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Annual Report 2017-2018

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

वार्षिक प्रतिवेदन

Annual Report
2017-18

भाकृअनुप-राष्ट्रीय पशु पोषण एवं शरीर क्रिया विज्ञान संस्थान
बेंगलूरु

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

Citation
ICAR-NIANP Annual Report 2017-2018

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June, 2018

Cover page theme
The graphic depicts our efforts for ensuring profitable livestock farming through scientific and sustainable animal husbandry practices.

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ISBN 978-81-932312-5-8

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Preface

The ICAR-NIANP has completed a long journey of 23 years towards serving the Nation with significant contributions in the field of Animal Nutrition and Physiology. Currently we are an ISO 9001:2015 certified Institute. I am privileged to mention that the ICAR-NIANP has a cohesive group of dedicated staff with potential to meet the expectations. We are persistently working on the basic and fundamental aspects of animal nutrition and physiology for providing solutions to the problems related with low performance level of Indian livestock and feed and fodder scarcity.

I personally believe that ICAR has revolutionized the Indian agricultural systems since independence. Nevertheless, we never have thought to quantify the contributions of our organization until recent days. One tricky factor for such quantification is that ICAR contributions were mainly directed to the huge numbers of small and marginal farming units, where quantification of specific economic benefits was always difficult. Further, ICAR contributed more towards the food and social security than in monitory terms to the millions of farmers. However, at today's context, it is imperative for us to quantify and document our contributions in economic terms that will help the policy makers to assess the impact of ICAR towards the socio-economic developments of this nation and the resources required for ICAR for its effective functioning.

During the reported period of 2017-18, the Institute organized and conducted various activities as per the mandate. Extensive research investigations were conducted under the six well conceptualized research programmes. Our efforts are reflected in the publications and recognitions that we achieved. The 4th Quinquennial Review Team evaluated the performance of the Institute for the period of April, 2012 to March, 2017 and expressed their satisfactions over the progress of the Institute. The ICAR-NIANP in collaboration with all the ICAR institutes located in Bengaluru, organized the mega event "Farmers' Conclave" on 16-17 February, 2018. The event was attended by more than 2000 farmers, Union Ministers, DG ICAR and professionals from different ICAR Institutes and KVKs located in Karnataka. The Institute in association with the Indian Poultry Science Association (IPSA) also organized the XXXIV Annual Poultry Science Conference (IPSACON 2017) from 28-30 November, 2017 at NIMHANS Convention Centre, Bengaluru. The conference was attended by more than 400 national and International delegates.

I take pleasure to present 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 KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat 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 (AS), ICAR. I am also thankful for the constant support and coordination extended by Dr BS Prakash (ADG, AN&P), 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 विज्ञान संस्थान ने अपनी स्थापना के बाद 22 साल सफलतापूर्वक पूरे किये हैं और किसानों, शिक्षाविदों, विस्तार-क्षेत्र से जुड़े कर्मियों, नीति निर्माताओं और पशुपालन से जुड़े उद्योगों की जरूरतों को पूरा करने में उत्कृष्टता हासिल की है।

वित्तीय वर्ष 2017-2018 के दौरान, संस्थान में 39 वैज्ञानिक, 7 तकनीकी कर्मचारी, 13 प्रशासनिक और लेखा कर्मी और 3 कुशल सहायक कर्मचारी कार्यरत थे। कुल बजट आवंटन 1943.20 लाख था और उसमें से कुल व्यय 1939.8 लाख (99.83%) हुआ। इस अवधि के दौरान संस्थान ने 39.13 लाख राजस्व भी अर्जित किया। संस्थान के वैज्ञानिकों ने जनादेश के अनुसार परिभाषित छह प्रमुख कार्यक्रमों के तहत अनुसंधान और प्रौद्योगिकी विकास और प्रदर्शन से संबंधित विभिन्न लक्ष्यों को प्राप्त करने के लिए समर्पित रूप से काम किया।

चारा उपयोगिता में सुधार के लिए लिग्नो- सेल्यूलोसिक बायोमास का विघटन

भारत में जुगाली करने वाले पशुओं को पारंपरिक रूप से उपलब्ध कम पाचकता तथा लिग्नोसेल्युलोजिक जटिल की उच्च मात्रा वाले फसल अवशेषों पर पाला जाता है। इस कार्यक्रम का उद्देश्य उन्नत तकनीकी अनुसंधान के माध्यम से ऐसे खराब गुणवत्ता वाले फसल अवशेषों की पाचकता में सुधार करना है।

इन विवो प्रयोगों में 10, 20 और 40% मात्रा पर एलआईपी एंजाइम के साथ उपचार किए गए बाजरे का भूसा खिलाये गए भेड़ समूहों में नियंत्रण की तुलना में 5, 10 और 12% डीएमडी की वृद्धि हुई। डब्ल्यूआरएफ से जीनोमिक डीएनए अलग करने की एक सरल और त्वरित विधि से एमएनपी उत्पादन कवक क्लिटोपाईलास स्किफोइडस् और गेनोडार्मा रासिनैसियम की त्वरित पहचान में सहायता मिली। पी. क्राइसोस्पोरियम से प्राप्त एलआईपी और मानक एंजाइम द्वारा उपचार किए गए नौ फसल अवशेषों में संरचनात्मक परिवर्तनों का एनएमआर स्पेक्ट्रोस्कोपी द्वारा अध्ययन किया गया। प्राप्त परिणाम में चोटियों की तीव्रता में मामूली महत्वपूर्ण अंतर से उपचार द्वारा विघटन की प्रक्रिया की पुष्टी होती है।

पशुओ में आंत सूक्ष्म जीवों की बायोजियोग्राफी

रूमेन में माइक्रोबियल कंसोर्टियम को पाचन प्रक्रिया के एक महत्वपूर्ण घटक के रूप में पहचाना गया है जो पशुओं में पोषण, प्रतिरक्षा और अन्य शारीरिक कार्यों में मदद करता है। आंत में माइक्रोबियल समुदायों का ज्ञान पशु उत्पादकता में सुधार, जुगाली करने वाले पशुओं से मीथेन उत्सर्जन कम करने और औद्योगिक अनुप्रयोगों के लिए नए जीनों की बायोप्रोस्पेक्टिंग उनकी अनपेक्षित क्षमता को समझने में मदद कर सकता है।

मवेशी, भैंस, भेड़ और बकरी मेटाजेनोम का 16 एस आरआरएनए एम्पलिकॉन अनुक्रमण के आधार पर प्रोफाइल किया गया। मवेशी, भैंस, भेड़ और बकरी के बीच मेटाजेनोम विविधता की तुलना की गई। यह देखा गया कि सभी मेटाजेनोमों में फाईला फर्मिक्यूट्स और बैक्टेरोइड्स का प्रभुत्व ज्यादा है, लेकिन प्रजातियों के बीच उनका अनुपात अलग है। माइक्रोबियल विविधता के अनुसार मवेशी और भैंस के मेटाजेनोम भेड़ और बकरी की तुलना में ज्यादा करीब है। यह देखा गया कि मवेशियों की तुलना में भैंसों में कम मेथनोजेन और फाइबर विघटक बैक्टीरिया है।अलग-अलग प्रकार की वसा के साथ पूरक खिलाई गई भेड़ों की रूमन से लिपोलाइटिक और लिपिड बायोहाइड्रोजनीकरण बैक्टीरिया को अलग करने और चिह्नित करने के प्रयास किए जा रहे हैं। प्रयोगात्मक जानवरों को संतृप्त और असंतृप्त वसा पूरक के साथ या बिना, आहार खिलाया गया था। प्रारंभिक परिणामों से संकेत मिलता है कि प्रयोगात्मक समूहों में 84 दिनों के खिलाने के परीक्षण के बाद, शरीर के वजन, दैनिक वजन की वृद्धि और डीएम (DM) सेवन में अधिक अंतर नहीं आया।

रूमन माइक्रोब कल्चर संग्रह भाकृअनुप का वेटेरनेरी टाईप कल्चर संग्रह विकसित करने कि पहल का एक हिस्सा है। भाकृअनुप - रापपोशक्रिविसं में, विभिन्न पशुधन प्रजातियों के रूमन पर्यावरण से पृथक कर सूक्ष्म जीवों को भविष्य के उपयोग के लिए वर्गीकृत, अभिलिखित और बनाए रखा जाता है। विभिन्न स्रोतों से कुल 19 कल्चर को पृथककरण और चरित्रांकन के बाद भंडार में जमा किया गया। जंगली स्लोथ भालू (4) और बन्दी तेंदुए (5) के मल से डीएनए निकालकर आणविक पहचान द्वारा नौ बैक्टीरिया प्रजातिओं को पृथक् किया गया।

