in HYPM package.

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, two meetings of Technical Screening Committee were held on 11.05.2020 and 19.03.2021.

Selection Process for ICAR-PDF at ICAR-NDRI

PME Unit provided the logistic Support in Selection of ICAR-PDF at ICAR-NDRI in framing the guidelines for ICAR-NDRI as per ICAR guidelines, publicizing it widely by issuing the letter to all Vice Chancellors for selection of ICAR-PDF fellows, scrutiny of applications for PDFs and selection of the candidates at ICAR-NDRI as per the ICAR directives.

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 -2019.
- ICAR-NDRI News Letter-a quarterly newsletter in English.
- Director's Report for the 18th Convocation.
- Research Projects (2020).
- 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 2020-2021.

Formulation of XIII Plan EFC Memo Document (2021-26)

- Formulation of EFC plan document under the theme No. 17: “Dairy Production & Technology” Sub-scheme 17 (1): ICAR-NDRI, Karnal with total outlay of (Rs.242.00) Crores.
- Prepared information regarding justification of continuation/extension of on-going schemes proposed under EFC document of the Institute for the period (2021-26) alongwith significant achievements of XIII Plan and year-wise outputs/ deliverables of XIV Plan.

Research Information Management

HalfYearly/Quarterly /Monthly Reports

- PME unit consolidated the half yearly/Quarterly/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) and North-Eastern Hill (NEH) Region schemes being carried out at Eastern Regional Station, Kalyani.

Assessment /Retention Cases of Scientists

PME Unit also processed the documents for Assessment and Retention of the scientists of ICAR-NDRI, Karnal. The meeting for 3 number assessment cases were held on 07.08.2020 and 10.08.2020 whereas the meetings for 25 number retention cases were held on 27.07.2020.

Action Taken Reports (ATRs)

This Unit also prepared the following **Action Taken Reports** on recommendations emerged during the following meetings and submitted the same to the Animal Science Division of ICAR, New Delhi.

- Action Taken Report on actionable points related to ICAR-NDRI during DAHD-ICAR Interface meeting held on January 2, 2020 and June 9, 2020.
- Action Taken Report on the recommendations pertaining to ICAR-NDRI, Karnal emerged out during the Senior Officers' Committee Meeting held on June 9, 2020.

- Action Taken Report on minutes of the meeting held under the Chairmanship of Additional Secretary, DARE & Secretary, ICAR to review the preparedness for ICAR Foundation Day celebrated on June 16, 2020.
- Action Taken Report on PMO communication regarding research be conducted on best indigenous practices of cattle feed.
- Action Taken Report on the inputs/comments/action points emerging with respect to ICAR-NDRI, Karnal during 246 GB meeting of ICAR held on February 3, 2020 to review the outlining the trends in research work during last 10 years.
- Action Taken Report regarding statement on status of implementation pertaining to ATR 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, Department of Agricultural Research and Education, Ministry of Agriculture of Farmers' Welfare New Delhi.
- Action Taken Report on recommendations emerged out with respect to ICAR-NDRI, Karnal during Video Conference held with all Directors of ICAR Institute under the chairmanship of Secretary (DARE) and DG, ICAR, New Delhi held on March 19, 2020.
- Action Taken Report on recommendations emerged out with respect to ICAR-NDRI, Karnal during the meeting of GoM on Agriculture and rural economy with SGoS on rural and agriculture held on July 6, 2020.
- Action Taken Report on recommendations emerged out with respect to ICAR-NDRI, Karnal during the meeting chaired by PM on priority performance and non-bovine milk review meeting.
- Action Taken Report on greater R&D focus on post production activities (traceability, assaying, package, higher shelf life and waste to wealth) sought by MoA & FW.
- Action Taken Report/Comments on the summary of records of the DADH-ICAR Interface meeting held on June 25, 2020.
- Revised Action Taken Report on PMO Communication on the minutes of the video conferencing held on 9th June, 2020 under the chairmanship of Secretary (AHD), DAHD, MoF, AH&D, New Delhi.
- Action Taken Report on proceedings of review meeting chaired by Hon'ble PM on the Priorities, Performance and Preparedness of ICAR held on July 4, 2020.
- Action Taken Report along with roadmap for carrying out research activities on non-bovine milk and milk products.
- Action Taken Report on estimating the life time profitability of indigenous breeds, crossbred cattle and buffaloes.
- Action Taken Report on actionable points related to ICAR-NDRI, Karnal emerged out on the proceedings of the virtual CG-Review meeting held on May 4, 2020.
- Updated Action Taken Report on the proceeding of the video conference held with all Directors of ICAR Institutes under the chairmanship of Secretary DARE and Director General, ICAR, New Delhi held on April 10, 2020.
- Prepared Action Taken Report and agenda items for the conference of Directors of ICAR institutes held on December 5, 2020.
- Action Taken Report on the minutes of the meeting to review DARE/ICAR output and outcome monitoring frame work held at NITI Aayog in the month of December, 2020.
- Action Taken Report (English and Hindi) on recommendations emerged out with respect to ICAR-NDRI, Karnal during XXV meeting of ICAR Regional Committee-II held at ICAR-NRRI, Cuttak during June 26 to 27, 2020.
- Action Taken Report on recommendations emerged out with respect to ICAR-NDRI, Karnal during the XXV meeting of ICAR Regional Committee-III held during November 23 to 24, 2019 at Assam Administrative Staff College, Guwahati, Assam.

- Action Taken Report on the recommendations made during ICAR-Regional Committee No. I held on June 30, 2020 at ICAR-CPRI, Shimla.
- Action Taken Report on the issues raised by states/UTs during the XXV meeting of ICAR-Regional Committee No. II held on October 8, 2020.
- Action Taken Report on the recommendations made during the XXV meeting of ICAR-Regional Committee No. IV (UP, Bihar AND Jharkhand) held on November 27, 2020.
- Status of Action Taken Report on the issues raised by states during the meeting of ICAR-Regional Committee No. V held on December 7, 2020 at ICAR-CSSRI, Karnal.
- Status of Action Taken Report on actionable points related to ICAR-NDRI, Karnal emerged out in the meeting ICAR-Regional Committee No. V held on November 2 t0 3, 2018.
- Action Taken Report on the recommendations made during the ICAR-Regional Committee No. VI held from February 4 to 5, 2019 at AAU, Anand.
- Action Taken Report on recommendations emerged out with respect to ICAR-NDRI, Karnal during the meeting of ICAR Regional Committee-VII held during August 9 to 10, 2019 and May 21, 2020.
- Updated Action Taken Report on recommendations related to ICAR-NDRI, Karnal emerged out during the XXVI meeting of Regional Committee No. VIII held during September 6 to 7, 2019 at IIHR, Bengaluru.
- Action Taken Report on actionable points regarding supply of frozen semen of Sahiwal cows during XXV meeting of ICAR Regional Committee of Himachal Pradesh.

Collation: This Unit also consolidated the following information sought by the Council:

- Inputs related to information sought in Part B&C of the questionnaire for third party evaluation of ICAR-NDRI as Central Scheme between 2012-13 & 2019-20.
- Information on Review of Existing ICT Applications and needed modifications for submission to SMD ICAR for VC Meeting to discuss ICT applications in Agriculture on 4th May, 2020.
- Data on On-going research projects at NDRI involving environmental and sustainable aspects was prepared and provided to Joint Director (Academics) for getting it uploaded on Project Monitoring and Tracking System (PMTS) Website of NAHEP, ICAR.
- Externally Funded Projects (including ICAR grants and state level public funded grants) from ICAR-NDRI for the year 2019-20 and 2020-21 till September were prepared in the prescribed format for Quarterly Output-Outcome Framework to NAHEP-ICAR.
- Inputs for Prime Minister's vision on Agricultural research and ICAR preparedness.
- Plan of action and time frame applicable at Institute level on QRT recommendations (2013-2018).
- Information required for Hon'ble Union Agriculture Minister regarding Hon'ble Prime Minister Vision of Atmnirbhar Bharat and effort made by ministry of Agriculture/DARE-ICAR and ICAR preparedness.
- Inputs of the Institute on background Note prepared by Department of Animal Husbandry and Dairying (MoFAH&D) in August, 2020 for examination by Standing Committee Meeting on Agriculture (2019-20) for ensuring quality of milk and consumer grievance redressal mechanism in dairy sector.
- Inputs of the Institute on preparation and formulation of guidelines made by the ICAR for import of animal feed including DDGS.
- Inputs of the Institute on the suggestions endorsed by PM Office regarding CPGRAMS Case related to environmental deterioration due to livestock and poultry production.
- Information on nutritive value of milk and milk power.
- Inputs of the institute on the actionable points made by Task Force Committee on Agricultural Development.

- Information on activities / task / mission with regard to celebration of 75th Anniversary of India's independence.
- Inputs of the Institute on the draft standards on milk products.
- Report on the celebration of Mahila Kisan Divas celebrated on October 15, 2020.
- Inputs of the Institute to explore and suggest the opportunities modalities and steps for collaboration with Bureau of parliamentary studies and training (Parliamentary Research and Training Institutes for Democracies (PRIDE), Government of India.
- Information on good manufacturing practices for export of agricultural & marine products, plantation crops, and turmeric and coir.
- Information in terms of inputs of the Institute on actionable points of the first meeting of ICAR Committee constituted for providing inputs on Ease of Doing Business.
- Inputs of the Institute on DPV in animal feeding as pellet binder sought by Animal Husbandry and Dairying Krishi Bhawan New Delhi.
- Information on the details of societies and NGOs involved in Programmes/ Schemes/Projects implementation.
- Information regarding on-going and completed research projects of (MFPI) for uploading on ICAR website and inclusion in the meeting held with Additional Secretary DARE & DG, ICAR on 19th November, 2020.
- Information regarding Institute's activities undertaken in the states during the period (2014-20).
- Information with respect to ICAR-NDRI, Karnal for the 92 Annual General Meeting of ICAR Society.
- Information for publishing ICAR Achievements during 2014 to 2020-21 compared to 2007-2008 to 2013-14 and 2020-21.
- Information on list of points for written replies on demands for grant (2021-22) Ministry of Agriculture and Farmers Welfare (DARE).
- Information regarding the achievements of last three years.
- Information regarding research achievements of last 10 years of the Institute.
- Information regarding new initiatives undertaken for the growth of dairy sector.
- Information regarding minimizing the compliance burden for citizen and business activities with respect to ICAR–NDRI, Karnal.
- Inputs of the Institute on Draft proposal for continuation of central sector scheme “Agriculture and Processed Food Export Promotion Schemes of APEDA”.
- Inputs of the Institute on the draft Cabinet note for establishing National Research Foundation (NRF).
- Inputs of the Institute on the draft proposal Memorandum of Expenditure Finance Committee (EFC) for continuation of centrally sponsored scheme catered RAFTAAR.
- Inputs of the Institute on the draft Cabinet Committee on Economic Affairs Note for revising and realizing various components of white revolution scheme for next 5 years.
- Ranking of Agricultural University for Joint Director (Academics).
- Information on Nodal Officers at SMD, Scheme leaders and technologies suggested and short listed technologies developed during 2017-20 for third party evaluation at SMD level.
- Information on buffalo cloning projects.
- Slides for GB on achievements of NDRI for the period January-June, 2020.
- Documents of RAC (2013-19)/ QRT (last two years)/ Vision Documents 2030 and 2050/Annual Reports (2013-2019).

- Information for the Scientific Advisor participation in innovation excellence indicators frame.
- Information on implementation strategy of the action plan on the recommendations inter-ministerial committee on doubling farmers' income.
- Information for 15th Finance Commission regarding a status note on most significant achievements in XIII Plan and future research thrust during the period 2021-26.
- Information on research collaboration under special package development for successor union tertiary of Ladakh.
- Information on baseline survey on environment and social aspects at Agriculture Universities.
- Information on achievements of the Institute regarding number of patents applied/ granted/number of agri-entrepreneurs incubated new and graduated/skills imparted to farmers/number of young farmers trained through training programmes, dissemination of superior male germplasm/technologies transferred to the dairy stake holders and farming community.
- Information on technologies transferred during last three years by ICAR-NDRI.
- Information on training programmes conducted by NDRI, Karnal for the period (2017-21).
- Inputs on observation(s) and suggestion(s) made in the cabinet meetings with respect to ICAR-NDRI, Karnal.
- Information on programmes for ICAR Centenary celebration for the period 2020-2028.
- Questionnaire with respect NDRI, Karnal for the evaluation/assessment of ICAR Central Schemes/ Programmes for the period 2019-20 in prescribed format.
- Information regarding PM Money Transfer to farmers.
- Information on certain points for preparatory meeting held between India and Philippins.
- Information on regarding details of incubation centre of the Institute for the period (2012-13 to 2019-20).
- Information on regarding details of collaborative projects alongwith its activities undertaken at Institute.
- Information for ASD Interactive meeting with Directors of Animal Science Institutes held on 12th December, 2020.
- Information regarding accreditation of NBAL Laboratory existed at the Institute.
- Information regarding suggestions and inputs on the training modules designed and developed by ICAR Institutes under various SMDs.
- Information regarding Vaccines candidates/Diagnostics developed during last seven years.
- Information regarding list of points for written replies on demands for grants (2021-22), Ministry of Agriculture and Farmers Welfare (DARE) Lok Sabha Secretariat, New Delhi.
- Information Non DAPSC (SCSP) targets proposed and achieved (2020-21) sought by DG Office on various schemes running during past six years for the states of Rajasthan, Kerala, Tamilnadu, West Bengal and Assam.
- Information for constitution of the committee to examine the issue of dairy analogues.
- Information regarding ASCI for establishing centre of excellence (CoE) for dairy skilling at KVK, NDRI, Karnal.
- Information regarding coffee table book.
- Information regarding Swachchh Bharat Abhiyan for past five years (2015-16 to 2019-20) alongwith photographs.
- Information regarding non-bovine milk and their nutritive value-a road map.
- Information regarding nutritive value of milk and milk powder with respect to ICAR-NDRI, Karnal.

- Information on semen sexing research work being carried out at ICAR-NDRI,Karnal. Information on activities taken-up at ICAR-NDRI, Karnal during last ten years (2009-14) & (2014-19).
- Information on impact analysis of central sector schemes operated during 2017-20 with respect to EFC Scheme No. 24.
- Information for inputs to prepare concept paper on green strategic partnership between India and Denmark.
- Information on rationalization of Qualification Packs (QPs) in dairy segment and model curriculum..
- Information regarding update on compendium: Creating wealth from Agricultural waste.
- Information on the significance of fatty acids of milk fat v/s Olive oil.
- Information sought by Cabinet Secretary on improving the competitiveness of our economy and concerted efforts burden for citizens and business activities.
- Information on research work being undertaken on Camel.

Research Papers: Research papers submitted by the scientists were processed by the unit for publishing in various journals of National and International repute. In addition, a large number of abstracts of papers were also processed for presentation at various Seminars/ Symposia/Workshops/Conferences etc.

Parliament Questions: During the period under report, a total number of 26 parliament questions (Lok Sabha & Rajya Sabha) were attended.

Action Taken Report on 10 point agenda items in English and Hindi asked by Parliamentary Standing Committee on Agriculture on the performance review of NDRI and the same was submitted to Animal Science Division of the Council for onward submission to Parliamentary Standing Committee on Agriculture.

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.

Highlights of Major Activities of PME Unit

•	In-house Research Projects	:	85
•	New Research Projects	:	24
•	Externally Funded Projects (National)	:	69
•	Externally Funded Projects (International)	:	06
•	Externally Funded Projects Proposals Screened	:	88
•	Contract/ Consultancy Projects Proposals Screened	:	08
•	MoUs Screened/Signed	:	09
•	IRC Meetings Convened and Co-ordinated	:	02
•	Manuscripts of Technical Bulletins/Books Scrutinized/Evaluated	:	05
•	NDRI-Annual Report (2019)	:	01
•	Quarterly NDRI News Letter (4 Issues)	:	04
•	Proceedings of IRC	:	02
•	Proceedings of RAC	:	01
•	Reports Collated	:	53
•	Action Taken Reports/Status Reports	:	94
•	Half Yearly Reports	:	02
•	Parliament Questions Attended	:	26
•	Monthly Reports	:	12
•	Quarterly Reports	:	04
•	Assessment Cases of Scientists Handled	:	34

Research Projects 2020-21 (In-House)

SN	Project Title	PI
1)	Influence of different growth promoting factors and macromolecules on in vitro development of cattle embryos	S. K. Das
2)	Production of CRISPR-Cas9 mediated β-lactoglobulin gene edited buffalo embryos	Satish Kumar
3)	Exploration of buffalo estrus specific salivary miRNA for LAMP color reaction development	Suneel Kumar Onteru
4)	Genome-wide Association Studies to Identify SNPs for Lactation Persistency in Murrah buffalo using ddRAD approach	VikasVohra
5)	Assessment of Genetic Diversity and Trends for Performance Traits in Karan Fries Cattle	S. M. Deb
6)	Exploring the use of Panchagavya and Mesenchymal Stem Cells for treatment of diabetes and cancer in rats	D. Malakar
7)	Productivity enhancement in hill cattle (Badri) conserved by SC, ST and other communities of Uttarakhand (SC/ST Funded)	Vikas Vohra
8)	Strategic modelling of reference population for effective implementation of advanced selection strategies	G. R. Gowane
9)	Use of mesenchymal stem cells for prevention of mastitis and metritis in cattle	Dhruba Malakar
10)	Peptidomic surveillance of urine in Sahiwal cows to evaluate its antibacterial potential against staphylococcus aureus	Sudarshan Kumar
11)	Assessing Genetic Relationship among Production, Functional and Linear Type Traits for selection of elite sires in indigenous and crossbreds dairy cattle	Sabyasachi Mukherjee
12)	Genome-wide scan for Autozygosity, Selection signature and Genomic inbreeding in Karan fries and Sahiwal cows	Anupama Mukherjee
13)	Genetic evaluation of functional traits and their effect of production and reproductive traits of crossbred cattle interventions	Ajoy Mandal
14)	Elucidating the Dynamics of Phoenixin during Reproductive Cyclicity and Elements of Kiss1/KiSS1R & SMIM20/GPR173 system in bovine ovary	M. Mondal
15)	Deciphering the modifications in miRNA binding regin of DNA repair genes in concurrence with thermal stress among dairy cattle	Rani Alex
16)	Delineation of mucins and carbohydrates associated with salivary crystallization patterns at estrus in buffaloes	Vedamurthy G. V.
17)	Harnessing geothermal energy for cooling and Heating of Animal Shed	Pawan Singh
18)	Effect of biostimulation on puberty and reproductive performance of dairy cattle and buffaloes	M. L. Kamboj
19)	Elucidating the effect of Kisspeptin on onset of puberty and induction of estrus in Murrah buffaloes	Nishant Kumar
20)	Development of dairy based integrated farming system for income enhancement of small farmers	A. K. Mishra
21)	Effect of moringa supplementation on hastening puberty in buffalo heifers	A. K. Roy
22)	Development of on-farm remote monitoring sensor device and its evaluation to predict parturition in cows	S. Jeyakumar
23)	Monitoring various physio-pathological conditions by Infra RedThermography (IRT) in dairy animals for efficient management decision	MukeshBhakat
24)	Livestock-crop based technological interventions for empowerment of scheduled caste farmers in selected districts of Himachal Pradesh, Uttarakhand and Haryana (SC/ST Funded)	Arun Kumar Misra
25)	Improvement of Black Bengal goats for enhancement of productivity in eastern region of India products	A. Santra
26)	Augmentation of fertility in jersey crossbred cows through nutritional and hormonal interventions	M. Karunakaran
27)	Enhancement of socio-economic condition of Scheduled Caste farmers through livestock based integrated farming in Eastern India interventions	AjoyMandal
28)	Faster multiplication of Sahiwalgermplasm through OPU-IVF-Assisted Reproductive Technology	T. K. Mohanty
29)	Nutritional evaluation of some aquatic macrophytes available in lower Gangetic Plain Region for utilization as ruminant feed resources	A. Chatterjee
30)	Evaluation of oat and berseem varieties under different agronomic practices vis-à-vis management of nitrate toxicity	Rakesh Kumar
31)	Crop diversification through fodder crops to maximization of fodder yield, profitability and sustain soil health	Hardev Ram
32)	Effect of organic nutrients management on different fodder crops	Sanjeev Kumar
33)	Formulation and evaluation of milk replacers for kids with special reference to black Bengal Goat	M. K.Ghosh
34)	Evaluation of Seaweeds as novel products to augment ruminant production performance	Asit Das
35)	Therapeutic efficacy and immunomodulatory role of trisoidum citrate and nano-minerals supplementation of subclinical mastitis in dairy cows	A. Manimaran
36)	Evaluation of Moringaoleifera L. cultivars for quality fodder production under differential plant geometry in eastern Haryana	Rajesh Kumar Meena
37)	Supplementation of micronutrients on attaining early sexual maturity of males	GoutamMondal
38)	Priobiotics, Prebiotics and phytogenic medicinal extracts exploration of their role in augmenting neonatal calf gut health and growth performance	Sachin Kumar
39)	Flavour and taste ingredient as feed additives and their effect on feed intake and growth performance of cattle calves	Raman Malik

40)	Effects of ameliorant in rations with different levels of aflatoxin B1 on nutrient use, production performance and carryover rate in milk in bovines	ChanderDatt
41)	Utilisation of paddy straw as strawlage: a complete feed solution for dairy animals	NitinTyagi
42)	Evaluation of Herbal Plant mix vis-à-vis Herbal Plant Probiotic mix on the growth and health performance of young Jersey Crossbred Calves	Saroj Rai
43)	Effect of probiotic administration on male reproductive parameters and semen characteristics in male mice model	Gautam Kaul
44)	Technology of goat milk based functional beverage	Heena Sharma
45)	Elucidation of physico-chemical quality and neutraceutical properties of select indigenous cattle milk and ghee	LaxmanNaik N.
46)	Protein profiling of milk from native indigenous breeds (cow and buffalo) in relation to their bioactive potential	Rajesh Kumar
47)	Comparative evaluation of camel milk protein hydrolysates in combating diabetes	Sunita Meena
48)	Unveiling the microbial diversity of traditional Indian fermented milk product 'Dahi' through culturomic and metagenomic approaches	Rashmi H. M
49)	Development of nutria-cereal based protein rich probiotic dairy spreads and dips	Devaraja H. C.
50)	Development of direct vat set (DVS) probiotics for preparation of fermented mlk products	Chand Ram
51)	Development of colostrum whey-derived bioactive peptide ingredients and preparation of protein-rich fermented whey beverage	ShilpaVij
52)	Technology of spray dried camel milk preparations	A. K. Singh
53)	Preparation of polyphenols rich whey powder	Manoj Kumar C. T.
54)	Development of low cost farm level milk cooling system	P. S. Minz
55)	Development of processed cheese from milk protein ingredients	YogeshKhetra
56)	Development of fermented whey with enhanced bio accessible iron content	Writdhama G Prasad
57)	Development of mechanised feed and fodder distribution and feeding system	Ankit Deep
58)	Technology for Moringaoleifera enriched cheese spread	NeelamUpadhyay
59)	Technology Development for the Production of Ghee Residue Powder	G. S. Meena
60)	Development of automatic integrated hybrid solar yogurt making system	Chitranayak
61)	On-package smart sensor as freshness indicator for set-type fermented dairy products	NarenderRajuPanjagari
62)	Development of Convective-Electrohydrodynamic Drying System for Paneer	F. M. Eljeeva Emerald
63)	Valorization of ghee residue as a source of phospholipids for application in select food products	Monika Sharma
64)	Development of multipurpose automatic controlled rate heating system for production of paneer and Greek yogurt	Vairat Amita Dinkar
65)	Development of improved bioreactor prototype for cattle waste management	P. S. Minz
66)	Conducting polymer based rapid detection of microbial quality of milk	Raghu H. V.
67)	Development of analytical tools to assess quality of milk-protein based health supplements	Rajan Sharma
68)	Quality evaluation of butter and Ghee prepared from Milk of indigenous and cross bred cattle	Raman Seth
69)	Functional analysis of urine of indigenous vis-à-vis crossbred cows	Mamta
70)	Biological smart time temperature indicator for monitoring thermal abuse and quality of paneer	Gaurav Kr. Deshwal
71)	Detection of Sorbitol as an adulterant in milk	Priyanka Singh Rao
72)	Development of lateral flow immunoassay to detect buffalo milk in cow milk	Kamal Gandhi
73)	Isolation & screening of bacteriophages for removal of Bacillus &Geobacillus biofilm from dairy surfaces	Pradip Behare
74)	Automation on commercial dairy farm in North India: Farmers perspective appraisal	H. R. Meena
75)	Dairy extension delivery system in Karnataka state: A stakeholder analysis	S. Subhash
76)	Fodder crop management interventions through bio-fertilizers and Bio-pesticide for sustainable dairy farming	Asif Mohammad
77)	Impact assessment of COVID-19 pandemic on Indian dairy sector	Ganjan Bhandari
78)	Impact assessment of selected technologies of NDRI	Anil K. Dixit
79)	Development of climate services for Murrah buffalo farmers of Haryana	SanjitMaiti
80)	Sustainable Livelihood Development of Scheduled Caste Farmers through Livestock based Technological Interventions in Kolar District of Karnataka	S. Subash
81)	Improving adaptive capacity of women farmers of Haryana through climate resilient Dairy farming practices	Sanchita Garai
82)	Promotion of dairy farming for upliftment of socio-economic status of tribal farmers through technological interventions in Meghalaya	B. S. Meena
83)	Identification of indigenous milch breeds of cattle through computer vision	A. P. Ruhil
84)	Estimation of life time economics of selected breeds of dairy animals in field conditions	B.S.Chandel
85)	Probiotics, prebiotics and phytogenic medicinal extracts: Exploration of their role in augmenting neonatal calf gut health and growth performance	Sachin Kumar

EXTRA-MURAL FUNDING AND COLLABORATIONS

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

International Collaborations

S.N.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
1)	Molecular markers for improving reproduction of cattle and buffaloes (MMIRCB)	T. K. Datta	Rakesh Kumar, Dheer Singh, Suneel Onteru, Rubina K. Baithalu, A. K. Mohanty, Sudarshan Kumar, T. K. Mohanty, J. K. Kaushik & M. Bhakat	Bill & Melinda Gates Foundation, USA	2018-2023
2)	Molecular markers for improving reproduction of cattle and buffaloes	A. Kumaresan	A. Manimaran and K. P. Ramesha	(MMIRCB)-Bill & Melinda Gates Found., USA	2018- 2023
3)	Regulation of the Gonadotrophin-ovarian Axix by Kisspeptin-KISSI/ R System in Cattle and buffaloes	Mohan Mandal	-	Indo-Egyptian	2017- 2020
4)	Development of Probiotic fermented food for prevention of childhood diarrhea against Indian diarrheal pathotypes	Suman Kapila		Indo-Spain Project	2020-2023
5)	DOSA-Diagnostics for one health and user driven solutions for AMR	Naresh Kumar		DBT-Indo-UK	2018–2021
6)	Explaining the biogenesis and interaction of piRNAs and PIWI proteins in buffalo testes in relation to bull fertility	Rakesh Kumar (ChonkoSaetung, Asstt. Professor, Thailand)	T. K. Datta	SERB Funded, ASEAN-INDO collaboration	2020-2022

National Collaborations

S.N.	Title of the Project	Name of PI	Name of Associates	Funding Agency	Duration
1.	Network project on buffalo improvement-Institute herd	I. D. Gupta	Pawan Singh, T. K. Mohanty, Mukesh Bhakat and Vikas Vohra	(CIRB-Hisar)-ICAR	2017-2020
2.	Network project on buffalo improvement-Field Unit	S. M. Deb	I. D. Gupta, VikasVohra and Omvir Singh (CTO)	ICAR(CIRB-Hisar)	2017-2020
3.	Indigenous breed programme (Sahiwal cattle)	Anupma Mukherjee	A. K. Gupta. T. K. Mohanty, S. S. Lathwal, Mukesh Bhakat & Vikas Vohra	ICAR	2017-2020
4.	Conservation of indigenous pig of Assam through Handmade Cloning technique	Manoj Kumar Singh	-	DBT	2017- 2020
5.	Genetic variability of milk protein and its characterization by proteomic approach in Indian goats	S. De PI of Coop. Institute	SunitaMeena	NASF	2017- 2020
6.	Synthesis, characterization and effect of graded levels of nano-selenium supplementation on the performance of broiler chicken	A. K. Mohanty	Sudarshan Kumar	NASF	2017- 2020

7.	Proteo-Genomic Approach to Elucidate Productive and Reproductive Performance of MalnadGidda, Deoni and Hallikar Breeds of Cattle		K. P. Ramesha Mukund A. Kataktalware, S. Jeyakumar, A.Manimaran, D. N. Das, A. Kumaresan, Keshavaprasad and H. Gowda	Department of Animal Husbandry & Veterinary Services, Govt. of Karnataka	2017-2021
8.	Incentivizing Research in Agriculture-Project-V-Semen Sexing in Cattle	A. K. Mohanty PI of Component 'B'	Sudarshan Kumar	ICAR	2017- 2021
9.	Genome editing of MFGE8 and S100 genes in bovine mammary epithelial cells to understand their role in milk production	A. K. Mohanty Sudarshan Kumar, J. K. Kaushik, D. Malakar		SERB-DST	2018- 2021
10.	Global transcriptome and miRNA analysis for deciphering reasons for low cloning efficiency in buffalo	P. Palta; M. K. Singh (From 1 Oct. 2020)	M. K. Singh	SERB-DST	2018- 2021
11.	Production of multiple copies of elite buffalo bulls using animal cloning technology	P. Palta; M. K. Singh (From 1 Oct. 2020)	M. K. Singh, S. S. Lathwal and Subhash Chand T.O (Vety.)	NASF-ICAR	2018- 2022
12.	Tissue-specific mitochondrial biogenesis, transcriptomics and proteomics studies in buffalo	Sadeesh E. M	-	SERB-DST	2018- 2021
13.	Amelioration of infertility in dairy cows through nutritional and biotechnological interventions	M. Karunakaran Asif Mohammad, M. K. Ghosh, Mohan Mondal and AjoyMandal		DBT	2018- 2020 (upto 22.9.2020)
14.	Improving the usability of buffalo spermatozoa by sperm surface remodeling and immune acceptance in female reproductive tract	T. K. Datta	Rakesh Kumar, J. K. Kaushik, S. M. Deb, T. K. Mohanty and Sarika (IASRI)	NASF-ICAR	2018- 2021
15.	Development of a rapid and robust high throughput reporter cell based bioassay for detection of xenobiotics in milk	Dheer Singh	Suneel Kumar Onteru and Vedamurty G. V	NASF-ICAR	2018- 2021
16.	Mitochondrial DNA Haplotypes as candidate biomarkers for prediction of reproductive efficiencies in buffalo	Sadeesh E. M	Sudarshan Kumar and S. De	DBT	2018- 2021
17.	CRISPR/CAS9 guided functional analysis of genes regulation early embryonic in buffalo	D. N. Das (SRS) & D. Malakar	Satish Kumar	NASF	2018- 2021
18.	Development of early pregnancy diagnostic assay through discovery of biomarkers in cattle and buffalo	A. K. Mohanty and A. K. Dang	Rubina K. Baithalu, T. K. Mohanty, Sudarshan Kumar and Rajeev Kapila	DBT	2018- 2021
19.	Mastitis related antibiotic resistance pattern mapping in three districts of Haryana	S. De	Rakesh Kumar and Raghu H. V.	SERB-DST	2019- 2022
20.	Understanding extracellular vesicles (EVs) protein cargo of seminal plasma as a reason for poor fertility in cattle & buffalo bulls	Rakesh Kumar	T. K. Datt and MukeshBhakat	DST-SERB	2019- 2022
21.	Cow dung processing and its conversion to bio–fortified fertilizer: A pilot study	K.P. Ramesha	Mukund A. Kataktalware, Menon RekhaRavindran, S. Jeyakumar	National Fertilizer Limited (An Undertaking of Govt. of India), Noida	2018- 2021
22.	Targeted immobilization of Y-bearing spermatozoa and modulation of oviduct milieu for skewing sex ratio towards female offspring in dairy cattle	Rakesh Kumar	T. K. Datta and S.K. Das	NASF	2018 -2021
23.	National innovations on climate resilient Agriculture	Ashutosh	Mahendra Singh, S. S. Lathwal, Nishant Kumar, NitinTyagi, Ashwani Roy, Anjali Aggarwal, M. K. Singh, SunitaMeena, Rani Alex, B. S. Meena, RituChakravarty, Richa Singh, Sachin Kumar, MadhuMohini and BiswaBhaskar	(NICRA)-CRIDA	2020-2025

24.	Water budgeting and improving water productivity livestock based farming	Ashutosh	Mahendra Singh, SunitaMeena and Satish Kumar	ICAR	2015-2025
25.	Incentivizing Research in Agriculture" Project-V Semen sexing in cattle	T. K. Mohanty PI of Component -A	Pawan Singh, MukeshBhagat, A Kumaresan and Rubina K. Baithalu	ICAR	2017-2021
26.	Understanding the aetiology of infertility associated with prolonged follicle dominance in bovine and its therapeutic management	A. Kumaresan	Jeyakumar S, A. Manimaran and K. P. Ramesha	DBT	2018-2021
27.	Genomic and proteomics approached to develop specific diagnostic assay for detection of estrus/silent estrus in buffaloes	Rubina K. Baithalu	A. K. Mohanty, Sudarshan Kumar, T. K. Mohanty and A. Kumaresan	DBT	2018- 2021
28.	Targeted immobilization of Y-bearing spermatozoa and modulation of oviduct milieu for skewing sex ratio towards female offspring in dairy cattle	A. Kumaresan	S. Jeyakumar, A. Manimaran and K.P. Ramesha	NASF-ICAR	2018- 2021
29.	Identifying factors affecting health behaviour of tribes of Uttarakhand and developing dairy based interventions to improve their health and livelihoodstatus	Nishant Kumar	Pawan Singh, S.S. Lathwal, M.L. Kamboj, T.K. Mohanty and K. Ponnusamy	ICMR	2019-2022
30.	Detection of sub-estrus / anoestrous behavior in water buffalo	T. K. Mohanty	MukeshBhakat	ICAR - Extramural Grant	2020-2022
31.	Exploring molecular basis of Seasonal variation of Seminal Attributes and Identification of potential Biomarkers for Selection of Buffalo Bulls with Quality Semen	Pawan Singh	ManishiMukesh, Rajeev A K Aggarwal and A.K.Tyagi	DBT	2020-2023
32.	Study of fodder crop assessment for dairy industry and potential areas of intensification of state level-Space Application Centre	Magan Singh PI of NDRI Component	Sanjeev Kumar and V. K.Meena	Ahmedabad	2016– 2020
33	Veterinary type culture collection-Rumen component	Sachin Kumar	NitinTyagi	ICAR NRC Equines	2016– 2022
34.	Up gradation of methane emission factors for Indian livestock and preparation of inventory of GHGs emission from Indian livestock	MadhuMohini	Gautam Mondal	MoE&F	2016 - 2020
35.	Manipulation of rumen microbes using medicinal plants extract to enhance the nutraceautical value of milk as a functional food	A. K. Tyagi	Sachin Kumar, Nitin Tyagi and Sumit Arora	DBT	2017 – 2020
36.	Utilization of crude glycerol obtained in biodiesel production as an alternate to glycogenic feed supplement for dairy cows	B. Srinivas	S. N. Sondur (KSCST, IISc, Bangalore)	DST Colloborative project: ICAR-NDRI & KSCST, IISc, Bengaluru	2017-2021
37.	Scheme on dairy microbes under Network Mode	S. K. Tomar	P. V. Behare	ICAR	2010-2022
38.	Bile responsive proteo-transcriptomics investigation of native probiotic strain lactobacillus helveticus MTCC-5463	P. V. Behare	A. K. Mohanty, Sudarshan Kumar and J. B. Prajapati (AAU)	SERB	2017-2020
39.	Development of edible antimicrobial packaging films for traditional dairy sweetmeats using metabolites of lactic acid bacteria	DiwasPradhan	Rashmi H. M and P. N. Raju	DST	2017 –2020
40.	Valorization of industrially produced soybean and groundnut de-oiled meals/cakes by extraction, purification and production of protein isolates	SumanKapila	Sanket Borad	NASF	2018 –2021
41.	Development of immunomodulatory-exopolysaccharides containing healthy fermented Dairy Foods	PradipBehare	S. K. Tomar, Shaik Abdul Hussain and Suman Kapila	MOFPI	2019- 2021
42.	Development of flaxseed-rich probiotic dairy foods to address menopause symptoms	Dr. Sangita Ganguly	Dr.Neelam Upadhyay	DST	September 8, 2020 to Sept. 7, 2023
43.	Evaluation of the efficacy of oral probiotics supplementation in children with Autism Spectrum disorders (ASDs): a randomized double blind, placebo controlled trial	Rashmi H. M.	Sunita Grover (till 31st July 2020)	ICMR	2019-2021

44.	Development of methods to assess the chemicals migration from the packaging used for dairy products	Rajan Sharma	Bimlesh Mann, Kamal Gandhi and Narender Raju Panjagari	MOFPI	2019-2020
45.	Elecrohydrodynamic encapsulation of probiotics in prebiotic nanofibres for food applications	P. Heartwin Amaladhas (CCPI- Sachin Kumar)	NitinTyagi	DST	2020-2023
46.	Prevalence of Antimicrobial resistance in dairy starter bacteria in Haryana region	Diwas Pradhan	Rashmi HM and Mr.Saurabh Kadyan	ICMR	2019-2022
47.	Resveratrol and catechins-loaded niosomes and nanoparticles as delivery vehicle for fortification of milk and milk products	P. Heartwin Amaladhas	N. LaxmanaNaik, F. M. E. Emerald, Subramanian Natesan and K.R. Ruckmani (Anna University)	NASF	2017-2020
48.	Process development for production of dipeptidyl peptidase-IV (DPP-IV) inhibitory peptides from milk of Gir Cows and their encapsulation through double emulsification technique	Satish Kumar M. H. (CCPI-LathaSabikhi)	B.C. Ghosh, Laxmana Naik, N CC Associates: Yogesh Khetra, Shaik Abdul Hussain and SunitaMeena	NASF	2018-2021
49.	Development of Calcium enriched high milk protein powder for convenience formulations of traditional dairy products	SumitArora	Vivek Sharma,. Ashish Kumar Singh and. G. S. Meena	MOFPI	2019-2021
50.	Development of Functional Traditional Sweetmeats Through 3-D Food Printing	Kaushik Khamrui, JatindraSahoo, Associate Professor, IIT-Delhi	Writdhama Prasad	ICAR-IITD	2019-2022
51.	Process technology for instant mixes for varieties of Payasam, Kheer and Phirni using Dry Crystallisation Approach	MenonRekha Ravindra	Monika Sharma and Devraja H.C.	MOFPI	2019-2020
52.	Monitoring of drug residues and other environmental pollutants-outreach project	Naresh Kumar	Raghu H. V.	ICAR Fund	2017-2020
53.	Surveillance of dairy products for Antibiotic resistant zoonotic bacterial pathogens under field conditions	Raghu H. V.	Rashmi H. M.	SERB-DST	2018 –2021
54.	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
55.	Upliftment of socio-economic condition of tribal people through integrated livestock farming in north eastern hill region/eastern part 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	ICAR	2017-2020
56.	Improving the livelihood through dairy f arming 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. Behare, Chander Dutt, S. Bandopadhyay (IVRI-ERS-Kolkata) Samiran Bandopadhyay (IVRI-ERS-Kolkata), S. Naskar (IVRI-ERS-Kolkata) and P. Dandapat (IVRI-ERS-Kolkata)	ICAR	2017-2020
57.	Capacity building of resource for farmers in paddy-wheat cum dairy production system through Farmer First Programme	GopalSankhala	A. K. Singh, Heena Sharma and SangitaGanguly, B. S. Meena, Ajmer Singh, S. S. Lathwal,	ICAR	2016-2020

			Rakesh Kumar H. R. Meena, Nitin Tyagi, V. K. Pandita (IARI, R. C. Karnal)		
58.	Improving livelihood of rural women through dairy based secondary agriculture	K. Ponnusamy	Latha Sabikhi and G. S. Meena	DST	2017-2021
59.	Enriching knowledge-integrating technology and institutions for holistic village development in horticulture based farming system	B. Balakrishna, IIHR, Benagluru	M. C. A. Devi and S. Subhash	ICAR	2016–2020
60.	Policy imperatives for promoting value chains of agricultural commodities in India	A. K. Dixit	A. K. Singh, Gunjan Bhandari and A. K.Sharma	ICAR	2018–2021
61.	Livelihood vulnerability to climate change among the changpa pastoral nomads of Leh-Ladakh	SanjitMaiti	K. S. Kadian, Sanchita Garai and Mukesh Bhakat	ICSSR	2018 – Sept.2020
62.	Farmer participatory assessment of cost effective solution for management of ticks and mites in dairy dairy animals	K.Ponnusamy	T. K. Mohanty and S. Raju	NIF-India	2019-2020
63.	Nurturing latent agro-animal based entrepreneurship among the Youth in Mewat district of Haryana	H. R. Meena	K. S. Kadian, B. S. Meena and Gunjan Bhandari	RKVY-RAFTAAR	2019- 2020
64.	Formulating coping up strategies for extreme weather events in Sundarbans region through livestock based Integrated Farming System: A societal perspective	Asif Mohammad	T. K. Dutta, and A. Chatterjee	ICSSR	2019–2021
65.	Evaluation and impact of dairy farmer collectives in Gujarat: A study in Saurashtra and Kutchh Regions	Ravindra Malhotra	UditaChaudhary, A. K. Dixit, Ritu Chakravarty, Gunjan Bhandari and Avinash Ghule (RA at IRMA)	VKCoE at IRMA	2019- June 2021
66.	Empowering farmers through selective interventions in salt affected agroecosystems of Ghaghar Plains Farmers FIRST Programme	SohanVir Singh (CCPI)	K. Ponnusamy	Funded by ICAR	2018-2021
67.	Mitigation of stubble burning through Custom Hiring Centers for Agricultural Machinery in Trans-Gangetic Plains Region	H. R. Meena	K. S. Kadian, B. S. Meena, Gopa lSankhala and GunjanBhandari	ICSSR	2019-2021
68.	Impact of mineral mixture on performance of dairy animals-	B. S. Meena	K. S, Kadian, H. R. Meena, A. K. Dixit and Sachin Kumar	ICAR Network Project	2019-2021
69.	Development of Dairy Business School Model for Farmers: An Action Research	Gopal Sankhala	A. K. Singh, Gaurav Deswal, S. S. Lathwal, T. K. Mohanty, K. S. Kadian and Hema Yadav,Director (NIAM)	National Institute of Agricultural Marketing (NIAM) Jaipur	2020-2021

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.

ITMC Meetings Conducted

- 44th ITMC meeting was held on February 7, 2020.
- 45th ITMC meeting was held on June 6, 2020.
- 46th ITMC meeting was held on September 11, 2020.
- 47th ITMC meeting was held on December 17&18, 2020.

At these meetings, pricing of technologies and examination of patent applications for their novelty and commercial applicability before filing patent applications were taken-up. A total of 28 new technologies developed at ICAR-NDRI were approved for commercialization.

During the year 2020, a total of 09 technologies developed at the Institute were transferred to 05 commercial houses through 09 different License agreements, thereby, earning a total of Rs. 19.95 lakh (excluding Service Tax) for the Institute through technology transfer fee. The lists of technologies transferred and other activities are as follows

Technology Approved for Commercialization (2020)

1) "Technology for Omega-3 rich mixed fat table spread" (Inventors: Neelam Upadhyay, Kuldeep Kamble and A K Singh) Dairy Technology Division, ICAR-NDRI, Karnal.
2) "A PCR based method for differentiating A1 &A2 Milk" (Inventors: Sachinandan De, Kailash Jaiswal) ABTC, ICAR-NDRI, Karnal.
3) "Technology for spreadable butter fortified with vegetarian source of omega-3 fatty acid" (Inventors: Monika Sharma) Dairy Technology Section, SRS, ICAR-NDRI, Bengaluru.
4) "Spore based strip for rapid detection of β-Lactum group in milk". (Inventors: Naresh Kumar and Prashant Goel) Dairy Microbiology Division, ICAR-NDRI, Karnal
5) "Technology of extended shelf-life sorghum lassi". (Inventors: Shaik Abdul Hussain and F.C. Garg) Dairy Technology Division, ICAR-NDRI, Karnal
6) "Lipid and Water soluble yellow natural colouring ingredients from bio-waste". (Inventors: Neelam Upadhyay, Swati Tiwari, Hemant Thawkar, Ashish Kumar Singh and Ravinder K Malhotra) Dairy Technology Division, ICAR-NDRI, Karnal
7) "Technology for the preparation of encapsulated flaxseed oil for its application in foods". (Inventors: Neelam Upadhyay, Hemant Thawkar, Ganga Sahay Meena and Ashish Kumar Singh) Dairy Technology Division, ICAR-NDRI, Karnal

8) "Production of buffalo milk-based milk protein concentrate 60 (MPC 60) powder with improved solubility". (Inventors: Ganga Sahay Meena, Shinde Ankush Punjaram, Neelam Upadhyay, Yogesh Khetra, Sanket G Borad and Ashish Kumar Singh) Dairy Technology Division, ICAR-NDRI, Karnal

9) "Buffalo Saliva Scope, an estrus identification kit". (Inventors: Suneel Kumar Onteru, Dheer Singh, Ravinder and S. Gangu Naidu) Animal Biochemistry Division, ICAR-NDRI, Karnal

10) "Electrospun Smart Oxygen Indicating Tag". (Inventors: Narender Raju and others) Dairy Technology Division, ICAR-NDRI, Karnal.

11) "Technology for preparation of milk based spray dried Nanoencapsulated curcumin formulation". (Inventors: Bimlesh Mann, Ankita Hooda, Rajan Sharma, Rajesh Kumar and Richa Singh)

12) "Additive combination for improvement in quality of sugarcane tops silage". (Inventors: Nitin Tyagi, Digvijat Singh, Nutan Chauhan, Neelam Kumari, Pradip Vishnu Behare, Sachin Kumar, AK Tyagi)

13) "Technology of Ricotta cheese from buffalo milk". (Inventors: Sangita Ganguly, Bhagwat Sameer Kisan, Yogesh Khetra, Latha Sabikhi and PN Raju)

14) "Technology of probiotic Ricotta cheese from buffalo milk". (Inventors: Sangita Ganguly, Yogesh Khetra, Latha Sabikhi and PN Raju)

15) "Technology for preparation of cow milk protein powder based Sandesh". (Inventors: Sumit Arora, Amrita S., Vivek Sharma, Hemant Gawande, Rita, AK Singh)

16) "Preparation of milk kefir/whey kefir drink". (Inventors: B C Ghosh, M H Sathish Kumar, Sonanki Mitra and Abila)

17) "Technology for the preparation of spray dried whey protein concentrate-iron (WPC-Fe) complex fortified biscuits". (Inventors: Kamal Gandhi, Indrajeet Singh Banjare and Sumit Arora)

18) "Strip based technology for early detection of sub-clinical and clinical mastitis". (Inventors: Naresh Kumar, Kirti Dua and Bhawani N)

19) "Spore based technology for rapid detection of antibiotic groups in milk and aqua-products". (Inventors: Naresh Kumar, Ramya S, S Shaikh and Raghu, H V)

20) "Lateral flow assay-based method for rapid detection of presence of buffalo milk in cow milk". (Inventors: Rajan Sharma, Archana Verma, Nitin Shinde, Kamal Gandhi and Bimlesh Mann)

21) "Trace mineral fortified Anionic mineral mixture for advanced pregnant cattle and buffaloes". (Inventors: Venna Mani, Harjit Kaur, A K Tyagi and Chander Datt)

22) "Native vitamin B_{12} producing *Lactobacillus reuteri* NCDC 958/VTCC610B for production of vitamin B_{12} bio-fortified soy curd". (Inventors: S K Tomar, Manorama Kumari, Harshil Kumar Patel and Pradip V. Behare)

23) "High Immunoglobulin colostrum powder". (Inventors: A K Singh, Sanket Borad, Latha Sabikhi, P N Raju, Sudhir Kumar Tomar and Sumit Arora

24) "Goat milk-based Spiced cheese rolls". (Inventors: A K Singh, Atanu Das, Latha Sabikhi, P N Raju, Sumit Arora, Sanket Borad and Heena Sharma

25) "Goat milk based probiotic yoghurt". (Inventors: A K Singh, Dharani Kumar M, Latha Sabikhi, P N Raju, Sumit Arora, Sudhir Kumar Tomar, Heena Sharma and Gaurav Kumar Deshwal)

26) "Giloy-goat milk beverage". (Inventors: Heena Sharma, A K Singh, Sanket Borad, Gaurav Kumar Deshwal and Sunita Meena)

27) "Indigenous probiotic strain *Lactobacillus plantarum* Lp91 (MTCC 5690)". (Inventors: Sunita Grover, V K Batish and Rashmi H M)

28) "Indigenous probiotic strain *Lactobacillus fermentum* Lf1 (MTCC 5689)". (Inventors: Sunita Grover, V K Batish and Rashmi H M)

Technology Transferred during (2020)

S.N.	Name of the Technology	Date (through Agrinnovate)	Name of the firm
1)	Misti Doi with fast acidifying high sugar tolerating lactic culture(s)	01.03.2020	Milky Mist Dairy Food Pvt Ltd., Chennai
2)	A new strip based test for detection of neutralizers in milk	01.03.2020	J. K. Scientific Industries, Ambala Cant
3)	Strip based test for detection of hydrogen peroxide in milk	01.03.2020	
4)	Strip based test for detection of maltodextrin in milk	01.03.2020	
5)	A new rapid test for detection of detergent in milk	01.03.2020	
6)	Misti Doi with Fast Acidifying high sugar tolerating lactic culture(s)	02.09.2020	VRS foods Limited, New Delhi
7)	Ready to Reconstitute Rasmalai Mix	02.09.2020	Chandigarh Sweets Limited, Chandigarh
8)	Ready to Reconstitute Kheer Mix	02.09.2020	
9)	Arjuna Herbal Ghee	23.10.2020	Mishti Farmer Producer Company Limited, Karnal

Patent Filed (2020)

S.N.	Application. Registration No.	Inventors of the Patent	Name of Innovation, Technology, Product, Variety	Date of Filing Registration
1)	202011006420	Naresh Kumar, Karanpriya	Paper strip-based sensor for detection of heavy metals in Milk	14.02.2020
2)	202011008229	Ashok Kumar Mohanty Vinod Kumar Yata, Bhanu Prakash, Vibhav Katoch	Microfluidic device for enrichment of live and motile spermatozoa of cattle	27.02.2020
3)	202011023895	AK Mohanty, Abhishek Parashar	Detection of BCM-7 peptide in urine sample by aptamers	08.06.2020
4)	202011026145	AK Mohanty, Munna Lal Yadav Sudarshan Kumar	Novel peptide sequence and generation of polyclonal antibody against Pregnancy Associated Glycoprotein 7 (PAG-7) for pregnancy diagnosis in bovine	22.06.2020
5)	202011033806	Bimlesh Mann, Ankita Hooda, Rajan Sharma, Rajesh Kumar and Richa Singh	Milk based spray Dried nanoencapsulated curcumin formulation and method thereof	07.08.2020
6)	202011033807	Ravi prakash and Menon Rekha Ravindra	A pail for cooling milk simultaneous to milking	07.08.2020
7)	202011046532	Chitranayak, Prashant Sourav Minz, AK Singh, endo-exo unit for dahi Jitender Kumar Dabas and Amita Dinkar Vairat	Development of pH - controller based automated	26.10.2020
8)	202011054432	Raghu, Anjali M.K., Mohit Singh, Bharath G., Naresh Kumar	A paper strip sensor for detection of E.Coli and total Plate Count (TPC) in milk using PANIPAC	15.12.2020

Request for Examination of Patents filed (2020)

S.N.	Application. Registration No.	Inventors of the Patent	Name of Innovation/ Technology / Product. Variety	Date of Filing Registration	Remarks
1)	202011008229	Ashok Kumar Mohanty Vinod Kumar Yata, Bhanu Prakash, Vibhav Katoch	Microfluidic device for enrichment of live and motile spermatozoa of cattle	27.02.2020	Request for examination submitted to Indian Patent Office, New Delhi on 08.06.2020
2)	201711036404	Y.S. Rajput, D.K. Nanda and Rajan Sharma	A cross-linked membrane with flow-line capable of arresting free-flowing gold nanoparticles and the process for the same	13.10.2017	Request for examination submitted to Indian Patent Office, New Delhi on 07.08.2020
3)	201811004766	Surendra Nath Battula, Jaya Sravani Vankayala,	Stabilization of non-ionic surfactant based Nanovesicles	08.02.2018	Request for examination

		Ruchmani Kandasamy, Grover Antoniraj, Mariya Antoniraj, Pushpadadass Heartwin Amaladhas, Naik Laxman Naik, Franklin Magdaline and Eljeeva Emerald	loaded with resveratrol using stearic acid and method of preparation thereof.		submitted to Indian Patent Office, New Delhi on 07.08.2020
4)	201811021472	Ravi Prakash, Chikkamutharayappa, guruvanna Mahesh kumar, Kerekoppa Puttaiah Bhaatta Ramesha, Giriyapura Basavarajappa Darshan, Menon Rekha Ravindra, Battula Surender Nath and Pushpadass Heartwin Amaladhas	Design and development of nanofluids based extended surface module and milk cooling.	08.06.2018	Request for examination submitted to Indian Patent Office, New Delhi on 07.08.2020
5)	201811023361	Narender Raju Panjagri, Shivam Panwar, Ashish Kumar Singh, Preashant Saurab Minz, Richa Badola and Gaurav Kr Deshwal	A biopolymer based electrospun Oxygen indicator for Dairy Products Packing	22.06.2018	Request for examination submitted to Indian Patent Office, New Delhi on 07.08.2020
6)	201811030055	Rajan Sharma, YS Rajput, GP Brath and Bimlesh Mann	An Indicator and the indicator impregnated strip for detection of neutralizers in milk	10.8.2018	Request for examination submitted to Indian Patent Office, New Delhi on 07.08.2020
7)	201711030808	Shilpa Vij, Arun Beniwal, Priyanka Saini and S. De	Construction of Mutant Strain of Kluyveromyces marxianus for Enhanced Galactose Utilization.	31.08.2017	Filing of Request of examination at Indian Patent office, New Delhi on 26.10.2020

Patent Granted (2020)

S.N.	Title of the application	Name of the inventors	Application number	Date of filing	Grant Number	Grant Date
1)	A process for bioethanol production by immobilized stress tolerant microorganism	Minakshi Dahiya, Shilpa Vij	3710/DEL/2011	19.12.2011	332454	19.02.2020
2)	Oil in Water Curcumin Nanoemulsion and Method of Preparation Thereof	Bimlesh Mann, Rajan Sharma, Rajesh Bajaj	201611018434	30.05.2016	345401	28.08.2020
3)	Aptamers specific for betacasomorphin - 7 (BCM 7)	Y. S. Rajput, Abhishek and Rajan Sharma	3703/DEL/2013	18.12.2013	354948	31.12.2020

Technology Transfer Events

Transfer of technology of "Ready to Reconstitute Rasmalai Mix & Ready to Reconstitute Kheer Mix" to M/S Chandigarh Sweets Limited, Chandigarh on 02.09.2020

Transfer of technology of "Rapid Detection of Various Adulterants (4 Nos.)" to M/s J.K. Scientific Industries, Ambala Cantt. on 07.03.2020.

