भाकृअनुप
ICAR

nianp

Annual Report 2019

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Silver Jubilee Year

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

वार्षिक प्रतिवेदन

Annual Report 2019

भाकृअनुप-राष्ट्रीय पशु पोषण एवं शरीर क्रिया विज्ञान संस्थान
बेंगलूरु

ICAR-National Institute of Animal Nutrition and Physiology
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Compiled and Edited by
Dr A Dhali - Chairman
Dr AP Kolte
Dr RU Suganthi
Dr G Krishnan
Dr A Mech

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Dr Raghavendra Bhatta
Director, ICAR-NIANP
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ICAR-National Institute of Animal Nutrition and Physiology
Adugodi, Hosur Road, Bengaluru - 560 030, Karnataka, India

Tel. No	+94-80-25711304, 25711303, 25702546
Fax	+94-80-25711420
Email	directornianp@gmail.com
Website	http://www.nianp.res.in

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Preface

The ICAR-NIANP is entering into the 25th year of its establishment with illustrious contributions in the area of Animal Nutrition and Physiology. During this journey, the Institute has developed several technologies and package of practices for the farmers as well as earned its own place in the basic and fundamental research. Managemental precision of the institute reflects through an ISO 9001:2015 certification. The Institute works with a strong belief that livestock sector has the potential to ensure economic and food security of the farmers and can be an invaluable tool towards the national goal of doubling farmers income.

India holds huge livestock population. In the backdrop of climate change issues, growing demand for feed and feed supplements, depleting feed resources, awareness about healthy and food safety concerns, reproductive and fertility issues, upcycling of feed resources, need for pro-environment farming techniques, stabilizing impact of climate change, technology translation etc., it becomes imperative on us to address these research concerns.The Institutehas made remarkable progress not only in the regular research programmes, but also under several International Collaborative Projects with Germany, Hungary, and ILRI. Finalization of a proposal for collaboration with The University of Melbourne, Australia is also on the anvil.

During the year 2019, NIANP successfully organized various Human Resource Development Programmes, such as Regional Training Programme for SAARC countries, post-doctoral fellowships in animal sciences for African citizen, Winter School, Short Course and Model Training Courses, for international trainees as well as trainees within the country from Animal Husbandry and Veterinary Departments of various states, officials from Agriculture/Animal/Veterinary Science Universities, scientists working in KVKs, and also technical staff of the Institute. For the benefit of farmers, the Institute disseminated various technological knowledge under 'Mera Gaon, Mera Gaurav' programme, Farmer First Projects and also organized on-site and off-site workshops and hands-on training. On the occasion of the Institute Foundation Day, the NIANP honoured several entrepreneurs of startup projects for their contributions in popularizing technologies developed, commercialized and patented by the Institute. The research contributions and efforts of the Institute are reflected with the publications in national and international journals of repute, and recognition of the scientists. During the year, the scientists received several prestigious Awards for the research contributions in their respective fields. The NIANP continued to contribute towards 'Swacch Bharat' mission by maintaining a model campus with clean and green environment. NIANP added to its green cover in the campus by initiating periodic tree plantation programmes, as also cleanliness drives, maintaining its pleasing ambience. As a result, the Institute secured First prize in the prestigious ICAR 'Swacchata Pakhwada' Award.

I take pride in presenting salient achievements of the Institute in this report. I sincerely believe that this report will serve as a reference to the personnel involved in the field of animal nutrition and physiology. I am extremely thankful to the Council for overwhelming support in terms of resources, guidance and various other facilities. I sincerely thank Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for his constant support and guidance. We are grateful to Dr K Pradhan, Chancellor, Siksha O Anusandhan University, Bhubaneswar and Chairman of the Research Advisory committee including other members of the committee for reviewing the research projects and providing constructive suggestions. I sincerely acknowledge the encouragement and support from Dr JK Jena, DDG(Animal Sciences &Fisheries), ICAR. I am also thankful for the constant support and coordination extended by Dr Ashok Kumar, ADG (AH), Dr Rajan Gupta (Principal Scientist, AN) and Dr Vineet Bhasin (Principal Scientist, AGB) from the Council. I congratulate all the staff of ICAR-NIANP and the Editorial Team for their dedication, contributions and hard work towards publishing this report in time.

Raghavendra Bhatta

कार्यकारी सारांश

भाकृअनुप-राष्ट्रीय पशु पोषण एवं शरीर क्रिया वज्ञिान संस्थान ने अपनी स्थापना के 24 साल सफलतापूर्वक पूरे कर लिए हैं और पशुपालन फार्म प्रबन्धन उद्योग से जुड़े किसानों, शिक्षाविदों, विस्तार कार्यकर्ताओं, नीतनिर्माताओं के जरूरतों को उत्कृष्टता के साथ पूरा किया है। इस वर्ष, संस्थान अपनी स्थापना की रजत जयंती मना रहा है। भाकृअनुप-रापपोशक्रविसिं एक आईएसओ 9001:2015 प्रमाणित संस्थान है।

अप्रैल से दिसंबर 2019 की अवधि के दौरान, संस्थान ने 38 वैज्ञानिकों, 9 तकनीकी कर्मचारियों, 12 प्रशासनिक और लेखा कर्मियों और 2 कुशल कर्मचारियों के साथ काम किया। वित्तीय वर्ष 2019-2020 के लिए कुल बजटीय आवंटन ₹2686.16 लाख था और रिपोर्ट की अवधि के दौरान कुल व्यय ₹1896.56 लाख था। इस अवधि में संस्थान ने ₹52.19 लाख राजस्व भी अर्जित किया। संस्थान के वैज्ञानिकों ने समर्पित रूप से अनुसंधान और प्रौद्योगिकी विकास और प्रदर्शन से संबंधित विभिन्न लक्ष्यों को प्राप्त करने के लिए काम किया, जो प्रमुख कार्यक्रमों के तहत शासनादेश के अनुसार परिभाषित किए गए थे।

पशुओ में आंत सूक्ष्म जीवों की बायोजियोग्राफी

रूमेन में असंतृप्त वसीय अम्लों के जैवउपकरण में शामिल रोगाणुओं की पहचान और उनकी लक्षण वर्णन के लिए एक अध्ययन किया गया था। रूमेन माइक्रोबियल संरचना और जैववश्लिेषण में शामिल बैक्टीरिया के अलगाव पर प्रभाव समझने के लिए संतृप्त और असंतृप्त वसा स्रोतों का पूरक दिया गया था। यह स्पष्ट था कि फ्लेक्ससीड तेल पूरक और नियंत्रण समूहों के तुलना में नारियल तेल के पूरक ने रूमेन माइक्रोबियल विविधता और प्रोटोजोअल के संख्या को ज्यादा कम किया था।

"वेटरनरी टाइप कल्चर- रुमेन माइक्रोब" पर आईसीएआर-नेटवर्क परियोजना के तहत, विभिन्न स्रोतों से कुल 55 बैक्टीरियल कल्चर को अलग किया गया और 10 बैक्टीरिया प्रजातियों का अनुक्रमण किया गया। दो प्रजातियों को पूरे जीनोम अनुक्रमण के लिए चुना गया। इसके अलावा, भेड़ के रुमेन से 35 माइक्रोब अलग किया गया और छह अलग-अलग उपभेदों को अनुक्रमण के लिए चुना गया।

पोषक तत्व, जैव उपलब्धता, पशु प्रजनन और उत्पादकता का आकलन और सुधार के लिए नवदृष्टिकोण

नवजात और प्री-हैच में अमीनो एसिड और ट्रेस मिनरल पूरकता के प्रतिक्रिया स्वरूप ब्रायलर चिकन में जठरांत्र और प्रतिरक्षा प्रणाली में हुए विकास पैटर्न का अध्ययन किया गया। ईन ओवो और पोस्ट-हैच अमीनो एसिड पूरक के कारण ब्रायलर चिकन के विकास में वृद्धि हुई। पोस्ट हैच अमीनो एसिड (लाईसीन, मथिओनिन, आर्जिनिन और थ्रिओनिन) और खनिजों (जस्ता, तांबा और सेलेनियम) के संयोजन के पूरकता के कारण ब्रायलर चिकन की शरीर की वृद्धि प्रदर्शन और सेल मध्यस्थता प्रतिरक्षा प्रतिक्रिया में वृद्धि हुई। हालांकि, परिणामों ने संकेत दिया कि ईन ओवो पूरक में तीन से अधिक अमीनो एसिड के संयोजन सावधानी के साथ किया जाना चाहिए और यह वाणिज्यिक ब्रॉयलर चिकन के लिए फायदेमंद नहीं भी हो सकता है।

बकरियों में प्रतिरक्षा प्रतिक्रियाओं को प्रभावित करने वाले ऊर्जा और प्रोटीन के विभिन्न स्तरों के तंत्र स्पष्ट करने के लिए प्रयास किया गया। प्रोटीन और ऊर्जा की कमी के कारण होने वाले पोषण संबंधी तनाव से विभिन्न शारीरिक मापदंड प्रभावित हुए। उल्लेखनीय रूप से तनाव समूहों में एचएसपी70, एचएसपी110 जीनों की उच्च अभिव्यक्ति के स्तर ने बकरियों में ऊर्जा और प्रोटीन की कमी के लिए इन जीनों की संवेदनशीलता का संकेत दिया।

ट्रेस खनिजों के जैवउपलब्धता और ऊतक उपयोग में सुधार और पशुओं के उत्पादन प्रदर्शन बढ़ाने के लिए प्रयोगशाला में धातु-कार्नटिाइन चीलेट्स उत्पादन के लिए प्रयास किया गया था। कॉपर-कार्नटिाइन, जस्ता-कार्नटिाइन, मैंगनीज-कार्नटिाइन और क्रोमियम-कार्नटिाइन के उत्पादन के लिए स्वदेशी प्रक्रियाओं का विकास किया गया। धातु-कार्नटिाइन चीलेट्स में खनिज सामग्री 100000 से लेकर 130000 मिलीग्राम/किग्रा थी।

पशुओं के लिए चारे के रूप में अंकुरित अनाज का मूल्यांकन किया गया था। मक्का के अंकुरित अनाज में प्रोटीन और फाइबर के संदर्भ में गेहूं के चोकर के समान पोषक मूल्य पाया गया और उसके साथ शुष्क पदार्थ के आधार पर उच्च ऊर्जा सामग्री पाया गया। इसके अलावा, मक्का के अनाज के अंकुर में उच्च विटामिन और अमीनो एसिड होते हैं। हालाँकि, भेड़ों में मक्का के दानों को 50% और 100% के स्तर पर खिलाने से शुष्क पदार्थ का सेवन कम हुआ और विकास की दर कम हो गई।

वाणिज्यिक ब्रॉयलर भेड उत्पादन के लिए पोषण मॉड्यूल का विकास किया गया। यह स्पष्ट था कि प्री-वीन अवशिान मेमनों में मील्क रेप्लेसर पूरकता के कारण शरीर के वजन में काफी वृद्धि हुई। प्री-वीनिग चरण के दौरान मील्क रेप्लेसर पूरकता के प्रभाव आगे की चरण में वृद्धि प्रदर्शन पर अध्ययन जारी है।

मुर्गीपालन में जस्ता की बेहतर जैवउपलब्धता के लिए सटीक वितिरण प्रणाली का विकास प्रगति पर है। जस्ता के विभिन्न लवण, वाल मेटेरियल्स और दो अलग-अलग तरीकों का उपयोग करके एन्कैप्सुलेटेड जस्ता तैयार करने के लिए एनकैप्सुलेशन तकनीक को मानकीकृत किया गया। माइक्रोएनकैप्सुलेटेड जस्ता पाउडर जस्ता सल्फेट हेप्टा हाइड्रेट और जस्ता ऑक्साइड से उत्पादित किया गया ।

अंडा और मांस प्रकार के मुर्गियों के उत्पादन प्रदर्शन के संबंध में दुर्लभ पृथ्वी तत्वों की जैविक गतिविधियों का आकलन करने के लिए परियोजना शुरू की गई। परत मुर्गियों में उनकी जैव उपलब्धता, सतत अंडे के उत्पादन, अंडे और हड्डी के जैवसंश्लेषण, आंतों की अखंडता और अवशिष्ट प्रभाव पर लैंथेनाइड्स पूरक के प्रभाव का अध्ययन करने के लिए एक परीक्षण प्रगति पर है।

भोजन और चारा के रूप में कीटों के उपयोगीकरण पर अध्ययन किया गया। पोल्ट्री फीड के रूप में ब्लैक सोल्जर फ्लाई (बीएसएफ) लार्वा की उपयुक्तता का आकलन किया गया। परिणामों से संकेत मिलता है कि बीएसएफ लार्वा के भोजन में एक अच्छा अमीनो एसिड प्रोफाइल है और यह ब्रायलर के आहार में सोयाबीन के एक प्रभावी आंशिक प्रतिस्थापन हो सकता है।

स्ट्रा बेलर पर यूरिया के घोल छिडकाव प्रणाली पर अध्ययन किया गया। यूरिया और नमी के इष्टतम सांद्रता को बालिग के समय चावल और गेहूं पुआल के लिए निर्धारित किया गया। बालिग के समय यूरिया के घोल छिडकने से उपचारित पुआल के क्रूड प्रोटीन की बृद्धि हुई।

बागवानी उपोत्पाद आधारति आहार पर जैव प्रौद्योगकिी संबंधी हस्तक्षेप द्वारा सूअरों के उत्पादक प्रदर्शन को बढ़ाने के लिए डीबीटी-ट्वनिगि परयिोजना के तहत एक अध्ययन कयिा गया। सूअर के राशन में फल और सब्जी का उपोत्पाद मूल्यांकन कयिा गया। इन वट्रिो प्रयोगों ने संत दयिा कि प्रीबायोटकि और प्रोबायोटकि के साथ मानक राशन में बागवानी उपोत्पादों का 30% समावेश बेहतर पाचन क्षमता देता है।

क्रायोप्रसिर्व्ड भैंस वीर्य वगिलन के बाद के गतशिीलता को बेहतर बनाने के लिए एक नव वीर्य वस्तिारक वकिसति करने का प्रयास कयिा गया। संभावति कम आणवकि भार चयापचयों जो भैंस वीर्य सेमनिेल प्लाज्मा के प्राकृतकि घटक हैं उनका उपयोग करके एक नया भैंस-वशिष्टि वीर्य वस्तिारक वकिसति कयिा गया। नए वीर्य वस्तिार ने क्रायोप्रसिर्व्ड भैंस के शुक्राणुजोजा के वगिलन के बाद के गतशिीलता और व्यवहार्यता में सुधार कयिा।

चयनात्मक थर्मो-सहष्णिु जीन अभव्यिक्ति पैटर्न के आधार पर गर्मयिों में गर्मी के तनाव के लिए वभिन्नि देशी बकरी नस्लों की लचीलापन क्षमता का तुलनात्मक मूल्यांकन कयिा गया था। मेटाजीनोमकि वशि्लेषण से पता चला है के स्वदेशी बकरी उस्मानाबादी, मालाबारी और सलेम ब्लैक नस्लों में कई आनुवंशकि स्तरों पर रुमेन माइक्रोबायोम और उष्मागत तनाव के बीच संबंध है। तीन नस्लों के बीच नयिंत्रण और गर्मी तनाव समूहों में अंतर माइक्रोबयिल वशिेषताओं में अधकिांश अलग-अलग पाए गए। परणिाम सुझाव देते हैं कि रुमेन में होस्ट और माइक्रोबायोम परस्पर क्रयिा गर्मी तनाव प्रतक्रियिा के भन्निता में योगदान देता है।

इन वट्रिो कल्चर सस्टिम में ऑक्सीडेटवि स्थतिि में बदलाव करके भेड़ के भ्रूण में लगि वभिेदीकरण का प्रयास कयिा गया। इन वट्रिो में कम O_2 सांद्रता में उत्पादति भ्रूण उच्च O_2 सांद्रता में उत्पादति भ्रूण की तुलना में अधकि वकिासात्मक क्षमता प्रदर्शन करते हैं। भ्रूण की प्लूरपिोटेंसी क्षमता में लगि द्वरूिपता से पता चला कि नर भ्रूण में मादा भ्रूण की तुलना में अधकि प्लुरपिोटेंसी क्षमता है।

जी-प्रोटीन युग्मति रसिेप्टर्स और आंत के हार्मोन पर आंत के कमिोससिगि और भेड़ में वसा के पाचन और अवशोषण के वनियिमन पर एक अध्ययन कयिा गया था। भेड़ में रूमेन संरक्षति लंबी श्रृंखला फैटी एसडि (डीएमआई के 3 और 5%) के पूरकता ने 1.8- 2.0 गुना बेहतर बॉडी कोंडीसोन स्कोर के साथ औसत दैनकि शरीर का वजन बढ़ाया। भेड़ों में फैटी एसडि खलिाने से भोजन के बाद का आंत हार्मोन कोलेलस्टिोकनिनि के स्राव बृद्धि हुआ जसिने वसा के पाचन और अवशोषण सुगम बनाया और ऊर्जा समस्थतिि बनाए रखने के लिए भोजन के बाद का घ्रेलनि स्राव को कम कर दयिा।

पोल्ट्री में वभिन्नि उत्पादन चक्रों के दौरान ऑक्सीडेटवि तनाव प्रेरति माइटोकॉन्ड्रयिल शथिलिता और ऑर्गेनोसल्फुर यौगकिों द्वारा इसके वनियिमन कम करने में यूरकि एसडि की भूमकिा समझने के लिए एक अध्ययन शुरू कयिा गया। ग्रहणी और अंडे के खोल ग्रंथि से पृथक की गई माइटोकॉन्ड्रयिा की झल्लिी क्षमता में आयु संबंधी गरिावट स्पष्ट थी। माइटोकॉन्ड्रयिल डसिफंक्शन का मुकाबला करने में लहसुन और/या एलसिनि के प्रभाव आकलन करने के लिए आगे अध्ययन प्रगतपिर है।

भेड़ों में प्रोस्टाग्लैंडीन मॉड्यूलेटर एडमनिसि्ट्रेसोन पर भ्रूण बचे रहने की प्रभाव पर जांच प्रगतपिर है। भेड़ प्लाज्मा में पीजीएफ2α और पीजीई2 का आकलन करने के लिए परख अनुकूलति कयिा गया। आईजीएफ2, एफजीएफ2 और β -एक्टनि प्रवर्धन के लिए स्थतिि को अनुकूलति कयिा गया। भेड़ में 9 दनिों के अंतराल पर ल्यूटलसि के दोहरे इंजेक्शन द्वारा एस्ट्रस सक्रिनाइज़ेशन हासलि कयिा गया।

पोस्ट-हैच ब्रायलर मुर्गयिों में भ्रूणजनन और शारीरकि प्रतक्रियिाओं के दौरान नव न्यूरोपैप्टाइड्स के माध्यम से *जीएनआरएच* प्रणाली के मॉड्यूलेशन की जांच की गई। एस्ट्राडयिोल-17 संयोजन के साथ जीएनआरएच ईन ओवो एडमनिसि्ट्रेसोन ने *जीएनआरएच* रसिेप्टर अभव्यिक्ति बढ़ाया और संवर्धति पट्यिूटरी कोशकिाओं में *जीएनआईएच* रसिेप्टर एमआरएनए की बहुतायत में कमी लाई। जीएच और स्टेरॉयड हार्मोन के उच्च स्तर ने पोस्ट-हैच ब्रॉयलर चकिन में वकिास दर सुगम बनाया।

भेड़ में ऊर्जा चयापचय के नयिमन में एडपिोनेक्टनि की शारीरकि भूमकिा जानने के लिए अध्ययन कयिा गया। एडपिोनेक्टनि और इसके रसिेप्टर्स (एडपिोआर1 और एडपिोआर2) की अभव्यिक्तयिों का अध्ययन गर्मी से तनाववाले बकरयिों में कयिा गया। उस्मानाबादी बकरयिों में, एडपिोनेक्टनि, एडपिोआर1 और एडपिोआर2 की अभव्यिक्ति गर्मी से तनाववाले बकरयिों में नयिंत्रण समूह की तुलना में अधकि पाई गई। मालाबारी बकरयिों में, नयिंत्रण समूह की तुलना में गर्मी में एडपिोनेक्टनि अभव्यिक्ति कम थी, लेकनि समूहों के बीच एडपिो आर1 और एडपिोआर2 की अभव्यिक्ति में कोई अंतर नहीं देखा गया। सलेम ब्लेक बकरयिों में, एडपिोनेक्टनि अभव्यिक्ति कम थी, लेकनि नयिंत्रण समूह की तुलना में गर्मी से तनाववाले बकरयिों में एडपिोआर1 और एडपिोआर2 अभव्यिक्ति अधकि थी।

भैंस में प्रारंभकि गर्भावस्था नदिान के लिए एनआईएएनपी_एमबीएल_1, 2 और 3 क्लोन, की अभव्यिक्ति मोनोक्लोनल एंटीबॉडी उत्पादन और इम्युनो परख के वकिास के लिए प्रयास कयिा गया। पीईटी28a (+) में वांछति 200 अमीनो एसडि समतुल्य अनुक्रम (क्लोन एनआईएएनपी_एमबीएल_3) को संश्लेषति और उप-क्लोन कयिा गया। *ई. कोलाई* में वांछति प्रोटीन व्यक्त कयिा गया और एसडीएस-पेज वशि्लेषण द्वारा पुष्टकिी गई।

नेशनल फेलो परयिोजना के तहत, शुक्राणु ट्रांस्क्रप्टिर हस्ताक्षर पर आधारति भैंस बैल प्रजनन नदिान चपि का वकिास प्रगतपिर है। मवेशयिों की तुलना में भैंस के शुक्राणुजोजा आरएनए अत्यधकि खंडति पाए गए। भैंस के शुक्राणुजोज़ा में व्यक्त प्रचुर जीनों में से कुछ में पीआरएम1 और एकेएपी12 जीन देखा गया।

पशुधन में प्रजनन प्रदर्शन बढ़ाने के लिए ईन वट्रिो प्रणाली उपयोग करके जातीय-पशु चकित्सिा अध्ययन कयिा गया। *मोरगिा ओलीफेरा* की एक सक्रयि सामग्री केम्पेरफोल की 10μM खुराक ने प्रीएंट्रेल फॉलकिल और ग्रेन्युलोसा कोशकिाओं के कार्यों को बढ़ावा दयिा। यह अन्य पौधे की सक्रयि सामग्रीयों की तुलना में डम्बिग्रंथकि कार्यों को बेहतर बनाने में अधकि प्रभावी पाया गया, जो कि माइरसिेटनि> क्वेरसेटनि> कार्बाजोल के क्रम में पाया गया।

आईसीएआर-आईसीआरपी परयिोजना के तहत "पशुओं में प्रजनन प्रदर्शन में सुधार के लिए पोषण और शारीरकि दृष्टकिोण" पर वभिन्नि अध्ययन कएि गए। भैंस वीर्य प्रोटीन एसपीआईएनके2 और एनईडीडी8 ने वीर्य की गुणवत्ता के साथ स्पष्ट रूप से महत्वपूर्ण सहसंबंध प्रदर्शति कयिा। एक नव भैंस-वशिष्टि वीर्य वस्तिारक ने क्रयायोप्रसिर्व्ड भैंस शुक्राणु की कार्यक्षमता और व्यवहार्यता में काफी सुधार कयिा। फील्ड में गायों में उपयोग कएि जाने वाले तीन एस्ट्रस सक्रिोनईजेसोन प्रोटोकॉल में, एस्ट्रा-डबलसकि को सबसे

प्रभावी पाया गया। भोजन के साथ बोरान पूरकता ने नर बकरियों में वीर्य की गुणवत्ता और प्रतिरक्षा और एंटीऑक्सीडेंट रक्षा क्षमताओं को बढ़ाया।

आईसीएआर-एक्सट्रामुरल परियोजना के तहत, छोटे और बड़े जुगाली करने वाले पशुओं में उर्वरता बढ़ाने के लिए नवीन जैविक अणुओं के रूप में किस्स्पेप्टीन और इसके एनालॉग्स पर जांच प्रगति पर है। प्रजनन हार्मोन का एक अनुकूल प्रोफ़ाइल उत्प्रेरण के लिए किस्स्पेप्टीन एडमनिस्ट्रेसोन की खुराक भेड़ में मानकीकृत किया गया। सिक्रिनाइज़ भेड़ में एस्ट्रस के प्रभावी प्रेरण के लिए किस्स्पेप्टीन (एनालॉग) की खुराक तय किया गया। किस्स्पेप्टीन और इसके एनालॉग्स के साथ इलाज किया गया सिक्रिनाइज़ मादा भेड़ों में प्राकृतिक वीर्यरोपण के बाद गर्भाधान दर बिना इलाज के नियंत्रण समूहों की तुलना में काफी अधिक पाया गया।

डीबीटी वित्त पोषित परियोजना के तहत, एक एकीकृत प्रोटिओमिक और जीनोमिक दृष्टिकोण के माध्यम से पहचाने जाने वाले नव बायोमार्कर का उपयोग करके गोजातीय में लिंग विशिष्ट शुक्राणुजोज़ा के चयनात्मक अलगाव पर काम किया गया। प्रोटीन टेक्टिन-3, ए-किनेज एंकर प्रोटीन3, कार्बोक्सीपेप्टिडेज क्यू, एल-लैक्टेट डिहाइड्रोजनेज, जोना पेलुसीडा बाइंडिंग प्रोटीन, आउटर डेंस फाइबर प्रोटीन2, आउटर डेंस फाइबर3 और ट्यूबलिन बीटा 4बी चेन पारंपरिक और एक्स-समृद्ध शुक्राणुजोज़ा के बीच अंतर व्यक्त पाया गया। इन प्रोटीनों की पहचान लिंग से जुड़े झिल्ली प्रोटीन के रूप में की गई।

डीएसटी प्रायोजित इंडो-हंगरी परियोजना का उद्देश्य अंडाशय के प्रीएंट्रल फॉलिकल्स और भ्रूण विट्रीफिकेशन की दक्षता में रणनीतिक सुधार करना है। विट्रिफिकेशन प्रोटोकॉल में एंटीऑक्सिडेंट रेटिनॉल और साइटोस्केलेटल पदार्थ साइटोसैक्लासिन उपयोग के परिणामस्वरूप अंडाशय के प्रीएंट्रेल फॉलिकल्स के बिघलन के बाद के जीवित दर उच्च पाई गई। विकासात्मक जीन की अभिव्यक्ति रैटिनॉल के साथ वित्रिफ़ाईद बिघलन के बाद के प्रीएंट्रेल फॉलिकल्स में अधिक पाई गई, लेकिन साइटोक्लासिन के साथ वित्रिफ़ाईद प्रीएंट्रेल फॉलिकल्स में यह नहीं देखा गया।

डीएसटी-एसआरबी परियोजना के तहत भेड़ के शुक्राणुजन्य स्टेम कोशिकाओं में दीर्घकालिक स्थिरता बनाए रखने के लिए इन विट्रो कल्चर स्थितियों में 3डी स्थापना का प्रयास किया गया। परिणामों से पता चला कि आकार में उल्लेखनीय वृद्धि के बिना स्पेरोइड कल्चर प्रणाली में शुक्राणुजन स्टेम कोशिकाएं (एसएससी) गठित होता है। एसएससी का प्रसार हुआ और गेल्ट्रेक्स कल्चर प्रणाली में स्थिरता बनाए रखने में सक्षम था।

आईसीएआर-एनएएसएफ द्वारा वित्त पोषित परियोजना के तहत भैंस में प्रारंभिक भ्रूण जीवित रखने को नियंत्रित करने वाले जीन के क्रिसिपर/ कस9 (CRISPR/Cas9) निर्देशित कार्यात्मक विश्लेषण पर अध्ययन शुरू किया गया। एंडोमेट्रियल उपकला कोशिकाओं को भैंस के गर्भाशय से सफलतापूर्वक अलग किया गया। भैंस विशिष्ट पीटीजीईएस और पीटीजीएफएस सीडीएनए का चरित्र-चित्रण किया गया।

डेयरी मवेशियों में मादा संतानों के प्रति लिंग अनुपात को झुकाने के लिए आईसीएआर-एनएएसएफ परियोजना, वाई-असर शुक्राणुजोज़ा के लक्षित स्थिरीकरण पर ध्यान केंद्रित करती है और इस उद्देश्य के लिए ओवडिक्ट मिलियू का मॉड्यूलेशन करती है। गाय में शुक्राणु-डिंबवाहिनी बंधन का अध्ययन करने के लिए इन विट्रो ओवडिक्ट एक्सप्लेंट मॉडल विकसित किया गया।

फ़ीड सूचना विज्ञान, फ़ीड गुणवत्ता और सुरक्षा और मूल्य संवर्धन

ब्रायलर उत्पादन में एंटीबायोटिक विकास प्रमोटरों के स्थान लेने के लिए एक नव फाइटोजेनिक मिश्रण का विकास प्रगति पर है। डीप लीटर सिस्टम में ब्रायलर मुर्गियों में उत्पादन प्रदर्शन और सीकेल माइक्रोफ्लोरा रचना पर एक नव फाइटोजेनिक मिश्रण की प्रभावकारिता मूल्यांकन किया गया। ब्रायलर मुर्गियों में फाइटोजेनिक मिश्रण (1%) के पूरक ने शरीर के वजन में सुधार किया और फ़ीड रूपांतरण अनुपात कम किया और सीकम में साल्मोनेला और कोलीफॉर्म काउंट कम किया।

रोगाणुओं में एंटीमाइक्रोबियल प्रतिरोध (एएमआर) एक वैश्विक चिंता है। इसलिए, पोल्ट्री उत्पादन वातावरण में एएमआर जीन का आकलन और चरित्र-चित्रण के लिए एक परियोजना शुरू की गई है। यह परियोजना पोल्ट्री उत्पादन पर्यावरण से एएमआर जीन सामग्री संदर्भ में मेटाजीनोम की क्षमता पहचान करने की परिकल्पना करती है।

आईसीएआर-सीआरपी परियोजना "पशुधन के लिए मूल्य संवर्धित अनाज (वीएसी) और अनाज उपोत्पाद का मूल्यांकन" के तहत, बाइओ-फोर्टिफाइड गेहूं भूसी किस्मों का विश्लेषण किया गया। यह स्पष्ट था कि इन विट्रो शुष्क पदार्थ पाचनशक्ति और रूमेन किण्वन पर प्रतिकूल प्रभाव डाले बिना बायो-फोर्टिफिकेशन से जस्ता सामग्री में वृद्धि हुई।

आईसीएआर-आउटरीच परियोजना के तहत दवा अवशेषों और पर्यावरण प्रदूषकों की निगरानी की गई। तेलंगाना राज्य के वारंगल क्षेत्र का सर्वेक्षण किया गया और कीटनाशक अवशेषों और भारी धातुओं की सामग्री विश्लेषण के लिए मिट्टी, पानी, चारा, चारा, दूध और बालों के 106 नमूने एकत्र किए गए।

आईसीएआर-एआईसीआरपी परियोजना के तहत मिट्टी और पौधों में सूक्ष्म और अप्रधान पोषक तत्वों और प्रदूषक तत्वों पर अध्ययन किया गया। नाले का पानी, चारा फसलों और सब्जियों में सीसा, कैडमियम और आर्सेनिक सामग्री कम और सुरक्षित सीमा के भीतर पाई गई। मिट्टी में जिंक सल्फेट (25 किग्रा/हेक्टेयर) अनुप्रयोग ने ज्वार में जिंक सामग्री (उपचार में 32.1 पीपीएम, नियंत्रण में 21.8 पीपीएम) और हरा चारा उपज (उपचार में 34 टन/हेक्टेयर, नियंत्रण में 31.5 टन/हेक्टेयर) में सुधार किया।

सीएमबी परियोजना के तहत जुगाली करने वाले जानवरों के राशन में रेशमकीट प्यूपा (एसडब्ल्यूपी) उपोत्पाद के फीडिंग मूल्य का मूल्यांकन किया गया। परिणाम संकेत देते हैं कि डिओइल्ड एसडब्ल्यूपी भोजन को पशुधन राशन में प्रोटीन पूरक के रूप में इस्तेमाल किया जा सकता है। एसडब्ल्यूपी तेल से तैयार उपोत्पाद को विकास और पोषक तत्वों उपलब्धता से समझौता किए बिना 15% तक भेड़ राशन में शामिल किया जा सकता है।

पशुधन पर जलवायु परिवर्तन का प्रभाव

आईसीएआर-आउटरीच परियोजना में विभिन्न खाद्य प्रणालियों के तहत मीथेन उत्सर्जन का अनुमान और शमन रणनीतियों के विकास पर जांच की गई। परिणामों ने संकेत दिया कि 2% स्तर पर रेशमकीट प्यूपा तेल पूरक भेड़ में पोषक तत्वों के सेवन, पाचनशक्ति और रक्त जैव रासायनिक मापदंडों को प्रभावित नहीं करते हैं। इसके विपरीत, तेल पूरकता से आंत्र समुदाय में परिवर्तन और प्रोटोजोआ कमी के कारण, मीथेन उत्सर्जन में कमी हासिल की जा सकती है। 16S आरआरएनए (rRNA) एम्प्लिकॉन सीक्वेंसिंग से पता चला है कि

मेथनोब्रेवबिैक्टर भेड़ों के रूमेन में आरकयिा जातमिें सबसे प्रचुर (कुल आरकयिा का 89-93%) है।

डेयरी गायों की उच्च जीवनकाल उत्पादकता के लिए फ़ीड संसाधनों के अनुकूलति उपयोग और आंत्रकि मीथेन उत्सर्जन पर परणिाम पर डीबीटी-डीएफजी द्वारा वत्तिपोषति इंडो-जर्मन सहयोगी परयिोजना कार्यान्वति कयिा गया। बेंगलुरू के उत्तर और दक्षणि इलाकों से एकत्र कएि गए आहार के नमूनों में मीथेन उत्पादन क्षमता (एमएल/100 मलिीग्राम वास्तव में पचा हुआ सब्सट्रेट) में 1.34 (पेड़ के पत्तों) से 6.01 (अनाज के भूसे) तक वसि्तृत ववििधिता देखा गया। शरि्फ सूखा चारा या चारे के साथ कंसेंट्रेट जोड़के तैयार कएि गए आहारों की तुलना में सूखा चारा, कंसेंट्रेट और हरे चारे का उपयोग करके तैयार की गई आहारों में कम मीथेन उत्पादन होता है। अध्ययन क्षेत्र में चयनति डेयरी फार्मों में आईपीसीसी टयिर II दशिानरि्देशों का उपयोग करके ग्रीनहाउस गैस उत्सर्जन का जीवन चक्र वशि्लेषण कयिा गया।

मीथेन उत्सर्जन और उसका शमन पर एक ईएलआर आई-आईसीएआर सहयोगी परयिोजना आरंभ की गई है। भेड़ में एन्टि-मेथेनोजेनकि सप्लीमेंट हरति धरा (आहार का 5%) के प्रभाव मूल्यांकन आंत्रकि मीथेन उत्सर्जन और पोषक तत्वों की सेवन और पाचन क्षमता पर कयिा गया। पोषक तत्वों के सेवन और पाचन क्षमता को प्रभावति कएि बनिा हरति धरा पूरक काफी हद तक आंत्रकि मीथेन उत्सर्जन (21%) कम कर सकता है। इसके अलावा, पूरकता ने भेड़ में कुल रुमेन प्रोटोजोआ आबादी को काफी कम कर दयिा।

आवषि्कार को उपयोग से संयोजति करने के लिए प्रौद्योगकिी अनुवाद

वभिन्नि डेयरी उत्पादन प्रणालयिों में पानी के उपयोग की दक्षता सूक्ष्म स्तर पर मूल्यांकन कयिा गया। छोटे धारक प्रणाली में प्रत्यक्ष जल का उपयोग औसत 97 लीटर प्रतदिनि और वाणज्यिकि डेयरी में औसत 97 लीटर प्रतदिनि पाया गया। गणना द्वारा छोटे धारक प्रणाली में पानी उपयोग की दक्षता 0.85 और वाणज्यिकि डेयरी के लिए यह 1.62 पाई गई।

कर्नाटक में डेयरी फार्म प्रबंधन की वभिन्नि प्रणालयिों के तहत दूध उत्पादन के आर्थकि अवस्था पर एक अध्ययन कयिा गया। वभिन्नि फ़ार्मगि प्रणालयिों के तहत दूध उत्पादन लागत का आकलन करने का प्रयास कयिा गया। इस अध्ययन द्वारा नविेश लागत सशुल्क (₹)24.8-29.9 और पारविारकि श्रम सहति लागत (₹)28.7-34.4 पाई गई।

ग्रामीण बेंगलुरु के डोड्डाबल्लपुरा तालुक में 10 गांवों के एक क्लस्टर में 1000 कसिानों परविारों को शामलि करते हुए, टकिाऊ पशुधन खेती के लिए तकनीकी हस्तक्षेप के माध्यम से कसिानों की आजीवकिा सुरक्षा में सुधार के लिए आईसीएआर-फरमार्स फ़र्स्ट परयिोजना कार्यान्वति कयिा गया। कसिानों और ग्रामीण युवाओं के लिए वभिन्नि प्रौद्योगकिी हस्तक्षेप शुरू कएि गए और जागरूकता अभयिान और क्षमता नरि्माण कार्यक्रम आयोजति कएि गए। इन हस्तक्षेपों के परणिामस्वरूप कसिानों की आय और आजीवकिा में काफी सुधार हुआ।

बागवानी आधारति कृषि प्रणाली में समग्र ग्राम वकिास के लिए प्रौद्योगकिी और संस्थानों को एकीकृत करने, ज्ञान समृद्ध करने पर एक अन्य आईसीएआर-फरमार्स फ़र्स्ट परयिोजना लागू की गई। कसिानों के लिए जागरुकता कार्यक्रम चलाए गए और उन्हें छोटी-मोटी उत्पादन प्रणालयिों में समस्या का सामना करने की सलाह दी गई। लाभार्थयिों को खनजि और प्रोटीन की खुराक वतिरति की गई और वर्ष में तीन बार सभी छोटे जुगाली करने वाले पशुओं को डीवोर्मगि कयिा गया।

प्रशक्षि्ण और योग्यता वर्धन

रपिोर्ट की गई अवधि के दौरान, संस्थान वभिन्नि मानव संसाधन वकिास संबंधी गतविधियिों में सक्रयि रूप से शामलि था। संस्थान ने आईसीएआर प्रायोजति शीतकालीन स्कूल, दक्षेस देशों (सार्क) के लिए वशिषज्ञ परामर्श बैठक, अफ्रीकी नागरकिों के लिए अल्पकालकि प्रशक्षि्ण पाठ्यक्रम और पांच अन्य लघु अवधि प्रशक्षि्ण पाठ्यक्रम आयोजति कएि।

वैज्ञानकिों, तकनीकी कर्मचारयिों और प्रशासनकि कर्मयिों ने कौशल वकिास के लिए वभिन्नि कार्यशालाओं, सम्मेलनों, सेमनिारों, संगोष्ठयिों और पेशेवर प्रशक्षि्ण में भाग लयिा। इसके अलावा, वैज्ञानकिों ने कसिानों और अन्य हतिधारकों के लाभ के लिए, क्षेत्र स्तर पर कई कार्यशालाओं और प्रशक्षि्णों का आयोजन कयिा।

संस्थान ने 11 वद्विानों को बाहरी अनुदान के साथ अनुसंधान करने के लिए प्रयोगशाला और अन्य सुवधिाएं भी प्रदान कीं। इसके अतरिक्ति, वभिन्नि वशि्वद्यिालयों में पंजीकृत 34 छात्रों ने संस्थान की वभिन्नि प्रयोगशालाओं में अपने एमवीएससी/एमएससी और पीएचडी शोध कार्य कएि।

अन्य कार्यकलाप

इस अवधि के दौरान वार्षकि संस्थान अनुसंधान समति (आईआरसी) की बैठक आयोजति की गई थी। वार्षकि आईआरसी बैठक के दौरान कुल 49 परयिोजनाओं की समीक्षा की गई जसिमें दो नए, 23 चालू और तीन पूरे हुए आईआरसी अनुमोदति संस्थान परयिोजनाएं, दो अंतर-संस्थागत परयिोजनाएं, 17 बाह्य वत्तिपोषति परयिोजनाएं और दो अंतर्राष्ट्रीय सहयोगी परयिोजनाएं शामलि थी।

Executive Summary

The ICAR-National Institute of Animal Nutrition and Physiology has successfully completed 24 years since its foundation and achieved excellence in catering to the needs of farmers, educationists, extension workers, policy makers and industries associated with livestock farming. This year, the Institute is celebrating Silver Jubilee of its inception. The ICAR-NIANP is an ISO 9001:2015 certified Institution.