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

पशु पोषण में बोरॉन एक ऐसा तत्व है जिसका अध्ययन बहुत ज्यादा नहीं हुआ है। इसलिए, जानवरों में कैल्शियम होमेओस्टसिस में बोरॉन की भूमिका स्थापित करने के लिए कई प्रयोग किए गए। इस अध्ययन से यह निष्कर्ष निकाला गया कि उत्पादन के चरण में खासतौर पर जैसे प्रारंभिक दुग्ध उत्पादन, तनाव और प्रतिरक्षा समझौते की स्थिति में बोरॉन को फायदेमंद सूक्ष्म पोषक तत्व के रूप में माना जा सकता है। भेड़ के बच्चे में आहार के माध्यम से खिलाये गये सेलेनियम का प्रभाव सेलेनोप्रोटीन जीन की अभिव्यक्ति पर और सेलेनोप्रोटीन जीन की अभिव्यक्ति एंटीऑक्सीडेंट और प्रतिरक्षा स्थिति और मांस की गुणवत्ता के बीच परस्पर क्रिया का अध्ययन किया गया। सुप्रान्युट्रिशनल सेलेनियम पूरकता द्वारा प्रतिरक्षा प्रतिक्रिया और एंटीऑक्सीडेंट स्तर में सुधार हुआ, लिपिड परोक्सीडेशन कम हो गया और यकृत, गुर्दे, थाइमस, प्लीहा और एल डी मांसपेशियों के ऊतकों में कोई भी रोगजनक परिवर्तन प्रेरित नहीं हुआ। जब सेलेनियम को विभिन्न सुप्रान्युट्रिशनल स्तरों पर खिलाया गया तब यह देखा गया कि यकृत और एल डी मांसपेशियों में जीपीएक्स (GPXs), टीएक्सएनआरडी (TXNRDs) और डीआईओ (DIOs) और एसईपीपी 1 (SEPP1),

एसईपीडब्ल्यू 1 (SEPW1) और एसईपी 15 (SEP15) के आइसोफॉर्मस के एमआरएनए (mRNA) अभिव्यक्ति पैटर्न, खुराक और ऊतक विशिष्ट होते हैं।

कार्बनिक तांबा और जस्ता के प्री- प्युबर्टल पूरकता द्वारा स्वदेशी नर बकरी में युवावस्था/प्युबर्टी 28-35 दिन पहले प्राप्त हुई। ताजा, पूर्व- हिमीकृत और विगलन के बाद के चरणों में वीर्य की मात्रात्मक और गुणात्मक विशेषताओं में सुधार हुआ, एंटीऑक्सीडेंट रक्षा तंत्र में सुधार हुआ और इसके परिणामस्वरूप उपचार दिए गए बकरों के शुक्राणु कोशिकाओं और रक्त के नमूने में चयनित जीन की उच्च अभिव्यक्ति देखी गई । कार्बनिक तांबा अनुपूरक, अकेले जस्ता और जस्ता और तांबे के संयोजन से बेहतर पाया गया।

तांबे और सेलेनियम का उपयोग करके ग्रैनुलोसा सेल एस्ट्रैडियोल संश्लेषण मॉड्यूल का बकरी में अध्ययन किया गया। परिणामों से यह संकेत मिलता है कि तांबे और सेलेनियम अकेले या तो संयोजन में डिम्बग्रंथि ग्रैनुलोसा सेल एस्ट्रैडियोल संश्लेषण और अपरिवर्तित एस्ट्रैडियोल संश्लेषण से जुड़े जीन को बढ़ावा देता है, इसलिए बकरियों में प्रजनन प्रबंधन कार्यक्रम में हार्मोन के साथ इसका उपयोग किया जा सकता है।

प्री-हैच और नवजात चिकन में अमीनो एसिड और ट्रेस खनिज पूरक का जठरांत्र और प्रतिरक्षा प्रणाली के विकास पैटर्न पर प्रभाव की जांच की गई। इन ओवो परिस्थिति में एमिनो एसिड और खनिजों के संयोजन के परिणामस्वरूप एक पूर्ण हैच विफलता देखी गई । इसके विपरीत, एमिनो एसिड (Lys, Met, Arg और Thr) और खनिज (जिंक, तांबा और सेलेनियम) के संयोजन के पोस्ट हैच पूरण से ब्रोइलर मुर्गियों में वृद्धि प्रदर्शन (फ़ीड सेवन, शरीर भार वृद्धि और एफसीआर) और सेल मध्यस्थ प्रतिरक्षा प्रतिक्रिया में वृद्धि देखी गई।

इन ओवो अवधि के दौरान हरे रंग की एलईडी रोशनी प्रदान करने से पोस्ट हैच पक्षियों के समूह में नियंत्रण की तुलना में शरीर के वजन पर प्रोत्साहनीय प्रभाव दिखाया। भ्रूणजन्य के दौरान हरी एलईडी रोशनी से प्राप्त चूजों में सफेद और लाल फोटो प्रोत्साहित चूजों की तुलना में 2 से 2.4 गुना अधिक छाती की मांसपेशी की सेटेलाईट कोशिकाएं देखी गई। ब्रोइलर चिकन में इन ओवो अवधि के दौरान ग्रीन एलईडी लाइटिंग ने नियंत्रण के सापेक्ष शुरुआती शरीर के वजन वृद्धि को एक सप्ताह पहले प्राप्त करवाया। हरे एलईडी के साथ इन ओवो इनक्यूबेट किये गए ब्रोइलर कम फ़ीड खाते हैं और परीक्षण अवधि के दौरान अधिक बढ़ते हैं; 35 वें दिन में शरीर के वजन में 1.94% की वृद्धि और 45 वें दिन में 8.41% की वृद्धि देखी गई। यह तकनीक अत्यधिक लागत प्रभावी है और फ़ीड लागत को कम कर सकती है और अत्यधिक मूल्यवान फ़ीड सामग्री की बचत कर सकती है।

भैंसे के वीर्य की क्रायो-प्रिजरवेशन के लिए एक नव वीर्य विस्तारक का विकास के लिए प्रयास किया गया । इसके संदर्भ में, तीन एजेंटों जैसे कि एजेंट-ए, α-टोकोफेरोल और जेनिस्टीन (एक डीएनए स्टेबलाइज़र) को कम -शुक्राणु व्यवहार्यता पर वीर्य विस्तारक में शामिल करने के प्रभाव, गतिशीलता, एक्रोसोम के साथ या एक्रोसोम के बिना शुक्राणु के प्रतिशत, एमडीए गठन, उन्नत ऑक्सीकरण प्रोटीन उत्पादों और क्रायो-प्रिजरवड शुक्राणु के डीएनए विखंडन पर अध्ययन किया गया। परिणाम इंगित करता है कि एजेंट-ए और जेनिस्टीन क्रायोप्रिजरवेशन से संबंधित पिघलाव के बाद व्यवहार्यता और गतिशीलता कम होने के कारण हुए नुकसान को कम करने की क्षमता रखते हैं और भैंसे के वीर्य / शुक्राणु में अन्य ऑक्सीडेटिव जैव-आणविक परिवर्तन को कम कर सकते हैं।

नर भेड़ के शुक्राणुजन्य स्टेम कोशिकाओं के पृथक्करण और कोशिकाओं के कल्चर के लिए आदर्श प्रोटोकॉल का विकास करने का प्रयास किया गया। दोहरे शुद्धिकरण विधि, बीएसए के साथ संयोजन में लैमिनिन का उपयोग करके अवकल प्लेटिंग के बाद फिकॉल घनत्व ढाल पृथक्करण नर भेड़ के एसएससी के संवर्धन के लिए प्रभावी पाया गया। इन विट्रो कल्चर पद्धति में ईजीएफ (20 ng/ml) और जीडीएनएफ (40 ng/ml) ने उच्च प्रसार और स्टेमनेस प्रदर्शित किया।

भैंसों में एक बेहतर प्रजनन प्रबंधन के लिए प्रारंभिक गर्भावस्था निदान परख महत्वपूर्ण है। फिर भी, वर्तमान में कोई भैंस विशिष्ट गर्भावस्था पता लगाने की किट उपलब्ध नहीं है। अन्य जुगाली करने वाले पशु प्रजातियों में उपलब्ध पीएजी की पहचान के आधार पर प्रत्यक्ष अवधारणा विशिष्ट परीक्षण किट भैंस के लिए भी विकसित करने के लिए कार्य प्रगति पर है। उपयुक्त कोशिकाओं में व्यक्त किए गए भैंस के रीकॉम्बिनेंट पीएजी प्रोटीन को भैंसों में गर्भावस्था का पता लगाने के लिए चार अलग-अलग इम्यूनो-कैप्चर एलिसा प्रारूपों में शुद्धिकरण और नियोजित किया गया।