ENTREPRENEURSHIP DEVELOPMENT, BUSINESS INCUBATION ACTIVITIES AND CONSULTANCY SERVICES

Contract Research

Institute is engaged in active collaboration with industry, government agencies and other stakeholders for executing the research projects on mandated areas. Four contract/ collaborative research projects with government and private organizations were initiated. The total budget outlay of these projects is Rs. 79, 60, 557/- only. One of he major achievements of the collaborative project is the launching of “Curd Maestro” a refrigerator by Samsung. Experimentation and validation trials by the ICAR-NDRI, Karnal assisted in development of world's first refrigerator with an attachment for making curd and yoghurt. Samsung has launched the refrigerator as **“Curd Maestro”** in Indian market and sold more than 1.5 lakhs units in last financial year. The projects are listed hereunder:

Sponsoring Agency	Project Title	Principal Investigator	Budget Outlay (Rs.)
Director, National Accounts Division, National Statistical Office, Ministry of Statistics & Plan Implementation, Sardar Patel Bhawan, Parliament Street, New Delhi	“Estimation of production and utilization pattern of milk and milk products in India” (2019-2022)	Dr. Ajmer Singh, DES & M Division	61,92,735/-
Predicteye Research India Pvt. Ltd., H.No.99/2,2ndFloorGaliNo.05, Near Sai Mandir Laxmi Nagar, New Delhi-110092	Real-time early detection of Mastitis in dairy animals based on somatic cell count using Hyper spectral Camera IOT sensors deve loped by predicteye Research India Pvt. Ltd.” (2020)	Dr. Naresh Kumar, DM Division	7,63,052/-
M/s Samsung Electronics India Ltd., two horizon centre, DLF phase-5, sector-43 gurugram-122202	Development of easy paneer maker (2020)	Dr. A.K. Singh DT Division	3,90,875/-
M/s Samsung Electronics India Ltd., two horizon centre, DLF phase-5, sector-43 gurugram-122202	Generation of basic engineering properties data and process validation of curd maestro refrigerator suitable for India, US and European market (yoghurt maker 2.0) (2020)	Dr. A.K. Singh DT Division	6,13,895/-

Consultancy Assignments

Institute is offering both general and advisory consultancy to individuals or organization on various aspects of dairy production, processing and management. The faculty and scientists of the institute has executed 8 consultancy assignments with different private companies, multinationals, start-up companies and government organizations. The total budget of these assignments is Rs. 11,81,082/- only.

Contract Services Executed

The Institute is assisting stakeholders through offering the services of analysis, supply of testing kits, cultures and custom hiring of equipment. Through contract services institute has served to 60 organizations, individuals and industries and generated revenue amounting to Rs. 8.45 lakh only.

SN	Organization/Client	Title of Consultancy	Principal Consultant	Total Amount
1)	M/s Inventis Technosys Pvt. Ltd., Mohali, Chandigarh	Vetting of design & layout for establishment of Food Lab. at HSIIDC, Sonipat'	Dr. Rajan Sharma, DC Division	23,600/-
2)	Mr. Jayanta Chakrabarti, Sr. Manager-Business Development, Shree Meera Lab. Pvt. Ltd., Chennai	'Various cleaning needs of milk processing plants in India'	Dr. G.S. Meena & Dr. G.K. Deswal, DT Division	5,900/-
3)	Indifoss Analytical Pvt. Ltd, Ahmadabad, F/1, F/2, F/3 science square above reliance fresh, science city road, sola Ahmadabad	" Validation of lateral flow kit for detection of aflatoxin M1 in milk"	Dr. Rajan Sharma, DC Division	4,51,291/-
4)	Senior Manager Infrastructure Corporation Ltd. Industrial Estate, Refinery Road, Panipat	"Vetting of bid P & M contract of Cold Storage (1000 MT) and Sorting grading Line of PPC' to be installed by HSIIDC, Panipat	Dr. J.K. Dabas, DE Division	51704/-
5)	Prompt Equipment Pvt. Ltd. 3-B, Vardan exclusive near stadium petrol pump, Narangpura, Ahmadabad, Gujrat-380014	"Testing of milkocheck liquid for its suitability in calibration of ultrasonic milk analyzer"	Dr. Rajan Sharma, DC Division	1,61,129/-
6)	M/S A.A. Agro Tech Solutions Hisar	Advisory Consultancy for Setting up of Milk Processing Plant and Trends in processing, packaging and quality improvement of Human Resource	Dr. P.N. Raju Mr. GK Deshwal	11210/-
7)	Chr. Hansen(I) Pvt. Ltd, 6th floor, B-605/606	"Evaluation by NDRI of lactic acid bacteria strains for technological properties in various applications like dairy"	Dr. Pradip Behare, DM Division	3,19,898/-
8)	M/s Brenntag ingredients(India) Pvt. Ltd, 12th Floor, Tower – B, Vatika Towers, Golf Course Road, Sector 54, Gurugram, Haryana 122003	Effect of targeted acidulant replacement on the quality of cottage cheese/paneer	Dr. A.K. Singh, DT Division	1,56,350/-

Capacity Building Programmes

ABI and SINED (TBI) is also coordinating and organizing short and long-term training programme for entrepreneurs, students from other universities and educational institutions, officials from industry and government organization and other development agencies. Due to Cocid-19 pandemic institute could not organize off-line training programme for the stakeholders. However, realizing the need, three Entrepreneurship Development Programme (EDP) were organized in the area of "Commercial dairy farming" and one on "Milk processing &value addition", which was attended by 60 participants from different parts of the country. A total of 18 students from other universities and educational organization were imparted training from 1to 6 months duration in various divisions and sections of the institute during the period. All these trainings were on payment basis except for the students form State Agriculture Universities and ICAR Deemed Universities. The total revenue from the training programme was Rs. 6, 40, 000/- only.

Entrepreneurship Promotion among the Students of ICAR-NDRI

- Under Student Ready Programme as per the suggestion of 5th Dean Committee UG students were provided mentor support (Faculty & Staff of MDP) for development of technological packages for value added dairy products. B. Tech. IVth year students participated in the programme and worked under the guidance of mentors to develop the technology of Carrot-Milk Powder, Fermented Traditional Beverage (Rab), Instant mixes for Milk-Rice/Refined wheat flour based traditional sweets (Mal pua & Till peetha), heat desiccated caramelized beverage and goat milk based beverages. The students conducted consumer acceptance studies and based on the feedback formulation and processing parameters were also modified.
- An interactive session for introducing the BIG BIRAC scheme was organized in collaboration with Society for Innovation in Entrepreneurship (SINE), IIT Mumbai as a part of BIG 17 outreach program. The programme was attended by the students, faculty and entrepreneurs of the institute. About 8 students have applied for the award and two of them awarded the funds under the BIG BIRAC scheme.

- An interactive session with the experts of DuPont was arranged on 3rd September, 2020 for the students of ICAR-NDRI, Karnal for discussing the modalities of **'DuPont NutriScholars Awards'** program initiated by DuPont Health & Biosciences across pan-India for the academic year 2020-2021 to endorse innovation in the protein foods amongst food science and technology students across Indian universities and institutes.
- Under Business Incubation activity, out of 12 proposals received, 3 were enrolled for the support. These include Mr. Shradha Jamwal under BIG BIRAC scheme, M/s Florecer Services Pvt. Ltd., New Delhi and Dr. Mnna Lal Yadav under BIG BIRAC scheme. Other proposals are under considerations. Mr. Munna Lal Yadav and M/S Florecer Services Pvt. Ltd., granted the "Star-up" status by DIPP.

Success Story of Incubatees and Entrepreneurs of Agribusiness Incubation (ABI) & SINED (TBI)

Nutrimeal/Silage Agro Pvt. Ltd.

A company established in 2015 by two engineering graduates and one economist with the aim to produce silage and make it available throughout country. The company has initiated contract farming to source maize for silage making, invested for creation of infrastructure and plant & machinery. Within a span of five years company has established 6 processing unit, sourcing raw materials grown in 6000 acre, produced 0.25 MT of silage and provided it to more than 0.20 million animals. ICAR-NDRI, Karnal in collaboration with ABI of ICAR-IARI, New Delhi supported them technically. Our scientists provided them information regarding the improvement and preservation of silage quality, alternate crops for silage making, prospective additives for silage manufacture and quality checks. From a start-up company to the largest silage manufacturer; now they are planning to expand their business by enhancing the capacity to produce 0.30 MT silage annually. Besides these, they are exploring the possibility of use of alternative crops and their residues for silage production, strategic interventions to minimize the aflatoxin content with ICAR-NDRI, Karnal. They are the pioneer in introducing the sugarcane and wheat silage in the country.

Mandakini Milk

In 2017 after completing an EDP programme on commercial dairy farming Mr. Sidhhant Vinod, a commerce graduate from Delhi University started a small dairy farm with just 15 cows at the outskirt of Lucknow city of Uttar Pradesh. Now the farm has around more than 100 animals belonging to Sahiwal, Gir, Rathi and Red Sindhi breeds of cows; delivering 700 Litres of milk per day in pasteurized and packaged from. During the entrepreneurial journey faced several challenges like scientific management of animals, availability of feed & fodder, lack of trained manpower and stiff competition in market. NDRI, Karnal assisted them by offering technical inputs, problem solving and guiding at crucial juncture. Realizing that liquid milk will no longer be a profitable proposition, the company shifted to value added dairy products and launched desi ghee, paneer and curd. Their business plan included quality fodder production on leased lands, adoption of advanced breeding technologies and creation of efficient supply chain.

Revnar

An integrated farming system based "Enterprise" Revnar was established in 2018 by Ms. Milan Sharma; a post-graduate in biochemistry and worked with German Embassy. Before venturing into dairy farming Ms. Milan attended EDP programmes on "Commercial Dairy Farming" and "Milk & Milk Product Processing" organized by ABI in collaboration with SINED (TBI), NDRI; Karnal. Journey started with 4 cows which increased to 170 by the end of 2020 and 200 L/day milk production. Cows in her farm are of indigenous breeds, which are reared by employing scientific management practices including feeding, disease management, breeding and unique blend of traditional knowledge with modern science. Development of local community is their prime objective and thus besides offering job, assisting them in transforming their agricultural practices to the one based on organic farming principles. Mrs. Milan has developed her own innovative methods for waste utilization, resource optimization; water recharging and agronomical practices for growing oilseeds, pulses and fodder crops that also assisted in generating the revenue. Farm waste is utilized for gas and electricity production and cow dung is converted into manure, dhoop batti, flower pots, candle and bricks. Data management of farm animals, input and output costing are other added dimension of Revnar's innovativeness. Surplus milk is utilized for the manufacture of value added dairy products which are great in demand. The turnover of Revnar is reached to Rs. 75 Lakhs by the end of 2020.

DAIRY EDUCATION

Education and Training

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 28.03.1989, 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 2020-21. The courses have been designed so as to provide broad based as well as specialized training on different aspects of dairying.

B.Tech. (Dairy Technology)

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

Master's and Doctoral Degree Programmes

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

1) Dairy Microbiology
2) Animal Genetics and Breeding
3) Food Safety & Quality Assurance
4) Livestock Production & Management
5) Dairy Chemistry
6) Animal Nutrition
7) Dairy Technology
8) Animal Physiology
9) Food Technology
10) Agricultural Economics
11) Dairy Engineering
12) Agricultural Extension Education
13) Animal Biochemistry
14) Agronomy
15) Animal Biotechnology
16) Veterinary Gynaecology & Obstetrics

Doctoral degree programme is offered in the all the above disciplines except Food Technology:

Scholarship and Fellowships

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

National Talent Scholarship

Institute Scholarships

Master's degree	:	Rs. 7,560/- P.M. for two years plus Rs. 6,000/- per annum as contingency
Ph.D.	:	Rs.25,000/- P.M. for first two years, Rs.28,000/- during third year and Rs. 10,000/- per annum as contingency.
Ph.D. (In-service)	:	Rs. 3,000/- P.M. for three years and Rs. 10,000/- per annum as contingency

ICAR Junior Research Fellowship

Master's degree	:	Rs. 8,640/- P.M. (For Non-Veterinarians) and
	:	Rs. 12,000/- P.M. (For veterinarians) for two years and Rs. 6,000/- per annum as contingency

The National Talent Scholarship (NTS) @ Rs.3,000/- per month is awarded by ICAR to each undergraduate student 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 final year students in various disciplines of the Deemed University. Campus placement services are generally availed by B.Tech. (Dairy Technology) and Post graduate students of the Dairy Processing streams. Representatives of the Human Resources Units of the leading Dairy/Food Industry both from private and cooperative sectors visit the campus starting from September month of each year and conduct intensive selection process to select the candidates. The process of contacting the industry begins at least three months before the campus interview season begins. The production and management disciplines students are mostly placed in government sector, non-government organizations or public sector. A few students prefer to join higher studies and it is more so in production and management disciplines. At graduation level, ~ 30% progress to higher degrees and the rest are recruited by dairy plants and other agencies, while about 20% students return for higher studies to NDRI at the post-graduation level. The median salary for the students placed in season 2019-2020 was Rs 5.00 lakhs/annum for UG and Rs 8.00 lakhs/annum for PG. The undergraduate students during the in-plant training in the final year were paid an average stipend of Rs. 6,000/month. Presently the cell is chaired by Dr Latha Sabikhi, Head, Dairy Technology Division. 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 students qualifying AIEEA (UG), AIEEA (PG) and ICAR AICE-JRF/SRF (Ph.D.) admission tests conducted by National Testing Agency (NTA) for admission to UG/PG/PhD programmes was organized by the Education Division of ICAR New Delhi.

Admissions

Admission to B. Tech. (Dairy Technology), M.Sc./M.V.Sc./M.Tech and Ph.D. programmes for the academic session 2020-21 for were successfully completed and the following numbers of students were finally admitted.

SN	Courses	No. of students admitted
1)	B.Tech.(Dairy Technology)	40
2)	Masters' programme	152
3)	Ph.D. Programme	111

Meetings

- 77th & 78th meetings of the Standing Committee on Faculty, Students Problems and Discipline were held on 4.6.2020 and 4.9.2020 respectively.
- 48th & 49th meeting of Academic Council was held on 8.06.2020 and 22.08.2020.

Measures Taken during the Covid Pandemic to Complete the Syllabus of Courses and Programs

Subsequent to closure of the institute due to Covid-19 lock down imposed in the third week of March, 2020, students vacated the hostels and returned to their homes. Situation was reviewed in a meeting conducted by Director cum Vice Chancellor of the Deemed University on May 13, 2020. Decision was taken to start conduct of the course work in on-line mode using different appropriate tools viz., Microsoft Team, Google Meet and Zoom. Soft copy of the lecture materials, pre-recorded video of theory and practical classes of appropriate duration were passed on to the students and need based doubt classes arranged every week. All the B. Tech. (Dairy Technology) students admitted in 2017, 2018 & 2019; Master's students admitted in 2018 (PR) & 2019 and Doctoral students admitted in 2018 (PR) and 2019 were promoted to next class based on cumulative performance of the current and the earlier semesters i) 50% weightage for performance till last Semester (OGPA for students having passed more than one semester and GPA for students who had passed only one semester) & ii) 50% weightage for performance in current semester based on performance indicators like Mid Term Examination, Oral Exam (Only Practical Syllabus), Written Test of Syllabus covered Online and Assignment. Mid-term examination was completed by June 30, 2020. Students failing to obtain 6.5 GPA in this semester were given "Satisfactory" grade with a specific mention in the grade card. In transcripts actual grade obtained by the student appeared with the indication using asterisk that the candidate progressed to the next semester with Satisfactory Grade as a special provision during the current semester. All such willing students were to be provided an option for appearing in improvement examination after commencement of the new semester in offline mode. The final examination in such cases will be of 100 marks. Post Graduate students (M.Sc./M.V.Sc/M.Tech) who completed significant parts of their research work pursuant to the recommendation of the Advisory Committee were allowed to submit digitally signed copy of the thesis online starting from the normal due date i.e. June 08, 2020 and upto 31st July, 2020 without any late fee. In specific cases, on recommendation of the advisory committee, guide and the head, the students were given more time to return to the campus to complete thesis research work. Viva-voce examination for all these students was conducted through Video Conferencing using electronic means. All such B. Tech (DT) students, who were not physically present at the place of their in-plant training after the declaration of lockdown-1, were given a comprehensive project work mentored by a faculty. The project reports from all such students were submitted along with the training report for the period when they physically attended the training concurrent with the training reports submitted by other students who were physically present at different plants. The reports were then evaluated and students examined online by the committee as per the regular procedure. Supplementary examination for all the year B. Tech (Dairy Tech), Master's and Doctoral students, who could not appear in the examination as scheduled earlier, was conducted on line and completed by July 15, 2020 by framing appropriate questions as per format to be issued by CoE. The deadline for supplementary examination of final year B. Tech (Dairy Tech) was June 30, 2020. During the first semester of the academic session 2020-21 online classes for only theory parts of the respective courses were continued in online mode. Theory classes of the second semester were also shifted to the first semester so that when physical classes commence in the following semester, all practical classes can be offered for hands on experience. Examination was also conducted in online mode based on the four indicators to evaluate comprehensive understanding of the theory components by the students.

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 2020. A total of 16 faculty members were selected for international training and out of which 7 faculty were currently undergoing training at 6 different universities located in USA and Netherlands. Besides one skill development training, one certificate course on entrepreneurship development, and four workshops were organized in physical mode of instructions. Following the spread of COVID pandemic, the project activities were switched over to virtual mode and over the remaining period of the calendar year, one workshop and nine webinars were organized for the benefit of our students and the faculty. Alumni data base was updated to strengthen Global Alumni network. A total of 2500 Alumni have registered on the Alumni portal website. Sprinkler water irrigation system was installed to cover total lawn areas of 13 acres in hostel, sports complex, guest house and administrative building premises with an aim to conserve water. A total of 190 electric bulbs were replaced with LED lighting for reducing energy use

Language Laboratory:

The University has recently set up a modern Language Laboratory with state-of-the-art audio-visual equipment to aid in imparting language skills to the students. The laboratory has been set up to be effectively utilized by the students for various self-enhancement and soft skill development activities. The language laboratory of the institute is equipped with master computer with high end advanced configuration, an interactive touch display with 75" screen size, digital touch pad, video conferencing camera with built-in microphone, licensed modules of 25 languages with LAN based digital interactive language lab software of latest version, comprising of different language modules including English, French, German, Spanish, etc. The laboratory has been set up with 24 computers and adequate number of furniture. The software installed in the laboratory provides the following features:

- The software is able to generate each student's performance report and the teacher will be able to view student's performance report at any given time.
- The system has a media library area which enables a teacher to upload audio, video and texts-based content and integrate into customized study modules, which enables a multi teacher access facility for sharing, and collaborating content resources remotely across the campus.
- The teacher is able to create session modules for students to access content management library on the media activity dashboard for self-study even when the teacher is not present in the class.
- The teaching materials have a minimum of 3 levels i.e., Basic, Intermediate and Advance. The basic levels use various scenarios to help students communicate.
- The students are able to record their own voices and check the level of the accuracy of their pronunciation.
- The software has feature to help develop public speaking by way of recording each student's video while giving a speech. The teacher will be able to evaluate the videos and send back the feedback through the software.
- The facility can be used as a virtual classroom facility to connect an instructor remotely located to undertake a teaching session through seamless video conferencing.
- The software has capabilities of Listening, Recording and Comparing of Speech patterns both via audio and visual. The software has speech spectrograph for visualization.

TECHNOLOGY DISSEMINATION AND EXTENSION PROGRAMMES

DAIRY EXTENSION DIVISION

Field-Farm Technician (FFT) Laboratory

The Field-Farm Technician (FFT) Laboratory is intended for extensive extension activities in the adopted villages (Shahpur, Hemda and Dadupur) around the institute. The FFT Laboratory is being operated through Stockman Centres (i.e., 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: (I) Organized fertility and veterinary aid campaigns.

Cross-breeding in cows and selective breeding in local buffaloes was promoted through Artificial Insemination (AI) using high pedigree bulls General health check-up and treatment camp was also organized in the adopted villages.

Breeding and health camps for dairy animals

Sl.No.	Activities	No. of Cases (beneficiaries)	Success measured	
			Conception rate (%)	Calves born (No.)
1)	A.I. in Cows	567	44.17	331
2)	A.I. in Buffaloes	376	41.60	264
3)	Health and general treatment	436	-	-

A total of nineteen infertility and veterinary aid campaigns were organized in Kulweri, Daniyalpur, Subhri and Jhanjhari villages. During these Campaigns, animals were treated for reproductive disorders and various other ailments such as ecto-parasitic and endo-parasitic control. Special attention was given to improve the productive and reproductive parameters of animals by diagnosis and proper treatment. A total of 1333 animals were treated during these campaigns. The details are as follows:

Infertility (Anoestrus and repeat breeding) (72); Pyrexia (15); Mastitis (42); Retained Placenta (31); Prolapsed of Uterus (19); Ecto- and Endo-parasite (1135).

Kisan Sangosthies

Ninteen Kisan Sangosthies were organized at village level and following topics were discussed in detail:

- Management of dairy animals during COVID-19 Lock down
- How to prepare balance ration at home
- Adaptation practices during extreme climate variability
- Role of reducing inter-calving period in lactating animals
- Preparation of value added milk products
- Management of service period in dairy animals
- Management of dairy animals in transition period

- Awareness on ecto & endo parasite infestation
- Role of mineral mixture in animal diet round the year green fodder production

Question/Answer sessions were also arranged in these sessions. These sessions provided excellent opportunities to the farmers to obtain solutions to their day to day problems. Feedback was also collected from farmers on these extension programmes.

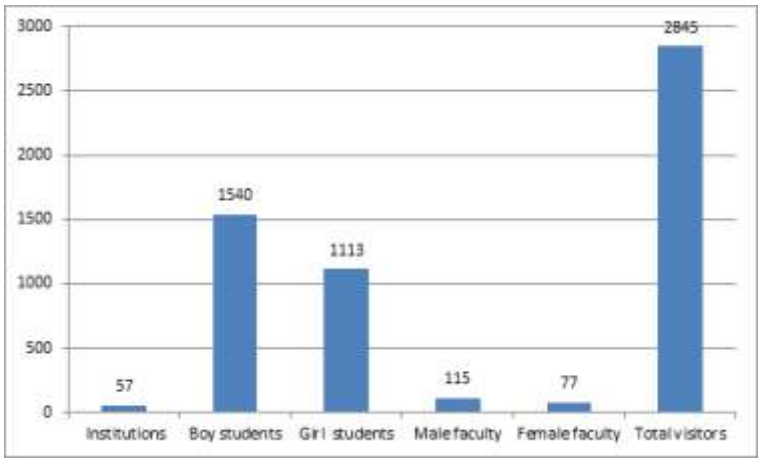
Dairy Education at Farmer's Door (DEFD)

DEFD–A new initiative–aimed to strengthen the dairy production and processing through effective dissemination and penetration of proven technologies among farming community. Under this programme, a team of NDRI scientists from production, processing and management group organize Dairy Education at Farmers' Door in various villages on 2nd Saturday of every Month. Arrangements for discussion with a group of farmers related to scientific dairy farming, crop husbandry practices and animal health related advise is usually made at the local common place of the village. In feedback, participating farmers expressed happiness and scientists pleased to devote holiday for betterment of farming community.

Farmers Farm School (FFS): NDRI-FFS provides formal education in the field of Dairying, Horticulture and Agriculture. The programme is designed for 25 farmers (in one batch on first come first basis) for a period of one year. In this School, farmers interact with the scientists through class room teaching as well as practical classes. The 6th batch consisting of 20 farmers of village Bhoji Khalsa is in progress.

Dairy Samachar: Quarterly Hindi Magazine "Dairy Samachar" was compiled and published by institute to make farmers and other stakeholders well aware about recent development in dairy sector. There are 1650 registered readers of Dairy Samachar.

Educational Visits: A total of 2845 visitors (students and faculty) from 57 Colleges/ Institutions/Universities visited the institute.. The groups were sensitized about the different research, teaching and extension achievements and facilities available in the Institute.



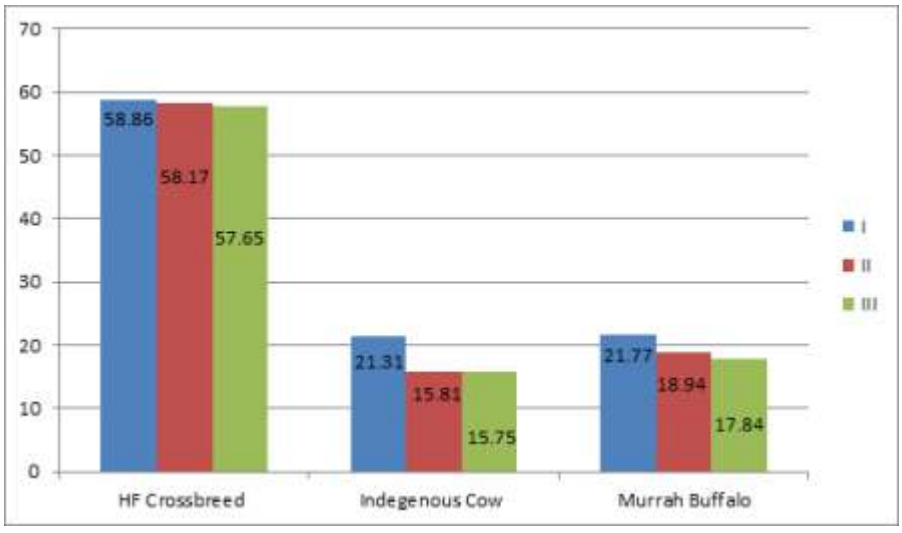
Educational Tours & Visits at NDRI

Advisory Services

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

National Dairy Mela-2020

National Dairy Mela (February 15 to 17, 2020) was inaugurated by Dr. M.S Chauhan, Director & Vice-Chancellor, NDRI. On this occasion, he released a souvenir for the farmers and urge them to adopt dairy based integrated agriculture in a scientific manner so as to realize Hon'ble Prime Minister Shri Narendra Modi dream of doubling farmers' income. In this melavarious by NDRI and other sister institutes located in and



Milk yield records of different types of dairy animals

around Karnal showcased their technologies. In addition, farmers also showcased their elite animals. The mela attracted more than 15000 visitors from different states like Uttar Pradesh, Haryana, Punjab, Delhi and Rajasthan.

He said that such events are also providing farmers to showcase which is a motivation to fellow farmers.

Dr. M.S. Chauchan Director, ICAR, NDRI inaugurating The Dairy Mela on Feb. 15, 2020

Exhibition stall

There were 107 exhibition stalls at the Dairy Mela were a visual treat for the diverse visitors who ranged from students, farmers, academicians, researchers as well as entrepreneurs. All the stalls were well equipped to cater to the information needs of the visitors. Out of 107stalls, 30 were government stalls and the remaining 77 exhibition stalls were occupied by private companies, involved in the production of livestock feed and medicines, and manufacturing of dairy machineries. This revealed the growing relevance of private players in the sector.

Kisan sangosthi during mela

The Farmers- scientist interaction "*Kisan sangoshthi*" was chaired by Dr. M.S. Chauhan, Director, NDRI and panelist were Dr. P.C. Sharma, Director, CSSRI, Karnal, Dr. G.P. Singh, Director, IIW&BR, Karnal , Professor Samar Singh, *Vice-Chancellor*, Maharana Pratap *Horticultural University, Karnal,* Dr. N. Kulshreshtha, Head, *Sugarcane* Breeding *Institute* Regional Centre, Karnal. During the interaction, the issues such as technology role in yielding sustainable growth and reduce the cost of production, enhancing income through diversification towards high value agriculture, demand driven production, utilization of by-products, etc. were discussed. During the function, Dairy Mela Smarika and Dairy Calendar-2020 were released for the dairy farming community.

Competition for dairy animals

The 177 animals from different parts of the country were brought to the Mela ground for the competition under 10 different categories, stole the show. Animal characteristics, beauty and milk yield were considered for ranking first, second and third position and awarding prize in case of lactating animals. The recorded milk yield (l/day) of prize winning animals is given as:

Milking and paneer making competition for women

Altogether, 59 women participated in the paneer making (31) and in milking (28) competition on the last day of the Mela. All the participants were appreciated by the chairman and organizer of the Mela.

Valedictory session and prize distribution

The Mela was concluded with a valedictory session chaired by Dr. A.K. Singh, Deputy Director General, Agricultural Extension, ICAR, New Delhi as a Chief Guest of function and honored the winner farmers with prizes. He appreciated the actively participating farmers and exhibitors. Dr. Singh recognized the contribution of NDRI in the dairy sector in the country. He emphasized on dairying (indigenous breeds) - as a potential source to increase the income of farmer, particularly those who are marginal or landless.

Director of National Dairy Research Institute, Dr. M. S. Chauhan congratulated the winners and appreciated the participants by saying "every contestant is a winner". Dr. Chauhan motivated the farmers to become dairy entrepreneur and asked them to take benefit of facilities available at NDRI. Dr. AK Tyagi, Joint Director (Research) also congratulated the farmers and participants from different parts of the country and encouraged the women farmers to come forward. He said Organizing Secretary Dr. K. S. Kadian welcomed all the dignitaries and participants and presented the mela report. On this occasion, students of NDRI depicted the life of a farmer through '*Nukkad Natak-Annadata'*. This was adored one and all including the farmers.

Technological interventions/demonstration at farmers filed

Five modules, viz., crop based, horticulture based, dairy based and enterprise based were identified and technological interventions were given under Farmers First Project in five villages of Karnal district covering more than 1000 households. Dairy based module covers interventions, that are, balanced feeding (Reducing Negative energy balance, Anionic Mineral Mixture, Minerals Mixture supplementation, Protected Amino Acids), parasite control (Ecto-and Endo-parasite), Vaccination & treatment of major diseases, Estrus synchronization and Ovulation synchronization. Besides, there is SMS Portal to deal with the query of the farmers. Demonstration camps for detection of mastitis in animals and farmers day were also organized.

KRISHI VIGYAN KENDRA (KVK)

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 activities. Need-based 1 to 5 days (on and off-campus) trainings on various disciplines, viz. Dairy Production, Dairy Processing, Agriculture, Vermi culture, Bee-keeping, Fish Farming and Home Science are being organized for farmers, farm-women, rural youth, in-service personnel and spearheads. KVK has initiated skill based vocational training programmes. A total 75 On Campus and 80 Off Campus training programmes were conducted and around 3534 and 2014 trainees were benefited, respectively. In addition, on-line training/webinar on pertinent topics such as fodder production and conservation, importance of weather information for livestock and agriculture were also organized during lockdown period. It is worth mentioning that these training programmes have covered women (16%) and SC/ST population (13%).

Training Achievements (January to December, 2020)

Title of the course	Duration (days)	No. of courses	No. of beneficiaries
Dairy Production	10	5	122
Dairy Processing	5	1	20
Crop Production	4	5	126
Crop Diversification	1	2	39
Post-Harvest Technology	2	1	19
Bee-keeping	4	1	23
Fish Farming	4	3	56
Home Science	1-4	2	34
Skill Development training in vermi compost making	25	1	20
Sub-Total (a)	21	459	
Short Visit cum Training Programmes (b)	1-5	54	3075
Total (a+b)		75	3534

Off campus training programmes

Title of the course	Duration (days)	No. of courses	No. of Beneficiaries
Crop Production	1	24	352
Home Science	1	12	399
Livestock Management	1	6	114
Crop Residue Management	1	29	972
Soil health and Fertility	1	5	96
Fisheries	1	3	59
Vermi culture	1	1	22
Total		80	2014

Off campus training programmes

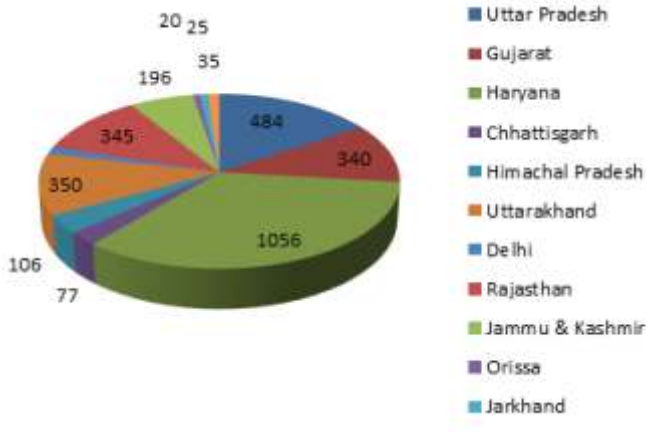
Title of the course	Date	Participants
Fodder Production & Conservation: A methodology approach for livestock production	31-05-2020	700
Livestock management, Fodder production & Conservation	10-06-2020	200
Importance of weather information in Agriculture and Farmers Income	27-07-2020	450
Far-reaching impacts of lockdown on dairy farmers and livestock holders: problems and solutions	29-07-2020	155
Importance of weather information for better agriculture practices	01-10-2020	35
Total	1540	

Gender wise beneficiaries of KVK training programmes

Gender	Beneficiaries	Percentage
Male	1373	84.49
Female	252	15.51
Total	1625	100.00

Category wise beneficiaries of KVK Training Programmes (On campus)

Category	No. of Trainees	Percentage
Others	399	86.92
SC/ST	60	13.07
Total	459	100.00



State-wise beneficiaries of KVK exposure visits

On-line Training/Webinar

KVK organized 5 online training-cum-webinars during COVID-19 pandemic and a total of 1540 famers were benefited.

Exposure Visits cum Short Training Programmes Organized

A total of 3075 number of farmers including women famers visited KVK from the states of Haryana, Himachal Pradesh, Uttar Pradesh, Chhattisgarh, Gujarat, Jammu and Kashmir, Uttarakhand, Rajasthan, Orissa, Delhi, Jharkhand and Bihar.

Field Visits

KVK organized 14 field visits on the Front Line Demonstration plots in different villages of Karnal district of Haryana to create awareness and to encourage them to grow pulses, oilseeds and sorghum. The details of the filed days are given in the following table.

Field Days / Visit during 2020

S.No.	Date	Village	Crop	No. of Farmers
1)	13.01.2020	Bhenikhurd	Mustard & Gram	11
2)	13.01.2020	Sultanpur	Mustard & Gram	10
3)	17.01.2020	Bhenikhurd	Gram	14
4)	17.01.2020	Sultanpur	Gram	12
5)	12.02.2020	Bhenikhurd	Mustard & Gram	12
6)	12.02.2020	Sultanpur	Mustard & Gram	10
7)	18.03.2020	Sangohi	Mustard & Gram	14
8)	17.03.2020	Bhenikhurd	Mustard & Gram	16
9)	17.03.2020	Sultanpur	Mustard & Gram	16
10)	19.03.2020	Kachawa	Mustard	8
11)	25.04.2020	Phurlak	Gram	19
12)	02.09.2020	Badarpur	Sorghum	12
13)	02.09.2020	Khera	Sorghum	10
14)	09.09.2020	Bheni Khurd	Sorghum	6
15)	21.11.2020	Sultanpur	Gram	12
		Total		182

Front Line Demonstrations on Oilseeds, Pulses, Cereals and Fodder

Front Line Demonstrations (FLD) is a national programme to promote pulses, oilseeds and fodder crops. One of the prime mandates of KVK is to analyze the potential of newly developed crop production technologies through FLD.

To popularize proven agriculture technologies and promote crop diversification, the following demonstrations were organized by KVK in various villages of Karnal.

Table : Results of FLD 2019-2020

S.No.		Crop	Variety	Total No of Demo.	Area (ha.)	Av. Yield(q/ha)	BC Ratio
1)	Pulses	Gram	HC-5	50	20.00	11.40	1:2.06
		Summer Moong	MH 421	-	-	-	-
2)	Oilseed	Mustard	CS-58	25	10.00	16.0	1:2.45
			CS-60	25	10.00	16.55	1:2.54
3)	Fodder	Sorghum	CSH-24	22	5.00	680.00	1:2.84
4)	Cereal	Wheat	DBW-173	12	4.8	48.60	1:2.82
			DBW-90	3	1.2	48.98	1:2.84
Total				**137**	**51**	**821.53**	

FLD Conducted 2020-21

S.No.	Crop		Variety	No of Demo.	Area (ha.)
1)	Pulses	Gram	HC-5	54	20
2)	Oil Seed	Mustard	CS-58	125	50
3)	Cereal	Wheat	DBW-187	20	4
		HD-3226	10	4	
Total				209	78

Performance of Crop Demonstration Unit

This KVK maintains 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. The performance of instructional farm (Crops production) including seed production during the year 2020 is given in the following table.

Seed produced at Crops Production Unit

Name of the Crop	Date of Sowing	Date of Harvest	Area (acre)	Details of Production		
				Variety	Type of Produce	Qty (Qtl.)
Seed			5.00	HD-3226	Seed	79.60
Cereal (Wheat)	Nov, 2019	Apr, 2020	11.00	HD-2967		120.40
			9.00	DBW-222		79.20
Paddy	Jun, 2020	Oct, 2020	15.20	PB-1509	Seed	200.00
			10.0	PB-1718		150.00
			5.55	PUSA 44		150.00
Fodder Berseem	Nov, 2019	May, 2020	10.00	BL-42	Seed	4.56

Production from other demonstration Units

SN	Products	Species/Varieties	Quantity
1)	Fish	Rohu, Katla & Mrigal	25 qtls
2)	Fish Fingerlings	Rohu, Katla & Mrigal	7,50,000
3)	Earthworm	Eisenia foetida	10 Kgs
4)	Vermi compost	Eisenia foetida	5 qtls
5)	Honey production	Apis mellifera	75 Kgs

Seed material of various crops and bio-products to the farmers as given below:

Seed sold during 2020

S.No.	Crop	Variety	Quantity	No. of farmers
1)	Paddy seed (produced in Kharif 2019)	PB-1509	126.40	215
		PR-114	107.4	200
2)	Wheat seed (produced in Rabi 2019-20)	HD-2967	120.40 qtls	56
		HD-3226	79.60	70
		DBW-222	79.20	70
3)	Berseem seed (produced in Rabi 2019-20)	BL 42	7.6	71

The revenue of Rs. 24.50 lakh generated from sale of seed, farm produce and other activities like training fee.

Field Extension Activities

- KVK celebrated Mahila Kisan Divas on October 15, 2020 in which more than 70 famers participated. The theme of the Mahila divas was “Dhartimata Ko Bachanahai, Paralinahijalanahai”. Quiz was organized and prize was distributed to the winners. The Subject Matter Specialists of KVK delivered lecture on 'Crop residue management' and 'Bioforfied crop varieties'.
- The scientific advisory committee meeting was held on January 28, 2020 to review the progress and finalize the action plan.
- KVK arranged web telecast of Hon'ble Prime Minister with farmers on December 25, 2020 where 50 farmers and farm women participated.
- KVK celebrated World Breast Feeding week in village Barotha on August 7, 2020 to educate women about importance of breast feeding, infant nutrition and the advantages of colostrum to the new born.
- Swachatha Abhiyan was celebrated on September 26, 2020 and Swachtha Pakwada week 2020 during December, 2020 in KVK by the staff under which the whole campus around KVK was cleaned.

- KVK celebrated Poshan Maah with the aim to create awareness among women on the importance of nutritional diet in their routine food. Six awareness camps were organized in different villages of Karnal district. A total of 248 women participated.
- KVK organized Parthenium awareness week on August 20, 2020. To create awareness about parthenium (weed) more than 22 farmers from Sangoha village participated.
- KVK participated and set up stall in exhibition organized by ICAR-Sugarcane Breeding Institute (Regional Station), Karnal on February 28 to 29, 2020.
- KVK organised "World Soil Health Day" on December 5, 2020 in which more than 79 farmers from different villages of Karnal district participated. In the programme the farmers were educated about importance of assessing the soil health and linking it with productivity. Dr. S.K Pandey, Head, Sugarcane Breeding Institute (Regional Station), Karnal was the Chief Guest of the function. Dr. A. K. Rai, PS, CSSRI, Karnal and Dr S.K. Gupta, Ex-PS, CSSRI, Karnal delivered lectures on soil health management. The farmers who had done excellent work in conservation of soil health were honoured in the function by the Chief Guest.
- KVK organized "Kisan Mela and Kisan Diwas" on December 23, 2020 at KVK campus. Theme of the event was 'Management of paddy crop residue'. Dr P.C Sharma, Director, CSSRI, Karnal was the chief guest and Dr. M.S. Chauhan, Director, NDRI, Karnal presided over the function. In this event, 182 farmers and farm women of different villages of Karnal district participated. Those farmers who did excellent work in conservation agriculture, crop diversification; integrated farming, dairy farming and milk processing were honoured in the function by the chief guest.

Implementation of Project: Promotion of Agriculture Mechanization for *In-Situ* Management of Crop Residue in the States of NCT Delhi and Haryana

KVK procured farm machines (i.e., Happy Seeder (3), Hydraulic Reversible M.B. Plough (2), Rotavator (1), Mulcher (2), Zero tillage seed drill (4) and used them on farmers' fields for demonstration on In-situ management of paddy straw in different villages of Karnal district. Sowing of wheat with the help of happy seeder and zero tillage seed drill was also demonstrated in two adopted villages namely Kamalpurrodan (222 acre) and Sirsi (162 acre) of Karnal district. A total of 79 famers were benefited.

KVK organized 10 field visits and trained 177 farmers for crop residue management. KVK organized 17 awareness programme and kisangoshthis and sensitize 746 farmers on adverse effect of burning of crop residue in the fields and benefits of In-situ management of crop residue.

Mobilization of School and College Students The students of government schools of different villages of Karnal district were roped in to convey the message on crop residue burning in their respective villages. Students, along with the staff of KVK, took part in conducting elocution competition and drawing competition on the theme "Ill effects of crop residue burning". Students were given lectures on the adverse effect of crop residue burning on health as well as environment by the expert and were also encouraged to dissuade their farmer parents, neighbors and relatives from burning of paddy residue in their fields.

Students and KVK staff took out 4 *Prabhat pheris* and elocution competition was organized in the adopted villages (Kamalpurrodan, Sirsi, Nabipur) and more than 500 students actively participated in the said events.

Publicity on Crop Residue Management

KVK developed pamphlets and folders on In-Situ crop residue management for distribution among the farmers in different villages and to those coming to KVK to attend various training programmes. KVK also created slogans to desist farmers from paddy straw burning and encourage them for In-situ crop residue management using happy seeder, zero tillage and MB plough. Wall paintings with slogans, against crop residue burring and to encourage crop residue management, were done on prominent public places in two adopted villages namely Kamalpurrodan and Sirsi, to generate mass awareness on crop residue management. The selected places on highways, near by the adopted villages, were also painted with slogans. Hoardings and banners, conveying the message on In-situ crop residue management were placed at prominent places, like mandis, ICAR institutes and main gates of railway stations, for maximum outreach among farmers in the district.

Kisan Mela on Crop Residue Management (CRM)

KVK organized a 'Kisan Mela' on December 23, 2020 to demonstrate various agriculture implements for in-situ crop residue management. The event was attended by more than 182 farmers and experts from various ICAR institutes of Haryana.

AGRICULTURAL TECHNOLOGY INFORMATION CENTRE (ATIC)

Agricultural Technology Information Centre at NDRI Karnal became operational in November 2004. This centre is engaged in disseminating information on dairying and allied agricultural fields. Besides 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

Presently, ATIC is using following approaches for dissemination of information to its users:

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

Services rendered in Agricultural Technology and Technology Products in 2020

SN	Detail of services	No. of Services	No. of Persons
1)	Dairy/Agriculture related information through Video show and Lecture	21	494
2)	Personal Discussion with Subject-Matter-Specialist on Dairy Farming	14	34
3)	Information through Dairy/Agriculture Literature	13	26
4)	Information on Agriculture (Seed/Fertilizer/Compost etc)	889	889
5)	Information through telephone (Toll-free) on Agriculture & Dairying etc.	644	644
6)	Information through e-mail on Agriculture & Dairying etc.	91	91
	Total	**1673**	**2178**

- Sale of inputs like seeds, fertilizer and NDRI publications accounted for Rs. 17.66 lakhs during January, 2020 to December, 2020.
- A total of 2178 persons were benefited from various services rendered by ATIC.

WOMEN EMPOWERMENT AND MAINSTREAMING OF GENDER ISSUES

WOMEN SELF HELP GROUPS AT THE FOREFRONT OF ENTREPRENEURSHIP IN DAIRYING

Gender mainstreaming in dairying

Given adequate motivation and encouragement to obtain education and training, farm women would be able to take up income-generating activities and ably demonstrate self-reliance. To sensitize and motivate rural women to take dairy based livelihood options, ICAR-National Dairy Research Institute undertook a project entitled “Improving Livelihood of Rural Women through Dairy based Secondary Agriculture” funded by Department of Science and Technology, Government of India, New Delhi during 2017-2021. The main objective of this project is socio-economic development of rural women through dairying. Under this project, women were motivated to utilize their spare time for dairy based livelihood activities by forming self help groups (SHG). Each group of women is formed in such a way that two to three members look after milk collection; an equal number of them make products and package them; one facilitates marketing and another maintains accounts. Ultimately, each member spends 2 to 3 hours in a day for these activities. This facilitates a group with 4 to 8 women members to take up a dairy based entrepreneurial venture easily without interfering with their day to day household chores and earn additional income for their family.

Capacity building of women

These women were provided training and demonstration on preparation of milk based products. Seventy trainings were organized covering 1023 rural women from 25 villages on value added dairy products. These training programs were designed as per the National Skills Qualification Framework (NSQF) prescribed by National Skill Council of India.

Both on- and off-campus training and demonstrations were conducted. The few on-campus trainings were organized at Women Empowerment Lab of NDRI, Karnal. Most of the trainings were conducted in villages so as to train maximum number of women. Among the several women groups formed in selected villages, ten groups in three districts of Haryana (seven from Karnal, two from Panipat and one from Sonipat) showed

Cross Functional Linkages in Facilitating Women Led Entrepreneurship

remarkable performance. Women groups have already started earning an additional monthly income ranging from Rs. 5,000 to Rs. 20,000 per group as compared to the period before joining the DST-based groups. In addition, this has also helped to promote the availability of unadulterated and healthy dairy products of good quality to consumers.

The Project team established linkages with 13 development organisations for supporting the women group activities. Some of them included NBARD for loan facilitation, Haryana State Rural Livelihood Mission for group formation and gender sensitization, KVKs for knowledge sharing and motivation, PIET College and DPS Panipat for market linkage, Haryana State Agricultural Marketing Board (HSAMB) for linking their canteen with women groups for sale of products and NGOs for continuous moral support and encouragement.

Success Stories of Women Groups

Ten women groups under the project were selling their products in nearby areas during marriages and other family functions and also at government fairs and functions. Sri Ram SHG from Manglora village in Karnal district took loan for Rs.10.5 lakhs from State bank of India to purchase dairy animals. The group not only sold the milk but also prepared and sold paneer, whey drink and *gulab jamun* in the village itself as well as in fairs organized by NABARD and state line departments. Two groups from Karnal district (Shivam SHG from Bharatpur Village and Santoshi SHG from Hasanpur Village) were selling *ghee* and *khoa*, respectively, in their own villages. The Bharti SHG from Karnal district participated in Saras Mela of International Gita Mahotsav, Kurukshetra (22nd November, 2020 to 10th December, 2020) and won Best Stall Award. The group sold *gulab jamun* during the mela and earned Rs. 35,000/-. The Bharti SHG during display and sale of *gulab jamun* in Saras mela of International Saraswati Mahotsav, Kurukshetra during January 27-29, 2020 earned Rs. 70,000/-. A National Dairy Mela was organised by ICAR-NDRI during February 15-17, 2020, in which two women SHG (Bharti SHG, Karnal and Sashakt SHG, Sonipat) participated and exhibited their skill by selling *gulab jamun* for Rs. 10,000 and ghee for Rs. 15,000, respectively. Bharti SHG also won the first position in *paneer* making competition. A group (Aarzoo SHG) from Pattikalyana Village of Panipat district was selling paneer in their own village. Another group (Lakshmi SHG) from Dinger Majra Village of Karnal was given the opportunity to serve gulab jamun during the meeting of "Haryana Vigyan Manch" on the occasion of World Environment Day (June 5, 2019) in Gharaunda block. In order to promote marketing of products of SHGs, a sale and display was organized in the premises of Delhi Public School, Panipat Refinery, wherein the school teachers evinced a keen interest for the products prepared by the SHGs. A few SHGs prepared and distributed face masks during Covid-19 crisis apart from selling milk products as per the demand of local villagers.