During the reported period from April to December 2019, the Institute functioned with 38 scientists, 9 technical staff, 12 administrative and accounts personnel and 2 skilled supporting staff. The total budget allocation was ₹2686.16 lakh for the financial year 2019-2020 and the total expenditure was ₹1896.56 lakh during the reported period. The institute also generated ₹52.19 lakh revenue during the period. The scientists of the Institute dedicatedly worked for achieving the various targets related to research and technology development and demonstration, defined under the major programmes as per the mandate.

Biogeography of Gut Microbes in Animals

A study was conducted to identify and characterize the microbes involved in biohydrogenization of unsaturated fatty acids in the rumen. Saturated and unsaturated fat sources were supplemented to study the effect on rumen microbial composition and isolation of bacteria involved in biohydrogenation. It was evident that coconut oil suppressed the rumen microbial diversity and protozoal counts as compared to that of flaxseed oil supplemented and control groups.

Under the ICAR-Network project on "Veterinary type culture- rumen microbes", a total of 55 bacterial cultures from various sources were isolated and 10 bacteria species were accessioned. Two species were selected for Whole genome sequencing. Further, 35 microbes from the rumen of sheep were isolated and six different strains were selected for accessioning.

Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

Developmental patterns of gastrointestinal and immune systems in response to pre-hatch and neonatal supplementation of amino acids and trace mineral were studied in broiler chicken. Growth performances of broiler chicken were enhanced due to *in ovo* and post-hatch supplementations of amino acids. Growth performances and cell mediated immune response of broiler chicken were enhanced due to post-hatch supplementation of the combination of amino acids (Lys, Met, Arg and Thr) and minerals (Zn, Cu and Se). However, the results indicated that *in ovo* supplementation of the combination of more than three amino acids should be done with caution and may not be beneficial for the commercial broiler chicken.

Attempt was made for elucidating the mechanisms of different levels of energy and protein influencing immune responses in goats. Different physiological parameters were affected by the nutritional stress caused by protein and energy deficiency. Significantly higher expression levels of the *HSP70, HSP110* genes in the nutritionally stress groups indicated the sensitivity of these genes to energy and protein deficiency in goats.

Efforts were made for the laboratory production of metal-carnitine chelates for improving bioavailability and tissue utilization of trace minerals and production performance in animals. Indigenous processes were developed for the production of Cu-Carnitine, Zn-Carnitine, Mn-Carnitine and Cr-Carnitine. The mineral content in the metal-carnitine chelates ranged from 100-130g/kg.

Grain sprouts was evaluated as fodder for livestock. Nutritive value of maize grain sprouts in terms of protein and fibre was found similar to wheat bran with higher energy content on DM basis. Further, maize grain sprouts contained higher vitamins and amino acids. However, feeding the maize grain sprouts at 50% and 100% levels resulted in lower dry matter intake and reduced growth rate in sheep.

Nutritional modules for commercial broiler sheep production was developed. It was evident that milk replacer supplementation in pre-weaned Avishaan lambs resulted in significantly higher body weight gains. The carry over effect of milk replacer supplementation during the pre-weaning phase in post weaning growth performance is on progress.

Development of precise delivery system for improved bioavailability of zinc in poultry is in progress. Encapsulation technology was standardized to prepare encapsulated zinc using different zinc salts, wall materials and two different methods. Microencapsulated zinc powder was produced from zinc sulphate hepta hydrate and zinc oxide.

Project was initiated to assess the biological activities of rare earth elements in relation to production

performance of egg and meat type chickens. A trial in layer hens is on progress to study the effect of supplementation of lanthanides on their bioavailability, sustainable egg production, biomineralization of egg and bone, intestinal integrity and residual effect, if any.

Studies on exploitation of insects as food and feed were conducted. Suitability of Black Soldier fly (BSF) larvae as poultry feed was assessed. The results indicate that BSF larvae meal possesses a good amino acid profile and it can be an effective partial replacement for soybean meal in broiler's diet.

Studies were conducted on retrofitting urea solution spraying system on straw baler. Optimum concentrations of urea and moisture were determined for rice and wheat straws at the time of baling. Addition of urea at the time of bailing increased crude protein value of the treated straws.

Studies were conducted under the DBT-Twinning project on biotechnological interventions for augmenting productive performance of pigs on horticultural by-product based diet. The fruit and vegetable by products were evaluated for use in pig ration. The *in vitro* experiments indicated that 30% inclusion of horticultural by-products in standard ration with prebiotic and probiotic was superior in terms of digestibility.

Efforts were made to develop a novel semen extender for improving the post-thaw motility of cryopreserved buffalo semen. A new buffalo-specific semen extender was developed using potential low molecular weight metabolites those are natural components of buffalo seminal plasma. The new semen extender improved the post-thaw motility and viability of cryopreserved buffalo spermatozoa significantly.

Comparative assessment of the resilience capacity of different indigenous goat breeds to summer heat stress based on selective thermo-tolerant gene expression pattern was performed. The metagenome analysis revealed associations between the rumen microbiome and heat stress at multiple genetic levels in the indigenous goat breeds Osmanabadi, Malabari and Salem Black. Most of the differential microbial features between the control and heat stress groups were found distinct among the three breeds. The results suggest that there are host and microbiome interactions in the rumen contributing to the variation in heat stress response.

Modulation of sexual differentiation in sheep embryos was attempted by altering the oxidative status of *in vitro* culture system. Embryos produced *in vitro* at low O_2 concentration exhibited greater developmental potential than those produced at high O_2 concentration. The sexual dimorphism in the pluripotency ability of the embryos suggested that the male embryos had greater pluripotency ability than the female embryos.

A study was conducted on G-protein coupled receptors and gut hormones in gut chemosensing and regulation of fat digestion and absorption in sheep. The supplementation of rumen protected long chain fatty acids (3 and 5% of DMI) in sheep increased the average daily body weight gain with 1.8- 2.0 fold improved body condition score. The feeding of fatty acids enhanced the post-prandial secretion of gut hormone cholecystokinin to facilitate the fat digestion and absorption, and reduced the post-prandial secretion of ghrelin to sustain the energy homeostasis in sheep.

A study was initiated to understand the role of Uric acid in alleviating oxidative stress induced mitochondrial dysfunction during different production cycles in poultry and its regulation by organosulphur compounds. Age associated decline in the membrane potential of mitochondria isolated from the duodenum and egg shell gland was evident. Further study is in progress for assessing the effect of garlic and/or allicin in combating mitochondrial dysfunction.

Investigation of the influence of administration of prostaglandin modulators on embryo survivability in sheep is in progress. Assays for estimating PGF2 and PGE2 in sheep plasma were optimized. PCR conditions for amplification of *IGF2, FGF2* and *β-actin* were optimized. Synchronization of estrus was achieved in sheep by double injection of Lutalyse at 9 days apart.

Modulation of GnRH system through the novel neuropeptides during embryogenesis and physiological responses was investigated in the post-hatch broiler chickens. *In ovo* administration of GnRH in combination with estradiol-17β enhanced the *GnRH* receptor expression and decreased the *GnIH* receptor mRNA abundances in the cultured pituitary cells. Higher levels of GH and steroid hormones facilitated rapid growth rate in the post-hatch broiler chicken.

Study was conducted for unravelling the physiological role of adiponectin in the regulation of energy metabolism in sheep. Expressions of *Adiponectin* and its receptors *(AdipoR1* and *AdipoR2)* were studied in the heat stressed goats. In Osmanabadi goats, the expression of *Adiponectin, AdipoR1* and *AdipoR2* was higher in the heat stressed than control group. In Malabari goats, *Aadiponectin*

expression was lower in the heat stressed than control group, but no difference was observed in the expression of *AdipoR1* and *AdipoR2* between the groups. In Salem black goats, the expression of *Adiponectin* was lower, but the expression of *AdipoR1* and *AdipoR2* was higher in the heat stressed than control group.

Attempt was made for over expression of NIANP_MBL_1, 2 & 3 clones, monoclonal antibody production and development of immuno assay for early pregnancy diagnosis in buffalo. Synthesised and sub-cloned the desired 200 amino acids equivalent sequence (clone NIANP_MBL_3) in the pET28a (+). The desired protein was expressed in E. coli and confirmed by SDS-PAGE analysis.

Under the National Fellow Project, the development of buffalo bull fertility diagnostic chip based on sperm transcripts signatures is in progress. Buffalo spermatozoal RNAs were found highly fragmented as compared to that of the cattle. The *PRM1* and *AKAP12* genes were observed to be a few of the abundant genes expressed in the buffalo spermatozoa.

Ethno-veterinary study for enhancement of reproductive performance in livestock was carried out using *in vitro* systems. Kaempferol, an active ingredient of *Moringa olifera* leaves at the dose of 10µM promoted the preantral follicle and granulosa cells functions. It was found more effective in improving the ovarian functions compared to the other plant active ingredients, which are in the order of Myricetin> Quercetin> Carbazole.

Various studies were conducted under the ICAR-AICRP project on "Nutritional and physiological approaches for improving reproductive performance in animals". It was evident that the buffalo seminal proteins SPINK2 and NEDD8 exhibited significant correlation with semen quality. A novel buffalo-specific semen extender resulted significantly improved post-thaw motility and viability of cryopreserved buffalo sperm. Among the three estrus synchronization protocols used in cows under field condition, Estra-doublesynch was found most effective. Dietary boron supplementation enhanced the semen quality and immune and antioxidant defence capacities in male goats.

Under the ICAR-Extramural project, investigation on Kisspeptin and its analogues as novel biomolecules to augment fertility in small and large ruminants is on progress. Dosages of Kisspeptin administration for inducing a favourable profile of reproductive hormones were standardized in sheep. Dosage of Kisspeptin (analogue) was established for effective induction of estrous of the synchronized ewes. Conception rate in the synchronized ewes treated with Kisspeptin and its analogue following natural insemination was found significantly higher as compared to the non-treated control ewes.

Under the DBT funded project, work was conducted on selective isolation of sex specific spermatozoa in bovines using novel biomarkers identified through an integrated proteomic and genomic approach. The proteins Tektin-3, A-kinase anchor protein 3, Carboxypeptidase Q, L-Lactate dehydrogenase, Zona pellucida binding protein, Outer dense fibre protein 2, Outer dense fibre protein 3 and Tubulin beta 4B chain were found differentially expressed between the conventional and X-enriched spermatozoa. These proteins were identified as the sex associated membrane proteins.

The DST sponsored Indo-Hungary project aimed for strategic improvement of efficiency of vitrification of ovine preantral follicles and embryos. Vitrification protocols using antioxidant retinol and cytoskeletal substance cytoschalasin resulted in higher post-thaw survival rates of ovine preantral follicles. The expression of the developmental genes was found higher in the post-thawed preantral follicles vitrified with retinol, but not with cytochalasin.

Establishment of 3D *in vitro* culture conditions for maintaining long-term stemness in sheep spermatogonial stem cells was attempted under the DST-SERB project. The results revealed that spermatogonial stem cells (SSC) formed in spheroid culture system without significant increase in size. The SSCs proliferated and were able to maintain stemness in the Geltrex culture system.

Studies on CRISPR/Cas9 guided functional analysis of genes regulating early embryonic survival in buffalo were initiated under the ICAR-NASF funded project. The endometrial epithelial cells were isolated successfully from buffalo uterus. The buffalo specific PTGES and PTGFS cDNAs were characterized.

The ICAR-NASF project on skewing the sex ratio towards female offspring in dairy cattle focused on the targeted immobilization of Y-bearing spermatozoa and modulation of oviduct millieu for the purpose. An *in vitro* oviduct explant model for studying sperm-oviduct binding in the cow was developed.

Feed Informatics, Feed Quality and Safety and Value Addition

A novel phytogenic blend to replace antibiotic growth promoters in broiler production has been developed. Efficacy of a novel phytogenic blend on production performance and caecal microflora composition was

assessed in broiler chickens under deep litter system. Supplementation of the phytogenic blend (1%) improved body weight gain and feed conversion ratio of broiler chickens and reduced the salmonella and coliform counts in caecum.

Antimincobial resistance (AMR) in the microbes is a global concern. Therefore, a project has been initiated for assessing and characterising AMR genes in poultry production environment. The project envisages identifying the potential of the metagenomes from poultry production environment in terms of AMR gene content.

Under the ICAR-CRP project on evaluation of value addition cereals and cereal by products for animal feeding, samples of bio-fortified wheat bran varieties were analysed. It was evident that bio-fortification resulted in increased zinc concentration, without adversely affecting *in vitro* dry matter digestibility and rumen fermentation.

Study was conducted under the ICAR-AICRP project on micro and secondary nutrients and pollutant elements in soil and plants. The contents of lead, cadmium and arsenic in sewage water, fodder crops and vegetables were found low and within the safe limits. Soil application of zinc sulphate (25kg/ha) improved zinc content (32.1ppm in treatment; 21.8ppm in control) and green fodder yield (34t/ha in treatment; 31.5t/ha in control) of jowar.

Feeding value of by-products of silkworm pupae (SWP) in ruminant rations was evaluated under the CSB funded project. The results indicate that deoiled SWP meal can be used as bypass protein supplement in livestock rations. By-product prepared from SWP oil can be incorporated in the ration of sheep up to 15% in the concentrate mixture without compromising the growth and nutrient utilization.

Climate Change Impact on Livestock

Investigations were carried out under the ICAR-Outreach project on estimation of methane emission under different feeding systems and development of mitigation strategies. The results indicated that the supplementation of silkworm pupae oil at 2% level did not affect the nutrient intake, digestibility and blood biochemical parameters in sheep. In contrast, due to changes in archaeal community and protozoa reduction with oil supplementation, a reduction in methane emission could be achieved. The16S rRNA amplicon sequencing revealed that *Methanobrevibacter* was the most abundant (89-93% of total archaea) archaea genus in the rumen of sheep.

The DBT-DFG funded Indo-German collaborative project on optimized use of feed resources for high lifetime productivity of dairy cows and consequences on enteric methane release was implemented. Methane production potential (ml/100mg in truly digested substrate) of the diet samples collected from the north and south transects of Bengaluru revealed a wide variation from 1.34 (tree leaves) to 6.01 (cereal straw). The diets formulated using dry fodder, concentrate and green fodder produced less methane as compared to the diets prepared with either dry roughage or roughage plus concentrate. Life cycle analysis of greenhouse gas emissions for the selected dairy farms in the study area was carried out using IPCC tier II guidelines.

An ICAR-ILRI collaborative project on methane emission was initiated. The impact of anti-methanogenic supplement Harit Dhara (5% of diet) on enteric methane emission and intake and digestibility of nutrient were assessed in sheep. The supplementation of Harit Dhara significantly decreased (21%) the enteric methane emission without affecting the nutrient intake and digestibility. Further, the supplementation significantly reduced the population of total rumen protozoa in sheep.

Technology Translation to Connect Discovery with Application

A micro level assessment of water use efficiency in different dairy production systems was conducted. The average direct consumptive water use was found 130l/d/animal for the smallholder system and 205l/d/animal for the commercial dairies. The calculated water use efficiency for the smallholder system was 0.85 and for the commercial dairying it was 1.62.

A study was conducted on the economics of milk production under different systems of dairy farm management in Karnataka. Efforts were made to assess the cost of milk production under different farming systems. The paid input cost (₹) was found 24.8-29.9 and the cost (₹) including family labour was found 28.7-34.4.

The ICAR-Farmer FIRST project on improving livelihood security of farmers through technological interventions for sustainable livestock farming was implemented in a cluster of 10 villages in the Doddaballapura taluk of Rural Bengaluru, covering 1000 farm families. Various technology interventions were introduced and awareness campaigns and capacity building programs were organized for the farmers, and rural youth. The interventions resulted in the considerable improvement of income and livelihoods of the farmers.

Another ICAR-Farmer FIRST project on enriching knowledge, integrating technology and institutions for

holistic village development in horticulture based farming system is underway. Awareness programs were conducted for farmers and they were advised on problems faced in small ruminant production systems. Mineral and protein supplements were distributed to the beneficiaries and all small ruminants were dewormed thrice in year.

Training and capacity building

During the reported period, the Institute was actively involved in various human recourse development activities. The Institute organized ICAR sponsored winter school, expert consultation meeting for SAARC countries, short term training course for African Nationals and five other short duration training courses.

The scientists, technical staff and administrative personnel attended various workshops, conferences, seminars, symposia and professional training for skill development. Further, the scientists, for the benefits of the farmers and other stakeholders, organized a number of workshops and trainings at field level.

The institute also provided laboratory and other facilities to 11 scholars for conducting research with external grants. Additionally, 34 students registered under different universities, conducted their MVSc/MSc and PhD research works at various laboratories of the Institute.

Others

The Annual Institute Research Committee (IRC) meeting was conducted during the reported period. A total of 49 projects were reviewed during the Annual IRC Meeting that included two new, twenty three ongoing and three completed IRC approved institute projects, two inter-institutional projects, 17 externally funded projects and two international collaborative projects.

The Vigilance Awareness Week was observed at the Institute and all the staff including permanent, contractual and students took the pledge for "Integrity: A Way of Life".

The MoS for Agriculture, Govt of India, Shri Parshottam Khodabhai Rupala Ji visited the Institute. He showed keen interest about the various activities of the Institute. He discussed about the issue of feeding of livestock and the need for taking up research activities on the climate resilient livestock production system.

Shri Atul Chaturvedi, IAS, Secretary (DAD), Govt of India, visited the Institute. He emphasized the need for research on reducing the cost of poultry feeds and approaches for doubling the farmers' income in terms efficient feeding of livestock.

During the reported period, one patent application was filed and two patents were granted. The technology of "Area Specific Mineral Mixture" and "Mineral Mixture for Small Ruminants" were commercialized to one firm in Karnataka through Agrinnovate India.

The Institute observed various official functions such as Republic Day, Independence Day, Hindi Pakhwada, Institute Foundation Day, International Yoga Day and others. Various social events were also organized by the 'Staff Welfare Club' for the staff and their families.

The Institute regularly conducted activities under the "Swachh Bharat Abhiyan" with the resolution to work towards Swachhta. Various initiatives were taken to maintain the office and campus premises clean and environment friendly and the "Swachhta Pakhwada" was observed. The scientists were also actively involved in the programme "Mera Gaon Mera Gaurav" for extending technical expertise for the benefit of farmers.

Chapter-1

INTRODUCTION

Genesis

The ICAR-National Institute of Animal Nutrition and Physiology (ICAR-NIANP) is on the threshold of completion of 25 years since its inception. The Institute has travelled and imprinted its footsteps during the past 25 precious years. It has certainly marked its glorious presence with its substantial progress on all counts during all these years and today it is a ISO 9001:2015 certified Institution.

The National Commission on Agriculture recommended the creation of the ICAR-NIANP during the year 1976 to work on the fundamental and the basic principles involved in optimum nutrient utilization. Subsequently, realizing the national need for improvement of feed resources and their utilization by unravelling basic physiological and nutritional principles to improve animal productivity, the proposal for establishment of the institute was approved by the Planning Commission in the VIII five-year plan. The ICAR constituted a committee of experts in October 1992 to suggest the location, structure, function and other related issues for establishment of the Institute. Consequently, the institute was established on 24 November 1995 as per the recommendations of the Stripe Review Committee. Currently, the ICAR-NIANP is primarily involved in conducting fundamental studies on basic nutritional and physiological aspects related to bio-physical translation of nutrients for productive functions in livestock.

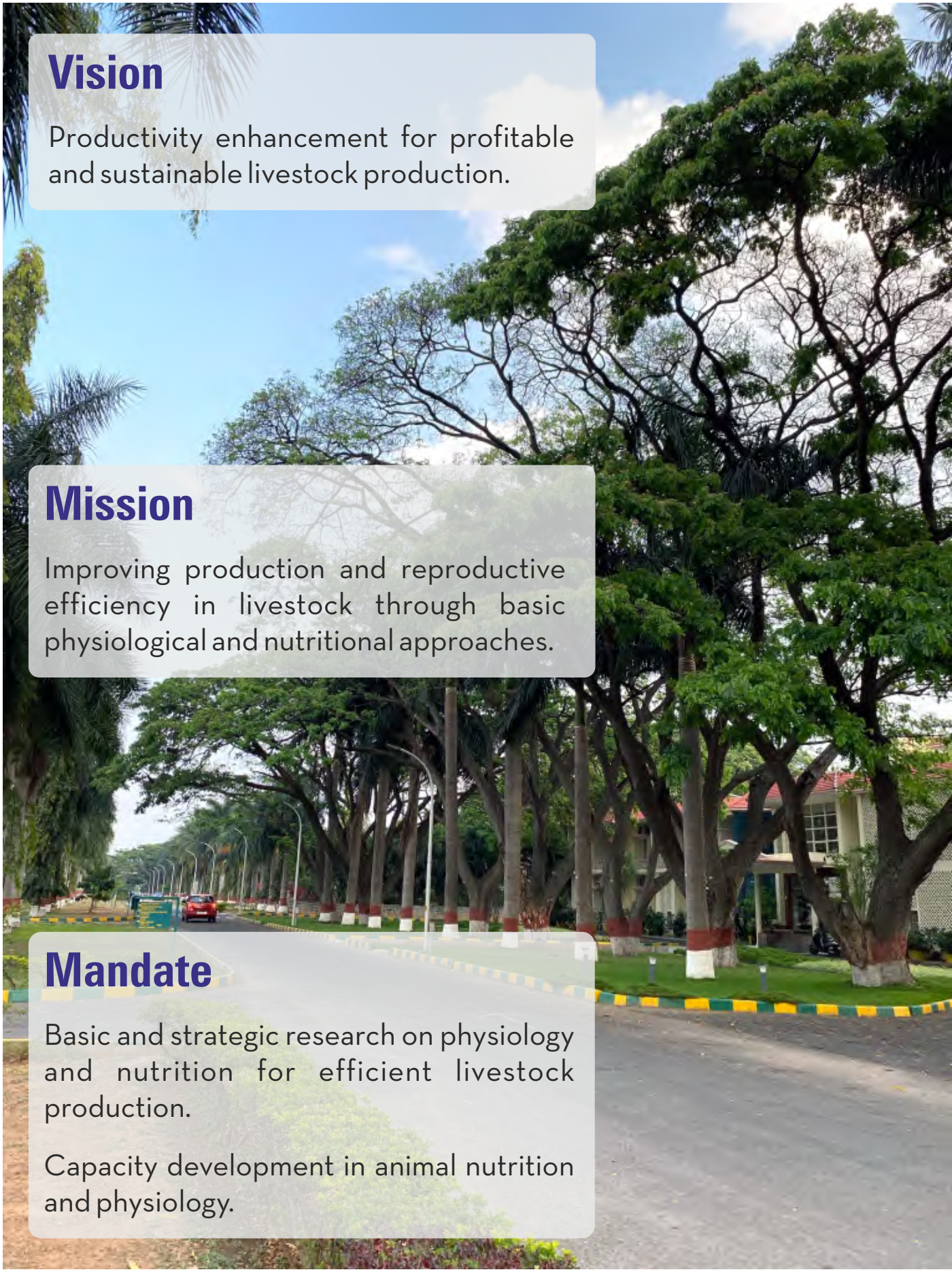
Location

The institute is located in the heart of sprawling Bengaluru city on the National Highway 7 on Bengaluru-Hosur Road. The institute is approximately 8 km away from the Bengaluru City Railway Station and 40 km from the Kempegowda International Airport.

Staff

The Institute is headed by the Director and currently 35 scientists including four women scientists are in position.

Staff Position as on 31 December, 2019		
Category	Sanctioned Posts	Staff in Position
Director	1	1
Scientific	44	35
Technical	12	9
Administration and Accounts	17	10
Skilled supporting staff	3	2
Total	77	57



Vision

Productivity enhancement for profitable and sustainable livestock production.

Mission

Improving production and reproductive efficiency in livestock through basic physiological and nutritional approaches.

Mandate

Basic and strategic research on physiology and nutrition for efficient livestock production.

Capacity development in animal nutrition and physiology.

Objectives

To carry out quantitative and qualitative assessment of feed resources and to develop district-wise information system.

To enhance availability of nutrients through various approaches viz., strategic supplementation, biotechnological interventions and feed-processing technologies.

To enhance reproductive efficiency of livestock through physiological and nutritional interventions.

To address issues of feed quality and safety.

To develop strategies for validation of evolved technologies at user's level for production enhancement.

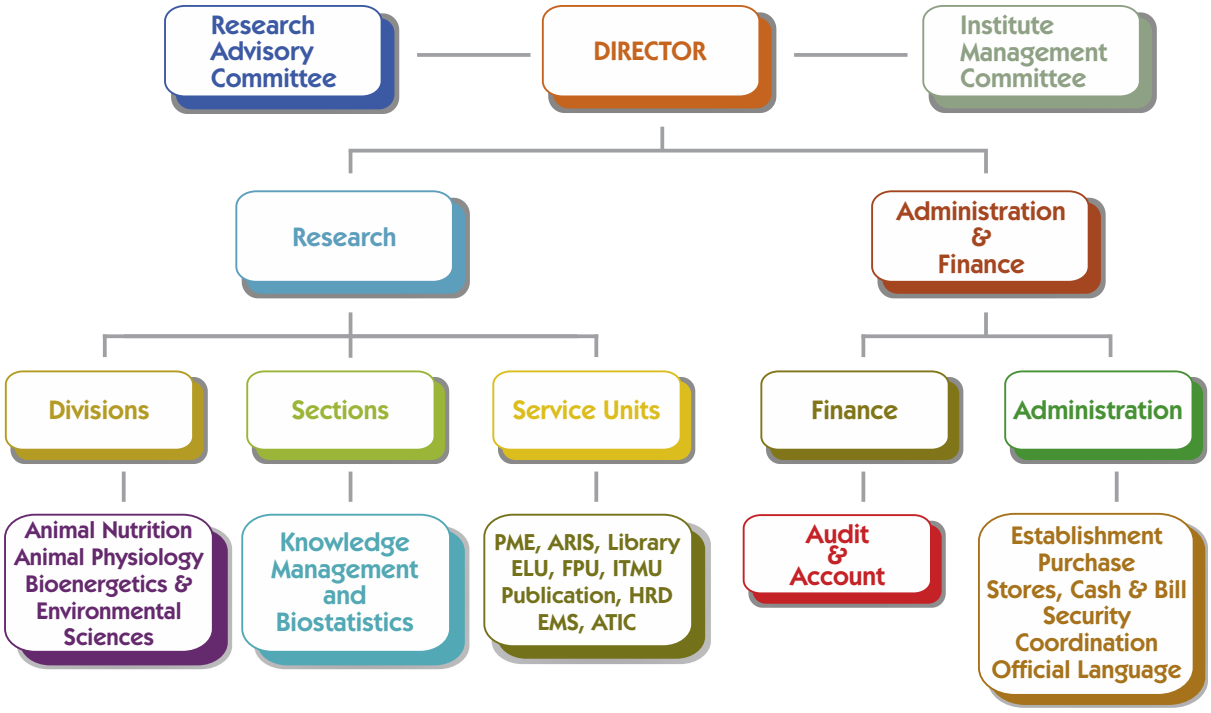
Priority Setting and Management

The Institute has a high powered Research Advisory Committee (RAC) comprising of eminent scientists and professors, who guide the research agenda of the institute and set research priorities. Dr K Pradhan, Chancellor, SOA University, Bhubaneswar is the chairman of the committee. The other members of the committee are scientists and professors from the field of animal nutrition, physiology and biotechnology.

The functioning of the institute is supervised by the Institute Managemental Committee (IMC) headed by the Director of the institute as Chairman and members drawn from state government, university and public including industry personnel. A number of internal committees such as Central Purchase, Library, Official Language Implementation, Grievance, Publication, Priority Setting Monitoring and Evaluation (PME) Cell, Staff Welfare Club, IPR Cell and Institute Technology Management Unit have been constituted to decentralize the management with developed responsibilities for smooth functioning of the institute. The Institute Joint Staff Council promotes healthy and congenial work environment. The Institute Research Council (IRC) provides a platform for effective professional interactions in respect of review and implementation of various research projects, which are also supported by an external evaluation committee. The PME Cell of the Institute plays a major role in prioritising the internal and external projects based on the mandate and thrust areas. Moreover it has forward and backward linkages with the RAC, IRC and HYPM in project monitoring and evaluation.

The Institute gave priority to the newly identified thrust areas to strengthen the basic and fundamental research. The Institute is coordinating the AICRP project on "Nutritional and Physiological Approaches for Enhancing Reproductive Performance in Animal" with collaborating 11 centres and an Outreach project on "Methane Emission in Ruminants" with six collaborating centres. The prestigious Farmer FIRST Project on "Improving Livelihood Security of Farmers through Technological Interventions for Sustainable Livestock Farming" is implemented at two different locations in Bengaluru. The Institute is also a partner in the Outreach project on "Drug Residues and Environmental Pollutants", ICAR-CRP project on "Evaluating Value Added Cereal By Products for Animal Feeding", ICAR-Network project on "Veterinary Type Culture Collection" and Farmer FIRST Project on "Enriching Knowledge and Integrating Technology and Institutions for Holistic Village Development in Horticultural Based Farming Systems". In addition, the Institute is also involved in the international research collaborations with Germany, Hungary and International Livestock Research Institute (ILRI). Besides, the scientists were involved with several externally funded research projects. The institute effectively implemented the programme "Mera Gaon Mera Gaurav" and "Swachh Bharat Abhiyan" and several trainings and workshops were organized for the stakeholders.

Organizational Setup



The matrix mode of management is adopted in the research activities, which provide devolved responsibilities for effective implementation of multidisciplinary/ interdisciplinary programmes. For administrative purposes, the Institute has identified three research divisions and one section with strong support of central facilities and computerized administrative set up. Director is the Head of the Institute, supported by administrative and financial wings. To strengthen the local decision-making and research monitoring, Research Advisory Committee, Institute Management Committee, Institute Research Council and PME Cell play a vital role through periodical meetings.

Institute Programmes

Programme	Title
1	Deconstruction of ligno-cellulosic biomass for improving feed utilization
2	Biogeography of gut microbes in animals
3	Novel approaches for assessing and improving nutrient bioavailability, animal reproduction and productivity
4	Feed informatics, feed quality and safety and value addition
5	Climate change impact on livestock
6	Technology translation to connect discovery with application

Expenditure Statement

Statement showing the sub head wise allocation and expenditure of fund during the period of April to December, 2019 (₹ in lakh).