एपोप्टोटिक सिग्नल से बचने के लिए पीआई 3 के-एकेटी (PI3K-AKT) संकेत को उत्तेजित करना या कैस्पेस कैस्केड को अवरोध करना डिम्बाणुजनकोशिका विकास क्षमता में सुधार करने के लिए संभावित लक्ष्य हो सकता है। यह देखा गया कि परिपक्वता के दौरान कैस्पेस 9/8 अवरोध ने भेड़ में इन विट्रो में परिपक्व डिम्बाणुजनकोशिका और मोरूला में कैस्पेस कैस्केड / एपोप्टोसिस से जुड़े जीन की अभिव्यक्ति पर अनुकूल प्रभाव डाला । इन विट्रो में आईवीएम (IVM) माध्यम में एकेटी एक्टिवेटर के 10 µg/ml के पूरक ने भेड़ के डिम्बाणुजनकोशिका की परिपक्वता दर में थोड़ा सुधार किया।

इन विट्रो कल्चर प्रणाली में ऑक्सीडेटिव स्थिति को बदलकर भेड़ भ्रूण में लैंगिक विभेदीकरण को संशोधित करने के लिए प्रयास किया गया। इन विट्रो में उत्पादित भेड़ भ्रूण एक विशेष लिंग की ओर पक्षपातपूर्ण पाया गया । कल्चर माध्यम की ऑक्सीडेटिव स्थिति में हेरफेर द्वारा इन विट्रो उत्पादित भ्रूण में लिंग अनुपात में परिवर्तन किया जा सकता है।

ओवाईन पूर्व-कोटरीय कूप क्रायोप्रिजर्वेशन करने के लिए वेट्रीफिकेशन् प्रोटोकॉल का मानकी करण किया गया। नियोजित तीन प्रोटोकॉल के बीच विगलन के बाद डिम्बाणुजनकोशिका की उत्तरजीविता दर में कोई महत्वपूर्ण अंतर नहीं था।

प्रारंभिक भ्रूण मृत्यु की दर प्रजनन विफलता के प्रमुख कारणों में से एक है

जिसके परिणामस्वरूप गर्भावस्था दर कम हो जाती है और जानवरों में अनुवांशिक सुधार धीमा हो जाता है। कुल भ्रूण मृत्यु दर गर्भावस्था के 8 और 17 दिन के बीच 40% से अधिक पाया गया है। गर्भावस्था की पहचान और स्थापना में कनसेप्टस, गर्भाशय और कॉर्पस ल्यूटियम के बीच में कई आणविक और कोशीय परस्पर क्रियायें शामिल हैं । प्रोस्टाग्लैंडिन उत्पादन और भेड़ में भ्रूण जीवित रहने पर ऑक्सीटॉसिन और एलपीएस (LPS) के प्रभाव को समझने के लिए काम शुरू किया गया है।

यह स्थापित किया गया है कि भैंस में डिम्बग्रंथि की ग्रैनुलोसा सेल एस्ट्रैडियोल संश्लेषण में Wnt संकेत की सकारात्मक भूमिका है, हालांकि यह मवेशियों के जैसा स्पष्ट नहीं है। Wnt सिग्नलिंग मार्ग भैंस और बकरी में शुरुआती पुटमकों की उत्पत्ति में भी शामिल है। हालांकि, भैंस में गैर एफएसएच (non FSH) मध्यस्थ एस्ट्रैडियोल संश्लेषण में Wnt संकेत की कोई स्पष्ट भूमिका नहीं भी हो सकती है।

चयापचय दबाव के तहत पुटकीय और डिम्बाणुजनकोशिका क्षमता के आणविक निर्धारकों के ट्रानस्क्रिप्ट प्रोफाइलिंग और कार्यात्मक महत्व पर अध्ययन संचालित किए गए। नतीजे बताते हैं कि β-हाइड्रोक्सिब्यूटाइरेट, रक्तोद में कुल एनईएफए (NEFA), अमोनिया और यूरिया, कूपिक, गर्भाशय और डिंबवाहिनी के तरल पदार्थ और मूत्र के नमूने चयापचय तनावग्रस्त मादा भेड़ के बायोमार्कर्स के रूप में माने जा सकते हैं। चयापचय तनावग्रस्त मादा भेड़ में टीएसएच (TSH), टी 3 (T3), टी 4 (T4), आईजीएफ -1 (IGF-1) और इंसुलिन में महत्वपूर्ण कमी दर्ज की गई । चयापचय तनावग्रस्तता के कारकों की ऊंची सांद्रता ने इन विट्रो संवर्धित ओवाईन पूर्व-कोटरीय कूप और संलग्न डिम्बाणुजनकोशिका के अस्तित्व और विकास को रोक दिया और वैश्विक साइटोसीन मिथाइलेशन स्तर पर अंतर के साथ डीनोवो डीएनए मिथाइल ट्रांसफरेज जीन (डीएनएमटी 3) की अभिव्यक्ति को काफी हद तक ऊपर विनियमित किया।

सांड के प्रजनन मार्करों की पहचान की गई जिनका उपयोग उच्च वीर्य गुणवत्ता के लिए सांड का चयन करने के लिए किया जा सकता है। ईस्ट्रस सिंक्रनाइज़ेशन के प्रोटोकॉल गर्भधारण दर में सुधार करने के लिए प्रभावी पाए गए। विशेष पोषक तत्व पूरक द्वारा दूध की गुणवत्ता और प्रजनन दक्षता में सुधार हुई। बोरॉन अनुपूरक ने नर बकरी में वीर्य की गुणवत्ता में सुधार द्वारा उत्साहजनक परिणामों का संकेत दिया।

एक एकीकृत प्रोटीमिक और जीनोमिक दृष्टिकोण के माध्यम से पहचाने गए नव बायोमार्कर्स का उपयोग करके गोजातीय पशु में लिंग विशिष्ट शुक्राणुजनो का चुनिंदा अलगाव पर जांच प्रगति पर है। शुक्राणु झिल्ली प्रोटीन को एचएफ (HF) बैल के अवर्गीकृत और पृथक्कृत वीर्य से अलग किया गया। दोनों समूहों (अवर्गीकृत और पृथक्कृत) की प्रोटीन अभिव्यक्ति प्रोफाइल की तुलना की गई। सेक्सड (एक्स) वीर्य की तुलना में अवर्गीकृत वीर्य में सात प्रोटीन धब्बे ऊपर विनियमित पाये गये।

शुक्राणु प्रतिलेख हस्ताक्षर के आधार पर भैंस में सांड प्रजनन डायग्नोस्टिक चिप विकसित करने के प्रयास किए जा रहे हैं। ट्रांसक्रिप्टोमिक्स विश्लेषण में, शुक्राणु के छोटे एमआरएनए (mRNA) टुकड़ों के लिए ट्रिममैटिक से क्युटाडेप्ट बेहतर पाया गया और बीडब्ल्यूए (BWA) और बोटी 2 (Bowtie2) की तुलना में एचआईएसएटी (HISAT) मैपिंग एल्गोरिदम को जीनोम की रिडस् के बेहतर मैपिंग प्रतिशत के साथ कुशल पाया गया। कुछ क्रोमोसाम के जीन शुक्राणु में उच्च ट्रांसक्रिप्टोमिक गतिविधि के साथ समृद्ध पाए गए और प्रारंभिक विश्लेषण ने उच्च और निम्न उपजाऊ जानवरों के बीच अलग-अलग व्यक्त जीन की उपस्थिति का संकेत दिया।

चुनिंदा थर्मो-सहिष्णु जीन अभिव्यक्ति पैटर्न के आधार पर ग्रीष्मकालीन गर्मी के तनाव के लिए अलग-अलग स्वदेशी बकरी नस्लों की तन्यकता का तुलनात्मक मूल्यांकन किया गया। नतीजे बताते हैं कि सलेम ब्लैक नस्ल उस्मानाबादी और मलाबरी नस्लों की तुलना में उनकी उच्च थर्मो-सहिष्णु क्षमता के कारण गर्मी तनाव चुनौतियों का अधिक कुशलता से सामना कर सकती है। इसलिए, किसानों के बीच सलेम ब्लैक नस्ल को बढ़ावा देना बदलते जलवायु परिदृश्य में किसानों को अपने उत्पादन को बनाए रखने में फायदेमंद साबित होगा।

भेड़ में आंत केमोसेंसिंग और वसा पाचन विनियमन और अवशोषण में जी-प्रोटीन युग्मित रिसेप्टर्स और आंत के हार्मोन की भूमिका को समझने के लिए जांच चल रही है। भेड़ के पाचन तंत्र के विभिन्न हिस्सों में जी-प्रोटीन युग्मित रिसेप्टर 120 को चिह्नित किया गया और इम्यूनोहिस्टोकैमिस्ट्री विश्लेषण द्वारा उसकी पुष्टि की गई।