Hand-holding support

The women groups along with the project team regularly collected feedback from the customers of milk products for continued improvements not only in the products but also the way they work with different stakeholders. The women groups gained self confidence, acquired skills for producing quality milk products and assessing and capturing potential markets and customers so as to embark a decent life in the midst of the gender biased society. The COVID-19 induced crisis provided an opportunity to produce and consume dairy products locally within villages or cluster of villages, thereby promoting the themes of Self Reliance (*atmanirbharta)* and Vocal for Local as envisioned by the Honourable Prime Minister of our country.

HONOURS AND AWARDS

Best Institute Awards

1) *ICAR-National Dairy Research Institute, Karnal* ***Ranked First*** *among 72 Agricultural Universities for the year 2019 among conferred in 2020* by Education Division of Indian Council of Agricultural Research, New Delhi. This award was declared by the ICAR and presented by Honourable Parshottam Khodabhai Rupala, Union Minister of State for Panchayati Raj, Agriculture and Farmers Welfare.

2) *Regional Centre SRS Bengaluru bagged the Runners-up award in DuPont Danisco Nutrischolars Award (2020): Team Gold Pro* received this position in Season 3. Their product "Golden High Protein Shake Premix" won a cash award of Rs. 25,000 under the "Convenient and Nutritious Breakfast" category of the competition. Team comprising of students of the Dairy Engineering Section: Amrik Hazra, Naveen Jose, Harshitha M., Rajesh K., Rajasekhar Tellabati, The team was mentored by Menon Rekha Ravindra, Principal Scientist.

3) Team NDRI comprising the students Girish Rajpurohit, B.Tech 3rd Year; Harshal, B.Tech 1st Year; Suhani Sharma, B.Tech 1st Year; David Haokip, B.Tech 1st Year and Prince Kamboj, B.Tech 1st Year won first prize carrying an award of Rs 15000/- in National Level Documentary/Short Film Competition on 'High Impact Scientific Interventions for Societal Development' organized by Indian Institute of Food Processing Technology, Thanjavur for remembering the scientific contributions of Dr A P J Abdul Kalam.

National Awards

4) Rajan Sharma (Team leader) and Naresh Kumar, Principal Scientists, NDRI, jointly received *Biotech Product and Process Development and Commercialization Award 2020* from Department of Biotechnology, Ministry of Science & Technology, Government of India.

Fellowships

5) Ashish Kumar Singh. Principal Scientist Selected as NAAS fellow for the year 2020.

6) Vikas Vohra, Principal Scientist received "SOCDAB Fellow Award" for the year 2020. The award was conferred to him by Society for Conservation of Domestic Animal Diversity (SOCDAB) during its XVII National Symposium on February 10, 2020 at NDVSU, College of Veterinary Sciences & A.H., Mhow (M.P.).

ICAR Awards

Best Teacher Award

7) Rajan Sharma, Principal Scientist, Dairy Chemistry Division, ICAR-NDRI, Karnal received "Bharat Ratna Dr. C. Subramaniam Award" for Outstanding Teachers 2019 and a cash prize of Rs 1 Lakh. (Awards presented by Indian Council of Agricultural Research (ICAR), New Delhi on ICAR Foundation Day on July 16, 2020).

JawaharLal Nehru Award

8) Mohamad Iqbal Bhatt, Ph.D. student of Animal Biochemistry Division, ICAR-NDRI, Karnal received "JawaharLal Nehru Award" for his Ph.D. Theses (Guide: Dr. Rajiv Kapila). (Awards presented by Indian Council of Agricultural Research (ICAR), New Delhi on ICAR Foundation Day on July 16, 2020).

Best ICAR Worker Awards

9) Uttam Kumar, Chief Technical Officer, ICAR-NDRI, Karnal received "ICAR Best Worker Award" under

Technical Category presented by Indian Council of Agricultural Research (ICAR), New Delhi. (Awards presented by Indian Council of Agricultural Research (ICAR), New Delhi on ICAR Foundation Day on July 16, 2020).

10) Vijender Kumar, Skilled Supporting Staff, ICAR-NDRI, Karnal received "ICAR Best Worker Award" under Supporting Staff Category presented by Indian Council of Agricultural Research (ICAR), New Delhi. (Awards presented by Indian Council of Agricultural Research (ICAR), New Delhi on ICAR Foundation Day on July 16, 2020).

Ganesh Shankar Vidayarthi Hindi Patrika Purasakaar

11) Grih Patrika "Dugdh Ganga" published by ICAR-NDRI, Karnal received "Ganesh Shankar Vidayarthi Hindi Patrika Purasakaar (Second Prize)" under the category of Large ICAR Institutes presented by Indian Council of Agricultural Research (ICAR), New Delhi. (Awards presented by Indian Council of Agricultural Research (ICAR), New Delhi on ICAR Foundation Day on July 16, 2020).

Memorial Awards

12) Dheer Singh, Joint Director (Research) was conferred the prestigious Prof. N. R. Moudgal Memorial Oration Award - 2020 on Reproductive Health with Emphasis on Reproductive Cancers, Infertility and Assisted Reproduction (ISSRF-2020) at the 30th Annual Meeting of the ISSRF along with the World Congress during February 14-16, 2020 at Shri Mata Vashino Devi University (SMVDU), Katra, Jammu and Kashmir. The award consists of a cash award of Rs. 25,000/, a gold plated medal and a citation and is given to an Indian scientist for outstanding research in the area of reproductive health.

13) Gopal Sankhala, PS, Dairy extension received Bharat Ratna Dr. A.P.J. Abdul Kalam Excellence award-2020 for outstanding individual Achievements & Distinguished services to the nation by Smt Meira Kumar, Former Speaker of LokSabha at New Delhi on 29th January,2020 at a Seminar on "Economic Growth & National Integration" organized by India International Friendship Society.

14) Malakar D. was awarded Bharat Ratna Indra Gandhi Gold Medal 2020 award from Global Economic Progress and Research Association.

Young Scientist Awards

15) Neelam Upadhyay, Scientist, Dairy Technology Division was conferred "Young Woman Scientist Award-2020" during the International Web-Conference on 'New Trends in Agriculture, Environmental and Biological Sciences for Inclusive Development (NTAEBSID-2020), organized during June 21-22, 2020 by Agro Environmental Development Society (AEDS) and co-organized by National Agriculture Development Co-operative Ltd., Baramulla and Babasaheb Bhimrao Ambedkar University, (A Central University), Lucknow.

16) Pooja Devi, Ph.D. scholar received "Smt. Kamala Madan Memorial Young Scientist Award-2020" for her best thesis research work presentation entitled "Effect of ChlorophytumBorivilianum Supplementation on Biochemical Profile, Hormones and Productive Performance of Cattle" by the SAPI in XXVIII Annual Conference of Society of Animal Physiologists of India held at CSWRI, Avikanagar from February 18-19, 2020.

17) Basavaprabhu H. N., Mr. Chette Ramesh, Dr. Rashmi H. M., Dr. Sunita Grover received "Young Investigator Award (Second)" for oral presentation on "Unraveling the biotherapeutic potential of live probiotics and para-probiotics as complementary armamentarium to confront the gut mediated infections of Methicillin-Resistant Staphylococcus aureus (MRSA): An in vitro approach" at 5th Biennial Virtual Conference of PAi and International Symposium on "Probiotics and Immunity: way forward to microbial therapy" held on November 19-20, 2020.

18) Sumit Kumar Singh (Major advisor: Dr. Sudarshan Kumar) received SITARE-Gandhian Young Technological Innovation (GYTI) Award 2020 on 7th Aug 2020 for project on Development of Electrochemical Impedence based Aptasensor for Semen sorting in Cattle (ID: BT/BIRAC/SITARE-GYTI0047/01/19). The award was conferred by the Society for Research and Initiatives for Sustainable Technologies and Institutions *(SRISTI)* in collaboration with BIRAC (DBT) as a sum of Rs. 15 Lakh for translational research for two years.

19) Shashank, C.G received Young Scientist Award- Second Position for the Abstract Entitled "Transitional Sahiwal Adapt Better than Karan Fries (Crossbred) Cattle during summer and Winter Seasons (co-author Anjali Aggarwal and S.V. Singh) presented during First Veterinary & Animal Science Congress & National Symposium on "Sustainable Scientific Strategies for Improving Health and Productivity of

Livestock and First Annual Convention of Association of Animal Scientists" organized by College of Veterinary & Animal Husbandry, Mhow; NanajiDeshmukh Veterinary Science University , Jabalpur in Collaboration with Association of Animal Scientists held at from 06-08 March 2020.

Best Paper Presentation Awards

20) Amit Thakur, Anil Kumar Dixit, Principal Scientist, Kamlesh Kumar Acharya, A. G. AdeethCariappa and TulikaKumari, DESM Division received "Best Paper Presentation Award" for their paper "Local Dairy Supply Chains: A Profitability Analysis in Haryana" presented during 6th National Seminar (Webinar) on 'Sustainable Development: Socio-Economic Concerns' conducted by the Department of Economics, Punjabi University, Patiala and the Society of Economics and Development, Ludhiana on June 22, 2020.

21) Ashok Kumar, Rajani C.S. and Sathish Kumar M.H. First prize for oral presentation Dipeptidyl peptidase-iv inhibitory (anti-diabetic) potential of whey protein hydrolysates isolated from Gir cow milk. National Conference on Health and Wellness through Nutrition and Nutraceuticals, held at M. S. Ramaiah University of Applied Sciences, Bengaluru during January 22-24, 2020.

22) BabitaKathayat, PriyankaLal and A. K. Dixit, Principal Scientist, DESM Division received "Best Paper Presentation Award" for their paper "Has the Consumption Pattern Changed? An Overview of Livestock Products" presented during 6th National Seminar (Webinar) on 'Sustainable Development: Socio-Economic Concerns' conducted by the Department of Economics, Punjabi University, Patiala and the Society of Economics and Development, Ludhiana on June 22, 2020.

23) Davuddin Baig Mohammed, Dr. Latha Sabikhi and Dr. A. K. Singh won the "First Best Oral Presentation Award" for their paper on "Studies on process standardization for camel milk cheese making" during 9th International Conference on Food Processing, Nutrition and Fortification with emphasis on Vitamin D, organized by School of Interdisciplinary Sciences & Technology along with School of Unani Medical Education and Research, Jamia Hamdard, New Delhi held on March 5-6, 2020 at New Delhi.

24) Dharani Kumar, Ashish Kumar Singh, P N Raju, Sumit Arora, Gaurav Kr Deshwal and Heena Sharma. Best Oral Presentation award on 'Development and Quality Enhancement of Goat Milk based Probiotic Yoghurt using Ultrafiltration, Microbial Transglutaminase and Exopolysachharides' In: National Conference on 'Emerging Trends for Development of Functional Foods' organized at MAFSU, Nagpur, Maharashtra from February 06-07, 2020.

25) Diwas Pradhan, Ms. Ganga Gulati, Ms. Anisha Singh, SaurabhKadyan, Rashmi H. M., J. K. Kaushik and Dr. Sunita Grover received "Abbvie-Eisai Investigator Award" alongwith a cash prize (600 US$) in the 8th Annual Meeting of Asian Organization for Crohn's& Colitis (AOCC 2020) held virtually in Busan, Korea from December16-18, 2020 for the oral presentation 'Lipoteichoic acid from probiotic *Lactobacilli* exhibit strain specific anti-inflammatory effects in dextran sodium sulphate induced colitis mice'.

26) Elango K, A Kumaresan, M Ashokan, T Karuthadurai, B S Pradeep Nag, M Bhaskar, B Arun Prasad, S Jeyakumar, A Manimaran, VinodBhat& K P Ramesha (2020). First Prize Award for the presentation of the research paper entitled "Dynamics of mitochondrial membrane potential and DNA damage during cryopreservation of cattle and buffalo bull spermatozoa" in the "National Level Online Research Paper Presentation Competition" organized by Lakhimpur College of Veterinary Science, Assam Agricultural University during August 19 to 24, 2020.

27) Gunjan Bhandari, Scientist bagged Best Presentation Award, 2020 for the presentation entitled, "Alternatives for accelerating agricultural growth in Uttar Pradesh – A zone-wise analysis" at the 6th National Seminar on Sustainable Development: Socio-economic Concerns jointly organised by the Department of Economics, Punjabi University and The Society of Economics and Development, Ludhiana on June 22, 2020.

28) Heena Sharma, Gaurav Kr Deshwal and Ashish Kumar Singh. Best oral presentation award on 'Development and Characterization of Shelf-stable debitteredgiloy-goat milk based functional beverage' In: International Conference on 'Livestock, Food Security & Food Safety- Challenges, Opportunities and Strategies' from January 28-29, 2020.

29) Nishant Kumar received Best Oral Presentation Award for the research entitled, "Ameliorative measures for reducing adverse impact of heat stress on animals" in International Webinar on Urban and Peri-urban Agriculture for livelihood organized by Dr. Ram Avatar Shiksha Samiti and ICAR-CAZRI, RRS, Pali, Marwar, Rajasthan from July 29-30, 2020.

30) Nishant Kumar received Best Oral Presentation Award for the research entitled" Effect of Exogenous Kisspeptin in Advancing Age of puberty in Murrah Buffalo Heifers" in National Webinar on Farm, Food & farmer organized by Samagra Vikas Welfare Society (SVWS) from September 24-25, 2020.

31) Ponnusamy K. received Best Oral presentation award in the International E-Conference on "Market Led Extension Management: Focus on Covid-19" organised by CCS National Institute of Agricultural Marketing, Jaipur, Rajasthan during 17-18 October 2020.

32) Rebeka Sinha, Beena Sinha, RaginiKumari, Vineeth M.R., Archana Verma and Ishwar Dayal Gupta received "Best Oral Presentation Award" for their research paper "Effect of udder conformation traits on milk production in crossbred cattle of tropical region" during International Conference on "Advances and Innovations in Agriculture and Allied Sciences (AIAAS- 2020)" held at Jawaharlal Nehru University Convention Centre, Delhi (India) from January 31 to February 01, 2020.

33) Shubham Kumar, Monika Sharma*, Devaraja H C, Menon Rekha Ravindra. First prize for oral presentation on Milk- finger millet based composite probiotic fermented product In: International Conference on Current Research and Approaches in Food Technology – 2020, held at Osmania University, Hyderabad during February 14-15, 2020.

34) Soumya Mohapatra and R Sendhil, Senior Scientist, IIWBR received "Best Paper Presentation Award" for their paper "Role of Milk Market Infrastructure for Sustainable Dairy Development" presented during 6th National Seminar (Webinar) on 'Sustainable Development: Socio-Economic Concerns' conducted by the Department of Economics, Punjabi University, Patiala and the Society of Economics and Development, Ludhiana on June 22, 2020.

35) Sunil Meena and KaushikKhamrui, Best Oral Presentation Award for the presentation titled "Development of microencapsulated curcumin emulsion by using dairy ingredient" at International Webinar on "Climate Resilient Agriculture for Food and Nutritional Security", organized by BHU, Varanasi during January 9-10, 2021.

36) Writdhama Prasad and KaushikKhamrui. Second Best Oral Presentation award for the work entitled 'Efficacy of zinc binding activity of different exo-polysaccharides in whey and their stability evaluation' in Global Conference on Emerging Agricultural Research to Endure the Predicament of COVID-19 Pandemic organized by Agricultural Economics and Social Science Research Association from 12-13 Dec, 2020.

37) Yallappa, M.S., S.V. Singh, Aditya Despande, Parvender Sheoran, and V.P. Chahal - First prize in oral presentation to article entitled "Physiological responses, energy metabolites and prolactin levels of buffaloes with dietary astaxanthin, prill fat and their combination during heat stress" Presented during National Seminar on "Agrometeorological interventions for enhancing farmers income" (AGMET-2020) Organized by Association of Agrometeorologists, Anand& KAU, Thrissur, Kerala from 20-22 January, 2020.

Best Paper Awards

38) Ramendra Das, IshwarDayal Gupta, Dr. Archana Verma, Mahesh VishwasChaudhari, LalrengpuiiSailo and Dr. Sohanvir Singh received "First Best Paper Award" for their paper "Identification of SNPs in ATP1A1 gene and their association with heat tolerance in Sahiwal and Karan Fries (Bostaurus × Bosindicus) cattle under tropical climatic condition" published in Indian Journal of Dairy Science in the category of "Dairy Production" during the 48th Dairy Industry Conference (DIC) at Jaipur at the Plenary Session on February 22, 2020.

39) Rebeka Sinha, Beena Sinha, RaginiKumari, Sushil Kumar, Vineeth M.R., Archana Verma and IshwarDayal Gupta received "Best Paper Award" for their research paper "Principal component analysis of linear udder type traits for milk production in Karan Fries cattle". XVII National Symposium on Enhancement of Farmers' Income through Management of Animal Genetic Resources Organized by Society for Conservation of Domestic Animal Biodiversity (SOCDAB) held at NDVSU-College of Veterinary Science and Animal Husbandry Mhow (M.P.) from February 10-11, 2020.

40) Rebeka Sinha, Beena Sinha, RaginiKumari, Vineeth M.R., Archana Verma and Ishwar Dayal Gupta received "Best Paper Award" in the Session II for the research paper "Selection of udder and teat morphometric traits for safe and quality milk production in crossbred cattle" during International Conference on "Livestock, Food Security and Food Safety – Challenges, Opportunities and Strategies" held at Madras Veterinary College, Tamil Nadu Veterinary and Animal Sciences University, Chennai-600007, India during January 28-29, 2020.

41) Yogesh Khetra First Best Paper Award by Indian Dairy Association for the research paper “Effect pf processing parameters on quality attributes of cream cheese”.

Best Poster Awards

42) Basavprabhu H. N., Chette Ramesh, Rashmi H.M., Sunita Grover received “Certificate of Appreciation” for poster presentation on Biosurfactants of Lactic Acid Bacteria: The Potential Weapons to Tackle the Persistence of Clinical Isolates of Methicillin-Resistant *Staphylococcus aureus*during AIIMS-ASM 2020 conference on Antibiotic Resistance : Renewed Fight held on October 7-8, 2020.

43) Chette Ramesh, Basavaprabhu HN, Sunita Grover, Rashmi HM received “Best Poster Award (First)” for poster presentation on “Probiotics Derived Biosurfactants: A Novel Postbiotic Candidate with Therapeutic Scaffold to Abrogate the Prevalence of Extended Spectrum Beta-Lactamase *Escherichia coli”* at 5th Biennial Virtual Conference of PAi and International Symposium on "Probiotics and Immunity: way forward to microbial therapy" held on November 19-20, 2020.

44) Darshan H. K., Sathish Kumar M. H. and Shakti Singh Chauhan. Best Poster Award - (2020). Optimization of poly-lactic acid and coconut shell powder based biodegradable composites for rigid container development. International Conference on Current Research and Approaches in Food Technology – 2020, held at Osmania University Hyderabad during February 14-15, 2020.

45) Deepak Chand Meena and Sanchita Garai Received Best Poster Presentation Award for the “*Ethno-Veterinary Medicine (EVM) used by the Raika Pastoralists of Marwar region of Rajasthan to cure common disease of small Ruminants*” during International web Conference on Global Research Initiatives for Sustainable Agriculture & Allied Sciences during December 28-30, 2020.

46) Dharani Kumar, Ashish Kumar Singh, Heena Sharma, G S Meena and Gaurav Kr Deshwal. Best Poster Presentation award on 'Effect of Supplementation of Milk Protein Concentrates on Various Properties of Probiotic Goat Milk Yoghurt' In: 27th ICFoST 'Raising Agro-processing & Integrating Novel Technologies for Boosting Organic Wellness' organized at Tezpur University, Assam from January 30- February 01, 2020.

47) Omkar D T, K Jayaraj Rao, Devaraja HC, Monika Sharma, Satish Kumar MH, Best Poster Award - Development of Composite dairy spread incorporated with Finger millet, International Conference on Current Research and Approaches in Food Technology- 2020, held at Osmania University, Hyderabad held during 14-15th February, 2020.

48) Ponnusamy K. and Kartikey Patel were awarded best poster award for the topic Control of ticks using polyherbal medication in Hindi Chetna Maas-2020 at NDRI, Karnal.

49) Rajani C. S., Sathish Kumar M. H. and Harshita Sonarthi. Best Poster Award - (2020). Gir cow milk beta casein hydrolysates- Wonder molecules for people suffering from diabetes. National Conference on Health and Wellness through Nutrition and Nutraceuticals, held at M. S. Ramaiah University of Applied Sciences, Bengaluru during January 22-24, 2020.

50) Rajani C.S. Ashok Kumar and Sathish Kumar M. H. Best Poster Award - (2020). Dipeptidyl peptidase-IV inhibitory potential of flavourzyme treated β-lactoglobulin and α-lactalbumin hydrolysates isolated from *Gir* cow milk. International Conference on Current Research and Approaches in Food Technology – 2020, held at Osmania University Hyderabad during February 14-15, 2020.

51) Shailesh Kumar Meena, Neelam Upadhyay, Pradip Behere and Ravinder Kumar Malhotra won the “Second Best Poster Presentation Award” for their poster on “Effect of natural preservatives on antioxidative and antimicrobial activity of naturally coloured, omega-3 rich table spread” during 48th Dairy Industry Conference on Dairying for Health and Wealth organized by Indian Dairy Association at Jaipur, Rajasthan from February 20-22, 2020.

52) Sonia Mor, SurendraNath, LaxmanaNaik, F Magdalene Emerald Eljeeva and P HeartwinAmaladhas were awarded with Best Poster Merit Award for the poster/Talk entitled preparation and characterization of milk biopeptides loaded niosomes at the National Conference on Health and Wellness through Nutrition and Nutraceuticals – 2020 organized by The Nutrition and Nutraceutical Research Centre, Ramaiah University of Applied Sciences, Bengaluru, India, from January 22-24, 2020.

53) The Bill & Melinda Gates Foundation grants ($375.00) to Rashmi Hogarehalli Mallappa, Amrita Tigga, E. Shree Niharika, Santhosh Kumar Muniyaappa, Saurabh Kadyan, Diwas Pradhan and Sunita Grover to present poster on for the ASM Conference on Rapid Applied Microbial Next-Generation Sequencing and Bio-informatic Pipelines, held online from December 7-11, 2020.

54) Uma K, P N Raju and Rakesh Kr Raman. Second Best ePoster Presentation Award at International Webinar on *Functional Dairy Foods: Way Forward for Dairy Industry after COVID-19* organized on the occasion of National Milk Day by Banaras Hindu University, Varanasi on 26th November 2020.

55) Yallappa M. Sommagond and S.V. Singh (2020) Second poster presentation award during E- poster competition programme combinedly organized by Professional Youths for one health and Animal Nutrition Society of India.

56) Yallappa, M.S., S.V. Singh, Aditya Despande, ParvenderSheoran, and V.P. Chahal Best poster presentation award - to article entitled "Infrared thermography: A potential non- invasive tool for mapping of surface temperature of buffaloes during summer season" Presented during the poster session "*Approaches for enhancing the productivity and health of dairy animals*" In: "Souvenir of 48th Dairy Industry Conference- *Dairying for health and wealth*" B.M. Birla Auditorium, Jaipur from 18-19 February, 2020. PP. 17-18.

Honours

57) Dixit A.K. was invited as a Jury Member at debate on 'Decoding the New Farm Bills 2020: Will the New Farm Bills benefit farmers', organized by students of DES&M Division on 24-10-2020 (online).

58) Dixit A.K. was invited to deliver Expert Lecture on "Self-Entrepreneurship on Dairy Farming". Bilingual (Hindi & English), C-DAC Mohali. .

59) Meena Malik received Appreciation Certificate from PI-IDP &Dean COVS, Guru Angad Dev Veterinary and Animal Science University University (**GADVASU**), Ludhiana for her invited lecture on "The Magic of Effective Communication" through virtual platform in the National Webinar.

60) Meena Malik was invited to deliver Expert Lecture on "Research Paper Writing" by Sri Venkateshwara Veterinary University, Tirupati, Andhra Pradesh.

61) Garai S, Singh M, Meena H R, Chitranayak , Meena B S , Kushwa R K, VermaA, Dutta C and Kadian K S Received second best Hindi publication award-2019-20 for publication of "*Rastriya Dairy Mela Smarika 2020 on Scientific Animal Husbandry Practices"* by Town official language implementation committee, Karnal, Haryana.

62) Manimaran A. Received Best poster (second prize) award for research paper entitled "Therapeutic efficacy of trisodium citrate and its combined supplementation with nanominerals on subclinical mastitis cows" during ISVPT e-Conference on 4-5th October, 2020.

63) Mohar Singh received Utkrisht Award for the folder "Gehoonki adhik paidavar ke liye naveentam Krishi taknik" by Raj BashaKaryawanSamiti, Karnalfor 2019-20.

64) Neelam Upadhyay got Commendation certificate for being the co-editor of Dugdh Ganga magazine that received First Prize under Utkrasht Hindi Grah Patrika category award of Utkrisht Hindi Prakashan Puraskar-2019-20 by Town Official Language Implementation Committee, Karnal 2020.

65) Neelam Upadhyay got Institute Rajbhasha Gaurav Certificate 2019-20 by ICAR-National Dairy Research Institute, Karnal.

66) Neelam Upadhyay got Letter of Appreciation from Director, NDRI for being the co-editor of Dugdh Ganga Magazine that received Second Prize and Trophy under Ganesh Shankar Vidyarthi Hindi Patrika PuraskarYojana 2018-19 of Indian Council of Agricultural Research.

67) Neelam Upadhyay got Second Prize in institute level essay competition held during Rajbhasha Hindi Ullas Maah-2020 by ICAR-National Dairy Research Institute, KarnalPoster Presentation (Student Category) during Hindi UllasMaah- 2020 by ICAR-National Dairy Research Institute, Karnal.

68) Nishant Kumar received 1st prize for hindi technical bulletin entitled " Navjaatewam Chhote Bachhdon ki Dekhbhaal ewam Prabandhan" under Vaigyaaniktathaa Takniki Vishyonki MulRoop se Hindi mein Likhe gaye prakashanon ki Puraskaar Yojna (Varsh 2019-2020) from ICAR-NDRI Karnal.

69) Nishant Kumar received 1st prize for hindi aalekh entitled "Bakriyon Mein Kritrim Garbhaadhaan" under Vaigyaani ktathaa Takniki Vishyon ki MulRoop Se Hindi mein Likhe Gaye Prakashanon ki PuraskaarYojna (Varsh 2019-2020) from ICAR-NDRI, Karnal.

70) Nishant Kumar received 1st prize for research entitled "Effect of zinc supplementation on performance of Peri-parturient Karan Fries Cows during heat stress condition" at "International Webinar on Climate Smart Livestock and Poultry Production through nutritional interventions" organized by Institute of

Animal Nutrition, Directorate of Centre for Animal Production Studies, TANUVAS on 23-24 November 2020.

71) Nishant Kumar received Excellence in Research Award in "International Webinar on Urban and Peri-urban Agriculture for livelihood" organized by Dr. Ram Avatar Shiksha Samiti and ICAR-CAZRI, RRS, Pali, marwar, Rajasthan from 29-30 July 2020.

72) Ponnusamy K. secured Second position in Essay writing on International Day for Biological Diversity-2020 organised by Haryana State Biodiversity Board, Government of Haryana, Panchkula.

73) Prateek Singh, Chander Datt, V.B. Singh, Kuldeep Dudi, Gauranavum Ashutosh Kumar First prize for popular article on "Protein, khanijtattavonaur vitamin ka pashu prajanan par prabhav.E-pashupalan.com/hi. 2 (2):88-90.

74) Prem Mehta. Institute Rajbhasha Gaurav Certificate 2019-20 by ICAR-National Dairy Research Institute, Karnal.

75) Puniya A. K. (Mentor), Pranali Balkishan Nikam, Ms. Neha, Ms. Vaishali Dasriya, Mohammad Rizwan and Ms. Khushbu Sao received "Certificate of Winner", 'Nutri-Scholars Award' (2020) during Academic Year 2020-21 for the project 'Nutripoi with Soymus' in the category of QSR Style Lunch/Dinner from DuPont Nutrition and Biosciences.

76) Sachin Kumar received *First Prize* at Hindi Pakhwada, 2020.

77) Shailesh Kumar Meena, Neelam Upadhyay, Pradeep Behare and Ravinder Kumar Malhotra. Second Best poster presentation award at 48th Dairy Industry Conference on 'Dairying for Health and Wealth' organized by Indian Dairy Association at Jaipur (Rajasthan during February 20-22, 2020.

78) Shailesh Kumar, Meena, Neelam Upadhyay, Priya Yawale, PradipBehare, Ravinder Malhotra, Sangita Ganguly. First Prize in institute level online Hindi Research Paper.

79) Singh A.K., C. Bhakat, M. K. Ghosh, M. Karunakaran, Ajoy Mandal, D.K. Mandal, T.K. Dutta, Asif Mohammad Secured second position in institute level online Hindi Research paper Poster Presentation Competition (non-Hindi speaking category) held on 25/09/2020 during Rajbhasha Hindi Ullas Maah-2020.

80) Chander Datt of Animal Nutrition Division received Commendation Certificate from Hon'ble Director ICAR-NDRI, Karnal for being member of Souvenir Publication Committee of Rashtriya Dairy Mela Samarika-2020.

81) Mohan Mondal was nominated a Member of the Project proposal evaluation committee of the BARD - The US-Israel Agricultural Research & Development Fund.

82) Sumit Arora was nominated a Member of the Scientific Panel on Labelling & Claims/Advertisements constituted by Food Authority, Food Safety and Standards Authority of India (Ministry of Health and Family Welfare of India) Government of India, vide Order File No. 1-34/SC/SP/2019-FSSAI-SSC dated 1st January 2020.

83) Sumit Arora was nominated a Member of the Scientific Panel on Sweets, Confectionery, Sweeteners, Sugars and Honey constituted by Food Authority, Food Safety and Standards Authority of India (Ministry of Health and Family Welfare of India) Government of India, vide Order File No. 1-34/SC/SP/2019-FSSAI-SSC dated 1st January 2020.

84) Sumit Arora was nominated aMember of the Expert Committee for shortlisting of proposals received against call for proposals on "Food fortification and newer technologies to improve bioavailability of nutrients" and "Geriatric Nutrition"vide Order No. BT/03/06/2009-FNS dated 24/12/2020.

85) Sumit Arora was nominated a Member of the working group to review issues related to vitamins and minerals under FSSR and other nutritional related issues constituted by Food Authority, Food Safety and Standards Authority of India (Ministry of Health and Family Welfare of India) Government of India, vide Order File No. stds/WG (Vitamins & Minerals)-SP (N & F)/FSSAI-2019 dated 22nd Jan, 2020.

86) Vikas Vohra was nominated a Member of the Committee to evaluate the use of gender biased semen in the state of Punjab, by Govt. of Punjab.

PUBLICATIONS

RESEARCH PAPERS

Animal Genetics & Breeding

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Akram, N., Kumar, R., Sharma, R. C., Kashyap, S. K., &Gowane, G. R. (2020). Molecular characterization of myostatin gene in Malpura sheep of Rajasthan. *Genetika, 52*(2),465-476.	0.761	7.19
2.	Ali, S. S., Kuralkar, S. V., Das, R., Raina, V., Kataria, R. S., & Vohra, V. (2020).Assessment of genetic diversity and bottleneck in Purnathadi buffaloes using short tandem repeat markers. *Animal Biotechnology,32*(4), 495-506.	2.282	7.26
3.	Chopra, A., Ali, S. A., Bathla, S., Rawat, P., Vohra, V., Kumar, S., & Mohanty, A. K. (2020). High-resolution mass spectrometer–based ultra-deep profile of milk whey proteome in Indian Zebu (Sahiwal) cattle. *Frontiers in Nutrition, 7*,150.	5.87	9.365
4.	Deb, R., Sengar, G. S., Junghare, V., Hazra, S., Singh, U., Alex, R., & Kumar, A. (2020). Characterization of a putative ribosome binding site at the 5 untranslated region of bovine heat shock protein 90. *Molecular Biology Reports, 47*(9), 7061-7071.	2.316	8.11
5.	Devadasan, M. J., Kumar, D. R., Vineeth, M. R., Choudhary, A., Surya, T., Niranjan, S. K., Verma, A. and Sivalingam, J., (2020). Reduced representation approach for identification of genome-wide SNPs and their annotation for economically important traits in Indian Tharparkar cattle. *3 Biotech, 10*(7),1-6.	2.406	7.79
6.	Dhandapani, S., Vohra, V., Chhotaray, S., Kumar, S., Singh, K. P., &Kataria, R. S. (2020). Number of pregnancies and season of calving influence the production and reproduction traits in Nili-Ravi buffalo. *Indian Journal Dairy Sci., 73*(5), 443-48	Nil	5.95
7.	Dinesh, K., Verma, A., Gupta, I. D., & Dash, S. K. (2020). Association of polymorphic variant of exons 6 and 11 of lactoferrin gene with mastitis in Murrah buffalo. *Indian J. Animal Sciences, 90*(4),588-591.	0.278	6.23
8.	Gowane, G. R., Akram, N., Misra, S. S., Chopra, A., Sharma, R. C., & Kumar, A. (2020). The breeding structure for the small ruminant resources in India. *Tropical Animal Health and Production, 52*(4), 1717-1724.	1.559	7.09
9.	Gowane, G. R., Swarnkar, C. P., Misra, S. S., Kumar, R., Kumar, A., Singh, D., & Prince, L. L. L. (2020). Selecting sheep for Haemonchuscontortus resistance and susceptibility: Flock dynamics and genetic architecture. *Research in Veterinary Science, 132*,116-126.	2.534	7.75
10.	Gowane, G. R., Swarnkar, C. P., Narula, H. K., & Chopra, A. (2020). Better odds of lamb survival in sheep at dry arid tropical region of India. ICAR.*Indian Journal of Animal Sciences,90*(4),628–635.	0.278	6.23

11.	Kumar, A., Gupta, I. D., Mohan, G., Vineeth, M. R., Jayakumar, S., & Niranjan, S. K. (2020). Development of PCR based assays for detection of lethal Holstein haplotype 1, 3 and 4 in Holstein Friesian cattle. *Molecular and Cellular Probes, 50*,101503.	2.365	8.51
12.	Kumar, B., Verma, A., & Gupta, I. D. (2020). Association of genetic variants of forebrain embryonic zinc finger-like (FEZL) gene exon 3 with clinical mastitis in Murrah buffaloes (Bubalus bubalis). *Indian Journal Dairy Science,73*(4),354-58.	Nil	5.95
13.	Kumar, D. R., Devadasan, M. J., Surya, T., Vineeth, M. R., Choudhary, A., Sivalingam, J., Kataria, R.S., Niranjan, S.K. Tantia, M.S. and Verma, A. (2020). Genomic diversity and selection sweeps identified in Indian swamp buffaloes reveals its uniqueness with riverine buffaloes. *Genomics, 112*(3),2385-92.	5.736	9.16
14.	Magotra, A., Gupta, I. D., Ahmad, T., & Alex, R. (2020). Polymorphism in DNA repair gene BRCA1 associated with clinical mastitis and production traits in indigenous dairy cattle. *Research in Veterinary Science, 133*,194-201.	2.534	7.75
15.	Mahala, S., Saini, S., Kumar, A., Sharma, R. C., &Gowane, G. R. (2020). Genetic trends for the growth rates and Kleiber ratio in Avikalin sheep. *Small Ruminant Research, 189*,106143	1.611	7.21
16.	Mahala, S., Saini, S., Kumar, A., Sharma, R. C., &Gowane, G. R. (2020). Genotype environment interaction affects sire ranking for live weights in Avikalin sheep. *Small Ruminant Research, 186*,106092.	1.611	7.21
17.	Mukherjee, S., Mukherjee, A., Jasrotia, R. S., Jaiswal, S., Iquebal, M. A., Longkumer, I., Mech, M., Vüpru, K., Khate, K., Rajkhowa, C., Rai, A.,& Kumar, D. (2020). Muscle transcriptome signature and gene regulatory network analysis in two divergent lines of a hilly bovine species Mithun (*Bos frontalis*). *Genomics, 112*(1), 252-262.	5.736	9.16
18.	Namith C., Verma, A., A.K. Gupta, A. K. Sharma, C.G. Shashank, Salim Yousouf and Ravindra Malhotra (2020) Prediction of Lifetime Performance in Sahiwal Cattle by Artificial Intelligence Based Machine Learning Models. International Journal of Current Microbiology and Applied Sciences, 9(4),1867-1873.	Nil	5.38
19.	Prakash, V., Prince, L. L. L., Gowane, G. R., Sharma, R. C., & Kumar, A. (2020). Direct and maternal effects models for variance components and genetic parameters estimation of growth traits in prolific Garole sheep. *Indian J of Animal Sciences, 90*(1),85-89.	0.278	6.28
20.	Raina, V. S., Kour, A., Chakravarty, A. K., & Vohra, V. (2020). Marker-assisted selection vis-à-vis bull fertility: coming full circle–a review. *Molecular Biology Reports, 47*(11), 9123–9133.	2.316	7.40
21.	Raja, T., Das, A., Rathee, S., Singh, U., Murthy, K., Alex, R., Kumar, S., & Patil, N. (2020). Modeling and evaluation of lactation curve functions in Gir cattle. *The IJ of Animal Sciences, 90*(9), 86-90.	0.278	6.28
22.	Raja, T., Rathee, S. K., Kumar, R., Prakash, B., Singh, U., & Deb, R. (2020). Multi-trait animal model-based estimation of direct and correlated responses in Frieswal cattle. *Indian J. Animal Sci., 90*(7), 1060-1064.	0.278	6.28
23.	Saikia, J., Verma, A., Gupta, I. D., Hazarika, D., Deshmukh, B., & Das, R. (2020). Novel SNP identified in HSBP1 gene and its association with thermal tolerance traits in Murrah buffalo. *Indian Journal Animal Res., 54*(3), 282-285.	0.395	6.44
24.	Singh, R., Lava Kumar, S., Mishra, S. K., Gurao, A., Niranjan, S. K., Vohra, V., Dash, S. K., Rajesh, C.,&Kataria, R. S. (2020). Mitochondrial sequence based evolutionary analysis of riverine–swamp hybrid buffaloes of India indicates novel maternal differentiation and domestication patterns. *Animal Genetics, 51*(3), 476-482.	3.169	8.24

25.	Singh, U., Alex, R., Kumar, S., Deb, R., Venkatesan Raja, T., Singhal, S., Sengar, G. S., Singh Rathod, B., Srirama Murthy, K.,& Vasant Rao Patil, N. (2020). Association of bovine KISS1 single nucleotide polymorphisms with reproductive traits in Indian Cattle. *Reproduction in Domestic Animals, 55*(8), 922-930.	2.005	7.64
26.	Singh, U., Alex, R., Kumar, S., Deb, R., Venkatesan Raja, T., Singhal, S., Sengar, G. S., Singh Rathod, B., Srirama Murthy, K.,& Vasant Rao Patil, N. (2020). Association of bovine KISS1 single nucleotide polymorphisms with reproductive traits in Indian Cattle. *Reproduction in Domestic Animals, 55*(8), 922-930.	Nil	5.95
27.	Verma, N., Alyethodi, R. R., Kathuria, A., Alex, R., Hussain, S., Singh, U., Tyagi, S., Sirohi, A. S., Kumar, S., Deb, R. and Sengar, G. S.,& Prakash, B. (2020). Effect of heat stress on superoxide anion production in native and crossbred cattle under in vitro whole blood culture model. *Journal of Thermal Biology, 87*, 102457.	2.902	7.90
28.	Verma, U. K., Vohra, V., Gupta, I. D., Verma, A., Mukherjee, A., & Deb, S. M. (2019). Assessment of lactation curve parameters for test-day Milk yield, Fat% and SNF% in Murrah Buffalo. Indian Journal of Dairy Science, 72(6), 639-644.	Nil	5.95

Livestock Production & Management

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Bhardwaj, S., Kumar, P., Jerome, A., Ravesh, S., Patil, C., Singh, P., &Lailer, P. C. (2020). Serum kisspeptin: New possible biomarker for sexual behaviour and sperm concentration in buffalo bulls. *Reproduction in Domestic Animals, 55*(9), 1190-1201.	2.005	7.42
2.	Bipate, M., &Misra, A. K. (2020). Effect of polyherbal supplementation on milk production and postpartum reproduction in crossbred cattle. *Indian J. Dairy Sci., , 73*(2), 136-139.	Nil	5.95
3.	Chikkagoudara, K. P., Singh, P., Barman, D., Potshangbam, C., Bhatt, N., Singh, S. V., &Lathwal, S. S. (2020). Eye temperature, an indicator for stress levels in young buffalo bulls–A case study of micro-environment modification. *Journalof Agrometeorology, 22*(3), 266-273.	0.469	6.47
4.	Choudhary, S., Kamboj, M., Raheja, N., Kumar, N., Saini, M., &Lathwal, S. (2020). Influence of bull biostimulation on age at puberty and reproductive performance of Sahiwal heifers. Indian Journal of Animal Sciences, 90(1), 28-34.	0.278	6.28
5.	Fahim, A., Kamboj, M. L., &Sirohi, A. S. (2020). Performance of Milking Machine at Different Vacuum Levels in Crossbred Dairy Cows Milked in Automated Herringbone Parlour. AMA-Agricultural Mechanization in Asia Africa and Latin America, 51(2), 52-57.	0.23	6.17
6.	Kumawat, R. N., &Misra, A. K. (2020). An estimation of feed and fodder availability in the arid Rajasthan. *Indian Journal of Animal Sciences, 90*(2), 249-253.	0.278	6.28
7.	Lone, S. A., Mohanty, T. K., Bhakat, M., Paray, A. R., Baithalu, R. K., Yadav, H. P., & Sinha, R. (2020). Supplementing extender with anandamide enhances quality of low sperm doses during cryopreservation in bulls. Andrologia, 52(11), e13782.	2.775	7.84
8.	Lone, S. A., Mohanty, T. K., Bhakat, M., Paray, A. R., Yadav, H. P., Singh, A., Sinha, R., Baithalu, R.K., Rahim, A., Kumar, R. and Kumar, P.,& Shah, N.(2020). Modification of French mini-straw plug position for cryopreservation of small doses of bull sperm. Animal Reproduction Science, 218, 106485.	2.145	7.65

9.	Misra, A. K., &Kumawat, R. N. (2020). Common Grazing Resources of Hot Arid Zone of Rajasthan, India: Problems and Prospects. *Annals of Arid Zone, 59*(3 & 4).	Nil	Nil
10.	Rajneesh, A. K., Jamwal, S., & Praveen, S. (2020). Evaluation of body parameters of lactating Murrah buffaloes on supplementation of bypass fatty acids and Tinospora cordifolia.*The Pharma Innovation Journal, 9*(12), 26-30.	5.98	5.03
11.	Rajput, M.S., Kamboj, M.L. and Kumar, N., (2020). Effect of bio stimulation on some behavioural aspects and energy balance of Sahiwal cows during peri-estrual period. *Indian Journal of Animal Research*. 10.18805/IJAR.B-4186.	0.395	6.40
12.	Rather, H. A., Kumaresan, A., Nag, P., Kumar, V., Nayak, S., Batra, V., Ganaie, B. A., Baithalu, R. K., Mohanty, T. K.,& Datta, T. K. (2020). Spermatozoa produced during winter are superior in terms of phenotypic characteristics and oviduct explants binding ability in the water buffalo (Bubalus bubalis). *Reproduction in Domestic Animals, 55*(11), 1629-1637.	2.005	7.4
13.	Regar, P.C, Kamboj, M.L.and Shinde, K.P (2020). Growth, productive and reproductive performance of goats in tribal areas of Rajasthan. *International J.of Livestock Research, 11*(1), 82-86.	2.01	5.36
14.	Singh, A., Chandel, B. S., Chauhan, A. K., & Kamboj, M. L. (2020). Cow Welfare: Only Sustainable Gaushalas can ensure it. *Quarterly Research Journal of Plant & Animal Sciences/Bhartiya Krishi Anusandhan Patrika, 35*(4), 207-218.	Nil	Nil

Animal Biotechnology Centre

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Ali, S. A., Singh, P., Tomar, S. K., Mohanty, A. K., &Behare, P. (2020). Proteomics fingerprints of systemic mechanisms of adaptation to bile in Lactobacillus fermentum. *J of Proteomics, 213*, 103600.	4.044	9.54
2.	Ansari, S., Jamwal, S., Saini, S., Singh, R., &Malakar, D. (2020). 84 Folate-methionine cycle and folate transport in developing buffalo embryos. *Reproduction, Fertility and Development, 32*(2), 168-168.	2.66	8.14
3.	Barik, S. K., Mohanty, K. K., Mohanty, A. K., Rawat, P., Gopal, G., Bisht, D., Patil, S. A., Singh, R., Sharma, D., Tripathy, S. P., Tandon, R., Singh, T. P., &Jena, S. (2020). Identification and differential expression of serotransferrin and apolipoprotein AI in the plasma of HIV-1 patients treated with first-line antiretroviral therapy. *BMC Infectious Diseases, 20*(1), 1-8.	1.30	0.00
4.	Bathla, S., Sindhu, A., Kumar, S., Dubey, S. K., Pattnaik, S., Rawat, P., Chopra, A., Dang, A., Kaushik, J.K.& Mohanty, A. K. (2020). Tandem Mass Tag (TMT)-based quantitative proteomics reveals potential targets associated with onset of Sub-clinical Mastitis in cows. *Scientific Reports, 10*(1), 1-10.	4.379	10.1
5.	Bathla, S., Sindhu, A., Kumar, S., Dubey, S. K., Pattnaik, S., Rawat, P., Chopra, A.& Mohanty, A. K. (2020). Quantitative proteomics revealed the putative biomarker for detection of early-stage intra-mammary gland infection in cow. *J. of Proteins and Proteomics, 11*(3), 173-181.	3.106	4.55
6.	Batra, V., Dagar, K., Nayak, S., Kumaresan, A., Kumar, R., & Datta, T. K. (2020). A higher abundance of O-linked glycans confers a selective advantage to high fertile buffalo spermatozoa for immune-evasion from neutrophils. *Frontiers in Immunology, 11*, 1928.	7.561	6.42
7.	Batra, V., Dagar, K., Nayak, S., Kumaresan, A., Kumar, R., & Datta, T. K. (2020). A higher abundance of O-linked glycans confers a selective advantage to high fertile buffalo spermatozoa for immune-evasion from neutrophils. *Frontiers in Immunology, 11*, 1928.	6.429	10.72
8.	Chopra, A., Ali, S. A., Bathla, S., Rawat, P., Vohra, V., Kumar, S., & Mohanty, A. K. (2020). High-resolution mass spectrometer–based ultra-deep profile of milk whey proteome in Indian Zebu (Sahiwal) cattle. Frontiers in Nutrition, 7, 150.	6.756	0.00

9.	Choudhary, R., Sharma, A., Kumar, S., Upadhyay, R. C., Singh, S. V., & Mohanty, A. (2020). Role of alpha-melanocyte stimulating hormone (-MSH) in modulating the molecular mechanism adopted by melanocytes of Bos indicus under UVR stress. Molecular and Cellular Biochemistry, 465(1), 141-53.	3.396	8.88
10.	Das, S., De, A. K., Perumal, P., Bera, A. K., Rana, T., Muniswamy, K., Kundu, A., Muthiyan, R., Malakar, D.B., Das, P. And Samanta, S. & Pan, D. (2020). Bioaccumulation and cytological alteration of immune organs of chicken following inorganic arsenic exposure. Indian Journal of Animal Sciences, 90(5), 683-87.	0.278	6.28
11.	Elango, K., Kumaresan, A., Sharma, A., Nag, P., Prakash, M. A., Sinha, M. K., Manimaran, A., Peter, E. S. K. J., Jeyakumar, S., Selvaraju, S. and Ramesha, K. P.& Datta, T. K. (2020). Sub-fertility in crossbred bulls: deciphering testicular level transcriptomic alterations between zebu (Bos indicus) and crossbred (Bos taurus x Bos indicus) bulls. BMC Genomics, 21(1), 1-14.	3.969	9.50
12.	Haldar, A., De, S., Gautam, D., Pal, P., & Brar, P. S. (2020). Age-specific peripheral anti-müllerian hormone concentration in buffaloes. Journal of Animal Research, 10(5), 725-32.	0.395	6.40
13.	Jaiswal, L., De, S., Singh, R. K., & Baithalu, R. K. (2020). Molecular characterization and protein structure prediction of heat shock transcriptional factors in goat (Capra hircus) and sheep (Ovis aries). Animal Biotechnology, 31(5), 432-39.	2.282	7.26
14.	Jaswal, S., Anand, V., Kumar, S., Bathla, S., Dang, A. K., Kaushik, J. K., & Mohanty, A. K. (2020). In-depth proteome analysis of more than 12,500 proteins in buffalo mammary epithelial cell line identifies protein signatures for active proliferation and lactation. Scientific Reports, 10(1), 1-13.	5.133	10.1
15.	Kumar, R., Ali, S. A., Singh, S. K., Bhushan, V., Mathur, M., Jamwal, S., Mohanty, A. K., Kaushik, J. K.& Kumar, S. (2020). Antimicrobial peptides in farm animals: an updated review on its diversity, function, modes of action and therapeutic prospects. Veterinary Sci., 7(4), 206.	2.304	0.00
16.	Kumar, S., Rajput, P. K., Bahire, S. V., Jyotsana, B., Kumar, V., & Kumar, D. (2020). Differential expression of BMP/SMAD signalling and ovarian-associated genes in the granulosa cells of FecBintrogressed GMM sheep. Systems Biology in Reproductive Medicine, 66(3), 185-201.	3.061	0.00
17.	Kumar, S., Singla, S. K., Manik, R., Palta, P., & Chauhan, M. S. (2020). Effect of basic fibroblast growth factor (FGF2) on cumulus cell expansion, in vitro embryo production and gene expression in buffalo (Bubalus bubalis). Reproductive Biology, 20(4), 501-11.	2.376	0.00
18.	Kumaresan, A., Das Gupta, M., Datta, T. K., & Morrell, J. M. (2020). Sperm DNA integrity and male fertility in farm animals: A review. *Frontiers in Veterinary Science, 7*, 321.	3.12	8.03
19.	Malik, H. N., Singhal, D. K., Saini, S., &Malakar, D. (2020). Derivation of oocyte-like cells from putative embryonic stem cells and parthenogenetically activated into blastocysts in goat. *Scientific Reports, 10*(1), 1-14.	4.379	8.54
20.	Nag, P., Sharma, A., Kamaraj, E., Kumaresan, A., Datta, T. K., Manimaran, A., Paul, N., Jeyakumar, S.&Ramesha, K. P. (2020). Identification of stable internal control genes for accurate normalization of real-time quantitative PCR data in testicular tissue from two breeds of cattle. *Asian Pacific Journal of Reproduction, 9*(5), 247-54.	0.82	0.00
21.	Phapale, P., Rai, V., Mohanty, A. K., & Srivastava, S. (2020). Untargeted Metabolomics Workshop Report: Quality Control Considerations from Sample Preparation to Data Analysis. *Journal of the American Society for Mass Spectrometry, 31*(9), 2006-10.	3.225	0.00