Sub heads	Budget 2019	
	RE (FY 2019-20)	Expenditure as on 31 Dec 2019
A. Institute		
1. Works	116	23.06
2. Equipment and other capital expenditure	135	16.21
3. Establishment charges	1350	1107.15
4. Pension and other retirement benefits	290	288.74
5. Travelling allowances	16	9.33
6. HRD	3.5	2.51
7. Research and operational expenses	118.78	56.79
8. Administrative expenses	360	230.20
9. Miscellaneous expenses	30.72	6.87
10. Loans and advances	58.16	1.50
Total A	**2478.16**	**1742.36**
B. AICRP and Outreach projects	208	154.20
Grand total (A+B)	**2686.16**	**1896.56**

Revenue Generation

Sub heads	Amount (₹ in lakh) as on 31 Dec 2019
A. Sale of farm products, livestock etc.	1.01
B. Other receipts	
1. Sale of publications, CDs/royalty etc.	0.18
2. Analytical testing fees	2.6
3. Other receipts including LF/Interest/IRGS/LS&PC	48.4
Grand total (A+B)	**52.19**

Chapter-2

RESEARCH PROJECTS

Biogeography of Gut Microbes in Animals

BGM 2.4: Isolation and characterization of lipolytic/ lipid biohydrogenation bacteria from the rumen of sheep supplemented with different fat sources

NM Soren, M Chandrasekharaiah, SBN Rao, M Bagath

- The study was initiated to identify and characterize the microbes involved in biohydrogenization of unsaturated fatty acids in rumen.
- Saturated and unsaturated fat sources were supplemented to understand the effect on rumen microbial composition and isolation of bacteria involved in biohydrogenation.
- Coconut oil suppressed the rumen microbial diversity and protozoal counts as compared to the flaxseed oil supplemented and control groups.

Rumen bacteria plays an active role in the biohydrogenation process, wherein unsaturated fatty acids(USFAs) are converted to saturated fatty acids (SFAs) in the rumen. Therefore, the ruminants's products like milk and meat are generally rich in SAFs. One of the ways to increase the USFAs content in ruminant products is to control the biohydrogenation process in the rumen. The major biohydrogenation intermediate present in the rumen is *trans*-vaccenic acid, which serves as a precursor for the synthesis of SFAs and CLAs at the tissue level. Controlled biohydrogenation process of USFAs could facilitate increase level of USFAs and CLAs in ruminant products. Identification of newer bacteria species involved in the biohydrogenation process in the rumen would aid in identifying different metabolic pathways involved in the process and the intermediate metabolites formed.

Three dietary treatments, G-1 (control; without fat supplementation); G-2 (saturated fat; coconut oil) and G-3 (unsaturated fat; flaxseed oil) were used in the study. The oils were mixed in the concentrate (5% level). The effect of different types of fat on rumen protozoa and bacteria was studied in sheep. The number of small holotrich, large holotrich, small spirotrich, large spirotrich and total protozoa were found significantly lower in the coconut oil supplemented sheep as compared to the control and flaxseed oil supplemented groups.

Rumen bacterial profile was studied by using 16s rDNA sequencing. The rumen DNA was sequenced at the read length of 2x300 bp and generated ~1 lakh reads per sample on MiSeq platform. Bioinformatics analysis was done using QIIME software.

Operational Taxonomic Units (OTUs) were identified and compared the communities by using taxonomic assignments. The maximum OTUs were identified from the flaxseed oil (G-3) supplemented sheep (1464), while minimum OUTs was identified from the sheep supplemented with coconut oil (G-2; 1264) that was lower than the control (1418). The results revealed a decrease in OUTs in the coconut oil supplemented group than the G-1 and G-2 group. The Shannon diversity index values in the study were 8.078, 7.422 and 8.059 in the G-1, G-2 and G-3 groups, respectively.

The NGS amplicon sequencing indicated several genera in the G-1 (70), G-2 (67) and G-3 (71) groups and good numbers of sequences were also found under the unclassified category in the G-1 (58), G-2 (60) and G-3 (61) groups. The dominant bacterial phyla in the rumen of the control (G-1) group of sheep in the decreasing order were Bacteroidetes (50.20), Firmicutes (30.44), Euryarchaeota (5.49), Lentisphaerae (3.66), Planctomycetes (1.90), Spirochaetes (1.53) and Verrucomicrobia (1.32).While in the G-2 group, the dominant phyla were Firmicutes (40.86), Bacteroidetes (34.42), Proteobacteria (6.50), Verrucomicrobia (3.77), Spirochaetes (2.90), Euryarchaeota (2.74), Lentisphaerae (2.54) and Cyanobacteria (2.28). In the G-3 group, the dominant phyla were Bacteroidetes (48.47), Firmicutes (35.68), Euryarchaeota (3.87), Spirochaetes (2.09), Lentisphaerae (1.92), Verrucomicrobia (1.43) and Planctomycetes (1.24).

The dominant genera in the rumen of G-1 group of sheep were *Prevotella* (29.3), *Methanobrevibacter* (5.3), *Ruminococcus* (3.9), *Succiniclasticum* (2.0), *Butyrivibrio* (1.8), *CF231* (1.7), *RFN20* (1.7), *Treponema* (1.4) and *Clostridium* (0.7). In the in G-2 group, the dominant genera were *Prevotella* (23.3), *Ruminococcus* (5.8), *RFN20* (4.1), *YRC22* (4.1), *Methanobrevibacter* (2.6), *Treponema* (2.7), *Succiniclasticum* (1.7), *Butyrivibrio* (1.5) and *Clostridium* (0.9). In the G-3 group, the dominant genera were *Prevotella* (31.3), *Ruminococcus* (5.9), *Methanobrevibacter* (3.5), *Butyrivibrio* (3.3), *Succiniclasticum* (2.3), *Treponema* (2.0), *RFN20* (1.8),

CF231 (1.3), *YRC22* (0.8) and *Clostridium* (0.5). However, only few bacterial species namely *Fibrobactersuccinogenes*, *Ruminococcusflavefaciens*, *Bifidobacteriumpseudolongum*, *Selenomonasruminantium*, *Bacillus foraminis*, *Lactobacillus iners*, *Oscillospiraguilliermondii*, *Sphingomonasyabuuchiae*, *Bifidobacteriumlongum* and *Selenomonasnoxia* could be identified across all the groups.

ICAR-Network: Veterinary type culture- rumen microbes

D Rajendran, NM Soren

- A total of 55 bacterial cultures from various sources were isolated and 10 bacteria species were accessioned. Two species were selected for whole genome sequencing.
- A total of 35 microbes from rumen of sheep were isolated and six different strains were selected for accessioning.

ICAR has established the "Nation Centre for Veterinary Type Culture" and rumen microbe repository is part of this project. ICAR-NIANP is the lead centre for rumen microbe culture collection. The co-operating Centres are ICAR-IVRI, ICAR-NDRI, ICAR-NRC Camel, ICAR-CIRG and ICAR-CSWRI. The project aims to isolate and purify anaerobic gut microbes, study the micro-morphological and biochemical characteristics, establish molecular signatures of the purified gut microbes and accession the cultures into the repository. During the reported period, sheep rumen liquor was collected for isolation of anaerobic bacteria. One ml of rumen fluid was added to 9 ml of ADS. From this stock solution, dilutions were made up to 10^{-5}. Inoculums (0.5 ml) from the test tube labelled 10^{-5}were introduced in anaerobic basal agar in the roll tubes. The tubes were incubated at 39°C for 3 days. A single isolated colony was picked up and transferred to anaerobic basal broth. Two pure cultures of bacteria were isolated, their morphological characters were studied by Gram staining and preliminary tests were performed such as catalase and oxidase tests. The cultures were then subjected to various biochemical tests by API-20A kit from Biomerieux. The enzyme activity of the isolates was tested by Zyme Kit from Biomerieux. The DNA was isolated by Zymo research DNA Kit and was sequenced. Based on the 16s rRNA sequence homology, the sequences were BLASTED on NCBI Portals. Based on the identity score, first 10 sequences were selected and aligned using multiple alignment software program CLUSTAL W. Isolated organisms were identified as *Bacillus flexus* NBRC 15715, *Bacillus flexus* IFO15715, *Streptococcus lutetiensis* CIP 106849, *Streptococcus lutetiensis* HDP90246, *Propionibacterium australiense* LCDC-98A07 and, *Bacillus subtilis* NRRL B-4219. A total of 35 microbes from the rumen of sheep were isolated and identified six different strains for accessioning. Further, the collaborators contributed three bacteria from ICAR-CIRG and 17 bacteria from ICAR-CSWRI centre.

Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

APR 3.9: Nutritional conditioning for neonatal programming in broiler chicken: gut development and immunity

AV Elangovan, NKS Gowda, J Ghosh, CG David, VB Awachat

- Growth performances of broiler chicken were enhanced due to *in ovo* and post-hatch supplementations of amino acids.
- Growth performances and cell mediated immune response of broiler chicken were enhanced due to post-hatch supplementation of the combination of amino acids (Lys, Met, Arg and Thr) and minerals (Zn, Cu and Se).
- *In ovo* supplementation of the combination of more than three amino acids should be done with caution and may not be beneficial for the commercial broiler chicken.

The project was taken up with the objective to explore the developmental patterns of gastrointestinal and immune system in response to pre-hatch and neonatal supplementation of amino acids and trace mineral. Series of trials were conducted to explore the optimum dose of amino acid combination for *in ovo* supplementation. The results of the Trial-I revealed that the hatchability decreased as the dosage of amino acids and minerals (Lys, Met, Arg, Thr, Glu, Zn, Se and Cu) and osmolarity of the solutions increased. To rule out any possible of amino acid and mineral interaction causing the reduction in hatchability, more trials were conducted without minerals and with only amino acid combinations (Trial-II to IV). *In ovo* supplementation of five amino acids (Lys, Met, Thr, Arg and Glu) and four amino acids (Lys, Thr, Arg and Glu) combinations even at lower doses (1x) resulted in poor hatchability (30%). The combination of four amino acids (Trial-III; Met, Thr, Arg and Glu) without Lys at lower doses resulted in good hatchability (86.6%). It is concluded that *in ovo* supplementation of more than three amino acids combination should be done with caution.

Series of growth trials were conducted to explore the effect of different amino acid/ mineral combinations for *in ovo* and post-hatch supplementation in broiler chicken. The salient findings are: *in ovo* supplementation of zinc did not influence the growth performance, gastrointestinal development, nutrient utilization and bone growth or mineralization of broiler chicken; cell mediated immune response of chicken was significantly higher on *in ovo* supplementation of organic and inorganic zinc (80·g) in egg; *in ovo* supplementation of amino acids (Thr, Arg and Glu) or minerals (Zn and Cu) increased the gut development at the time of hatch; growth performances of broiler chicken were enhanced due to *in ovo* and post hatch supplementations of amino acids (Lys, Met and Thr); growth performances and cell mediated immune response of broiler chicken was enhanced due to post-hatch supplementation of the combination of amino acids (Lys, Met, Arg and Thr) and minerals (Zn, Cu and Se).

APR 3.10: Development of a novel semen extender for improved post-thaw motility of cryopreserved buffalo semen

SC Roy, A Dhali, KS Roy

- A new buffalo-specific semen extender was developed using potential low molecular weight metabolites those are natural components of buffalo seminal plasma.
- The new semen extender improved the post-thaw motility and viability of cryopreserved buffalo spermatozoa significantly.

The semen is cryopreserved for subsequent breeding and improvement of farm animal species through artificial insemination. However, the major drawback of cryopreserved semen is its reduced post-thaw motility and the fertility. Among the ruminants, buffalo spermatozoa are more susceptible to hazards during freezing-thawing than that of the cattle spermatozoa. Consequently, the average conception rate in buffaloes inseminated with frozen-thawed semen is lower than that of cattle. Over several decades, the composition of semen extender used for cryopreservation of buffalo semen remains primarily similar to that of cattle, even though it has been aptly reported that the composition of sperm structure and seminal plasma of these two species are significantly different. For the last 2-3 decades, various agents have been added empirically to the semen extender for improving the post-thaw sperm motility and fertility. However, most of these approaches remained primarily unsuccessful and hence could not find a place in semen cryopreservation protocol of semen stations. Further, most of these agents have been added to the semen extender without knowing whether those are really required for the sperm or whether they are natural component of the seminal plasma of a specific species. Thus, currently a suitable buffalo-specific semen extender is not available and hence there is a desperate need to develop such a semen extender.

The components of the seminal plasma play important roles for motility and fertility functions of a mammalian spermatozoon. Thus, ideally, it is necessary to provide the sperm a microenvironment similar to that of the seminal plasma during semen dilution and cryopreservation. Nevertheless, in practical situation, it becomes very difficult to find a replacement for seminal plasma as several of the constituents or factors of seminal plasma are still remain unidentified. Neither, all the known components of seminal plasma are available commercially to be added during dilution. Until now, several fertility enhancing proteins of seminal plasma

Fig. 1: The new buffalo-specific semen extender developed at ICAR-NIANP.

have been identified, but, none of them is available commercially. Further, the cost-economics of such approach is yet to be worked out. Thus, the available intervention that appears feasible and economic is to supplement the extender with naturally occurring key small metabolites of seminal plasma that have potential for sperm protection and function. In view of this, an attempt was made to analyze small metabolites of the both cattle and buffalo seminal plasma using a modern tool of mass spectrometry. Out of the 35 selected small metabolites analyzed, the concentrations of many metabolites were found significantly low in seminal plasma of buffaloes as compared to that of cattle. Effects of pre-freeze addition of each of these deficient metabolites to semen extender on buffalo sperm functions were studied. The optimum concentration of each deficient metabolite that improved the post-thaw viability and motility of buffalo sperm was determined. After screening several of these, about five promising metabolites were selected and subsequently used for the development of a new buffalo-specific semen extender (Fig. 1). Trials of the newly developed buffalo-specific semen extender are in progress before its application in the field level. In preliminary studies, the new extender improved the post-thaw sperm motility and viability of cryopreserved buffalo spermatozoa significantly over the control group.

APR 3.14: Comparative assessment of the resilience capacity of different indigenous goat breeds to summer heat stress based on selective thermo-tolerant gene expression pattern

V Sejian, G Krishnan, M Bagath, RK Veeranna, R Bhatta

- The results of metagenome analysis revealed associations between the rumen microbiome and heat stress at multiple genetic levels in the indigenous goat breeds Osmanabadi, Malabari and Salem Black.
- Most of the differential microbial features between the control and heat stress groups were found distinct among the three breeds.
- The results suggest that there are host and microbiome interactions in the rumen contributing to the variation in heat stress response.

The project aimed to evaluate the resilience capacity of different indigenous goat breeds to heat stress, compare differences in economically important thermo-tolerant gene expression in different indigenous goat breeds exposed to heat stress and to establish the association of the gene expression data with the phenotype traits related to heat stress during summer season.

Variations in the composition of rumen microbiotain response to heat stress were assessed based on metagenome analysis in the different indigenous goat breeds (Fig. 2). In goat, the most abundant genera (representing more than 0.1%) found in rumen were Prevotella (26.05%), Psychrobacter (20.42%), Pseudomonas (4.10%), Veillonella (4.46%), Pedobacter (3.79%), Bacteroids (3.33%), SHD_231 (5.06), Ruminococcus (2.44%), Bifidobacterium (3.04%), Streptococcus (2.90%), Planococcus (2.46%), Butyrivibrio (3.28%), Faecalibacterium (2.18%), Methanobrevibacter (1.16%), Lachnospira (1.09%) and Sutterella (0.88%).A remarkable variation in the rumen microbial composition was observed in Osmanabadi and Salem Black heat stressed goats

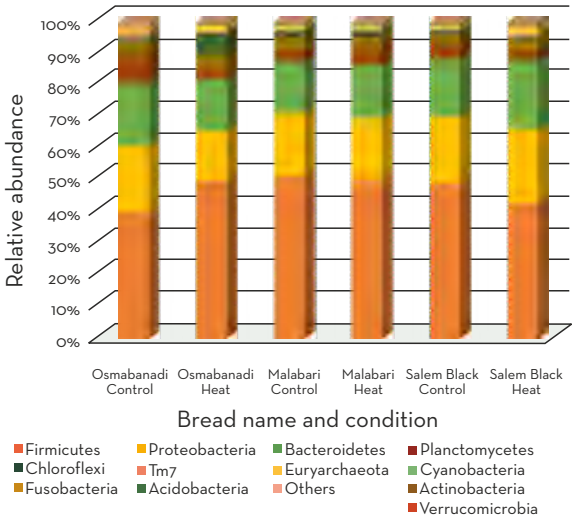


Fig. 2: Rumen bacterial communities at phylum level in the experimental groups.

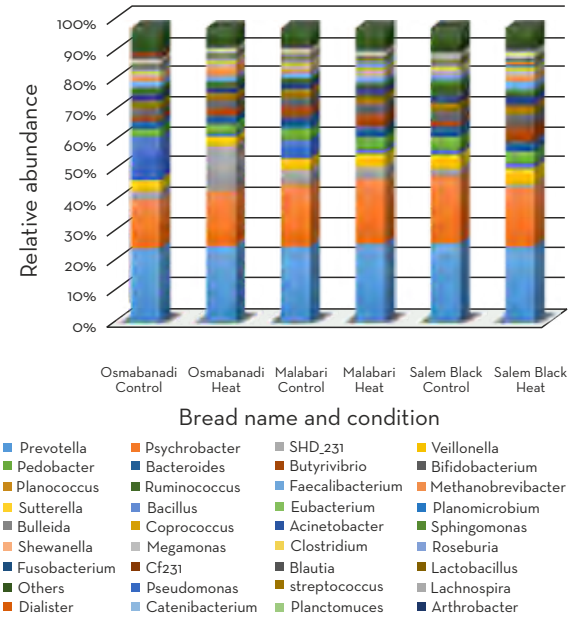


Fig. 3: Rumen bacterial communities at genus level in the experimental groups.

than their control. However, a relatively lower variation in rumen microbiota was observed in Malabari goats subjected to heat stress. While the heat stressed Osmanabadi goats had a relatively higher abundance of Firmicutes (40.14% to 50.04%), the same phyla had a lower abundance in Salem Black (49.15% to 42.99%) and Malabari (51.33% to 50.62%) goats under heat stress. Additionally, a substantial decline in the relative abundance of Proteobacteria (21.06% to 15.76%), Planctomycetes (9.51% to 3.42%) and TM7 (2.51% to 0.70) was observed in heat stressed Osmanabadi goats. However, these variationswere not observed in Malabari and Salem Black goats under heat stress. The relative abundance of Proteobacteria and TM7 was similar in both the treatment groups, an increased abundance of Planctomycetes was observed in heat stressed Malabari goats (3.76% to 5.61%), while the same had a lower abundance in Salem Black goats (4.69% to 2.98%). The phyla Euryarchaeota also had an increased relative abundance in heat stressed Osmanabadi (0.82% to 1.51%) and Salem Black (0.36% to 1.58%) goats. An increased relative abundance of Chloroflexi was observed only in heat stressed Osmanabadi goats (1.38% to 6.89%), while in the other two breeds this phyla was either unaffected or had a mild reduction.

The variation in the ruminal microbial genera at the breed level was also evaluated (Fig.3). The genera that exhibiteda substantial abundance in these groups were *SHD_231*, *Pseudomonas*, *Butyrivibrio*, *Methanobrevibacter* and *Ruminococcus*. The relative abundance of *Pseudomonas* was similar both in Salem Black control and heat stress goats, but a drastic reduction was noticed in Osmanabadi (14.79% to 0.82%) and Malabari (6.16% to 1.23%) heat stressed goats than their respective controls. Although, the relative abundance of *Pseudomonas* was similar across all the breeds subjected to heat stress, the proportion of its reduction varied substantially; the maximum reduction noticed in Osmanabadi (-13.97%) than the Malabari goats (-4.93%). The relative abundance of *SHD_231* varied in Osmanabadi and Salem Black goats, while it remained almost the same in Malabari goats. The relative abundance of *SHD_231* was higher in heat stressed Osmanabadi goats (2.9% to 15.03%), while a decline was observed in heat stressed Salem Black goats (2.40% to 0.91%) as compared to control. Comparing across the three heat stressed breeds, Osmanabadi goats had the highest relative abundance of *SHD_231*, while Salem Black had the least (15.03% and 0.91%, respectively). Another highly variable relative abundance was observed in the genus *Methanobrevibacter*. While the relative abundance of this genus declined in Malabari goats (1.32% to 0.66%), a substantial increase was noticed in Osmanabadi (1.72% to 3.26%) and Salem Black (0.41% to 1.98%) heat stressed goats. Across the heat stressed breeds, Osmanabadi had a highest relative abundance of *Methanobrevibacter*, followed by Salem Black and least in Malabari goats. The genus *Butyrivibrio* and *Ruminococcus* also exhibited varied relative abundance across the breeds and treatment groups. The relative abundance of *Butyrivibrio* was higher in heat stressed Osmanabadi (1.63% to 2.66%) and Salem Black (1.79% to 5.78%) goats than the control with a highlighting increase in the later breed. The relative abundance of *Ruminococcus* was also drastically reduced in Salem Black (4.96% to 2.06%) goats subjected to heat stress compared to its control goats. The relative

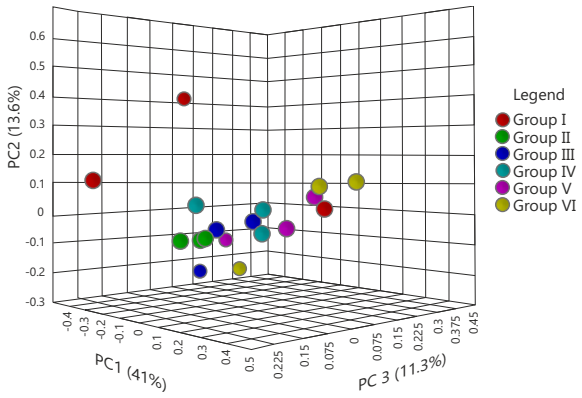


Fig. 4: Microbial diversity among the experimental groups based on principal component analysis.

abundance of these two genera was almost similar in Malabari goats.

The principal component analysis was also performed based on the Bray Curtis index (Fig. 4) to assess differences in microbial diversity among the groups (Osmanabadi control: Group I; Osmanabadi heat stress: Group II; Malabari control: Group III; Malabari heat stress: Group IV; Salem Black control:Group V; Salem Black heat stress: Group VI). Overall, the results indicated a clear division among all the six groups. The respective samples for control and heat stressed groups of each breed had a division in their clustering. The Osmanabadi control group samples exhibited a variation among the samples. Additionally higher variation was observed in the clustering between Osmanabadi control and heat stressed goats. On the other hand, the treatment and control groups had lower variation in Malabari and Salem Black goats.

APR 3.15: Modulation of sexual differentiation in embryos altering oxidative status of *in vitro* culture system

A Mishra, A Dhali, IJ Reddy, PSP Gupta

- » Sheep embryos produced *in vitro* at low O_2 concentration exhibited greater developmental potential than those produced at high O_2 concentration.
- » The sexual dimorphism in the pluripotency ability of the embryos suggested that the male embryos had greater pluripotency ability than the female embryos.

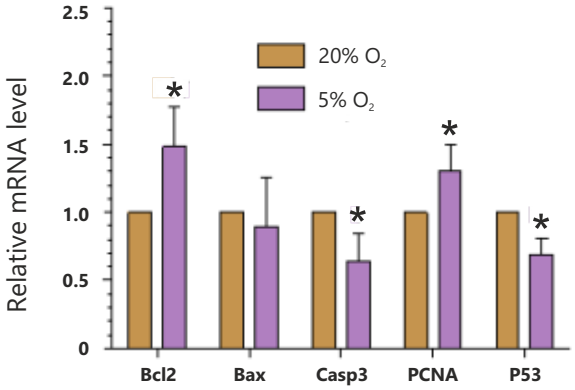


Fig. 5: Effect of different O_2 concentrations on expression of the apoptosis related genes in ovine blastocysts. * indicates a significant difference ($p<0.05$).

Effect of different O_2 (5 and 20 %) concentrations on the developmental potential of *in vitro* produced ovine embryos and expression of genes related to the apoptotic pathway and pluripotency in those embryos were compared. Oxygen concentration did not influence the maturation and cleavage rates, but the percentage of morula and blastocysts were significantly more at the 5% as compared to 20% O_2. A significant upregulated expression of the *Bcl2* and *PCNA* genes and significantly downregulated

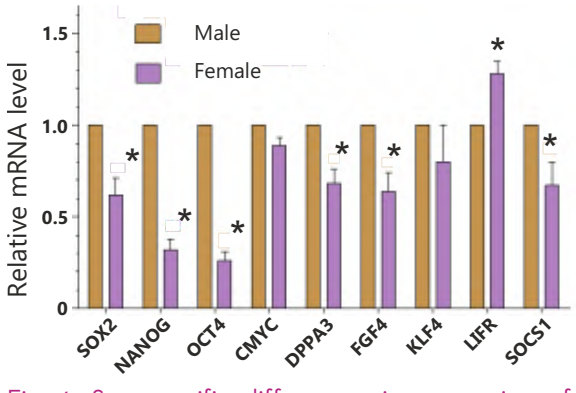


Fig. 6: Sex specific differences in expression of embryonic transcription factors related to pluripotency. * indicates a significant difference ($p<0.05$).

expression of the *Casp3* and *p53* genes were observed in the blastocysts at 5% as compared to those at 20% O_2 (Fig. 5). The expression of *Bax* was not influenced by the O_2 concentration (Fig. 5).

Among the pluripotency related transcripts, the expression of Oct4 was significantly upregulated and the expression of *Sox2* and *Nanog* was significantly downregulated in the embryos at 5% than at 20% O_2 (Fig. 6). The results indicate that the embryos produced at low O_2 (5%) had more developmental

potential than those produced at high (20%) O_2 concentration.

The sexual dimorphism in the intracellular level of reactive oxygen species (ROS) and the expression of embryonic transcription factors related to pluripotency suggest that intracellular ROS level was significantly low in the female embryos than male (Fig. 7), and male embryos had more pluripotency ability as compare to the female embryos. Although intracellular ROS level was low in the female embryos than male, the developmental potential of female embryos were diminished *in vitro* due to the ROS mediated suppression of energy metabolism that caused depletion in ATP, in turn kept the female embryos more stressful as compared to the male embryos. Further, the differentiation properties of the embryonic stem cells were affected and pluripotency ability of the female embryos was reduced.

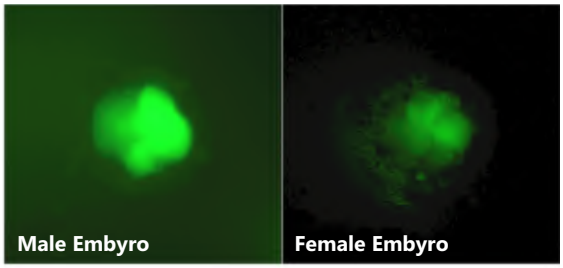


Fig. 7: Sex specific differences in intracellular embryonic ROS level.

APR 3.16: G-protein coupled receptors and gut hormones in gut chemosensing and regulation of fat digestion and absorption in sheep

G Krishnan, V Sejian, M Bagath, MN Soren, C Devaraj, RK Veeranna

- The supplementation of rumen protected long chain fatty acids (3 and 5% of DMI) in sheep increased the average daily body weight gain with 1.8- 2.0 fold improved body condition score.
- The feeding of fatty acids enhanced the post-prandial secretion of gut hormone cholecystokinin to facilitate the fat digestion and absorption, and reduced the post-prandial secretion of ghrelin to sustain the energy homeostasis in sheep.

Lipid ingestion activates many changes in the enteroendocrine system that affects appetite and feed intake to sustain the energy homeostasis. A study was conducted in adult sheep for a period of 60 days to assess the chemosensing of fat digestion and absorption by the gut hormones. The experimental animals were randomly divided into three groups (G-I: Control, N=8; G-II: Treatment-I, N=8; G-III: Treatment-II; N=8). The animals were fed as per the ICAR standard and the animals in the treatment-I (G-II) and treatment-II (G-III) groups were fed with an additional 3% and 5% bypass fat on dry matter intake, respectively. Blood sampling was done at fortnightly interval (08.00h and 11.00h) and ELISA was carried to determine the concentration of ghrelin and cholecystokinin (CCK). The body condition score was improved in all the groups. However, it was 1.8 to 2-fold higher in the animals fed with protected fat than the control (Fig. 8). The average daily body weight gain (g) was significantly higher in the G-II (85.00±7.36) and G-III (79.17 5.67) as compared to G-I (62.08±4.82).

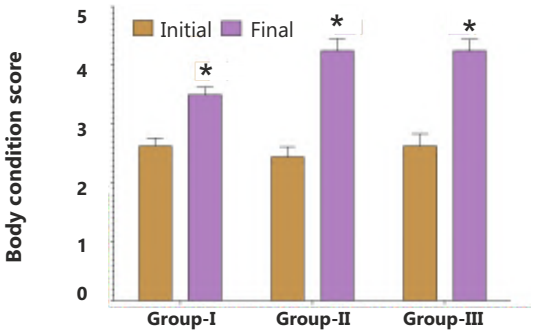


Fig. 8: Impact of supplementation of long chain fatty acids on body condition score in sheep. * indicates a significant difference ($p<0.05$).

Fat-rich feed are potent stimulators of CCK secretion, which in turn restricts feed intake. The pre-prandial CCK (pg/ml) was 157.20±1.53 on day-0 in all the groups and the post-prandial concentration was increased by 23.03%, 26.57% and 34.60% in the G-I (191.10±6.53), G-II (197.70±6.15) and G-III (214.70±8.08), respectively (Fig. 9).

The post-prandial increase in CCK was higher in the fat supplemented groups (G-II: 38.83±4.40; G-III: 39.94±6.38) than the control (G-I: 21.73±5.67). Hence, the increase of long chain fatty acids enhanced the post-prandial secretion of CCK to facilitate the fat digestion and absorption in sheep.

Ghrelin is a gut-derived hunger hormone and its concentration reaches peak immediately before feeding and decreases following feeding. The pre-prandial level of ghrelin (ng/ml) was higher in the fat supplemented groups (G-II: 3.49±0.24; G-III: 4.59±0.46) as compared to the G-I (2.57±0.26) on day-15. However, the post-prandial reduction in ghrelin was found more with the supplementation of fat (G-II:

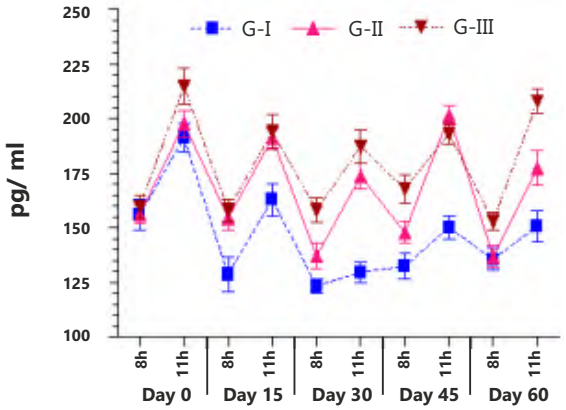


Fig. 9: The pre- and post-prandial secretory pattern of cholecystokinin (pg/ml) in sheep fed with long chain fatty acids.

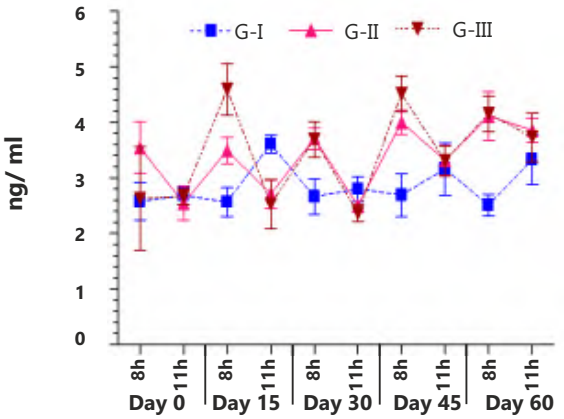


Fig. 10: The pre- and post-prandial secretory pattern of ghrelin (ng/ml) in sheep fed with long chain fatty acids.

2.71±0.25; G-III: 2.53±0.44) than the control (G-I: 3.61±0.16). The significantly descending trend of the post-prandial ghrelin was 22% and 44% on day-15 and the level was decreased to 9% and 7% by day-60 in the G-II and G-III, respectively as compared to the G-I (Fig. 10). The results indicate that the animal tried to sustain the energy homeostasis.

APR 3.17: Elucidating the mechanisms of different levels of energy and protein influencing immune responses in goats

M Bagath, V Sejian, G Krishnan, C Devaraj, D Rajendran

- The physiological parameters were affected by the nutritional stress caused by protein and energy deficiency.
- Significantly higher expression levels of the HSP70, HSP110 genes in the nutritionally stress groups indicates the sensitivity of these genes to energy and protein deficiency in goats.

A study was conducted to assess the impact of different proportion of energy and protein impacting nutritional stress on the physiological, behavioural and different HSP gene expression in goats. Adult Salem Black does (average body weight 16.0kg) were divided into five groups, GI (N=8; ICAR recommended); GII (N=8; 50% Low Protein and normal Energy); GIII (N=8; Normal Protein and 50% Low Energy), GIV (N=8; 50% Low Protein and Low Energy) and GV (N=8; 70% Low Protein and Low Energy). The study was conducted over a period of 90 days. The morning respiration rate were significantly lower in GIII, GIV and GV as compared to GI, however in the afternoon all the groups showed significantly lower respiratory rate as compared to GI. The pulse rate was significantly lower in GII and GIII during morning, while in GII alone during afternoon as compared to GI. Further, the rectal temperature was significantly lower only in GV animals as compared to GI both during forenoon and afternoon, while the rest of the groups did not show any variation with GI. The STSM (Surface Temperature Shoulder Morning), STSA (Surface Temperature Shoulder Evening), STFM (Surface Temperature Flank Morning) and STFM (Surface Temperature Flank Evening) showed significantly lower values in GIV and GV signifying the importance of appropriate energy protein ratio in the diet. The plasma cortisol level differed significantly only between GII and GV, while in rest of the groups the level was comparable. Standing time, lying time and defecating frequency did not show any significant changes between GII, GIII, GIV and GV as compared to GI. However, drinking frequency significantly varied in GIII, GIV and GV as compared to GI, while in GIII, GIV and GV urinating frequency varied significantly as compared to GI. The results indicated that Salem Black breed showed resilience for the alteration of protein energy ratio in the diet. However, when the magnitude of alteration was on the higher side as in the case of 70% reduction in energy and protein level, it was detrimental for adaptation as reflected by changes in the physiological variables and plasma cortisol level. Thus the study signifies the importance of maintaining appropriate energy and protein ratio even in the extremely adapted Salem Black breed. The behavioural changes also indicate

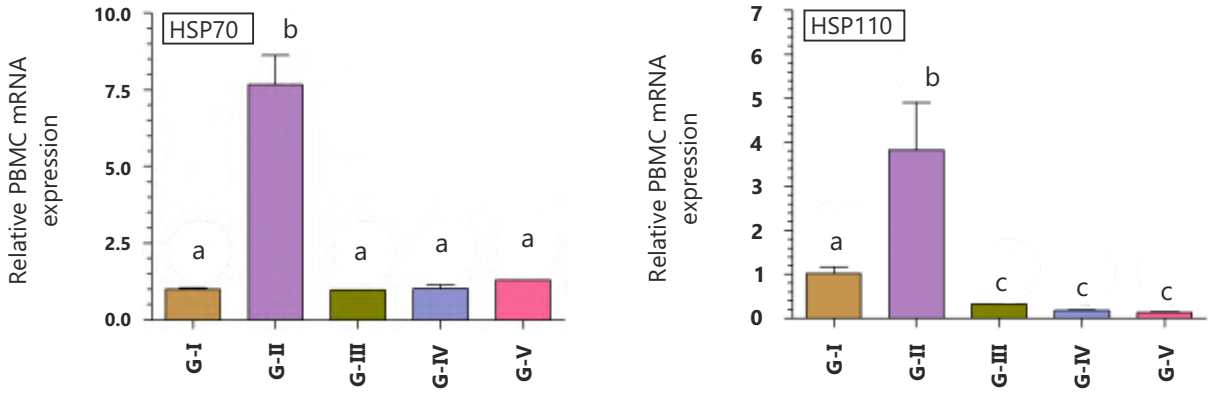


Fig. 11: Effect of different proportion of protein and energy compositions on the expression pattern of *HSP70* and *HSP110* in Salem Black goats. Different letter above error bar indicates a significant difference ($p<0.05$).

the importance of the proportion of protein and energy as based on the changes in the drinking and urinating frequency.