प्रतिरक्षा प्रतिक्रियाओं को प्रभावित करने वाले ऊर्जा और प्रोटीन के विभिन्न स्तरों के तंत्र को बकरियों में स्पष्ट करने के प्रयास किए जा रहे हैं। प्रोटीन, ऊर्जा या उनके संयोजन का प्रतिरक्षा प्रणाली पर प्रभाव और प्रतिरक्षा प्रणाली से संबंधित जीन इन कारकों से कैसे प्रभावित होते हैं, ये समझने के लिए कार्य शुरू किया गया है।

मुर्गीओं में विभिन्न उत्पादन चक्रों के दौरान ऑक्सीडेटिव तनाव से प्रेरित माइटोकॉन्ड्रियल डिसफंक्शन को कम करने में यूरिक एसिड की भूमिका को समझने के लिए एक परियोजना शुरू की गई है। लहसुन और एलिसिन का उपयोग करके अंडा देने वाली मुर्गीओं में खिलाने का परीक्षण शुरू किया गया है।

जैव उपलब्धता में सुधार, ऊतक द्वारा ट्रेस खनिजों के उपयोग और जानवरों में ऊतक कार्निटीन सांद्रता पर धातु कार्निटीन चिलेट्स की भूमिका पर अध्ययन प्रगति पर है। तांबा-कार्निटीन और जस्ता-कार्निटीन एक विशेष मोलर अनुपात और विशिष्ट स्थितियों में तांबा और जस्ता धातुओं का उपयोग करके प्रयोगशाला में तैयार किए गए थे। उत्पादों को एसिड और क्षारीय pH दोनों घोल में पूरी तरह से घुलनशील पाया गया।

गांवों में हरी घास की कमी विशेष रूप से गर्मियों के महीनों के दौरान, एक आम समस्या है जो पशुओं के उत्पादन को प्रभावित करती है। हाल के वर्षों में, भारत के विभिन्न राज्यों में हरे चारों के उत्पादन के लिए हाइड्रोपोनिक इकाइयां स्थापित की जा रही हैं। देशीय फसल अवशेष के संस्तरण पर

फफूंदी-मुक्त अंकुरित चारा उत्पादन करने के लिए संशोधित हाइड्रोपोनिक का एक तरीका विकसित किया गया है। एक किलो मक्का अनाज से 3.95 किलोग्राम गीला अंकुरित चारा प्राप्त करने के लिए लगभग 8 लीटर पानी की आवश्यकता होती है। उत्पादन की लागत प्रति किलोग्राम मक्का के गीले अंकुर के लिए लगभग 4 है।

भेड़ में मांस उत्पादन क्षमता को अधिकतम करने के लिए विकास के विभिन्न चरणों के लिए उचित फीडिंग मॉड्यूल विकसित करने का कार्य प्रगति पर है। दूध छुड़ाए अवीशान नस्ल के भेड़ के बच्चे को बाईपास वसा के साथ या वसा के बिना अधिक चारा और सूखी पैरा घास आधारित आहार खिलाया गया। दूध छुड़ाने के बाद की अवधि के दौरान नर अवीशान भेड़ों में औसत दैनिक शरीर भार वृद्धि (ADG) उच्चतर पाया गया। हालांकि बाईपास वसा अनुपूरक के औसत दैनिक शरीर भार वृद्धि में मामूली बेहतरी पाई गई जो महत्वपूर्ण नहीं है।

ताजे पानी के मत्स्य पालन की उत्पादकता में सुधार करने के लिए पौधों से प्राप्त मन्नान ओलिगोसेकेराइड का उत्पादन करने का प्रयास किया गया। पानी के साथ 24 घंटे फेंटने के बाद ग्वार बीज से मन्नान निकालना संभव हुआ और यह रिडीयुसड शर्करा से मुक्त था। मछली के आंत के नमूने को अगली पीढ़ी के अनुक्रम विश्लेषण ने लैबियो फिम्ब्रिटस में एमओएस (MOS) पूरक के कारण आंत बैक्टीरिया में चुनिंदा हेरफेर का संकेत दिया।

फ़ीड सूचना विज्ञान, फ़ीड गुणवत्ता और सुरक्षा और मूल्य संवर्धन

पशुओं की आबादी और खाद्य संसाधनों की वास्तविक समय की जानकारी, पशुधन क्षेत्र के विकास के लिए महत्वपूर्ण है। डेटा संग्रह और संकलन में सुधार के लिए, भारत के सभी मंडलों / तालुकों में कनसेन्ट्रेट फ़ीड, हरे और सूखे चारे के मामले में फ़ीड और चारा संसाधन की उपलब्धता का अनुमान लगाने के लिए सूचना प्रौद्योगिकी आधारित उपकरण विकसित किए गए। डेटाबेस योजनाकार / प्रशासकों की सहायता के लिए वास्तविक समय में सूक्ष्म स्तर पर अधिशेष / कमी की भविष्यवाणी करने में उपयोगी होगा। परियोजना के तहत डिज़ाइन की गई वेबसाइट वर्तमान में आईसीएआर-आईएएसआरआई, नई दिल्ली के अशोक सर्वर में होस्ट की गई है। नई दिल्ली के नास (NASC) परिसर में आईसीएआर अधिकारियों की एक बैठक में वेबसाइट का प्रदर्शन भी किया गया, तथा डीएएचडीएफ, भारत सरकार के माध्यम से इस के संभावित कार्यान्वयन पर प्रकाश डाला।

प्राचुर्य की अवधि के दौरान अतिरिक्त चारों के संरक्षण द्वारा, विशेष रूप से उच्च उपज वाले जानवरों को अभाव की अवधि के दौरान उन की पोषण जरूरतों को पूरा कर सकते हैं। साईलेज बना कर चारा फसलों के संरक्षण द्वारा पूरे साल नियमित आपूर्ति सुनिश्चित कर सकते हैं। गुणवत्ता के साईलेज उत्पादन के लिए एक या मिश्रित सार्वभौमिक इनोकुलम के विकास के लिए अध्ययन किए गए। ताजा घास और चारों में लैक्टिक एसिड बैक्टीरिया को प्रमुख देशी माइक्रोफ्लोरा के रूप में पाया गया। लैक्टिक एसिड बैक्टीरिया के साथ इनोक्यूलेशन ने pH की कमी से एसिड उत्पादन का संकेत दिया। समय में वृद्धि के साथ एसिड के उत्पादन में कोई वृद्धि नहीं हुई थी। परिणामों से संकेत मिलता है कि माइक्रोबियल कल्चर के उपयोग से साईलेज की गुणवत्ता को बढ़ाने में मदद मिलेगी।

ब्रोइलर उत्पादन में एंटीबायोटिक ग्रोथ प्रमोटरों को प्रतिस्थापित करने के लिए एक नव फाइटोजेनिक मिश्रण के विकास के लिए कार्य प्रगति पर है। ब्रोइलर फ़ीड में 1% फाइटोजेनिक मिश्रण पूरक से विकास प्रदर्शन, सीरम प्रोटीन और आंत हिस्टोमोर्फोमेट्री में सुधार हुआ और एंटीबायोटिक पूरक के मुकाबले वक्ष के मांस में ड्रिप लास कम हुआ। इसलिए, फाइटोजेनिक मिश्रण को ब्रोइलर में एंटीबायोटिक ग्रोथ प्रमोटरों के संभावित प्रतिस्थापन के रूप में उपयोग किया जा सकता है।

कृषि की प्रथाओं में कीटनाशकों और पशुधन में एक्टोपैरासिटिसाईड्स और भारी धातुओं जैसे पर्यावरण प्रदूषक के व्यापक उपयोग से भारी मात्रा में उनके अवशेषों की उपस्थिति सीधे मिट्टी, पानी और फ़ीड के माध्यम से जानवरों के उत्पादों में आती है। पानी, चारा, फोडर्स और पशु उत्पादों में इन पर्यावरण प्रदूषकों की निगरानी के लिए एक प्रयास किया गया। पानी, धान के भूसे, हरे चारे, कनसेन्ट्रेट पेलेट्स, तेल के केक, चावल की भूसी, बाल और दूध के नमूनों को संग्रह किया गया और γ-बीएचसी, क्लरोपाईरिफास, एंडोसुलफान-α और -β, o, p'- डीडीटी, साइपारमेथ्रिन और डेल्टामेथ्रिन के अवशेषों लिए विश्लेषण किया गया। कोई भी नमूने उपरोक्त कीटनाशकों के लिए सकारात्मक नहीं पाये गये। नमूनों को भारी धातुओं (आर्सेनिक, सीसा और कैडमियम) के लिए भी विश्लेषण किया गया और इनमें से कुछ विश्लेषण किए गए नमूने भारी धातुओं के लिए सकारात्मक पाए गए।