22.	Pöhland, R., Souza-Cácares, M. B., Datta, T. K., Vanselow, J., Martins, M. I. M., Silva, W. A. L. D., Cardoso, C. J. T.& Melo-Sterza, F. D. A. (2020). Influence of long-term thermal stress on the in vitro maturation on embryo development and Heat Shock Protein abundance in zebu cattle. *Animal Reproduction, 17*(3), e20190085.	2.145	7.82
23.	Punia, H., Tokas, J., Bhadu, S., Mohanty, A. K., Rawat, P., & Malik, A. (2020). Proteome dynamics and transcriptome profiling in sorghum [*Sorghum bicolor* (L.) Moench] under salt stress. *3 Biotech, 10*(9), 1-10.	2.406	7.79
24.	Rather, H. A., Kumaresan, A., Nag, P., Kumar, V., Nayak, S., Batra, V., Ganaie, B. A., Baithalu, R. K., Mohanty, T. K.& Datta, T. K. (2020). Spermatozoa produced during winter are superior in terms of phenotypic characteristics and oviduct explants binding ability in the water buffalo (Bubalus bubalis). *Reproduction in Domestic Animals, 55*(11), 1629-37.	2.005	7.64
25.	Sah, S., Sharma, A. K., Singla, S. K., Singh, M. K., Chauhan, M. S., Manik, R. S., &Palta, P. (2020). Effects of treatment with a microRNA mimic or inhibitor on the developmental competence, quality, epigenetic status and gene expression of buffalo (*Bubalus bubalis*) somatic cell nuclear transfer embryos. *Reproduction, Fertility and Development, 32*(5), 508-21.	2.66	8.14
26.	Shama A., Saini, S., Sharma, V., &Malakar, D., (2020). Fasting promotes longevity through autophagy. *Everyman's Sci.*, *5*, 303-07.	Nil	Nil
27.	Sharma, A., Kumaresan, A., Mehta, P., Nala, N., Singh, M. K., Palta, P., Singla, S. K., Manik, R. S.& Chauhan, M. S. (2020). Successful transplantation of transfected enriched buffalo (*Bubalus bubalis*) spermatogonial stem cells to homologous recipients. *Theriogenology, 142*, 441-49.	2.74	8.30
28.	Shyam, S., Goel, P., Kumar, D., Malpotra, S., Singh, M. K., Lathwal, S. S., Chand, S.,&Palta, P. (2020). Effect of Dickkopf-1 and colony stimulating factor-2 on the developmental competence, quality, gene expression and live birth rate of buffalo (*Bubalus bubalis*) embryos produced by hand-made cloning. *Theriogenology, 157*, 254-62.	2.74	8.30
29.	Singh, A. K., Upadhyay, R. C., Chandra, G., Kumar, S., Malakar, D., Singh, S. V., & Singh, M. K. (2020). Genomewide expression analysis of the heat stress response in dermal fibroblasts of Tharparkar (zebu) and Karan-Fries (zebu× taurine) cattle. *Cell Stress and Chaperones, 25*(2), 327-44.	3.667	8.90
30.	Singh, F., Hirpurkar, S. D., Rawat, N., Shakya, S., Kumar, R., Rajput, P. K., & Kumar, S. (2020). Occurrence of the genes encoding carbapenemases, ESBLs and class 1 integron integrase among fermenting and non fermenting bacteria from retail goat meat. *Letters in Applied Microbiology, 71*(6), 611-19.	2.858	7.81
31.	Singh, R., Saini, S., Ansari, S., Jamwal, S., &Malakar, D. (2020). Exploring the use of mesenchymal stem cells for treatment of mastitis and metritis in cattle. *Reproduction, Fertility and Development, 32*(2), 238-238.	2.66	8.14
32.	Upadhyay, A., Chakravarty, A. K., De, S., Selvan, A. S., Shivahre, P., Gupta, A. K., & Singh, A. (2020). Genetic polymorphism in MAP1B gene associated with conception rate in Holstein Friesian crossbred breeding bulls. *IJ of Animal Sciences, 90*(4), 658-60.	0.278	6.28
33.	Vats, A., Gautam, D., Maharana, J., Chera, J. S., Kumar, S., Rout, P. K., Werling, D., & De, S. (2020). Poly I: C stimulation in-vitro as a marker for an antiviral response in different cell types generated from Buffalo (*Bubalus bubalis*). *Molecular Immuno., 121*, 136-43.	4.407	8.0
34.	Verma, M., Dige, M. S., Gautam, D., De, S., & Rout, P. K. (2020). Functional milk proteome analysis of genetically diverse goats from different agro climatic regions. *Journal of Proteomics, 227*, 103916.	4.044	9.54
35.	Yata, V. K., Gangwar, D. K., Sharma, V., Dubey, S. K., Yadav, S. K., Choudhary, S., Kumar, S., Mohanty, T. K.& Mohanty, A. K. (2020). Semen analysis and sperm characteristics of Karan Fries cattle. *Animal Reproduction Science, 212*, 106250.	2.145	7.82

Animal Physiology Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Alhussien, M. N., & Dang, A. K. (2020). Sensitive and rapid lateral-flow assay for early detection of subclinical mammary infection in dairy cows. *Scientific Reports, 10*(1), 1-12.	4.379	10.1
2.	Alhussien, M.N., & Dang, A. K. (2020). Interaction between stress hormones and phagocytic cells and its effect on the health status of dairy cows: A review. *Veterinary World, 13*(9), 1837-1848.	2.11	Nil
3.	Choudhary, R., Sharma, A., Kumar, S., Upadhyay, R. C., Singh, S. V., & Mohanty, A. (2020). Role of alpha-melanocyte stimulating hormone (-MSH) in modulating the molecular mechanism adopted by melanocytes of Bos indicus under UVR stress. *Molecular and cellular Biochemistry, 465*(1), 141-53.	3.396	8.80
4.	Debbarma, S., Saini, S., & Gowda, S. B. (2020). Seasonal effect in expression of AQP1, AQP3 and AQP5 in skin of Murrah buffaloes. *Journal of Thermal Biology, 93*, 102727.	2.902	8.36
5.	Debnath, B., Laishram, M., Aggarwal, A., & Kumar, S. (2020). Changes in plasma concentration of Leptin, adiponectin and Resistin in karan-fries cows of high and medium body conditions during winter and summer seasons. *Agricultural Science Digest-A Research Journal, 40*(2), 203-06.	0.041	4.21
6.	Debnath, B., Laishram, M., Aggarwal, A., & Kumar, S. (2020). Changes in plasma concentration of Leptin, adiponectin and Resistin in karan-fries cows of high and medium body conditions during winter and summer seasons. *Agricultural Science Digest-A Research Journal, 40*(2), 203-06.	Nil	Nil
7.	Deshpande, A., Singh, S., Somagond, Y. M., Sheoran, P., Naskar, S., & Chahal, V.P. (2020). Physio-biochemical responses and growth performance of buffalo heifers to betaine supplementation during hot humid season under field conditions. *Indian Journal of Animal Sciences, 90*(3), 416-423.	0.278	6.23
8.	Francis, F., &Parkunan, T. (2020). A comparative study on the expression profile of aquaporin 3 (AQP3) gene in the skin fibroblast cells of Barbari and Sirohi breeds of goat. *Indian J. Dairy Sci., 73*(2), 140-144.	Nil	5.95
9.	Kumar, G., Ashutosh, S. S., Somagond, Y. M., & Shukla, S. (2020). Effect of treated waste water intake on physiological responses and growth parameters in crossbred (Alpine x Beetal) kids. *Journal of Entomology and Zoology Studies, 8*(5), 861-65.	5.48	Nil
10.	Kumar, S., & Singh, S. V. (2020). Influence of astaxanthin supplementation on attainment of puberty and lipid peroxidation in Sahiwal and Karan Fries (Holstein×Tharparkar) heifers during summer season. *Biological Rhythm Research, 51*(1), 15-28.	1.219	6.83
11.	Kushwah N., Upadhyay V.R., Singh M. and Roy A.K. (2020) Incidence, Causes and Treatment of Ketosis in Lactating Bovines. *International Journal of Livestock Research, 10*(6), 1-10.	2.01	5.36
12.	Maurya, S., Singh, M, Aggarwal, A. and Sharma, R. (2020). Effect of seasons on physiological responses, milk production and composition in Indigenous cows. *Journal Of Veterinary Medicine and Animal Sciences, 5*(1), 11-20.	Nil	Nil
13.	Mishra, S. M., Roy, A. K., Mahendra, S., & Gupta, I. D. (2020). Effect of Certain Plasma Hormones, Metabolites, Milk -lactalbumin and Lactoferrin on the Persistency of Lactation in Sahiwal Cattle. *International Journal of Current Microbiology and Applied Sciences, 9*(8), 2279-2290.	4.963	5.38
14.	Mohapatra, S. K., Panda, B. S., Verma, A. K., Kapila, R., & Dang, A. K. (2020). Implantation associated changes in expression profile of indoleamine-2, 3-dioxygenase 1, Th1-Th2 cytokines and interferon-stimulated genes on neutrophils and peripheral blood mononuclear cells of crossbred cows. *J of Reproductive Immunology, 142*, 103188.	4.054	10.02
15.	Pal, P., Ghosh, S., Grewal, S., Sahu, J., & Aggarwal, A. (2019). Role of hormones in persistency of lactation: A review. *Journal of Entomology and Zoology Studies, 7*(2), 677-83.	5.48	5.53

16.	Pal, P., Ghosh, S., Grewal, S., Sahu, J., & Aggarwal, A. (2019). Role of hormones in persistency of lactation: A review. *Journal of Entomology and Zoology Studies, 7*(2), 677-83.	5.48	Nil
17.	Panda, B. S., Mohapatra, S. K., Chaudhary, D., Alhussien, M. N., Kapila, R., & Dang, A. K. (2020). Proteomics and transcriptomics study reveals the utility of ISGs as novel molecules for early pregnancy diagnosis in dairy cows. *Journal of Reproductive Immunology, 140*, 103148.	4.054	10.02
18.	Panda, B. S., Mohapatra, S. K., Verma, A. K., Kamboj, A., Alhussien, M. N., & Dang, A. K. (2020). A comparative study on various immunological parameters influencing embryo survivability in crossbred dairy cows. *Theriogenology, 157*, 140-48.	2.74	8.09
19.	Ponnusamy, K., Chakravarty, R., & Singh, S. (2019). Extension interventions in coping of farmers against effect of climate change in dairy farming. *Indian Journal of Dairy Science, 72*(4), 430-36.	Nil	5.95
20.	Rautela, A., Painkra, P. and Rautela, R. (2020). Prevalence of Parasitic infestation in Karan Fries, Tharparkar and Murrah Calves Provided with Normal and Treated Effluent Water in Tropics of Haryana. *International Journal of Livestock Research, 10*(9), 173-77.	2.01	5.36
21.	Saikia, J., Verma, A., Gupta, I. D., Singh, S., & Hazarika, D. (2019). Identification of genetic variants in HSF1 gene and their association with heat tolerance in Murrah buffaloes. *Indian Journal of Animal Sciences, 89*(10), 1099-1103.	0.278	6.28
22.	Singh, A. K., Upadhyay, R. C., Chandra, G., Kumar, S., Malakar, D., Singh, S. V., & Singh, M. K. (2020). Genomewide expression analysis of the heat stress response in dermal fibroblasts of Tharparkar (zebu) and Karan-Fries (zebu×taurine) cattle. *Cell Stress and Chaperones, 25*(2); 327-344.	3.667	8.89
23.	Somagond, Y. M., Singh, S., Deshpande, A., Sheoran, P., & Chahal, V. P. (2020). Physiological responses, energy metabolites and prolactin levels of buffaloes supplemented with dietary astaxanthin, prill fat and their combination during heat stress. *Indian Journal of Animal Sciences, 90(1)*, 55-60.	0.278	6.28
24.	Yadav, S. K., Singh, P., Kumar, P., Singh, S. V., Singh, A., & Kumar, S. (2019). Scrotal infrared thermography and testicular biometry: Indicator of semen quality in Murrah buffalo bulls. *Animal Reproduction Science, 209*, 106145.	2.145	7.66

Animal Nutrition Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Baban, B. N., Datt, C., Sharma, P. H., Dudi, K., & Sharma, V. K. (2020). Residual feed intake and related biochemical parameters in male Sahiwal calves. *Indian Journal of Animal Sciences, 90*(10), 1423-29.	0.278	6.28
2.	Chaudhari, A., Tyagi, N., Sediqi, J., Kumar, S., & Tyagi, A. K. (2020). Effect of diets with varying levels of metabolizable energy on lactation performance and metabolic profile of buffaloes. *Indian Journal of Animal Nutrition, 37*(1), 1-8.	Nil	5.66
3.	Chaudhari, A., Tyagi, N., Sediqi, J., Kumar, S., & Tyagi, A. K. (2020). Effect of diets with varying levels of metabolizable energy on lactation performance and metabolic profile of buffaloes. *Indian Journal of Animal Nutrition, 37*(1), 1 - 8 .	Nil	5.66
4.	Jaglan, N., Kumar, S., Choudhury, P. K., Tyagi, B., Banakar, P. S., Tyagi, N., & Tyagi, A. K. (2020). Effect of supplementing conjugated linoleic acid producing Bifidobacterial strains on in vitro rumen fermentation attributes. *Indian J.of Anim. Nut., 37*(2), 132-37.	Nil	5.66
5.	Pal, R. P., Mani, V., Sarkar, S., Mir, S. H., Sharma, A., & Sharma, H. (2020). Comparing the effect of different levels of zinc hydroxy chloride with inorganic zinc sulfate on in vitro rumen fermentation parameters. *Indian J. Dairy Sci., , 73*(6), 582-86.	Nil	5.95

6.	Patil, A. K., Verma, A. K., Singh, P., Munde, V. K., & Das, A. (2020). Effect of molasses based multi-nutrients and chromium supplementation on milk quality and serum biochemistry of mid and late lactating Murrah buffaloes (*Bubalus bubalis*). *Indian Journal of Animal Sciences, 90*(9), 1285-91.	0.278	6.28
7.	Sankar, V., Singh, P., Verma, A. K., Patil, A. K., & Kumar, D. (2020). Influence of urea molasses mineral blocks having bentonite as binder on haemato-biochemical and serum mineralprofile of crossbred calves. *Journal of Animal Research, 10*(4), 651-58.	0.395	6.40
8.	Sharma, A., Mani, V., Pal, R. P., Sarkar, S., & Datt, C. (2020). Boron supplementation in peripartum Murrah buffaloes: The effect on calcium homeostasis, bone metabolism, endocrine and antioxidant status. *Journal of Trace Elements in Medicine and Biology, 62*, 126623.	3.849	9.25
9.	Sharma, H., Mani, V., Kumar, S., & Mondal, G. (2020). Effect of sodium sesquicarbonate supplementation on blood biochemical parameters and antioxidant activity in lactating Karan Fries Cattle. *Indian Journal of Animal Nutrition*, *37*(3), 284-87.	Nil	5.66
10.	Sharma, H., Mani, V., Kumar, S., & Mondal, G. (2020). Effect of sodium sesquicarbonate supplementation on blood biochemical parameters and antioxidant activity in lactating Karan Fries Cattle. *Indian Journal of Animal Nutrition, 37*(3), 284-87.	Nil	5.66
11.	Sharma, H., Mani, V., Kumar, S., Sarkar, S., & Tariq, H. (2020). Effect of different levels of sodium sesquicarbonate on in vitro rumen fermentation parameters. Indian J of Dairy Science, 73(3), 246-49.	Nil	5.95
12.	Sharma, H., Mani, V., Kumar, S., Sarkar, S., & Tariq, H. (2020). Effect of different levels of sodium sesquicarbonate on in vitro rumen fermentation parameters. *Indian J of Dairy Science, 73*(3), 246-49.	Nil	5.95
13.	Singh, D., Datt, C., Mishra, A., Shivani, S., Gupta, R., & Mani, V. (2020). Influence of dietary vanadium supplementation on nutrient utilization, growth performance and blood biochemical parameters in sahiwal calves. *Indian J. of Animal Research, 54*(8), 973-80.	0.395	6.40
14.	Tarun, A., Mani, V., Bhakat, M., Mohanty, T. K., & Mondal, G. (2020). Effect of dietary supplementation of manganese, chromium and cobalt on semen qualities in sahiwal bulls. Indian Journal of Animal Research, 54(9), 1109-14.	0.395	6.40
15.	Tyagi, A. K., Kumar, S., Choudhury, P. K., Tyagi, B., & Tyagi, N. (2020). Conjugated linoleic acid producing potential of lactobacilli isolated from goat (AXB) rumen fluid samples. *Asian-Australasian Journal of Animal Sciences, 33*(8), 1233-41.	1.857	7.66

Forage Research and Management Centre

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Bhakar, A., Singh, M., & Kumar, S. (2020). Growth, Productivity and Profitability of Fodder Sorghum and Cluster Bean as Influenced by Mixed Cropping and Nutrient Management. *Legume Research-An International Journal, 1*, 7.	0.531	6.53
2.	Bhakar, A., Singh, M., Kumar, S., Dutta, S., Mahanta, R. K., & Onte, S. (2020). Ensuring nutritional security of animals by mixed cropping of sorghum and guar under varying nutrient management. *Indian Journal of Animal Nutrition, 37*(1), 48-56.	Nil	5.75
3.	Bhakar, A., Singh, M., Kumar, S., Kumar, D., Meena, B. L., Meena, V. K., & SINGH, Y. (2021). Enhancing root traits and quality of sorghum and guar through mixed cropping and nutrient management. *The Indian Journal of Agricultural Sciences, 91*(1), 99-104.	0.371	6.21

4.	Dutta, S., Singh, M., Meena, R. K., Onte, S., Basak N, Kumar, S., & Meena, V. K. (2020). Effect of organic and inorganic nutrient sources on growth, yield, nutrient uptake and economics of fodder cowpea [Vigna unguiculata (L.) Walp.]. *Legume Research-An International J.*	0.531	6.53
5.	Kumar, R., Yadav, M. R., Arif, M., Mahala, D. M., Kumar, D., Ghasal, P. C., Yadav, K.C. & Verma, R. K. (2020, August). Multiple agroecosystem services of forage legumes towards agriculture sustainability: An overview. *IJ of Agricultural Sciences, 90*(8),1367-77.	0.371	6.21
6.	Kumar, S., Kumar, A., Kumar, P., Mann, A., & Kumar, R. (2019). Comparative study of fodder halophytes in saline and alkaline soils. *Bhartiya Krishi Anusandhan Patrika, 34*(3 and 4), 237-240.	Nil	3.25
7.	Kumar, S., Singh, M., Meena, B. L., Meena, V. K., Onte, S., & Bhattchargee, S. (2020). Yield and qualitative evaluation of fodder maize (Zea mays L.) under potassium and zinc based integrated nutrient management. *Indian J of Animal Nutrition, 37*(3), 235-241.	Nil	5.75
8.	Mallikarjun, H. R., Kumar, R., Singh, M., & Meena, R. K. (2021). Effect of Rhizobia Inoculation and Tillage Practices on Fodder Cowpea (Vigna unguiculata). *Legume Research-An International Journal, 1*, 6.	0.531	6.53
9.	Meena, R. K., Singh, Y. V., Meena, V. K., Kumar, R., & Ram, H. (2019). Growth, productivity and profitability of Wheat (Triticum aestivum L.) under rice-wheat cropping system as influenced by of in-situ microbial inoculated rice residue and nitrogen management. *Bhartiya Krishi Anusandhan Patrika, 34*(3&4), 170-177.	Nil	3.25
10.	Singh, K., Ram, H., Kumar, R., Meena, R. K., & Kumar, R. (2021). Effect of Weed Management Practices on Weed Dynamics, Nutrient Depletion, Productivity and Profitability of SummerMungbean (Vigna radiata) under Zero Tillage Condition. *Legume Research*.	0.531	6.53
11.	Singh, M., Dutta, S., Kala, S., Dwivedi, S., Meena, R. K., Meena, V. K., Kumar, S., Kumar, H. & Onte, S. (2020). Fodder crops assessment using multi-temporal Landsat-8 data by NDVI based classification in Haryana State of India. *Range Management&Agroforestry,41*(1),67-73.	0.37	6.53
12.	Soni, P. G., Basak, N., Rai, A. K., Sundha, P., Narjary, B., Kumar, P., Yadav, G., Kumar, S. & Yadav, R. K. (2021). Deficit saline water irrigation under reduced tillage and residue mulch improves soil health in sorghum-wheat cropping system in semi-arid region. *Scientific Reports, 11*(1), 1-13.	5.133	10.00
13.	Soni, P. G., Yadav, R. K., Kumar, A., Kumar, R., Gajender, Yadav, T., Sharma, A. & Kushwaha, M. (2020). Effect of water quality regimes, irrigation schedules, RSC levels and neutralizer on physiological and biochemical behaviour of fodder sorghum (Sorghum bicolor). Indian Journal of Agricultural Sciences, 90(9), 1702-1707.	0.371	6.21
14.	Yadav, T., Kumar, A., Yadav, R. K., Yadav, G., Kumar, R., & Kushwaha, M. (2020). Salicylic acid and thiourea mitigate the salinity and drought stress on physiological traits governing yield in pearl millet-wheat. *Saudi Journal of Biological Sciences, 27*(8), 2010-2017.	4.219	8.80

Animal Biochemistry Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Bhat, M. I., Kapila, S., & Kapila, R. (2020). Lactobacillus fermentum (MTCC-5898) supplementation renders prophylactic action against *Escherichia coli* impaired intestinal barrier function through tight junction modulation. *LWT-Food Science and Technology, 123*, 109118.	4.952	10.006
2.	Bhat, M. I., Sowmya, K., Kapila, S., & Kapila, R. (2019). Potential probiotic Lactobacillus rhamnosus (MTCC-5897) inhibits Escherichia coli impaired intestinal barrier function by modulating the host tight junction gene response. Probiotics and Antimicrobial Proteins, 12(3),1149-60.	4.609	9.553
3.	Chaurasiya, V., Kumari, S., Onteru, S. K., & Singh, D. (2020). miR-326 down-regulate CYP19A1 expression and estradiol-17b production in buffalo granulosa cells through CREB and C/EBP- . *The Journal of Steroid Biochemistry and Molecular Biology, 199*, 105608.	4.292	9.813

4.	Chaurasiya, V., Kumari, S., Onteru, S. K., & Singh, D. (2020). Up-regulation of miR-326 regulates pro-inflammatory cytokines targeting TLR-4 in buffalo granulosa cells. *Molecular Immunology, 119*, 154-58.	4.407	9.641
5.	Devi, S., Pal, G. K., Kapila, R., & Kapila, S. (2020). C-terminal sequence deletion effect on antioxidative characteristics of VLPVPQK bioactive peptide from buffalo milk casein. *LWT-Food Science and Technology, 119*, 108816.	4.952	10.006
6.	Goud, E. S. K., Pandey, M., Singh, P., Singh, C., Veerappa, V. G., Singh, D., & Onteru, S. K. (2020). An in-silico structural characterization of the buffalo steroidogenic proteins. *Acta Scientific Veterinary Sciences,2*(3), 2582-2583.	0.518	6.518
7.	Kaur, H., Gupta, H., Kapila, S. and Kapila, R. (2020). Role of fermented dairy foods in human health. *Indian Journal of Dairy Science, 73*(2), 97-110.	Nil	5.95
8.	Kumar, N., Devi, S., Mada, S. B., Reddi, S., Kapila, R., & Kapila, S. (2020). Anti-apoptotic effect of buffalo milk casein derived bioactive peptide by directing Nrf2 regulation in starving fibroblasts. *Food Bioscience, 35*, 100566.	4.240	9.07
9.	Kumar, S., Hussain, A., Bhushan, B., & Kaul, G. (2020). Comparative toxicity assessment of nano-and bulk-phase titanium dioxide particles on the human mammary gland *in vitro*. *Human & Experimental Toxicology, 39*(11), 1475-86.	2.903	8.670
10.	Kumar, T. V. C., Sharma, D., Surla, G. N., Vedamurthy, G. V., Singh, D., &Onteru, S. K. (2020). Body condition score, parity, shelter cleanliness and male proximity: highly associated non-genetic factors with post-partum anestrus in Murrah buffalo in field conditions. *Animal Reproduction Science, 214*, 106282.	2.145	7.66
11.	Kumari, A., Bhawal, S., Kapila, S., Yadav, H., & Kapila, R. (2020). Health-promoting role of dietary bioactive compounds through epigenetic modulations: a novel prophylactic and therapeutic approach. *Critical Reviews in Food Science and Nutrition,* 1-21, https://doi.org/ 10.1080/ 10408398.2020.1825286.	11.176	13.862
12.	Lyngdoh, E. L., Nayan, V., Vashisht, M., Kumari, S., Bhardwaj, A., Bhatia, T., Dalal, J., Pawaria, S., Onteru, S. K., Sikka, P.& Singh, D. (2020). Gold nanoparticles modulate the steroidogenic and apoptotic pathway in a buffalo granulosa cell model. *Biotechnology Letters, 42*(8), 1383-95.	2.461	7.977
13.	Meena, S., Rajput, Y. S., Sharma, R., & Singh, R. (2020). Milk improves cholesterol homoeostasis by protecting liver against oxidative damage in hypercholesterolemic rats. South Asian Journal of Food Technology and Environment, 6(1), 885-93.	2.088	Nil
14.	Mohapatra, S. K., Panda, B. S., Verma, A. K., Kapila, R., & Dang, A. K. (2020).Implantation associated changes in expression profile of indoleamine-2, 3-dioxygenase 1, Th1-Th2 cytokines and interferon-stimulated genes on neutrophils and peripheral blood mononuclear cells of crossbred cows. *Journal of Reproductive Immunology, 142*, 103188.	4.054	10.018
15.	Nayan, V., Sinha, E. S., Onteru, S. K., & Singh, D. (2020). A proof-of-concept of lateral flow based luteinizing hormone detection in urine for ovulation prediction in buffaloes. *Analytical Methods, 12*(26), 3411-3424.	2.896	8.596
16.	Rana, S., Bhawal, S., Kumari, A., Kapila, S., & Kapila, R. (2020). pH-dependent inhibition of AHL-mediated quorum sensing by cell-free supernatant of lactic acid bacteria in *Pseudomonas aeruginosa* PAO1. *Microbial Pathogenesis, 142*, 104105.	3.738	8.914
17.	Rani, P., Onteru, S. K., & Singh, D. (2020). Genome-wide profiling and analysis of microRNA expression in buffalo milk exosomes. *Food Bioscience, 38*, 100769.	4.240	9.07

18.	Samtiya, M., Bhat, M. I., Gupta, T., Kapila, S., & Kapila, R. (2020). Safety assessment of potential probiotic Lactobacillus fermentum MTCC-5898 in murine model after repetitive dose for 28 days (Sub-Acute Exposure). *Probiotics and Antimicrobial Proteins, 12*(1), 259-70.	4.609	9.553
19.	Shandilya, S., Rani, P., Onteru, S. K., & Singh, D. (2020). Natural ligand-receptor mediated loading of siRNA in milk derived exosomes. *Journal of Biotechnology, 318*, 1-9.	3.307	9.503
20.	Sharma, Y., Verma, S. K., Kumar, L. K., Surla, G. N., Vedamurthy, G. V., Singh, D., &Onteru, S. K. (2020). Apolipoprotein A1 and Ceruloplasmin, the key crosstalk players between the liver and adipose tissue during early postpartum of buffaloes: An in-Silico transcriptome-based network analysis. *Computers in Biology and Medicine, 126*, 104024.	4.589	9.434
21.	Upadhyay, D., Kaur, T., Kapila, R., & Kapila, S. (2020). Repertoire of Structure–Activity-Based Novel Modified Peptides Elicits Enhanced Osteogenic Potential. *Journal of Agricultural and Food Chemistry, 68*(31), 8308-8320.	5.279	10.19

Dairy Chemistry Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Agarwal, A., Pathera, A. K., Kaushik, R., Kumar, N., Dhull, S. B., Arora, S., & Chawla, P. (2020). Succinylation of milk proteins: Influence on micronutrient binding and functional indices. *Trends in Food Science & Technology, 97*, 254-264.	12.563	17.08
2.	Baria, B., Singh, A. K., Panjagari, N. R., Arora, S., & Minz, P. S. (2021). Colouring properties and stability of black carrot anthocyanins in yoghurt. *J of Food Science and Technology, 58*(10), 3953-3962.	2.701	7.85
3.	Dhankhar, J., Sharma, R., & Indumathi, K. P. (2020). A comparative study of sterols in milk fat of different Indian dairy animals based on chemometric analysis. *Journal of Food Measurement and Characterization, 14*, 2538-2548.	2.431	7.65
4.	Hooda, A., Mann, B., Sharma, R., & Bajaj, R. (2020). Physicochemical characterisation of native micellar casein concentrates from buffalo and cow skim milk harvested using microfiltration. *International Journal of Dairy Technology, 73*(4), 781-789.	4.374	7.64
5.	Lohan, A., Kaushik, R., Bansal, V., & Gandhi, K. (2020). Flax seeds and finger millet enriched functional rusk. *International Journal of Food Studies, 9*(1), 213-224.	0.78	Nil
6.	Mann, B., Sonu, K. S., Sharma, R., Kumar, R., & Singh, R. (2020). Formulation of peppermint oil nanoemulsion using conjugates of whey proteins with maltodextrin and its characterization. *Indian Journal of Traditional Knowledge (IJTK), 19*(2), 394-400.	0.757	6.73
7.	Mitul, B., Amit, C., Singh, R., Arora, S., Mann, B., & Rao, P. S. Efficiency of bronopol and kathon in preservation of milk and milk products samples stored for analytical purpose. *Indian Journal of Dairy Science, 73*(1), 21-27.	Nil	5.95
8.	Pralhadrao, J. V., Arora, S., Shilpashree, B. G., Sharma, V., Singh, A. K., & Panjagari, N. R. (2021). Standardization of model for the production of spray dried whey protein-zinc complex and its acceptability in milk. *LWT, 137*, 110450.	4.952	10.01
9.	Rana, S., Arora, S., Gupta, C., Bodemala, H., & Kapila, S. (2021). Evaluation of in-vivo model for vitamin A bioavailability from vitamin A loaded caseinate complex. *Food Bioscience*, 101174.	4.240	9.07
10.	Ranvir, S., Sharma, R., Gandhi, K., & Mann, B. (2020). Assessment of physico-chemical changes in UHT milk during storage at different temperatures. *Journal of Dairy Research, 87*(2), 243-247.	1.628	7.63

11.	Sehrawat, R., Sharma, R., Ahlawat, S., Sharma, V., Thakur, M. S., Kaur, M., Mishra & Tantia, M. S. Quality Characteristics of Breast and Thigh Chicken Meat from Free-Range System: Comparative Antioxidant Profile of Indigenous and Improved Germplasm. *Indian Journal of Animal Research, 1*, 9.	0.395	6.40
12.	Sharma, N., Sharma, R., Rajput, Y. S., Mann, B., & Gandhi, K. (2021). Distinction between glycomacropeptide and -lactoglobulin with 'stains all'dye on tricine SDS-PAGE gels. *Food Chemistry, 340*, 127923.	7.514	12.31
13.	Shilpashree, B. G., Arora, S., Kapila, S., & Sharma, V. (2020). Whey protein-iron or zinc complexation decreases pro-oxidant activity of iron and increases iron and zinc bioavailability. *LWT, 126*, 109287.	4.952	10.01
14.	Shilpashree, B.G., Arora, S., Kapila, S., Sharma, V. (2020). Whey protein-iron or zinc complexation decreases pro-oxidant activity of iron and increases iron and zinc bioavailability.*LWT – Food Science and Technology, 126*(1), 109287.	4.952	9.71
15.	Suvartan, R., Sharma, R., Gandhi, K., & Mann, B. (2020). Assessment of physico-chemical changes in UHT milk during storage at different temperatures. *Journal of Dairy Research, 87*(2), 243-247.	1.63	7.63
16.	Suvartan, R., Sharma, R., Gandhi, K., Upadhyay, N., & Mann, B. (2020). Assessment of proteolysis in ultra-high temperature milk using Attenuated Total Reflectance-Fourier Transform Infrared spectroscopy (ATR–FTIR). *International J of Dairy Technology, 73*(2), 366-375.	4.374	7.64

Dairy Technology Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Baria, B., Singh, A. K., Panjagari, N. R., Arora, S., &Minz, P. S. (2020). Colouring properties and stability of black carrot anthocyanins in yoghurt. *Journal of Food Science and Technology, 58*(10), 3953–62.	2.701	7.85
2.	Chaudhary, N., Sabikhi, L., Hussain, S. A., &Kumar, M. H. S. (2020). A comparative study of the antioxidant and ACE inhibitory activities of selected herbal extracts. *Journal of Herbal Medicine, 22*, 100343.	3.032	Nil
3.	Chaudhary, N., Sabikhi, L., Hussain, S. A., Kumar, R., & Choudhary, U. (2020). Emblicanin rich *Emblica officinalis* encapsulated double emulsion and its antioxidant stability during storage. *European Journal of Lipid Science and Technology, 122*(4), 1900316.	2.056	7.85
4.	Choudhary, U., & Sabikhi, L. (2020). Selection of stabilizers and processing aids to encapsulate bitter gourd extract in a stable double emulsion. *Indian J. Dairy Sci., , 73*(5), 409-18.	Nil	5.95
5.	Deshwal, G. K., Ameta, R., Sharma, H., Singh, A. K., Panjagari, N. R., &Baria, B. (2020). Effect of ultrafiltration and fat content on chemical, functional, textural and sensory characteristics of goat milk-based Halloumi type cheese. *LWT-Food Science and Technology, 126*, 109341.	4.952	9.71
6.	Deshwal, G. K., Singh, A. K., Kumar, D., & Sharma, H. (2020). Effect of spray and freeze drying on physico-chemical, functional, moisture sorption and morphological characteristics of camel milk powder. *LWT-Food Science and Technology, 134*, 110117.	4.952	9.71
7.	Hossain, S., Khetra, Y., Ganguly, S., Kumar, R., & Sabikhi, L. (2020). Effect of heat treatment on plasmin activity and bio-functional attributes of Cheddar cheese. LWT-Food Science and Technology, 120, 108924.	4.952	9.71
8.	Kisan, B. S., Ganguly, S., Sakhala, S., & Narender, P. (2020). Shelf-life estimation of probiotic buffalo milk Ricotta cheese.*Journal of Entomology and Zoology Studies, 8*(1), 1503-08.	5.48	5.53

9.	Kumar, R., Sabikhi, L., Rathod, G., & Chaudhary, N. (2020). Storage Studies of Flaxseed Oil Encapsulated by Buttermilk Solids. *Food and Bioprocess Technology, 13*(8), 1392-1404.	4.465	9.03
10.	Mahadev, G. M., & Meena, G. S. (2020). Milk protein concentrates 80: Does composition of buffalo milk matter for its poor functionality? *LWT-Food Science and Technology, 131*, 109652.	4.952	9.71
11.	Maurya, N., Kaushik, K., & Prasad, W. (2020). Preparation and stability evaluation of curcumin fortified Lassi, a fermented dairy beverage. *International Journal of Fermented Foods, 9*(1), 19-30.	Nil	Nil
12.	Maurya, N., Khamrui, K., & Prasad, W. G. (2020). Studies on curcumin fortification in different lassi types using Tween-80 as a binding material. *Indian J. Dairy Sci., , 73*(6), 628-31.	Nil	5.95
13.	Padinjarakoot, N., Sabikhi, L., Panjagari, N. R., & Kumar, C. M. (2020). Adsorption isotherm and thermodynamic properties of high fiber reduced calorie multigrain biscuit. *Journal of Food Processing and Preservation, 44*(10), e14801.	2.190	7.29
14.	Pahwa, A., & Khamrui, K. (2020). Optimization of ingredients and processing time for the development of functional dairy dessert (Kheer). *Journal of Food Processing and Preservation, 44*(6), e14451.	2.190	7.29
15.	Pahwa, A., Khamrui, K., & Prasad, W. (2020). Influence of oat flour on pasting properties of flour blends, cooking quality and sensory attributes of vermicelli. *The Annals of the University Dunarea de Jos of Galati. Fascicle VI-Food Technology, 44*(2), 70-84.	2.115	7.52
16.	Ponnusamy, K., Sabikhi, L., & Meena, G. S. (2020). An appraisal of scope for women-led entrepreneurship in dairying. *Indian Journal of Dairy Science, 73*(6), 608-13.	Nil	5.95
17.	Sameer, B., Ganguly, S., Khetra, Y., & Sabikhi, L. (2020). Development and characterization of probiotic buffalo milk ricotta cheese. LWT-Food Science and Technology, 121, 108944.	4.952	9.7
18.	Sawale, P. D., Patil, G. R., Hussain, S. A., Singh, A. K., & Singh, R. R. B. (2020). Development of free and encapsulated Arjuna herb extract added vanilla chocolate dairy drink by using response surface methodology (RSM) software. *Journal of Agriculture and Food Research, 2*, 100020.	Nil	Nil
19.	Sharma, H., Mendiratta, S. K., Agarwal, R. K., &Gurunathan, K. (2020). Bio-preservative effect of blends of essential oils: natural anti-oxidant and anti-microbial agents for the shelf-life enhancement of emulsion-based chicken sausages. *Journal of Food Science and Technology, 57*(8), 3040-50.	2.701	7.85
20.	Singh, R., Khamrui, K., & Prasad, W. (2020). Effect of cardamom powder and rosemary extract on textural, sensory, microbiological and colour properties of pinni during storage. *Indian Journal of Dairy Science, 73*(5), 392-401.	Nil	5.95
21.	Wankhede, V. P., Sharma, P., Hussain, S. A., & Singh, R. R. B. (2020). Structure and stability of $W_1/O/W_2$ emulsions as influenced by WPC and NaCl in inner aqueous phase. *Journal of Food Science and Technology, 57*(9), 3482-92.	2.701	7.85

Dairy Microbiology Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Behare, P. V., Ali, S. A., & McAuliffe, O. (2020). Draft Genome Sequences of *Fructobacillusfructosus* DPC 7238 and *Leuconostocmesenteroides* DPC 7261, Mannitol-Producing Organisms Isolated from Fructose-Rich Honeybee-Resident Flowers on an Irish Farm. *Microbiology Resource Announcements, 9*(50), e01297-20.	Nil	Nil

2.	Behare, P. V., Mazhar, S., Pennone, V., & McAuliffe, O. (2020). Evaluation of lactic acid bacteria strains isolated from fructose-rich environments for their mannitol-production and milk-gelation abilities. *Journal of Dairy Science, 103*(12), 11138-51.	4.034	9.08
3.	Hundal, J. S., Wadhwa, M., Veena, N., &Puniya, A. K. (2020). Effect of Bypass Nutrients on Fatty Acid Composition, Reichert Meissl and Polenske Value of Cow Milk Fat. *Indian Journal of Animal Research, 54*(12), 1512-16.	0.395	6.44
4.	Kadyan, S., Kumar, N., Lawaniya, R., Sharma, P. K., Arora, B., & Tehri, N. (2020). Rapid and miniaturized method for detection of hygiene indicators, *Escherichia coli* and coliforms, in dairy products. *Journal of Food Safety, 40*(5), e12839.	1.953	7.67
5.	Kumar, A., Vishweswaraiah, R. H., Mallappa, R. H., Bharath, G., Kumar, B., Jaswal, A., & Kumar, N. (2020). Prevalence of Antimicrobial Resistance in *Escherichia coli* isolated from Dairy Supply Chain by Phenotypic Methods. *The Indian Journal of Veterinary Sciences and Biotechnology, 16*(2,3, &4), 12-16.	Nil	4.47
6.	Kumar, N., Kumar, V., Waheed, S. M., & Pradhan, D. (2020). Efficacy of Reuterin and Bacteriocins Nisin and Pediocin in the Preservation of Raw Milk from Dairy Farms. *Food Technology and Biotechnology, 58*(4), 359-69.	3.918	7.52
7.	Kumari, M., Kokkiligadda, A., Behare, P. V., &Tomar, S. K. (2019). Evaluation of environmental stress tolerance of extracellular vitamin B12 producing lactobacilli cultures. *Journal of Pharmacognosy and Phytochemistry, 8*(6), 923-27.	5.52	5.21
8.	Lindahl, J. F., Goyal Kumar, N., Deka, R. P., Shome, R., & Grace, D. (2018). Serological evidence of Brucella infections in dairy cattle in Haryana, India. *Infection Ecology & Epidemiology, 8*(1), 1555445.	Nil	Nil
9.	Lule, V. K., Tomar, S. K., Chawla, P., Pophaly, S., Kapila, S., & Arora, S. (2020). Bioavailability assessment of zinc enriched lactobacillus biomass in a human colon carcinoma cell line (Caco-2). Food Chemistry, 309, 125583.	7.514	11.40
10.	Mahajan, R., Chandel, S., Puniya, A. K., & Goel, G. (2020). Effect of pretreatments on cellulosic composition and morphology of pine needle for possible utilization as substrate for anaerobic digestion. *Biomass and Bioenergy, 141*, 105705.	5.061	9.54
11.	Manzoor, M., Sharma, V., Singha, D., Sohal, J.S., Aseri, G.K., Kharea, N, Vij, S., Saroopc, J., & Sharma D. (2020). Probiotic and Techno-Functional Traits of *Lactobacillus pentosus* DS2 Isolated from Naturally Fermented Plant Beverage. *International Journal of Research in Pharmaceutical Sciences, 11*(4), 7417-24.	0.60	NA
12.	Raghu, H.V., & Kumar, N. (2020). Rapid Detection of Listeria monocytogenes in Milk by Surface Plasmon Resonance Using Wheat Germ Agglutinin. *Food Analytical Methods, 13*(4), 982-91.	3.366	8.41
13.	Sharma, G., Mutua, F., Deka, R. P., Shome, R., Bandyopadhyay, S., Shome, B. R., Goyal Kumar, N., Grace, D., Dey, T. K., Venugopal, N. and Sahay, S., & Lindahl, J. (2020). A qualitative study on antibiotic use and animal health management in smallholder dairy farms of four regions of India. *Infection Ecology & Epidemiology, 10*(1), 1792033.	Nil	Nil
14.	Singh, B. P., Bhushan, B., &Vij, S. (2020). Antioxidative, ACE inhibitory and antibacterial activities of soy milk fermented by indigenous strains of lactobacilli. *Legume Science, 2*(4), e54.	Nil	Nil

Dairy Engineering Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Ammu, V. K., Minz, P. S., Singh, A. K., Vairat, A. D., Chitranayak, J. A. K., &Jayswal, D. K. (2020). An overview of mechanization in chhana production. *Indian J. Dairy Sci., 73*(1), 1-6.	Nil	5.95

2.	Kumari, K., &Mridula, D. (2020). Extrusion processing of agri-horti and dairy products: A review. *International Journal of Chemical Studies, 8*(1), 1424-33.	0.565	5.31
3.	Lakshmana, N., Barnwal, P., Deep, A., Chavhan, B., Khetra, Y., &Sukre, V. N. (2020). Determination of functional, textural and colour properties of market Mozzarella cheese. Indian J. Dairy Sci., 73(4), 301-05.	Nil	5.95
4.	Mittal V., Bhatt M., Kishore A., Kumar N. and Kumari K. (2020) Development of nutritional enriched herbal cookies: Physical, sensory and nutritional properties. *Journal of Food, Agriculture and Environment, 18* (3&4), 53-57.	Nil	Nil
5.	Sakare, P., Jadhav, M. L., & John, H. (2020). Study on Physical Properties of Soaked Soybean and Functional Properties of Germinated Soy flour. *Journal of The Institution of Engineers (India): Series A, 101*(4), 787-94.	Nil	Nil

Dairy Economics, Statistics &Management Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Acharya, K. K., & Malhotra, R. (2020). Economic analysis of milk production in peri-urban dairy farms of Odisha. *Indian J. Dairy Sci., 73*(2), 155-159.	Nil	5.95
2.	Acharya, K. K., Malhotra, R., Lal, P., Thakur, A., & Rathore, R. (2020). An estimation of total factor productivity and its determinants among peri-urban dairy farms of Odisha. *Indian Journal of Economics and Development, 16*(2s), 467-71.	Nil	5.15
3.	Balaganesh, G., Malhotra, R., Sendhil, R., Sirohi, S., Maiti, S., Ponnusamy, K., & Sharma, A. K. (2020). Development of composite vulnerability index and district level mapping of climate change induced drought in Tamil Nadu, India. *Ecological Indicators, 113*, 106197.	4.958	10.23
4.	Bhandari, G. (2020). Alternatives for accelerating agricultural growth in Uttar Pradesh-a zone-wise analysis. *Indian Journal of Economics and Development, 16*(2s), 77-85.	Nil	5.15
5.	Bhandari, G., & Chandel, B. S. (2020). Socio-economic determinants of breed choice-A case of Sahiwal vs. crossbred in India. *International Journal of Current Microbiology and Applied Sciences, 9*(1), 1427-37.	4.963	5.38
6.	Bhandari, G., & Ravishankar, K. M. (2020). Implications of COVID-19 for Indian Dairy Sector. *Food and Scientific Reports, 1*, 43-46.	Nil	Nil
7.	Bhandari, G., &Kathayat, B. (2016). Can Haryana go the Sikkim way? Problems and prospects of transition to organic farming. *Food and Scientific Reports, 1(7),* 29-32.	Nil	Nil
8.	Bhandari, G., Chandel, B. S., &Bhakat, M. (2020). Cost of conservation of indigenous dairy cattle breed-A case of Sahiwal in India. *The Indian Journal of Animal Sciences, 90*(10), 1392–97.	0.278	6.28
9.	Chandel, B., Dixit, A. K., Singh, A., & Devi, A. (2020). Economic Analysis of the Impact of COVID-19 Lockdown on Indian Dairy Sector. *Indian Journal of Microbiology, 77*(8), 21-27.	Nil	Nil
10.	Chaudhary, U., Kumar, S., Meena, A.L., Punia, P., and Kashyap, P. (2020). Plan-wise report on five-year plans (I-XII) vis-à-vis animal husbandry and dairying. *Agriculture and Food: e-newsletter, 2*(11), 228-42.	Nil	Nil
11.	Kathayat, B., Lal, P., & Dixit, A. K. (2020). Has the consumption pattern changed? an overview of livestock products. *Indian Journal of Economics and Development, 16*(2s), 312-17.	Nil	5.15
12.	Kharkwal, S. (2020). Assessment of the food security status of households belonging to different regions of Himalayan Belt. *Economic Affairs, 65*(4), 335205.	Nil	5.08

13.	Kumari, B., Chandel, B. S., & Lal, P. (2020). Profit Efficiency among Dairy Farms in the Eastern Region of India. *Indian Journal of Economics and Development, 16*(1), 97-103.	Nil	5.15
14.	Lal, P., Chandel, B. S., Kumari, B., Kumari, T., & Rathore, R. (2020). An epitome of organic agriculture in North-Eastern India: A way forward for a sustainable future. *Indian Journal of Economics and Development, 16*(2s), 492-95.	Nil	5.15
15.	Namith, C., Verma, A., Gupta, A.K., Sharma, A.K., Shashank, C.G., Yousuf, S. and Malhotra, R. (2020). Prediction of lifetime performance in Sahiwal cattle by artificial intelligence-based machine learning models. *International Journal of Current Microbiology and Applied Sciences, 9*(4), 1867-1873.	4.963	5.38
16.	Rathore, R., Malhotra, R., Chaudhary, U., &Jangid, R. (2020). A comparative study on economics of milk production among self-help group members and non-members in Rajasthan. *Indian J. Dairy Sci., 73*(6), 592-99.	Nil	5.95
17.	Singh, S. P., & Chandel, B. S. (2020). Constraints Faced by the Dairy Farmers and Agencies Involved in Livestock Insurance in Haryana. *Agricultural Science Digest, 40*(1), 95-99.	Nil	4.21
18.	Singh, S. P., Chandel, B. S., & Alli, M. M. Why Farmers do not take up Livestock Insurance or Discontinue? An Investigation into Reasons in Karnal District of Haryana. International Journal of Agriculture Environment and Biotechnology 13(2):1-4	3.118	4.54
19.	Thakur, A., & KM, A. K. D. (2020). Economic analysis of informal dairy processing units in Karnal district of Haryana. *Indian Journal of Dairy Science, 73*(2), 151-154.	Nil	5.95
20.	Thakur, A., Dixit, A. K., Acharya, K. K., Cariappa, A. G., & Kumari, T. (2020). Local dairy supply chains: A profitability analysis in Haryana. *Indian Journal of Economics and Development, 16*(2s), 508-511.	Nil	5.15
21.	Vani, G.K., Bhandari, G., Renjini, V.R., Sahu, S. and Mishra, P. (2020). Need for agrochemicals in era of organic farming: An economic study. *Journal of Crop and Weed, 16*, 44-48.	5.963	5.28
22.	Vishwakarama, R. K., Jha, S. N., Rai, A., & Ahmad, T. (2020). Estimation of Harvest and Post-Harvest Losses of Cereals and Effect of Mechanization in Different Agro-Climatic Zones of India.*Indian Journal of Agricultural Economics, 75*(3), 317-336.	-	5.30

Dairy Extension Division

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Balaganesh, G., Malhotra, R., Sendhil, R., Sirohi, S., Maiti, S., Ponnusamy, K., & Sharma, A. K. (2020). Development of composite vulnerability index and district level mapping of climate change induced drought in Tamil Nadu, India. *Ecological Indicators, 113*, 106197.	4.958	10.23
2.	Balaganesh, G., Malhotra, R., Sendhil, R., Sirohi, S., Maiti, S., Ponnusamy, K., & Sharma, A. K. (2020). Development of composite vulnerability index and district level mapping of climate change induced drought in Tamil Nadu(I). *Ecological Indicators, 113*, 106197.	4.232	10.23
3.	Bhatt, A., Meena, B. S., & Shashank, C. G. (2020). Changes in Physiological Parameters of Bullocks during Agricultural Field Operations and their Field Efficiency in Mountain Agriculture. *International Journal of Current Microbiology and Applied Sciences, 9*(4), 3001-3005.	Nil	5.38
4.	Bhatt, A., Meena, B. S., & Shashank, C. G. (2020). Changes in Physiological Parameters of Bullocks during Agricultural Field Operations and their Field Efficiency in Mountain Agriculture. *International Journal of Current Microbiology and Applied Sciences, 9*(4), 3001-05.	Nil	5.38