It was observed that the HSP genes exhibited different patterns of expression among the groups indicating different role of these genes (Fig. 11). Among all HSP genes studied, the significantly higher level of *HSP70, HSP110* genes in the stress groups (GII) as compared to control (GI) indicated the sensitivity of these genes to protein deficiency in goats. Therefore, *HSP70, HSP110* genes could serve as a reliable indicator for protein deficiency in Salem Black goat.

APR 3.18: Role of uric acid in alleviating oxidative stress induced mitochondrial dysfunction during different production cycles in poultry: regulation by organosulphur compounds

CG David, RK Gorti, IJ Reddy, M Sridhar

- » Age associated decline in the membrane potential of mitochondria isolated from the duodenum and egg shell gland was evident.
- » Further study is on progress for assessing the effects of garlic and/or allicin in combating mitochondrial dysfunction.

Production cycles induce certain level of oxidative stress in livestock including poultry. Efficient utilization of nutrients is pivotal for sustained production cycles. ATP produced from the mitochondria is a major source of energy supply to meet the energy demands of birds for the production of egg and meat. Since mitochondria is the major contributor of ROS in the body, a delicate balance between oxidant production and antioxidant defenceis required, to maintain the structural and functional homeostasis of the mitochondria for the sustained production. Further, changes in the mitochondrial efficiency will have large impact on energy and feed efficiencies. Our earlier studies on supplementing garlic in the ration of layer hens has revealed enhanced and sustained egg production with a concomitant increase in the level of uric acid, a potent antioxidant in poultry. However, the mechanism behind has not been understood fully, especially with respect to combating oxidative stress induced by mitochondrial dysfunction. Hence, this project aims to understand whether the beneficial effects of feeding garlic is due to allicin or other polyphenols present in garlic and how cumulative effect of oxidative stress contributes to age related changes in the mitochondrial function impeding production performance in egg type chicken and to establish the role of uric acid in combating mitochondrial ROS production.

The results of the Phase-1 study revealed age associated decline in the membrane potential of mitochondria isolated from the duodenum and egg shell gland. However, the study was terminated due to premature moulting of the birds. Therefore, the effect of allicin and garlic could not be compared. The second trial is on progress with 240 layer hens to study the objectives of this project.

APR 3.19: Studies on metal-carnitine chelates for improving bioavailability and tissue utilization of trace minerals and production performance in animals

DT Pal, NKS Gowda, D Rajendran

- Metal chelates are nutritionally beneficial as they serve dual purposes; fulfil the requirement of minerals and benefit of the chelated molecule.
- Indigenous processes were developed for preparation of Cu-Carnitine, Zn-Carnitine, Mn-Carnitine and Cr-Carnitine. The mineral content in metal-carnitine chelates ranged from 100-130g/kg.

Fig. 12: Different metal-carnitine chelates prepared in the laboratory.

The process for preparing metal-carnitine chelates was developed in the laboratory. Metal-carnitine chelates such as Cu-Carnitine, Zn-Carnitine, Mn-Carnitine and Cr-Carnitine products were prepared in large scale for feeding sheep (Fig. 12). Cu-Carnitine, 0.2kg; Zn-Carnitine, 0.5kg; Mn-Carnitine, 0.5kg; and Cr-Carnitine, 0.1kg were prepared in the laboratory using carnitine and metals under specific conditions as per the requirement for supplementing sheep for a 90-day feeding trial. The products were analysed for mineral content by ICP-OES and tested for chelation by qualitative test. The mineral content in metal-carnitine chelates ranged from 100-130g/kg.

APR 3.20: Evaluation of grain sprouts as fodder for livestock

NKS Gowda, S Anandan, K Giridhar, NM Soren

- Nutritive value of maize grain sprouts in terms of protein and fibre is similar to wheat bran with higher energy content on DM basis.
- The maize grain sprouts contained higher vitamins and amino acids.
- Feeding the maize grain sprouts at 50 and 100% levels resulted in lower dry matter intake and reduced growth rate in sheep.

The total dry matter (DM) loss during the sprouting from maize grain to sprouts (Fig. 13) in a period of 10 days is 17%. Analysis of maize grain spouts (MGS) showed higher minerals (Ca, P, Mg, Zn and Fe) and vitamins (vitamin E and K and Ascorbic acid) as compared to maize grain on DM basis. The overall nutritive value of MGS on DM basis was found almost similar to wheat bran in terms of protein and fibre content with higher energy content. During 150 days of feeding study, sheep fed diets with MGS at 50% and 100% of maize green fodder replacement showed significantly lower dry matter intake and sheep fed diet with MGS at 100% of maize green fodder replacement showed significantly higher dry matter digestibility. There was no significant variation in the blood biochemical parameters (serum enzymes, protein profile and blood urea), mineral content (Ca, P, Mg, Cu and Zn) and humoral immunity between the control and MGS supplemented diets. The growth rate was significantly lower in both the groups of sheep fed diets with MGS at 50% and 100% of maize green fodder replacement. It was concluded that MGS can be considered as green feed supplement and can not replace conventional green fodder.

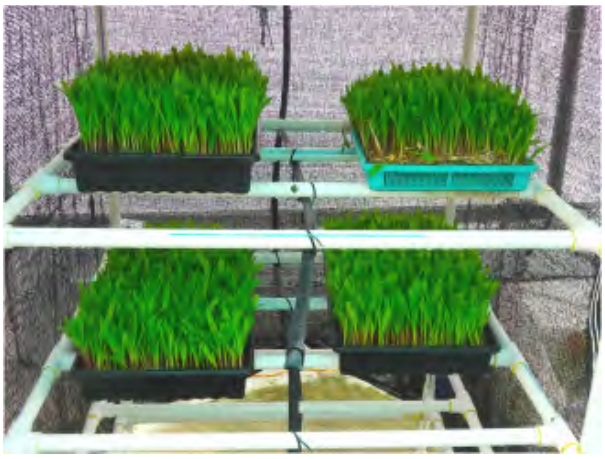


Fig. 13: Production of maize grain sprouts at the institute.

APR 3.21: Influence of administration of prostaglandin modulators on embryo survivality in sheep

S Mondal, IJ Reddy, S Nandi, PSP Gupta, NM Soren, A Mishra

- Assays for estimating PGF2α and PGE2 in sheep plasma were optimized.
- PCR conditions for amplification of *IGF2, FGF2* and *β-actin* were optimized.
- Synchronization of estrus was achieved in sheep by double injection of Lutalyse at 9 days apart.

Early embryonic mortality is one of the major causes of reproductive failure resulting in reduced pregnancy rate and slower genetic improvement in buffalo. More than 40% of the total embryonic mortality has been found to occur between the days 8 and 17 of pregnancy in bovines. Recognition and establishment of pregnancy involve several molecular and cellular interactions among the conceptus, uterus, and corpus luteum (CL). Prostaglandins are the key players in regulation of luteal function, implantation, recognition and establishment of pregnancy. Endometrial prostaglandin F2α (PGF2α) is the luteolysin, whereas PGE2 is considered a luteoprotective or luteotrophic mediator at the time of establishment of pregnancy. The candidate genes responsible for prostaglandin biosynthesis, transport and signal transduction are among the first to consider for major involvement in MRP. Impaired P4 secretion from CL has been linked with a reduced capacity of the developing embryo to secrete interferon-tau (IFNτ) at threshold amounts necessary to prevent luteolysis. Various modulators such as lipopolysaccharide, TNFα, oxytocin, estrogen and FGF2 alter the prostaglandin and progesterone biosynthesis by CL through the modulation of expression of different components of prostaglandin biosynthetic machinery. However, the impact of administration of modulators on prostaglandin production and embryo survivability is completely lacking in sheep. The project aims to delineate the effect of oxytocin and LPS on prostaglandin production and embryo survivability in sheep. The assays of PGF2α and PGE2 were optimized in sheep plasma and the sensitivity was 0.002 ng/ml and 0.1 ng/ml, respectively. Total RNA was isolated from the sheep endometrium and cDNA was synthesized. The PCR conditions for amplification of *IGF2, FGF2* and *β-actin* were optimized. Trials were conducted on three ewes for synchronization of estrus using two doses of Lutalyse (dinoprosttromethamine; 1 ml) at 9 days apart and out of three ewes two ewes exhibited estrus symptom.

APR 3.22: Development of nutritional modules for commercial broiler sheep production

S Anandan, NM Soren, T Chandrappa, VB Awachat

- Milk replacer supplementation in pre-weaned Avishaan lambs resulted in significantly higher body weight gains.
- The carry over effect of milk replacer supplementation during pre weaning phase on post-weaning growth performance is being studied.

Fig. 14: Pre-weaned Avishaan lambs.

The project aims at developing appropriate feeding modules for different stages of growth to maximize the meat production potential. Towards achieving this objective, post-weaning growth performance of weaned lambs of Avishaan breed showed promising growth rates. It was hypothesized that the pre-weaning growth rate affects the post-weaning growth and the final body weight. To verify the hypothesis, twin and triplet lambs of Avishaan breed (Fig. 14) were randomly allotted to two groups of eight lambs each and the treatment group was supplemented with milk replacer along with creep feed and Napier hay *ad lib*

Table 1: Growth performance in pre weaned Avishaan lambs supplemented with milk replacer. * indicates a significant difference between the groups (p<0.05).

Treatment	Average body weight at 90 days (kg)	SEM
Control (suckling +creep feed +hay)	16.7	0.44
Treatment (control + milk replacer)	18.6*	0.52

with access to dams' milk. Milk replacer was reconstituted with water at 1:5 and fed to lambs individually through bottle in increasing quantities with age reaching a maximum of 250ml/d/lamb.The control group was similar to the treatment group except that it was devoid of milk replacer. Lamb body weights were recorded at weekly intervals until weaning age of 90 days. The body weights at the 90 days of age indicated that milk replacer supplemented group had significantly higher body weight gain as compared to the control (18.6 to 16.7 kg) group (Table 1). The lambs in both the groups were continued during the post-weaning phase on ad lib concentrate mixture and dried roughage to assess the effect of supplementing milk replacer during pre-weaning phase on the final body weight at the end of six months.

APR 3.23: Unravelling the physiological role of adiponectin in regulation of energy metabolism in sheep

C Devaraj, M Bagath, G Krishnan, PK Malik, V Sejian, S Anandan

- In Osmanabadi goats, the expression of *Adiponectin, AdipoR1* and *AdipoR2* was higher in the heat stressed than control group.
- In Malabari goats, *Aadiponectin* expression was lower in the heat stressed than control group, but no difference was observed in the expression of *AdipoR1* and *AdipoR2* between the groups.
- In Salem black goats, the expression of *Adiponectin* was lower, but the expression of *AdipoR1* and *AdipoR2* was higher in the heat stressed than control group.

Adipose tissue is an important endocrine organ that plays a major role in the regulation of energy metabolism by controlling carbohydrate and lipid metabolism. Adipose tissue synthesises and secretes several enzymes, growth factors, cytokines and hormones that are involved in overall energy metabolism. Adiponectin, a novel adipose tissue hormone plays a significant role in glucose and lipid metabolism by improving insulin sensitivity and increasing fatty acid oxidation, respectively. Its gene expression and blood levels are inversely related with body fat mass. Adiponectin binds to its receptors AdipoR1 and AdipoR2 and activate a protein kinase cascade. The study aimed to assess the impact of energy restriction on the expression pattern of adiponectin and its receptors in sheep and to study the interrelationship of adiponectin with other metabolic hormones associated with energy metabolism pathways during energy restriction in sheep.

The expressions of *Adiponectin* and its receptors *(AdipoR1* and *AdipoR2)* were studied in the heat stressed goats, as a pilot study. Skeletal muscle samples of both control and heat stressed groups of Osmanabadi, Malabari and Salem Black goat were collected. Total RNA was isolated from the samples, RNA quality and quantity were determined and the extracted total RNA were reverse transcribed into cDNA and stored at -80°C for further analysis. Quantification of the transcripts of *Adiponectin, AdipoR1* and *AdipoR2* were performed using Quantitative Real-time PCR (QPCR). The relative expressions of selected genes were studied using SYBR PCR Master Mix and gene specific primers that were designed using NCBI Primer-BLAST tool. The *SDHA* and *HPRT* were used as housekeeping genes. The results indicated that the expression of *Adiponectin* and its receptors (*AdipoR1* and *AdipoR2*) was higher in the heat stressed as compared to the control in the Osmanabadi goats. In the Malabari goats, *Adiponectin* expression was lower in the heat stressed than the control group. However, no difference was observed in the expression of *AdipoR1* and *AdipoR2* between the control and heat stressed Malabari goats. In the Salem black goats, *Adiponectin* expression was lower in the heat stressed as compared to control group. However, the expression of *AdipoR1* and *AdipoR2* was found higher in the heat stressed than the control in the Salem black goats.

APR 3.24: Modulation of GnRH system through novel neuropeptides during embryogenesis and physiological responses in post hatch broiler chicken

IJ Reddy, A Mishra, S Mondal, RK Gorti, V Awachat

- » *In ovo* GnRH in combination with estradiol-17β enhanced the *GnRH* receptor expression and decreased the *GnIH* receptor mRNA abundances in the cultured pituitary cells.
- » Higher levels of GH and steroid hormones facilitated rapid growth rate in the post-hatch broiler chickens.

Normal anterior pituitary function is essential for reproduction, growth and production in vertebrates. The release of LH, FSH and GH from the gland is regulated primarily by the hypothalamically-derived gonadotropin releasing hormone (GnRH). It has been identified that a novel peptide, phoenixin, regulates pituitary gonadotropin secretion by modulating the expression of the GnRH receptor, an action with physiologically relevant consequences. Compromise of phoenix *in vivo* using siRNA results in the delayed appearance of oestrus and a reduction in GnRH receptor expression in the pituitary. Phoenixin may represent a new class of hypothalamically-derived pituitary priming factors (PFs) that sensitise the pituitary to the action of other RFs, rather than directly stimulating the fusion of secretory vesicles to pituitary membranes. The objectives of this study are: To develop the GnRH and its receptor system at critical embryonic phases through exogenous neuropeptides and to study their impact on productive performance in post-hatch broiler chickens; To modulate melatonin receptors through exogenous modulators and in turn suppression of GnIH during embryonic stage to study post-hatch broiler chicken production. *In ovo* studies were conducted with different doses of hypothalamic peptides GnRH and GnRH in combination with estradiol-17β to transfect required GnRH and estradiol-17β during different days of embryogenesis in broiler chickens.

Uniform sized Cobb fertile broiler eggs (N=100) were set for incubation. The fertile eggs were divided into two groups. In one group (N=50), GnRH (150nM) and estradiol-17β (100·g) were administered *in ovo* (amniotic cavity) on day-12 of the embryogenesis. In the other group (N=50), placebo was administered and served as control. The chicks hatched from the different treatment groups were randomly distributed into battery cages (6 replicates with 7 chicks in each). Body weight gain, feed intake and FCR were calculated. Hormones were estimated in plasma at weekly interval. The expression of *GnRH* and *GnIH* in the pituitary and hypothalamic tissues were assessed. The chGnRH, IGF1 and chGH were estimated by species specific ELISA kits.

The *in ovo* administration of oestrogen in combination with *GnRH* downregulated the *GnIH-R* mRNA and upregulated the GnRH (3.22±1.00nM) concentration in the cultured pituitary cells. The levels of estradiol-17β (280±028pg/ml), progesterone (2.78±0.28ng/ml), testosterone (142±0.98pg/ml), GH (8.67±0.22ng/ml) and IGF-1 (16.88±0.28ng/ml) were found significantly higher in the cultured cells in the treated group. The study revealed that the *GnRH* receptor expression was more in the treated group as compared to the control. However, *GnIH* receptor expression was significantly lower in the treated group. The results suggest that the combination of GnRH and sex-steroid effectively upregulated the pituitary *GnRH-R*, steroids and somatotrophic hormones in post-hatch broiler chickens.

APR 3.25: Development of precise delivery system for improved bioavailability of zinc for poultry

SBN Rao, D Rajendran, M Bagath, AV Elangovan, F Magdaline

- » Encapsulation technology was standardized to prepare encapsulated zinc using different zinc salts, wall materials and two different methods.
- » Microencapsulated zinc powder was produced from zinc sulphate hepta hydrate and zinc oxide.

Conventionally micro-nutrients are supplemented in the form of trace elements in the livestock and poultry. Recently, there has been a surge in incorporating various kinds of micronutrients in functional food and beverage products to improve human health and wellness. It is further suggested that micronutrients cannot be simply incorporated in the commercial food products in their pure form due

to various physiochemical and biological constraints. As these nutrients are prone to physical, chemical or enzymatic degradation during food processing, transport, storage or preparation and need to be protected. To facilitate improved micro-nutrient stability and bio-availability, efficient delivery systems are needed for their stability and bio-availability to stabilize the micronutrient within food, but release in a bioactive form even after consumption. Poultry industry has gained lot of commercial importance and there will always be pressure on nutritionists, food technologists to develop products with more bio-availability with minimal degradation to the environment. In this context, it is very pertinent to attempt development of the encapsulated zinc for higher bio-availability with reduced dosage for poultry.

Micro encapsulation of zinc was attempted using spray drying the Zinc sulphate hepta hydrate($ZnSO4.7H_2O$). Microencapsulated zinc powder was produced by using different wall materials such as maltodextrin, modified starch (HICAP-100) and whey protein isolate (Fig. 15). Microencapsulation process was optimized using Taguchi orthogonal array. The selected independent variables were inlet air temperature of the spray drier, wall material to zinc ratio and wall material. The dependent variables were encapsulation efficiency and bulk density. The optimized powder was obtained using HICAP-100 at inlet air temperature of 185°C and wall material: zinc ratio as 20:1. The optimized powder was characterized using SEM, EDX, XRD and FTIR. The SEM analysis revealed that the powder had uniform and circular particles. SEM-EDX spectra confirmed the zinc encapsulation. SEM micrographs indicated that the particle size of the powder obtained from cyclone separator ranged from 1 to 13·m. XRD revealed the amorphous nature of MEP and disappearance of crystalline peaks of zinc, suggestive of incorporation of zinc inside the wall material. FTIR indicated the chemical bond formed between wall materials and zinc.

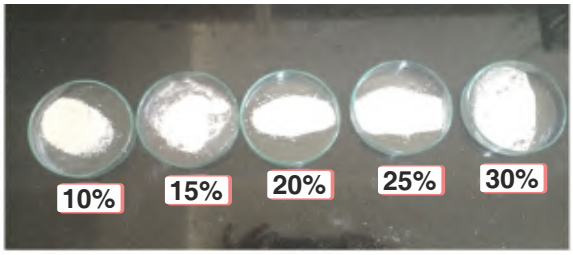


Fig. 15: Encapsulated powders using different concentrations of zinc oxide.

Zinc oxide (ZnO, containing 80% Zn) was used as a core material at different concentrations to increase the zinc content of encapsulated product. Zinc oxide was used at 10,15,20,25 and 30% along with wall materials (Maltodextrin and gum Arabic) and freeze drying technology. The zinc content ranged from 10.19 to 23.62% in different concentrations and the efficiency of encapsulation varied from 32.98 to 66.30. However, at the concentration of 20%,ZnO gave maximum encapsulation efficiency.

APR 3.26: Biological activities of rare earth elements in relationship to production performance of egg and meat type chicken

RK Gorti, CG David, IJ Reddy, VB Awachat, KP Suresh, PA Heartwin

- The study aims to assess the effect of lanthanides on the productivity and feeding efficiency in egg and meat type chickens.
- A trial in layer hens is on progress to study the effect of supplementation of lanthanides on their bioavailability, sustainable egg production, biomineralization of egg and bone, intestinal integrity and residual effect if any.

Rare Earth Minerals (REE) such as lanthanides have been shown to increase feed conversion ratio, egg production and body weight gain in case of egg and meat type chicken respectively over the past 4 decades. Lanthanides share chemical properties with that of calcium, yet their use as calcium analogues in egg and meat type chicken have not been fully explored. They have been shown to act as non-antibiotic growth promoter in mono-gastric animals especially pigs and broilers. Further, Lanthanides also have been shown to exert maximum beneficial effect on animal growth and immunity to yield enhanced productivity. The exact biological mechanism behind the beneficial action of lanthanides (owing to their poor bioavailability) is yet to be fully elucidated. This project was envisaged to unravel the basic physiological mechanism(s) behind the action of lanthanides in sustaining peak productivity and laying persistency of egg-type chickens with improved feeding efficiency and in promoting growth of meat-

type chickens with improved feeding efficiency. A trial is on progress to study the effect of supplementation of lanthanides on their bioavailability, sustainable egg production, biomineralization of the egg and bone, intestinal integrity and residual effect if any in 360 layer hens (13- 90 weeks of age).

APR 3.27: Over expression of NIANP_MBL_1, 2 & 3 clones, monoclonal antibody production and development of immuno assay

J Ghosh, KS Roy, CG David, SK Dhara

- » Synthesised and sub-cloned the desired 200 amino acids equivalent sequence (clone NIANP_MBL_3) in the pET28a (+).
- » The desired protein was expressed in E. coli and confirmed by SDS-PAGE analysis.

Early pregnancy diagnosis in buffalo is not successful due to non-availability of early pregnancy specific purified homologous biomarker antigens and specific monoclonal antibodies directed against the released antigen. Available reports so far indicated identifications of the predominant early pregnancy biomarker transcripts and partial E coli expression of predominantly expressed biomarker. However, the pure antigens with native conformation for generation of specific antibodies and homologous assay against the buffalo early pregnancy biomarkers are not available. We have generated full coding sequence of two buffalo early biomarker transcripts earlier (clone NIANP_MBL_1 and NIANP_MBL_2) and expressed a 124 amino acid partial biomarker protein sequence. The failure and low level of expression of all these clones warrants further refinement of strategy in mammalian and E coli based expression systems. A bigger size 200 amino acid sequence equivalent clones will be generated (NIANP_MBL_3). Thus, this experiment is designed with the objectives to over express NIANP_MBL_1, 2 & 3 clones in suitable host cells, purification and monoclonal antibody generation, develop Strip/EIA/RIA based assay using suitable antibody (ies) and test the efficiency of early pregnancy diagnosis.

The protein coding sequences of 200 amino acids was optimized for codon usage patterns of E coli and synthesised with desired restriction enzyme sites for

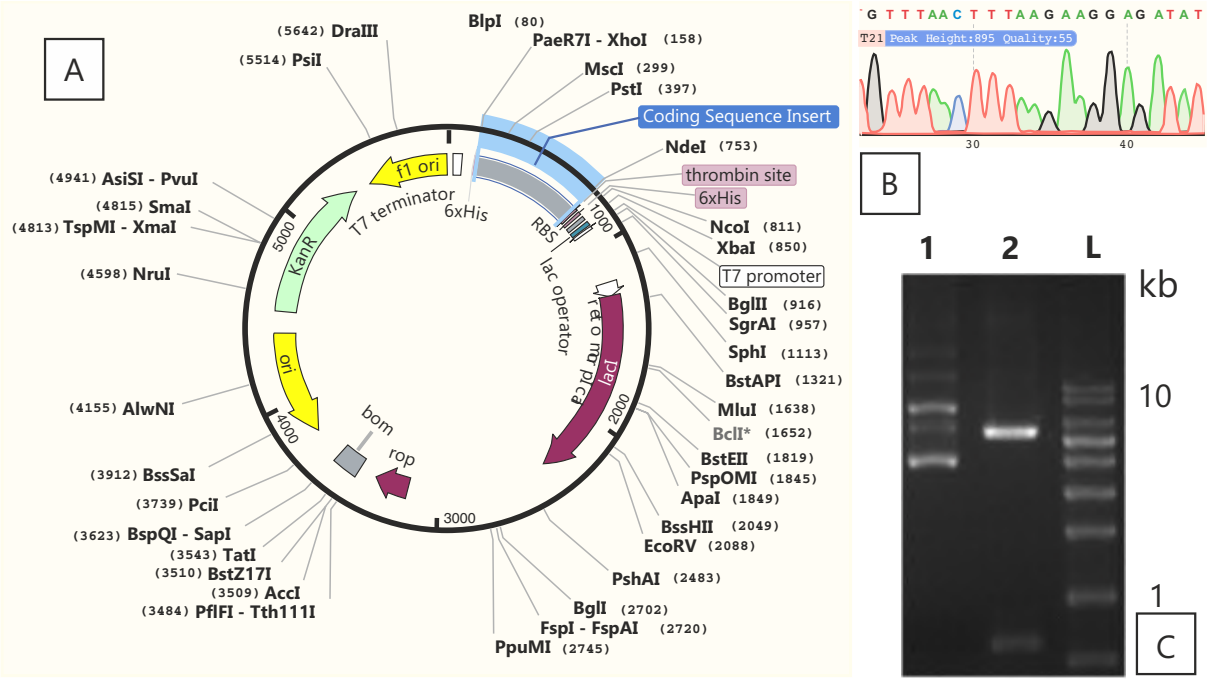


Fig. 16: Panel-A: NIANP_Clone #3 map of pET28a vector showing the position of inserted sequence. Panel-B: Sanger sequencing chromatogram results. Panel-C: Confirmation of insert by RE digestion (600bp Xho1-Nde1). BL21 (DE3) E coli cells were transformed with the vector for IPTG induced expression of the desired protein. The cDNA sequence was inserted in the vector by directional cloning approach using Xho1 and Nde1 restriction enzyme digestion. 6xHistidine tag was kept for easy affinity purification by NiNTA matrix.

directional cloning and purification tags and cloned in suitable cloning vector. The desired sequences were inserted in the pET28a+ expression vector by directional cloning approach (NIANP_MBL_3). In brief, the vector and the insert were digested with the suitable restriction enzymes and ligated. The mixture after ligation reaction was used for transformation of Top10 E coli cells for cloning. Positive clones were sequenced to understand the direction and orientation of expression (Fig 16). Plasmid from the confirmed clones were purified and used for transformation of BL21 (DE3) E coli host cells for protein expression induced by IPTG. The expression protocol optimized and the expression was confirmed by testing expression of approximately 28kDa protein in SDS-PAGE gel (Fig 17). The level of expression was found suitable for further up scaled production in small batch culture and purification. Optimization of purification protocol is in progress.

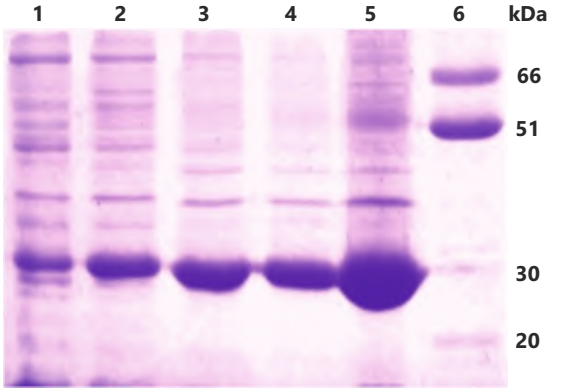


Fig. 17: SDSPAGE (15%) analysis of *E. coli* cell extracted proteins after 4h (1), 6h (2), 8h (3), 12h (4) 16h (5) of induction of expression using 1mM IPTG. The proteins after electrophoresis were stained with Coomassie brilliant blue R250 for visualization. The molecular weights of the standard molecular weight markers and the prominent expressed protein bands are labelled.

National Fellow Project: Development of buffalo bull fertility diagnostic chip based on sperm transcripts signatures

S Selvaraju

- Buffalo spermatozoal RNAs were found highly fragmented as compared to that of the cattle.
- *PRM1* and *AKAP12* genes were observed to be a few of the abundant genes expressed in the buffalo spermatozoa.

Since one bull produces thousands of insemination doses, the contribution of bulls become significant for improving fertility in dairy animals. In order to overcome the limitations associated with semen quality assessment tests, transcriptomic profiling is employed with an aim to develop bull fertility chip for selection of superior bulls for artificial insemination programme.

Semen samples were collected from the Murrah buffalo bulls with known fertility rate. Fresh semen samples were collected from ten animals and the percentages of sperm plasmalemma integrity, DNA integrity, functional membrane integrity and sperm subpopulation positive for both acrosome integrity and functional membrane integrity were 65.3±3.19, 96.5±0.26, 48.2±5.75 and 33.5±5.70, respectively.

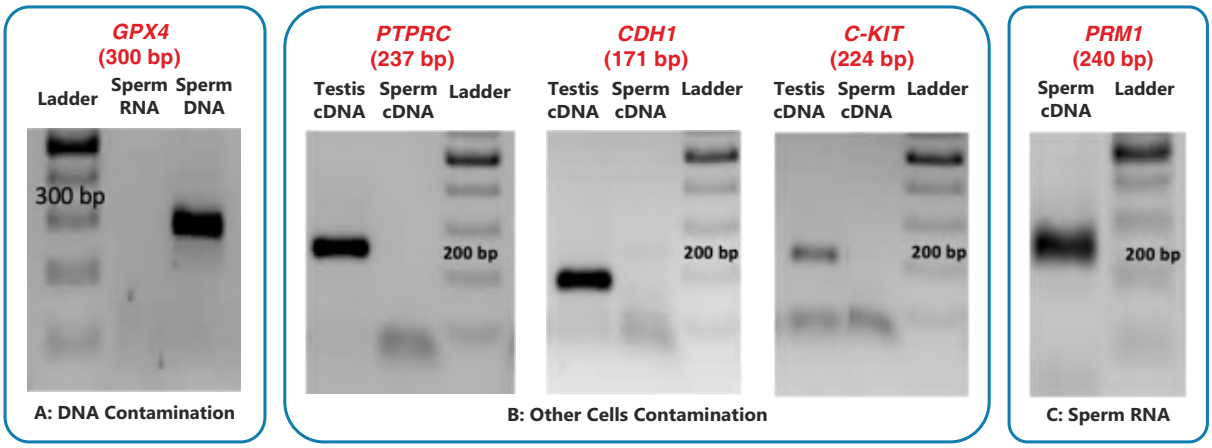


Fig. 18: Assessment of genomic DNA (Panel-A) other cell contamination (Panel-B) and validation of RNA seq data with PRM1 primer (Panel-C).

Post-thaw semen samples from 20 bulls were collected with the conception rate ranging from 22 to 58% and their functional parameters were analysed. The neat semen samples from two ejaculates were pooled and used for RNA isolation. The RNA was isolated by employing double lysis technique combined with column based method. DNA contamination was assessed in the RNA samples using *GPX4* intron spanning primer and other cell contaminant such as leukocytes, somatic cells and germ cells were assessed using gene-specific primers for *PTPRC*, *CDH1* and *C-KIT* (Fig. 18).

Buffalo sperm RNA size distribution was determined using the Bioanalyzer profile. The sperm RNA does not have the ribosomal peaks. The Holstein Friesian spermatozoal RNA has a mean peak size of 85 nt whereas the buffalo spermatozoal RNA has a peak size of only 25 nt indicating that the buffalo sperm RNA is highly fragmented (Fig. 19).

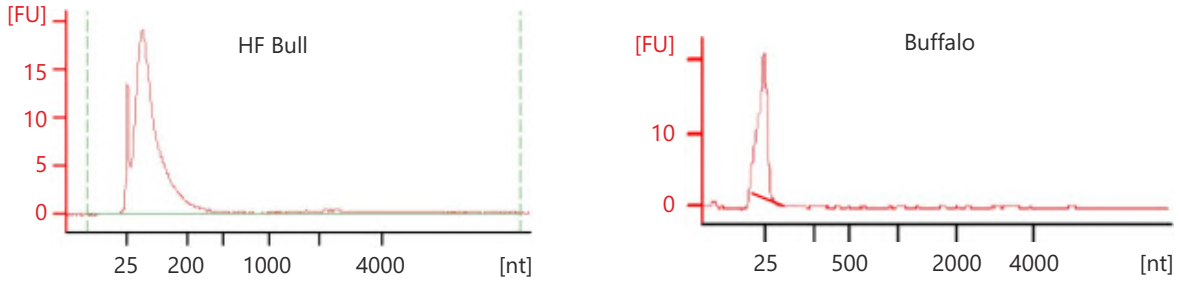


Fig. 19: Bioanalyzer profile of buffalo sperm RNA as compared to cattle. The buffalo spermatozoa RNA are highly fragmented as compared to cattle.

The spermatozoal transcript profiling was done using Illumina platform. The RNA seq data pipeline was standardized for identifying novel transcripts, analyzing transcription factor and motif prediction in spermatozoal RNA seq data. The RNA seq reads were mapped against bovine genome and the mapping percentage was observed to be approximately 60%. *ACTB*, *PRM1* and *AKAP12* were observed to be some of the abundant genes expressed in the buffalo spermatozoa. Since buffalo genome is poorly annotated, de novo assembly of buffalo transcriptome is being carried out for further analysis. The RNA seq data was validated using qPCR by confirming the presence of *PRM1* gene (gene specific primer of 240bp) in the buffalo spermatozoa (Fig. 18C). Based on bovine spermatozoa RNA seq data, the paternal transcripts that are being delivered to the oocyte during fertilization and early embryonic development was identified. Such transcripts can be used for selecting fertile bulls for the breeding programme.

ICAR-AICRP: Nutritional and physiological approaches for improving reproductive performance in animals

Coordinator: R Bhatta

NKS Gowda, IJ Reddy, KS Roy, SC Roy, DT Pal, BK Binsila

- Buffalo seminal proteins SPINK2 and NEDD8 exhibited significant correlation with semen quality.
- A novel buffalo-specific semen extender showed significantly improved post-thaw motility and viability of cryopreserved buffalo sperm.
- Among the three estrus synchronization protocols used in cows under field condition, Estra-doublesynch was found most effective.
- Dietary boron supplementation enhanced the semen quality and immune and antioxidant defense capacities in male goats.

Buffalo seminal proteins, viz., SPINK2 and NEDD8 were identified through quantitative proteomics and confirmed by western blotting have significant positive correlation with sperm kinematic parameters such as straight line velocity, linearity, straightness and hence can be ideal markers for good quality semen (Fig. 20 and 21). Novel buffalo-specific semen extender was developed using deficient metabolites, showed significantly improved post-thaw motility (77%) and viability (59%) of cryopreserved buffalo sperm. Total 150 dairy cows were used in this study. Among the three estrus synchronization protocols used in cows under field condition, Estra-doublesynch was most effective (85% conception). Dietary Boron supplementation (40 ppm/day) increased the sperm concentration, sperm motility and enhanced the

immune and antioxidant defense capacity in male goats without any untoward tissue changes in visceral organs. There was a significant increase in the mRNA expression of serine proteinase inhibitor (*SERPIN*) and interferon γ (IFN γ) in the testis of boron supplemented than the control group. Boron supplementation up-regulated the immune-regulatory gene, interleukin 2 (*IL2*) and antioxidant gene, catalase (*CAT*) in the PBMC. On contrary, *TLR2* mRNA expression was significantly ($p<0.05$) down-regulated in boron and selenium supplemented groups.