बायोफोर्टिफिकेशन, एक विशेष पोषक तत्व, जो अनाज में कम है लेकिन पशु प्रदर्शन के लिए महत्वपूर्ण है उसकी मात्रा को बढ़ाने की एक विधि है। भाकृअनुप-रापपोशक्रिविसं, बैंगलोर को पशुधन में परंपरागत किस्मों की तुलना में बायोफोर्टिफाइड अनाज और उनके उप-उत्पादों के पोषक तत्व के उपयोग के संदर्भ में उनकी गुणवत्ता मूल्यांकन करने की ज़िम्मेदारी सौंपी गई थी। विभिन्न स्थानों से अनाज, पुआल और छः आशाजनक गेहूं की किस्मों और दस किस्मों के ज्वार कडवी के नमूने पोषक गुणों के लिए विश्लेषण किए गए।

वर्तमान में, देश में फ़ीड संसाधनों की उपलब्धता अपर्याप्त है। इसलिए, उपलब्धता और आवश्यकताओं के बीच के अंतराल को भरने के लिए गैर-खाद्य स्रोतों से वैकल्पिक तिलहन मील / प्रोटीन / ऊर्जा की खुराक के उपयोग का पता लगाना आवश्यक है। इस संबंध में उपयोग किए गए रेशम के कीड़े (एसडब्ल्यूपी) के प्यूपा के उप-उत्पाद महत्वपूर्ण हैं। संकर मवेशियों में एसडब्ल्यूपी के उप-उत्पाद के खाद्य मूल्य का मूल्यांकन करने के लिए अध्ययन प्रगति पर है। वसा से वंचित एसडब्ल्यूपी (डीएसडब्लूपी) के पूरक का इन विट्रो में रागी स्ट्रॉ आधारित राशन पर 100% तक रूमन किण्वन और पाचन क्षमता पर कोई महत्वपूर्ण प्रभाव नहीं पड़ा। नतीजे बताते हैं कि रूमन किण्वन और पोषक उपयोग से समझौता किए बिना सोयाबीन मील को बदलकर डीएसडब्ल्यूपी को 30% तक मवेशियों के राशन में शामिल किया जा सकता है।

मिट्टी में पोषक तत्वों की कमी के सुधार से फसलों के साथ-साथ पशुओं के स्वास्थ्य में सुधार होने की उम्मीद है। टुमकुर जिले के दुर्गा नागनहल्ली गांव में पांच भेड़ के किसानों के साथ एक अध्ययन किया गया ताकि जस्ता सल्फेट प्रयोग के आर्थिक लाभ का मूल्यांकन चारे के रूप में उगाई गई मक्का और भेड़ में किया जा सके। मिट्टी में जस्ता प्रयोग के कारण लागत लाभ अनुपात 1:8.5 पाया गया। परिणामत: मिट्टी में जस्ता प्रयोग के माध्यम से चारा के साथ-साथ भेड़ की मटन की उपज में सुधार द्वारा संभावित आर्थिक लाभों को स्पष्ट रूप से इंगित करता है।

पशुधन पर जलवायु परिवर्तन का प्रभाव

आंतों का किण्वन और पशु खाद से मीथेन (Ch4), पशु खाद से नाइट्रस ऑक्साइड (N2O) और भूमि उपयोग परिवर्तन (एलयूसी) से कार्बन डाईआक्साइड (CO2) का उत्सर्जन,पशुधन से उत्सर्जित ग्रीन हाउस गैसें (जीएचजी) हैं। मौजूदा घटिया खाद्य प्रणाली, जो मुख्य रूप से कम लागत वाली यौगिक फ़ीड के साथ फसल अवशेषों पर आधारित है, उसको भारतीय जुगाली करने वाले पशुओं से अधिक जीएचजी उत्सर्जन का कारण माना जाता है। कर्नाटक राज्य के चयनित डेयरी फ़ार्म से जीएचजी उत्सर्जन के जीवन चक्र मूल्यांकन के जरिए डेयरी फार्म प्रबन्ध के विभिन्न चरणों में होने वाले जीएचजी उत्सर्जन का विश्लेषण करने के लिए एक अध्ययन किया गया। कुल जीएचजी उत्सर्जन (CO2 eq प्रति किलो वसा प्रोटीन संशोधित दूध (एफपीसीएम) के रूप में व्यक्त) मध्यम (2.03) और बड़े (1.66) डेयरी फार्म की तुलना में छोटे डेयरी फार्म (0.58) के लिए कम पाया गया।

विभिन्न खाद्य प्रणालियों से मीथेन उत्सर्जन का अनुमान लगाने और उपयुक्त सुधार ऋणनीति विकसित करने के प्रयास किए गए। भारतीय पशुधन के वार्षिक उत्सर्जित मीथेन की इनवेंटरी से यह प्रकट होता है कि उत्तर प्रदेश आंत्रिक मीथेन उत्सर्जन में देश में राज्यों के बीच सबसे बड़ा राज्य है। बुनियादी आहार में 2% स्तर पर रेशम के कीड़े के प्यूपा की तेल निरंतर और अंत:क्रियात्मक पूरक द्वारा भेड़ में, मीथेन उत्सर्जन और रूमन प्रोटोजोआ की आबादी काफी कम होती है। भेड़ में, संघनित टैनिन, हाइड्रोलाइजेबल टैनिन की तुलना में बहुत कम स्तर पर भी लगभग समान मीथेन कम करने में अधिक प्रभावी पाई गई है।

मवेशी और भैंसों में रूमन मेथनोजेन्स की विविधता 16 एस आरआरएनए आधारित अगली पीढ़ी अनुक्रमित दृष्टिकोण का उपयोग करके स्थापित की गई। इसके अलावा, दो अलग भौगोलिक स्थानों से भैंस में रूमन मेथनोजेन्स की विविधता का पता लगाया गया। वर्ग स्तर पर मवेशियों और भैंसों में रूमन आर्किया ने मेथनोबैक्टेरिया को रूमन में प्रमुख मेथनोजेन के रूप में प्रकट किया। जाति स्तर पर, दोनों मवेशी और भैंसों में मेथनोब्रेविबैक्टर प्रमुख रूमन मेथनोजेन थे।

प्राकृतिक पौधों से विभिन्न फाइटो स्रोतों का मूल्यांकन करके पशुधन से आंत्रिक मीथेन उत्सर्जन को सुधारने के लिए प्रयास किया गया। फाइटो स्रोत पिट्सस्पोरम एरियोकार्पम, प्रुनस डोमेस्टिका और बर्बेरिस लाइसिम जिसमें लगभग बराबर अनुपात में संघीनित टैनिन (सीटी) और हाइड्रोलाइजेबल टैनिन (एचटी) होता है, वह सीटी या एचटी की सराहनीय मात्रा वाली फाइटो स्रोतों की तुलना में तुलनात्मक रूप से कम मीथेन उत्सर्जित करता है।

पेरी- अरबान डेयरी फ़ार्म से आंत्रिक मीथेन उत्सर्जन की भविष्यवाणी करने वाले एक मॉडल और एक इनवेंटरी विकसित करने के लिए पारंपरिक खाद्य पदार्थों, आहार और वैकल्पिक अनुकूलित / संतुलित राशन की मीथेन उत्पादन क्षमता निर्धारित करने के प्रयास किए जा रहे हैं और विभिन्न फीड्स और राशनों के मीथेन उत्सर्जन क्षमता और पेरी- अरबान डेयरी फ़ार्म से जीएचजी उत्सर्जन (मुख्य रूप से प्रवेश) के जीवन चक्र मूल्यांकन की गणना का कार्य प्रगति पर है। बेंगलुरु के ग्रामीण-शहरी इंटरफ़ेस से 28 डेयरी फ़ार्म से एकत्रित खाद्य नमूनों में राख, कार्बनिक पदार्थ और क्रूड प्रोटीन की मात्रा की मापा गया। भेड़ में लेजर तकनीक और एसएफ 6 तकनीक द्वारा निर्धारित मीथेन उत्सर्जन की तुलना की गई।

आविष्कार को उपयोग से संयोजित करने के लिए प्रौद्योगिकी अनुवाद

पानी एक ऐसा पोषक तत्व है जो पशुधन को सबसे बड़ी मात्रा में आवश्यक है। शुष्क और स्तनपान करने वाली गायों की पानी की आवश्यकता, पीने के पानी से 60 से 80% तक और चारे से शेष पानी की आवश्यकता पूरी होती है। पानी की उपलब्धता और गुणवत्ता का डेयरी मवेशियों के स्वास्थ्य और उत्पादन प्रदर्शन पर प्रत्यक्ष प्रभाव पड़ता है। पानी के संसाधनों का सिकुडना पानी के विवेकसम्मत उपयोग को इख़्तियार करता है, क्योंकि कम पानी की उपलब्धता से पशु विकास और उत्पादन में प्रतिकूल प्रभाव पड़ेंगे। सूक्ष्म स्तर पर विभिन्न डेयरी उत्पादन प्रणालियों की जल उपयोग की दक्षता का आकलन किया गया। छोटे धारक प्रणाली मे औसत प्रत्यक्ष उपभोग्य जल उपयोग प्रति दिन 97 लीटर और वाणिज्यिक डेयरी फ़ार्म के लिए प्रति दिन 17 लीटर पाया गया। परिकलित की गई पानी की उपयोग दक्षता छोटे धारक प्रणाली के लिए 0.85 और वाणिज्यिक डेयरी फ़ार्म के लिए 1.62 थी।