5.	Bhuyan, M. and Ponnusamy, K. (2020) Problems of farm women in adoption of improved dairy production technologies. *Journal of Community Mobilization and Sustainable Development, 15*(3), 572-576.	Nil	5.67
6.	Dutta, S., Maiti, S., Garai, S., Abrar, F., Jha, S. K., Bhakat, M., Mandal, S. andKadian, K. S. (2020). Analyzing adaptation strategies to climate change followed by the farming community of the Indian Sunderbans using Analytical Hierarchy Process. *Journal of Coastal Conservation, 24*(5), 1-14.	1.839	7.37
7.	Garai, S., &Maiti, S. (2020). Group dynamics effectiveness among the women self-help group members of new alluvial zone of West Bengal, India. *Journal of Community Mobilization and Sustainable Development, 15*(1), 123-129.	Nil	5.67
8.	Garai, S., Maiti, S., & Meena, B. S. (2020). Knowledge level vis-à-vis improved dairy farming practices: an appraisal on the Santhal dairy farmers of Burdwan district (West Bengal). *Indian Research Journal of Extension Education, 20*(1), 1-4.	Nil	5.22
9.	Girish, C. E., Kadian, K. S., & Mandi, B. M. K. (2020). Socio-Economic Profile of Farmers in Sericulture Based Dairy Farming System in Karnataka State, India. *International Journal of Current Microbiology and Applied Sciences, 9*(4), 2071-2078.	Nil	5.38
10.	Girish, C. E., Kadian, K. S., Meena, B. S., & Mandi, K. (2020). Knowledge Assessment of Farmers Regarding Sericulture Based Dairy Farming in Karnataka State. *Asian Journal of Agricultural Extension, Economics & Sociology, 38*(4), 16-20.	Nil	4.86
11.	Jaisridhar, P., Sankhala, G., Kadian, K. S., Kumar, S., & Sangeetha, S. (2013). Factors determining adoption of scientific dairy farming with special reference to farmers call centre of Tamil Nadu. *Pakistan Journal of Agricultural Sciences, 50*(4), 549-553.	0.66	6.66
12.	Jose, E., Meena, H. R., & Verma, A. P. (2019). Case Studies of Dairy Based Farmer Producer Companies in Kerala. *International Journal of Current Microbiology and Applied Sciences, 8*(1), 501-505.	Nil	5.38
13.	Kad, S.V., Kadian, K. S., Raju, R., Maiti, S., Rai, C. K., & Kad, S. (2020). Dairy Farmer's attitude towards the Kamdhenu Dattak Gram Yojana on dairy development in Maharashtra. *Indian Journal of Extension Education, 56*(3), 161-164.	Nil	5.95
14.	Kalyan, M., &Ritu, C. (2020). Rediscovering potential of dairy co-operatives in Eastern India. *Agriculture Update, 15*(1/2), 98-103.	Nil	Nil
15.	Manu, H. A., Meena, H. R. and Priyanka, B. N. (2020) Factorial analysis of perceptual understanding of researchers towards animal cloning,*International Journal of Current Microbiology and Applied Sciences,9*(3),3228-3234.	Nil	5.38
16.	Manu, H. A., Meena, H. R., & Priyanka, B. N. (2020). Likelihood of Consuming Cloned Animal Products: Ordered Logistic Regression Model. *International Journal of Current Microbiology and Applied Sciences*,*9*(1), 479-485.	Nil	5.38
17.	Meena, D. C., Garai, S., Maiti, S., Bhakat, M., Meena, B. S., &Kadian, K. S. (2020). Ethno-Veterinary practices used for common health ailments of sheep and goat: A participatory assessment by the Raika pastoralist of Marwar Region, Rajasthan. *Indian Journal of Animal Sciences, 90*(9), 1310-1315.	0.278	6.28
18.	Meena, D. C., Garai, S., Maiti, S., Meena, B. S., Roy, S. K., &Kadian, K. S. (2020). Adoption of improved camel husbandry practices: An exploratory study among the raika pastoralists of Rajasthan. *Indian Journal of Extension Education, 56*(3), 116-119.	Nil	5.95
19.	Meena, D. K., Sankhala, G., & Kumar, S. (2020). Utilization Pattern of Feed and Fodder for Dairy Animals in Rajasthan State of India. *Int. Journal of Livestock Research*, *10*(3), 67-73.	2.01	5.36

20.	Meena, H. R., Chaudhary, S., Meena, B. S., &Kadain, K. S. (2020). Farmers' perception towards dairy farm automation in north India. *Indian Journal of Dairy Science, 73*(2), 167-174.	Nil	5.95
21.	Patel, D., Ponnusamy, K., & Verma, A. P. (2020). Reproductive Efficiency of Dairy Animals in Different Dairy Production Systems under Field Conditions.*International Journal of Livestock Research, 10*(5), 89-96.	2.01	5.36
22.	Patnaik, N. M., Gupta, J., & Meena, B. S. (2020). Field level study to understand dimensions of antimicrobial use in dairy farms of Punjab. *Indian Journal of Dairy Science, 73*(5), 457-463.	Nil	5.95
23.	Paul, P., Meena, B. S., Maji, S., & Bhatt, A. (2020). Determinants of Likelihood Access for Different Livestock Based Enterprises by the Farmers of Tripura, India. *Indian Journal of Animal Research, 54*(1), 122-124.	0.395	6.40
24.	Ponnusamy, K., & Sharma, P. (2020). Extension and policy reforms in the midst of disaster in agriculture. *International Journal of Development Extension, 11*(1), 14-22.	Nil	Nil
25.	Ponnusamy, K., Oberoi, P. S., & Kumar, A. (2020). Impact analysis of women centric technological interventions in rural dairy farming. *Indian J. Dairy Sci., 73*(4), 365-70.	Nil	5.95
26.	Ponnusamy, K., Sabikhi, L., & Meena, G. S. (2020). An appraisal of scope for women-led entrepreneurship in dairying. *Indian J. Dairy Sci., 73*(6), 608-613.	Nil	5.95
27.	Ponnusamy, K., Sabikhi, L., Meena, G.S. and Sharma, P. (2020). Strategies for women empowerment in dairying. *Bhartiya Krishi AnusandhanPatrika, 35*(1&2), 106-109.	Nil	Nil
28.	Prakash, B. B., Chakravarty, R., & Manjunath, K. V. (2020). Profile Characteristics of the Dairy Women SHG Members under Shri KshethraDharmasthala Rural Development Project (SKDRP) in Karnataka. *Advances in Research, 21*(10), 91-98.	Nil	4.80
29.	Rai, C. K., Sankhala, G., Lal, S. P., & Singh, K. (2019). Mapping adaptive capacity of tribal dairy farmers to climate variability and change: A study of western Himalayan region. *Indian J. Dairy Sci., 72*(6), 668-675.	Nil	5.95
30.	Raj, K., Ponnusamy, K., Yadav, R., Kishore, C. N., & Begum, M. (2018). Effectiveness of Public Private Partnership model of dairy farming in Haryana. *Indian J. Dairy Sci., 73*(1).	Nil	5.95
31.	Roy, S. K., & Meena, B. S. (2020). Studies on Breeding and Feeding Practices in Karnal District of Haryana: A Descriptive Study. *International Journal of Current Microbiology and Applied Sciences, 9*(2), 3026-3032.	Nil	5.38
32.	Verma, A. P., Meena, H. R., Kadian, K. S., & Meena, B. S. (2019). Exploring the Perceived Feedback of Commercial Dairy Farmers about Effectiveness of Android Mobile Apps 'Brucellosis Advisor Apps'. *International Journal of Current Microbiology and Applied Sciences, 8*(1), 3007-13.	Nil	5.38
33.	Verma, A. P., Meena, H. R., Sawant, M. N., & Bhatt, A. (2019). A Test to Measure Commercial Dairy Farmer's Knowledge towards Brucellosis in Dairy Animals. *International Journal of Current Microbiology and Applied Sciences, 8*(2), 847-54.	Nil	5.38

34.	Verma, A.P., Meena, H.R., Patel, D. and Kar, P. (2020) Constraints perceived by field veterinarians for providing animal health services in Haryana and Punjab State. *International Journal of Livestock Research, 10*(3), 152-59.	2.01	5.36
35.	Verma, K. V. S., Garai, S., Maiti, S., Meena, B. S., Bhakat, M., &Kadian, K. S. (2020). Indian dairy farmers' willingness to pay for sexed semen. *Journal of Dairy Research, 87*(4), 406-09.	1.63	7.63
36.	Verma, K. V. S., Garai, S., Maiti, S., Meena, B. S., Bhakat, M., &Kadian, K. S. (2020). Demand driven livestock extension services: Farmers' participatory assessment in Eastern Haryana. *Indian Journal of Animal Sciences, 90*(5), 792-97.	0.278	6.28
37.	Yadav, R., Ponnusamy, K., Meena, H. R., & Mandi, K. (2020), The Constraints Experienced by Krishi Vigyan Kendra (KVK) Trainees in Forming Entrepreneurial Units.*Current Journal of Applied Science and Technology, 39*(15), 112-17.	Nil	4.71
38.	Yadav, R., Ponnusamy, K., Meena, H.R. and Mandi, K. (2020) Motivational factors influencing entrepreneurial behavior among trainees of KVK, ICAR-NDRI, Karnal. *Multilogic in Science, 10*(34), 971-75.	Nil	4.51

PME Cell

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Malik, Meena (2020) Documenting Success Stories: Style of Reporting. *International Journal of English Literature, Language & Skills (IJELLS)* 9(1), 105-11	3.235	Nil
2.	Malik, Meena (2020) English for Empowering Science and Engineering Graduates. *International Journal of English Literature, Language & Skills (IJELLS)* 8(4), 132-38.	3.235	Nil

Southern Campus, Bengaluru

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Akshay Baliyan, Jeyakumar Sakthivel, Rakesh Ahuja and Ram Karan (2020). Effect of Supplementation of Trace Minerals and Vitamins during Transition Phase on Lactation Performance of Deoni Primiparous Heifers. *International Journal of Current Microbiology and Applied Sciences, 9*(5), 532-538 DOI: 10.20546/ ijcmas.	4.963	5.38
2.	Deshmukh, G. P., Ravindra, M. R., Jose, N., Wasnik, P. G., & Dhotre, A. V. (2020). Moisture sorption behavior and thermodynamic properties of dry crystallized Paladapayasam (rice flakes milk pudding) mix determined using the dynamic vapor sorption method. *Journal of Food Processing and Preservation, 44*(10), e14819.	1.405	7.41
3.	Devi, L.G., Adbhal, A.D., Kataktalware, M.A., Mech, A., Pal, D.T., Giridhar, K., Arangasamy, A., Senani, S. and Niketha, L. (2020). A critical control points-based approach for reduction of mastitis incidence in dairy farms of Karnataka. *Indian Journal of Animal Sciences, 90*(3), 357-61.	0.278	6.28
4.	Elango, K., Kumaresan, A., Sharma, A., Nag, P., Prakash, M.A., Sinha, M.K., Manimaran, A., Peter, E.S.K.J., Jeyakumar, S., Selvaraju, S. and Ramesha, K.P. (2020). Sub-fertility in crossbred bulls: deciphering testicular level transcriptomic alterations between zebu (*Bos indicus*) & crossbred (Bos taurus x Bos indicus) bulls. *BMC Genomics,21*(1),1-14.	3.969	9.59
5.	Emerald, F. M. E., Pushpadass, H. A., Manjunatha, M., Manimala, K., Dejey, D., Salish, K., & Nath, B. S. (2020). Modelling approaches for predicting moisture transfer during baking of chhana podo (milk cake) incorporated with tikhur (*Curcuma angustifolia*) starch. *Journal of Food Measurement and Characterization, 14*(6), 2981-97.	2.431	7.65

6.	Girgo, U. G., Kimothi, S. S., &Kumaresan, A. Influence of omega-3 rich fatty acid enriched feed on biochemical markers and post-partum reproductive performance of cross bred dairy cows. *Journal of Indian Veterinary Association,18(1),* 110-21.	Nil	3.84
7.	Gupta, J., Subash, S., & Mandi, K. (2020). Constraints Faced by Dairy Farmers in Adoption of Animal Welfare Practices in Uttar Pradesh. *Advances in Research,* 55-59.	Nil	4.80
8.	Gupta, J., Subash, S., Devi, M. C. A., & Mandi, K. (2020). Adoption Level of Good Dairy Management Practices among Dairy Farmers in Central Plain Zone of Uttar Pradesh, India.*Current Journal of Applied Science and Technology, 39*(13), 47-53.	Nil	4.71
9.	Gupta, J., Subash, S., Devi, M. C. A., & Mandi, K. (2020). Adoption Level of Animal Welfare Practices among Dairy Farmers in Central Plain Zone of Uttar Pradesh. *Asian Journal of Agricultural Extension, Economics & Sociology*, 38(4), 94-100.	Nil	4.86
10.	Hallolli, A.C., Sharma, D., Manimaran, A., Kumaresan, A., Sivaram, M., Bagath, M., Prakash, M.A., Jeyakumar, S. and Rajendran, D. (2020). Evaluation of indirect diagnostic tests and PBMC expression of innate immune genes in subclinical mastitis in dairy cows. *Indian Journal of Animal Sciences, 90*(8), 1103-08.	0.278	6.28
11.	Jamuna, G., Sharma, A. K., Manimaran, A., & Sankar, P. (2020). Ameliorative effect of *Withaniasomnifera* and *Allium sativum* on ochratoxin an induced neurotoxicity in Wistar rats. *Journal of Pharmacognosy and Phytochemistry, 9*(1), 1293-96.	5.22	5.21
12.	Jeyakumar, S., Sunder, J., Yadav, S. P., De, A. K., Kundu, A., Kundu, M. S., & Sujatha, I. (2020). Estimation of Genetic Diversity Among Teressa Goat Population of A and N Islands by using Microsatellite Markers. *Indian Journal of Animal Research, 54*(12), 1465-69.	0.395	6.40
13.	Kumaresan, A., Das Gupta, M., Datta, T. K., & Morrell, J. M. (2020). Sperm DNA integrity and male fertility in farm animals: A review. Frontiers in Veterinary Science, 7, 321.	3.12	8.25
14.	Kuntareddi, C., Kumaresan, A., Saraf, K.K., Nag, P., Paul, N., Kurati, S.P., Selvaraju, S., Jeyakumar, S., Manimaran, A., Ramesha, K.P. and Arangasamy, A. (2020). Characterization of antisperm antibody binding patterns in relation to sperm phenotypic attributes and field fertility in dairy bulls. *Theriogenology, 141*, 161-67.	2.74	8.09
15.	Laxmana Naik, Surendra Nath, Madhumita. Arjuna V.M., Nandini H.S., Brunda S. Murthy and Ramakrishna Prasad (2019). Process Optimization for Preparation of Carotine and Fibre Enriched Processed Cheese Spread and Assessment of its Quality Parametrs. *Indian Journal of Dairy Biosciences. 28*(1).	Nil	Nil
16.	Laxmana Naik, Surendra Nath, Mahesh P., Thimmesha H.B., Nandini H.S., Brunda S. Murthy and Ramakrishna Prasad (2019). Characterization of Chemical Quality of Ghee Enriched with Turmeric Extracts. *Indian Journal of Dairy Biosciences, 28*(1).	Nil	Nil
17.	Mandi, K., & Subash, S. (2019). Adoption of Good Management Practices by the Gaushalas (Cow-shed) in Karnataka State, India. *Asian Journal of Agricultural Extension, Economics & Sociology*, *37*(4),1-9.	Nil	4.86
18.	Mandi, K., Subash, S., Koloi, S., Kumar, R., & Singh, N. P. (2020). Analysis of animal welfare practices adopted by Gaushalas (Cow-shelters) in Karnataka State. *International Journal of Livestock Research*, *10*(2), 20-29.	2.01	5.36
19.	Nag, P., Sharma, A., Kamaraj, E., Kumaresan, A., Datta, T.K., Manimaran, A., Paul, N., Jeyakumar, S. and Ramesha, K.P.(2020). Identification of stable internal control genes for accurate normalization of real-time quantitative PCR data in testicular tissue from two breeds of cattle. *Asian Pacific J of Reproduction, 9*(5), 247.	1.48	Nil

20.	Neethu, K. C., Emerald, F. M. E., &Pushpadass, H. A. (2020). Measurement and prediction of thermal properties of pantoa during deep-fat frying. *Indian Journal of Dairy Science, 73*(1), 7-12.	Nil	5.95
21.	P Shruthi, P. A., Pushpadass, H. A., Franklin, M. E. E., Battula, S. N., & Naik, N. L. (2020). Resveratrol-loaded proniosomes: Formulation, characterization and fortification. *LWT- Food Science and Technology, 134*, 110127.	4.952	9.71
22.	Pathak, R., Prasad, S., Kumaresan, A., Patbandha, T.K., Kumari, S., Boro, P., Sreela, L. and Manimaran, A. (2020). Association of peripartum progesterone, estradiol, cortisol, PGFM and relaxin concentrations with retention of fetal membranes in crossbred dairy cows. *Indian Journal of Animal Sciences, 90*(7), 993-97.	0.278	6.28
23.	Prakash, M. A., Kumaresan, A., Sinha, M. K., Kamaraj, E., Mohanty, T. K., Datta, T. K., & Morrell, J. M. (2020). RNA-Seq analysis reveals functionally relevant coding and non-coding RNAs in crossbred bull spermatozoa. *Animal reproduction science, 222*, 106621.	2.145	7.82
24.	Puhle Japheth, K., and Kumaresan, A. (2020). Usage of herbs and spices in ethno-veterinary practice: a review. *Journal of Indian Veterinary Association, 18*(1),18-34.	Nil	3.84
25.	R. Saravanan, N. Murali, A.K. Thiruvenkadan, D.N. Das. 2020. Comparitive Genome Sequence Analysis of Bovine Lymphocyte Antigen BoLA DRB3.2 Alleles in Deoni and Ongole (*Bos indicus*) Cattle Breeds of India. *Indian Journal of Animal Research (Published online).*	0.440	6.40
26.	Ramesha, K. P., Mol, P., Kannegundla, U., Thota, L. N., Gopalakrishnan, L., Rana, E., Azharuddin, N., Mangalaparthi, K.K., Kumar, M., Dey, G. and Patil, A., and Prasad, T. S. K. (2020). Deep proteome profiling of semen of Indian indigenous MalnadGidda (*Bos indicus*) cattle. *Journal of Proteome Research, 19*(8), 3364-3376.	4.074	10.07
27.	Raosaheb, C. V., Manimaran, A., Sivaram, M., &Jeyakumar, S. (2020). Antimicrobials use pattern under organized and unorganized dairy production conditions in southern India. *Indian Journal of Animal Sciences, 90*(3), 362-66.	0.278	6.28
28.	Rather, H.A., Kumaresan, A., Nag, P., Kumar, V., Nayak, S., Batra, V., Ganaie, B.A., Baithalu, R.K., Mohanty, T.K. and Datta, T.K. (2020). Spermatozoa produced during winter are superior in terms of phenotypic characteristics and oviduct explants binding ability in the water buffalo (Bubalus bubalis). Reproduction in Domestic Animals, 55(11), 1629-1637.	1.641	7.64
29.	Saraf, K.K., Kumaresan, A., Dasgupta, M., Karthikkeyan, G., Prasad, T.S.K., Modi, P.K., Ramesha, K., Jeyakumar, S. and Manimaran, A. (2020). Metabolomic fingerprinting of bull spermatozoa for identification of fertility signature metabolites. *Molecular Reproduction and Development, 87*(6), 692-703.	3.113	8.82
30.	Seethu, B. G., Pushpadass, H. A., Emerald, F. M. E., Nath, B. S., Naik, N. L., & Subramanian, K. S. (2020). Electrohydrodynamic encapsulation of resveratrol using food-grade nanofibres: Process optimization, characterization and fortification. *Food and Bioprocess Technology, 13*(2), 341-54.	4.465	9.36
31.	Singh, A., & Srinivas, B. (2020). Plasticity of gut and metabolic limitations of Deoni calves in comparison to crossbred calves on a high plane of nutrition. *Tropical Animal Health and Production, 52*(6), 3365-3371.	1.559	7.33
32.	Vignesh, K., Murugavel, K., Antoine, D., Prakash, M.A., Saraf, K.K., Nag, P., Karuthadurai, T. and Kumaresan, A. (2020). The proportion of tyrosine phosphorylated spermatozoa in cryopreserved semen is negatively related to crossbred bull fertility. *Theriogenology, 149*, 46-54.	2.74	8.09

Eastern Regional Station, Kalyani

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Baneh, H., Javanrouh, A., Sadeghi, S. A. T., Yazdanshenas, M. S., Mandal, A., Ahmadpanah, J., & Mohammadi, Y. (2020). Characterization of population structure and genetic diversity of Adani goats. *Journal of Livestock Science and Technologies, 8*(1), 79-89.	Nil	Nil
2.	Behera, R., Mandal, A., Rai, S., Karunakaran, M., & Mondal, M. (2020). Temperature Humidity Index and Its Relationship with Production Traits of Dairy Cattle and Buffaloes-Review. *Journal of Livestock Research, 10*(3), 38-48.	2.01	5.36
3.	Bhakat, C., Mohammad, A., Mandal, D. K., Mandal, A., & Karunakaran, M. (2020). Effect of Dry Period Duration on Udder Health, Milk Production and Body Condition of Jersey Crossbred Cows at Lower Gangetic Tropics. *Indian Journal of Animal Research, 1*, 5.	0.395	6.40
4.	Bhakat, C., Mohammad, A., Mandal, D.K., Mandal, A., Rai, S., Chatterjee, A., Ghosh, M.K. and Dutta, T.K. (2020). Readily usable strategies to control mastitis for production augmentation in dairy cattle: A review. *Veterinary World, 13*(11), 2364.	2.11	5.71
5.	Dey, D., Sharma, B., Mohammad, A., Mandal, D. K., Bhakat, C., Dutta, T. K., & Chatterjee, A. (2020). Effect of feeding rice distillers dried grain with solubles as major protein source on nutrient digestibility and growth performance of Jersey crossbred calves. *Indian Journal of Animal Research*, *54*(4), 446-51.	0.395	6.40
6.	Karunakaran, M., Gajare, V. C., Mandal, A., Mondal, M., Das, S. K., Rai, S., & Ghosh, M. K. (2020). Heparin Binding Proteins of Black Bengal Buck Semen and Their Correlation with Sperm Characters and Freezability. *Indian Journal of Animal Research*, *54*(7), 829-34.	0.395	6.40
7.	Kinkar, D., Karunakaran M, Debajyoti, S., Asish, D., Mokidur, R. and Sangram, S.K. (2020). Review on recent advancement in semen additives for improving cryopreservation of bull semen. *Journal of Entomology and Zoology Studies,8*(6), 1493-1505.	5.48	5.53
8.	Koloi, S., & Mandal, A. (2020). Genetic analysis of persistency indices of milk yield in Jersey crossbred cattle. *Journal of Dairy Research, 87*(3), 330-3 3 .	1.628	7.63
9.	Kumar, A., Mandal, D. K., Mandal, A., &Bhakat, C. (2020). Effects of loose housing designs on expressions of milking parlour behaviours and milk yield of crossbred Jersey cows. *Journal of Animal Research, 10*(2), 315-23.	Nil	5.68
10.	Kumar, R., Chandra, P., Konyak, P., Karunakaran, M., Santra, A., & Das, S. K. (2020). In vitro development of preimplantation caprine embryo using cryopreserved black bengal buck semen. *Indian Journal of Animal Research, 54*(10), 1210-13.	0.395	6.40
11.	Kumar, S., Alex, R., Gaur, G.K., Mukherjee, S.S., Mandal, D.K., Singh, U., Tyagi, S., Kumar, A., Das, A.K., Deb, R. and Raja, T.V. (2020). Success Story on Frieswal-A National Milch Crossbred Cattle. *Biotica Research Today, 2*(5), 208-09.	Nil	Nil
12.	Kumari, T., Bhakat, C., & Singh, A. K. (2020). Adoption of management practices by farmers to control sub-clinical mastitis in dairy cattle. *Journal of Entomology and Zoology Studies*, *8*(2), 924-27.	5.48	5.53
13.	Kumari, T., Bhakat, C., & Singh, A. K. (2020). Adoption of management practices by farmers to control sub-clinical mastitis in dairy cattle. *Journal of Entomology and Zoology Studies, 8*(2), 924-27.	5.48	5.53

14.	Mandal, A., Baneh, H., Koloi, S., &Bhakat, C. (2020). Estimation of variance components and genetic parameters for lactation persistency indices in crossbred cattle using Bayesian and REML methods. *Meta Gene, 26*, 100780.	0.514	NA
15.	Mandal, A., Baneh, H., Subramanyam, B. V., &Notter, D. R. (2020). Genetic variability and population structure based on pedigree information for Muzaffarnagari sheep in India. *Small Ruminant Research, 191*, 106182.	1.611	7.27
16.	Mohammad, A. and Chatterjee. A. (2020) Livelihood Security Vis-à-Vis Perception towards Extreme Weather Events among Farmers Engaged in Different Farming Enterprises in Sundarbans Region of India. *International Journal of Current Microbiology and Applied Sciences, 9*(12), 1092-98.	4.963	5.38
17.	Mohammad, A., & Chatterjee, A. (2020). Traditional Health Management vis-à-vis Rearing Practices Followed By the'Black Bengal Goat'Farmers in Nadia District of West Bengal, India. *Journal of Animal Research, 10*(5), 733-39.	Nil	5.43
18.	Muwel, N., Mondal, M., Choudhary, S., Karunakaran, M., & Ghosh, M. K. (2020). Effect of area specific mineral mixture feeding on reproductive performance and milk yield in crossbred cattle reared under intensive farm condition. *Journal of Animal Research, 10*(5), 771-75.	Nil	5.43
19.	Paul, A., Bhakat, C., Mondal, S., & Mandal, A. (2020). An observational study investigating uniformity of manual body condition scoring in dairy cows. *Indian Journal of Dairy Science*, *73*(1), 77-80.	Nil	5.95
20.	Perveen, S., Das, P. K., Ghosh, P. R., Banerjee, D., Mukherjee, J., & Mondal, M. (2020). Expression profile of growth hormone receptor (GHR), insulin like growth factor receptor (IGFR) and leptin genes, with associated blood biochemicals and endocrines profiles in black Bengal kids (*Capra hircus*) during different stages of pre-pubertal growth. *Veterinarskiarhiv*, *90*(3), 243-5 4 .	0.492	6.49
21.	Rai, S., Dutta, T. K., Behera, R., Mandal, D. K., Chatterjee, A., Ghosh, M. K., & Karunakaran, M. (2020). THI and health estimates of Jersey crossbred calves reared in different housing system in the lower Gangetic plains of West Bengal. *Journal of Agrometeorology*, *22*(3), 313-319.	0.55	6.47
22.	Rai, S., Dutta, T.K., Behera, R., Mandal, D.K., Bhakat, C., Chatterjee, A., Ghosh, M.K. and Karunakaran, M. (2020). Susceptibility of commensally available *Escherichia coli* isolates of neonatal calves on commonly used on-farm antimicrobials. *Eye, 2*(1), 6.	0.278	6.28
23.	Rai, S., Mandal, S., Behera, R., Sahu, J., Dutta, T.K., Jas, R., Chatterjee, A., Mandal, D.K., Karunakaran, M. and Ghosh, M.K. (2020). Effect of feeding fermentable synbiotics (*Lactobacillus rhamnosus* (NCDC 298 and fructo-oligosaccharide) to Jersey crossbred calves up to 3 months of age. *Indian Journal of Animal Sciences, 90*(4), 614-17.	0.278	6.28
24.	Sahu, J., Rai, S., Behera, R., Mandal, S., Jas, R., Ghosh, M. K., Mandal, D.K., & Chatterjee, A. (2020). Faecal score and dry matter content after feeding synbiotics to neonatal Jersey crossbred calves. *Indian Journal of Dairy Science*, *73*(3), 280-83.	Nil	5.95
25.	Santra, A., & Karim, S. A. (2020). Nutritional evaluation of some Indian tree pods for livestock feeding. *The Indian Journal of Animal Sciences*, *90*(11).	0.278	6.28
26.	Santra, A., Das, S. K., Mandal, A., & Dutta, T. K. (2020). Influence of Kamela (*Mallotusphilippensis*) leaves as herbal feed additive on nutrient utilization and performances in growing crossbred calves. *The Indian Journal of Animal Sciences*, *90*(10).	0.278	6.28
27.	Singh, A. K., Bhakat, C., Chatterjee, A., & Karunakaran, M. (2020). Influence of alteration in far-off period feeding management on water intake, water and dry matter efficiency, relative immunoglobulin level in dairy cows at tropical climate. *J of Animal Research*, *10*(5), 741-49.	Nil	5.43

28.	Singh, A. K., Bhakat, C., Kumari, T., Mandal, D. K., Chatterjee, A., & Dutta, T. K. (2020). Influence of alteration of dry period feeding management on body weight and body measurements of Jersey crossbred cows at lower Gangetic region. *Journal of Animal Research*, *10*(1), 137-41.	Nil	5.43
29.	Singh, A. K., Bhakat, C., Kumari, T., Mandal, D. K., Chatterjee, A., Karunakaran, M., & Dutta, T. K. (2020). Influence of pre and postpartum alpha-tocopherol supplementation on milk yield, milk quality, and udder health of Jersey crossbred cows at tropical lower Gangetic region. *Veterinary World*, *13*(9), 2006-11.	2.11	5.71
30.	Singh, A. K., Bhakat, C., Mandal, D. K., & Chatterjee, A. (2020). Effect of pre and postpartum alpha-tocopherol supplementation on body condition and some udder health parameters of jersey crossbred cows at tropical lower gangetic region. *Journal of Animal Research*, *10*(5), 697-703.	Nil	5.43
31.	Singh, A. K., Bhakat, C., Mandal, D. K., Mandal, A., Rai, S., Chatterjee, A., & Ghosh, M. K. (2020). Effect of reducing energy intake during the dry period on milk production, udder health, and body condition score of Jersey crossbred cows in the tropical lower Gangetic region. *Tropical animal health and production*, *52*(4), 1759-67.	1.559	7.33
32.	Singh, A. K., Bhakat, C., Mohammad, A., Chatterjee, A., Karunakaran, M., & Ghosh, M. K. (2020). Economic Analysis of Pre and Postpartum Alphatocopherol Supplementation for Milk Performance and Dry Matter Intake of Dairy Cows in Tropical Region. *International Journal of Livestock Research*, *10*(10), 137-43.	2.01	5.36
33.	Singh, A. K., Bhakat, C., Yadav, D. K., Kansal, G., & Rajput, M. S. (2020). Importance of measuring water intake in dairy animals: A review. International Journal of Advanced Agricultural Science and Technology, 7(2), 23-30.	Nil	3.77
34.	Singh, A. K., Bhakat, C., Yadav, D. K., Kumari, T., Mandal, D. K., Rajput, M. S., & Bhatt, N. (2020). Effect of pre- and post-partum Alphatocopherol supplementation on body measurements and its relationship with body condition, milk yield, and udder health of Jersey crossbred cows at tropical lower Gangetic region. *Journal of Entomology and Zoology Studies*, *8*(1), 1499-1502.	5.48	5.53
35.	Singh, A. K., Prakash, C., Rohit, K., Santra, A., & Das, S. K. (2020). Cattle embryos development through in vitro techniques using thyroxine hormone as a culture media supplement.Indian Research Journal of Genetics and Biotechnology, 12(1), 24-29.	Nil	3.49
36.	Vipin and M. K. Ghosh (2020). Mitigation Strategies for Greenhouse Gas Emissions at Livestock Farm Level. *Vigyan Varta, 1*(8), 17-21.	NA	NA
37.	Vipin, P. K. Soni, K. Kumar, P. Singh and M. K. Ghosh (2020). Significance of vitamin A and E during peri-parturient period in dairy cows and buffaloes - A Review. *Indian Journal of Animal Health,59*(2), 125-136. DOI:10.36062/ijah.59.2.2020.125-36.	Nil	5.25

Review Articles

S.No.	Research Papers	Impact Factor	NAAS Rating
1.	Ali, S. A., Singh, P., Tomar, S. K., Mohanty, A. K., &Behare, P. (2020). Proteomics fingerprints of systemic mechanisms of adaptation to bile in *Lactobacillus fermentum*. *Journal of proteomics, 213*, 103600.	4.044	9.51
2.	Hess, M., Paul, S. S., Puniya, A. K., van der Giezen, M., Shaw, C., Edwards, J. E., &Fliegerová, K. (2020). Anaerobic fungi: past, present, and future. *Frontiers in microbiology, 11*, 584893.	4.235	10.23
3.	Kumar, J., Rani, K., & Datt, C. (2020). Molecular link between dietary fibre, gut microbiota and health. *Molecular Biology Reports*, *47*(8), 6229-6237.	2.316	7.40
4.	Nataraj, B. H., Ali, S. A., Behare, P. V., & Yadav, H. (2020). Postbiotics-parabiotics: the new horizons in microbial biotherapy and functional foods. *Microbial cell factories, 19*(1), 1-22.	4.187	10.19

5.	Pradhan, D., Mallappa, R. H., & Grover, S. (2020). Comprehensive approaches for assessing the safety of probiotic bacteria. Food Control, 108, 106872.	5.548	10.26
6.	Thakuria, A., Datt, C., Shambhvi, K. D., Gajender, P. T., & Yadav, R. K. (2020).Edible spineless cactus (*Opuntia ficus-indica*): A promising alternative forage source for livestock. *Indian Journal ofDairy Science*, *73*(3), 185-191.	Nil	5.95

Popular Articles/ e-papers/Technical Articles Published

Baljeet, Sanjeev Kumar, Santosh Onte and Magan Singh. 2020. Molybdenum: Essential element for plants and animals .*Agriallis, 2*(5), 42-47.

Bhagwat, S., and Ganguly, S., (2020). Metabiotic-A novel ingredient for functional foods: A review. *Journal of Pharmacognosy and Phytochemistry, 9*(1), 2228-2230.

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चित्रनायक, शुभम ठाकरे, प्रशान्त मिंज, अमिता वैराट, खुशबू कुमारी, जीतेन्द्र डबास सुनील कुमार (2020); देश में बढ़ता दुग्ध उत्पादन व कुलिंग प्रोसेसिंग तकनीक में ऊर्जा दक्षता; दुग्ध गंगा (भाकृअप–राष्ट्रीय डेरी अनुसंधान संस्थान, करनाल प्रकाशन), अंक 10, वर्ष 2019–20, पृष्ठ 106–118.

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Webinar on challenges to farming community under COVID-19 and impact on small holder farmers; the pendemic threats to livelihoods as well as food security organized on October 28, 2020

TRAINING AND CAPACITY BUILDING

Human Resource Management (HRM) unit has been established at NDRI for effective coordination and implementation of training programmes in accordance with the Govt pf India National Training Policy in 2012 based on the tenet of competency based training for all. The training plan of NDRI addresses the gap between the existing and the required competencies and provides opportunities to the employees to develop their competencies.

(A) Deputations Abroad

The following employees were deputed for Training under International Development Plan:

Name of the Scientist	Institute	Duration
Shaik Abdul Hussain	Skill and curriculum development programme for the faculty of Agriculture and Engineering at university of Jaffna, Sri Lanka	January 27 – Feb., 2, 2020
Richa Singh	Animal Sciences and Industry 220 Call Hall, 530 Mid Campus Deive North Kansas State University Manhattan, USA.	February 17 - July 16, 2020
S. Subhash	Iowa State University 0030, Curties Hall Ames, Iowa 50011, USA.	February 17 - July 16, 2020
Sunita Meena	Overseas training programme under IDP-NAHEP at Department of Physiology, University of Tennessee, Memphis, USA	February 25 - July 23, 2020
Yogesh Khetra	Wageningen University and Research, The Netherlands.	March 1 - July 30, 2020
Manoj Kumar C.T.	Department of Food Science, College of Agriculture Purdual University, 745 Agriculture Mall Drive, West Lafayette In 47907, USA.	March 1 - July 31, 2020
Rajeev Kapila	Training programme under IDP-NAHEP in Department of Internal Medicine Section on Molecular Medicine and the Centre for Redox Biology and Medicine at Wake Forest School of Medicine, Winston Salem, Noth Carolina, USA.	March 9-23, 2020
Rajan Sharma	Biosensing & Diagnostics (BSD) Wageningen Food & Biobased Research Wageningen Uniersity and Research PO Box 17, 6708 Wagenin The Netherland.	March 11- May 9, 2020

(B) Participation in Training/ Conferences/Seminars/Workshops within India

Name of Scientist	Name of Training Programme Attended	Duration
Ashish Kumar Singh	National Training programme on “Phenomics and Genomics Evaluation of Dairy Animals for Sustainable Production” organized by ICAR-NBAGR, Karnal.	January 2-22, 2020
A. K. Dixit Gunjan Bhandari	Training Programme on Animal Disease Economics organized by International Livestock Research Institute and ICAR	January 8-10, 2020.
Monika Sharma, Sathish Kumar M. H.	National Conference on Health and Wellness through Nutrition and Nutraceuticals, held at M. S. Ramaiah University of Applied Sciences at Bengaluru	January 22-24, 2020
A. Kumaresan	Quality control Aspects in frozen Semen processing organised by CFSP & TI	January 25, 2020

Heena Sharma, Gaurav Kr Deshwal	International Conference on “Livestock, Food Security & Food Safety- Challenges, Opportunities and Strategies” organized at TANUVAS, Chennai.	January 28-29, 2020
S. Subash	International workshop on “Transfer of Mitigation Technologies for heat Stress in Farm Animals” organized by ICAR-NIANP, Bangalore in association with Australia-India Council, held at NIANP, Bengaluru	February 5-7, 2020.
P Barnwal, Ankit Deep Heena Sharma, Ashish Kumar Singh Pradip Behare	National Conference on “Emerging Trends for Development of Functional Food” MAFSU-College of Dairy Technology, Warud (Pusad) at MAFSU-Nagpur Veterinary College, Nagpur, Maharashtra	February 6-7, 2020
A. Kumaresan, Devaraja H C.	Recent trends in life sciences and an intercollegiate fest–Biogala organized by CHRIST (Deemed to be University)	February 11, 2020
Sathish Kumar M.H	International Conference on Current Research and Approaches in Food Technology, Held at Osmania University at Hyderabad	February 14-15, 2020
Latha Sabikhi, P. Barnwal Chitranayak, S.A. Hussain Neelam Upadhyay, Ankit Deep Bikash C. Ghosh Devaraja H C Sathish Kumar M.H	48th Dairy Industry Conference on “Dairying for Health & Wealth” Organised by Indian Dairy Association (North Zone) & Rajasthan State Chapter at Jaipur, Rajasthan	February 20-22, 2020
Latha Sabikhi, Heena Sharma Ganga Sahay Meena, Gaurav Kr Deshwal	National Dairy Mela organized at ICAR-NDRI, Karnal	February 25-27, 2020
Heena Sharma, Gaurav Kr Deshwal	Workshop cum training program on ‘Metabolomics: Basic Principles and Applications organized by IDP, NDRI, Karnal	March 3-5, 2020
Saurabh Kadyan	Massive Open Online Course (MOOC) on “COVID-19: The Pandemic organized by RK University, Rajkot, India	May 11-15, 2020
Rani Alex	Seminar on ‘Science communication for Smart scholars’ organized by ICAR-CIFE, Mumbai	May 12-25, 2020
Mamta, Latha Sabikhi, Archana Verma Heena Sharma	International e-webinar on “Business development skills in life science” organized by Deptt. Of animal health and management, Alagappa University, Karakudi, Tamilnadu	May 27, 2020
Monika Sharma	Webinar on Benefits of Artificial Insemination in Indian Dairying; Dr. Verghese Kurien Lecture by NADS (I) on the occasion of World Milk Day.	June 1, 2020
Gunjan Bhandari	Annual IFCN Dairy Conference (Online) on Status of Dairy World in times of COVID-19 organized by IFCN Dairy Research Network, Kiel, Germany	June 2-3, 2020
Shilpa Vij, Chand Ram Grover	Milk as a medium to improve immune system during Covid19 organized by NDDB	June 5, 2020
Shilpa Vij	Decoding Secrets of Agri-Dairy Sector: Towards Self Employment	June 9, 2020
Sanjit Maiti	International webinar series on “Emerging trends in	June 10-16, 2020
Ashish Kumar Singh	Webinar on “COVID-19 Challenge on Food Processing Industry- Remedial Measure & Issues Involved” organized by Center for Food Technology, JIWAJI University, Gwalior.	June 13-14, 2020
Monika Sharma	Four day International E-Conference on “Novel Nutrition Approach and Emerging Opportunities to sustain in Pandemic Scenario” organized by Department of Nutrition & Dietetics Mount Carmel College, Autonomous, Bengaluru in association with IITB Remote Centre, Women’s Polytechnic College, Puducherry	June 15-18, 2020
Vikas Vohra	Webinar on “Sustainable Dairy Production through Breeding Interventions” organized by College of Veterinary Science and Animal Husbandry Sardar krushinagar Dantiwada Agricultural University, Sardarkrushinagar	June 16-17, 2020
Mukund A. Kataktalware	DDCI - Dutch Dairy Days Webinar (3)–Milking technology/ farm management	June 17, 2020

Latha Sabikhi, Mamta, Chand Ram Grover	Webinar on 'Skill Sets for Hybrid Teaching and Learning in Post-COVID Era' organized by IDP, NDRI, Karnal.	June 18, 2020
Neelam Upadhyay	International Web Conference on "New Trends in Agriculture Environmental and Biological Sciences for Inclusive Development" organized by Agro Environmental Development Society in collaboration with NADC Ltd., Baramulla, BBAU, Lucknow, UNAd, Mexico and CU, Egypt.	June 21-22, 2020
A.K. Dixit, Gunjan Bhandari	National Seminar on Sustainable Development: Socio-economic Concerns organized by Department of Economics, Punjabi University and The Society of Economics and Development, Ludhiana	June 22, 2020
M.C.A. Devi	Webinar on the 'Impact of Modern Intellectual Property Rights in the livestock sector' at NaaViC Agri-Business Incubation Centre and ICAR-NIVEDI	June 22, 2020
S.A. Hussain	American Dairy Science Association (ADSA) Virtual Annual Meeting 2020	June 22-24, 2020
Shilpa Vij	Assurance of Microbiological Safety of Ready- to-Eat Foods organized by Delhi University	June 26, 2020
Ganga Sahay Meena	Webinar on "Technological Innovations and Entrepreneurship in Animal Industry By-products" Under the Institutional Development Plan (IDP) being operational in Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab (India).	June 27, 2020
Monika Sharma	Online International, Student and Faculty development programme on Innovative Food Processing Technologies: Value Addition, Food Safety and Security organised by NAHEP, RVSKVV, Gwalior from June 29, 2020 to July 01, 2020 on youtube.	June 29 - July 1, 2020
Shilpa Vij, Latha Sabikhi Ashish Kumar Singh, Mukund	Brain storming Session on "Potential of Non-Bovine Milk" organized by NAAS	June 29, 2020
A. Kataktalware, P. Behera	Designing of eLearning Content (DELC) conducted by ICAR-NAARM, Hyderabad by virtual mode	July 1-30, 2020
Rubina K. Baithalu	National Webinar on "Impact of uterine disease on early embryo development in cattle" organized by Indian Society for study of Animal Reproduction	July 10, 2020
Archana Verma	Webinar on 'From Mendelian Genetics to Modern Genomics' organized by ICAR-IARI, New Delhi	July 11, 2020
Shilpa Vij, Vikas Vohra A. Manimaran, S.Subash, Mamta	Webinar on "Pharmacological Potential of A1 and A2 Milk: Myths and Facts" organized by Indian Society of Veterinary Pharmacology and Toxicology	July 11, 2020
Sanjit Maiti	Talk Series on Environmental Issues organized by College of Agriculture, CAU, Imphal	July 11, 2020
Rubina K. Baithalu	National Webinar on "Recent developments in estrous synchronization programs for cattle" organized by Indian Society for study of Animal Reproduction	July 13, 2020
Sanjit Maiti	Webinar on "Experimental Research in Social Science" organized by Bihar Agricultural University, Sabour	July 13, 2020
M.Sivaram	ICAR- Annual Day Function of Indian Agricultural Statistics Research Institute organized by ICAR-IASRI, New Delhi	July 2, 2020
A. Manimaran	National Webinar on "Applications of Flow Cytometry in Semen Analysis" organised by Theriogenology Laboratory, SRS, ICAR-NDRI & Beckman Coulter Life Sciences	July 21-22, 2020
M.C.A. Devi	7th Edition of e-Confluence on 'How Higher Education can Reboot the Economy' at E-Confluence Team IFIM Business School and NHRD	July 25, 2020
Vikas Vohra, Latha Sabikhi Chitranayak	Webinar on "Modern genetic approaches for improvement of indigenous cattle" organized by U.P. Pandit Deen Dayal Upadhyay Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, DUVASU Mathura	July 29, 2020
B.S. Meena	एक दिवसीय वैज्ञानिक संगोष्ठी 'लॉकडाउन का डेरी कृषकों व पशुपालकों पर दूरगामी प्रभाव' Organised by ICAR-NDRI for the benefit of farmers.	July 29, 2020

A. K. Misra, Nishant Kumar	International Webinar on Urban & Peri-urban Agriculture for livelihood organized by Dr. Ram Avatar Shiksha Samiti (DRASS) and ICAR-CAZRI, RRS, Pali, Marwad, Rajasthan	July 29-30, 2020
A. Kumaresan	The Indian Society for study of Animal Reproduction organized by Dept. of Veterinary Gynecology & Obstetrics.	July 3, 2020
Heena Sharma, Gaurav Kr Deshwal	Virtual workshop in Management of IPR in Knowledge Economy organized by BRIC-IKP and ICAR-NDRI	July 7, 2020
A. Kumaresan	Frozen semen technology in domestic animals organized by College of Veterinary Science & Animal Husbandry	July 7-16, 2020
Chitranayak, P.S. Minz, Ankit Deep	8thInternational Conference on Advancements in Engineering and Technology (ICAET-2020) at BGIET, Sangrur, Punjab	July18, 2020
S.Subash	Virtual digital discourse series 2020 on 'Gender and Pandemic: Challenges and Issues' organize by ICAR-ATARI, Bengaluru, ICAR-CPCRI, ICAR-NIANP, ICAR-IIHR and ICAR-CIFT	August 1-12, 2020
Ankit Deep	Online Training Programme on "Analysis of Experimental Data using R" organized by ICAR-NAARM, Hyderabad	August 5-11, 2020
Latha Sabikhi, Rubina K. Baithalu A. K. Misra, Shilpa Vij	Webinar on "Challenges and Opportunities for Dairy Development In Eastern India" organized by National Academy of Dairy Sciences (India) & Bihar Animal Sciences University	August 8, 2020
Mukund A. Kataktalware	Digital Discussion Series 2020 on Gender and Pandemic: Challenges and Opportunities organized by ICAR-ATARI, Bengaluru	August 10-12, 2020.
Latha Sabikhi	Launch of MOOC course content on Commercial Dairy Farming: A Joint Initiative of ICAR-NDRI and ICAR-NAARM organised by NDRI, Karnal and NAARM, Hyderabad. Supported by NAHEP, ICAR.	August 14, 2020
Shilpa Vij, Saurabh Kadyan	Contaminants in Milk and Milk Products organized b Alumni Association (Regd.) Southern Regional Station ICAR-National Dairy Research Institute Bengaluru	August 28, 2020
S. Jeyakumar	Training programme on "Smart Dairy Farming: Boosting productivity through innovations" organized by NAHEP-CAAST team of NAU, Navsari	August 18-22, 2020
Mamta	International webinar on Nutritional Intervention for improving production performance of dairy animals" organize by College of Veterinary Science & A H, Chhattisgarh, India	August 20, 2020
K. Ponnusamy	National Conference on Transformation of Agricultural Extension-Strategies for effective Reformation organize by College of Agriculture, Bapatla, Andhra Pradesh	August 20-21, 2020
A. Manimaran	National Webinar on Antimicrobial Resistance from food perspective through online organised by ISVPT	August 22, 2020
Ankit Deep	Online National Webinar Series 2020 on "Recent Advances in Dairy Process Engineering" organised by TANUVAS DFPE, College of Food and Dairy Technology (CFDT), Koduvalli	August 24-28, 2020
S.Subash	Webinar on 'Secondary Agriculture for Atmanirbhar - Entrepreneurship' at Institution for Agricultural Technologists, Bengaluru	August 27, 2020
Latha Sabikhi	Webinar on "Contaminants in Milk and Milk Products" organized by Alumni Association-SRS	August 28, 2020
A. Kumaresan	National webinar on "Recent advances in diagnosis and therapeutic management of infertility in dairy animals organized by Director of Clinics, College Veterinary Science, AAU, Khanapara.	August 28, 2020
P. Barnwal	Online training on IP Valuation and Technology Management at ICAR-NAARM, Hyderabad	September 1-5, 2020
M.C.A. Devi	Participated in an online training workshop on 'Education Management and Academic Leadership' at ICAR-NAARM, Hyderabad	September 3-17, 2020
Latha Sabikhi, Ashish Kumar Singh Heena Sharma, A. Kumaresan M.Sivaram	Webinar on "Stray Cattle-Strategies and Challenges" organised NADS (I) and SRS, NDRI, Bengaluru.	September 5, 2020
S.Subash, M.C.A. Devi	Webinar on 'Future Perspectives in Agricultural Education' at NAHEP- ICAR & CAAST-IARI	September 5, 2020

A. Kumaresan	Online Short course on “Technology coated roadmap for profitable dairying in Assam” organized by Director of Clinics, College Veterinary Science, AAU, Khanapara	September 7, 2020
S.Subash	21 days virtual training programme on ‘Innovative Practices in Extension Research and Evaluation’ at ICAR-NAARM, Hyderabad	September 8-28, 2020
Meena Malik	An On-line Orientation Programme of IGNOU Regional Centre Committee against Sexual Harassment (RC-CASH) on the University Policy on Prevention, Prohibition and Redressal of Sexual Harassment at the Workplace organised by RSDCASH, IGNOU, New Delhi.	September 8, 2020
Latha Sabikhi	Webinar on “Converting Crisis into an Opportunity” organised by Indian Dairy Association (West Zone) and College of Dairy Technology, Warud (Pusad)	September 9, 2020
Narender Raju Panjagari	Virtual Workshop cum Training Programme on “Intellectual Property Rights in Agricultural Research & Education in India” jointly organized by National Agricultural Higher Education Project (NAHEP) and Intellectual Property and Technology Management (IP&TM) Unit of ICAR Headquarters, New Delhi.	September 12-28, 2020
Mukund A. Kataktalware	Webinar on Production Diseases in Farm Animals- Part-I” organized by Intas Polyvet	September 13, 2020
M.Sivaram	Birth Centenary Symposium on Contributions of Prof. C.R. Rao in Statistics organized by ICAR-IASRI, New Delhi	September 15, 2020
Raghu H V	2- week Distance Learning Program on Practical course & guidelines on “Uncertainty of Measurement” organized by MAFSU, Nagpur Maharashtra Training and Capacity Building (TCB) Cell, Quality Council of India (QCI).	September 15-30, 2020
K. Ponnusamy	Panel discussion on Science of Writing Good Research Papers as part of Innovative Practices in Extension Research and Evaluation organized by NAARM, Hyderabad	September 24, 2020
Nishant Kumar	National Webinar on Farm, Food & farmer organized by Samagra Vikas Welfare Society (SVWS)	September 24-25, 2020
Latha Sabikhi	Webinar on “Development of New and Value Added Products to Increase Disposal of Milk during and after COVID 19” organised by Indian Dairy Association, Rajasthan Chapter	September 26, 2020
Mukund A. Kataktalware	Webinar on Production Diseases in Farm Animals- Part-II” organized by Intas Polyvet ICAR-NDRI, Karnal at the 150th Gandhi Jayanti Celebrations.	September 27, 2020
K. Ponnusamy	E-National policy Meet on Control of endoparasite infestation and mastitis ailment through indigenous herbal medicine for livestock organized by National Innovation Foundation-India, Gujarat 150th Gandhi Jayanti Celebrations.	September 30, 2020
A. Manimaran	ISVPT e-conference & 20th Annual Conference of Indian Society of Veterinary Pharmacology & Toxicology (e-ISVPT: 2020) & International Webinar on Receptor Dynamics in Cell Signalling and National e-conference of on Translational Approaches in Herbal Drug Development organized by Dept. of Pharmacology & Toxicology, CoVS & AH, DUVASU Mathura (UP)	October 4-5, 2020
Mukund A. Kataktalware	Webinar on Lesser-Known Animal Genetic Resources of India: An Overview organized by ICAR-NBAGR, Karnal	October 5, 2020
Sanchita Garai	Online Training Programme on "Climate Change: Challenges and Response (for women scientists)" organize by Centre for Disaster Management (CDM), Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussoorie	October 5-9, 2020
Vikas Vohra	Webinar on “Present Challenges and Future Prospects of Dairy Sector in Eastern India” organized by ICAR-NDRI, ERS, Kalyani (West Bengal)	October 7, 2020
S.Subash	Webinar on ‘Gender and Pandemic: Tackling the Farm Women Issues for Empowerment’ organized by ICAR-CIAE, Regional Station, Coimbatore.	October 9, 2020

Meena Malik	AICTE Training and Learning (ATAL) Academy sponsored Five Day On-line Faculty Development Programme Training Programme on " Life Skills" organized by University of Petroleum and Energy Studies, Dehradun (Uttarakhand)	October 12 -16, 2020
A. Kumaresan	Emerging Horizons on Veterinary Diagnostics and Therapeutics organized by Maharashtra Animal and Fishery Sciences University, Nagpur.	October 12-14, 2020
Archana Verma	Webinar on 'World Food Day and 75th Anniversary of FAO organized by ICAR, New Delhi	October 16, 2020
Monika Sharma	International Webinar on Global Prospective on New Horizons in Food Science organized by Department of Dairy Science and Food Technology, Banaras Hindu University & AFST (I)-Varanasi Chapter	October 16, 2020
Mamta	"Quality improvement and standardization technologies for milk, milk product and cattle feed" organized by Indian Dairy Association	October 16, 2020
Archana Verma, A. Kumaresan Bandla Srinivas	National Webinar on 'Present Challenges and Future Prospects of Dairy Sector in Eastern India' organized by Eastern Regional Station, ICAR-NDRI, Kolkatta	October 17, 2020
K. Ponnusamy	INSEE-CCSNIAM International E-Conference on Market Led Extension Management: Focus on Covid 19 organized by National Institute of Agricultural Marketing, Jaipur, Rajasthan	October 17-18, 2020
S. Jeyakumar	International E-Conference on "Expanding Horizons in Physio-Biochemical and Molecular approaches for improving livestock health and production" organized by VCRI, Orathanadu, TANUVAS	October 19-20 2020
M.Sivaram	Relevant and Quality Data for Agricultural Research and Policy Planning organized by ICAR-IASRI, New Delhi	October 20, 2020
Archana Verma, Latha Sabikhi Shilpa Vij, Ganga Sahay Meena Bandla Srinivas	Webinar on 'Challenges to Farming Community under Covid 19 and impact on small holder farmers: The pandemic threats to livelihoods as well as food security' organized by ICAR-NDRI (NAAS-Haryana Chapter)	October 28, 2020
Naresh Kumar	Virtual World One Health Congress held at Edinburgh, Scotland, UK	Oct. 30 - Nov. 3, 2020
Narender Raju Panjagari	Online Faculty Development Programme (FDP) on "Postharvest and Processing (Food Technology)" organized by AICTE Training and Learning (ATAL) Academy at NIFTEM, Kundli.	November 2-6, 2020
Archana Verma	Webinar on 'Feature Selection for Genomic Selection' organized by ICAR-IVRI, Bareilly (NAHEP)	November 3, 2020
Rani Alex	Webinar on 'Climate Resilient Livestock Production: Opportunities and Threats' by ICAR-National Institute of Abiotic Stress Management, Baramati	November 3, 2020
Shilpa Vij	8th IDF International symposium on goat, sheep and other non-cow milk'	November 4-6, 2020
A. Kumaresan	Offspring Sex Selection: Methods and Concepts organized by Indian Society for the study of Animal Reproduction (ISSAR).	November 5, 2020
Latha Sabikhi	Webinar on "Emerging Technologies and Entrepreneurship in Dairy and Meat Sectors" organised by Kerala University of Fisheries & Ocean Studies (KUFOS), Kochi, Kerala.	November 5-6, 2020
Latha Sabikhi	Webinar on 'Emerging Technologies and Entrepreneurship in Dairy and Meat Sectors' organised by Kerala University of Fisheries & Ocean Studies (KUFOS), Kochi, Kerala	November 5-6, 2020
S. Jeyakumar	Lead Speaker in e-Workshop on "Application of Ultrasonography in Animal Reproduction" and "AI in Small Ruminants" for Field Veterinarians organized by TANUVAS, Chennai organized by VCRI, Tirunelveli TANUVAS, Chennai	November, 5, 2020
Bandla Srinivas	Online faculty development webinar on 'Research Proposal Development'	November 7, 2020
K. Ponnusamy	E-Workshop on Policy Implications in Control of ectoparasite infestation through indigenous herbal medicine for livestock organized National Innovation Foundation-India, Gujarat	November 08, 2020

Meena Malik	Two-day Virtual Conference on “On-line University Education and English Language Teaching, Scope and Challenges” organised by VIT, Vellore	November 13-14, 2020
Narender Raju Panjagari	Webinar on “Dairy Products for a Healthier World and Sustainable Industry” organized by Indian Dairy Association (North Zone)	November 17, 2020
S.Subash	Virtual Dialogue on ‘Future of Agricultural Extension and Advisory Services’ at MANAGE, Hyderabad	November 18-20, 2020
Archana Verma, Chand Ram Grover	5th biennial conference and International symposium on “Probiotics and immunity: way forward to microbial therapy organized by Probiotic association of India and ICAR –NDRI, Karnal	November 19-20, 2020
Nishant Kumar	International Webinar on Climate Smart Livestock and Poultry Production through Nutritional intervention organized by Institute of Animal Nutrition, Directorate of Centre for Animal Production Studies, Tamil Nadu Veterinary and Animal Sciences University	November 23-24, 2020
Latha Sabikhi	Webinar on “Changing Paradigms on Food Security and Food Sufficiency”. Online Short Term Training Programme (STTP) organized by College of Food and Dairy Technology, Tamil Nadu Veterinary and Animal Sciences University, Chennai	November 23-28, 2020
Archana Verma	Webinar on ‘The promise of livestock genomics’ organized by ICAR-NBAGR, Karnal	November 26, 2020
Shilpa Vij	International Webinar on " Functional Dairy Foods: The way forward for Dairy Industry after COVID-19 organized by Department of Dairy Science and Food Technology, IAS, BHU in association with IDA (Eastern U.P. Chapter) and Indian Institute of Packaging, Mumbai	November 26, 2020
Narender Raju Panjagari	Webinar on “Non-Bovine Milks: Health Benefits, Processing and Market Potential” organized by Indian Dairy Association (North Zone)	December 7, 2020
S.Subash	Virtual International Conference on ‘Circular Economy: Responsible Management for Sustainability and Circularity’ organized by IIM-Jammu and University of Bradford, U.K	December 14-15, 2020
R.Behera	“Climate Change: Challenges and Response” conducted at Centre for Disaster Management, LBSNAA, Mussoorie organized in collaboration with Department of Science & Technology, Ministry of Science & Technology, Government of India.	December 14-18, 2020
Archana Verma	International Webinar on Present and future trends in conservation and breeding technologies to enhance production in Indigenous animals’ TANUVAS, Tirunelveli (TN)	December, 15, 2020
Chand Ram Grover	International Conference on Emerging Strategies in Antimicrobial Agents and Bio-innovations organized by Department of Microbiology, School of Science, RK University	December 18-19, 2020
Monika Sharma	Young Scientists' Conference, India International Science Festival 2020, organised by Ministry of Science & Technology, Ministry of Earth Sciences and, Ministry of Health and Family Welfare, Govt. Of India in collaboration with Vijnana Bharati (VIBHA) (Virtual mode)	December 22-24, 2020
A. Kumaresan	Managing Uterine Infections in Bovines organized by Intas Animal Health	December 27, 2020
Ganga Sahay Meena	Webinar on Master Trainer's Training programme being sponsored by IIFPT, Thanjavur under the aegis of PM-FME Scheme of Govt. of India	December 29, 2020

MAJOR EVENTS

The Institute hosted quite a good number of Seminars, Workshops and Short Courses with the participation of delegates from India and abroad.