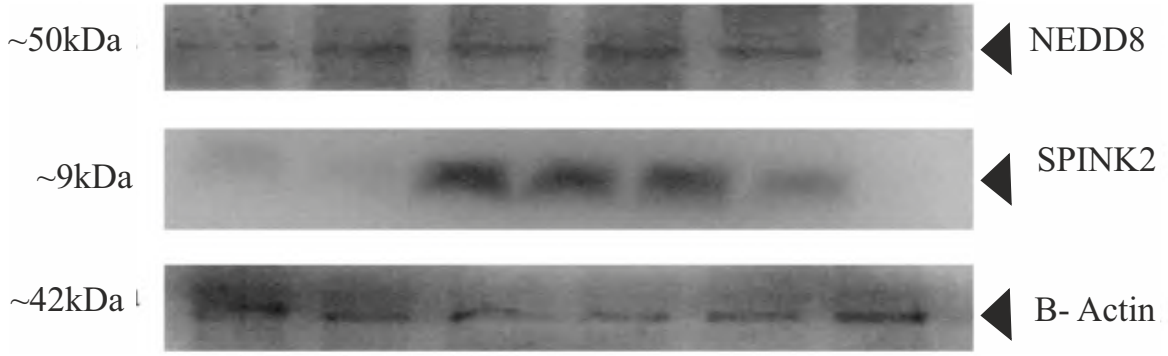


Fig. 20: Western blot of the buffalo seminal fertility markers (NEDD8 and SPINK2) and housekeeping protein (Beta actin).

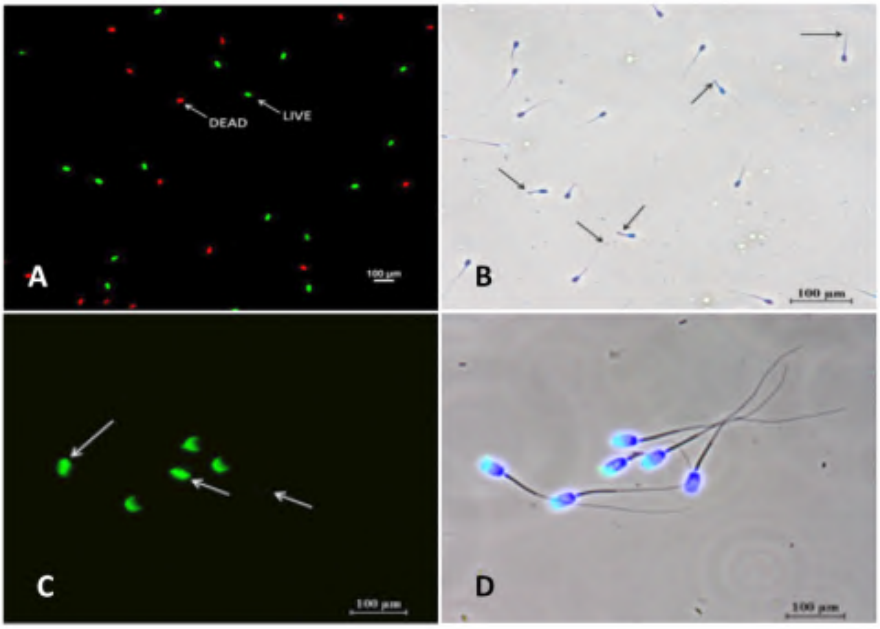


Fig. 21: Assessment of sperm viability by SYBR 14/PI dual staining (A), membrane integrity by HOST (B), Acrosome integrity by Lectin PNA (C) and Alexafluor 488 conjugate (D) in buffaloes.

ICAR-Extramural: Kisspeptin and its analogues as novel biomolecules to augment fertility in small and large ruminants under recent climate change scenario

KS Roy, J Ghosh

- Dosages of Kisspeptin administration for inducing a favourable profile of reproductive hormones were standardized in sheep.
- Dosage of Kisspeptin (analogue) was established for effective induction of estrous of the synchronized ewes.
- Conception rate in the synchronized ewes treated with Kisspeptin and its analogue following natural insemination was found significantly higher as compared to the non-treated control animals.

A strong association of Kisspeptin secretion with the release of GnRH has been shown in laboratory animals and humans. GnRH regulates the major reproductive hormones such as LH, FSH and prolactin and other steroid hormones like estradiol, progesterone etc. However, no reports are available at present on the effect of administration of Kisspeptin or its analogues towards the changes in endocrine profile in large and small ruminants. The project aims to determine effective dose of Kisspeptin or its analogue for induction/synchronization of estrus in large and small ruminants.

The dosages of Kisspeptin administration for inducing a favourable profile of reproductive hormones were standardized in sheep for intra-mascular and intra-venous routes of administration. The endocrine profiles of LH, FSH, estradiol 17 and progesterone were established in blood plasma of both control and treated groups. The meteorological parameters such as dry and wet bulb temperatures and humidity were recorded and THI was determined during the entire experimental period to know the impact of abiotic stress on the experimental animals. Further, for effective induction of estrous of the synchronized animals, a different dosage of Kisspeptin (analogue) was established. The rate of conception in the synchronized ewes treated with Kisspeptin and its analogue following natural insemination was found significantly higher as compared to the non-treated control animals (Fig. 22).

Fig. 22: Lambs born using Kisspeptin in the synchronization protocol.

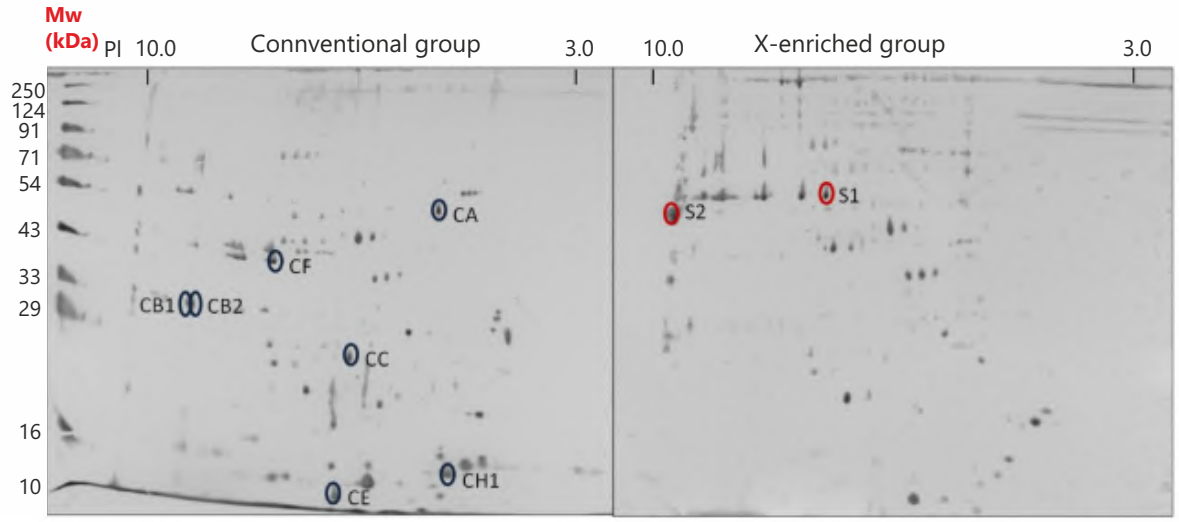
DBT: Selective isolation of sex specific spermatozoa in bovines using novel biomarkers identified through an integrated proteomic and genomic approach

A Arangasamy, BK Binsila

- The proteins Tektin-3, A-kinase anchor protein 3, Carboxypeptidase Q, L-Lactate dehydrogenase, Zonapellucida binding protein, Outer dense fibre protein 2, Outer dense fibre protein 3 and Tubulin beta 4B chain were found differentially expressed between the conventional and X-enriched spermatozoa.
- These proteins were identified as the sex associated membrane proteins.

Having control on sex ratio is very beneficial to the livestock farming. Female sex is preferred for milk production, whereas males are preferred in meat industries. Spermatozoa or embryo sexing along with other "Omics" approaches is a recognized approach to produce pre-sexed livestock which is much sought after. There have been several attempts to look at unique features of the X- and Y-spermatozoa and utilize them in modifying the semen to increase the comparative percentage of X- or Y-spermatozoa to establish a likelihood of a female or male offspring. The flow cytometry is one of the successful techniques in sorting spermatozoa. However, the technique has several limitations towards applicability. This project aims to target sperm cell surface proteins (sex associated membrane; SAM) to

identify novel candidate proteins. The identified SAM proteins will be localized on the sperm and specificity will be checked between X- and Y- spermatozoa. Such novel proteins will be used for developing aptamer to sort sex specific spermatozoa. In the previous years, we have standardized the methodology for isolation and purification of membrane proteins by using 2-D gel electrophoresis. Based on the 2-Dimensional electrophoresis, the major protein spots observed to be abundant and differing between unsorted and sorted groups were excised, digested and subjected to LCMS (Fig. 23). Nine spots were identified that differentially expressed between X-sorted and unsorted spermatozoa. In-solution form of conventional and X-sorted spermatozoa was also subjected to LCMS (Table 2). The differentially expressed and identified proteins will be processed for localization studies.



Sl No.	Proten identified	Accession No.	Molecular Weight (kDa)	X-sorted group
S1	Keratin, type I cytoskeletal 14	A0A3Q1M2I5	50.2	↑
S2	Zona pellucida binding protein	A0A3Q1MFF0	37.8	↑
CA	Carboxypeptidase Q	A0A3Q1LSW9	52.9	↓
CB1	Malate dehydrogenase, mitochondrial	Q32LG3	36.1	↓
CB2	L-lactate dehydrogenase A-like 6B	Q3T056	42.0	↓
CE	Glyceraldehyde-3-phosphate dehydrogenase, testis-specific	Q2KJE5	43.6	↓
CF	Dynein light chain 2	Q3MHR3	10.4	↓
CH1	Seminal plasma protein PDC-109	P02784	15.9	↓
CC	IZUMO family member 4	F1MYA6	24.9	↓

Fig. 23: Differential protein spots observed between the conventional and X-enriched spermatozoa.

Table 2: Differentially expressed proteins identified through in-solution digestion.

Sl No.	Protein identified	Accession No.	MW (kDa)	X- enriched group
1.	Outer dense fiber protein 2	A0A3Q1LHX7	76.2	↓
2.	Tektin-3	F1MX07	57.0	↓
3.	Sperm surface protein Sp17	F1MI43	16.9	↓
4.	A-kinase anchor protein 3	F1MJS8	95.7	↓
5.	Tubulin polymerization-promoting protein family member 2	Q3T077	18.6	↓
6.	Outer dense fiber protein 3	A0A3Q1LYN4	76.2	↓
7.	GAPDH testis specific	Q2KJE5	43.6	↑
6.	Tubulin beta 4B chain	Q3MHM5	50.2	↓

DST (Indo-Hungary): Strategic improvement of efficiency of vitrification of preantral follicles and embryos of sheep: Genomic changes with reference to apoptosis and developmental competence

PSP Gupta, S Nandi, S Mondal

- Vitrification protocols using antioxidant retinol and cytoskeletal substance cytoschalasin resulted in higher post-thaw survival rates of ovine preantral follicles.
- The expression of the developmental genes was found higher in the post-thawed preantral follicles vitrified with retinol but not with cytochalasin.

Infertility is a major concern for the animal industry. The preantral follicles (PFs) are more in number as compared to the antral follicles that ovulate during estrus cycle. Preservation of ovarian cortex with PFs holds promises for future use. Therefore, potent technologies are required for the conservation of valuable germplasm of superior animals and indigenous breeds. The objectives of this project are: To study the effect of vitrification on the survival rate of PFs of sheep; To study the effect of addition of anti-oxidants and cytoskeletal stabilizing substances to vitrification medium on the survival rates of vitrified PFs of sheep and; To study the effect of addition of anti-oxidants and cytoskeletal stabilizing substances to vitrification medium on the genomic changes with special reference to apoptosis and developmental competence of oocytes in the PFs of sheep.

Studies were conducted to cryopreserve PFs of sheep and buffalo. The efficiency of cytoskeletal stabilizing substance such as cytochalasin was evaluated in the vitrification of ovine and bubaline preantral follicles. Further, the effect of addition of antioxidant retinol on the expression of genes associated with development (*BMP-15, POU5F1* and *GDF-9)* and apoptosis (*BCL-2L1, ANNEXIN A5, BAD, BAX* and *Caspase 3*) were evaluated. The vitrification base medium consisted of TCM-199, FBS 20%, gentamycin 50µg/ml and HEPES 25mM was effectively used for the above studies. The vitrification medium (in base medium) I consisted of EG 10%, DMSO 10% and sucrose 0.3M.The vitrification medium II consisted of EG 25%, DMSO 25% and sucrose 0.3M. The thawing medium (in base medium) I consisted of sucrose 0.3M, the thawing medium (in base medium) II consisted of sucrose 0.15M and the thawing medium (in base medium) III consisted of sucrose 0.075M.

PFs were first equilibrated at room temperature in vitrification media I for 15min. Then they were transferred to vitrification media II for 5min. Later PFs were transferred to 1ml cryotube containing 200µl of vitrification media II and were then immersed into liquid nitrogen for 7 days. For thawing, PFs were removed from liquid nitrogen, kept at room temperature for 1 min and then immersed in a water bath at 37°C until vitrification medium got completely melted. Cryoprotectant was removed by washing with thawing media I (5min), II (5min) and III (5min) sequentially.

The effect of Vitrification of ovine preantral follicles with the above medium was tested with different concentrations of retinol (2, 5 and 10µM) for its effects on the expression of the development (*BMP-15, POU5F1* and *GDF-9*) and apoptosis (*BCL-2L1, ANNEXIN A5, BAD, BAX* and *Caspase 3*) associated genes. Highest percentage of viable follicles was observed in the vitrification treatment with 5·M retinol (85.4%) than the follicles vitrified without retinol (72.43%). The expression of the developmental genes such as *GDF* and *BMP* and the expression of the apoptotic genes such as *BCL-2L1, ANNEXIN A5, BAD, BAK, BAX* and *Caspase 3* were found significantly higher in the 5µM retinol group. Although not significant, the *in vitro* estradiol synthesis in the follicles vitrified with 5µM retinol was found higher as compared to the other groups. The addition of cytochalasin to the vitrification medium of PFs improved their post thaw survival rates by 8%. The results indicated that the viability of vitrified PFs increased significantly with 10µg (92.8%) and 15µg (93.4%) as compared to the 7.5µg (83.5%) or 0µg (84.9%) of cytochalasin (Fig. 24). However, cytochalasin did not alter the expression of the developmental or apoptosis related genes.

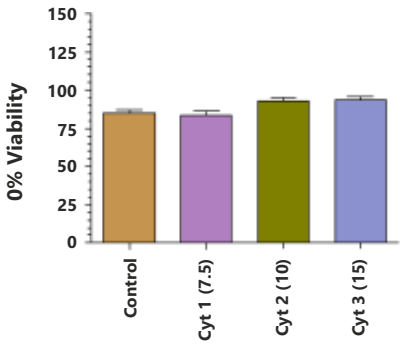


Fig. 24: Effect of cytochalain in vitrification medium on the post thaw viability of ovine preantral follicles.

DBT-Twinning: Biotechnological interventions to augment productive performance of pigs on horticultural byproduct based diet

M Chandrasekharaiah, NM Soren, AP Kolte

- The fruit and vegetable by products were evaluated for use in pig ration.
- Studies conducted in a two stage *in vitro* experiments indicated that 30% inclusions of horticultural by-products in standard ration with prebiotic and probiotic was superior in terms of digestibility.

Horticultural by-products based feed was prepared by mixing six by-products such as fruit by-products (pineapple wastes, orange peels and banana peels) and vegetable by-products (pumpkin, carrot and cabbage wastes) in equal proportion, which will be used to make 100 parts. Seven iso-nitrogenous experimental diets/rations were prepared: Standard/control ration prepared with maize, wheat bran, rice polish, GNC, soybean meal and mineral mixture (R-I); Horticultural by-products and standard/control ration in 30:70 without prebiotic and probiotic (R-II); Horticultural by-products and standard/control ration in 30:70 with prebiotic and probiotic (R-III); Horticultural by-products and standard/control ration in 40:60 without prebiotic and probiotic (R-IV); Horticultural by-products and standard/control ration in 40:60 with prebiotic and probiotic (R-V); Horticultural by-products and standard/control ration in 50:50 without prebiotic and probiotic (R-VI); Horticultural by-products and standard/control ration in 50:50 with prebiotic and probiotic (R-VII).

In vitro experiments were conducted to study the effect of supplementation of different levels of horticultural by-products based rations with pre and probiotics on *in vitro* fermentation and digestibility. The results of the preliminary studies conducted in two-stage *in vitro* experiments (Pepsin, Pancreatic) indicated that the digestibility of R-III was significantly higher, while R-II recorded significantly lower digestibility. However, the digestibility recorded for R-I, RIV, RV. RVI and RVII were comparable. Initiated the three-stage *in vitro* experiments to evaluate the above seven rations and the work is under progress. The results of the preliminary *in vitro* experiments indicated that the ration mixed with horticultural by-products and standard/control ration in 30:70 with prebiotic and probiotic (R-III) is better in terms of digestibility, while the other rations (except R-II), irrespective of different ratio or level of inclusion of horticultural by-products with or without pre or probiotics were as good as the standard/control ration.

DST-SERB: Establishment of 3D *in vitro* culture conditions for maintaining long-term stemness in sheep spermatogonial stem cells

BK Binsila

- Spermatogonial stem cells (SSC) formed in spheroid culture system without significant increase in size.
- The SSCs proliferated and were able to maintain stemness in the Geltrex culture system.

Spermatogonial stem cells (SSC) are unipotent stem cells and serve as the precursor cells for the production of spermatozoa. SSCs play significant role in augmenting male fertility. SSCs isolated from the fertile donor can be transplanted to the infertile recipient to induce spermatogenesis. To achieve success in these applications, sufficient numbers of SSCs are required. The proportion of SSCs in the testis cell population is very low (~ 0.01-0.03%). Hence, it is highly essential to develop an in vitro culture system that should propagate sufficient numbers of SSCs and maintain SSCs for long term by subculturing. The advanced culture system such as 3D culture methods and oxygen tension optimization could increase better SSCs proliferation *in vitro* with optimal stemness. The study was taken up with the objectives to establish three-dimensional (3D) culture condition for sheep spermatogonial stem cells (SSCs) stemness maintenance *in vitro* and to understand the molecules involved in stemness associated pathways in SSCs culture systems.

SSCs were isolated and enriched with the earlier protocol developed in our laboratory. Cells were cultured in the advanced DMEM medium with the additives and growth factors such as GDNF (10ng/ml), EGF (20ng/ml) and IGF (100ng/ml). Trials have been initiated with 3D culture methods such as spheroids

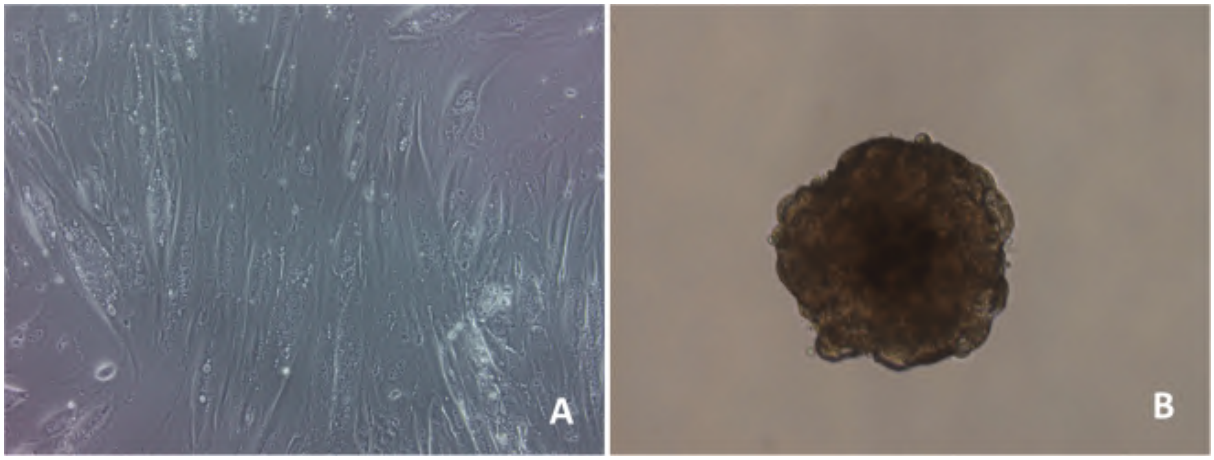


Fig. 25: Representative images of the sheep SSCs culture using the Geltrex (Panel-A) and Spheroid (Panel-B) culture systems.

and Geltrex culture system for the long term culturing of SSCs (Fig.25). Spheriods were developed through hanging drop culture methods (10,000 cells/spheroid) and SSCs formed compact spheroid within 24-48h. Though SSCs maintained the compact structure, but there was no significant increase in spheroids size after one month of culture in the preliminary study. SSCs proliferated in the Geltrex culture could able to maintain cell proliferation for four passages with stemness marker expression of *PLZF, ITGA6, GFRα1* and *CDH1* (Fig. 26). The spheroid characterization and long term SSC culture study are in progress.

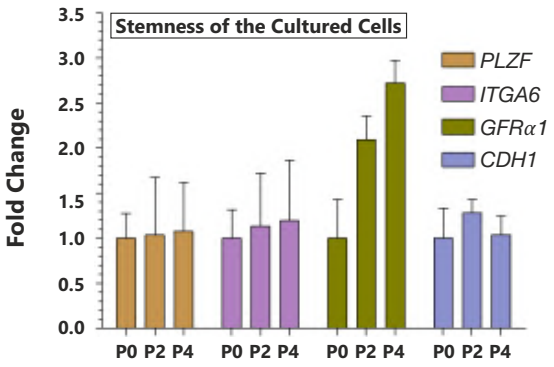


Fig. 26: Expression of the stemness markers *PLZF, ITGA6, GFRα1* and *CDH1* in the sheep SSCs culture.

ICAR-NASF:CRISPR/Cas9 guided functional analysis of genes regulating early embryonic survival in buffalo

S Mondal, IJ Reddy, S Nandi, PSP Gupta

- The endometrial epithelial cells were isolated successfully from buffalo uterus.
- The buffalo specific *PTGES* and *PTGFS* cDNAs were characterized.

Early embryonic mortality is a major impediment hampering the reproductive efficiency and accounts for a main component of post fertilization losses in buffalo. Prostaglandins (PGs) are the crucial regulators of implantation, decidualization, embryo development and survivality in ruminants. The first limiting step in generation of PGs is transformation of arachidonic acid by prostaglandin synthases 1 and 2 (PGHS-1, -2 or COX-1, COX-2). The downstream enzymes, prostaglandin E synthase (PTGES) and prostaglandin F synthase (PTGFS), catalyze the conversion of PGH2 to PGE2 and PGF2, respectively. Targeted genome editing by CRISPR/CAS9 technology has recently emerged as novel approach to modify endogenous genes in various cell types. The objectives of the current project are: Studying the CRISPR-Cas9 based editing of *COX-2, PTGES, PTGFS* and *AKR1B5* genes associated with prostaglandin biosynthetic pathways in buffalo; Studying the *in vitro* over expression of *COX-2, PTGES, PTGFS* and *AKR1B5* in mouse and buffalo uterine epithelial cells and; Generation of knockout mouse for most effective *COX-2, PTGES, PTGFS* and *AKR1B5* genes for determination of their role in fertility.

After washing the mid-luteal buffalo uterine horn (days 6-15 of cycle) with HBSS supplemented with gentamycin and 0.1% BSA, sterile HBSS containing 0.3% trypsin was infused into the uterine lumen. Epithelial cells were isolated by incubation at 37°C for 60min. The filtrate was subsequently washed with

HBSS supplemented with gentamycin and BSA. After cell counting and viability determination, the epithelial cells were seeded at the rate of 1·105 viable cells in RPMI 1640 medium at 38.5°C in humidified atmosphere of 5% CO2 in air for 5 days. The cells were also harvested on day 5 and total RNA was isolated from the cultured cells. PCR conditions were optimized for amplification of 196bp fragment for *PTGES* gene; 618bp fragment for *PTGFS* gene; 928bp fragment for *AKR1B5* gene as well as 341bp fragment of β-actin, respectively. The nucleotide sequence of bubaline *PTGES* cDNA exhibited 97.9, 96.4, 95.9, 92.9 and 88.3% identity with that of cattle, goat, sheep, pig and human, respectively. The amino acid sequence of bubaline PTGES protein showed 100, 96.9, 96.9, 93.7 and 85.9% identity with that of cattle, goat, sheep, pig and human, respectively. The nucleotide sequence of bubaline *PTGFS* cDNA exhibited 98.1, 96.1, 96.3, 85.3 and 83.1% identity with that of cattle, goat, sheep, pig and human, respectively. The amino acid sequence of bubaline PTFGES protein showed 96.6, 95.6, 94.1, 79.9 and 74.6% identity with that of cattle, goat, sheep, pig and human, respectively. The nucleotide sequence of bubaline *AKR1B5* cDNA exhibited 98.2, 97.9, 97.8, 89.9 and 87.9% identity with that of cattle, goat, sheep, pig and human, respectively. The amino acid sequence of bubaline AKR1B5 protein showed 98.1, 97.7, 98.1, 89.0 and 85.8% identity with that of cattle, goat, sheep, pig and human, respectively. The amplified 196bp fragment of *PTGES* gene and 928bp fragment of *AKR1B5* gene were gel purified and is being cloned into a cloning vector. Further work on cloning of *PTGES* and *AKR1B5* genes is in progress. The CRISPR/Cas9 construct was designed for editing *PTGES* gene and trials have been initiated for transfection in cultured buffalo endometrial cells.

ICAR-NASF: Targeted immobilization of Y-bearing spermatozoa and modulation of oviduct millieu for skewing the sex ratio towards female offspring in dairy cattle

D Rajendran, A Arangasamy

» Developed an *in vitro* oviduct explant model for studying sperm-oviduct binding in the cow.

Oviduct has its role from pre-fertilization to the time when the embryo gets into the uterus. Oviduct previously was considered as a passive organ, which helps in fertilization, but now it is considered as highly active and dynamic organ. Many recent works suggested that the oviduct selects spermatozoa for its quality and spermatozoa with particular trait such asacrosome integrity, high mitochondrial membrane potential, low protein tyrosine phosphorylation and un-capacitated spermatozoa. Apart from this, the oviduct is also said to select spermatozoa of a particular sex. A recent study indicates that the battle of sexes starts in oviduct and emphasized the ability of the oviduct of differentiate the spermatozoa of different sex. However, the mechanism by which oviduct select spermatozoa of a particular sex is still obscure. To study the microenvironment of oviduct on selection of sex, an oviduct explants model was developed. To obtain oviduct explants, bovine oviducts were separated from the facia and washed with DPBS. The trimmed oviduct was placed on a sterile slide, the contents of the oviduct were squeezed using another slide at an angle of 45°. The contents thus obtained were transferred into sterile TCM199 medium. The oviduct cells were obtained by passing the contents through 22 Gauge needle and the separated cell clumps were incubated at 37°C in 5% CO2, 95% humidity for 24h. The explants were observed under microscope under 400X and the motile and viable explants were selected for the study. The explants were incubated with different concentrations of spermatozoa and time combinations and stained with JC-1 and washed with DPBS to remove unbound spermatozoa. The number of spermatozoa bound to 0.1mm explant area was calculated and indicated as binding index. Higher binding index was observed with 1 million spermatozoa incubated for 1h and was selected for further experiments.

Inter-Institutional: Studies on exploitation of insects as food and feed

AV Elangovan

» Suitability of Black Soldier fly (BSF) larvae as poultry feed was assessed.

» The results indicate that BSF larvae meal possesses a good amino acid profile and it can be an effective partial replacement for soybean meal in broiler's diet.

Insects, as a protein source can contribute to global food security via feed to poultry. Among the insects, one of the most promising ones is the Black Soldier fly (BSF). Therefore the project was taken up with the objective to explore the suitability of BSF larvae as poultry feed. An experiment was conducted to explore the suitability of BSF larvae as poultry feed. Unsexed Cobb chicks (90-day old) were distributed into 2 treatment groups (one control group without insect meal and another group with 5% insect meal) with 5 replicates under each treatment with 9 birds in each replicate in a completely randomized design for three weeks. Results indicated similar body weight gain, feed intake or FCR in chicks fed insect meal or control group during the experimental period. No significant difference was observed in the length or weight of duodenum, jejunum, ileum and caecum between the treatments. Similarly, no difference in CP digestibility and cell-mediated immune response was observed between the groups. The results indicate that BSF larvae meal possesses a good amino acid profile and can be incorporated in broiler's diet efficiently.

Inter-Institutional: Retrofitting urea solution spraying system on paddy straw baler

SBN Rao, M Chandrasekharaiah

- » Optimum concentrations of urea and moisture were determined for rice and wheat straws at the time of baling.
- » Addition of urea at the time of bailing increased crude protein value of the treated straws.

One of the best possible ways to enhance the digestibility of poor quality roughages like rice and wheat straw is urea treatment. Conventionally, the straw is mixed urea solution and sealed in pits/bags for a certain period. The handling task could be minimized substantially by treating baled straw in batches of desired size, and the mixing task could be eliminated altogether if urea solution were applied into the straw bales by the dripping method.

ICAR-NIANP has evaluated the urea treated rice and wheat straws obtained from ICAR-CIAE Bhopal. Three different combinations of urea and moisture were applied to rice straw at the time of baling. Nine different levels of urea (3, 4, 5 at 50 % added moisture; 3.6, 4.8, 6 at 60% added moisture; 4,2, 5.6 and 7 at added 70% moisture) were evaluated at the time of baling. The values (% DM) for CP, total ash, NDF, ADF, IVDMD and IVOMD, and ME (MJ/kg) varied from 6.61±0.24 to 13.4±0.75, 15.1 to 19.6, 59.6 to 73.7, 34.8 to 43.7, 45.5±0.73 to 51.0±0.69, 48.3±1.08 to 54.8±1.09 and 6.62±0.09 to 7.41±0.04 respectively. The overall results indicate that due to optimum increase in CP, IVDMD and IVOMD of the treated rice straw, 4% urea with 50 % moisture level can be recommended for baling.

In case of wheat straw, six combinations were used for treatment (4, 5 at 50% moisture; 4.8, 6.0 at 60 % moisture; 5.6, 7 at 70 % moisture).The values (% DM) for CP, total ash, NDF, ADF, gas and IVOMD, and ME (MJ/kg) varied from 3.68±1.17 to 13.4±2.40, 7.87 to 10.3, 71.9±3.07 to 77.1±2.58, 43.5±0.41 to 46.5±1.83, 20.7±0.61 to 27.3±0.45, 32.4±3.70 to 46.3±2.49 and 5.54±0.08 to 6.60±0.05 respectively. The overall results indicate that due to optimum increase in CP, IVDMD and ME of treated wheat straw, 5.6% urea with 70% moisture level can be recommended for baling.

Inter-Institutional: Ethno-Veterinary study for enhancement of reproductive performance in livestock

S Nandi, PSP Gupta, S Mondal

- » Kaempferol, an active ingredient of *Moringaolifera* leaves at the dose of 10μM promoted the preantral follicle and granulosa cells functions.
- » It was found more effective in improving the ovarian functions compared to the other plant active ingredients, which are in the order of Myricetin>Quercetin>Carbazole.

Ethno-Veterinary practices have been used for many years for disease alleviation and augmentation of reproductive efficiency leading to the transfer of knowledge to the farming sector. Varieties of

medicinal plants are being used as a traditional knowledge to treat animals. They have been proved for their effectiveness on reproductive disorder management in farm animals. The project is being carried out with the objective: To study the effect of the extracts from leaves of *Murrayakoenigii, Mimosa Pudica, Aeglemarmelos, Bacopamonnieri,Leptadenia reticulate, Asparagus racemosus* and *Moringaoleifera* on the ovarian responses in mice/rats; To study the effect of pure form of active ingredients of the above plants on ovine ovarian follicle development, granulosa and uterine cell functions and to elucidate the mechanisms of pro-fertility/anti-fertility responses and; Validation of these practices on management of reproduction. The efficacy of carbazole, Myricetin, Quercetin and Kaempferol, potent plant molecules of *Murrayakoenigii* and *Moringaolifera* on functional parameters of preantral follicles, granulosa and uterine cells was examined. The preantral follicles, the granulosa cells and uterine cells retrieved from abattoir derived ovine ovaries were treated with the plant molecules at the concentration of 0.1, 1, 2.5, 5, 10,25, 50 and 100µM. The preantral follicle growth rates, viability rates, antrum formation and apoptosis, and the functional parameters of the granulosa/uterine cells (viability, growth rates, monolayer formation rate, apoptosis) were evaluated. It was observed that the growth parameters of primordial follicles and uterine cells did not significantly changes with the changing doses. The small preantral follicles below 250µm diameter had less capacity to respond to these doses as compared to those observed with the large follicles. All the plant molecules have the efficiency to improve the preantral follicles and granulosa cell functions in dose dependent manner. However, the functional parameters of the preantral follicles and granulosa cells reached the plateau at the doses above 25µM in all active ingredients examined. Of all the plant molecules examined, the Kaempferol from *Moringaolifera* was found to be the most beneficial. The investigation of the optimum dose of the above said and other plant molecules on cellular growth improvement, steroidogenesis and expression of the genes related to key regulatory pathways are in progress.

Feed Informatics, Feed Quality and Safety and Value Addition

FQS 4.3: Development of a novel phytogenic blend to replace antibiotic growth promoters in broiler production

RU Suganthi, J Ghosh, VB Awachat

- Efficacy of a novel phytogenic blend on production performance and caecal microflora composition was assessed in broiler chickens under deep litter system.
- Supplementation of the phytogenic blend (1%) improved body weight gain and feed conversion ratio of broiler chickens and reduced the Salmonella and Coliform counts in caecum.

Sub-therapeutic doses of antibiotics are being used as growth promoters (AGPs) in poultry production to control sub-clinical infections and to enhance growth, feed conversion efficiency and economics of broiler chicken production. The use of sub-therapeutic doses of antibiotics as growth promoters in poultry feed has been reported as one of the contributing factors for the emergence of antibiotic resistance in zoonotic pathogens and carryover of antibiotic residues in poultry products. Antibiotic resistance is considered as one of the major health issues of this century and hence AGP use is banned in many countries. Therefore, there is an immediate need for alternatives to AGPs and attention thus has been diverted to the search for new growth promoting alternatives to antibiotics. Phytogenics are reported to improve the health and growth of poultry and are considered as safe and residue free. The project has been taken up with the objective to complement broiler feed with a novel phytogenic blend as a replacement to AGP in broiler production.

During the period under report, herbal products were procured, processed and prepared as a bend for use in broiler study. A study was conducted in a broiler farm under deep litter system at Krishnagiri District, Tamil Nadu (Fig. 1). A total of 450 day-old commercial broiler chicks were procured from a commercial hatchery and subjected to three treatments to ascertain the efficacy of phytogenic blend on production performance, intestinal microflora and meat characteristics. During the experimental period, feed intake, body weight and

mortality were recorded. At the end of 42 days, from each of the replicates, blood samples were collected from representative birds and the birds were sacrificed. Results showed higher average body weight gain and improved feed conversion ratio in birds supplemented 1% phytogenic blend. Mortality percentage between phytogenic and antibiotic treatments was not significantly different. Study of caecal microflora revealed that the *Lactobacilli*, total aerobic bacteria, *Enterococci* and *Clostridum* counts were not affected by dietary supplementation of phytogenic blend. In contrast, Salmonella and Coliform counts were reduced significantly in the birds fed phytogenic blend as compared to the antibiotic group. Studies on other parameters are under progress.