कर्नाटक में डेयरी फार्म प्रबंधन की विभिन्न प्रणालियों के तहत दूध उत्पादन की आर्थिक व्यवस्था का आकलन करने के लिए एक अध्ययन शुरू किया गया है। शहरी और ग्रामीण परिदृश्य में अर्ध-गहन की तुलना में एक्सटेनसिव फार्म, जो ग्रामीण क्षेत्र के आस-पास में विस्तृत है, प्रबंधन में प्रारंभिक अवलोकन में सूखा चारा कनसेन्ट्रेट फ़ीड का अधिक पक्षपातपूर्ण उपयोग, गैर-अनुरूप स्वच्छता से लेके लंबे समय तक बांधना, लेकिन बेहतर आवास और स्वास्थ्य सुविधाओं की व्यवस्था प्रतिबिंबित करता है।

पहले किसान परियोजनाओं (Farmer FIRST Projects) के तहत, प्राथमिक परियोजना कार्यान्वित क्षेत्रों में बेसलाइन सर्वेक्षण किया गया। चयनित तकनीकी हस्तक्षेप और पशु स्वास्थ्य शिविरों के लिए जागरूकता अभियान और योग्यता वर्धन कार्यक्रम भी आयोजित किए गए। दुधारू पशुओं के उत्पादकों को खनिज मिश्रण और प्रोटीन की खुराक जैसे महत्वपूर्ण निविष्टियां वितरित की गईं । हस्तक्षेपों के बाद किसानों की आमदनी और आजीविका में उल्लेखनीय सुधार देखा गया।

शिक्षाविदों, प्रशिक्शण

प्रशिक्षण और योग्यता वर्धन

रिपोर्ट की अवधि के दौरान, संस्थान विभिन्न मानव संसाधन विकास गतिविधियों में सक्रिय रूप से शामिल था। विभिन्न विश्वविद्यालयों के तहत पंजीकृत कुल 26 छात्रों ने संस्थान की विभिन्न प्रयोगशालाओं में एमएससी और पीएचडी शोध कार्यों को संचालित किया। वैज्ञानिकों, शिक्षाविदों, विस्तार पेशेवरों, नीति निर्माताओं और किसानों के लिए विभिन्न प्रशिक्षण, कार्यशालाएं, बैठक और प्रौद्योगिकी जागरूकता कार्यक्रम आयोजित किए गए। वैज्ञानिकों ने विभिन्न कार्यशालाओं, सम्मेलनों, संगोष्ठियों, कृषि मेला और एक्सपो में भाग लिया। तकनीकी, प्रशासनिक और सहायक कर्मचारियों ने कौशल विकास के लिये विभिन्न पेशेवर प्रशिक्षण भी प्राप्त किए।

बेंगलुरु में स्थित सभी भाकृअनुप संस्थानों के सहयोग से संस्थान ने 16-17 फरवरी, 2018 को मेगा इवेंट "फारमर्स कॉन्क्लेव" का आयोजन किया। इस कार्यक्रम में 1500 से अधिक किसानों और कर्नाटक में स्थित विभिन्न भाकृअनुप संस्थानों और केवीके के पेशेवरों ने भाग लिया। माननीय केंद्रीय कृषि और किसान कल्याण मंत्री, श्री राधा मोहन सिंह, केन्द्रीय सांख्यिकी और कार्यक्रम कार्यान्वयन मंत्री, श्री डी.वी. सदानंद गौड़ा, कौशल विकास और उद्यमिता मंत्री, श्री अनंत कुमार हेगड़े, केन्द्रीय संसदीय मामलों , रसायन और उर्वरक मंत्री, श्री अनंत कुमार, सचिव, डीएआरई और महानिदेशक, भाकृअनुप, डॉ त्रिलोचन महापात्र और डीडीजी (कृषि विस्तार), भाकृअनुप, डॉ ए के सिंह ने समारोह के उद्घाटन समारोह में भाग लिया और इस अवसर की शोभा बढ़ाई।

अन्य कार्यकलाप

चौथी क्विनक्वेंनियल रिव्यू टीम (क्यूआरटी) ने अप्रैल, 2012 से मार्च, 2017 की अवधि के लिए संस्थान के प्रदर्शन का मूल्यांकन किया। इस टीम के अध्यक्ष मेरठ के सरदार वल्लभभाई पटेल कृषि और प्रौद्योगिकी विश्वविद्यालय के पूर्व उप कुलपति प्रोफेसर (डॉ) एम पी यादव थे। टीम ने विभिन्न केंद्रों का दौरा किया और एआईसीआरपी और आउटरीच कार्यक्रम के तहत अंतिम उपयोगकर्ताओं के स्तर पर प्रौद्योगिकियों के प्रभाव का निरीक्षण करने के लिए क्षेत्रीय दौरे किए। टीम की समाप्ति बैठक 18-20 जनवरी, 2018 को आयोजित की गई और टीम द्वारा समीक्षा रिपोर्ट भाकृअनुप के मुख्यालय, नई दिल्ली को प्रस्तुत की गई। संस्थान पहले ISO9001:2008 प्रमाणित संगठन था और तदनुसार गुणवत्ता प्रबंधन प्रणाली के आवश्यक सिद्धांत लागू किए गए थे। इस प्रमाणीकरण का 30 अगस्त, 2017 को ISO9001:2015 में उन्नयन किया गया।

इस रिपोर्ट की अवधि के दौरान, संस्थान ने "फारमर्स कॉन्क्लेव " के अवसर पर दो प्रौद्योगिकियों को रिलीज़ किया और पहले दर्ज तीन पेटेंट आवेदन पर आईसीएआर को स्वीकृति प्रदान की गई ।

संस्थान ने गणतंत्र दिवस, स्वतंत्रता दिवस, हिंदी पखवाड़ा, संस्थान का स्थापना दिवस और अन्य विभिन्न सरकारी समारोह आयोजित किए। कर्मचारियों और उनके परिवारों के लिए 'कर्मचारी कल्याण क्लब' द्वारा विभिन्न सामाजिक समारोह भी आयोजित किए।

संस्थान ने महात्मा गांधी के सपने को साकार करने की दिशा में काम करने के संकल्प के साथ "स्वच्छ भारत अभियान" के तहत नियमित रूप से कार्यकलापों का आयोजन किया। कार्यालय और कैंपस परिसर को स्वच्छ और पर्यावरण अनुकूल बनाए रखने के लिए विभिन्न पहल की गई। इस पूर्ण अवधि में किसानों के हितलाभ के लिए और तकनीकी विशेषज्ञता विस्तार के लिए सभी वैज्ञानिक समूह "मेरा गाँव मेरा गौरव" कार्यक्रम में सक्रिय रूप से शामिल थे।

Executive summary

The ICAR-National Institute of Animal Nutrition and Physiology has successfully completed 23 years since its inception and achieved excellence in catering the farmers, educationists, extension workers, policy makers and industries associated with livestock farming. During the financial year 2017-2018, the Institute functioned with 39 scientists, 7 technical staff, 13 administrative and accounts personnel and 3 skilled supporting staff. The total budget allocation was 1943.20 lakh and the total expenditure was 1939.88 lakhs (99.83% utilization). The institute also generated 39.13 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 six major programmes as per the mandate.

Deconstruction of ligno-cellulosic biomass for improving feed utilization

Indian ruminants are traditionally fed on crop residues containing high amount of lignocellulosic complexes with poor digestibility. The programme is aimed at improving the digestibility of such poor quality crop residues through advanced technological research.

In vivo experiments in sheep fed ragi straw treated with lignin degrading enzyme (LiP) at the concentrations of 10, 20 and 40 % showed 5 ,10 and 12 % increase in DMD as compared to the control. A simple and quick method for isolating genomic DNA from white rot fungi aided in quick identification of MnP enzyme producing fungi *Clitopilus scyphoides* and *Ganoderma rasinaceum*. NMR spectroscopic studies were employed for ascertaining the structural changes in the nine crop residues treated with LiP from *P. chrysosporium* and standard enzyme. The results indicated moderately significant difference in the intensity of obtained peaks, confirming the degradation process upon treatments.

Biogeography of gut microbes in animals

The microbial consortium in the rumen has been identified as an important constituent of the digestive process that helps in nutrition, immunity and other physiological functions in animals. Knowledge of the microbial communities in the gut can help in understanding their unexplored potential for improving animal productivity, ameliorating methane emissions from ruminants and bioprospecting newer genes for industrial applications.