Conferences/Seminars/Symposia/Workshops/Training Programmes Organized during 2020

S.No.	Title of Workshop / Conference / Seminar / Training organized	Duration
1)	Centre for Advanced Faculty Training in Dairy Production, National Training Prgram on Phenomics and Genomic Evaluation of Dairy Animals for Sustainable Production	January 2-22, 2020
2)	Training on Management of Modern Dairies for Established Agripreneurs in collaboration with MANAGE, Hyderabad	January 6-9, 2020
3)	Centre for Advanced Faculty Training in Dairy Processing, National Training Program on Emerging Trends of Bio-process Technology in Dairy and Food Processing	January 15, 2020- Feb. 4, 2020
4)	Documenting Success Stories in collaboration with MANAGE, Hyderabad	February 3-7, 2020
5)	National Dairy Mela	February 15-17, 2020
6)	International Women's Day	March 8, 2020
7)	Group meeting under DST project at Manglora village	May 27, 2020
8)	Webinar on the occasion of World Milk Day at Southern Regional Station, Bengaluru	June 1, 2020
9)	Webinar on Decoding Secrets of Agri-Dairy Sector: Towards Self Employment	June 9, 2020
10)	Webinar on "How to Design Your Life in 5 years and Fundamentals of Goal Setting and World and Business after COVID 19"	June 10, 2020
11)	Webinar on Bridging the Gap between the Education and Industry	June 11, 2020
12)	6th International Yoga Day	June 17-21, 2020
13)	Alumni-Institute Engagement	June 18, 2020
14)	Webinar on Skill Sets for Hybrid Teaching and Learning in the Post COVID Era	June 18, 2020
15)	98th Foundation Day of ICAR-NDRI	July 1, 2020
16)	Webinar on primer for Entire Date Analytics Course	July 2, 2020
17)	IP Workshop on Management of IPR in Knowledge Economy	July 7, 2020
18)	Webinar onf Higher Education Opportunities in Management for Dairy Technology Students, MBA in India and Abroad	July 9, 2020
19)	Flow cytometry Webinar at SRS	July 21-22, 2020
20)	Webinar on Far-reaching Impact of the Global Pandemic Corona (COVID-19) on Dairy Farmers	July 29, 2020
21)	Webinar on Contaminants in Milk and Milk Products	August 28, 2020
22)	Webinar on Stray Cattle: Strategies and Challenges conduced at Southern Regional Station of ICAR-NDRI	September 5, 2020
23)	Gandhi Ulhas Saptah	September 25 to October 2, 2020
24)	Webinar on A Holistic Approach to Overall Well-being to commemorate 150th birth anniversary of Mahatma Gandhi	September 29, 2020
25)	World Food Day at Southern Regional Station, Bengaluru	October 16, 2020
26)	Webinar on Challenges to farming Community under COVID-19 and Impact on Smallholder Farmers: the Pandemic Threats to Livelihoods as well as Food Security	October 28, 2020
27)	Symposium on Probiotics and Immunity: Way Forward to Microbial Therapy	November 19-20, 2020
28)	National online workshop on Psychometric scale construction techniques: Basic to Advances	November 24-28, 2020
29)	Webinar on 'Role of Fundamental Rights in Intellectual Development'	November 26, 2020
30)	National Milk Day at Southern Regional Station, Bengaluru	November 26, 2020
31)	International Conference on Proteomics for System integrated bio-omics, One Health and food safety	December 2-4, 2020
32)	Online Training for Master Trainers on Dairy Processing	Dec. 28, 2020- Jan. 01, 2021

DISTINGUISHED VISITORS

25.01.2020	Sh. Karma Tshiteem, Head, NSCWG, Bhutan alongwith Bhutanese delegation comprising of 5 members and 6 members from Ministry of Agriculture, Royal Govt of Bhutan.
24.02.2020	Sh. Sanjay Singh, Additional Secretary, DARE & Secretary ICAR.
15.03.2020	Dr. Sanjeev Balyan, Hon'ble Minister of State Animal Husbandry, Dairying and Fisheries Govt. of India.
23.06.2020	Dr. Sanjeev Balyan, Hon'ble Minister of State Animal Husbandry, Dairying and Fisheries Govt. of India.
27.08.2020	Sh. Virender Kanwar, Hon'ble Rural Development and Panchayati Raj, Agriculture, Animal Husbandry & Fisheries Minister, Himachal Pradesh & other dignitaries.
15.09.2020	Dr. Gurbachan Singh, Former Chairman, ASRB, New Delhi
28.09.2020	Sh. Kanwar Singh Chauhan, G.B. Member.
26.10.2020	Sh. K.K. Kulshreshtha, Director (Admn) ICAR and Sh. Vinod Kumar Gaur Chairman-cum-Managing Director.
07.11.2020	Sh. Ajay Tamta, Former Textile Minister and other dignitaries.
09.11.2020	Sh. Sanjeev Verma, IAS, Commissioner, Karnal.

Sh. Sanjay Singh, Additional Secretary, DARE & Secretary visiting Livestock Research Center at ICAR-NDRI, Karnal

PERSONNEL

INSTITUTE STAFF

As on December 31, 2020

Director's Cell	
M.S. Chauhan, PhD	Director
Nirmala Kumari, BA	Private Secretary
Meena Kumari,	Assistant
Ravinder Kumar,	LDC
Joint Director (Research) Cell	
Dheer Singh, PhD	Joint Director (Research) {Officiating}
Shakuntla Rani, BA	Private Secretary
Research Prioritisation, Monitoring and Evaluation Unit	
Meena Malik, BA(Honours) MPhil, PhD	Professor (English)
Braj Kishor, MA, BLib Sci	Asst. Chief Technical Officer
Sunil Sharma, MSc	Technical Officer
Joint Director (Academics) Cell	
R.R.B. Singh, PhD	Joint Director (Academics)
Santosh, BA	Private Secretary
Academic Affairs Management Unit	
S.K. Tomar, PhD	Principal Scientist & Academic Coordinator
A.P. Ruhil, PhD	Controller of Examinations
Bhagwan Das, BA	Asst. Administrative Officer
Administrative Wing	
Vivek Purwar, MTech	Chief Administrative Officer &
Joint Director (Admn.) & Registrar {Acting}	
Abhishak Rana, BE	Sr. Administrative Officer
Ram Niwas, BA	Administrative Officer
Ritu Dalal, BTech	Administrative Officer
Rajbir, BA	Asst. Admn. Officer
S.S. Meena, BA	Asst. Admn. Officer
Braham Prakash, BA	Asst. Admn. Officer

Dharam Singh Meena, BA	Asst. Admn. Officer
Subhash Chand, BA	Asst. Admn. Officer
Ajit Singh, BA	Asst. Admn. Officer
Mukesh Dua, BA	Asst. Admn. Officer
Ram Pal,	Asst. Admn. Officer
Vivek Saini, B. Tech.	Asst. Admn. Officer
Gurjeet, M. Pharma.	Asst. Admn. Officer

Right to Information Act (RTI)

Dheer Singh, PhD	Appellate Authority
Abhishak Rana, BE	Central Public Information Officer
M. K. Ghosh, PhD	Asst. Public Information Officer
Jeya Kumar, PhD	Asst. Public Information Officer
Gurjeet, M. Pharma.	Asst. Public Information Officer

Finance Wing

D. D. Verma, MCom, PGDFM	Comptroller
R. K. Singh	Sr. Finance & Account Officer
Kunal Kalra, BCom, PGDM	Finance & Accounts Officer
Vishal Acharya, MA	Asst. Finance & Account Officer

Animal Genetics & Breeding Division

S. M. Deb, PhD	Principal Scientist & Head
Archana Verma, PhD	Principal Scientist
I. D. Gupta, PhD	Principal Scientist
Anupama Mukherjee, PhD	Principal Scientist
Vikas Vohra, PhD	Principal Scientist

Livestock Production & Management Section

Pawan Singh, PhD	Principal Scientist & Incharge
A. Kumar 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	Sr. Scientist
Mukesh Bhakat, PhD	Sr. Scientist
Nishant Kumar, MSc	Scientist
Rubina Baithalu, MVSc	Scientist
Shiv Kumar, MSc	Asst. Chief Technical Officer

Animal Nutrition Division

Madhu Mohini, PhD	Principal Scientist & Head {Acting}
Veena Mani, PhD	Principal Scientist
Raman Malik, PhD	Principal Scientist
Chander Datt, PhD	Principal Scientist

Asit Das, PhD	Principal Scientist
Nitin Tyagi, PhD	Sr. Scientist
Goutam Mondal, PhD	Sr. Scientist
Sachin Kumar. PhD	Scientist
Gian Singh, MSc	Sr. Technical Officer
Sumit Narayan, MSc	Sr. Technical Officer

Animal Physiology Division

Parveen Kumar, PhD	Principal Scientist
Sohanvir Singh, PhD	Principal Scientist
A.K. Dang, PhD	Principal Scientist
Anjuli Aggarwal, PhD	Principal Scientist
A.K. Roy, PhD	Sr. Scientist
Manju Ashutosh, PhD	Sr. Scientist
Ashutosh, PhD	Sr. Scientist
Y.P. Singh, BSc	Technical Officer
Dheeraj Kumar	Technical Officer
Avnish Kumar, BCom	Personal Assistant

Animal Biotechnology Centre

T.K. Datta, PhD	Principal Scientist & Incharge
S. De, PhD	Principal Scientist
J.K. Kaushik, PhD	Principal Scientist
A.K. Mohanty, PhD	Principal Scientist
D. Malakar, PhD	Principal Scientist
Satish Kumar, PhD	Principal Scientist
Rakesh Kumar, PhD	Principal Scientist
M.K. Singh, PhD	Scientist
S. Kumar, PhD	Scientist

Animal Biochemistry Division

Dheer Singh, PhD	Principal Scientist & Head
Gautam Kaul, PhD	Principal Scientist
Rajeev Kapila, PhD	Principal Scientist
Suman Kapila PhD	Principal Scientist
Sunil Kumar Onteru, PhD	Sr. Scientist
Ms. Suneeta Meena, MSc	Scientist
Sadeesh E. M., PhD	Scientist
Ravi Kant, PhD	Asst. Chief Technical Officer
Anita Rani, BA	Private Secretary

Dairy Technology Division

Latha Sabikhi, PhD	Principal Scientist & Head
Ashish Kumar Singh, PhD	Principal Scientist
Kaushik Khamrui, PhD	Principal Scientist

Narender Raju Panjagari, PhD	Sr. Scientist
Ganga Sahay Meena, PhD	Scientist (Sr. Scale)
Yogesh Khetra, PhD	Scientist (Sr. Scale)
Shaik Abdul Hussain, PhD	Scientist (Sr. Scale)
Gunvantsinh Rathod, MTech	Scientist (On Study Leave w.e.f. 27.08.2019)
Neelam Upadhayay	Scientist (Sr. Scale)
Writdhama G. Prasad, PhD	Scientist (Sr. Scale)
Sangita Ganguly, PhD	Scientist
Heena Sharma, PhD	Scientist
Manoj Kumar, CT, PhD	Scientist
Gaurav Kr. Deshwal, MTech	Scientist
Prem Mehta, BA	Private Secretary

Experimental Dairy

Surinder Kumar	Chief Technical Officer & Incharge
Lehri Singh, MSc (Chemistry)	Chief Technical Officer
Sanjeev Kumar, MA (Economics)	Asst. Chief Technical Officer
Gurpartap Singh, MTech (Mech. Engg.)	Technical Officer
Jagdish, BA	Technical Officer
Pardeep Singh, MTech	Technical Officer

Dairy Chemistry Division

Raman Seth, PhD	Principal Scientist & Head
Bimlesh Mann, PhD	Principal Scientist
Sumit Arora, PhD	Principal Scientist
Vivek Sharma, PhD	Principal Scientist
Rajan Sharma, PhD	Principal Scientist
Rajesh Bajaj, PhD	Principal Scientist
Richa Singh, PhD	Scientist
K. P. Indumati, MSc	Scientist
Kamal Gandhi, PhD	Scientist
Rajani Gandhi, BA	Private Secretary

Dairy Microbiology Division

A. K. Puniya, PhD	Principal Scientist & Head
S. K. Tomar, PhD	Principal Scientist
Naresh Kumar, PhD	Principal Scientist
Shilpa Vij, PhD	Principal Scientist
Chand Ram, PhD	Principal Scientist
P. V. Behare, PhD	Scientist (SS)
Raghu H.V., PhD	Scientist (SS)
Rashmi H. M., MTech, PhD	Scientist (SS)
Diwas Pradhan, MTech, PhD	Scientist
Saurabh Kadyan, MTech	Scientist

R. K. Malik, PhD	Emeritus Scientist
Seema Rani, BA, BEd	Personal Assistant

Dairy Engineering Division

P. Barnwal, PhD	Pr. Sci. & Head
Chitranayak, PhD	Sr. Scientist
P.S. Minz, PhD	Scientist (Sr. Scale)
Amita Vairat, PhD	Scientist
Ankit Deep, MTech	Scientist
KhushbuKumari, MTech	Scientist
Priyanka, MTech	Scientist (w.e.f. April 04, 2020)
Hima John, PhD	Scientist (w.e.f. April 04, 2020)
S.K. Chaudhary, AMIE	Chief Technical Officer
R.K.Bansal, BE (Civil)	Chief Technical Officer (w.e.f. April 27, 2020)
J.K.Dabas, PhD	ACTO (up to April 20, 2020)
Sunil Kumar, MTech	Assit. Chief Technical Officer
Parveen Kumar, Dip. (Machinist)	Technical Officer
ManjuBala, Dip. (Arch)	Technical Officer
Varinder Hans, BA, ITI Welder	Technical Officer
Suraj Singh Meena, BSc,DMLT	Private Secretary, (w.e.f. Feb. 19, 2020)

Dairy Economics, Statistics and Management Division

B. S. Chandel, PhD	Principal Scientist & Head {Acting}
Ravinder Malhotra, PhD	Principal Scientist
Ajmer Singh, PhD	Principal Scientist
A. P Ruhil, PhD	Principal Scientist
A. K. Sharma, PhD	Principal Scientist
Anil Kumar Dixit, PhD	Principal Scientist
Udita Chaudhary, MSc	Scientist
Gunjan Bhandari, MSc	Scientist
Tara Chand, BSc	Asst. Chief Technical Officer

Dairy Extension Division

K. S. Kadian, PhD	Principal Scientist & Head {Acting}
Gopal Sankhala, PhD	Principal Scientist
K. Ponnusamy, PhD	Principal Scientist
B. S. Meena, PhD	Principal Scientist
H. R. Meena, PhD	Principal Scientist
Ritu Chakravarty, PhD	Sr. Scientist
Sanchit Maiti, PhD	Scientist
Sanchita Garai, PhD	Scientist
Meenu Rani	Private Secretary

Forage Research and Management Centre

Anurag Saxena, PhD	Principal Scientist & Incharge
Hardev Ram, PhD	Scientist Agronomy

Mohar Singh, MSc	Asst. Chief Technical Officer.
Anil Kumar Dagar, MSc	Asst. Chief Technical Officer
Ravi Rawat, MSc	Asst. Chief Technical Officer
Mahender Pal	Technical Officer (W/S)

Agricultural Technology Information Centre (ATIC)

A.K. Mishra	Principal Scientist & Incharge
J.S Rana	Assit. Chief Technical Officer
Dharam Pal	Technical Officer

Krishi Vigyan Kendra / TT C

Rakesh Kumar, PhD	Principal Scientist & Incharge
Ramesh Kumar Chandra, PhD	Principal Scientist
Raj Kumar, PhD	Principal Scientist
Neelam Upadhyay, PhD	Scientist
Mohar Singh, MSc	Asst. Chief Technical Officer
Rakesh Kumar Tonk, PhD	Asst. Chief Technical Officer
Balraj Singh	Technical Officer
Deepa Kumari, BSc, MA	Technical Officer

Forage Production Section

Ashutosh, PhD	Sr. Scientist & Incharge
Satish Kumar, PhD (Horti.)	Chief Technical Officer
Anil Kumar Dagar, MSc	Assit. Chief Technical Officer
Ravi Rawat, MSc (Entomology)	Sr. Technical Officer
Mahender Pal	Technical Officer

Livestock Research Centre

S. S. Lathwal PhD	Principal Scientist & Incharge
Nishant Kumar, MVSc	Sr. Scientist
Rubina Kumari Bithalu, MVSc	Scientist
Pramod Kumar, MSc	Asst. Chief Technical Officer
Amarpal Singh, PhD	Sr. Technical Officer
Ashwani Kumar, MSc	Sr. Technical Officer
Rajbir	Technical Officer
Samar Singh	Technical Officer

Animal Health Complex

Parveen Kumar, MVSc	Chief Technical Officer
S. Raju, MVSc	Chief Technical Officer
J. K. Pundir, BVSc	Asst. Chief Technical Officer
Sahdev Singh, MSc	Asst. Chief Technical Officer

Artificial Breeding Research Centre

T. K. Mohanty, PhD	Principal Scientist & Incharge
Mukesh Bhakat, PhD	Sr. Scientist

Subhash Chand, BVSc	Sr. Technical Officer
Kaushal Kumar	Technical Officer
Ghanshyam Meena	Technical Officer

National Library in Dairying

S. M. Deb, PhD	Principal Scientist & Head
B. P. Singh, MA, PGDCA, MLib, ISc	Asst. Chief Technical Officer
Narendra Singh, MCA, M Lib I Sc	Technical Officer
Lakshman, BCom	Technical Officer

Computer Centre

A. K. Sharma, PhD	Principal Scientist & Incharge
A. P. Ruhil, PhD	Principal Scientist
Naresh Kumar Dahiya, MTech	Asst. Chief Technical Officer
Des Raj, Diploma CSP	Technical Officer

Communication Centre

Diwas Pradhan, MTech, PhD	Scientist & Incharge
Saurabh Singh, MTech	Technical Officer

Vehicle Maintenance Section

Sanjeev Kumar, BTech, MSc (CS)	Technical Officer

Official Language Unit

Dhiraj Sharma, MA (Eng), PGJMC	Dy. Director (OL)
Rakesh Kumar, MA (Eng, Hindi, Sanskrit) and PGDT	Asst. Director (OL)
Kanchan Choudhary, MA	Asst. Chief Technical Officer

Security Section

Ashutosh, PhD	Sr. Scientist & Incharge
Deepak Chopra, BA	Security Officer
Rajvir Singh, MA, PGDCA	Security Supervisor

Maintenance Section

J.K. Dabas, BE (Civil)	Chief Technical Officer & Incharge
S. K. Saini, BTech (Mechanical)	Asst. Chief Technical Officer
Balbir Singh, ITI (Electrical)	Technical Officer
Arun Kumar, ITI (Electrical)	Technical Officer

Human Health Complex

Dheer Singh, PhD	Principal Scientist & Incharge
Manoj Kumar, MBBS	Sr. Medical Officer
Richa Walia, Diploma Nursing	Technical Officer
Saroj Kathuria, Diploma Nursing	Technical Officer
K. S. Khanna	Technical Officer

Saroj Bala, Diploma Pharma	Technical Officer
Anuradha, Diploma Nursing	Technical Officer
Deeapak	Technical Officer

Hospitality Cell

Pradip Vishnu Behare, PhD	Scientist & Incharge
Sanjiv Kumar, BTech, MSc (CS)	Technical Officer
Navdeep Singh, BTech	Technical Officer

Sports Section

A. K. Singh, PhD	Principal Scientist & Incharge
G. S. Meena, PhD	Coordinator
Sandeep Deswal	Sports Instructor

Estate Section

Sushil Kumar Kamboj, MSc	Chief Technical Officer & Incharge
P. M. Meena, MSc	Asst. Chief Technical Officer

Southern Regional Station, Bengaluru

K. P. Ramesha, PhD	Principal Scientist & Head
Bikash Chandra Ghosh, PhD	Principal Scientist
Bandla Srinivas, PhD	Principal Scientist
K. Jayaraj Rao, PhD	Principal Scientist
D. N. Das, PhD	Principal Scientist
M. C. Arunmozhi Devi, PhD	Principal Scientist
A. Kumaresan, PhD	Principal Scientist
S. Jeyakumar, PhD	Principal Scientist
P. Heartwin Amala Dhas, PhD	Principal Scientist
M. Sivaram, PhD	Principal Scientist
Menon Rekha Ravindra, PhD	Principal Scientist
Mukund A. Kataktalware, PhD	Sr. Scientist
F. Magdaline Eljeeva Emerald PhD	Sr. Scientist
Mamta, PhD	Sr. Scientist
Priyanka Singh Rao, MSc	Scientist
S. Varalakshmi, PhD	Scientist
S. Subash, PhD	Scientist
A. Manimaran, PhD	Scientist
Monika Sharma, PhD	Scientist
H.C. Devaraju, MTech	Scientist
Sathish Kumar. M. H., PhD	Scientist
Lakshman Naik. N., PhD	Scientist
P. Muruganantham, MLib Sci	Chief Technical Officer
V.R.V. Surendranath Naik, MD	Chief Medical Officer
B.K. Rajashekaraiah, BSc (Agri.)	Asst. Chief Technical Officer
Veeraju, BE (Civil)	Asst. Chief Technical Officer

P.G. Satish, BVSc	Asst. Chief Technical Officer
Siddaramanna, PhD	Sr. Technical Officer
R. Keshavamurthy, BSc (Agri.)	Sr. Technical Officer
Gurunath Gouda Patil, BSc (Agri.)	Sr. Technical Officer
K. Ningaraju, MVSc	Sr. Technical Officer
Meganathan, Dip. (Elec. Engg.)	Sr. Technical Officer
K.P. Lakshminarayanappa, DME (Mech.)	Sr. Technical Officer
Janakshi, MCA	Sr. Technical Officer
M.S. Nagarajaiah, Dip. (Civil Engg.)	Sr. Technical Officer
Vimala, BSc	Technical Officer
K. Ramakrishna Prasad, MSc	Technical Officer

Eastern Regional Station, Kalyani

M.K. Ghosh, PhD	Principal Scientist & Head {Acting}
T.K. Dutta, PhD	Principal Scientist (Animal Nutrition)
Subrata K Das, PhD	Principal Scientist (Animal Biotechnology)
A. Santra, PhD	Principal Scientist (Animal Nutrition)
Champak Bhakat, PhD	Principal Scientist (LPM)
A. Mandal, PhD	Principal Scientist (AGB)
D.K. Mandal, PhD	Principal Scientist (LPM)
A. Chatterjee, PhD	Principal Scientist (Animal Nutrition)
M. Karunakaran, PhD	Principal Scientist (Animal Reprod. & Gynae.)
M. Mondal, PhD	Sr. Scientist (Animal Physiology)
Asif Mohammad, PhD	Scientist (Ag. Extension)
Saroj Rai, PhD	Scientist (Livestock Production & Management)
Rajalakshmi Behra, PhD	Scientist (Animal Genetics & Breeding)
Alokesh Goswami, MSc	Chief Technical Officer
Amitava Ghosh, MVSc	Chief Technical Officer
Somnath Dutta, MVSc	Chief Technical Officer
P. Saha, MSc	Chief Technical Officer
D. Munjani	Technical Officer
Sukhdev Singh	Asst. Administrative Officer
S. Roy Deb	PS to Head, ERS

PERSONALIA

Joining/Appointment/Promotion

- Dr. Manmohan Singh Chauhan, joined as Director, ICAR-NDRI, Karnal w.e.f. 30.01.2020.
- Mr. Vivek Saini, Assistant promoted to the post of AAO w.e.f. 06.01.2020.
- Mr. Gurjeet Singh, Assistant promoted to the post of AAO w.e.f. 06.01.2020.
- Dr. Priyanka, joined as Scientist (AS&PE) at ICAR-NDRI, Karnal w.e.f. 04.04.2020.
- Dr. Hima John, joined as Scientist (AS&PE) at ICAR-NDRI, Karnal w.e.f. 04.04.2020.
- Mr. B. C. Katoch, joined as Administrative Officer at ICAR-NDRI, Karnal w.e.f. 06.06.2020.
- Mr. Dhiraj Sharma, joined as Deputy Director (Official Language), ICAR-NDRI, Kamal w.e.f. 10.09.2020.
- Dr. Raj Kumar, Sr. Scientist, Agricultural Extension, joined his duties in the FN of 17.08.2020 at ICAR-

NDRI, Karnal upon his transfer from from ICAR-Central Sheep & Wool Research Institute, Avikanagar, Rajasthan.

- Mr. Subhash Chander, Assistant promoted to the post of Assistant Administrative Officer w.e.f. 11.08.2020.
- Dr. Ashwani Kumar Roy, Sr. Scientist promoted as Principal Scientist w.e.f. 01.01.2015.
- Dr. Nitin Tyagi, Sr. Scientist promoted as Principal Scientist w.e.f. 17.08.2018.
- Dr. Mukesh Bhakat, Sr. Scientist promoted as Principal Scientist w.e.f. 29.08.2018.
- Dr. Goutam Mondal, Sr. Scientist promoted as Principal Scientist w.e.f. 07.09.2018.
- Dr. Suneel Kumar Onteru, Sr. Scientist promoted as Principal Scientist w.e.f. 20.12.2018.
- Dr. Mukund A. Kataktalware, Sr. Scientist promoted as Principal Scientist w.e.f. 26.02.2019.
- Dr. Anurag Saxena, Principal Scientist, Agronomy joined ICAR-NDRI w.e.f. 18.12.2020 upon his transfer from ICAR-CAZRI, Jodhpur.

Transfer/Retirement/Relieving

- Mr. Susanta Saha, Joint Director (Administration) & Registrar retired from Council's service w.e.f. 31.01.2020.
- Dr. A.K. Tyagi, Head, Animal Nutrition relieved from ICAR-NDRI Karnal to join as Assistant Director General (Animal Nutrition & Physiology), ICAR Hqrs., New Delhi w.e.f. 27.02.2020
- Dr. A.K. Chauhan, Principal Scientist, Agricultural Economics, retired from Council's service w.e.f. 31.03.2020.
- Dr. Neelam Upadhyay, Scientist (Food Technology) is transferred to Krishi Vigyan Kendra, ICAR-NDRI, while retaining the existing laboratory of Dairy Technology Division for research work and position of faculty of DT Division for allotment of students and teaching.
- Dr. P. K. Dixit, Principal Scientist (Agricultural Economics) SRS of ICAR-NDRI, Bengaluru retired from Council's service w.e.f. 31.05.2020.
- Smt. Krishna Devi Azad, AAO retired from Council's service w.e.f. 30.06.2020.
- Dr. Sunita Grover, Principal Scientist & Head, Dairy Microbiology Division retired from Council's service w.e.f. 31.07.2020.
- Dr. Mahendra Singh, Principal Scientist & Head, Animal Physiology Division retired from Council's service w.e.f. 31.07.2020.
- Dr. Sujata Pandita, Principal Scientist, Animal Physiology Division retired from Council's service w.e.f. 31.07.2020.
- Dr. B. Surendranath, Principal Scientist, Dairy Chemistry, Southern Regional Station, Bengaluru retired from Council's service w.e.f. 31.08.2020.
- Dr. Prabhat Palta, Principal Scientist, Animal Biotechnology Centre retired from Council's service w.e.f. 30.09.2020.
- Dr. Vedamurthy G V. Scientist, Animal Bio-Chemistry transferred to Southern Regional Station of ICAR-NDRI, Bengaluru w.e.f. 17.07.2020.
- Dr. Priyanka Singh Rao, Scientist, Dairy Chemistry transferred to SRS of ICAR-NDRI, Bengaluru w.e.f. 27.10.2020.

Additional Responsibility

- Dr. K.S. Kadian, Principal Scientist entrusted with the responsibility of Acting Head, Dairy Extension Division for a period of six months w.e.f. 01.01.2020.
- Dr. (Mrs.) Bimlesh Mann, Principal Scientist entrusted with the responsibility of Acting Head, DC Division for a period of six months w.e.f. 02.01.2020.
- Dr. B.S. Chandel, Principal Scientist entrusted with the responsibility of Acting Head, DES&M Division for a period of six months w.e.f. 09.01.2020.
- Dr. (Mrs.) Madhi Mohini, Principal Scientist entrusted with the responsibility of Acting Head, Animal Nutrition Division for a period of six months w.e.f. 09.01.2020.

- Mr. Vivek Purwar, Chief Administrative Officer entrusted with the responsibility of Incharge JD (Admn.) & Registrar w.e.f. 01.02.2020.
- Dr. M.K. Ghosh, Principal Scientist entrusted with the responsibility of Acting Head, ERS of ICAR-NDRI, Kalyani, Kolkata for a period of six months w.e.f. 07.02.2020.
- Dr. Dheer Singh, PS & Head, Animal Biochemistry Division entrusted with the responsibility of Acting Joint Director (Research) w.e.f. 29.02.2020.
- Dr. S.M. Deb, Principal Scientist entrusted with the responsibility of Acting Head, AG&B Division for a period of six months w.e.f. 01.03.2020
- Dr. (Mrs.) Latha Sabikhi, Principal Scientist entrusted with the responsibility of Acting Head, Dairy Technology Division for a period of six months w.e.f. 10.03.2020.
- Dr. Anil Kumar Puniya, Principal Scientist Dairy Microbiology Division entrusted with the additional responsibility of Acting Head for a period of six months w.e.f. 1.08.2020.
- Mr. Abhishek Rana, Senior Administrative Officer assigned the responsibility of CPIO in place of Dr. Meena Malik, Professor w.e.f. 26.11.2020.
- Dr. Diwas Pradhan, Scientist assigned the responsibility of Incharge, Communication Centre w.e.f. 26.11.2020.
- Dr. Archana Verma, Principal Scientist assigned the responsibility of Nodal Officer, Gender Budget Cell w.e.f. 30.12.2020.

Dr. M.S. Chauhan, Director, ICAR-NDRI, Karnal inaugurating the new building of Artificial Insemination Centre

MAIN CAMPUS, ICAR-NDRI, KARNAL

RESEARCH DIVISIONS

Animal Genetics and Breeding Division

Animal Genetics & Breeding 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 as well as 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.

Another important mandate of the division is the development of human resources through academic activity of masters, and doctoral programmes and also training in the field of animal genetics and breeding. The Center of Advanced Faculty Training (CAFT) in Animal Genetics and Breeding established at the division during eighth plan continued its activities on conducting the national training to scientists / teachers from Research Institutes, State Agricultural/Veterinary Universities and Livestock Development Organizations in advanced areas of Animal Genetics and Breeding. A total of 35 National Training Programs have so far been organized under the aegis of CAFT (AG & B) in the division.

The division also fulfills the mandate of extension in the area of Animal Genetics & Breeding through training programs in KVK, TBI and dairy extension division, consultancy services to farmers and various dairy stake holders, supplies superior germplasm in the form of frozen semen and surplus breeding males to farmers, livestock developmental agencies, state governments and other stake holders 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. Besides this, breeding herds of cattle (Karan Fries, Karan Swiss, Sahiwal, Tharparkar & Gir) and Murrah buffaloes are also the integral part of the research component of Animal Genetics and Breeding Division. The Divisional Library has 480 books, 241 M.Sc./M.V.Sc. and 148 Ph.D. theses.

Livestock Production & Management Section

The Livestock Production and Management (LPM) section came into being in June, 2009 after being carved out of Dairy Cattle Breeding Division of the institute. Separate faculty of LPM along with board of studies was in existence since 1976 and post graduate and doctorate degree programmes in LPM were continuing. The faculty of LPM is engaged in conducting research in the frontline areas of all applied aspects of dairy animal production and has been successful in evolving many transferable technologies and development of package of practice on the routine care and management of dairy animals. The faculty of LPM is engaged teaching both at UG and PG levels. The LPM faculty is also shouldering the responsibility of the routine management of the cattle yard and breeding bulls maintained at the Animal Breeding Research Center of Institute besides supporting the training and extension activities of the institute.

The mandate of the section includes, (i) To maintain elite germplasm repository of dairy animals of the identified breeds, ii) Development of state-of-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 behavior lab, Molecular Reproduction lab, ABRC, Andrology and semen preservation lab, milk analysis lab, ARGO lab in LRC, Livestock research center. The Divisional Library has 480 books, 241 M. Sc./M. V. Sc. and 148 Ph. D. theses.

Animal Biotechnology Center

Animal Biotechnology was initiated at NDRI, Karnal during mid-eighties under a UNDP 'Centre of Excellence on Biotechnology' programme. The urgent need for 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 establishment of 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 i) To undertake biotechnology oriented basic and applied research programmes for improving animal productivity and for developing innovative dairy processes for producing superior quality, safe and wholesome dairy products, ii) To train manpower in application of Biotechnology in Dairy Production and Dairy Processing, and iii) To organize Masters and Ph.D. programmes in Biotechnology for the NDRI Deemed University.

A state-of-the-art biotechnology research facility, which offers a working space of more than 20,000 sq. ft., was created in 2007 to consolidate the biotechnology research at NDRI. It has specialized laboratories on Embryo Biotechnology, Regenerative Biotechnology, Animal Genomics, Proteomics Research, Structural Biology etc.

Animal Physiology Division

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 division made a humble beginning with limited resources at its disposal. 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 not only succeeded in establishing the state-of-the-art research facilities, but also earned fame in publishing the best quality research papers at the Institute. The scientists and the students have earned exemplary recognitions while working at this division and abroad during training and postdoctoral programs. The alumni of the division have achieved higher positions in research and management in the Institute and in ICAR/SAUs. The division has always taken a lead in organizing various brain storming sessions, conferences, symposia and training programs for the benefit of scientific and technical community engaged in research.

The division has been committed to conduct Research, Teaching, and Extension activities in the different areas of Animal Physiology Discipline that are Environmental and Stress Physiology, Lactation and Immuno Physiology, Growth and Reproductive Physiology, and Endocrinology. In particular, the division has always come forward to solve the problems of dairy farmers. 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). During the last five years 41 MVSc and 22 PhD students have passed out and most of the students have been well placed in ARS/Agricultural University and others are pursuing their higher studies.

Animal Nutrition Division

Dairy Cattle Nutrition Division is one of the founding divisions of this prestigious institute National Dairy Research Institute, Karnal. It was established in the year 1972, as Dairy Cattle Nutrition and Physiology Division. Later in the year 1978, it was bifurcated into independent division as Dairy Cattle Nutrition and Dairy cattle Physiology. Research and teaching in the field of animal nutrition has been the main focus of the division. Dairy Cattle Nutrition Division was renamed as Animal Nutrition Division in the year 2016. Animal Nutrition Division undertakes basic and applied research in 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. Work on various aspects of energy and protein nutrition in cattle and buffalo was initiated in context of Indian scenario since inception of this division. Milk replacer and calf starter based on locally available sources were developed along with their feeding schedule. Utilization of NPN compounds upto 33% of the requirement was worked out and recommended. Protection of protein and fat was carried out resulting into efficient utilization of protein and decrease in bio-hydrogenation of fats leading to production of unsaturated fatty acids in milk. Work was also done on nutrient requirements of cattle, buffalo and goats. Utilization of Zn and 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. Utilization of various newer feed resources and improvement of nutritive value of straw by biological treatment, block making and detoxification of anti-nutritional factors had been carried out. Surveys have been carried out to find the prevalence of pesticide and toxic metals as well as essential trace minerals.

Recently work has been initiated on newer feed resources and trace elements, utilization of various newer feed resources and improvement of nutritive value of straw to curb the shortage of feed resources for the livestock. With the emergence of one health concept more focus has been diverted into value addition of milk and meat products, probiotics and prebiotics application in animal nutrition, mineral nutrition, and methane emission and its mitigation strategies.

Animal nutrition division has many national, international and collaborative research projects which are externally funded by agencies like ICAR, DBT, DST, NABARD, NDDB and MoE. Every year this division publishes several research papers in national and international journals which are on par with the international research papers. In recognition of the research work, faculty of dairy cattle nutrition division are appreciated with various awards like Vasvik research award, NAAS fellow, ANA fellow, Dr. K. Pradhan Young Scientist Award and several. Scientists of the division are activity involved in extension activities, and village awareness programs such as Swach Bharat Abhiyan and also involved in educating dairy farmers on ration balancing through technical bulletins, folders and manuals of feed formulations. This division offers PhD and Masters Program in animal nutrition discipline. Students of animal nutrition have bagged various national and international scholarships like with PM international scholarship, JENESYS International fellowship and are being placed in various institutes as scientist, assistant professors and also in industry.

The research laboratories are equipped with modern analytical instruments for chemical and physical analysis. The Division has developed excellent laboratory facilities, which are central facilities for research and education, not only for the Institute but also for various sister organizations seeking such support from time to time. The central facilities include central fine instrumentation laboratory, laboratory for anaerobic rumen microbial work, laboratory for environment related studies including methanogenesis, quality control laboratory, feed processing unit 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 SF_6 technique, spectrophotometer, PCR machine etc. Research on precision nutrition is being undertaken since the past few years. Besides research, Animal Nutrition Division also offers the M.Sc./M.V.Sc. and Ph.D. in Animal Nutrition

Forage Research and Management Centre

Agronomy Section (Forage Research and Management Centre) was established as sister section of forage production section since July 2013 to strengthen the research and teaching and extension activities related to round the year forage production and quality improvement of forages through agronomic manipulations. The mandate of section includes, generating the human resource in Forage Agronomy, developing the agro-techniques for enhancing the fodder productivity and quality through efficient management of resources and to disseminate the knowledge about new agro-techniques for forage crop production and management to the dairy farmers/extension functionaries. At present, the section offers masters and doctoral programmes in forage agronomy. The section has about 10 acre land for conducting research experiments and facilities for quality analysis of forage.

Animal Biochemistry Division

The Division of Animal Biochemistry came in to being in September 1984 with the merger of the discipline of Animal Biochemistry of Dairy Chemistry Division and the Division of Human Nutrition and Dietetics. Research endeavours of the Division are presently directed towards development of probiotic foods, dairy nutraceuticals and their mechanism of action, validation of health benefit claims of Indian dairy products, characterization of genes related to fertility in buffalo, signal transduction mechanism in sperm functions, identification of fertility markers, and bioinformatics in dairy processing and production.

The salient research achievements of the Division are: development of different types of probiotic dahi and validation of their health-benefits in reducing serum cholesterol levels, protection against gastrointestinal cancer and management of diabetes in animal models, validation of nutraceutical attributes of dairy ghee in coronary heart diseases, gastro-intestinal and mammary cancer and improvement of immune system, and elucidation of its molecular mechanism, bioavailability of vitamins and minerals from dairy products, levels of conjugated linoleic acid in milk products, characterization of 8 amino acid transport systems in mammary gland and their induction at the onset of lactation, antiatherogenic properties of milk and its mechanism, hormonal profile of reproductive phases of buffalo, biochemical changes in sperm maturation, capacitation, acrosome reaction and semen freezing, signal transduction mechanism of sperm function, expression and hormonal regulation of fertility related ovarian genes in buffalo, SSCP analysis of CYP19 aromatase gene in anestrus buffaloes, transduction pathways (PI3K and MAPK) in cattle granulosa cells during steroidogenesis and apoptosis, estrus identification in buffaloes by typical fern-like patterns of saliva, health benefits of bovine and non-bovine milk, osteoanabolic peptides from casein and whey proteins, antiaging, antiallergy, immunomodulaory, antidiabetic and hypocholeteomic effect of three probiotic cultures *Lactobacillus fermentum* (MTCC: 5898) and *Lactobacillus rhamnosus* (MTCC: 5897) & *Lactobacillus rhamnosus* (MTCC: 5957), Molecular basis of resistance against pediocin and nisin by *Enterococcus faecalis and* nanosafety of anthropenic nanomaterials.

The organizational structure for research consists of Functional Foods and therapeutics lab; Immunochemistry lab; Molecular Endocrinology, Functional Genomics and Systems Biology Lab; Mammalian cell culture lab, Laboratory of mitochondrial biology of farm animals; Non-bovine milk lab and Nanotechnology lab. In addition, The Division has instrument rooms with modern equipments viz. Alpha- and Beta-counters, Ultra-centrifuge, High speed centrifuges, Micro-centrifuges, UV-visible spectrophotometers, Spectrofluorometer, PCR, Real Time PCR, ELISA Plate readers, High Pressure Liquid Chromatography, Gas Liquid Chromatography, Inverted and fluorescent microscopes, Ice flaking machines, Water purification systems, Freeze dryer, Gel documentation (Imaging) systems, ultra filtration unit, Ultra-low temperature freezers and Carbon dioxide incubators. Further, the division has a divisional library.

Dairy Chemistry Division

The mandate of Division is to conduct fundamental and applied research for understanding chemistry of milk and milk products, to impart educational programmes for undergraduate and postgraduate courses and to provide R&D support towards chemical-quality control related problems of the dairy industry.

Credited with nearly 32 industrial licenses of different technologies in last five years, Division's work on detection of adulteration in milk and milk products and low cholesterol ghee has won it wide national and international acclaim. Dairy Chemistry division has generated significant quantum of intellectual property

(more than 17 in 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 by ICAR, NAAS, NRDC, Professional Societies and research funding from national and international agencies.

The divisional academic program leading to Master of Science/ Technology and Doctor of Philosophy degrees provides a solid background in dairy chemistry while allowing for specialization in the areas of chemistry of milk constituents, chemistry of milk products, or food chemistry and analytical chemistry. Since our curriculum is grounded in basic science, graduates are able to pursue careers in a wide variety of professional and technical fields.

The Division has contributed significant knowledge on the chemistry of milk and milk products. The salient achievements are: evaluation of physico-chemical properties of buffalo milk and alteration in its calcium and casein levels; casein micelle stability in relation to manufacture of quality dairy products and encapsulation of bioactive components; triglyceride profile of cow and buffalo milk fat; revealing chemistry of ghee and ghee residue flavour; chemical makeup and structural integrity of milk fat globule membrane; influence of various processing parameters on the water soluble vitamins, major minerals and trace elements and their partitioning; lactoferrin structure and its bacteriostatic role; characterization and crystallization of buffalo lactoperoxidase; functional properties of milk protein products; production and characterization of milk protein derived bioactive peptides enriched ingredients; calcium fortified milk, low cholesterol ghee; nanoencapsulation of bioactive components and nutrients for their application in functional foods; preparation of spray dried milk protein-vitamin A/vitamin D complexes for fortification of various food products; Attenuated Total Reflectance-Fourier Transform Infrared (ATR–FTIR) spectroscopy based analytical method for assessment of proteolysis in UHT milk; A method for analysis of the panchgavya components; rapid and simple methods for the determination of SNF in milk; modification of Gerber test for simultaneous estimation of milk fat; simple tests for the detection of adulteration of milk and milk products; a platform test for detection of detergent in milk; a colour based test to detect adulteration of milk with soya milk; Strip based tests developed for the detection of added Urea, Neutralizers, Hydrogen peroxide, Glucose, Maltodextrin, salt and sucrose in milk; A Method for Vegetable oil detection in ghee using RP-HPTLC; Nanotechnology based method for detection of melamine and pesticide; formulation of quality standards of milk and milk products which are now prescribed Food Safety and Standards Authority under Ministry of Health as well as Bureau of Indian Standards.

Division is also supplying a kit for detection of nine different adulterants in milk to various dairy industries on their demand. A wide range of science-based analytical services are offered to food and allied industries through the consultancy cell for compliance under the provision of FSSA 2006, Bureau of Indian Standard (BIS), AGMARK, and other national and international standards. The Faculty from the division is also managing the activities of Chemical Section of National Referral Centre of Milk Quality and Safety. This facility is ISO 17025:2005 certified and has been accredited for more than 175 analytical parameters for chemical testing of milk and milk products.

The Division has state of the art air conditioned Seminar room, Lecture room equipped with interactive board, LCD projectors, Visualiser, Podium etc., Quality control Lab, Undergraduate and Postgraduate labs, Instrument room (equipped with HPLC, GLC, Mastersizer, Ultra filtration, Electrophoresis, Imaging system, Refrigerated water bath, Dual beam digital Spectrophotometer, Water purification system, BOD incubator, Sonicator etc.), Research labs (lipids, proteins and bioactive peptides, minerals, functional foods/ nutraceuticals and quality assurance), chemical section of National Referral Centre for Milk Quality and Safety (equipped with FTIR, HPLC, GC-MS, AAS, PCR, Real-time PCR, Particle size analyzer, Electrophoresis, Elisa Reader, Western Blot, Digital Refractometer, Protein Analyzer, Lyophilizer, Fume Hoods, Conductivity & O_2 Meter etc.).

Dairy Technology Division

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) and Masters (Food Technology). The research efforts of the Division faculty are brought to

fruition through sponsored as well as in-house projects including dissertations of post graduate 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 a number of 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 others, including Best Research Paper awards. Under the recently awarded Institutional Development Plan under the National Agricultural Higher Education Project for the incentivisation of undergraduate program, several activities for the improvement of faculty and students are in progress in the Division. The most noteworthy contribution of the Dairy Technology Division to the Indian Dairy Industry has been the industry's human resource pool, in addition to the repository of technologies.