Fig. 1: Feeding trial in broiler chickens under deep litter system for assessing the efficacy of phytogenic blend.

FQS 4.4: Assessment and characterisation of AMR genes in poultry production environment

AP Kolte, A Dhali, PK Malik, DT Pal, R Bhatta

» Antimincobial resistance (AMR) in the microbes is a global concern.
» The project is initiated to assess the AMR gene potential in the poultry production environments.

The prophylactic, therapeutic and growth promoter role of antibiotics in the production systems, especially in poultry industry has become a major concern after discovery of several multi drug resistant microbes across the continents. The major reason for development of antibiotic resistance in the microbes is inadvertent use of antibiotic in different production systems as well as easy availability of therapeutic antibiotics over the counter in many countries. Although, the exact origin of the antimicrobial resistance (AMR) is still debatable, however, it is posing a major threat to the global human health. The project was initiated to understand the prevalence of the antimicrobial resistance genes in the poultry production systems. The AMR gene databases were surveyed from the literature and downloaded for use in the project. Short bred marker databases like QMI-AR, CARD and ARG-ANNOT were downloaded and evaluated on the available data of the shotgun metagenome in the institute. Other nucleotide databases like VFDB and Res-Finder and ARES databases are also being evaluated. Poultry farm samples werecollected for total DNA isolation. Feed, water and poultry dropping samples will be used for metagenomic DNA isolation. The project envisages identifying the potential of the metagenomes from poultry production environment in terms of AMR gene content. The long term goal of the project is to assess the antimicrobial gene dynamics at different farm settings and to study the effect of different poultry farming systems on AMR incidence.

ICAR-CRP: Bio-fortification of cereals- Evaluation of value addition cereals (VAC) and cereal by products for animal feeding

KS Prasad, SBN Rao, NM Soren

» Bio-fortification of wheat bran resulted in increased zinc concentration, without adversely affecting in vitro dry matter digestibility and rumen fermentation.

Bio-fortified varieties (N=4) of wheat bran (WB2, HPBW01, HD3086, WH1105) along with their respective controls were obtained from ICAR-IIWBR, Karnal. They were analysed for proximate principles, NDF, ADF and minerals such as zinc, iron, copper and manganese. Further they were subjected to *in vitro* gas production test. The fermentation metabolites such as acetate, propionate, butyrate, valerate were analysed using gas chromatograph. Zinc contents were found higher in WB-2, WH-1105 varieties (Table 1). IVOMD, ME contents, fermentation metabolites such as acetate, propionate, butyrate, valerate were similar in all varieties irrespective of bio-fortification.

Table 1: Nutritional Evaluation of different wheat bran varieties.

Variety	CP (%)	Zinc (ppm)	IVOMD (%)	ME (MJ/ Kg)	Acetate (mM/l)	Propionate (mM/l)
WB-2 (Control)	13.4	63.4	86.7±0.37	10.1±0.12	29.6±2.44	11.1±0.23
WB-2(Biofort.)	14.8	68.4	86.4±0.19	10.3±0.15	33.7±2.09	12.1±0.81
HPBW-01 (Control)	14.5	52.9	84.2±0.37	10.1±0.23	35.3±0.38	12.6±0.56
HPBW-01 (Biofort.)	14.2	67.7	85.3±0.65	10.3±0.15	34.3±2.53	12.9±1.59
Hd3086 (Control)	12.4	44.4	86.4±0.74	10.5±0.18	35.9±2.14	12.6±1.12
Hd3086 (Biofort.)	13.9	54.9	84.4±0.71	10.3±0.26	28.7±2.81	9.5±1.24
Wh1105 (Control)	14.0	56.8	85.5±0.94	10.4±0.17	31.3±1.98	11.0±0.74
Wh1105 (Biofort.)	14.37	67.41	85.3±1.01	10.4±0.39	30.9±0.27	10.8±0.17

ICAR-Outreach: Monitoring of drug residues and environmental pollutants

KS Prasad, SBN Rao, DT Pal

» Warangal area of Telangana state was surveyed and 106 samples of soil, water, feed, fodder, milk and hair were collected for the analysis of pesticide residues and heavy metals content.

The project team surveyed the Warangal district of Telangana and collected samples of soil, water, feed, fodder, milk and hair samples for pesticide residue and heavy metal analysis. A total of 106 samples (Soil, 9; Water, 11; Paddy straw,15; green fodder, 17; concentrates, 26; milk, 28) were collected from Gunturpalli (SangyamMandal), Kamareddypalli, Aliabad (Parkalamandal) Karakapalli (Ganupur), Morchanapalli (Bhupalapalli), Potharajapalli (Gijukonda) and Mamnoor (Khila Warangal). Selected samples (N=18) of soil, water, paddy straw, green fodder, concentrate and milk were sent to ICAR-IIHR for the estimation of Phorate, Butachlor, Pretlachlor, Chloropyriphos, Cyhalothrin, Cartap hydrochloride, Carbendazim, Mancozeb, Buprofezin, Hexaconazole, Propiconazole, Tricyclozole and Acetamiprid using LC-MS-MS and GC-MS-MS. Further, all the samples were processed for the analysis of pesticide residues (γ -BHC, Chloropyriphos, Cypermethrin and Deltamethrin) and heavy metals (Lead, cadmium and Arsenic). The analysis is on progress.

ICAR-AICRP: Micro and secondary nutrients and pollutant elements in soil and plants

K Giridhar, NKS Gowda, DT Pal

» The contents of lead, cadmium and arsenic in sewage water, fodder crops and vegetables were found low and within the safe limits.

» Soil application of zinc sulphate (25kg/ha) improved zinc content (32.1ppm in treatment; 21.8ppm in control) and green fodder yield (34t/ha in treatment; 31.5t/ha in control) of jowar.

Heavy metals contribute to environmental pollution, as they are non-biodegradable and generally do not leach from the topsoil. Irrigation with untreated industrial sewage effluents causes accumulation of heavy metals in soil and subsequently in crops like fodders and vegetables, posing a health hazard to livestock and humans. In this context, a study was conducted to monitor the heavy metals in soil, water and green fodder crops in the periurban areas using untreated sewage water for irrigation.

A total of 36 samples of soil, bore well water, sewage water and green fodder were collected from the villages of Malur and Hoskotetaluks of Kolar district.

Lead, cadmium and arsenic were analyzed using ICP-OES. These metals were present in low quantities in the sewage water, fodder crops and vegetables and found within the safe limits. Traces of minerals could be detected in the soil samples collected from the fields, where sewage irrigation is not being done, but were completely absent in bore well water samples.

Soil application of zinc sulphate (25kg/ha) in the farmers' fields improved mean zinc content in fodder jowar (variety: CoFS-31) to 32.1ppm against 21.8ppm in the control plots (no Zn application). With zinc application to low zinc soils, mean green fodder yield of jowar improved to 34t/ha as compared to 31.5t/ha in the control plot (no zinc application).

CSB: Development of value added products from spent pupae of mulberry silkworm, *Bombyx mori L*

M Chandrasekharaiah, NM Soren, KS Prasad

- » Deoiled silkworm pupae (SWP) meal can be used as bypass protein supplement in livestock rations.
- » By-product prepared from SWP oil can be incorporated in the ration of sheep up to 15% in the concentrate mixture without compromising the growth and nutrient utilization.

Experiments were conducted in 5 phases to evaluate the feeding value of byproducts of silkworm pupae (SWP) in ruminant rations. In the first phase, the in vitro experiments were conducted to study the effect of supplementation of different inclusion levels of deoiled SWP by replacing (0, 10, 20....100%; T0, T10, T20....T100) soybean meal (SBM) in the concentrate mixture on finger millet, wheat and paddy straw based diets on *in vitro* digestibility and rumen fermentation. In the second phase, the *in sacco* studies were carried out in crossbred fistulated steers to determine degradability of byproducts of silk worm pupae. In the third phase, *in vitro* experiments were conducted to study the effect of supplementation of different inclusion levels of byproducts of SWP oil (0, 10, 15 and 20%; T0, T10, T15 and T20), in the concentrate mixture on finger millet, wheat and paddy straw-based diets on in vitro digestibility and rumen fermentation. Indigenous technology was developed for improved recovery of pupae oil (~32%) from silkworm pupae powder and also novel enzymatic or fermentation technique was developed for one-way recovery of α-inolenic acid (97% purity) from silkworm pupae powder by the collaborating institute (CSRTI, Mysore). In the fourth phase, experiments were conducted in two stages in cattle to evaluate the effect of different inclusion levels of defatted silkworm pupae meal (DSWP) on rumen fermentation, microbial protein synthesis and nutrient utilization in cattle fed on finger millet straw (FMS) based diet. Four isonitrogenous concentrate mixtures were prepared with DSWP replacing SBM at 0, 10, 20 and 30% (T0, T1, T2, T3). In the first stage, rumen fermentation experiment was conducted in a 4·4 Latin switch over design using four crossbred steers (average body weight 497kg) to study the effect of different levels of DSWP (0,10, 20 and 30%) on rumen fermentation. In the second stage, the digestibility trial was conducted in 20 crossbred cattle, which were divided into four experimental groups of five animals each in a complete randomized design to study the effect of different rations (T0, T1, T2 and T3) on microbial protein synthesis and nutrient utilization. In the fifth phase, experiments were conducted in two stages in sheep. In first stage, to evaluate the effect of different inclusion levels of DSWP on growth and nutrient utilization in 24 sheep fed on Super Napier fodder-based diet. In second stage, to evaluate the effect of different inclusion levels of by-product prepared from SWP pupae oil on growth and nutrient utilization in 24 sheep fed on Super Napier fodder-based diet. Overall results of all the phases of the study indicated that, the supplementation of DSWP up to 100% had no significant effect on *in vitro* rumen fermentation and digestibility on different straw (finger millet, paddy, wheat etc.) based rations. By-product can be prepared from spent pupae oil of mulberry silkworm. By-product prepared from SWP oil can be incorporated in the ration up to 15- 20% without compromising the *in vitro* digestibility different straw-based diets. The results of the *in vivo* study in cattle indicated that the DSWP can be incorporated in the ration of cattle up to 30% by replacing SBM protein without compromising the rumen fermentation and nutrient utilization. The results of the *in vivo* study in sheep indicated that the DSWP can be incorporated in the ration of sheep up to 75% by replacing GNC protein without compromising the growth and nutrient utilization and therefore can be used as a source of bypass protein. However, long-term studies are required to be carried out. The results of the *in vivo* study in sheep indicated that the by-product prepared from SWP oil can be incorporated in the

ration up to 15% in the concentrate mixture without compromising the growth and nutrient utilization. Therefore, Protein supplements were developed from unconventional sources and demonstrated that SWP meal can be used as an alternative source of protein and as a source of bypass protein in the diet of livestock. Developed the by-product and process for preparation of by-product from silkworm pupae oil, which can be incorporated in the ration up to 15% in the concentrate mixture without compromising the growth and nutrient utilization in sheep.

Climate Change Impact on Livestock

ICAR-Outreach: Estimation of methane emission under different feeding systems and development of mitigation strategies

Coordinator: R Bhatta

PK Malik, AP Kolte, C Devaraj

- Supplementation of silkworm pupae oil at 2% level did not affect the nutrient intake, digestibility and blood biochemical parameters in sheep.
- In contrast, due to changes in archaeal community and protozoa reduction with oil supplementation, a reduction in methane emission could be achieved.
- 16S rRNA amplicon sequencing revealed that *Methanobrevibacter* is the most abundant (89-93% of total archaea) archaea genus in the rumen of sheep.

Enteric methane emission is an integral, but wasteful process that occurs in the rumen. Methane emission from the ruminants is associated with climate change and loss of feed energy. The project is being implemented with the objectives to generate a database for the annual enteric methane emission from Indian livestock, develop mitigation strategies for enteric methane emission, conduct long term studies with established mitigation approaches and ascertain the effect on enteric methane mitigation, growth and milk yield and to explore the rumen methanogens plasticity and adaptation during long term evaluation of established methane mitigating phyto-sources.

Feeding of silkworm pupae oil in sheep did not reveal any adverse impact on the dry matter intake between the control and test groups. Similarly, OM, CP, NDF and ADF intake in continuous and intermittent oil feeding groups also did not differ from the control group. However, EE intake was significantly higher in the test groups as compared to control. Similarly, the nutrient digestibility except EE and blood biochemical parameters were also not affected with oil supplementation in the test groups. Methanogen diversity assessed through 16S rRNA amplicon sequencing established *Methanobrevibacter* as major archaea genus in the sheep, which constituted 89-93% of total archaea in the rumen (Fig. 1).

Methanobrevibactergottschalkii irrespective of the dietary treatments was distributed with maximum abundance in the rumen. The abundance of the *Methanobrevibactergottschalkii* was in the range of 48-60%, higher in the continuous oil supplemented group. However, the abundance of the *Methanobrevibacterwolini* and *Methanobrevibactermillerae* were almost similar in the control and test groups and did not change with the silkworm pupae oil supplementation. The abundance of another major hydrogenotrophic methanogen *Methanobrevibacterruminantium* clade was adversely affected with the oil supplementation. Results of the *in vivo* study indicated that silkworm pupae oil supplementation at 2% level did not affect the nutrient intake, digestibility and blood profile. However, due to changes in archaeal community and protozoa reduction with oil supplementation, a reduction in methane emission could be achieved.

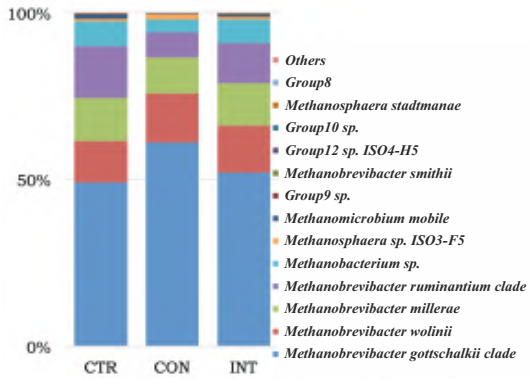


Fig. 1: Compositional variations in the rumen methanogens at species level.

DBT-DFG project: Optimized use of feed resources for high lifetime productivity of dairy cows and consequences on enteric methane release

R Bhatta, PK Malik, A Mech

- Methane production potential (ml/100mg in truly digested substrate) of the diet samples collected from the north and south transects of Bengaluru revealed a wide variation from 1.34 (tree leaves) to 6.01 (cereal straw).
- Diets formulated using dry fodder, concentrate and green fodder produced less methane as compared to the diets prepared with either dry roughage or roughage plus concentrate.
- Life cycle analysis of greenhouse gas emissions for the selected dairy farms in the study area was carried out using IPCC tier II guidelines.

To meet the increasing requirement for milk and milk products, the livestock sector is under tremendous pressure especially in the peri-urban areas, where most of the produces are sold in the urban market. Dairies in the urban areas are affected with day to day variations in feed prices, feed availability and season. Intensification of the dairies in peri-urban sector is also one of the reasons for high enteric methane emission from the livestock. Ameliorative strategies for enteric methane reduction, due to the vast diversity in seasonal availability of feed resources across the states in country cannot be adopted as such and there is a need to devise the location specific strategies for enteric methane amelioration, when intensification of livestock production is must. The project aims to determine the methane production potential of conventional feedstuffs and diets and of alternative optimized/balanced rations at peri-urban dairy farms, develop a model that predicts enteric methane emission from peri-urban dairy farms near Bengaluru, develop an inventory of the methane emission potential of different feeds and rations and to compute a life cycle assessment of enteric GHG emissions from peri-urban dairy farms near Bengaluru.

During the report period, a total of 226 feed and diet samples were collected from the north and south transects of Bengaluru. All the samples were analyzed *in vitro* for nutrient composition, dry matter digestibility and methane production. Chemical analysis revealed that concentrate contained 18% crude protein, while green and dry fodders in north transect contained 8 and 3.5% crude protein, respectively. Crude protein content in the feed samples collected from the south transects was also similar in all the categories. Methane production potential(ml/100mg in truly digested substrate) data revealed a large variation from 1.34(tree leaves) to 6.01 (cereal straws) for the analyzed samples. Dry matter digestibility of diets formulated with maize stover was reported higher than the diets formulated with sorghum stover and finger millet straw (Fig. 2). Formulation of diets using dry fodder, concentrate and green fodder produced less methane as compared to the diets prepared with either dry roughage or roughage plus concentrate. Life cycle analysis of greenhouse gas emissions for the selected dairy farms in study area was also worked out using IPCC tier II guidelines.

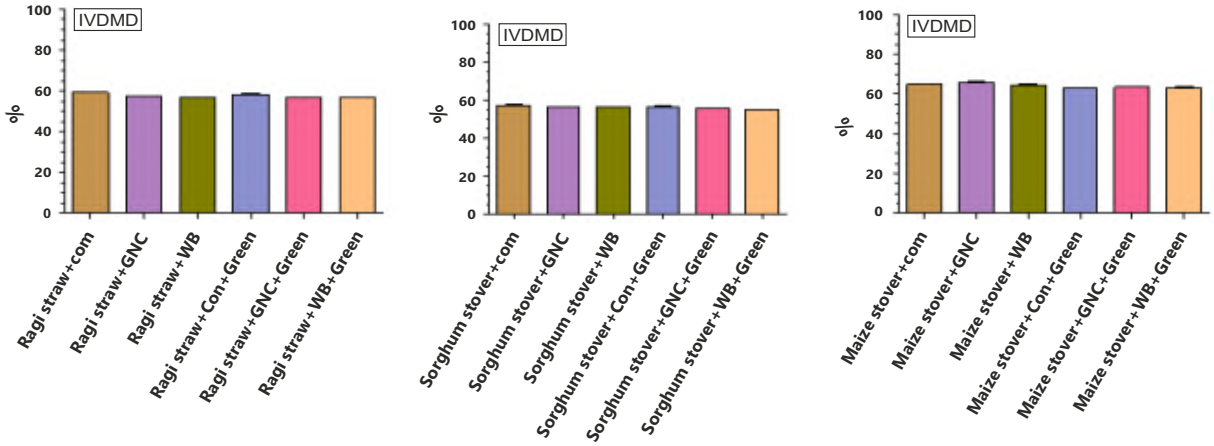


Fig. 2: Dry matter digestibility (%) of prevailing diets in the rural and urban interface transects.

ICAR-ILRI: Methane emission and its mitigation

R Bhatta, PK Malik, AP Kolte, V Sejian

- Impact of anti-methanogenic supplement Harit Dhara (5% of diet) on enteric methane emission and intake and digestibility of nutrient were assessed in sheep.
- Supplementation of Harit Dhara significantly decreased (21%) the enteric methane emission without affecting the nutrient intake and digestibility.
- Further, the supplementation significantly reduced the population of total rumen protozoa in sheep.

Greenhouse gases such as carbon dioxide, methane and nitrous oxide majorly contribute to climate change and global warming through their absorption of infrared radiation in the atmosphere. Methane is classified as a trace gas and is estimated to have a total global concentration of 1774 parts per billion (ppb). Globally, 50-60% of methane emissions are from the agricultural sector, specifically from livestock and rice cultivation. Ruminant animals are one of the principal sources of methane emissions from the agricultural sector. Domesticated ruminants, such as cattle, sheep and goats produce as much as 85-90 million metric tonnes of methane from the enteric fermentation per year. Practical strategies to reduce agricultural greenhouse gas emissions are urgently sought, particularly for enteric methane. The most successful strategies will be those, which lead to a profitable increase in animal productivity, as well as reduce enteric methane emission. Considering the importance of enteric methane amelioration from livestock, the International Livestock Research Institute (ILRI), Nairobi and Indian Council of Agricultural Research (ICAR), New Delhi have joined hands and formulated this collaborative project for a period of four years with the following objectives: To evaluate the established anti-methanogenic product(s) for the reduction in enteric methane emission in large/small ruminants and ascertaining the impact on nutrient availability and ruminal microbes; To study the effect of long-term rotational feeding with established methane ameliorating agents on the rumen methane emission and rumen microbial population including methanogens and; To compare the enteric methane emission among indigenous and crossbred cattle and buffaloes fed on the similar feeding regimes.

During the reported period, a study was conducted in sheep divided into three groups (N=6 in each group) to ascertain the impact of anti-methanogenic supplement Harit Dhara at 5% of diet on enteric methane emission, nutrient intake and digestibility. The results indicated similar intake and nutrient digestibility among the control and test groups. In contrast, enteric methane emission in Harit Dhara supplemented group was significantly reduced by 21% as compared to the control (Fig. 3). Similarly, there was a significant reduction in the population of total rumen protozoa (Entodiniomorphs and Holotrichs) due to the anti-methanogenic product supplementation in sheep. The Holotrichs protozoa were almost completely disappeared due to the supplementation in the present study. It was concluded that the supplementation of Harit Dhara significantly decreased the enteric methane emission without affecting the nutrient intake and digestibility.

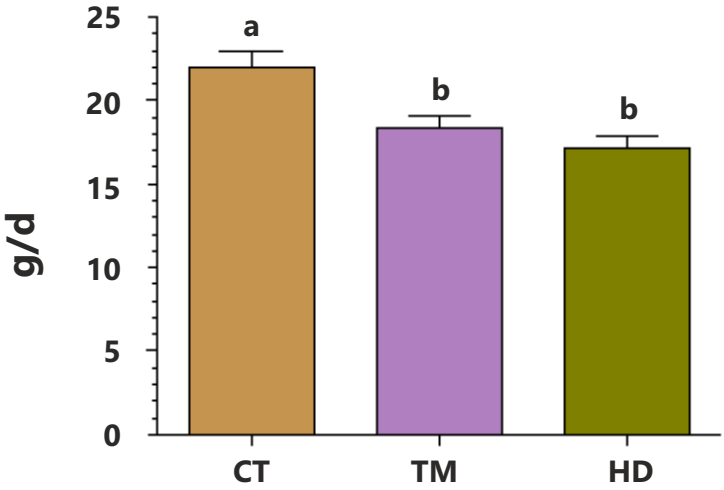


Fig. 3: Effect of supplementation of Harit Dhara on enteric methane emission (g/d) in sheep.

Technology Translation to Connect Discovery with Application

TTA 6.2: A micro level assessment of water use efficiency in different dairy production systems

G Letha Devi, A Mech, RK Gorti, V Sejian

- The average direct consumptive water use was found 130l/d/animal for the smallholder system and 205l/d/animal for the commercial dairies.
- The calculated water use efficiency for smallholder system was 0.85 and for commercial dairying it was 1.62.

Drinking water provides 60-80% of dry and lactating cows' water needs and feed provides the rest of the water needed. Water quality is equally important as quantity or availability. Water availability and quality have a direct impact on health and production performance in dairy cattle. With ever increasing population, industrial growth, water pollution, and climate change, the water availability per capita is shrinking per day. Shrinking water resources warrants judicious use of water since low water availability will lead to adverse effect on animal growth and production. Modern dairy practices require considerable resources and it includes water intensive operations. Increased water use efficiency contributes to improve livelihoods, food security and household nutrition, while reversing land degradation and safeguarding environmental resilience. The project aimed to understand the water use efficiency of different dairy production systems at the micro level, factors affecting water use efficiency and to develop model for improved water use efficiency in different dairy production systems.

Primary data were collected from 90 small and medium sized dairy farms in Shimoga district. The water inputs for animals considered were drinking water, water contained in forages, water for on-farm servicing, water for crop irrigation and water for all upstream inputs other than feeds and water output by animals (urine and water in milk). The water inputs through forage and other feed ingredients were found more as compared to the water inputs through drinking water and that used for on farm servicing operations such as cleaning etc. (Table 1).

The average direct consumptive water use by the smallholder system was found 130l/d/animal and the corresponding figure was 205l/d/animal for the commercial dairies. The calculated water use efficiency for the smallholder system was 0.85 and for the commercial dairying it was 1.62. A linear regression model for efficient water use was developed, which is currently being evaluated in the adopted villages.

Table 1: Water use (l/d/kg of milk) in different dairy production systems.

Operations	Small holder system	Commercial dairying
Drinking	40	52
Washing shed	55	90
Washing animals	25	38
Cleaning cans and other equipment	10	25
Water contained in feed and fodder	743	740
Total	873	945
Milk yield/d/animal	7.40	15.4
Water use efficiency	0.85	1.62

TTA 6.3: Economics of milk production under different systems of dairy farm management in Karnataka

S Jash, T Chandrappa, G Ravikiran

- Efforts were made to assess the cost of milk production under different farming systems.
- For producing one litre of milk, the paid input cost (₹) was found 24.8-29.9 and the cost (₹) including family labour was found 28.7-34.4.

The pricing indices of milk must be accommodative to its cost of production, with reasonable cushion of profitability to sustain livelihood, enterprise and farm welfare. The study envisioned on the quantitative and qualitative requirements of inputs, considering infrastructure in terms of appreciative depreciative functions of capital investments, loans, insurance, as well the operational costs in terms feed, health, labour, power, and ancillary components. The novelty of such an exponent has been extended to the evaluation of milk production cost under extensive, semi-intensive, intensive and organic farming systems. The final scroll shall provide a SWOT analysis of these farming systems with estimable future forecast.

The four defined farming systems have been selected across the urban, peri-urban and rural tracts, across the districts of Bengaluru (urban), Bengaluru (rural), Kolar and Tumkur, which forms the heartland milk-shed in Karnataka. So far, the cost of per litre milk production in investigative locales of fifteen households in Intensive, and ten households in the Semi-intensive and Extensive were estimated (Table 2). Further, 10 organic farm units were under observable estimations, selected in conjunction to the socio-economic status of the farmers.

The gradual appreciative values feature the zonation of access to feed and labour availability, its transportation costs, farm power usage, cushions on loans, interests, and insurance cover, investments on health and vaccination programmes, as well as a plethora of support systems extended to rural semi-intensive and extensive systems. The observation of farm welfare, sewage and sanitation factors, technology interfaces in urban and per-urban intensive dairy farms have also been enumerated, while considering the price indices of inputs.

The input components of the specialised organic farming system is being estimated in the certified thirty organic milk farms of "Akshayakalpa" around Tiptur, Arsikere, Channarayapatna, ChikkanayakanaHalli, Kadur and Holenarasipura regions of Tumkur and Hassan Districts.

Table 2: Illustration of comparative numeric of the cost of per litre of milk production (₹) in the different farming systems.

Price regime	Intensive		Semi-intensive	Extensive
	Urban	Peri-urban		
Paid input cost (A)	29	26.1	24.8	22.7
A+ family labour	34.4	28.7	-	-

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

D Rajendran

- Awareness programs were conducted for farmers and they were advised on problem faced in small ruminant production systems.
- Mineral and protein supplements were distributed to the beneficiaries.
- All small ruminants were dewormed thrice in year.

This programme aimed for holistic village development and the ICAR-NIANP was assigned to work on small animal production system in the selected villages at Kanakkapura taluk of Ramanagara district in Karnataka. Small ruminant like sheep and goat farming is subsidiary in this area. Flock size

ranges from two animals to sixty animals. This area is known for sericulture farming and rain fed agriculture. Three type of grazing land found in selected village were roadside grazing land, fallow land and hillock area, which cover more than 500 acres. Small sized flock are not grazed and fed mostly at stall with green fodder and very little concentrate. Medium and large size flocks are allowed for about eight hours of grazing without any stall feeding and extra supplementation or mineral mixture. Tree fodders are used for rearing of goats under stall fed condition. Small ruminants are rarely dewormed and whenever required they were vaccinated against contagious disease. No major outbreaks have been encountered in this area in the recent past. Farmers are rearing small ruminants in traditional way and not following any scientific technologies. Most of the animals in this area mainly depend on grazing and they are encountered with mineral deficiencies and reproductive issues. It is observed that farmers are not supplementing adequate level of protein to their animals.

From the inception of the project, all the small ruminants were supplemented with species-specific mineral mixture and were dewormed thrice in a year (January, May and September). Awareness program was conducted and farmers were educated about the problem faced for small ruminant production system. Protein supplements such as sunflower DOC, soybean meal, groundnut DOC and cotton DOC were distributed among the beneficiaries.

ICAR-Farmer FIRST: Improving livelihood security of farmers through technological interventions for sustainable livestock farming

Coordinator: R Bhatta

S Senani, G Letha Devi, DT Pal, K Giridhar, A Arangasamy, A Mech, MA Kataktalware, GB Manjunath Reddy, BN Narayanaswamy

- The project was implemented in a cluster of 10 villages in the Doddaballapura taluk of Rural Bengaluru, covering 1000 farm families.
- Various technology interventions were introduced and awareness campaigns and capacity building programs were organized for the farmers, and rural youth.
- The interventions resulted in the considerable improvement of income and livelihoods of the farmers.

Livestock production is an integral part of rural life and contributes significantly to rural economy. While a horizontal growth has been achieved in terms of number of animals, there is a need to achieve vertical growth in terms of improving productivity and livelihood security of rural households. Livestock plays economic and socio-cultural roles in small-farm system. Livestock production is very diverse, not only for the animal, but also differs among regions depending on physical, economical, social and cultural influences. By integrating livestock into crop production, farming system can be made more efficient for improving productivity and welfare.

This project is an effort to go beyond the issues of production and address the complex and diverse realities at field level through enhancing farmer-scientist interaction with multi stake holders participation. The major aim is to enrich farmer-scientist interface for technology development and application through focus on innovations, multi-stake-holders participation and technological interventions for sustainable livelihoods. The project is being undertaken in a cluster of 10 villages in Doddaballapura taluk of Rural Bengaluru, covering 1000 farm families.

Eight technology interventions were introduced at field. There was considerable improvement in the milk yield and milk fat percentage through the intervention of ASMM. More than 90% of the reproductive issues could be resolved, due to the interventions under reproductive management. Awareness was created about clean milk production and fodder varieties, production and various conservation methods were popularised in the field. Seeds, seedlings of vegetables and flowers were given to the farmers under horticulture intervention. Awareness campaign and capacity building programs were organized. After a couple of months following the technological as well as institutional interventions, the impacts were analysed and quantified, especially for the interventions such as ASMM, management of mastitis and lameness, horticulture crop production and quality milk production. It was observed that the interventions resulted in the considerable improvement of income and livelihoods of the farmers. Employment was created among the rural youth through the introduction of milking machines as a service. Introduction of milking machine, chaff cutter and rubber mats resulted in drudgery reduction among the farmwomen involved in dairy farming.

Chapter-3

PUBLICATIONS
AWARDS & HONOURS

Research Papers

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Selvaraju S

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Recent Advances in Predicting Bull Fertility. Winter School on "Conservation and Improvement of Indigenous Bovine Genetic Resources through Integrated Omic Approaches and Optimal Resource utilization", 6-26 November 2019, SRS ICAR-NDRI, Bengaluru.

Sperm Transcripts and MicroRNAs in Relation to Semen Quality and Bull Fertility. Brain storming session on "Semen Biology", 17 August 2019, SRS ICAR-NDRI, Bengaluru.

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Management Practices for Dairy Animals Against Climatic Stress. Model Training Course on "Good Dairy Management Practices for Sustainable Dairy Farming", 23-30 September 2019, SRS ICAR-NDRI, Bengaluru.

Climate Change Impact on Livestock: Adaptation and Mitigation with Special Reference to Nutritional Interventions. ICAR Sponsored Winter School on "Recent Biotechnological Advances for Precision Feeding of Livestock and Poultry", 4-24 September 2019, WBUAFS, Kolkata.

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Giridhar K

Farmer Friendly Green Fodder Production Technologies. Regional Workshop on "Sustainable Livestock Production in Doubling the Farmers Income", 11-12 July 2019, SVVU, Tirupati.

Plant Breeding Strategies for Improving Fodder Production. National Workshop on "Feeding the Indian Livestock: Challenges and Solutions", 19 July 2019, ICAR-IVRI, Bareilly.

Low Cost Feed Production: New Options. National Dialogue on "Land Use for Integrated Livestock Development", 1-2 November 2019,NASC Complex, New Delhi.

Strategies to Improve Fodder Production in India. SAARC Expert Consultation meeting on "Identification of Best Practices in Livestock and Fodder Production and Management", 21-23 May 2019, ICAR-NIANP, Bengaluru.

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User Friendly Ration Formulation Tools for Ruminant Animals. Model Training Course on "Good Dairy Management Practices for Sustainable Dairy Farming",23-30September 2019,SRS ICAR-NDRI, Bengaluru.

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Alternate Feed Resources and Technologies for Their Safe Usage. SAARC Expert Consultation meeting on "Identification of Best Practices in Livestock and Fodder Production and Management", 21-23 May 2019, ICAR-NIANP, Bengaluru.