Cattle, buffalo, sheep and goat metagenomes were profiled based on 16s rRNA amplicon sequencing. Metagenome diversity among cattle, buffalo, sheep and goat was compared. It was observed that the phyla Fermicutes and Bacteroides dominated all the metagenomes, but their proportions were different among the species. The metagenomes of the cattle and buffalo were found closer than sheep and goat in terms of microbial diversity. It was noticed that buffalo had less methanogens and fibre degrading bacteria as compared to cattle.

Efforts are being made to isolate and characterize lipolytic and lipid biohydrogenation bacteria from the rumen of sheep supplemented with different types of fat. The diets of the experimental animals were supplemented without or with saturated and unsaturated fats. Preliminary results indicated that following 84-day feeding trial, body weight, daily weight gain and DM intake did not differ significantly among the experimental groups.

The rumen microbe culture collection is a part of ICAR initiative on developing Veterinary Type Culture Collection. At ICAR-NIANP, microbes isolated from rumen environment of various livestock species are accessioned, characterized and maintained for future use. A total of 19 bacterial cultures from various sources were isolated, characterized and preserved in the repository. Nine bacterial species were also isolated from wild sloth bear (N = 4) and captive leopard (N = 5) faeces and DNA was extracted for molecular identification.

Novel approaches for assessing and improving nutrient bioavailability, animal reproduction and productivity

Boron is a less studied element in animal nutrition. Therefore, several experiments were conducted to establish the role of boron in calcium homeostasis in animals. It was concluded that boron could be considered as a beneficial micronutrient, particularly in situations of peak production like early lactation, stress and immune compromised status.

Influence of dietary selenium on the expression of selenoprotein genes and the interaction between selenoprotein gene expression and antioxidant and immune status and meat quality were studied in lambs. Supranutritional selenium supplementation improved immune response and antioxidant status, reduced lipid peroxidation

and did not induce any pathological changes in liver, kidney, thymus, spleen and LD muscle tissues. The mRNA expression patterns of the isoforms of GPXs, TXNRDs and DIOs and, SEPP1, SEPW1 and SEP15 in liver and LD muscles were observed to be dose and tissue specific, when selenium was fed at different supranutritional levels.

The pre-pubertal supplementation of organic copper and zinc advanced the puberty by 28-35 days in indigenous bucks and the quantitative and qualitative characteristics of semen improved at fresh, pre-freeze and post thaw stages, improved the antioxidant defence mechanism and resulted in significantly higher expression of selected genes in sperm cells and blood samples of the treated bucks. Organic copper supplementation was found to be better than the zinc and/or combination of zinc and copper.

Modulation of granulosa cell estradiol synthesis using copper and selenium was studied in goat. The results indicated that copper and selenium either alone or in combination promoted the ovarian granulosa cell estradiol synthesis and up-regulated estradiol synthesis associated genes, hence can be used in reproductive management programme in goats along with hormones.

Developmental patterns of gastrointestinal and immune system in response to pre-hatch and neonatal supplementation of amino acids and trace mineral were investigated. In ovo supplementation of combination of amino acids and minerals resulted in complete hatch failure. In contrast, post hatch supplementation of combination of amino acids (Lys, Met, Arg and Thr) and minerals (zinc, copper and selenium) enhanced growth performance (feed intake, body weight gain and FCR) and cell mediated immune response in broiler chickens.

Exposure to green LED light during in ovo period showed stimulatory effects on body weight in post hatch birds over controls. Chicks obtained from green LED illumination during embryogenesis showed 2 to 2.4 times more breast muscle satellite cells as compared to white and red photo-stimulated chicks. Exposure to green LED light during in ovo period advanced the early body weight gain by one week relative to controls in broiler chicken. Broilers incubated in ovo with green LEDs also consumed less feed and grew most during the test period; 1.94 % increase in body weight at day-35 and 8.41 % increase at day-45. This technology is highly cost effective and can reduce the feed cost and save highly valuable feed ingredients.

Efforts are being made to develop a novel semen extender for cryopreserving buffalo semen. Effects of incorporation of three agents; Agent-A, α-tocopherol and genistein (DNA stabilizer) to the semen extender on post-thaw sperm viability, motility, percentages of sperm with acrosome reacted/lost, MDA formation, formation of oxidized protein products and DNA fragmentation of cryo-preserved buffalo sperm was studied. The results indicates that Agent-A and genistein have the potential to reduce cryopreservation-associated loss of post-thaw viability and motility and can minimize other oxidative biomolecular changes in buffalo semen/sperm.

Development of ideal protocol for isolation and culture of ram spermatogonial stem cells (SSCs) was attempted. Double purification method, ficoll density gradient separation followed by differential plating using laminin in combination with BSA was found effective for enrichment of ram SSCs. Culture medium supplemented with EGF (20 ng/ml) and GDNF (40 ng/ml) exhibited higher proliferation and stemness of SSCs under in vitro culture system.

Early diagnosis of pregnancy is important for better managemental practice in buffaloes. Nevertheless, no buffalo specific pregnancy detection kit is available currently. Work is on progress for developing a direct conceptus specific buffalo test kit based on PAG detection, as available in other ruminant species. Recombinant buffalo PAG protein expressed in suitable mammalian cells were purified and employed in four different immuno-capture ELISA formats to detect pregnancy in buffaloes.

Stimulating PI3K-AKT signal or inhibiting caspase cascade to evade apoptotic signal could be the possible targets for improving oocyte development competence. It was observed that Caspase9/8 inhibition during maturation exerted a favourable effect on the expression of caspase cascade/apoptosis associated genes in sheep matured oocytes and morula in vitro. Supplementation of 10 µg/ml of AKT activator in IVM medium marginally improved the maturation rate of sheep oocytes in vitro.

Attempt was made to modulate sexual differentiation in sheep embryos by altering oxidative status of in vitro culture system. Sheep embryos produced in vitro were found biased towards a particular sex. Manipulation of oxidative status of culture medium may alter the sex ratio of transferable in vitro produced embryos.

Vitrification protocols were standardized for cryopreserving

the ovine pre-antral follicles. There was no significant difference in the post thaw survival rates of oocytes in the pre-antral follicles among the three protocols employed.

Early embryonic mortality is one of the major causes of reproductive failure resulting in reduced pregnancy rate and slower genetic improvement in animals. More than 40 % of the total embryonic mortality has been found to occur between the day-8 and -17 of pregnancy. Recognition and establishment of pregnancy involve several molecular and cellular interactions among the conceptus, uterus and corpus luteum. Work has been initiated to understand the effect of oxytocin and LPS on prostaglandin production and embryo survivability in sheep.

It has been established that Wnt signal has a positive role in ovarian granulosa cell estradiol synthesis in buffalo, though it is not as pronounced as in cattle. Wnt signalling pathway is involved even in the early folliculogenesis in buffalo and goat. However, Wnt signal may not have a discern role in the non FSH mediated estradiol synthesis in buffalo.

Studies were conducted on transcript profiling and functional significance of molecular determinants of follicular and oocyte competence under metabolic stress. The results indicate that β-hydroxybutyrate, total NEFA, ammonia and urea in serum, follicular, uterine and oviduct fluid and urine samples can be considered as biomarkers of metabolic stressed ewes. Significant decrease in TSH, T3, T4, IGF-I and insulin was recorded in metabolic stressed ewes. Elevated concentration of metabolic stressors inhibited the survival and growth of in vitro cultured ovine pre-antral follicles and enclosed oocytes and, significantly upregulated the expression of de novo DNA methyl transferase gene (dnmt3) along with differences in global cytosine methylation level.

Bull fertility markers were identified that can be used to select the bull for higher semen quality. Estrus synchronization protocols were found effective in improving conception rate. Supplementing special nutrient supplement improved milk quality and reproductive efficiency. Boron supplementation indicated encouraging results in improving semen quality in bucks.

Investigations on selective isolation of sex specific spermatozoa in bovines using novel biomarkers identified through an integrated proteomic and genomic approach are on progress. The sperm membrane proteins were isolated from the unsorted and sorted semen of HF bulls. The protein expression profiles of the two groups (unsorted and sorted) were compared. Seven protein spots were found to be up regulated in the unsorted semen as compared to the sexed (X) semen.

Efforts are being made for developing buffalo bull fertility diagnostic chip based on sperm transcripts signatures. For transcriptomics analysis, Cutadapt was found to be better than Trimmomatic for the shorter fragments of sperm mRNA samples and HISAT mapping algorithm was found efficient as compared to BWA and Bowtie2 with better mapping percentage of the reads to the genome. Genes from few chromosomes were found enriched with a high transcriptomic activity in spermatozoa and preliminary analysis indicated the presence of differentially expressed genes between high and low fertile animals.

Comparative assessment of the resilience capacity of different indigenous goat breeds to summer heat stress based on selective thermo-tolerant gene expression pattern was conducted. The results indicated that Salem Black breed cope up with heat stress challenges more efficiently due to their higher thermo-tolerant ability as compared to Osmanabadi and Malabari breeds. Hence, promoting Salem Black breed among the farmers will prove beneficial to sustain their production in the changing climate scenario.