Dairy Microbiology Division

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

The Division is currently engaged in research, teaching, consultancy, training and technology transfer in specialized field of Dairy Microbiology. Broadly, the research work of the division covers the areas related to starter cultures and fermented milk products; direct vat starters (DVS); indigenous probiotics, their functional efficacy and gut microbiota, prebiotics and synbiotics; diversity of traditional fermented milk products by metagenomic, metabolomic and culturomic approaches, bioactive peptides, microbial metabolites and bio-preservatives; biosensors, quality assurance and food safety. The Division has played a key role in establishing National Collection of Dairy Cultures' (NCDC) with current repository of more than 800 cultures and National Referral Centre for Milk Quality and Safety. The Division has transferred technologies on two indigenous strains of probiotics, Misti Dahi, rapids kits for antibiotic residues, Listeria monocytogenes and Enterococci to potential stake holders in our country for their industrial application. Few more such products like vitamin B12 rich propioni-yoghurt, blueberry fortified Probiotic Dahi, real time test for detection of E. coli and antibiotic residues in milk have been developed and are under process of validation for their commercialization.

The faculty is also involved in imparting teaching and guidance for both under-graduate and post-graduate programmes. The Division offers M. Tech and Ph.D. programmes in Dairy Microbiology as well as Food Safety and Quality Assurance. Besides, Division is also contributing in teaching Microbiology courses to B. Tech (Dairy Technology) students. Division also offers contractual and consultancy/training services such as supply of starter cultures, freeze-drying of cultures, microbiological analysis and setting standards for regulatory compliance of dairy products in our country. Division regularly organizes need based specialized short term symposia/ conferences/seminars covering basic and applied areas of dairy microbiology including quality assurance, food safety, starter cultures and fermented health foods for HRD development in our country. Division also coordinates the activities of National Referral Centre on milk quality and safety.

Dairy Engineering Division

The mission of the DE 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 is established as one of the major research divisions since 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, Research & Development workshop and equipment testing hall to support both research and teaching activities.

During the past three decades, the Division has achieved breakthroughs in developing a number of 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 development or in adoption of the research efforts.

The Division has developed equipment for the manufacture of Khoa, Burfi, Basundi, Ghee etc on industrial scale. Recent research achievements include development of weight based filling system for Kheer, machine vision system for colour measurement of dairy products, turbo assisted scraped surface heat exchanger (SSHE) etc. Current research areas focus on development of weight based filling system for Rabri and equipment for mechanized production of Kheer and Rabri. The Division also conducts specialized training to graduate engineers during summer.

Dairy Economics, Statistics and Management Division

A Division of Dairy Economics, Statistics and Management (DES&M) was created in 1972 from erstwhile Statistics Section which was constituted at NDRI in 1960. Dr. R. K. Patel joined as the first Head of the Division. He steered the Division to expand its research and teaching activities and the discipline of Dairy Economics got real impetus under his able leadership.

The Division occupies central place location-wise and academically in the national institution of higher learning in the field of dairying. The Division is an amalgamation of three disciplines, that is, Agricultural Economics, Agricultural Statistics and Computer Application. We offer post-graduate programs at Master and Doctoral levels in Agricultural Economics. Our faculty members teach variety of courses at under-graduate level also, that is, B. Tech. (DT). The issues of economics and statistics are central to all research studies in the institute and our Division addresses them. 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 dairy sector at national and international level, 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 & program, developing institutional mechanisms and facilitating decision-making process of the stakeholders at micro, meso and macro levels.

Dairy Extension Division

Dairy Extension Division was established at NDRI, Karnal in May, 1961 to undertake extension activities, besides teaching and research in Extension Education. Research endeavors of the Division are in the areas of information and communication technologies, organizational behaviour, information management, participatory technology development and impact studies of dairy innovations. The faculty has also been engaged in human resource development through post graduate and doctoral programmes of NDRI. The objectives of the division are, (i) To carry out extension research as per clientele needs, (ii) To enable the end-users to adopt the innovations in dairy farming, (iii) To facilitate technology assessment and refinement of dairy innovations evolved by NDRI, (iv) To undertake HRD programmes in dairy extension, and (v) To promote convergence and collaboration for sustainable dairy farming.

The main extension programme of the institute such as Dairy Mela and demonstrations, field days, etc. are organized by the Division. Research-Extension-Industry-Farmer Interface is also organized by the Division to provide an opportunity for the convergence of all stake holders working together for dairy development. Interface not only helps the dairy organizations to find solutions for today's problems, but also to realize the vision for the future. The Division also organizes technology transfer campaigns, infertility and veterinary aid campaigns, Kisan Sanghosthies and field workshops at the adopted villages regularly. These activities strengthen the linkages with end users, helps in understanding the problems of farmers and better dissemination of technologies as well as easy availability of feedback from the farmers. A new Extension Education Programme "Dairy Education at Farmers' Door" is initiated in 09/02/2009, to strengthen the effective dissemination of dairy production and processing technologies among farming community.

A new Extension Approach “Farmers' Farm School" in village was initiated in 2014 for updating farmers knowledge in the field of dairy farming in particular and agriculture in general. Need based technology development and refinement are continuous processes in which research and extension components work hand in hand. The Institute extension service maintains live and intimate links with the research departments one hand and the field level functionaries of different state departments, development agencies and farmers on the other.The Institute constituted an Extension Council in the year 1989, which is a decision making body for the purpose of assessment and execution of extension programmes. The Council works under the chairmanship of the Director, NDRI and meets twice a year for formal planning and execution of extension activities of the institute.

SUPPORT SECTIONS

Livestock Research Centre

The total milk production of the herd during the current year was 749533.4 Kg. The production performance of the two crossbred strains developed by the NDRI viz. Karan Swiss and Karan Fries was 6.2 and 8.7 kg per head per day, respectively. The milking average of Sahiwal, Tharparkar, Gir and Murrah buffaloes were 5.5, 3.2, 4.2 and 6.4 kg per animal per day, respectively.

One Sahiwal cow (SW-2188) produced the best milk yield of 21.0 kg in peak lactation. Best yield in Murrah buffalo (MU-6919) was 17.5 kg per day during the current year. The peak milk yield by the KF and KS crossbred cows was 25.0 kg (KF-8061) and 14.5 kg (KS-4457), respectively. Average No. of animals in milk per day: cows: 214, Buffaloes: 91 & Goats: 63.

Artificial Breeding Research Centre

Artificial Breeding Research Centre, ICAR-National Dairy Research Institute, Karnal maintaining breeding bulls consisting of Sahiwal, Tharparkar, Karan Fries and Karan Swiss breeds of cattle and Murrah breed of buffalo. ABRC is involved in production, processing, preservation and utilization of quality semen from cattle and buffalo bulls of high genetic merit. The Artificial Breeding Research Center is playing a proactive role in achieving the following mandate, (i) Research on genetic improvement of dairy cattle and buffaloes, reproduction management of male animals/ breeding bulls and frozen semen technology.

Performance of Dairy Animals during the year 2020 (01.01.2020 to 31.12.2020)

Particulars	Genetic Groups									
	Sahiwal	Tharparkar	Gir	Karan Swiss	Karan Fries	Total cattle	Murrah	AXB Goats	SXB Goats	Total Goats
Average number of animals in milk per day	78	20	31	05	80	214	91	49	14	63
Average number of dry animals per day	117	56	50	05	67	295	112	21	07	28
Milking average (kg) per day	5.5	3.2	4.2	6.2	8.7	6.3	6.4	1.3	1.4	1.3
Best yield (kg) in a day	21.0	12.5	10.5	14.5	25.0	-	17.5	3.8	3.4	-
Animal Number	2188	1362	44	4457	8061	-	6919	305	276	-

Month-wise Milking Average (Kg.) of Cows, Buffaloes and Goats Maintained at NDRI, Karnal during 2020

Months	Cows				Buffaloes				Goats							
	Sahiwal		Tharparkar		Gir		Karan n Swiss		Karan Fries		Murrah		Alpine x Beetal		Sannen x Beetal	
	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)	(i)	(ii)
January	68	6.8	21	3.9	18	2.6	05	6.5	82	10.5	127	7.3	71	1.6	19	1.7
February	77	6.6	23	3.6	19	3.3	06	7.0	84	10.3	125	6.8	69	1.5	19	1.6
March	85	6.4	22	3.1	26	4.4	06	7.1	91	8.9	117	6.5	66	1.7	18	1.7
April	90	5.4	23	2.9	29	3.8	05	5.9	92	10.0	101	6.3	64	1.6	18	1.6
May	92	5.5	19	3.4	30	4.7	04	5.5	86	10.0	91	5.8	61	1.4	17	1.5
June	92	4.4	16	2.9	34	5.6	03	5.0	83	6.8	77	4.9	60	0.8	17	0.8
July	94	4.6	19	3.2	39	4.2	05	6.4	82	6.6	62	5.0	57	0.6	13	0.6
August	94	3.9	20	2.6	43	3.6	04	5.4	83	5.5	60	4.1	28	0.5	06	0.5
September	82	4.3	20	2.6	40	4.2	04	5.3	76	6.7	70	5.2	04	0.4	02	0.5
October	66	5.4	20	2.3	36	5.2	05	7.8	71	8.2	75	7.1	06	1.0	04	1.0
November	57	6.3	18	3.2	28	4.4	05	8.2	69	9.5	85	8.0	50	1.4	17	1.4
December	50	7.2	15	5.2	30	3.9	05	6.6	60	12.1	101	8.3	57	1.5	19	1.7
Average	78	5.5	20	3.2	31	4.2	05	6.2	80	8.7	91	6.4	49	1.3	14	1.4

(i) No of animals in milk/day(ii) Milk yield (kg)/animal/day

Bovine Strength of Cattle and Buffaloes as on 31-12-2020

Age Group	Cattle			Buffaloes				Total Bovines
	Sahiwal	Tharparkar	GIR	Karan Swiss	Karan Fries	Total	Murrah	
Male calves upto 6 months	33	11	09	01	19	73	39	112
Female calves upto 6 months	20	12	11	02	20	65	42	107
Heifers	159	61	51	03	117	391	141	532
Cows/ Buff	181	66	76	07	114	444	194	638
Male Stock	13	03	18	-	20	54	09	63
Bulls	-	-	-	-	09	09	16	25
Teaser Bull	-	-	-	-	-	-	-	-
Bullock	-	-	-	-	-	-	02	02
Total	406	153	165	13	299	1036	443	1479

Flock Strength of Goats as on 31-12-2020

Age Group	**Alpine x Beetal**	**Sannen x Beetal**	**Total**
Female			
Kids upto 6 months	61	16	77
Yearling	59	14	73
Goats	70	26	96
Male			
Kids upto 6 months	38	16	54
Bucks	44	15	59
Total	272	87	359

Sale of Livestock During the year 2020 (01-01-2020 to 31-12-2020)

Mode of Disposal	**Cattle**	**Buffaloes**	**Goats**	**Total**
Public Auction	213100.00	2036200.00	385700.00	2635000.00
On Book Value	--	20870.00	80460.00	101330.00
Grand Total	213100.00	2057070.00	466160.00	2736330.00

Auction of animals was conducted on 18, 19 and 20.08.2020

Fodder and Concentrate during the year 2020 (01.01.2020 to 31.12.2020)

Months	Type of Fodder (Qntls.)				Concentrate
	Green	Dry/Hay	Silage	G. Total	(Kgs.)
January	20112.00	1680.00	-	21792.00	90049.00
February	19088.50	623.00	-	19711.50	83157.00
March	24455.00	77.35	-	24532.35	94500.00
April	20717.50	38.00	-	20755.50	94500.00
May	19379.00	623.00	-	20002.00	80616.00
June	22661.50	250.00	-	22911.50	10359.00
July	27654.50	165.00	-	27819.50	89092.00
August	27012.50	95.00	-	27107.50	Nil
September	21321.50	80.00	-	21401.50	64496.00
October	20294.00	-	-	20294.00	78525.00
November	15922.00	580.00	-	16502.00	90499.00
December	19926.00	835.60	-	20761.60	83185.00
Total	258544.00	5046.95	-	263590.95	858978.00

Total milk production & milk supplied to expt. dairy during the year 2020

Month	Total milk	To calves	To other	Total disposal	Total milk	Total milk
	production	/kids	Division	milk	send to Expt. Dairy	recd. by Expt. Dairy
January	80459.2	13348.9	2725.5	16074.4	63914.3	63594.0
February	74939.7	12325.2	2397.0	14722.2	59686.7	59351.0
March	79189.0	13809.8	1814.8	15624.6	63141.9	62965.0
April	72404.1	14300.7	656.5	14957.2	57008.3	56895.0
May	70251.4	15705.0	406.5	16111.5	53795.8	53833.0
June	50446.3	13402.0	334.0	13736.0	36637.7	36779.0
July	49485.3	12691.0	288.5	12979.5	35964.9	35835.0
August	41263.8	16608.0	101.0	16709.0	24304.3	24433.0
September	44719.5	16322.0	93.5	16415.5	27651.5	27829.0
October	54841.4	15643.4	156.7	15800.1	38385.7	38499.0
November	60776.8	17520.8	175.0	17695.8	42556.6	42782.0
December	70756.9	18891.0	214.5	19105.5	51392.7	51373.0
Total	749533.4	180567.8	9363.5	189931.3	554440.4	554168.0

(i) Teaching of post-graduate students, training and consultancy on male reproduction.

(ii) Conservation and dissemination of superior male germplasm of cattle and buffaloes.

(iii) To generate revenue for the Institute.

Forage Production Section

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

Fodder/Feed Production and Supply

Good quality of fodder, 284839.00 q. Green, 2125.00 q. dry fodder and 3429.00 q. Straw has been produced from high yielding varieties of fodder crops of Maize, Sorghum, Napier Grass, Sugargraze and Cowpea during *Kharif* season and Berseem, Oats, Chinese Cabbage and winter Maize in *Rabi* season. Similarly, seed/grain crops of Oats, Sorghum was also grown. During the period under report a total of 286987.00 q of fodder including 284839.00 q. green fodder 23.00 q. Straw and 2125.00 q. dry fodder was supplied to cattle yard and other sections.

Revolving Fund Scheme on Seed Production

The biggest constraint in increasing the production of fodder grains crops is unavailability of good quality seeds of improved varieties of fodder crops. Thus, a Revolving Fund Scheme on Seed Production of Fodder Crops was initiated at the institute in 80-hectare area to produce the seeds of improved varieties of fodder crops for cultivation at Institute Farm, Regional stations, sale to farmers and other Agencies. During the year under the report 2512.65 q. seeds of improved varieties of fodder crops 90.50 q. grains, 44705.50 q. green fodder, 2201.75 q. Bhusa were produced and total calculated cost of Seed, Grain is Rs 73,92,877.00 (Table-7,8) Green Fodder and Bhusa is Rs. 78,06,700.00 (Table-9) and revenue generated by sale/supply of seeds and grains is Rs. 72,09,977.00 (Table-10) under Revolving fund scheme on Seed Production during the report as per given below:

Production and Productivity of Forage Crops in terms of green fodder and dry fodder at Forage Production Section during 2020

Sl.No.	Crop	Area(ha)	Average Yield(q/ha)
Rabi 2019-2020			
1)	Berseem + Oats + Mustard	68.55	1129.44
2)	Maize + Jowar + Oats	2.98	398.80
3)	Napier Grass + Mixture	10.57	502.84
Kharif 2020			
1)	Oats	44.37	390.74
2)	Sugargraze	70.50	682.47
3)	Maize	61.60	312.46
4)	Maize + Cowpea	71.88	449.44
5)	Jowar (Single Cut)	86.06	334.43
6)	Nutrifeed	20.45	549.02
7)	Jowar (Multi Cut)	4.31	822.27
8)	Cowpea	5.32	247.56
9)	Napier Grass + Mixture	10.57	635.43
10)	Jowar (Honey-Pot)	0.81	88.89
11)	Jowar (Sweet-Spot)	0.40	151.25
12)	Jowar (Fat-Bay)	0.40	372.50
13)	Wonder-Leaf	0.40	245.00
14)	Napier Grass	13.56	660.44
15)	Maize + Mustard	22.35	319.19
	Total	495.08	

Production and Productivity of Grain Crops at Forage Production Section during 2020

Sl. No.	Crop	Area (ha)	Average Yield (q/ha)	Total Production (q)
1)	Oats	86.60	15.90	1377.25
2)	Jowar	8.42	2.02	17.00 (on selection basis)
3)	Wheat	32.63	54.51	1778.65
4)	Mustard	4.05	8.40	34.00
	Total		131.70	3206.90

Production and productivity of Straw at Forage Production Section during 2020

Sl.No.	Crop	Area (ha)	Average Yield (q/ha)	Production (q)
1)	Oats Straw	86.60	29.32	2539.25
2)	Wheat Straw	32.63	26.56	866.75
	Total	119.23		3406.00

**23.00 q. Grain straw received from Agronomy Section and supplied to LRC.*

Fodder Supply to Cattle Yard/ DCN/ others (Dairy Mela) during 2020 (FPS & RFS)

Month	Green (q)	Dry Straw (q)	Dry Fodder (q)	Total (q)
January	22811.00	-	1627.00	24438.00
February	21626.50	-	498.00	22124.50
March	26335.00	-	-	26335.00
April	22676.50	23.00	-	22699.50
May	21594.00	-	-	21594.00
June	24979.50	-	-	24979.50
July	30146.50	-	-	30146.50
August	29552.50	-	-	29552.50
September	23371.50	-	-	23371.50
October	24439.00	-	-	22439.00
November	17783.00	-	-	17783.00
December	21524.00	-	-	21524.00
Total	2,84,839.00	23.00	2125.00	2,86,987.00

Calculated cost of fodder supplied to LRC/DCN during 2020

Sl.No.	Crop Name	Quantity (q.)	Rate (Rs./q.)	Amount (Rs.)
1)	Green	284839.00	150/-	42725850/-
2)	Dry Fodder	2125.00	100/-	212500/-
3)	Straw	23.00	500/-	11500/-
Total	**-**	**-**		**4,29,49,850/-**

Maintenance Engineering Section

In the year 1979, the Institute took over the maintenance works from CPWD and UHBVNL and created an in-house centralized maintenance facility named as Maintenance Engg. Section to operate the essential services of electric supply, water supply and sewerage water disposal and provide maintenance services of all kinds to the whole institute. The following works/ functions are included in the mandate of M.E. Section.

- Operation and Maintenance of the water supply through bore wells and water supply lines throughout campus & sewage disposal system through sewage pumps/ sewage lines and ETP of the Institute.
- Operation and Maintenance of Electric-Sub-Station, Electrical-overhead -lines, street lights, service connections, electric supply of the office area as well as whole residential area of the Institute including meter reading / billing of the residential quarters.

Production of Seed under RFS Seed Production during the year 2020 (Rabi 2019-20 & Kharif-2020)

Sr. No.	Kind of Seed	Quantity of Seed (q.)	Rate (Rs. /q.)	Calculated Cost (Rs.)
1)	Oats Kent	700.00	3800/-	2660000.00
2)	Mustard Chinese Cabbage.	34.00	8000/-	272000.00
3)	Wheat Seed	1778.65	2406.25	4279877.00
Total	2512.65	-----	72,11,877.00	

Production of Grains under RFS Seed Production during the year 2020

Sl. No.	Kind of Grain	Quantity of Grain (q.)	Rate (Rs. /q.)	Calculated Cost (Rs.)
1)	Oats	90.50	2000/-	181000.00
	Total	90.50	2000/-	181000.00

**Grand Total of Calculated Cost (Table No. 7 & 8) Rs. 73,92,877/-*

Production of Green Fodder, Dry fodder and Bhusa under RFS, Seed Production and supplied to LRC through Forage Production Section during Rabi 2019-20 & Kharif 2020

Sl. No.	Kind of Fodder	Quantity (q.)	Rate (Rs./q.)	Calculated cost (Rs.)	Remarks
1)	Green Fodder	44705.50	150/-	6705825.00	Supplied to LRC
2)	Bhusa	2201.75	500/-	1100875.00	Supplied to LRC
	Grand Total	46,905.25	-	78,06,700.00	

Revenue Generation by sale /supply of seed/grains under RFS (Seed Production) 2020

SN	Kind	Supplied (q.)	Sold (q.)	Rate per q.	Amount (Rs.)
1)	Mustard Seed (Chinese Cabbage)	-	33.30	8000/-	266400/-
2)	Oats Seed	-	681.30	3800/-	2588940/-
3)	Wheat Seed	-	1778.65	2406.25/-	4279877/-
4)	Mustard Seed (C.C.)	30 Kg.-ERS, NDRI Kalyani,	-	8000/-	2400/-
5)	Mustard Seed (C.C.)	40 Kg. FPS, NDRI, Karnal	-	8000/-	3200/-
6)	Oats Seed	18.20 ERS NDRI, Kalyani		3800/-	69160/-
	Total	18.90	2,493.25	-	72,09,977/-
7)	Sale of Other Products i.e FYM, Fuel Wood, Oats seed, Perineal grass, Napier, Vegetable etc.				81526/-
	at FP Section				
		Grand Total			7291503/-

Allocation of the Farm Land to different units

Sl. No.	Unit	Area (Acres)	Area(Hectare)
1)	Forage Production Section &RFS (Seed)	785.39	317.97
2)	Farm Building, Road Drains, Channel & Silo Pit.	106.21	42.78
3)	Area under Eucalyptus trees (Farm)	5.01	2.23
4)	Land under Forage Production Section	896.61	362.98
5)	Land under Campus, Buildings and other Institute activities:		
	• Narmada Hostel, Kalki Bhawan, Plantation area and Dairy Mela Ground	42.75	17.31
	• Institute campus and Building	324.53	131.39
	• Dairy Demonstration & other schemes, KVK	33.39	13.52
	• Animal Breeding Complex, Block-5	10.00	4.05
	• Model Dairy Plant	20.50	8.30
	• NICRA	04.00	01.62
	• ATIC	03.50	01.42
	• Agronomy Section	09.00	03.64
	• Exhibition Unit	02.91	01.18
	• Examination Hall	0.89	0.36
	Sub Total	451.47	182.79
	Grand Total	1348.08	545.77
6)	Land handed over to other agencies:-		
	• Indian Railway	0.49	0.20
	• 33KVA H.S.E.B., Karnal (Station)	0.49	0.20
	• N.B.A.G.R. (ICAR)	74.99	30.36
	• DWR	47.97	19.42
	Sub Total	123.94	50.18
Overall Land as on May, 2021		1472.02	595.95

- To provide uninterrupted electric supply to the whole Institute by providing generator supply to office & residential area including International, Girls & Boys Hostels, Guest House and Scientist Home in case of power failures.
- To provide maintenance services in the field of civil, electrical, mechanical and refrigeration/AC Engg., which includes repair/ renovation of buildings, complete plumbing installations, electric installations and ACs/ AC plant and specialized refrigeration equipment/ deep freezers in the labs.
- Preparation of Civil/ Electric estimates of all kinds of new and repair/ renovation works required in the Institute.
- Liaison woks with UHBVN, CPWD and Haryana State Pollution Control Board etc., for execution of various works of the Institute and other compliances.

- To provide addition/alterations required in the various labs of the Institute for creating better environment conducive for research activities.
- To keep charge of all the residential quarters and maintain their occupation/ vacation records.
- To process the cases of House Building Advances of the employees & conducting house inspections at different stages of construction before releasing of loan-installments by the Administration.
- Planning and inspection of new buildings in the Institute and maintenance of plinth area records of all the Institute's buildings.
- Operation and Maintenance of the ETP of the Institute as per CPCB/ HSPCB norms.
- Generation and processing of purchase proposals to purchase parts and consumables to be used in maintenance and keeping the inventory by maintaining Civil and Electric stores.

Human Health Complex

The Human Health Complex was established in 1991. It is catering to the health needs of the employees of NDRI as well as to other Sister ICAR Institutes in Karnal i.e. IARI and IIWBR, in addition to the students and retired ICAR employees.

Human Health Complex had organized the following free Health check-up Camp and Health talk in public interest for screening the patients.

1) Free Check-up ENT and DENTAL camps by MAHABIR DAL Hospital.
2) Free Diagnostic test Camp by Dr. Nishtha Khera, Bandhu Path. Lab, Ram Nagar Karnal.
3) Free Check-up camp Orthopedic by Ivy ELITE Hospital, Mohali

During Annual year Jan., 2020-Dec., 2020 approx. 16,330 patients were benefitted by Allopathic treatment.

In Human Health Complex, a Diagnostic Clinical Lab is well equipped with fully automated Hematology Analyzer. A well qualified Nursing staff, LAB Technicians and Pharmacist assist the doctors in providing the medical facilities. Complex also organizes various Health awareness programmes. Human Health Complex is also equipped with 160 MAS X-RAY machine with a qualified X-RAY Technical Officer.

Experimental Dairy Plant

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 2020, Experimental dairy manufactured and sold Skimmed Milk Powder (Roller)- 13023 Kg., Pasteurized table butter 329.4 Kg, Ghee 10897.0 Kg, Paneer 28197 Kg, Kalakand – 24382.5 Kg, Lassi (200 ml) – 26902 pkts, Ice–cream (100 ml) – 13968 cups, Flavoured Dairy Drink (200 ml)- 65859 pkts, Processed Cheese Slices (200 gm) – 801 pkts. Gulab Jamun Mix 4807.0 kg. Pizza Cheese (200 gm) 2628 pkt, Cheddar Cheese 38.5 Kg, Khoa – 155.0 kg, Mozzarella Cheese – 5.0 Kg, Table Cream 6.0 Kg. and cooking butter – 6.75 kg.

During the pandemic COVID-19, Experimental Dairy introduced Masala Paneer which contained immunity boosting spices like Black Pepper, White Pepper, Lauang, Dalchini and Fresh Ginger among other. The product was well accepted amongst the consumers. These products were sold through the well stabilized milk parlour located at the main entrance gate of the Institute. 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.

Fourteen students from several institutions were provided practical training during the year 2020 in the experimental dairy. This self sustaining Experimental Dairy has been running under Revolving Fund Scheme since 1989-90. Revenue generated through scheme is being utilized for development of infrastructure and maintenance of this dairy. Experimental Dairy is a Quality management system ISO 22000: 2018 certified

dairy. The revenue generated from the sale of milk and milk products during the year 2020 was Rs.3,74,06,310/-.

Computer Centre

Computer Centre is a central facility to provide computational support to the scientists and administration; and imparting training to students/scholars. The Computer Centre offers two Computer Science courses to under-graduate students and one course to post-graduate students including PhD scholars. There is a well established Computer Laboratory for students' teaching, which is equipped with state-of-the-art 64-bit i5 computer systems together with multi-function laser printers. These computer systems are equipped with different software, i.e., operating systems such as Unix/Linux, MS-Windows; and statistical/scientific computing systems like SAS 9.3 with JMP, MATLAB, R Studio, WEKA, etc. Also, compilers for various programming languages are available, which include FORTRAN 90, C, C++, R, Python, etc. Computer Centre manages various computing and communication facilities throughout the campus and state-of-the-art campus wide network over the Optical Fiber Cable, thereby providing connectivity to all the scientists, technical/administrative staff and students. Computer Centre also provides design and implementation services for computer network in the Institute and also provide the support in the office automation activities like E-office, PFMS and ERP (MIS/FMS) implementation.

Teaching & Training

Advanced Base SAS and JMP programming concepts as well as Microsoft Excel tools are being taught using animal sciences/dairying related case studies to PG Students (including PhD scholars) of all disciplines of dairying under common-for-all course CS-621: Software Packages for Statistical Computing. Besides, the Centre imparts training on advanced topics in Soft Computing and Machine Learning using open source R Programming language to several externally sponsored students through consultancy scheme.

Management Information Service

Computer Centre continued to prepare various MIS reports relating to milk production, supply of feeds and fodders, herd performance, animal management system, etc., for decision support to the farm managers/heads of divisions using in-house developed software.

Agriculture Knowledge Management Unit

The Agriculture Knowledge Management Unit (AKMU) is fully functional with the Internet and e-mail connectivity through National Knowledge Network (NKN) node provided by the National Informatics Centre (NIC) Govt. of India. AKMU is equipped with state-of-the-art, Unified Threat Management (UTM) System FortiGate-600C and Network-Analyser-200D. These devices enforce essential security mechanism (antivirus/antimalware, antispam, vulnerability management), including firewall, VPN, intrusion prevention, application control and Web content filtering, etc. AKMU is also undertaking the implementation of ICAR programmes like Personnel Management Information System (PERMISNet), National Information System for Agriculture Education Network (NISAGENet), and the like.

The AKMU team is supporting and making the smooth conduct of online teaching, virtual meetings, Webinars, and other official meetings in virtual mode during the Covid-19 pandemic. The Computer Centre also procured a Zoom Licensee to cater to the demand of institute users for online meetings.

WEBSITE

The new responsive Website (http://www.ndri.res.in) of the Institute is live with more dynamic contents by a single click to the access of social media pages of the Institute. It disseminates latest information to its various stakeholders and end-users about Research, Teaching, Faculty, News, Success Stories, Related Links, Opportunities, Tenders, Office Circulars, Forthcoming Workshop/Conference/Summer/Winter School announcements, Institute Publications (Annual Reports/Newsletters), RTI related information, Telephone Directory, University Information (B.Tech., M.Sc. and Ph.D. Rules, Admission Notice), COVID-19 Advisories, etc.

National Library in Dairying

The Institute Library has an impressive collection of literature on Dairy Science and related subjects. More than 62 scientific periodicals were subscribed to keep track of the current scientific/technical developments.

There are 95,588 volumes which include books, bound journals, theses, standards and annual reports. In addition of that 873 e-book of different foreign and Indian publishers are 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 Computerized Issue-Return and Reservation facilities. The Library, NDRI is an active partner CeRA (Consortium for e-Resources in Agriculture) and provides single point search for consortia subscribed. The library also subscribed open access journals to its users under institute's IP addresses. It 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 53,627 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. Library uploaded 6117 digitized records of institute outputs, which includes valuable books, institutional publications, M.Sc. and Ph.D. Dissertations, reports, conference proceedings and ~ reprints etc. on KrishiKosh- Institutional Repository of Indian National Agricultural Research System. In addition of above complete online library catalogue is also available on URL: library.ndri.res.in by using Koha-Library Management System.

The Library, NDRI subscribed anti-plagiarism software iThenticate, which has repository of over 50 million research articles, is one of the largest repositories of database and has **exclusive access to Crossref Database**. More than 80% of the bio-medical publishing houses including Elsevier, Nature, Willey-Blackwell, Taylor & Francis, Springer, Oxford University Press etc. Additionally, iThenticate uses 110 million online and offline articles from aggregators, content providers e.g. PubMed, MedLine, ABC CLIO, SAGE Reference, ProQuest, gale etc.

Communication Centre

Communication Centre has audio visual / video and photo laboratories for providing the services to the staff and students of the Institute. This centre organized exhibitions at different villages of Karnal District and other research and development organizations across the country. This centre covers the internal event organized by the Institute.

Meeting with progressive dairy farmers on June 20, 2020

The audio visual lab handled Sound and Projection Systems in Dr. D. Sundaresan Auditorium, Pinaki hall, and University committee room and conference halls of the Institute. Besides this, audio visual lab also provided Sound System in play ground for students and staff activities.

The center successfully organized the following programme by Communication Centre:

Independence Day

- Facility of audio system provided in the sports ground to organize International Yoga Day from 17th June to 21st June 2020.
- Republic Day
- Meeting with progressive farmers in Pinaki Hall - 20-06-2020

Model Dairy Plant

A state-of-the-art commercial Dairy Plant was established in 1996 at N.D.R.I. 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 1,30,000 – 1,40,000 liters per day. Model Dairy Plant is presently certified under the Food Safety Management System ISO 22000:2018

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, Karnal.

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 1.18 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 1,30,000 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 35-40 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 44.7 metric tons from January 2020–March 21.

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, 606 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 the year

1) Raw Milk Silo of capacity 60,000 each was installed.

2) Rain Water Harvesting of roof top was installed at three places.

3) New 10 KL milk pasteurizer installed.

REGIONAL CAMPUS

SOUTHERN REGIONAL STATION OF ICAR-NDRI

The National Dairy Research Institute was started at Bengaluru in 1923 as Imperial Institute of Animal Husbandry and Dairying. It was the forerunner institution in starting dairy education programmes to meet the manpower requirements of the dairy industry. Upon shifting the institute Head Quarters to Karnal in 1955, the establishment at Bengaluru continued as the Southern Regional Station of NDRI. The station has been catering to the research, training and extension needs of the dairy farmers and dairy industry of the southern region.

The Campus is endowed with necessary infrastructure in terms of qualified staff, farmland, dairy herd, laboratories, library, staff dispensary, hostel facilities etc. The Campus has a land area of about 46 hectares. About 16 hectares of land is utilized for the cultivation of various forage crops for meeting the feeding requirement of the dairy herd.

The Campus has good laboratory and infrastructural facilities for carrying out research work on animal genetics and breeding, dairy animal production and reproduction, screening of microbes, chemical and microbiological analyses of dairy products, testing of dairy equipments, manufacturing of various dairy products, etc. The research, training and transfer of technology programmes at the campus are carried out through different sections. To cater the needs of the students, the library is stocked with books, journals, theses and reprints. Hostel and guest house facilities also exist at the campus for students and visitors.

Education

The course work for Ph.D (Dairy Engg.), M.Tech (Dairy Engg.), M.Tech (Dairy Technology), and Diploma (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 Gynecology and Obstetrics, Livestock Production Management, Agricultural Economics and Agricultural Extension Education are being guided for their Doctoral and Masters' dissertation work.

Short term trainings are being conducted in Dairy Processing, Quality Assurance, Dairy Production and Extension for students, dairy farmers/ entrepreneurs and personnel from Co-operative Federations and Private Organisations. Besides, In-plant training and In-lab training are provided to the UG and PG students of other Colleges/Universities. PG students of other Universities are also guided to carry out their Project Work. 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

Technology Dissemination and Extension Programmes

- Advisory services were rendered to 180 clientele during personal visits to the institute, phone and mail enquiries. The advisory profile comprised information needs for technical advice on dairy start-ups, training programme on preparation of dairy products, scientific management of cross bred and indigenous dairy cattle, hydroponic fodder cultivation and new methods of processing ghee from indigenous cow's milk.

- During the period under report, 340 visitors visited the campus. These visitors comprised small and progressive dairy farmers from different parts of Karnataka and Tamil Nadu States and students from various educational institutes from various states and field extension/veterinary officers of the region and media personnel. The visitors were taken round the institute to various sections as per their needs and were explained about the ongoing research and extension activities.
- An Exposure cum Training programme was organised for 106 farmer trainees in four batches comprising farmers, farmwomen and farm youth from Pudukottai, Madurai, Karur and Tuticorin districts of Tamilnadu under 'Support to State Extension Programmes for Extension Reforms' (SSEPERS) under Agricultural Technology Management Agency (ATMA) scheme. The farmer trainees were made aware of quality milk production, importance of green fodder production, clean milk production and dairy animal health care through lecture presentations in local language by faculties. Visits were organised to Livestock Research Centre and Experimental Dairy Plant for benefit of the farmer trainees.
- Extension literature on mastitis management, green fodder production, azolla cultivation, hydroponics fodder production and Guidelines for Scientific Dairy Management were prepared in regional language for the benefit of the farming community. Extension literature on clean milk production, indigenous dairy animals and dairy products were made available to the needy clientele groups.
- The Dairy Education at Farmer's Door was organized in the selected clusters of villages of Bangalore South and North Taluks. Multidisciplinary teams visited 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.
- Selected cluster villages in Ramanagara and Bangalore Rural Districts of Karnataka State, Hosur, Krishnagiri District of Tamil Nadu State were visited under rural extension programme. Need-based technical advice on farming aspects and scientific dairying was rendered to the needy clientele by the multi-disciplinary team.
- Participated in the Mega Science Exhibition, Pride of India ISC Expo of 107th Indian Science Congress 2020, held during January 3 to 7 2020 at GKVK Campus, UAS, Bengaluru, organised by Ministry of Science & Technology, showcasing the Institute technologies / relevant research information on dairy production and processing aspects. NDRI stall was well- visited by multitude of scientists, researchers, academicians and progressive farmers from many stated and school children from the rural and urban districts of Bengaluru.
- Participated in the National Horticultural Fair 2020, of ICAR-IIHR, held from February 5 to 8, 2020 at IIHR Campus, Hesaraghatta Bengaluru and NDRI stall depicted need-based knowledge sharing and showcasing updated and ongoing institute activities and technologies of dairy production & processing for the benefit of the farming community of the region with participation of multitude of farmers of the region and neighbouring States.

SUCCESS STORIES

Development of MOOCs on Commercial Dairy Farming:

SRS of ICAR-NDRI, 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 formally launched by Dr. B.N. Tripathi, DDG (Animal Science) and Dr. R.C. Aggrawal, National Director, NAHEP and DDG (Education) on 14 August 2020. The MOOCs was developed under ICAR-NDRI- NAHEP project on "Incentivizing Dairy Education through Innovative Learning Approaches".

Consultancy

Yoghurt drink mix homogenization trials were carried out by Dr *Sathish Kumar, M.H. and Dr. Jayaraj Rao, K*for M/S Thinking Forks, Indiranagar, Bengaluru and earned a revenue of Rs 18,880/- in September, 2020.

Patent Granted

Patent granted on 19-3-2021 to P.S. Hegde, K.P. Ramesha and K.M. Nagaraja for an invention entitled "Livestock Feed Comprising Jackfruit Biowaste and Process Thereof" for the term of 20 years from November 19, 2015 in accordance with the provisions of the Patents Act,1970

Education

The course work for PhD (Dairy Engg.), MTech (Dairy Engg.), M.Tech (Dairy Technology), and Diploma (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, Agricultural Economics and Agricultural Extension Education are being guided for their Doctoral and Masters' dissertation work. Due to the pandemic situation, all the academic activities, including teaching, evaluation, thesis and comprehensive viva-voce examinations were conducted in 'Online' mode. Besides, PG students of other Universities are also guided to carry out their Project Work. 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 2020-21, 54 students have registered for their PGDFSQM at SRS.

Scholarships and Fellowships

PhD and M.Tech. Students are awarded ICAR-NDRI Fellowship and external fellowship as shown below:

Scholarship/fellowship	Ph D students	Masters students
NDRI Fellowship	37	20
ICAR-SRF/JRF	-	01
UGC fellowships	03	-
BIRAC - GYTI	01	-
DST- INSPIRE	02	-

Livestock Research Centre

Lactation performance of Deoni and HF crossbred cows

The Livestock Research Centre (LRC) of the station houses Deoni, HF crossbred and Malnad Gidda cattle. The total milk production of the herd during the year 2020 was 1, 82,317.00 kg. The total milk production of Deoni and HF crossbred cattle was 25,119.80 and 1, 57,197.20, respectively. The average number of milking Deoni and HF crossbred cattle in the herd in a month was 16 and 38 cows respectively. Total green fodder production including Paragrass, Hybrid Napier, Guinea grass, Fodder Maize, Jowar and miscellaneous including cowpea, Hedge lucerne, Sudan grass was 2104.91 tonnes for the year 2020. A total quantity of 5.16 tonnes of hydroponic fodder and 4.0 tonnes of drum based maize silage was produced. A total quantity of 2.936 tonnes of vermicompost was produced and sold. In addition, Panchagavya production has been initiated and 25 litre of Panchagavya was made available commercially for the public. A total of 6000 hybrid Napier fodder stem cuttings as a planting material were also distributed to the farmers.

EASTERN REGIONAL STATION

The National Dairy Research Institute (NDRI) is a premier institute devoted to research on dairying. The main institute (Head Quarter) is located at Karnal, Haryana. The main objective of establishing the Eastern Regional Station is to identify the major constraints of dairy production in eastern and north eastern India and to offer solutions through research and extension activities to these problems. It serves as a vital link between the NDRI, Karnal and the far-flung areas of the eastern and north eastern regions of the country for transfer of technology developed at the institute and provides appropriate feedback after trial for perfection. The research work undertaken at this station is mainly strategic and applied in nature and the thrust of research is to improve the socio-economic condition of dairy farmers of this region.

The 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 ERS of NDRI with effect from June 1, 1968. In 1978 the Government of West Bengal granted 100 acres of land at Kalyani where cattle sheds, forage unit, staff quarters etc. were gradually built up. The Station built its own laboratory building and the entire station started functioning within the same campus from May, 1987.

The research work during the period of 1964-1972, was mainly related to Animal Nutrition, During 1972-1976, it was related to Animal Nutrition and Dairy Chemistry and Bacteriology while during 1977-1985, it was related to Animal Nutrition, Animal Breeding, Soil Science, Dairy Economics and Dairy Extension. During, 1986-1991, the focus was mainly on Animal Nutrition, Livestock Production and Management, Animal Breeding, Forage Production, Dairy Economics & Statistics and Dairy Extension and that during 1992-1997, it was on Animal Nutrition, Livestock Production and Management, Animal Breeding, Forage Production, Dairy Economics & Statistics and Dairy Extension. Animal Biotechnology Section started functioning during 2005. The Animal Physiology and Reproduction Laboratory were also established in 2013-14. Goat Farm was also established in 2014-15 in a small scale for research, education and training purposes. Krishi Vigyan Kendra-II, Nadia District of West Bengal was sanctioned in 2016-17 for establishment in the Campus of ERS-NDRI, Kalyani.

The Eastern regional station of ICAR-National Dairy Research Institute has infrastructure facilities like Research Laboratories, Cattle Herd, Fodder Farm, Library, Computer Section, Academic Cell, Hostels and Guest House, Estate Section *etc*.

Keeping in view the enormous demand for milk in the eastern region, low milk production potential of the native stock, shortage of feed and fodder resources and diversified agro-climatic and socio-economic conditions, this research station has a great role to play in the field of dairy development in this region.

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

Organisation and Structure

HEAD		
RESEARCH LABS / SECTIONS	ADMINISTRATION	SUPPORT SECTION
Animal Nutrition	Personnel	Cattle Yard
Livestock Production & Management	Cash and Bill	Forage Section
	Goat Unit	
Animal Breeding	Purchase and Store	Computer Cell
Animal Biotechnology		Library
Animal Physiology and Reproduction		Estate Section
Dairy Extension		Research Coordination Cell
		Academic Cell
		Security Section
		Sports Unit
		Guest House and Hostels

Staff Strength at ERS of ICAR-NDRI, Kalyani (as on Dec'2020)

Category	Number
Scientific	13
Technical	06
Administrative	05
Supporting Staff (Group D)	01
Total	25

Livestock Farm

Annual Performance of ERS-NDRI, Kalyani Herd (Jan'20-Dec'20)

Particulars	Jersey Cross
Herd strength	220
Total milk production (kg)	210567.5
Av. no. of cows' in milk/day	76
Av. no. of cows' in dry/day	26
Wet average (kg)/day	7.6
Herd average (kg)/day	5.7
Age at first calving (month)	33.1
No. of animals inseminated	220
No. of animals pregnant	92
Conception rate (%)	41.8
Service period (days)	105
Inter calving period (days)	457
Mortality (%)	8.6

Milk Production Performance at ERS-NDRI, Kalyani Herd

Months (2017)	Milk Production(kg)	Wet Average (kg)	Herd Average (kg)	Average FAT %	Average SNF %
January	17423.0	7.67	5.90	5.40	9.38
February	16560.5	7.84	5.84	5.31	9.31
March	18415.0	8.44	6.18	5.24	9.15
April	17398.5	7.67	5.73	5.02	9.26
May	17941.0	8.00	5.60	4.96	9.17
June	18149.5	8.00	6.00	4.90	8.98
July	17851.5	7.60	5.48	4.90	8.92
August	17716.0	7.37	5.36	4.96	8.97
September	18594.5	7.52	5.63	4.88	8.94
October	17342.5	7.45	5.50	5.04	8.88
November	16647.5	7.13	5.60	5.26	9.10
December	16528.0	6.75	5.33	5.11	8.86
Total Milk	210567.5				
Overall Average	17547.292	7.62	5.68	5.08	9.08

cultivation of fodder crops, the Forage Section also has a mini workshop for regular servicing of agricultural machineries including tractors, chaffcutter 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, shesham, 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 at ICAR-NDRI-ERS, Kalyani, during 2020 (Jan to Dec-2020)

SN	Particulars of Fodders	Quantity (q)
1)	Maize/ Maize+ cowpea	3992.40
2)	Sorghum/ Sorghum+ cowpea	4057.95
3)	Berseem/Berseem+ Chinese cabbage	2517.65
4)	Oats/ Oats+ Chinese cabbage	3910.45
5)	Cowpea/ Rice bean	1046.90
6)	Bajra	94.25
7)	Perennial fodders (Hybrid Napier Grass, Guinea Grass)	1271.55
	Total	16,891.15

Library

The Library of ERS contains 1818 books, 4078 volumes of bound journals and other periodicals in the field of Dairying. Besides, Annual Reports of different Institutes and proceedings of various workshops and seminars are also available for reference. Presently Indian Journals are subscribed for students and Scientists.

Computer Cell

The computer center facilitates the maintenance of database and analysis of research data. The institute has Internet connectivity through NKN, which are useful for searching literature and references. The cell is facilitating the practical of DAHD students.

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 2020, sevenMaster degree students and one Ph.D. student have successfully completed their thesis works and awarded the respective degrees. Presently, twelveMaster degree students and fifteen Ph.D. students are pursuing their research work. Since 2014, a diploma course on Animal Husbandry & Dairying (DAHD) is also running at this campus. The fifth batch of DAHD course comprising a total number of sixstudents have sucessfully completed the course and passed out in 2020. Other than academics,several cultural, sports and literary acivities are organized in which students take keen interest.

Resource Generation (Jan 20-Dec'20)

SN	Heads	Amount (Rs.)
1)	Sale of Milk (including previous year collection Rs. 29,74,349.00)	84,12,620.00
2)	Sale of Animals (cow)	2,50,000.00
3)	Sale of fodder/seed	33,559.00
4)	Rent of guest house	40,100.00
5)	Semester fees (Diploma)	13,400.00
6)	Sale of Semen straws	89,700.00
7)	Sale of goat	62,620.00
8)	Any others/ Miscellaneous	24,478.00
	Total	89,26,477.00

TSP Activities

Upliftment of socio-economic condition of tribal people through integrated livestock farming in north eastern hill region/eastern part of India

In different agro-climatic zones of Eastern and North- Eastern India, the TSP project of the Institute was implemented. Especially in red and lateritic soil zone, new alluvial zone of West Bengal, Hilly zone of Nagaland and Chhotonagpur plateau region of Jharkhand. In West Bengal the project was implemented in Birbhum, Jhargram, South 24 parganas and Nadia districts, in Nagaland the project was implemented in New Chalkot and in Jharkhand state the project was implemented in Ranchi district. Several interventions like veterinary health care facilities, deworming and vaccination (In case of cattle & buffalo FMD, HS, BQ, in case of goat and sheep PPR and in case of birds R2B vaccine), improved fodder seed distribution and distribution of several inputs like mineral mixture, cattle feed and livestock etc. were provided to the tribal farmers to scientifically manage their livestock and to improve the livelihood on sustainable basis. Regular dissemination

of scientific information was done using SMS portal developed under the project. Several on- campus training programmes were organised under the project giving exposure to the tribal farmers and farm women about efficiently manage their animals. During the period under report, 9 scientists'-farmers' interaction sessions and veterinary health camps were organised in different parts of Eastern and North- Eastern India.

NEH activities

Improving the livelihood through dairy farming in North Eastern region of India

Three North Eastern states of India namely, Meghalaya, Arunachal Pradesh and Mizoram were covered under the project during the year 2020. Frequent visits were organized and inputs such as livestock (poultry birds, goats, piglets etc.), veterinary medicines, mineral mixture, concentrate mixture, fodder seeds, extension literatures etc. were distributed among the farmers from North Eastern region of India.

Activities undertaken in Meghalaya

A session of interaction with farmers was organized in the state of Meghalaya. In that session several inputs like goats (40 nos.), piglet (20 Nos.), 60 kg mineral mixture etc. were distributed among the farmers. Farmers were exposed to the knowledge of different facets of scientific dairy farming during the scientists- farmers' interaction session organized during the visit.

Activities undertaken in Arunachal Pradesh

One visit was organized in the state of Arunachal Pradesh during the year 2020. Scientists farmers interaction sessions cum off-campus training programme was organized during that visit. Several inputs like 24 q pig feed, 300 kg poultry feed, duckling (600 no.), and piglets (40 no.)-were distributed among 110 farmers.

Activities undertaken in the state of Mizoram

One camp was organized in Mizoram state by collaborating with CAU, Aizwal. Several inputs like 250 kg Pig feed and 31 Piglets were distributed among 32 farmers.

SCSP Activities

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

The Scheduled Caste community in West Bengal are economically poor and having low level of education and they are dependent on agriculture-based farming to meet their household needs. As the crop enterprise could not help the scheduled caste farmers to increase their income and employment because of poor productivity, low availability of per capita arable land and also lack of other income generating avenues, so, they are dependent on animal husbandry activities, as an alternative income generating source. The project was formulated with an aim to uplift the socio-economic condition of scheduled caste people in SC dominated villages of Nadia district in West Bengal through integrated livestock farming. Two villages i.e., Dhakshin Chadamari and Muratipur villages of Chakdah block from Nadia district were identified. Similarly, two villages of Bolpur block of Birbhum district i.e., Supur and Paruldanga villages were also identified. Beneficiary lists of these villages from both Nadia and Birbhum districts were prepared. An interview schedule for collecting base level data from these SC dominated villages was prepared. Collection of baseline information regarding population dynamics, socio-economic condition of villagers, existing dairy husbandry practices, production performance and animal diseases occurrence etc .of the 100 beneficiaries (25 beneficiaries from each village from each district) of both the districts was done. In Nadia district, most of the farmers are either landless or low to marginal type having practically no land or 10-80 katha (0.15 -1.3 acre) land in Muratipur village and 30-300 katha (0.5- 5 acre) land in Dhakshin Chandamari village. Majority of farmers'/animal rearer rears 1-5 cows in Muratipur village and 2-10 cows in Dhakshin Chandamari village. Goat population in these areas is less. But farmers' are interested to rear goats. Mainly, non-descript, Sahiwal and Jersey crossbred are available in both the villages and some HF crossbred are also found in Dhakshin Chandamari village. Average milk production is 5-6 kg/day/ in Muratipur village and 7.5-8 kg/day in Dhakshin Chandamari village. The major problems identified in these villages are infertility of cows, high disease incidence and worm infestation of animals along with calf mortality due to diarrhoea. Most of the famers are low to marginal type having land holding of 3.0 katha-7.0 bigha (0.05 -2.5 acre) land in Supur village and 20-120 katha (0.3- 2 acre)

land in Paruldanga village. Some farmers' have no land in Supur village. Majority of farmers'/animal rearers' rear 1-7 cows in Supur and Paruldanga village. Majority of houses have 2-8 goats in Supur and Paruldanga villages and farmers' of these villages are very much interested to rear goats. Ducks and Poultry are also available in these areas. Generally, Sahiwal and Jersey crossbred and some HF crossbred cattle are dominating in these villages. On an average, the milk production is 1-4 kg/day/household in Supur village and 2.0-4.5 kg/day/household in Paruldanga village. The infertility of cattle, calf mortality and high disease occurrence are the main problems for livestock rearing in these areas. Several animal health camp and scientists-farmers' interaction meet was organized in Muratipur and Dhakshin Chandamari villages of Nadia district.

Extension Activities under Tribal areas of Eastern India

Several extension intervention was given to tribal livestock farmers belonging to places such as the red and lateritic soil zone, West Bengal's new alluvial zone, Nagaland's Hilly zone and Jharkhand's Chhotanagpur plateau area during the year 2020. Several interventions were carried out under the TSP programme, such as organizing scientist-farmers engagement sessions, fodder demonstration, animal health cum vaccination camps in tribal villages, on and off-campus training programs, etc. Improving the awareness level of tribal farmers and shifting tribal population's attitudes towards the modernization of livestock farming was achieved through interaction and demonstration. The project also arranged nine engagement sessions for farmers-scientists. Focus was given on scientific animal rearing practices in those discussion sessions. Several inputs were distributed among farmers, including veterinary medicines, mineral mixture, livestock, etc. In addition to that, fodder seeds and planting materials were also distributed.