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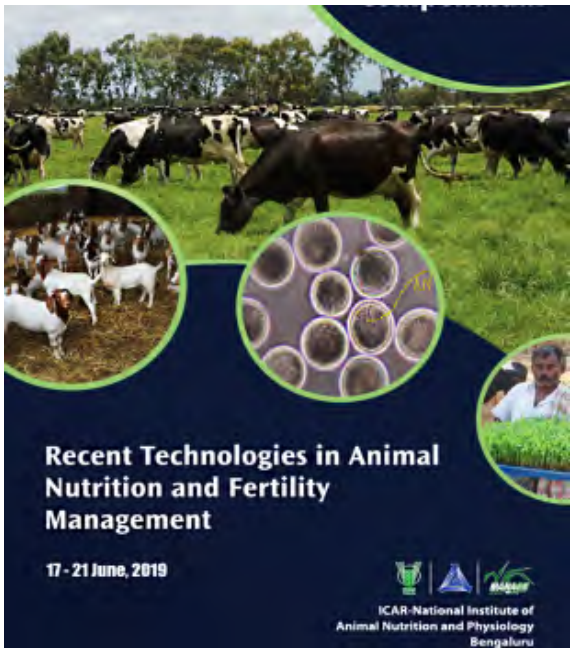

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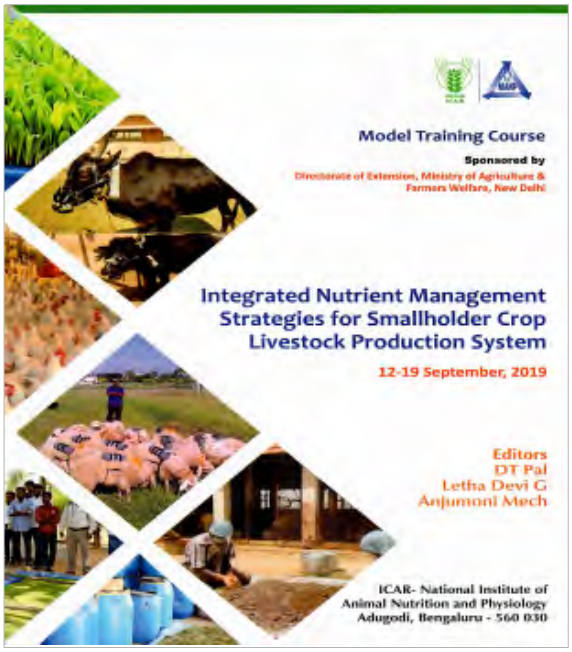

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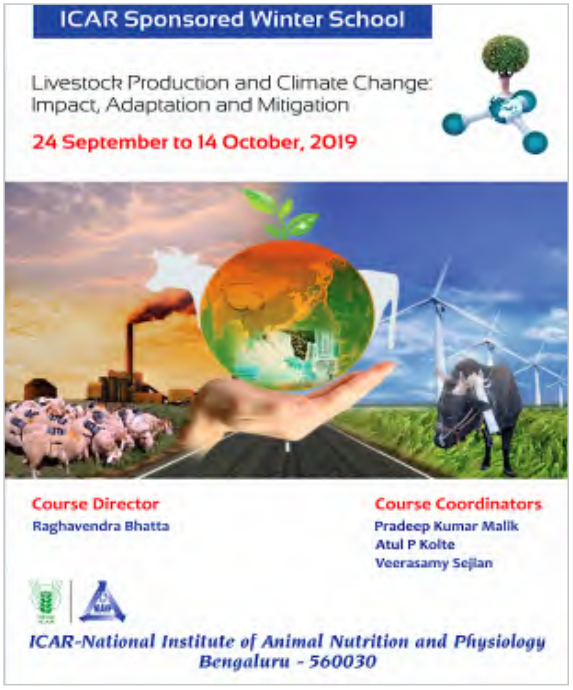

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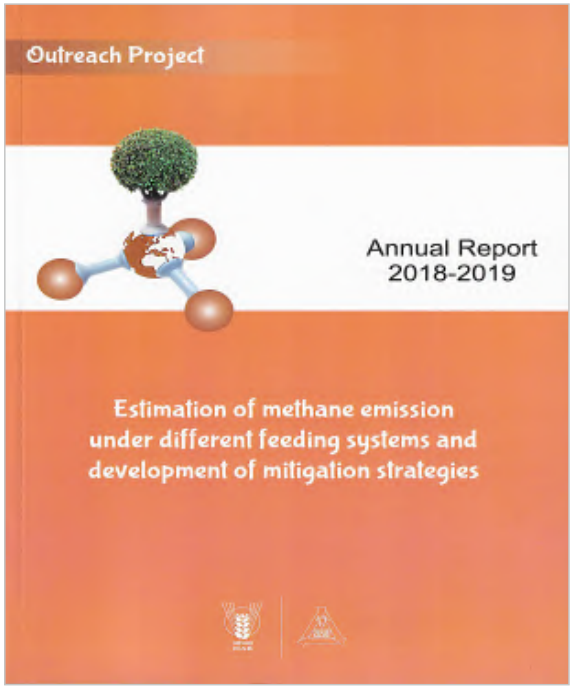

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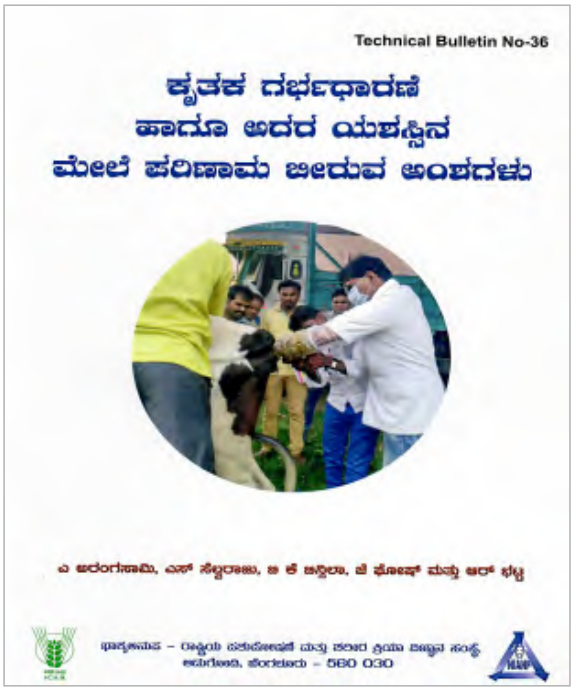

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Awards and Honours

ICAR-NIANP received the "Swachhata Pakhwada Award-2018 (First)" among all the ICAR institutes. The award was received by Dr Raghavendra Bhatta, Director, from the Honorable Secretary, DARE and DG, ICAR during the ICAR's 91st Foundation Day celebrations, 16 July 2019, NASC, New Delhi.

Dr Raghavendra Bhatta, Director, ICAR-NIANP received the "Compound Livestock Feed Manufacturers Association (CLFMA) of India Award" for meritorious contribution to the Indian livestock sector during the 61st National Symposium of CLFMA, 22 August 2019, New Delhi.

Dr Raghavendra Bhatta, Director, ICAR-NIANP received the "Achievers Veterinarian Award for Visionary Leadership" during the International Conference of the Indian Veterinary Association, 26 July 2019, New Delhi.

Dr BK Binsila Received the "ICAR-NIANP Best Research Paper Award" for the Year 2018-19. The award was presented during the celebration of Institute foundation day.

Dr PK Malik received the "Associate Fellow of Animal Nutrition Society of India "during the International Conference on Animal Nutrition 2019 (INCAN 2019), 17-19 December 2019, Kolkata.

Dr Luna Barua's PhD thesis was selected for Dr SK Ranjan's best PhD thesis award, received by Dr R Bhatta (PhD guide) during the International Conference on Animal Nutrition 2019 (INCAN 2019), 17-19 December 2019, Kolkata.

Dr A Dhali and his team received the "Nil's Lagerlof Memorial Award-2019" of the Indian Society for Study of Animal Reproduction for meritorious contribution to the research in animal reproduction during the XXXV Annual Convention of ISSAR, 18-20 December 2019, Namakkal, Tamil Nadu.

Dr KS Roy received the "2nd Prize from TOLIC, Bengaluru" for Hindi Technical Writing, 17 December 2019, ISRO-URSC, Bengaluru.

Technology Assessed and Transferred

The Anti-methanogenic Product Harit Dhara.

Grain Sprout as Green Feed Supplement for Livestock.

Conference presentation Awards

Conferences	Awards
Annual Conference of the Animal Physiologists Association (APACON-2019) on "Issues and Strategies for Physiological Capacity Building in Animals", 14-15 October 2019, SVVU, Tirupati.	Best paper presentation award for "Effect of withanamides present in Withania somnifera on blood brain barrier integrity and antioxidant status in rodent model: A pilot study" by Yallappa BS, Veeranna RK, Ravindra JP, Vaibhav AB, David CG.
XXXV Annual Convention of ISSAR and International Symposium on "Global Perspectives to Enhance Livestock Fertility through Modern Reproductive Techniques for Doubling Farmer's Income", 18-20 December 2019, VCRI, Namakkal, Tamil Nadu.	Young Scientist Award-2019 for the oral presentation "Fetal programming for oxidative stress protection: impacts of *chlorella vulgaris* supplementation on birth attributes and prepubertal growth rates of rabbit progenies" by Sikiru AB, Arangasamy A, Alemede IC, Egena SSA, Ijaiya, AT.
	Young Scientist Award-2019 for the poster presentation "Functional association of spermatozoal RNAs with bull fertility" by Ramya L, Swathi D, Parthipan S, Kolte AP, Selvaraju S.

International Conference on "Nutritional Strategies for Improving Farm Profitability and Clean Animal Production, INCAN 2019", 17-19 December 2019, Kolkata.	Best paper presentation award for "Systematic investigation to ascertain the impact of short and long-term silkworm pupae oil supplementation and withdrawal on enteric methane emission and methanogens diversity in sheep" by Thirumalaisamy G, Malik PK, Kolte AP, Trivedi S, Devaraj C, Sejian V, Dhali A, Bhatta R. Best paper presentation award for "In vitro evaluation of different wheat straw varieties as livestock feed" by Soren NM, Prasad KS, Rao SBN, Terhuja M.
International Seminar on "Innovative Extension Management for Uplifting Livelihood of Farmers - Status, Initiatives and Way Forward, ISEM2019", 27-28 June 2019, Chennai.	Best Paper Award for "Awareness and preparedness of livestock farmers for ICT tools" by Letha Devi G, Adhiguru P, Niketha L.
KVA State Level Workshop,20-21 July 2019, GKVK, Bengaluru.	Best Paper Award for "Efficient water use for sustainable dairy production" by Letha Devi G, Mech A, Ravikiran G, Sejian V, Kataktalware MA. Best Paper Award for "Comfortable dairy cattle housing for optimal productivity" by Kataktalware MA, Adbhai AD, Kumar P, Letha Devi G.
National Conference on "Issue and Strategies for Physiological Capacity Building in Animals", 14-15 October 2019, SVVU, Tirupati.	Best Poster Award for "A Novel method of synthesis of nanocurcumin" by Shwetha HS, Narayanaswamy M, Rajendran D, Babu PE, Kalmath GP, Veena MP.

Chapter-4

TRAINING AND CAPACITY BUILDING

Training/ Workshop/ Meeting Organized

ICAR Sponsored Winter School on "Livestock Production and Climate Change: Impact, Adaptation and Mitigation", 24 September - 14 October, 2019

The ICAR sponsored 21-day Winter School on "Livestock Production and Climate Change: Impact, Adaptation and Mitigation" was conducted from 24 September to 14 October 2019. A total of 21 including eight female participants from seven States participated in the training program. Theory lectures on various aspects such as stress, methane emission, impact of climate change on male and female reproduction, feed quality and biomass yield, emerging feed resources, microclimatic alterations, feeding during calamities and shelter management were delivered. Further, hands on training on methane measurement techniques, IPCC based estimations of carbon footprint, microbial diversity and bioinformatics analysis were conducted during the training. External faculties were also invited from other the Institutes to deliver lectures on specialized topics.

Expert Consultation Meeting on "Identification of Best Practices in Livestock and Fodder Production and Management" for SAARC countries, 21-23 May 2019

The Expert Consultation for SAARC countries was organized at the Institute from 21-23 May 2019. It was sponsored by the "SAARC Agricultural Centre (SAC)",Dhaka, Bangladesh. The meeting was attended by country representatives from Bangladesh, Bhutan, Sri Lanka and India. Chief Guest of the inaugural function, Dr JK Jena, Deputy Director General (Fisheries and Animal Sciences), ICAR, New Delhi appreciated the initiatives and called for more cooperation among the member countries in areas of mutual interest. Dr AK Samanta, Senior Programme Specialist, SAC Dhaka gave an overview about SAC activities. Guest lectures were delivered by the experts from NDDB, CLFMA and State Agricultural Universities. The participants also visited the KMF Feed Processing Unit, Central Poultry Development Organisation and Training Institute and Central Semen Bank.

Short term training course for the African Nationals on "Feed and Fertility Management in Livestock", sponsored by the Ministry of External affairs, Govt of India, 9-18 August 2019

A short-term training programme on "Feed and Fertility Management in Livestock" was organized by the Institute from 9-18 August 2019. It was sponsored by the India-Africa Forum Summit, IAFS-III, Ministry of External Affairs, Govt of India, for the benefit of African nationals. Eight participants representing Kenya, Egypt, Sudan and Namibia participated in the training. The training offered lectures and practical demonstration on agronomic management of new varieties of forage crops and fodder trees, alternate feed resources for livestock, conservation of fodder, hydroponics and azolla cultivation, nutritional management, precision feeding and ration balancing, amelioration strategies for greenhouse gases, management of stress to improve productivity of livestock, fertility assessment and management of bulls, assisted reproductive technologies. A filed trip to KMF Feed Processing Plant was also organized for the trainees.

Model Training Course on "Integrated Nutrient Management Strategies for Smallholder Crop Livestock Production System", sponsored by the Directorate of Extension, Ministry of Agriculture & Farmers Welfare, Govt of India, 12-19 September 2019

The Institute organized a Model Training Course on "Integrated Nutrient Management Strategies for Smallholder Crop Livestock Production System" on 12-19 September 2019. It was organized for the extension functionaries, working in Agriculture and Allied Departments of States in the country. Seventeen participants from various States attended the training program. The training program was designed with both lectures and practical classes focusing on improved fodder production and conservation, alternate feed resources, mineral supplementation, ration balancing tools, poultry nutrition, micro-climate modification for enhancing performance of dairy cattle, nutrient management strategies for sustainable livestock production, management of ruminants production during stress, fish as a component of integrated farming and intensive feeding of sheep for mutton production.

MANAGE sponsored Training programme on "Recent technologies in Animal Nutrition and Fertility Management", 17-21 June 2019

A short-term training programme on "Feed and Fertility Management in Livestock" was organized by the Institute from 9-18 August 2019. It was sponsored by the India-Africa Forum Summit, IAFS-III, Ministry of External Affairs, Govt of India, for the benefit of African nationals. Eight participants representing Kenya, Egypt, Sudan and Namibia participated in the training. The training offered lectures and practical demonstration on agronomic management of new varieties of forage crops and fodder trees, alternate feed resources for livestock, conservation of fodder, hydroponics and azolla cultivation, nutritional management, precision feeding and ration balancing, amelioration strategies for greenhouse gases, management of stress to improve productivity of livestock, fertility assessment and management of bulls, assisted reproductive technologies. A filed trip to KMF Feed Processing Plant was also organized for the trainees.

Workshop on "Pragmatic Usage of Hindi in Office", 11-12 April 2019

A2-days workshop on "Pragmatic Usage of Hindi in Office" was organized at the institute for all the Bengaluru based ICAR institutes from 11-12 April 2019. The different topics that were discussed during the workshops were the key points of the Official Language policy and the practical utility of Hindi teaching scheme, official correspondence in Hindi, use of Hindi shorthand, Hindi typing and noting, Hindi vocabulary and practical grammatical problems and their solution, E-platform usage for Hindi and Hindi translation. Shri MP Damodaran, Deputy Director (OL), Coffee Board, Bengaluru, Dr GR Chaudhari, In Charge (OL), DARE-DRDO, Bengaluru and Shri IC Mishra, Assistant Director, Translation Bureau, Bengaluru were invited as experts for different sessions during the workshop. A total 21 participants from different ICAR institutes of Bengaluru took part in the workshop.

Exposure visit for the skilled support staff from ICAR-CIFRI, Bengaluru, 17 December 2019

The Institute organized a one-day field/ exposure visit for the skilled support staff of the ICAR-Central Inland Fisheries Research Institute (CIFRI), Bengaluru regional station 17 December 2019. Three staff from ICAR-CIFRI participated in the training and it was coordinated by the technical and administrative staff of the ICAR-NIANP. The participants were provided exposures of various activities of the Institute.

Off-Campus NAARM Training Programme on "Motivation, Positive Thinking and Communication Skills" for Technical Staff of ICAR, 05-11 December 2019

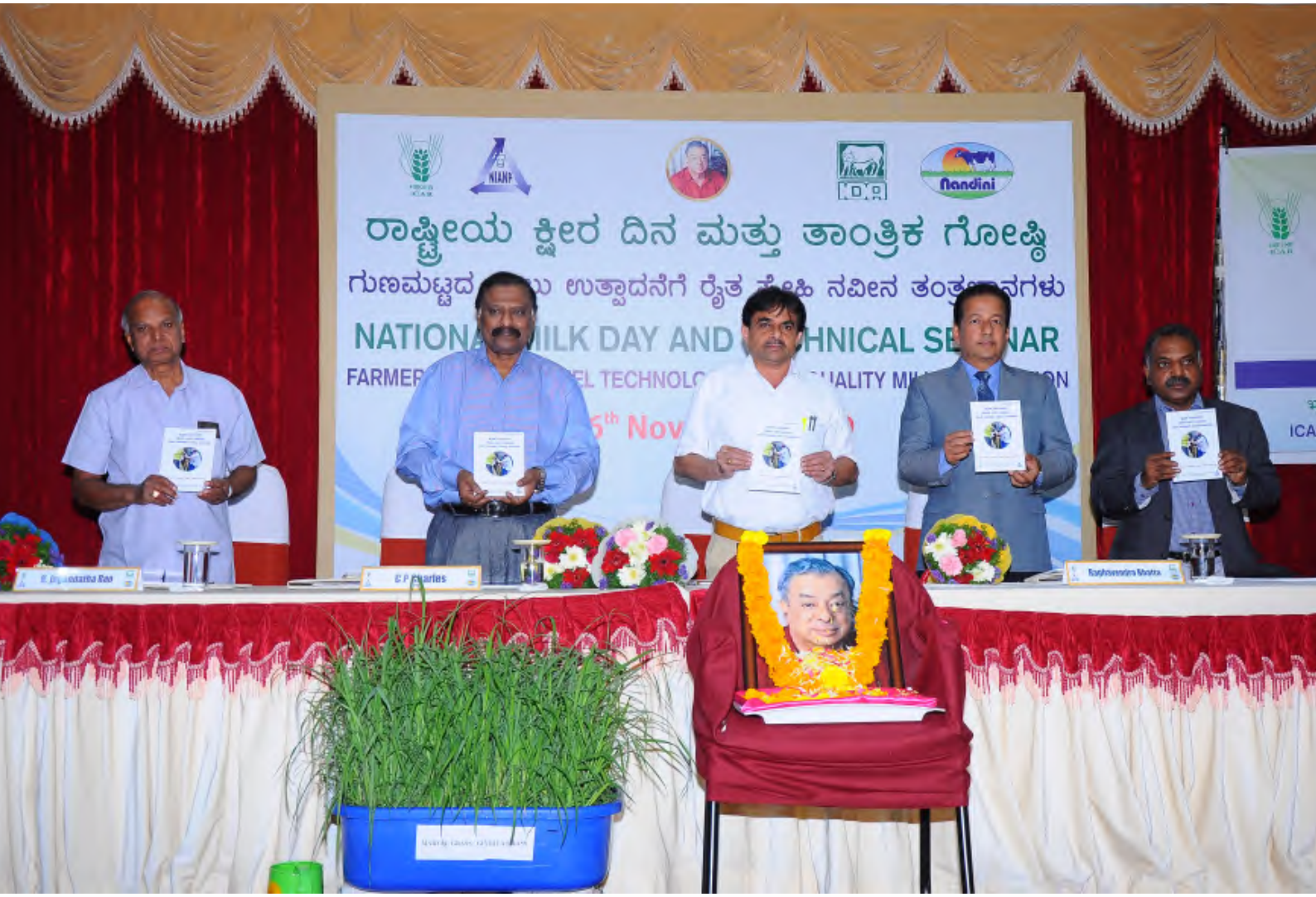
The Institute organized a 7-day off-campus training programme in collaboration with the ICAR-National Academy of Agricultural Research and Management (NAARM), Hyderabad during the period of 05-11 December 2019. The main objective of training was to motivate the technical staff (T-1 to T-4) for their growth and development. Nineteen participants from various ICAR institutes of the country participated. The training mainly focused on positive thinking on role and responsibilities of technical staff in Agricultural Research System, motivation and effective communication and presentation techniques. Further, lectures were delivered on topics such as personality profiling, positive attitude in personality development, interpersonal relationship and team building. The faculty experts from ICAR-NAARM delivered most of the lectures along with practical demonstrations.

International Trainee

Mr Akeem Babtunde Sikiru, PhD scholar from Federal University of Technology, Minna, Nigeria joined the Institute under the DBT TWAS fellowship on June, 2018. He worked on the project entitled "Influence of Chlorella vulgaris diets on oxidative stress and reproductive performance at physiological reproductive stages in New Zealand white rabbits" under the guidance of Dr A Arangasamy. He completed his project work on 28 December 2019.

Celebration of National Milk Day, 26 November 2019

The Institute in collaboration with the Indian Dairy Association (IDA) and Karnataka Milk Federation (KMF) celebrated the National Milk Day on 26 November. On this occasion, a 1-day technical seminar for progressive dairy farmers was organised on the theme "Quality Milk Production. More than 400 dairy farmers participated in the event. Ten exhibition stalls were displayed during the event and eight lectures were presented by eminent speakers on different aspects of dairy production and quality milk production. Dr DN Hegde, Director, Animal Husbandry, KMF delivered the plenary lecture highlighting the various measures taken for clean milk production and to provide quality milk to consumers.



Hosting Scholars with External Grant for Conducting Research

Scholar	Title of the Research Project	Grant	Mentor
A Ravichandran	Production, Characterization and Over Expression of Versatile Peroxidase (VP) of White-Rot Fungi for Deconstruction of Lignocellulosic Crop Residues	DST Women Scientist A	M Sridhar
BS Raghavendra	Production of genetically desired sires through transplantation of spermatogonial stem cells	DBT RA	S Selvaraju
BS Yallappa	Identification of food ingredients capable of crossing blood brain barrier and Combat G-stress	ICMR SRF	ICG David
J Chikkerur	Isolation of microbes for enzymatic production of short chain oligosaccharides and its evaluation as prebiotic	CSIR SRF	AK Samanta
K Krishna	Effects of novel peptides isolated from buffalo ovarian follicular fluid on in vitro maturation, fertilization and embryo development of oocytes retrieved from vetrified preantral follicles	DST Women Scientist Scheme-A	PSP Gupta
KK Kalpana	Effect of cryopreservation of preantral follicles on their estradiol synthesis pathway and oocyte development in ruminants	DBT SRF	PSP Gupta
MV Krishnaiah	Supplementation of organic zinc copper on spermatozoal gene and protein expression pattern in male goat (Capra hircus)	CSIR Fellow	A Arangasamy
P Singh	Endocrine disrupting chemicals and ovarian functions genomics epigenomics and steroidogenic pathways	UGS JRF	S Nandi
S Roy	Bioconversion of D-galactose into D-tagatose for evaluation as nutraceutical	DST KSTePS	AK Samanta
Sharanya J	Effect of calcium and magnesium on sex ration and placental genes expression in New Zealand White rabbit	CSIR Fellow	A Arangasamy
SS Archana	Immuno-modulatory molecular signature in relation to semen fertility	DST Women Scientist Scheme-A	S Selvaraju
VS Gurupriya	Molecular cloning and characterization of some of the proteases and proteases inhibitors of buffalo (Bubalus bubalis) male reproductive tract	ICMR SRF	SC Roy

Training Undergone by Staff

Scientist

Particulars	Participants
"Hands-on Training and Demonstrations in Laboratory Mouse Pre-implantation Embryo Handling and Microinjection Techniques", Mouse Genome Engineering Facility, NCBS, Bengaluru, 6-9 May 2019	A Mishra
"Laboratory Animal Techniques, Ethics and Welfare", CFTRI, Mysore, 6-10 May 2019	A Arangasamy

"Recent Bioinformatics Tools for Genome and Proteome Analysis", ICAR-NAARM, Hyderabad, 17-21 September 2019	NM Soren, C Devraj
"Innovative Practices in Extension Research", ICAR-NAARM, Hyderabad, 5-8 November 2019	Letha Devi G
"Metabolomics by Mass Spectrometry: A Basic Course", C-CAMP, GKVK, Bengaluru, 31 July-2 August, 2019	SC Roy
ICAR sponsored Winter School on "Conservation and Improvement of Indigenous Bovine Genetic Resources through Integrated Omic Approaches and Optimal Resource Utilization", SRS ICAR-NDRI, Bengaluru, 6-26 November 2019	S Jash

Technical and administrative Personnel

Particulars	Participants
"Capacity Building and Skill Up-gradation Program on Farm Management", ICAR-IISFR, Modipuram, 17-23 September 2019	V Awachat
"Recent Technologies in Animal Nutrition and Reproduction", CAR-NIANP, 17-21 June 2019	V Awachat, Maya G, K Bharathi, Veerana K
"Motivation, Positive Thinking and Communication Skills for Technical Staff", ICAR-NAARM off campus training conducted at ICAR-NIANP, 5-11 December 2019	Maya G, K Bharathi, YC Vijayalakshmi, M Shivarama
"Repair and Maintenance of the Office, Residential Building Including Guest House, ICAR-CIAE, Bhopal, 21-23 January 2020	V Ramesh
"MIS-FMS Pay roll System", ICAR-CPCRI, Kasargod, 3-5 October 2019	YC Vijayalakshmi, A Murthy, M Naveen Kumar

Meeting/ Conference/ Symposium Attended by the Director

Particulars	Date
Brainstorming Session on "Sustainability of Livestock and Fishery Production Systems in India: Issues and Indicators" organized by ILRI,ICAR-NDRI, Karnal	20 Apr 2019
VI Bi-monthly review meeting of Indo German Collaborative research project on "Rural- Urban Interface of Bangalore: A Space of Transitions in Agriculture, Economics and Society",ICAR-NIANP, Bengaluru	3 May 2019
Meeting of "Selected Peer Groups" of the Livestock Sector (Dairy, Sheep and Goat, Poultry, Meat, Value Addition, Feeds and Fodder: Including Innovations, Technologies, Investments, Government Programmes and Policies etc.)", TAAS Office, New Delhi	10 Jun 2019
Preliminary meeting of the committee for preparation of EFCs for the period 2020-2023 and 2020-2025, ICAR, New Delhi	13 Jun 2019
Interaction Meeting of Directors of Animal Science Institutes, ICAR, New Delhi	17 Jun 2019
Brainstorming Session for Feed and Fodder, ICAR, New Delhi	1 Jul 2019
ICAR Foundation Day, ICAR, New Delhi	16 Jul 2019
International Conference on "Emerging Challenges to the Veterinary Profession" organized by the Indian Veterinary Association, NASC complex, New Delhi	26 Jul 2019
52nd Annual General Meeting and 61st National Symposium 2019 on "Indian Livestock Farming: Prospects and Role of Government Policies" organized by CLFMA of India, New Delhi	22 Aug 2019

Regional Committee meeting, ICAR-IIHR, Bengaluru	6 Sep 2019
Annual Review Meeting of Outreach Programme on "Estimation of Methane Emission Under Different Feeding Systems and Development of Mitigation Strategies", NASC Complex, New Delhi	9 Sep 2019
Meeting of Members of the Advisory Committee constituted as per rule 16 of the Veterinary Council of India (Procedure for Recognition and De-recognition of Veterinary Colleges and Veterinary Qualifications) Rules, 2017, Krishi Bhawan, New Delhi	13 Sep 2019
Mid-term Review Meeting of the ILRI-ICAR Collaborative Projects, ILRI, New Delhi	25 Sep 2019
Brainstorming Meeting of DBT and BMGF, New Delhi	4 Oct 2019
Deputation to represent NIANP during the evaluation of the INDO-German collaborative project "Optimized Use of Feed Resources for High Lifetime Productivity of Dairy Cows and Consequences on Enteric Methane rRlease A-03" under the thematic project "FOR2432 the Rural-Urban Interface of Bangalore: A space of Transition in Agriculture, Economics and Society, University of Kassel and University of Gottingen, Germany	16-23 Oct 2019
Selection Committee Meeting as Member of DG's Nominee at Madras Veterinary College Campus, Chennai	29 Oct 2019
National Dialogue on "Land Use for Integrated Livestock Development" organized by TAAS in collaboration with ICAR and ILRI, NASC Complex, New Delhi	1 Nov 2019
Meeting with Secretary, DARE and DG, ICAR at Animal Science and Fisheries Science Division, ICAR, New Delhi	1 Nov 2019
Annual Review meeting of the AICRP project on 'Nutritional and Physiological Interventions for Enhancing Reproductive Performance in Animals", OUAT, Bhubneshwar	16 Nov 2019
National Seminar on "Animal Nutritional Strategies for Optimizing Production Cost, Milk Quality and Quantity in Small-holder Dairy Farming Systems" organized by the Animal Nutrition Group of NDDB, Anand, Gujarat	21 Nov 2019
Deputation to Kenya to attend meeting of ICAR-ILRI collaboration on GHG emissions, ILRI, Nairobi	1-6 Dec 2019
International Conference on Animal Nutrition-2019 on "Nutritional Strategies for Improving Farm Profitability and Clean Animal Production", Kolkata	17 Dec 2019

Dr Raghavendra Bhatta, the Director, ICAR-National Institute of Animal Nutrition and Physiology visited Germany to participate in the review meeting of the Indo-German collaborative project at University of Kassel and Gottingen, Germany from 16th to 23rd November, 2019.

Dr Raghavendra Bhatta, the Director, ICAR-National Institute of Animal Nutrition and Physiology visited ILRI, Nairobi, Kenya to attend the meetings and discussed collaborations between ICAR-ILRI on Green House Gas Emissions and visited the state of the art Mazingira Laboratory from 1st to 6th December, 2019.

Workshop/ Conference/ Seminar/ Symposium/ Krishi Mela/ Expo/ Meeting Attended by Scientists and Technical Officers

Particulars	Participants
International Seminar ISEM2019, 27-28 June 2019, MVC, Chennai	Letha Devi G
Second Annual Meeting of the APA and National Conference on "Issues and Strategies for Physiological Capacity Building in Animals", 14-15 October 2019, College of Veterinary Science, Tirupati	IJ Reddy, G Krishnan, V Sejian, S Nandi, S Selvaraju, K S Roy, C Devaraj, M Bagath
ISSRF Mid-term National Symposium on "Impact of Lifestyle and Environmental Factors on the Reproductive Health and Fertility", 16 October 2019, College of Veterinary Sciences, Tirupathi	S Selvaraju
National Symposium on "Paradigm transformation if technological advancement in veterinary science:National perspective" 26-27 November 2019, PGIVAS, MAFSU, Akola	AP Kolte
International Conference eSARD 2019, 14-16 December 2019, KVK, Suttur	Letha Devi G
International Conference of the Animal Nutrition Society of India (INCAN 2019) on "Nutritional strategies for improving farm profitability and clean animal production", 17-19 December 2019, Kolkata	RU Suganthi, PK Malik, D Rajendran, NM Soren, SBN Rao
International Conference on "Current scenario and future strategies of disease control for augmenting livestock and poultry production under changing climatic conditions", 20-22 November2019, Veterinary College and Research Institute, Namakkal	D Rajendran
XXXV Annual Convention of the ISSAR and International Symposium on "Global Perspectives to Enhance Livestock Fertility through Modern Reproductive Techniques for Doubling Farmer's Income", 18-20 December 2019, Veterinary College and Research Institute, Namakkal	A Arangasamy, S Selvaraju, A Dhali, AP Kolte
International Conference on "Materials for Environment, Sustainable Society and Global Empowerment-2019", 19-20 December 2019, VTU, Chikkaballapur	S Mondal
Bi-monthly review meeting of the Indo-German collaborative project on "The Rural-Urban Interface of Bangalore: A space of Transitions in Agriculture, Economics and Society", 3 May 2019, ICAR-NIANP, Bengaluru	PK Malik
Science and Engineering Research Board Meeting, Department of Science and Technology, 14-15 June 2019 and 26-27 July 2019, New Delhi	S Selvaraju
Regional workshop on "Sustainable Livestock Production in Doubling the Farmers Income, 11-12 July 2019, SVVU, Tirupati	K Giridhar, SBN Rao M Chandrasekharaiah
National Workshop on "Feeding the Indian Livestock: Challenges and Solutions," 19 July 2019, ICAR-IVRI, Bareilly	K Giridhar
KVA state level workshop,20-21 July 2019, GKVK, UAS, Bengaluru	Letha Devi G, M Chandrasekharaiah
International Workshop on "World Wildlife Fund Forum on Environment and Climate Change with Relevance to Protein Sustainability", 24-25 July 2019, New Delhi	V Sejian
International Workshop on "Livestock Gene Editing", 7 August 2019, Madras Veterinary College, Chennai	A Arangasamy, BK Binsila, S Selvaraju

The First Enclave of DBT TWAS Fellowship organized by CCSTDS, DBT, 8-9 August 2019, Chennai	A Arangasamy
Brainstorming session on Semen Biology, 17 August 2019, SRS ICAR-NDRI, Bengaluru	A Arangasamy, BK Binsila, S Selvaraju
National level Workshop on "Strategies to Augment the Potential and Opportunities on Export of Poultry Egg and Meat", 22 August 2019, College of Poultry Production and Management, Hosur	ICG David
Annual review meeting of the Outreach Project on " Estimation of Methane Emission Under Different Feeding Systems and Development of Mitigation Strategies", 9 September 2019, NASC Complex, New Delhi	PK Malik
Mid-term review meeting of the ILRI-ICAR collaborative project on "Methane Emission and Its Mitigation", 25 September 2019, NASC Complex, New Delhi	PK Malik
Institute Management Committee Meeting of ICAR-NRCM, 4 October 2019, Jharnapani, Nagaland	DT Pal
Annual Review Meeting of ABIs, ZTMCs and ITMUs, 4-5 October 2019, NASC Complex, New Delhi	AP Kolte
Krishi Mela, 24-27 October, 2019, GKVK, UAS, Bengaluru	S Selvaraju, SBN Rao, K Giridhar, D Rajendran, RU Suganthi, Letha Devi G, NKS Gowda, KS Roy
National Dialogue on "Land Use for Integrated Livestock Development", 1-2 November 2019, NASC Complex, New Delhi	K Giridhar
Workshop on "Flow Cytometry", 13-15 November 2019, SRS ICAR-NDRI, Bengaluru	ICG David
Fourth National workshop on Krishi web portal, 10-11 December 2019, NASC Complex, New Delhi	D Rajendran
DBT Project Review Meeting, 18 December 2019, Department of Biotechnology, New Delhi	M Chandrasekharaiah

List of Workshop/ Training Conducted for Stakeholders

Particulars	Date	Venue
Training of "Azolla Production in Ready to Use PVC Ponds"	5 Apr 2019	Timmajanahalli and S. Nagenahalli, Doddaballapur
Training on "Silage Production in Drums" and health camp for ruminants	11 Jun 2019	Timmajanahalli, Doddaballapur
Training on "Improved Cultivation Practices for New Fodder Varieties"	13 Jun 2019	Malur, Kolar
Workshop on "Mastitis Management"	14 Jun 2019	Timmajanahalli, Doddaballapur
Training on "Hydroponic Cultivation of Grain Sprouts and Vegetables"	15 Jun 2019	ICAR-NIANP, Bengaluru
Health camp for ruminants	27 Jun 2019	Timmajanahalli, Doddaballapur
Health camp for ruminants	28 Jul 2019	S. Nagenahalli, Doddaballapur
Workshop on "Mastitis Management"	7 Aug 2019	Lakshmidevipura, Bengaluru Rural

Training on "Grain Sprouts Production"	24 Aug 2019	S. Nagenahalli, Doddaballapur
Health camp for ruminants	26 Aug 2019	S. Nagenahalli, Doddaballapur
Training on "Hydroponic Fodder" for the trainees from Harsha trust, Odisha	16-17 Sep 2019	ICAR-NIANP, Bengaluru
Health camp for ruminants	26 Sep 2019	Lakshmidevipura, Bengaluru Rural
Training on "Grain Sprouts Production"	18 Oct 2019	Timmajanahalli, Doddaballapur
Health camp for ruminants	26 Oct 2019	Lakshmidevipura, Bengaluru Rural
Training on "Hydroponic Fodder Production"	29 Oct 2019	Yelahanka, Bengaluru Urban
Workshop on "Mastitis Management"	6 Dec 2019	S. Nagenahalli, Doddaballapur
Training on "Improved Cultivation Practices for New Fodder Varieties"	7 Dec 2019	Lakshmidevipura, Bengaluru Rural
Health camp for ruminants	7 Dec 2019	Timmajanahalli, Doddaballapur

Allocation and Utilization of HRD Fund, April-December 2019

HRD fund allocation (lakh)	Actual expenditure (lakh)	Utilization (%)
3.00	2.51	83.67

Chapter-5

OTHER ACTIVITIES

Institute Research Committee

The Annual Institute Research Committee (IRC) meeting for the period April 2018 to March 2019 was held on 26-27 April 2019 in the seminar hall under the Chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP. Dr Rajan Gupta, Principal Scientist, ICAR, New Delhi attended the annual IRC meeting as an Expert Nominee from the Council. A total of 39 scientist members participated the IRC meeting and a total of 49 projects were reviewed during the Annual IRC Meeting that included two new, 23 on going and three completed IRC approved institute projects, two inter-institutional projects, 17 externally-funded projects and two international collaborative projects. The Director asked the scientists that the new technologies or products developed by them should be disseminated as soon as possible so that the institute gets its due credit. Further, he emphasized to bring out quality research publications in the reputed international journals with high impact factors.