Organization of Livestock-cum Agricultural Mela in Bolpur of Birbhum District, West Bengal

Eastern Regional Station of ICAR-NDRI, Kalyani organized Livestock-cum Agricultural Mela in Hatrasulganj football ground under Raipur-Supur Gram

Panchayat (near Bolpur) of Birbhum District, West Bengal on 6th Feb., 2020 under NDRI-TSP and SCSP Component. In the mela several inputs like goats, chicks, poultry feed, medicines etc. were distributed among the farmers. There were animal competitions in different categories of animals (dairy cattle, heifer, calves, female goat, breedable male goat, kids, poultry, duck), which were judged by the expert committee members and prizes were also distributed to the winners. Different ICAR Institutes, namely, ICAR-Central Research Institute for Jute and Allied Fibres (CRIJAF), Barrackpur, ICAR-National Institute for Natural

Fibre Engineering and Technology (NINFET), Kolkata, KVK, east Bardhaman, ICAR-Indian Veterinary Research Institute-ERS, Kolkata, ICAR-National Dairy Research Institute-ERS, Kalyani, different NGOs (including Bolpur Manab Jamin) and Self-Help Goups

(SHGs) participated the Mela for technology demonstration of their Institute/Organization to the farmers of Birbhum District. During the Scientists/Experts-Farmers interaction session farmers were appraised about different scientific technologies/processes which may be easily implemented at farmers' field for enhancing the return from their livestock farming and agriculture practices. Quiz competition was also organized on different aspects of livestock/poultry rearing and agricultural practices and farmers were encouraged by the NDRI team.

Extension activities in North Eastern Hill Region

Activities undertaken under NEH project

The ICAR-NDRI-ERS team visited three Scientists- farmers' interaction sessions cum input distribution camps organized under NEH project during the period in Mizoram, Arunachal Pradesh and Meghalaya. Inputs like 91 Piglets, 40 Goats, 6000 Chicks, 122 kg Mineral Mixture, 4650 kg pig feed, 300 kg poultry feed and veterinary medicines etc were distributed among the farmers. Through these interventions, farmers from North Eastern Region got immense benefit. The teams from ERS organized veterinary health camps, demonstration and scientists-farmers interaction session during 2020 and visited the State of Meghalaya, Arunachal Pradesh and Mizoram. Veterinary drugs and fodder seeds were distributed to the farmers in those camps. Discussions and interactions were carried out during the interaction sessions on different subjects, such as health management, clean milk production, reproductive efficiency, different livestock production

system and its constraints, solutions, etc. Several inputs were distributed among the farmers, such as livestock, mineral mixture, poultry feed, pig feed, veterinary drugs, etc.

Extension activities of Dairy Vikash Kendra in adopted villages:

ERS of ICAR-NDRI, Kalyani is providing day-to-day service on treatment of ailing animals, deworming, vaccination, AI etc. in the adopted villages. In the two adopted villages namely Muratipur and South Chandamari ERS of ICAR-NDRI, regularly veterinary health care facilities are provided to the livestock farmers. Scientists and technical officers of ERS visits farmers' home and solve their problem at their doorstep. Artificial Insemination of 84 dairy cattle has been done through the *'Dairy Vikas Kendra'* located at Muratipur village and managed by ERS of ICAR-NDRI. A total of 684 animals have been treated from the village centre and 477 farmers benefitted by the centre. Veterinary medicines and treatment was done free of cost. Apart from that in those adopted villages seven *'Vaccination & Veterinary Health Camps'* were organized and through those camps 416 animals has been treated and vaccinated.

Organization of swatchhata abhiyan

ERS of ICAR-NDRI has organized *swatcchata abhiyan* in the month of October 2020 and during the occasion the staff and students of the station actively participated in the cleanliness drive of the campus. Apart from that, plantation programme was also carried out on the occasion.

Organization of farmers' interaction programme on the occasion of honorable PM's interaction with farmers:

On December 25 2020, during the occasion of honorable PM's interaction with farmers, 150 Scheduled Caste farmers visited the campus and got firsthand knowledge about the different aspects of scientific goat farming. Live telecast of Honorable Prime Minister's programme was also shown to the farmers. At the end of the programme, guided visit of different facilities was organized for the farmers.

Amelioration of infertility in dairy cows through nutritional and biotechnological intervention

DBT funded societal development programme was implemented in Chakdah Block of Nadia District. Veterinary Health camps and Infertility Camps were organized in the Dairy Vikas Kendra located in the Muratipur village, Chakdah Block, Nadia District. Animals were screened for general health and reproductive problems. 485 farmers benefited in the veterinary health camps and 772 animals were provided with veterinary services. Based on the health and productive status of the animals, they were treated with deworming, vaccination and supplementation on mineral mixture. Reproductive health status was assessed based on breeding history, gynaeco-clinical examination, rectal examination of reproductive organs, and nature of reproductive secretions etc. 120 infertile cows (73 anoestrus + 47 Repeat breeding) were treated with progesterone based CIDR device/ GnRH based Ovsynch protocol and made pregnant. Other infertility problems were treated by non-hormonal methods. Information on reproductive management for better profitability in dairy farming such as signs of estrus, estrus detection method, right time of breeding, post-partum cow management, feeding management were deliberated during the camps. Exposure visits to institute dairy farm were arranged to demonstrate scientific dairy cow management. 10 days duration trainings were also organized for 14 participants on scientific dairy farming. 15 veterinary graduates were also provided with hands on training on estrus induction and fixed time AI in cattle.

Activities of Krishi Vigyan Kendra, Nadia (Additional)

Krishi Vigyan Kendra, Nadia (Additional) is functioning under the aegis of ICAR-NDRI, ERS and organized regular training programmes for benefit of the farming community in the designated blocks of Nadia district of West Bengal. Demonstration of improved cultivation practices of different agricultural crops and scientific way of managing animals in the farmer's field was carried out by the KVK.

A total of 1047 farmers have been trained out of which 353 male farmers and 245 female farmers belonged to SC community, 7 male and 67 female farmers belonged to ST community and 248 male and 127 female farmers belonged to other communities. They were trained for different topics like different cultivation practices of pulse crops, oilseed crops, fodder crops etc.; soil health management, weed management, scientific dairy and goat farming etc.

Training programme organized by KVK

No. of courses	Number of Participants								
	SC		ST		Others		Total		
	Male	Female	Male	Female	Male	Female	Male	Female	Total
48	353	245	7	67	248	127	608	439	1047

Organization of Front Line Demonstrations (FLD) and On Farm Testing (OFT):

Two Front Line Demonstrations (FLDs) were organized during 2020. One FLD was organized on 'Cultivation of oilseed (Mustard) crop' in which 105 farmers including 93 male farmers and 12 female farmers participated. Another FLD on cultivation of pulse (black gram) crop was organized and the FLD was organized by involving 63 famers (48 male and 15 female).

Three 'On farm testing' (OFT) was carried out during the period under report. The OFTs were conducted on pest management in pulse crop, fodder crop cultivation using bio-fertilser and reproductive health management of dairy animals by using by-pass fat. In total 71 male farmers and 5 female farmers participated in those OFTs.

Apart from those activities, 138 awareness camps were organized during the year 2020 in which 1511 farmers participated and 4 exposure visits were organized in which 190 farmers participated.

BUDGET AND EXPENDITURE

The financial outlays in terms of actual expenditure for Grants for the year 2019-2020 was Rs. 22,614.31 lakhs and the sanctioned budget for Grants in 2020-21 was Rs. 22,830.34 lakhs. These figures include the financial outlays for Regional Campuses.

Financial Outlays & Expenditure during 2020-21

NDRI (including ERS, Kalyani)

(Rs. in lakhs)

SN	Head	Grants	
		Budget	Expenditure
1)	Grant in Aid : Capital	350.88	278.75
2)	Grant in Aid : Salaries	7302.39	7301.61
3)	Grant in Aid : General	12789.07	12661.77
	Total	**20442.34**	**20242.13**

SRS, Bengaluru

(Rs. in lakhs)

SN	Head	Grants	
		Budget	Expenditure
1)	Grant in Aid : Capital	51.00	41.94
2)	Grant in Aid : Salaries	1253.00	1252.27
3)	Grant in Aid : General	1084.00	1077.97
	Total	**2168.03**	**2127.89**

Revenue Generation

The Revenue Receipts of the Institute and its Regional Campuses for the year 2020-21 were Rs. 627.75lakhs.

(Rs. in lakhs)

SN	Head	Amount
1)	Sale of Farms Produce	292.48
2)	Sale of Livestock	61.43
3)	Income from Royalty/Sale of Publication and Advertisement	0.15
4)	License fee	63.44
5)	Interest Earned on Loans and Advances	10.39
6)	Analytical and Testing Fee	3.06
7)	Diploma charges	0.04
8)	Receipt from Services Rendered	0.11
9)	Interest Earned on Short Term Deposits	11.19
10)	Income generated from Internal Resource	35.08
11)	Miscellaneous receipts	150.38
	Total	627.75

Position of Manpower at NDRI, Karnal and its Regional Stations as on 31.12.2020

Type of Posts	Existing Approved by D/o Expenditure	In position	Vacant
Scientific	195	146	49
Administrative (Group A&B)	32	30	02
Technical	340	181	159
Administrative (Group Non-Gazetted)	127	101	26
Supporting	384	291	93
Total	1078	749	329

राजभाषा गतिविधियां – 2020

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। संस्थान में राजभाषा नीति, नियमों एवं व्यवस्थाओं के नियमानुसार अनुपालन एवं कार्यान्वयन के लिए संस्थान के राजभाषा एकक में वर्ष 1988, 1989 एवं 2011 में क्रमशः हिन्दी अनुवादक, सहायक निदेशक एवं उप निदेशक के पद सृजित किए गए। 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 भी प्रदान किया जा रहा है। रिपोर्टाधीन अवधि में संस्थान के द्वारा निम्नलिखित गतिविधियों का आयोजन किया गयाः–

संस्थान राजभाषा कार्यान्वयन समिति की बैठकें

1. संस्थान प्रमुख डा. एम.एस. चौहान, निदेशक एवं अध्यक्ष, संस्थान राजभाषा कार्यान्वयन समिति, भाकृअनुप–राडेअनुसं, करनाल की अध्यक्षता में संस्थान के विभिन्न प्रभागों व अनुभागों में राजभाषा हिन्दी के प्रयोग की स्थिति की समीक्षा हेतु पिनाकी सभागार में दि. 11.02.2020 को अपराह्न 3 बजे से संपन्न समीक्षा बैठक में संस्थान के प्रशासनिक अनुभागों के 18 प्रतिनिधि अधिकारी शामिल हुए। इस बैठक में संस्थान प्रमुख ने सभी सहभागियों से यह आग्रह किया कि वे भारत सरकार, राजभाषा विभाग, गृह मंत्रालय के द्वारा समय समय पर जारी किये जाने वाले सभी निर्देशों की अक्षरशः पालना सुनिश्चित करवायें तथा वार्षिक राजभाषा कार्यक्रम में उल्लिखित लक्ष्यों की प्राप्ति की दिशा में सार्थक प्रयास जारी रखें।

2. संस्थान के निदेशक एवं अध्यक्ष, संस्थान राजभाषा कार्यान्वयन समिति डा. एम.एस. चौहान की अध्यक्षता में तिमाही अंत मार्च, 2020 की तिमाही बैठक दिनांक 21.04.2020 को पिनाकी सभागार में आयोजित की गई। भारत सरकार द्वारा कोविड–19 की रोकथाम हेतु जारी दिशानिर्देषों के मद्देनजर इस बैठक में अध्यक्ष सहित 4 पदाधिकारी, श्री विवेक पुरवार, संयुक्त निदेशक (प्रशासन), श्री डी.डी. वर्मा, वित्त नियंत्रक, श्री एस.एम. देब, प्रभारी पुस्तकालय सेवाएं एवं सदस्य–सचिव श्री राकेश कुमार शामिल हुए। बैठक में यह निर्णय लिया गया कि संस्थान के सभी प्रभागों/ अनुभागों के आन्तरिक व बाह्य डाक प्राप्ति व डाक वितरण रजिस्टर व पिअन बुक आदि में अधिकाधिक इन्दराज हिन्दी में किए जाएंगे तथा डाक आदि भेजने के लिए केवल द्विभाषी या हिन्दी मानक डाक वितरण सूची (स्टेंडर्ड डाक डिस्ट्रीब्यूशन लिस्ट) का ही प्रयोग किया जाएगा। बैठक में हिन्दी कार्यालय टिप्पणियों की प्रतिष्ठता को बढ़ाने तथा पुस्तकालय के द्वारा सभी परिपत्र, पत्र, नोट स्वीकृति आदेश आदि द्विभाषी तैयार कर जारी करवाने का निर्णय भी लिया गया।

3. दिनांक 4.07.2020 को संपन्न हुई तिमाही बैठक में यह निर्णय लिया गया कि संस्थान के बेंगलूरू तथा कल्याणी क्षेत्रीय केन्द्रों के द्वारा नजदीकी नगर राजभाषा कार्यान्वयन समिति की सदस्यता प्राप्त की जाएगी। तदनुसार दोनों केन्द्रों ने नजदीकी न.रा.का.स. की सदस्यता ग्रहण करने की पुश्टि की है। बैठक के दौरान यह निर्णय भी लिया गया कि संस्थान मुख्यालय तथा दोनों केन्द्रों में सितंबर–अक्तूबर, 2020 माह में हिन्दी दिवस/सप्ताह/पखवाड़ा/माह का कोविड के संक्रमण के चलते भारत सरकार द्वारा जारी सोशल डिस्टेंसिंग व अन्य प्रोटोकॉल की दृढ़तापूर्वक पालना के साथ हिन्दी प्रतियोगिताएं आदि आयोजित कराये जाएंगे। तदनुसार हिन्दी दिवस/सप्ताह/माह का सफलतापूर्वक भव्य आयोजन किया गया।

4. संस्थान राजभाषा कार्यान्वयन समिति की 01 जुलाई से 30 सितंबर, 2020 तक की अवधि की तिमाही बैठक दिनांक 09.09.2020 को आयोजित की गई। बैठक में सरकारी कामकाज के दौरान हिन्दी कार्यालय टिप्पणियों की प्रतिष्ठता, क्रय अनुभाग में हिन्दी पत्राचार की प्रतिशतता तथा ई–ऑफिस प्लेटफार्म पर हिन्दी पत्राचार को बढ़ाने का निर्णय लिया गया।

5. संस्थान राजभाषा कार्यान्वयन समिति की 01 अक्तूबर से 31 दिसंबर, 2020 तक की अवधि की तिमाही बैठक दिनांक 19.12.2020 को आयोजित की गई। बैठक के दौरान यह निर्णय लिया गया कि संस्थान के सभी प्रभागों तथा दोनों क्षेत्रीय

केन्द्रों को पर्याप्त संख्या में वृहद् प्रशासनिक शब्दावलियां खरीद कर वितरित की जाएंगी। तदनुसार वैज्ञानिक एवं तकनीकी शब्दावली आयोग, भारत सरकार, नई दिल्ली से 200 वृहद् प्रशासनिक शब्दावलियां (अंग्रेजी से हिन्दी) खरीद कर वितरित की गई हैं।

हिन्दी कार्यशालाएं, संगोष्ठियां एवं प्रशिक्षण

- संस्थान के कुशल सहायक कर्मचारी से अवर श्रेणी लिपिक (एलडीसी) पद पर पदोन्नत हुए 9 कर्मचारियों को हिन्दी यूनिकोड टाइपिंग सीखने हेतु एक सप्ताह का डेस्क प्रशिक्षण 13 से 21 मार्च 2020 तक प्रदान किया गया।
- दि. 17.06.2020 को 'राजभाषा प्रबंधन : समस्याएं एवं समाधान' विषय पर नगरस्तरीय हिन्दी संगोष्ठी का आयोजन किया गया।
- दि. 18.06.2020 को 'हिन्दी पत्राचार व टिप्पणियां कैसे बढ़ाएं' विषय पर हिन्दी कार्यशाला का आयोजन किया गया।
- दि. 29.07.2020 को 'कोरोना का डेरी कृषकों/पशुपालकों पर दूरगामी प्रभाव' पर वैज्ञानिक तकनीकी संगोष्ठी का आयोजन किया गया।
- दि. 21.09.2020 को 'ई–टूल्स के द्वारा हिन्दी का प्रयोग कैसे बढ़ाएं', विषय पर राजभाषा विभाग, भारत सरकार के श्री नागेन्द्र सिंह, वरिष्ठ तकनीकी निदेशक ने 98 प्रतिभागियों को नगरस्तरीय वर्चुअल हिन्दी कार्यशाला में प्रशिक्षण प्रदान किया।
- दि. 25.09.2020 को आयोजित नगरस्तरीय गांधी स्मृति व्याख्यानामाला में 88 प्रतिभागी सम्मिलित हुए।
- दि. 02.10.2020 को दिल्ली विश्वविद्यालय के प्रोफेसर सुधीर सिंह द्वारा 'गांधीवादी दर्शन की वर्तमान समाज में उपयोगिता' जैसे अत्यंत उपयोगी विषय पर दिए गए वर्चुअल व्याख्यान में 82 प्रतिभागी सम्मिलित हुए।
- दि. 19.12.2020 को श्री धीरज शर्मा, उप निदेशक (राजभाषा) ने 'वॉइस टाइपिंग सॉफ्टवेयर से हिन्दी टाइपिंग कैसे करें', विषय पर आयोजित कार्यशाला के माध्यम से 22 प्रतिभागियों को डेस्क प्रशिक्षण प्रदान कर हेंड्स ऑन अभ्यास के दौरान प्रतिभागियों की शंकाओं का समाधान किया।

हिन्दी पखवाड़ा/राजभाषा हिन्दी उल्लास माह का आयोजन

संस्थान मुख्यालय, राडेअनुसं, करनाल में हिन्दी दिवस/हिन्दी उल्लास माह का आयोजन

संस्थान में हिन्दी दिवस से प्रारंभ करके दि. 14.09.2020 से 13.10.2020 तक की अवधि में राजभाषा हिन्दी उल्लास पर्व एवं हिन्दी माह का भव्य आयोजन किया गया। कोविड संबंधी निर्देशों के मद्देनजर 14 सितंबर 2020 को हिन्दी दिवस उद्घाटन समारोह का वर्चुअल आयोजन किया गया, जिसमें संस्थान के सभी पदाधिकारी, प्रभागाध्यक्ष, प्रभारी व क्षेत्रीय केन्द्र बेंगलूरू तथा कल्याणी के सभी संवर्गों के अधिकारी व कर्मचारी शामिल हुए। हिन्दी उल्लास माह के दौरान 14.09.2020 को हिन्दी दिवस कार्यक्रम के अवसर पर ऑनलाइन हिन्दी कविता पाठ, दिनांक 16.09.2020 को हिन्दी निबंध प्रतियोगिता (विषय–कोरोना बनाम स्वच्छता), दिनांक 18.09.2020 को हिन्दी टिप्पण/प्रारूप लेखन प्रतियोगिता, दिनांक 21.09.2020 को नगरस्तरीय वर्चुअल हिन्दी कार्यशाला (विषय–ई टूल्स के द्वारा हिन्दी का प्रयोग, व्याख्याता : श्री नागेन्द्र सिंह, वरिष्ठ तकनीकी निदेशक, राजभाषा विभाग, गृह मंत्रालय, नई दिल्ली), दि. 25.9.2020 को गांधीजी के विचारों की प्रासांगिकता पर नगरस्तरीय हिन्दी व्याख्यानमाला एवं 26.09.2020 को ऑनलाइन हिन्दी शोध–पत्र पोस्टर प्रोत्साहन प्रतियोगिता (वैज्ञानिक, विद्यार्थी व गैर हिन्दीभाषी श्रेणी) का आयोजन किया गया। दिनांक 3.11.2020 को निदेशक, डा. एम.एस. चौहान की अध्यक्षता में हिन्दी उल्लास माह व वार्षिक राजभाषा पुरस्कार वितरण के वर्चुअल कार्यक्रम का वीडियो कान्फ्रेन्सिंग के माध्यम से आयोजन किया गया, जिसमें संस्थान मुख्यालय, करनाल के पदाधिकारियों/प्रभागाध्यक्षों व स्टाफ के साथ–साथ बेंगलूरू व कल्याणी क्षेत्रीय केन्द्रों के अध्यक्षों व उनके स्टाफ ने बढ़–चढ़ कर भाग लिया। वार्षिक राजभाषा पुरस्कार वितरण कार्यक्रम के दौरान हिन्दी उल्लास माह के दौरान आयोजित प्रतियोगिताओं के विजेताओं के अलावा वार्षिक हिन्दी मूल हिन्दी टिप्पण आलेखन प्रतियोगिता (2019–20), वार्षिक हिन्दी ईमेल प्रोत्साहन प्रतियोगिता (2019–20), उत्कृष्ट प्रभाग/अनुभाग प्रतियोगिता (2019–20), अधिकारियों की वार्षिक हिन्दी डिक्टेशन प्रतियोगिता (2019–20), संस्थान राजभाषा गौरव पुरस्कार (2019–20) आदि प्रतियोगिताओं के विजेताओं को प्रमाणपत्र/राशि से सम्मानित करने की घोषणा की गई। संस्थान के द्वारा राजभाषा हिन्दी उल्लास माह के दौरान 14.9.2020 से 13.10.2020 तक मासिक हिन्दी हस्ताक्षर व हिन्दी इन्दराज अभियान भी चलाया गया। संस्थान स्तर पर राजभाषा के क्षेत्र में उत्कृष्ट कार्य हेतु उत्कृष्ट प्रभाग/अनुभाग पुरस्कार (2019–20) के अंतर्गत डेरी सूक्ष्मजीवाणु प्रभाग को उत्कृष्ट प्रभाग पुरस्कार, चारा उत्पादन अनुभाग को उत्कृष्ट अनुभाग (वैज्ञानिक)

पुरस्कार एवं स्थापना–4 अनुभाग को उत्कृष्ट अनुभाग (प्रशासनिक) पुरस्कार प्रदान किया गया। वार्षिक राजभाषा पुरस्कार वितरण कार्यक्रम के दौरान अधिकारियों द्वारा हिंदी में श्रुतलेख देने की प्रोत्साहन योजना (2019–20) के अंतर्गत श्री विवेक पुरवार, मुख्य प्रशासनिक अधिकारी एवं कार्यकारी संयुक्त निदेशक (प्रशासन) एवं कुलसचिव, श्री डी.डी.वर्मा, वित्त नियंत्रक, डा. सुनीता ग्रोवर, भूतपूर्व अध्यक्षा, डेरी सूक्ष्मजीवाणु प्रभाग, श्री सुशांत साहा, भूतपूर्व संयुक्त निदेशक (प्रशासन) व कुलसचिव को प्रमाणपत्र से सम्मानित करने की घोषणा की गई। पुरस्कार वितरण समारोह के दौरान संस्थान की हिन्दी ईमेल प्रोत्साहन योजना प्रतियोगिता (2019–20) के 10 विजेताओं तथा हिन्दी ईमेल प्रोत्साहन योजना 2019–20 के दो विजेताओं को उनकी पात्रतानुसार नकद प्रोत्साहन राशि तथा प्रमाणपत्र से सम्मानित करने की घोषणा भी की गई। वर्चुअल कार्यक्रम के दौरान ही संस्थान के डा. महेन्द्र सिंह, प्रधान वैज्ञानिक एवं अध्यक्ष, पशु शरीरक्रिया अनुभाग, डा. सुनीता ग्रोवर, प्रधान वैज्ञानिक एवं अध्यक्षा, डेरी सूक्ष्मजीवाणु प्रभाग, डा. राकेश कुमार, प्रधान वैज्ञानिक एवं प्रभारी, कृषि विज्ञान केन्द्र, डा. निशान्त कुमार, वरिष्ठ वैज्ञानिक, पशुधन उत्पादन एवं प्रबंधन प्रभाग, डा. नीलम उपाध्याय, वैज्ञानिक, कृषि विज्ञान केन्द्र (डेरी प्रौद्योगिकी संकाय), श्रीमती प्रेम कुमारी मेहता, निजी सचिव, डेरी प्रौद्योगिकी प्रभाग, श्रीमती सीमा रानी, निजी सचिव, डेरी सूक्ष्मजीवाणु प्रभाग, श्री लखविन्द्र सिंह, वरिष्ठ लिपिक, ऑडिट अनुभाग को हिन्दी में सराहनीय कार्यों के लिए ''संस्थान राजभाषा गौरव प्रमाणपत्र'' से सम्मानित करने की घोषणा भी की गई।

दक्षिणी क्षेत्रीय केन्द्र, रा.डे.अनु.सं., बेंगलूरू में हिन्दी सप्ताह का आयोजन

केन्द्राध्यक्ष डा. के.पी.रमेशा की अध्यक्षता में बेंगलूरू केन्द्र में 14 से 21 सितंबर 2020 तक हिन्दी सप्ताह का आयोजन किया गया। 14 सितंबर को हिन्दी दिवस कार्यक्रम के आयोजन के साथ हिन्दी सप्ताह के दौरान 5 प्रतियोगिताओं का आयोजन किया गया। इनमें कर्मचारी श्रेणी की हिन्दी निबंध प्रतियोगिता (16.09.2020), कर्मचारी श्रेणी की हिन्दी अनुवाद प्रतियोगिता (17.09.2020), कर्मचारी श्रेणी की हिन्दी गीत–गायन प्रतियोगिता (18.09.2020), हिन्दी निबंध प्रतियोगिता (छात्र श्रेणी) (17.09.2020) एवं तकनीकी विषयों पर लघु हिन्दी वार्ता (वैज्ञानिक व तकनीकी कर्मचारी श्रेणी) (19.09.2020) का आयोजन कर विजेताओं को प्रमाणपत्र व नकद पुरस्कार राशि वितरित कर हिन्दी में कार्य हेतु प्रेरित व प्रोत्साहित किया गया।

पूर्वी क्षेत्रीय केन्द्र, रा.डे.अनु.सं., कल्याणी में हिन्दी सप्ताह का आयोजन

केन्द्राध्यक्ष डा. मनोज कुमार घोष की अध्यक्षता में दिनांक 7.09.2020 से 14.09.2020 तक हिन्दी सप्ताह का आयोजन किया गया। इस दौरान हिन्दी हस्ताक्षर अभियान के अन्तर्गत सभी वैज्ञानिकों, अधिकारियों व कर्मचारियों को अपने सरकारी दस्तावेजों में हिन्दी में हस्ताक्षर करने व सभी आधिकारिक दस्तावेज इत्यादि के साथ हिन्दी अग्रेषण पत्र के उपयोग के लिए प्रेरित किया गया, जिससे हिन्दी पत्राचार में वृद्धि दर्ज की गई। दिनांक 14.09.2020 को आधिकारिक संचारों में हिन्दी के अधिकाधिक उपयोग को प्रेरित करने के लिए एक हिन्दी कार्यशाला का आयोजन किया गया जिसमें 33 प्रतिभागियों ने भाग लिया। 14 सितंबर 2020 को ही हिन्दी दिवस कार्यक्रम का आयोजन किया गया जिसमें केन्द्र के पदाधिकारियों व वैज्ञानिकों ने हिन्दी के प्रयोग को बढ़ाने पर अपने विचार साझा किये तथा प्रतिभागियों को हिन्दी के प्रयोग को बढ़ाने की दिशा में प्रयास करने के लिए प्रोत्साहित भी किया गया। इस कार्यक्रम के दौरान हिन्दी प्रश्नोत्तरी भी आयोजित की गई तथा विजेताओं को मौके पर स्टेशनरी सामग्री वितरित कर प्रोत्साहित किया गया।

संस्थान द्वारा वर्ष 2020 के दौरान प्रकाशित हिन्दी प्रकाशनों की सूची

- संस्थान की गृह पत्रिका ''दुग्ध–गंगा'' का दसवां अंक (100 पृष्ठ से अधिक)
- राडेअनुसं, करनाल की छुट्टियों की तालिका–2020 (1 पृष्ठ)
- वार्षिक डेरी कैलेण्डर–2020 (12 पृष्ठ)
- प्रत्येक तिमाही में हिन्दी न्यूज लैटर ''डेरी समाचार'' (अप्रैल–सितम्बर, 2020 व अक्तूबर–दिसम्बर, 2020)
- राष्ट्रीय डेरी मेला स्मारिका–2020 (विषयः पशुपालन की वैज्ञानिक तकनीकियाँ)
- हिन्दी फोल्डर (गेहूँ की अधिक पैदावार के लिए नवीनतम कृषि तकनीक)
- हिन्दी फोल्डर (नेपियर घास– (कम लागत में वर्षभर हरा चारा)
- नराकास करनाल के अध्यक्षीय कार्यालय के रूप में राजभाषा गृह पत्रिका ''कर्णोदय'' का सोलहवां अंक।
- कर्णोदय– 01 अंक वर्ष 2020 (100 पृष्ठ से अधिक)

- न्यूज लैटर हिन्दी : अप्रैल से सितम्बर, 2020
- गेहूँ की अधिक पैदावार के लिए नवीनतम कृषि तकनीक (6 पृष्ठ का फोल्डर)
- वैज्ञानिक विधि से पशुपालन (150 पृष्ठों की पुस्तक)
- मृदा स्वास्थ्य एवं पर्यावरण को बचाने के लिए धान फसल अवशेष प्रबन्धन (6 पृष्ठ का फोल्डर)
- जलवायु परिवर्तन का कृषि पर प्रभाव (6 पृष्ठ का फोल्डर)
- खरीफ फसलों में प्रमुख रोग व उनका प्रबन्धन (6 पृष्ठ का फोल्डर)
- ग्रामीण महिलाओं के कौशल विकास हेतु मूल्य वर्धित दुग्ध उत्पादों की तकनीक (26 पृष्ठों की पुस्तक)
- नीम–निरगुंडी के पौधे की पत्ती से हर्बल दवा बनाकर डेरी पशुओं में चिचड़ी / जूँ की रोकथाम (2 पृष्ठ का लीफलेट)

हिन्दी प्रशिक्षण / अन्य आयोजन

1. संस्थान के 9 कर्मचारियों को भारत सरकार, राजभाषा विभाग, नई दिल्ली से प्राइवेट अभ्यर्थी के रूप में हिन्दी टाइपिंग परीक्षा में 07.01.2020 को शामिल करवाया गया एवं सभी परीक्षार्थी उत्तीर्ण हुए।
2. संस्थान के कुशल सहायक कर्मचारी से अवर श्रेणी लिपिक (एलडीसी) पद पर पदोन्नत हुए 9 कर्मचारियों को हिन्दी यूनिकोड टाइपिंग सीखने हेतु एक सप्ताह का डेस्क प्रशिक्षण 13 से 21 मार्च 2020 तक प्रदान किया गया।
3. संस्थान के करनाल मुख्यालय एवं बेंगलूरू व कल्याणी क्षेत्रीय केन्द्रों के प्रशासनिक कार्यों में हिन्दी नोटिंग को बढ़ाने के लिए दिनांक 1.6.2020 से 15.06.2020 तक 15 दिवसीय हिन्दी नोटिंग अभियान का सफलतापूर्वक आयोजन किया गया। हिन्दी नोटिंग अभियान को 16.7.2020 से 16.10.2020 तक भी चलाया गया, जिसे करनाल मुख्यालय तथा दोनों क्षेत्रीय केन्द्रों के अधिकारियों व कर्मचारियों ने इस दौरान हिन्दी नोटिंग लेखन को बढ़ाने में अपना भरपूर योगदान दिया।

अर्जित पुरस्कार / उपलब्धियां

1. **उत्कृष्ट कार्यालय पुरस्कार** : नराकास करनाल के द्वारा राजभाषा के क्षेत्र में उत्कृष्ट कार्य हेतु संस्थान को नराकास वार्षिक पुरस्कार 2019–20, ''केन्द्रीय कार्यालय श्रेणी'' में ''प्रथम स्थान''।
2. **नगर राजभाषा गौरव पुरस्कार** : श्री राकेश कुमार, सहायक निदेशक (राजभाषा) को नगर राजभाषा कार्यान्वयन समिति, करनाल के द्वारा 15.11.2019 को नगर राजभाषा गौरव सम्मान।
3. **गणेश शंकर विद्यार्थी पुरस्कार** : भारतीय कृषि अनुसंधान परिशद, नई दिल्ली के द्वारा वर्ष 2018–19 के दौरान ''क'' / ''ख'' क्षेत्र में स्थित संस्थानों में संस्थान की हिन्दी पत्रिका 'दुग्ध गंगा' को ''गणेश शंकर विद्यार्थी पुरस्कार योजना'' के अंतर्गत ''द्वितीय पुरस्कार / शील्ड'' का सम्मान।
4. **क्षेत्रीय राजभाषा पुरस्कार 2019–20** : राष्ट्रीय डेरी अनुसंधान संस्थान के अध्यक्षीय समन्वय में नगर राजभाषा कार्यान्वयन समिति, करनाल को राजभाषा विभाग, गृह मंत्रालय, नई दिल्ली के द्वारा उत्तर क्षेत्र–1 में स्थित 109 नराकासों में राजभाषा हिन्दी के प्रचार, प्रसार व कार्यान्वयन की दिशा में उत्कृष्ट कार्य हेतु ''क्षेत्रीय राजभाषा पुरस्कार 2019–20'' के अंतर्गत ''द्वितीय स्थान'' से सम्मानित करने की घोषणा की गई है।
5. **उत्कृष्ट वार्षिक हिन्दी पत्रिका पुरस्कार** : नराकास करनाल के द्वारा उत्कृष्ट हिन्दी प्रकाशन पुरस्कार (2019–20) की उत्कृष्ट हिन्दी गृह पत्रिका श्रेणी के अंतर्गत संस्थान की ''दुग्ध गंगा'' पत्रिका के 10वें अंक को ''प्रथम पुरस्कार'' से सम्मानित किया गया।
6. **उत्कृष्ट वार्षिक हिन्दी स्मारिका पुरस्कार** : नराकास करनाल के द्वारा उत्कृष्ट हिन्दी प्रकाशन पुरस्कार (2019–20) की उत्कृष्ट हिन्दी वार्षिक स्मारिका श्रेणी के अंतर्गत संस्थान की ''राष्ट्रीय डेरी मेला स्मारिका को ''प्रथम पुरस्कार'' से सम्मानित किया गया।

अन्य उल्लेखनीय गतिविधियां :

1. राजभाषा नियम 1976 के नियम 10 (4) के तहत संस्थान भारत सरकार के राजपत्र में अधिसूचना संख्याः 13–5 / 95–हिन्दी दिनांक 10.3.1995 के तहत अधिसूचित है। तदनुसार संस्थान के सभी 43 प्रभागों व अनुभागों को

नियम 8 (4) के अंतर्गत अपना समस्त प्रशासनिक कार्य शतप्रतिशत हिन्दी में निष्पादित करने के लिए विनिर्दिष्ट किया गया है।

2. राजभाषा हिन्दी के प्रगामी प्रयोग से संबंधित सभी रिपोर्टें एवं बैठकों के कार्यवृत्त परिषद मुख्यालय तथा राजभाषा विभाग को ऑनलाइन प्रेषित किए जाते हैं। तिमाही हिन्दी बैठकों के कार्यवृत्तों/तिमाही प्रगति रिपोर्टों पर परिषद मुख्यालय/राजभाषा विभाग, नई दिल्ली से प्राप्त हुई अभ्युक्तियों एवं मार्गदर्शन के अनुसार अक्षरशः अनुपालना की जाती है तथा इंगित की गई कमियों का तत्काल निराकरण किया जाता है।

3. संस्थान के दक्षिणी क्षेत्रीय केन्द्र, बेंगलूरू व पूर्वी क्षेत्रीय केन्द्र, कल्याणी में भी संस्थान राजभाषा कार्यान्वयन समितियां गठित की गई हैं। दोनों केन्द्रों में भी प्रत्येक तिमाही में हिन्दी बैठक का आयोजन करके तिमाही प्रगति रिपोर्ट के साथ बैठक का कार्यवृत्त संस्थान मुख्यालय करनाल को प्राप्त होते ही उसकी समीक्षा कर आवश्यक निर्देश जारी किये जाते हैं। संस्थान के उप निदेशक/सहायक निदेशक के द्वारा क्षेत्रीय केन्द्रों को राजभाषा हिन्दी के कार्यान्वयन के संबंध में आवश्यक मार्गदर्शन भी प्रदान किया जाता है।

4. ''सरकारी कामकाज में मूल हिन्दी टिप्पण/आलेखन योजना'' के 10 विजेताओं को नियमानुसार नकद पुरस्कार व प्रमाणपत्रों से सम्मानित किया जा रहा है।

5. संस्थान की ''वैज्ञानिक तथा तकनीकी वार्षिक मूल हिन्दी टिप्पण एवं आलेखन प्रतियोगिता'' का नियमित रूप से प्रत्येक वर्ष आयोजन किया जा रहा है तथा विजेताओं को नकद पुरस्कार एवं प्रमाण पत्रों से प्रोत्साहित किया जा रहा है।

6. 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 करके सभी प्रतिभागियों को प्रतिभागिता प्रमाणपत्र व विजेताओं को नकद पुरस्कार व प्रशस्ति प्रमाणपत्र से सम्मानित किया जाता है।

7. संस्थान के डेरी कैलेण्डर को विगत वर्षों की भाँति कृषकों व पशुपालकों के हित को ध्यान में रखकर उनसे संबंधित उपयोगी जानकारी को संक्षिप्त रूप में केवल हिन्दी में तैयार कर प्रकाशित किया जा रहा है।

8. संस्थान के विभिन्न प्रभागों द्वारा किसानों व जनसामान्य के लिए आयोजित किए जाने वाले सभी कार्यक्रमों में हिन्दी भाशा में प्रशिक्षण प्रदान किया जा रहा है। सभी प्रचार–सामग्री प्रशिक्षण सामग्री भी हिन्दी अथवा द्विभाषी में प्रकाशित करवाई जाती है।

9. संस्थान के निदेशक, नगरस्तरीय नगर राजभाषा कार्यान्वयन समिति, करनाल के पदेन अध्यक्ष भी हैं। उनकी अध्यक्षता में समिति की दो बैठकें, प्रथम बैठक दिनांक 4.8.2020 को एवं दूसरी बैठक दिनांक 24.11.2020 को संपन्न हुई हैं। नराकास की छमाही बैठकों में करनाल स्थित केन्द्र सरकार के सभी सदस्य कार्यालयों के प्रशासनिक प्रमुख व भारत सरकार, राजभाषा विभाग के प्रतिनिधि अधिकारी शामिल होते हैं।

10. संस्थान के शोधरत छात्र–छात्राओं के शोधपत्रों के सारांश को हिन्दी में अनुवाद कर प्रस्तुतीकरण की व्यवस्था की जाती है। इसी प्रकार संस्थान के मास्टर्स और पी.एच.डी. छात्र–छात्राओं के लिए हिन्दी नॉन क्रेडिट कोर्स की कक्षाओं का पाठ्यक्रमानुसार नियमित रूप से संचालन किया जा रहा है।

11. संस्थान के वैज्ञानिकों से प्राप्त वैज्ञानिक एवं लोकप्रिय लेख, छात्रों के शोध सारांश, वार्षिक प्रतिवेदन, प्रशासनिक पत्र, परिपत्र, ज्ञापन, विभिन्न समारोहों की प्रेस विज्ञप्ति, गण्यमान्य अतिथियों, मंत्रियों आदि के संबोधन, व्याख्यान एवं अन्य सामग्री का अनुवाद कार्य संस्थान के राजभाषा एकक द्वारा किया जा रहा है।

स्वच्छ भारत और मेरा गांव मेरा गौरव

स्वच्छ भारत अभियानः स्वच्छ और हरित एनडीआरआई

'स्वछता से धार्मिकता – एक कहावत है'। भाकृअनुप–एनडीआरआई ने न केवल अपने परिसर को स्वच्छ और हरा–भरा रखने के लिए बड़ी पहल की, बल्कि इसने भारत सरकार के स्वच्छ भारत अभियान के नूतन कार्यक्रम के तहत ग्रामीण क्षेत्रों के समुदाय को स्वच्छ और स्वस्थ वातावरण बनाए रखने के लिए जागृत भी किया। इसमें संस्थान परिसर के साथ एनडीआरआई द्वारा अंगीकृत किए गए गांवों में स्वच्छता अभियान, स्वच्छता पर प्रेरक वार्ता, जागरूकता शिविर आदि का आयोजन सम्मिलित है। संस्थान परिसर के निवासियों और ग्रामीणों को भी अभियान को प्रभावी और सफल बनाने के लिए शिक्षित किया गया। वर्ष 2020 के दौरान संस्थान के सभी वैज्ञानिकों, छात्रों और कर्मचारियों ने न केवल परिसर में बल्कि संस्थान के आसपास के गांवों में भी बड़े पैमाने पर स्वच्छता अभियान चलाया। इसके अलावा, घरेलू स्तर पर स्वास्थ्य और स्वच्छता बनाए रखने के वाले मूल्य को विकसित करने के लिए संस्थान परिसर के अंदर अनेक स्थानों पर कई पर्यावरण के अनुकूल कूड़ेदान रखे गए।

डा. एम.एस. चौहान, निदेशक संस्थान के कर्मचारियों को स्वच्छता के प्रति प्रोत्साहित करते हुए

जागरूकता अभियान

संस्थान द्वारा अंगीकृत किए गए गांवों में व्यापक स्तर पर जागरूकता अभियान चलाया गया। संस्थान के डेरी विस्तार प्रभाग के वैज्ञानिकों की टीम ने ग्रामीणों को स्वच्छता के महत्व और गांवों को साफ–सुथरा रखने के विषय में शिक्षित किया। जैव–अपशिष्ट प्रबंधन को व्यापक रूप से अपनाने पर जोर दिया गया जिसके तहत जैव अपशिष्टों को प्रसंस्कृत कर स्वच्छ और पर्यावरण के अनुकूल जैव–ईंधन और जैविक खाद में जैव–अपशिष्ट के प्रसंस्करण की दिशा में । संस्थान के वैज्ञानिकों, तकनीकी अधिकारियों, कर्मचारियों और छात्रों ने प्रक्षेत्र उन्मुख अनुसंधान कार्यक्रमों(फार्मर्स फ़र्स्ट, डीएसटी, निकरा, एससीएसपी, आईसीएमआर आदि) के लिए आसपास के गांवों का जब दौरा किया किसानों को डेरी शिक्षा, किसान फार्म स्कूल और मेरा तो गांव मेरा गौरव कार्यक्रमों के अन्तर्गत भी

उन्होंने स्वच्छ भारत अभियान के महत्व पर जोर दिया जिससे उनमें स्वच्छता के लिए जिम्मेदारी की भावना पैदा हुई। इसी तरह कृषि विज्ञान केंद्र और संस्थान की महिला अधिकारिता प्रयोगशाला द्वारा आयोजित प्रशिक्षण कार्यक्रमों में भाग लेने के लिए आने वाले किसानों को भी घरेलू स्तर पर और अपने संबंधित इलाकों के आसपास स्वास्थ्य और स्वच्छता बनाए रखने के महत्व के बारे में जागरूक किया गया।

स्वच्छ भारत अभियान के दौरान महिला किसानों को शिक्षित किया गया

स्वच्छता पखवाड़ा

25 सितंबर से 2 अक्टूबर, 2020 तक गांधी उल्लास सप्ताह के उत्सव के अलावा, एनडीआरआई, करनाल ने 16 से 31 दिसंबर, 2020 तक संस्थान में "स्वच्छ भारत अभियान" कार्यक्रम के तहत स्वच्छता पखवाड़ा मनाया । इस स्वच्छता अभियान में संस्थान के सभी वैज्ञानिकों, तकनीकी अधिकारियों, प्रशासनिक, वित्तीय, सहायक कर्मचारियों और छात्रों ने भाग लिया और एनडीआरआई परिसर और संस्थान के आसपास के स्थानों की सफाई की। आबंटित क्षेत्र की सफाई करने के बाद, प्रतिभागियों ने कचरा एकत्र किया और उसे डंपिंग ग्राउंड में डाल दिया। इसके अलावा, एनडीआरआई परिसर और एनडीआरआई द्वारा अंगीकृत किए गए गांवों में वृहत पैमाने पर सफाई अभियान चलाया। एनडीआरआई के कर्मचारियों और छात्रों ने संस्थान के कोने–कोने की सफाई का जिम्मा लिया।

निदेशक, एन.डी.आर.आई. पौधरोपण करते हुए

एनडीआरआई के निवासियों को अपने परिवेश को स्वच्छ बनाने के लिए जागरूक किया गया। राष्ट्रीय स्वच्छता अभियान (स्वच्छ भारत अभियान) को लागू करने के लिए एनडीआरआई के कर्मचारियों ने ग्रामीणों के साथ संयुक्त रूप से अनेक अभियान चलाए ।

एनडीआरआई के सभी वैज्ञानिक, छात्र और कर्मचारी इस प्रयास को सफल बनाने में योगदान दे रहे हैं। तदनुसार, कोविड–19 के लिए दिशा–निर्देशों का पालन करते हुए, सभी प्रभागों/अनुभागों/इकाइयों के वैज्ञानिकों और

स्वच्छ भारत अभियान के दौरान निदेशक संस्थान के कर्मचारियों को शपथ दिलाते हुए

तकनीकी अधिकारियों के साथ–साथ सभी कर्मचारी के सभी सदस्य ने डॉ. एम.एस. चौहान, निदेशक के कुशल मार्गदर्शन और निदेशों के तहत संस्थान स्तर पर स्वच्छ भारत मिशन/अभियान की सफलता में योगदान सक्रिय रूप से शामिल रहे हैं।

1) व्यक्तिगत कक्षों/कार्यालयों, प्रयोगशालाओं और गलियारों को साफ कर कीटाणुरहित किया गया।

2) प्रयोगशालाओं में कार्य क्षेत्रों, स्लैब, रासायनिक और मीडिया रैक, भंडारण–शेल्फ, रेफ्रिजरेटर, उपकरण को साफ/कीटाणुरहित किया गया, जबकि रसायनों और मीडिया को फिर से व्यवस्थित किया गया था।

3) स्वच्छता और एसडब्ल्यूएमरू परिसर के भीतर (आवासीय कॉलोनियों, बाजार स्थलों, आदि) कीटाणुशोधन उद्देश्यों के लिए छिड़काव के साथ–साथ स्वच्छता और स्वच्छता अभियान चलाया गया।

4) श्कम्पोस्ट पिट' में फैलाने के उद्देश्य से 'जैविक अपशिष्ट पदार्थ' जैसे जैविक कचरा, पेड़–पत्ते आदि के संग्रह/व्यवस्था।

5) मिट्टी की उर्वरता में सुधार के लिए प्रभावी अपशिष्ट प्रबंधन और मिश्रित खाद का उपयोग।

6) जैव–अपशिष्ट प्रबंधन के साथ–साथ जैव–अपशिष्ट के स्वच्छ और पर्यावरण के अनुकूल जैव–ईंधन और जैविक खाद में प्रसंस्करण को व्यापक रूप से अपनाने में सुविधा।

7) कोविड–19 के संभावित प्रभाव की तुलना में कृषक समुदाय के बीच स्वच्छ और जैविक कृषि पद्धतियों के प्रचार–प्रसार पर ध्यान दें।

8) संस्थान के परिसर के अंदर कई स्थानों पर पर्यावरण के अनुकूल कूड़ेदान भी रखे गए हैं।

मेरा गांव मेरा गौरव

भाकृअनुप की महत्वाकांक्षी योजना मेरा गांव मेरा गौरव कार्यक्रम को सन 2015 से ही भाकृअनुप–एनडीआरआई द्वारा कार्यान्वित किया जा रहा है। संस्थान की 24 टीमें जिसमें प्रत्येक विषय के 4 वैज्ञानिक 120 गांवों में एमजीएमजी गतिविधियों में शामिल हुए। इस नवोन्मेषी दृष्टिकोण के पीछे प्रमुख उद्देश्य किसानों के साथ वैज्ञानिकों के सीधे संपर्क को बढ़ावा देना है ताकि अंगीकृत गांवों के किसानों को नियमित आधार पर आवश्यक जानकारी, ज्ञान और सलाहकार सेवाएं प्रदान करते हुए प्रयोगशाला से भूमि तक की प्रसार प्रक्रिया में तेजी लाई जा सके। 27 गांवों में कुल 143 फील्ड गतिविधियों से 2580 किसान कोविड–19 की प्रकोप के बावजूद लाभान्वित हुए।

मेरा गांव मेरा गौरव के मुख्य उद्देश्यों के अनुरूप, संस्थान के वैज्ञानिकों ने प्रक्षेत्र स्तर पर ग्रामीणों के साथ नियमित रूप से बातचीत की और खेती संबंधी उनकी मुख्य समस्याओं को दूर करने का प्रयास किया। एमजीएमजी के गांवों में किसानों के बीच कई डेरी केंद्रित तकनीकों को लोकप्रिय बनाया गया है।

किसानों की प्रतिक्रिया के आधार पर इस कार्यक्रम को और अधिक सार्थक बनाने के लिए दृष्टिकोण से जमीनी स्तर पर शामिल हितधारकों के एक प्रभावी कार्य विकसित की गई तदनुसार, एक योजना तैयार की गई जिसमें डेरी केंद्रित तकनीकों की पहचान की गई। इसके अलावा, चयनित किए जा रहे तकनीकों के आधार पर समूहों का गठन किया गया और मार्च 2018 में चयनित गए गांवों पर केंद्रित थी।

एमजीएमजी के तहत आयोजित गतिविधियां

क्रम सं	गतिविधियों के नाम	आयोजित गतिविधियों की संख्या	भाग लेने वाले और लाभान्वित किसानों की संख्या
1)	टीमों द्वारा गावों का दौरा	12	600
2)	परस्पर बैठकें/ गोष्ठियाँ/ प्रशिक्षण	30	350
3)	प्रदर्शन किया गया	12	600
4)	मोबाइल आधारित सलाह	50	50
5)	साहित्य संबंधी सहायता प्रदान की	15	300
6)	जागरूकता पैदा की	12	600
7)	इनपुट समर्थन प्रदान किया गया	12	80
	कुल	143	2580

एमजीएमजी के तहत आयोजित अन्य गतिविधियां

क्रम सं	गतिविधि	विवरण	संख्या
1)	अन्य एजेंसियों के साथ विकसित संपर्क	एजेंसी की संख्या (संख्या)	8
		लाभान्वित किसान (नहीं)	500
2)	सुविधाएं		
	i) नई किस्में	संख्या	5
		क्षेत्रफल (हेक्टेयर)	20
		लाभान्वित किसान (संख्या)	30
	ii) प्रौद्योगिकी (संख्या)	संख्या	10
		क्षेत्रफल (हेक्टेयर)	1000 पशु
		लाभान्वित किसान (नहीं)	400
	iii) बीज (क्विंटल)	क्षेत्रफल (हेक्टेयर)	10
		मात्रा (क्विंटल)	200
		लाभान्वित किसान (नहीं)	50
	iv) नई फसलें (संख्या)	संख्या	1
		लाभान्वित किसान (नहीं)	20
	v) अन्य (अंकुर, जैव–उर्वरक कुक्कुट पक्षी आदि)	संख्या	1
		क्षेत्रफल (हेक्टेयर)	20
		लाभान्वित किसान (नहीं)	600

"The TEJAS, cloned bull, born on 20th June 2020 through a simplified animal cloning technology developed by NDRI. TEJAS is a clone of 1st ranked breeding bull Mu-4354 (Set 15th of All India Coordinated Research Project on buffaloes). Buffalo cloning can help in multiplying elite germplasm."

भाकृअनुप–राष्ट्रीय डेरी अनुसंधान संस्थान

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