Observance of Vigilance Awareness Week

The Vigilance Awareness Week was observed at the Institute from 28 October to 2 November 2019. All the staffs of ICAR-NIANP including permanent, contractual and students assembled in the institute auditorium in the morning 10.30 AM on 28 October and took the pledge for "Integrity: A Way of Life" as administered by the Director. Before the pledge, Director addressed the gathering and signified the importance of preventing the corruption in office work to keep the institute and thus the nation corruption free. He also mentioned the importance of integrity in workplace for smooth functioning of the organization.

Celebration of Institute Foundation Day

ICAR-NIANP celebrated its 24th Foundation day on 25 November 2019. Shri Dilip Rath, Chairman, NDDB, Anand was the Chief Guest and Prof. Vishnu Sharma, Honourable Vice Chancellor, RAJUVAS, Bikaner was the Guest of Honour of the function. Dr Raghavendra Bhatta, Director of the Institute, welcomed the guests and made a short presentation on the institute's progress. He mentioned about the salient achievements, technology developed and their commercialization. Some of the niche areas, where the Institute has made significant progress such as stem cell research, exclusive semen extender for buffaloes, identification of sub-fertile bulls, biomarker for climate resilience, embryo sexing as an alternate for semen sexing and nano minerals were highlighted. Prof. Vishnu Sharma released the bilingual pamphlets 'Farmers friendly enteric methane amelioration approaches' in English and Hindi. During his address, he highlighted the significance of setting up a "National Advisory Services" on animal nutrition at ICAR-NIANP to disseminate information pertaining to feed and fodder resources. He also connoted the importance of collaboration between ICAR-NIANP and other Institutes and State Agricultural Universities in the field of Animal Nutrition. Shri Dilip Rath released the publication "Protocols for the animal experiments under institutional animal ethics committee". He complimented the significant contribution of ICAR-NIANP in a relatively short span of time. He emphasized the importance of addressing the fodder deficit especially with the increasing population of livestock indicated in the latest livestock census. Further, he urged the need for NDDB to collaborate with ICAR-NIANP and other relevant Institutes to meet the huge future fodder demand for dairy animals. All the retired employees and best workers in scientific, technical and supportive categories for the year 2018-19 were felicitated during the function. The firms, which adopted the ICAR-NIANP technologies were also felicitated during the function. The scientists from SRS ICAR-NDRI, NDDB and other sister ICAR Institutes located in Bengaluru also attended the function. A cultural extravaganza by the students of the Department of Performing Arts, Bangalore University was organized during the celebration.

Visit of Shri Parshottam Khodabhai Rupala, MoS for Agriculture, Govt of India

The MoS for Agriculture, Govt of India, Shri Parshottam Khodabhai Rupala Ji visited the Institute on 22-23 December 2019. Dr Raghavendra Bhatta, Director, NIANP explained the activities of the Institute, the various farmer friendly technologies the institute has developed and their commercialized. Hon Minister showed keen interest about the various activities and complimented the Director and the Scientists. He also visited the fodder production area. Observing the spineless cactus plot, he emphasized the need to popularize it among the farmers because of its climate resilience and meagre water requirement. He also discussed about the issue of feeding of livestock and the need for taking research on climate resilient livestock production system.

Visit of Shri Atul Chaturvedi, IAS, Secretary (DAD)

Shri Atul Chaturvedi, IAS, Secretary(DAD), Govt of India, visited the Institute on 07 October 2019. Dr Raghavendra Bhatta, Director of the Institute made a brief presentation on the activities of the Institute. He explained about the salient achievements, ongoing projects, patent granted and technologies commercialized. The Secretary appreciated the contribution of the Institute in terms of the farmer friendly technologies developed and commercialization of technologies. He mentioned that out of the four approaches for doubling the farmers' income, disease control, breed improvement, feeding and processing and value addition and marketing, the feeding of livestock plays the most crucial role. He emphasized the need for research on reducing the cost of poultry feeds and approaches for doubling the farmers' income in terms efficient feeding of livestock. He also interacted with the scientists of the Institute.

Celebration of International Yoga Day

The Institute celebrated the International Day of Yoga on 21 June 2019. All the staff members including 25 trainees from various states of India taking part in the MANAGE sponsored ongoing training program took part in the Yoga program. Dr Vinutha Rao, Yoga Specialist from The Institute of Ayurveda and Integrative Medicine (I-AIM), Bengaluru, conducted the Yoga session. Common Yoga Protocol videos were shown to the participants and the same was shared with the trainees through WhatsApp. Dr Raghavendra Bhatta, Director, ICAR-NIANP, spoke about the importance of Yoga and the contents of the circular from Ministry of AYUSH about "Festival of Yoga and Well-being" and emphasized that Yoga should become an integral part of the lifestyle.

Linkage/ Collaboration

The Institute has been working as a partner of the ILRI-ICAR collaborative research project on "Methane emission and its mitigation" for the period of January 2019 to December 2022. The participating Institutions in this project are ICAR-NIANP, Bengaluru, ICAR-IVRI, Barielly and ILRI, Nairobi, Kenya (CGIAR).

In House Seminar

Date	Talk Delivered	Speaker
21 January 2019	Exploration of *chlorella vulgaris* as supplement for improving livestock reproductive performance	Mr Akeem Babatunde Sikiru, PhD Scholar under DBT-TWAS Programme
22 March 2019	Application of NGS technologies in animal sciences	Ms Ramya L, PhD Scholar, Animal Physiology Division
14 June 2019	Boron chemicals – physiological applications and science for social entrepreneurship	Prof. Soundararajan, Former Executive Researcher at Washington State University, USA
02 August 2019	Recent approaches for production of offspring of desired sex with emphasis on bovine species	Ms Sharanya J, PhD Scholar, Animal Physiology Division
03 October 2019	Challenges in prediction of male fertility	Ms Swathi D, PhD Scholar, Animal Physiology Division

Students' Research

Name of the Student	Degree	University registered	Dissertation title
A Sreeja	PhD	Jain University	Purification and properties of fungal phytase and its evaluation in broiler chicken
AA Sha	PhD	Jain University	Metagenomic profiling of faecal microbial community in Carnivorous leopards *(Pantherapardus)* and omnivorous Sloth bears *(Melursusursinus)*
Archana SS	PhD	Jain University	Identification of sperm immune regulatory proteins influencing semen quality in HF bulls
BC Divyashree	PhD	Jain University	Molecular characterization of some motility associated proteins in buffalo *(Bubalusbubalis)* bull semen
D Shet	PhD	Jain University	Production and evaluation of microbial phytase in the diet of layer chicken
G Thirumalaisamy	PhD	ICAR-NDRI	Evaluation of silkworm pupae *(Bombyxmori)* oil with continuous and intermittent dosing as methane suppressant in cattle and sheep
J Chikkerur	PhD	Jain University	Isolation of microbes for enzymatic production of short chain oligosaccharides and its evaluation as prebiotic

JNK Tej	PhD	ICAR-NDRI	Studies on the effect of copper and selenium on oestrous induction and estradiol synthesis pathways in goats
JR Francis	PhD	Jain University	Effect of season on oocyte development competence in sheep
K Kaushik	PhD	Jain University	Effect of cryopreservation of preantral follicles on their estradiol synthesis pathway and oocyte development in ruminants
K Krishna	PhD	Jain University	Effects of novel peptides isolated from ruminant ovarian follicular fluid on in vitro maturation, fertilization and embryo development of oocytes retrieved from vitrified preantral follicles
K Sangeetha	PhD	Jain University	Supplementation of asymmetric cell kinetic inhibitor on long term maintenance of porcine mesenchymal stem cell culture
L Baruah	PhD	Jain University	Metagenomic analysis of rumen methanogen and fermentation dynamics using plant phenolics
MV Krishnaiah	PhD	Jain University	Supplementation of organic zinc and copper on spermatozoa gene and protein expression pattern in male goats *(Capra hircus)*
P Kumari	PhD	Jain University	Endocrine disruptions and ovine ovarian functions: Genomics, epigenomics and steroidogenic pathways
PK Javvaji	PhD	ICAR-NDRI	Effects of cytokine supplementation on the development and quality of in vitro cultured sheep oocytes and embryos
Ramya L	PhD	Jain University	Identification of sperm novel transcripts and RNA elements influencing semen quality and fertility in Murrah buffalo
RG Rao	PhD	ICAR-NDRI	Biochemical characterization and mechanism of lignin degradation in crop residues using manganese peroxidise of Basidiomycetes
S Roy	PhD	Jain University	Effective biological production of D-tagatose using Dgaltose and evaluation of its neutraceutical potential
SA Babatunde	PhD	Federal University of Technology, Minna, Nigeria	Influence of *Chlorella vulgaris* diets on reproductive performances and oxidative stress status at physiological reproductive stages in New Zealand white rabbits
Saranya J	PhD	Jain University	Effect of dietary calcium and magnesium on sex ratio and placental gene expression in Zealand white rabbits

Savitha ST	PhD	KVAFSU	Impact of heat stress on different Toll like receptors expression patterns in four different indigenous goat breeds
SK Tripathi	PhD	Jain University	Metabolic stress on oocyte and uterine cell functions and its ameliorations: cellular and genomic approaches
Swathi D	PhD	Jain University	Elucidation of sperm-enriched biological processes and their candidate genes regulating fertility in Murrah buffalo
VS Gurupriya	PhD	ICAR-IVRI	Molecular cloning and characterization of some motility associated proteins in buffalo *(Bubalusbubalis)* bull semen
Yallappa BS	PhD	Jain University	Efficacy of phytochemicals crossing over Blood brain barrier to combat gravitational stress in rodent model with central stress
A Vijay	MVSc	ICAR-IVRI	Effects of boron supplementation in production performance antioxidant activity and calcium utilization in laying hens
DT Sakhare	MVSc	ICAR-IVRI	Effect of selective metabolism on cryopreservation associated protein tyrosin phosphorylation in buffalo sperm
GV Koujalagi	MVSc	ICAR-IVRI	Effect of kisspeptin on endocrine profile of sheep during winter and summer season
H Behra	MVSc	ICAR-IVRI	Dietary flaxseed and coconut oil supplementation effects on semen profile and hormone level in adult ram
Lavanya M	MVSc	ICAR-IVRI	Influence of osmolality, pH and urea on bull sperm functional attributes invitro
M Saravanakumar	MVSc	ICAR-IVRI	Effect of perinatal supplementation of selected amino acids on post hatch performance of broiler chicken
R Nair MR	Msc	Kerala Agricultural University	Comparative assessment of climate resilient capacity of few indigenous goat breeds based on changes in both phenotypic and genotypic traits
Spandan PV	MVSc	KVAFSU	Effect of heat stress on the carcass traits and skeletal muscle myostatin and HSP70 gene expression in indigenous goats

Distinguished Visitors

Name of visit	Date of visit
Dr JK Jena, Deputy Director General (FySci & AS), ICAR, New Delhi	21 May 2019
Dr V Sridhar, General Manager, National Dairy Development Board, Anand, Gujarat	21 May 2019
Dr D Bhosale, GM, AB Vista, South Asia and Former Chairman, CLFMA of India	21 May 2019
Dr S Ayyappan, NABARD Chair Professor and Former Secretary DARE & DG ICAR	22 May 2019
Dr AM Paturkar, Vice-Chancellor, MAFSU, Nagpur	23 May 2019
Dr S Abdul Rahman, Executive Director, Commonwealth Veterinary Association	20 Aug 2019
Dr VP Chahal, ADG (Ag Ext), ICAR, New Delhi	20 Aug 2019
Dr BR Pillai, Director, CIFA, Bhubaneshwar	28 Aug 2019
Dr DN Hegde, Director, Animal Husbandry, Karnataka Milk Federation	19 Sep 2019
Shri A Chaturvedi, Secretary (AHD), Government of India, New Delhi	07 Oct 2019
Dr SS Honnappagol, Former Commissioner, AH&D, Govt of India	14 Oct 2019
Dr John Goopy, Senior Animal Nutritionist, ILRI, Nairobi, Kenya	16 Oct 2019
Shri D Rath, Chairman, NDDB, Anand, Gujarat	25 Nov 2019
Prof. V Sharma, Honourable Vice Chancellor, RAJUVAS, Bikaner	25 Nov 2019
Shri PK Rupala, MoS for Agriculture, Govt of India	25 Nov 2019

Others

Institute Technology Management Unit

The "Institute Technology Management Unit (ITMU)" maintains intellectual property (IP) portfolio, contract research and commercialization of the technologies developed. The unit is guided by the Assistant Director General (IP&TM), New Delhi and ZTMC, ICAR-IVRI, Bareilly, UP. The ITMU is headed by the Director, ICAR-NIANP and members are drawn from different divisions/ section with an external intellectual property expert. The unit is mandated to create awareness among the Institute scientists for developing technologies with potential of IP and guiding them for patent filing process. During the reported period, one patent application was filed and two patents were granted. The technology of Area Specific Mineral Mixture and Mineral Mixture for Small Ruminants were commercialized to M/s Vijayarathna Industries, Karnataka through Agrinnovate India.

ARIS Cell

The "Agricultural Research Information Systems (ARIS) Cell" was set up in 1998. The ARIS cell felicitates proper maintenance of computer systems along with printers and scanners through outsourced agency. The ARIS cell is also responsible for the information security of the Institute through a centralized network based security system comprising a Cyberoam firewall and antivirus software. Internet facility is provided by the "National Knowledge Network (NKN)" initiative of the Govt of India. As a hub of the NKN, the institute is provided with 100 mbps link. The cell also maintains the website of the Institute with regular updates about recruitments, tenders, training courses etc. The software "Feed Base" and web portals such as "Feed Chart" and "Indian Livestock Feed Portal" have been developed and are being hosted on the Institute website.

ICAR-ASRB Online Examination Centre

The "ICAR-ASRB Online Examination Centre" for Karnataka was established at the Institute for conducting ICAR NET/ARS examinations. The centre is equipped with 100 examination PC terminals supported by two servers and UPS backup for conducting the examinations. Online monitoring of the entire examination process is done through IP based CCTV surveillance system. Recently, the centre has been further strengthened with the procurement of new furniture. Online examinations are regularly being conducted at the centre.

Experimental Livestock Unit

The Experimental Livestock Unit (ELU) has the facilities for housing experimental animals such as large and small ruminants, poultry bird and mouse and rat. The unit also possesses feed processing and storage facility. During the reported period, 23 cattle, 15 buffaloes, 151 sheep, 425 poultry, 30 rats and 40 rabbits were maintained for various experiments of the 13 different research projects. Revenue was also generated from the unit by selling of farm produce (meat, eggs, live birds and animals) on completion of experiments under various projects. The establishment of new facility "Centre for Climate Resilient Animal Adaptation Studies" was nearly completed at ELU during the reported period. The centre would be having two state of the art climate chambers to accommodate 12 animals each with individual, feeding, watering, urine and defecation collection facilities.

Fodder Production Unit

The Fodder Production Unit (FPU) ensures regular supply of green fodder to the ELU of the Institute. Demonstration plots of stylo, super napier hybrid bajra, spineless cactus and drumstick (variety: Bhagya) were established in the FPU during the reported period. Quality protein maize crop was raised to evaluate its potential. Various forage crops like rhodes grass, marvel grass, guinea grass, perennial sorghum, hybrid napier bajra, maize and para grass were cultivated. Top feeds were also supplied to the ELU from the fodder trees such as Melia, Sesbania, Moringa and Gliricidia. Silage from various forage crops was prepared in plastic drums to ensure adequate green fodder supply during the lean months. Azolla cultivation continued in HDPE as well as silpaulin ponds for its use as supplemental feed. The stem cuttings of super napier, root slips of guinea grass and marvel grass, seedlings of sesbania and Azolla culture were supplied to several farmers. Method demonstrations were also conducted on silage making in plastic drums, production of hydroponic fodder, Azolla cultivation in ready to use PVC ponds and preparation of shade dried Azolla for popularization of these technologies among farmers.

Library

The Institute has a spacious and well organised Library. It subscribes Indian and foreign scientific journals, general magazines and newspapers regularly for keeping its readers abreast with the current developments. Until the last financial year, the library archived 3506 numbers of back volumes of Indian and foreign journals and procured 1315 scientific and administrative reference books and 447 books on Rajbhasha (Hindi). It also received 236 gratis publications from India and abroad during the reported period. Currently, the library is subscribing 14 scientific journals published from India. The library and the staff of the institute have online access to most of the required foreign and Indian scientific research journals though Consortium of e-resources in Agriculture (CeRa)/J-Gate Plus platform subscribed by ICAR, New Delhi. In addition, the library subscribes 12 general magazines and eight newspapers in English, Hindi and Kannada for the readers. The Library facilities are also offered to the offcials and students of the other ICAR institutes, veterinary colleges, universities and researchers for their reference work. The library maintains computer terminals for the readers for browsing of scientific literature and references. During the reported period, the library also catered the requests of scientists and students of other universities made through CeRA/J-Gate Plus platform for the research articles that were available with the ICAR-NIANP library. The library rendered various reprographic services to the researchers, students, trainees and staff of the institute as well. Currently, all the accessions and majority of the operations of the library including issue of books/ journals/ reading materials and its records have been made digitalized.

Guest House

The Institute has a picturesque guest house within the campus. It is furnished with AC suites and rooms. Television with DTH connection and internet connectivity are available in each room apart from the basic amenities. VIPs, Institute guests and invited guests are accommodated at this guest house. Other facilities at the Guest House includes, dining hall with kitchen and food is available for all the residing guests on prior request.

Official Language Implementation Cell

The main objective of the "Official Implementation Cell" is smooth implementation of Hindi as Official Language in the institute. The Official Language Implementation Committee (OLIC) is consisted of the heads and in charges of all the divisions and section with Director as the Chairman and In Charge of the Cell as the member secretary. Quarterly meetings of OLIC were held at regular intervals to review the progress in implementation of Official Language in different divisions and sections. The decisions taken in the OLIC meetings were implemented in the day to day work and the minutes of the meetings were sent to the ICAR headquarter, New Delhi, Town Official Language Implementation Committee (TOLIC-1), Bengaluru and Regional Implementation Office (South) for future observations and recommendations. Hindi Workshops were conducted regularly, once in every quarter, to promote correspondence and usage of Official Language in the day to day work. The different topics that were discussed in the workshops were use of scientific and technical words in Hindi, progressive usage of Hindi in office and work and promotion plans in Hindi. Besides, a two days workshop on "Pragmatic Usage of Hindi in Office" was organized at the institute for all the Bengaluru based ICAR institutes from 11- 12 April 2019.The institute also observed "Hindi Pakhwada" from 14-28 September 2019. Various competitions like noting and drafting, letter writing, translation, research paper presentation, slogan writing, quiz, extempore, antakshari and poem reading were organized during the celebration of "Hindi Pakhwada". Prizes were distributed to the winners during the valedictory function held on 28 September 2019. The In Charge of the cell represented the Institute during the TOLIC-1 Meetings held on 17 July 2019 and 17 December 2019 at the UR Rao Satellite Centre, ISRO, Bengaluru.

Complaints Committee/ Women's Cell

The Women's Cell focuses on the wellbeing of all the women employees working in the institute including contractual staffs and students. To further benefit the women employees, the women's cell room has been renovated and is being furnished.

Agricultural Technology Information Centre

Agricultural Technology Information Centre (ATIC) acts as a single window to provide information and advisory services on livestock production, sale of institute publications and as a location contact point for farmers and other visitors of the Institute. The centre facilitates information-based decision-making among the farmers by providing technology information in a customized manner. ATIC provides advisory service on livestock farming, suitable species, breeds, feeding and management practices etc., which are critical for the farmers. Information dissemination is carried out through personal interaction with visitors, interaction through telephone, information through reply of letters and participation in various exhibitions, fairs and farmers' meets.

Staff Welfare Club

The institute Staff Welfare Club (SWC) was actively involved in initiating various activities and organized various programmes during the reported period. The SWC bid farewell to Dr S Senani (Principal Scientist), Dr (Mrs) Manpal Sridhar (Principal Scientist and I/C Head BEES), Dr KS Prasad (Principal Scientist and I/C Head AND) and Smt R Kalaivani (Assistant Administrative Officer). The SWC also organized several events such as the celebration of Republic Day, Independence Day, swachhata award, Gandhi Jayanthi, Ganesh Chaturthi, Ayudha Puja, International Yoga Day, Kannada Rajyotsava and Foundation day. The club also recognized the children of permanent staff, who have passed the board examinations (10th and 12th) with outstanding grades/marks.

Infrastructure Development

During the reported year, various infrastructure developments were taken up and completed for the benefits of the staff and for up keeping various facilities of the Institute. The EFC approved work of vehicle parking facilities for staff quarters and office were constructed. According to the mandatory guideline from the Council to equip the buildings with fire protection gear, fire alarms and smoke detectors were installed at key locations in the institute main building. A mock fire drill was also arranged for the awareness of the staff. The EFC approved work of black topping of the Institute peripheral roads was also completed during the reported period.

Games and Sports

The games and sports section of the Institute organized various sports events to inculcate competitive spirit and to ensure welfare of the staff and their children. Various sports events were organized for women, men and children during the celebrations of Independence Day and Republic Day. Further, friendly cricket matches were also organized for the staff and students of the Institute. The Institute also represented the "ICAR Zonal Sports Meet" organized by the ICAR-CIFT, Cochin by sending 19 contingents.

Swachh Bharat

Institute implemented the "Swachh Bharat Abhiyan" programme and actively adopted the campaign. The "Swachhta Pakhwada" was observed during 16-31 December 2019. All the staff actively participated in the programme. Various activities were organized during the reported period under the campaign. Different cleaning and maintenance activities such as cleaning of the Institute premises, buildings, quarters, roads, children's park, storm water drainage, harvesting of rain water, periodical uprooting of weeds, garbage collection from residential area, collection of horticultural waste, control of termites and mosquitoes and pruning of dead tree branches were performed. The sanitation and solid waste management were streamlined with the implementation of proper disposal of laboratory and office wastes, specific protocol for disposal of biohazard wastes, effective collection and disposal of dung at ELU and use of horticultural waste for vermicomposting. Further, various Swatchhta Awareness Programme were organized in the adopted villages. Several tree plantation programmes and seminars were organized to emphasize the maintenance of the Institute campus clean, green and Environment friendly. During the reported period, 43 tree saplings were planted in various locations of the Institute.

On a special note, the honourable Minister of State for Agriculture, Govt of India, Shri Parshotham Roopala Ji, planted tree saplings in the Institute campus on 22 December 2019 to mark the campaign of Green India.

Mera Gaon Mera Gaurav (MGMG) Programme

Under the Mera Gaon Mera Gaurav (MGMG) program, the Institute constituted 10 teams of scientists and technical staff. Each team adopted 5 villages within 100km distance from Bengaluru. These teams regularly visited the villages and interacted with farmers to appraise about scientific feeding, production, fodder cultivation, clean milk production and management of livestock. Literatures and calendar containing various technical information were printed in local language and distributed to farmers. Technical information were also provided through workshops and seedlings and seeds of various fodder crops were distributed among the beneficiaries.

Right to Information

During the reported period of April-December 2019, a total of six RTI queries/applications were received. Requisite information were provided to all the queries as per the provision of RTI Act.

Chapter-6

PERSONNEL

List of Employees

Scientific personnel

Name	Designation
Dr Raghavendra Bhatta	Director
Animal Nutrition Division	
Dr SBN Rao	Principal Scientist, I/C
Dr M Chandrasekharaiah	Principal Scientist
Dr AK Samanta	Principal Scientist (on lien)
Dr S Anandan	Principal Scientist
Dr DT Pal	Principal Scientist
Dr D Rajendran	Principal Scientist
Dr NM Soren	Senior Scientist
Dr AP Kolte	Scientist
Dr M Bagath	Senior Scientist
Animal Physiology Division	
Dr JR Ippala	Principal Scientist, I/C
Dr PSP Gupta	Principal Scientist
Dr S Mondal	Principal Scientist
Dr SC Roy	Principal Scientist
Dr S Nandi	Principal Scientist
Dr J Ghosh	Principal Scientist
Dr ICG David	Principal Scientist
Dr S Selvaraju	National Fellow
Dr A Arangasamy	Senior Scientist
Dr V Sejian	Senior Scientist
Dr A Mishra	Senior Scientist
Dr G Krishnan	Senior Scientist
Dr BK Binsila	Scientist
Bioenergetics and Environmental Sciences Division	
Dr AV Elangovan	Principal Scientist, I/C
Dr KS Roy	Principal Scientist
Dr G Ravikiran	Principal Scientist
Dr A Dhali	Principal Scientist
Dr (Mrs) RU Suganthi	Principal Scientist

Dr PK Malik	Senior Scientist
Dr (Mrs) A Mech	Senior Scientist
Dr C Devaraj	Scientist

Knowledge Management and Biostatistics	
Dr NKS Gowda	Principal Scientist, Section I/C
Dr K Giridhar	Principal Scientist
Dr (Mrs) G Letha Devi	Senior Scientist
Dr S Jash	Scientist
Shri T Chandrappa	Scientist

Technical Officers / Technicians

Name	Designation
Shri V Ramesh	Assistant Chief Technical Officer, T-7/8 (Maintenance)
Dr VB Awachat	Assistant Chief Technical Officer, T-7/8 (ELU)
Shri VR Kadakol	Technical Officer, T-5 (APD)
Shri DR Govinda	Senior Technical Assistant, T-4 (Estate and Maintenance)
Mrs Maya G	Senior Technical Assistant, T-4 (BEES)
Shri Kamalesh KM	Technical Assistant, T-3 (Maintenance)
Ms Vijayalakshmi YC	Technical Assistant, T-3 (Establishment)
Mrs K Bharathi	Technical Assistant, T-3 (AND)
Shri M Shivarama	Senior Technician, T-2 (Maintenance)

Administrative Personnel

Name	Designation
Administration	
Mrs S Shashikala	AO
Shri SR Sreenivasa	AAO w.e.f. 01-11-2019
Shri R Suresh Babu	Assistant
Mrs JV Jyothi	Assistant
Mrs Geetha B	Assistant
Shri Ajayan P	PS (on deputation)
Shri L Gowda	LDC
Shri A Murthy	LDC
Accounts and Audit	
Mrs Sheeja PP	AFAO
Mrs MP Mridula	Assistant

Mrs P Nagaraju	UDC

Supporting Staff

Name	Designation
Shri K Narayana	SSS
Smt J Lakshmi	SSS

In Charges of Section/ Unit/ Cell

Section/ Unit/ Cell	In Charge
Priority Setting, Monitoring and Evaluation Cell	Dr DT Pal
Institute Research Council	Dr DT Pal
Official Language Implementation Cell	Dr A Mech
HRD Nodal Officer	Dr S Anandan
Academic Cell	Dr J Ghosh
Library	Dr SC Roy
Institute Technology Management Unit	Dr AP Kolte
Publication Cell	Dr A Dhali
Consultancy Processing Cell	Dr D Rajendran
Agricultural Technology Information Centre	Dr NKS Gowda
ARIS Cell	Dr G Ravikiran
Experimental Livestock Unit	Dr V Sejian
Fodder production Unit	Dr K Giridhar
Women's Cell	Dr RU Suganthi
Public Relation Officer	Dr V Sejian
Public Information Officer	Dr KS Roy
Radiological Safety Officer	Dr IJ Reddy
Institutional Animal Ethics Committee	Dr A Mishra
Citizen's Charter and Grievance Cell	Mrs S Shashikala
Institute Joint Staff Council official / staff	Shri SR Sreenivasa/ Shri VR Kadakol

Retirement

Name	Particulars
Dr S Senani	PS Superannuation retirement on 30-06-2019
Dr M Sridhar	PS Superannuation retirement on 31-08-2019
Dr KS Prasad	PS Superannuation retirement on 31-10-2019
Smt R Kalaivani	AAO Superannuation retirement on 31-10-2019

Shri M Naveen Kumar	Resigned and relieved from the post of LDC on 27-11-2019

Promotion

Name	Promoted to the next higher post of	With effect from
Dr VB Awachat	Assistant Chief Technical Officer (T-7/8)	20-03-2017
Dr M Bagath	Senior Scientist (RGP 8000)	10-02-2018
Dr BK Binsila	Scientist (RGP 7000)	01-07-2018
Mrs Geetha B	Assistant	22-02-2019
Shri VR Kadakol	Technical Officer (T-5)	14-09-2019
Mrs Maya G	Senior Technical Assistant (T-4)	29-09-2019
Shri SR Sreenivasa	AAO	01-11-2019

Recruitment/ Appointment/ Joining

Name	Designation/ Previous institute if any	With effect from
Shri Ajayan P	Private Secretary (on deputation)	17-05-2019

Chapter-7

LIST OF RESEARCH PROJECTS

Biogeography of Gut Microbes in Animals

Funding	Project Title	Duration	
		Start	End
Institute	BGM 2.4. Isolation and characterization of lipolytic/lipid biohydrogenation bacteria from the rumen of sheep supplemented with different fat sources	Apr, 2017	Mar, 2020
ICAR-Network	Veterinary type culture – rumen microbes	Oct, 2009	Mar, 2020

Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

Funding	Project Title	Duration	
		Start	End
Institute	APR 3.9. Nutritional conditioning for neonatal programming in broiler chicken: Gut development and immunity	May, 2015	Mar, 2020
Institute	APR 3.10. Development of a novel semen extender for improved post-thaw motility of cryopreserved buffalo semen	Jul, 2015	Mar, 2020
Institute	APR 3.14. Comparative assessment of the resilience capacity of indigenous goat breeds to summer heat stress based on selective thermo-tolerant gene expression pattern	Apr, 2017	Mar, 2020
Institute	APR 3.15. Modulation of sexual differentiation in embryos altering oxidative status of *in vitro* culture system	Apr, 2017	Mar, 2020
Institute	APR 3.16. G-Protein coupled receptors and gut hormones in gut chemosensing and regulation of fat digestion and absorption in sheep	Apr, 2017	Mar, 2020
Institute	APR 3.17. Elucidating the mechanisms of different levels of energy and protein influencing immune responses in goats	Apr, 2017	Mar, 2020
Institute	APR 3.18. Role of uric acid in alleviating oxidative stress induced mitochondrial dysfunction during different production cycles in poultry: Regulation by organosulphur compounds	Apr, 2017	Mar, 2020
Institute	APR 3.19. Studies on metal carnitine chelates for improving bioavailability and tissue utilization of trace minerals and production performance in animals	Apr, 2017	Mar, 2020
Institute	APR 3.20. Evaluation of grain sprouts as fodder for livestock	Apr, 2017	Mar, 2020
Institute	APR 3.21. Influence of administration of prostaglandin modulators on embryo survivality in sheep	Nov, 2017	Mar, 2020
Institute	APR 3.22. Development of nutritional modules for commercial broiler sheep production	Apr, 2017	Mar, 2020
Institute	APR 3.23. Unravelling the physiological role of adiponectin in regulation of energy metabolism in goats	Apr, 2018	Mar, 2021
Institute	APR 3.24. Modulation of GnRH system through novel neuropeptides during embryogenesis and responses in post hatch broiler chickens	Apr, 2018	Mar, 2021
Institute	APR 3.25. Development of precise delivery system for improved bioavailability of zinc for poultry	Apr, 2018	Mar, 2021

Institute	APR 3.26. Biological activities of rare earth elements in relationship to production performance of egg and egg and meat type chicken	Apr, 2018	Mar, 2021
Institute	APR 3.27. Over expression, monoclonal antibody production and development of immune assays against NIANP_MBL_1,2&3 clones	Apr, 2019	Mar, 2022
ICAR-National Fellow	Development of buffalo bull fertility diagnostic chip based on sperm transcripts signatures	May, 2017	May, 2022
Inter-institutional	Studies on exploitation of insects on food and feed	Jan, 2017	Mar, 2020
Inter-institutional	Retrofitting urea solution spraying system on paddy straw baler	Jan, 2018	Dec, 2019
Inter-institutional	Ethno-Veterinary study for enhancement of reproductive performance in livestock	Mar, 2019	Feb, 2021
AICRP	Nutritional and physiological interventions for enhancing reproductive performance in animals	Apr, 2014	Mar, 2020
DBT	Selective isolation of sex specific spermatozoa in bovines using novel biomarkers indentified through an integrated proteomic and genomic approach	May, 2017	May, 2020
DST (Indo-Hungarian)	Strategic improvement of efficiency of vitrification of preantral follicles and embryos of sheep and buffalo: Genomic changes with reference to apoptosis and developmental competence	Jun, 2017	Jun, 2020
DBT Twinning	Biotechnological interventions to augment productive performance of pigs on horticultural by-product based diet	Mar, 2018	Apr, 2021
NASF	CRISPR/CAS9 guided functional analysis of genes regulating early embryonic survival in buffalo	Aug, 2018	Jul, 2021
NASF	Targeted immobilization of Y- bearing spermatozoa and modulation of oviduct millieu for skewing the sex ratio towards female offspring in dairy cattle	Aug, 2018	Jul, 2021
ICAR Extramural	Efficacy of Kisspeptin and its analogues in the existing estrus synchronization protocols to augment fertility in small and large ruminants	Feb, 2019	Feb, 2021
DST-SERB	Establishment of the 3D in vitro culture conditions for maintaining long-term stemness in sheep spermatogonial stem cells	May, 2019	May, 2022

Feed Informatics, Feed Quality and Safety and Value Addition

Funding	Project Title	Duration	
		Start	End
Institute	FQS 4.3. Development of a novel phytogenic blend to replace antibiotic growth promoters in broiler production	Dec, 2017	Mar, 2021
Institute	FQS 4.4. Assessment and characterization of Antimicrobial Resistance (AMR) genes in dairy and poultry production environment	Apr, 2019	Mar, 2022
ICAR-CRP	Bio-fortification of cereals- evaluation of value addition cereals (VAC) and cereal by-products for animal feeding	Jan, 2015	Mar, 2020
AICRP	Micro and secondary nutrients and pollutant elements in soil and plants: Effect of zinc fortification of soil on zinc status in fodder and livestock	Jan, 2016	Mar, 2020

ICAR-Outreach	Monitoring of drug residues and environmental pollutants	Nov, 2009	Mar, 2020
CSB	Development of value added products from spent pupae of mulberry silkworm, *Bombyx mori* L	Jun, 2016	Jun, 2019

Climate Change Impact on Livestock

Funding	Project Title	Duration	
		Start	End
ICAR-Outreach	Estimation of methane emission under different feeding systems and development of mitigation strategies	Apr, 2008	Mar, 2020
DST (Indo-German)	Optimized use of feed resources for high lifetime productivity of dairy cows and consequences on enteric methane release	Nov, 2016	Nov, 2019
ILRI-ICAR	Methane emission and its mitigation	Jan, 2019	Dec, 2022

Technology Translation to Connect Discovery with Application

Funding	Project Title	Duration	
		Start	End
Institute	TTA 6.2. A micro level assessment of water use efficiency in different dairy production systems	Apr, 2016	Sep, 2019
Institute	TTA 6.3. Economics of milk production under different systems of dairy farm management in Karnataka	Apr, 2017	Mar, 2020
ICAR (FarmerFIRST)	Improving livelihood security of farmers through technological interventions for sustainable livestock farming	Nov, 2016	Mar, 2020
ICAR (FarmerFIRST)	Enriching knowledge and integrating technology and institutions for holistic village development in horticultural based farming systems	Nov, 2016	Mar, 2020

ICAR-National Institute of Animal Nutrition and Physiology
Adugodi, Bengaluru - 560 030, Karnataka, India
An ISO 9001:2015 Institute

Tel : +91-80-25711304, 25711303, 25702546. Fax : 91-80-25711420.
Email: directornianp@gmail.com, Website: http://www.nianp.res.in

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