Investigations are on progress to understand the roles of G-protein coupled receptors and gut hormones in gut chemosensing and regulation of fat digestion and absorption in sheep. G-protein coupled receptor 120 was characterized in various segments of digestive tract of sheep and confirmed by immunohistochemistry analysis.

Efforts are being made to elucidate the mechanisms of different levels of energy and protein influencing immune responses in goats. Work has been initiated to understand the impact of protein, energy or their combination on the immune system and to comprehend, how the regulations of the immune system related genes are affected by these factors.

A project has been initiated to understand the role of uric acid in alleviating oxidative stress induced mitochondrial dysfunction during different production cycles in poultry. Feeding studies have been initiated in layer hens using garlic and allicin.

Studies on metal carnitine chelates for improving bioavailability, tissue utilization of trace minerals and tissue carnitine concentrations in animals are on progress. Cu-

carnitine and Zn-carnitine were prepared in the laboratory using Cu and Zn metals in a particular molar ratio and specific conditions. The products were found to be completely soluble in both acid and alkaline pH solution.

Green fodder deficit is a very common problem in villages, especially during the summer months, affecting the livestock production. In recent years, hydroponic units for production of green fodder are being established in different states of the India. A modified hydroponic way to produce mold-free sprouts on local crop residue bedding has been developed. Approximately 8 lit of water is required to obtain 3.95 kg of wet sprouts from 1 kg of maize grains. The cost of production is approximately 4 /kg of wet sprouts of maize.

Develop appropriate feeding modules for different stages of growth to maximize the meat production potential in sheep is in progress. Weaned lambs of Avishaan breed were fed high concentrates and para grass hay based diet without or with bypass fat. Higher ADG observed in male Avishaan lambs during the post weaning. Although not significant, marginally better ADG was observed with bypass fat supplementation.

Production of plant sourced mannan oligosaccharides for improving the productivity of freshwater aquaculture was attempted. It was possible to extract the mannan from guar seed following stirring for 24 h with water and it was free from reducing sugars. Next generation sequencing analysis of the fish gut samples indicated selective manipulation of gut bacteria owing to the MOS supplementation in Labeo Fimbriatus.

Feed informatics, feed quality and safety and value addition

Real time information of animal population and feed resources is vital for development of livestock sector. Information technology based tools were developed to improve data collection and compilation, estimate feed and fodder resources availability in terms of concentrates, green and dry fodder in all the mandals/taluks of India. The database would be useful in forecasting the surplus/deficit at micro level in real time to assist the planners/administrators. A website designed under the project is currently hosted at Ashoka server of ICAR-IASRI, New Delhi. The demonstration of the website has also been done at a meeting of ICAR officials at NASC complex, New Delhi, emphasizing its possible implementation through DAHDF, Govt. of India.

Manipulating surplus fodder during the periods of abundance can bridge the gap during scarcity periods especially for high yielding animals. Preservation of fodder crops by silage making can ensure regular supply throughout the year. Studies were undertaken for developing a universal inoculum/s for production of quality silage. Lactic acid bacteria was detected as major native microflora in fresh grasses and fodders. Inoculation with lactic acid bacteria caused a decrease in pH indicating acid production. There was no increase in production of acid with increase in time. The results indicated that addition of microbial culture would help to enhance the silage quality.

Work is on progress for developing of a novel phytogenic blend to replace antibiotic growth promoters in broiler production. Supplementation of the 1 % phytogenic blend in broiler feed improved growth performance, serum protein and gut histomorphometry and, reduced drip loss in breast meat as compared to the antibiotic supplementation. Therefore, the phytogenic blend can be used as a potential replacer to antibiotic growth promoters in broilers.

The widespread use of pesticides in agricultural practices and ectoparasiticides in livestock and other environmental pollutants such as heavy metals are directly or through soil, water and feeds, lead to the presence of their residues in the products of animal origin. Efforts were made to monitor environmental pollutants in water, feeds, fodders and animal products. Water, paddy straw, green fodder, concentrates pellets, oil cakes, rice bran, hair and milk samples were collected and analysed for γ-BHC, chlropyriphos, endosulphan-α and -β, o,p'-DDT, cypermethrin and deltamethrin. None of the samples were found positive for above pesticides. The samples were also analyzed for heavy metals (arsenic, lead and cadmium) and some of these samples were found positive for the content of the analyzed heavy metals.

Biofortification is the method for increasing the content of a particular nutrient, which is deficient in cereals, but critical to animal performance. ICAR-NIANP, Bangalore was entrusted with the responsibility of quality evaluation of biofortified cereals and by-products as compared to their conventional varieties in terms of nutrient utilization in livestock. Samples of grains, straws and brans of six promising wheat varieties and ten sorghum stover varieties from various locations were analyzed for nutritional qualities.

Currently, the availability of feed resources is inadequate in the country. Therefore, it is necessary to explore the usage of

alternate oilseed meals/protein/energy supplements from non-edible sources to bridge the gap between the availability and requirements. By-products from spent pupae of silk worm (SWP) are important in this regard. Studies are on progress for evaluating the feeding value of byproducts of SWP in crossbred cattle. Supplementation of defatted SWP (DSWP) up to 100 % had no significant effect on in vitro rumen fermentation and digestibility on finger millet straw based ration. The results indicate that DSWP can be incorporated in the ration of cattle up to 30 % by replacing soybean meal without compromising the rumen fermentation and nutrient utilization.

Correction of nutrient deficiencies in soil is expected to improve the health of crops as well as livestock. A study was taken up with five sheep farmers to evaluate the economic benefit of zinc sulphate application to fodder maize and sheep at Durga Nagenhalli village of Tumkur district. The cost benefit ratio due to zinc application to soil was found to be 1:8.5. The results clearly indicate the potential economic benefits of zinc fortification through soil application for improving yield of fodder as well as sheep mutton.

Climate change impact on livestock

The green house gas (GHG) emissions from livestock are methane (CH4) emissions from enteric fermentation and manure management, nitrous oxide (N2O) emissions from animal manure and carbondioxide (CO2) emissions from land-use change (LUC). The existing poor feeding system, which is mainly based on crop residues added with small quantities of low-cost compound feed is regarded as the reason for source of high GHG emission rate from Indian ruminants. A study was undertaken to analyze the GHG emissions occurring at different stages of dairy farming by conducting life cycle assessment of GHG emissions from selected dairy farms of Karnataka State. The total GHG emission expressed as CO2 eq kg-1 of fat protein corrected milk (FPCM) was found low for small dairy farms (0.58) as compared to medium (2.03) and large (1.66) dairy farms.

Efforts were made to estimate methane emission form different feeding systems and develop suitable amelioration strategies. Inventory of annual enteric methane emission form Indian livestock revealed Uttar Pradesh as the largest enteric methane emitting state in the country. In sheep, continuous and intermittent supplementation of silkworm pupae oil at 2 % level in basal diet significantly reduced methane emission and the population of rumen protozoa. In sheep, condensed tannins, even at a much lower level than hydrolysable tannins was more effective in achieving almost similar methane reduction.

Rumen methanogens diversity in cattle and buffaloes was established using 16S rRNA based next generation sequencing approach. Further, rumen methanogens diversity in buffalo from two distinct geographical locations was explored. Rumen archaea in cattle and buffalo at class level revealed Methanobacteria as the major methanogens in rumen. At genus level, Methanobrevibacter were the major rumen methanogens in both cattle and buffalo.

Attempt was made to ameliorate enteric methane emission from livestock by evaluating various phyto sources from natural plants. The phytosources Pittosporum eriocarpum, Prunus domestica and Berberis lycium containing both condensed tannin (CT) and hydrolysable tannin (HT) in almost equal proportion produced comparatively less methane than phytosources containing appreciable amount of either CT or HT.

Efforts are being made to determine the methane production potential of conventional feedstuffs and diets and of alternative optimized/balanced rations at peri-urban dairy farms, to develop a model that predicts enteric methane emission from peri-urban dairy farms and to develop an inventory of the methane emission potential of different feeds and rations and compute a life cycle assessment of (primarily enteric) GHG emissions from peri-urban dairy farms. Ash, organic matter and curde protein contents in the feed samples collected from 28 dairy farms from rural-urban interface of Bengaluru were determined. Methane emissions from sheep quantified by laser technique and SF6 technique were compared.

Technology translation to connect discovery with application

Water is a nutrient that is required in largest quantity by livestock. Drinking water provides 60 to 80 % of dry and lactating cows' water requirement and feed provides the rest of the water needed. Water availability and quality have a direct impact on health and production performance in dairy cattle. Shrinking water resources warrants judicious use of water, since low water availability will lead to adverse effect as animal growth and production. Water use efficiency of different dairy production systems at the micro level was assessed. The average direct consumptive water use by small holder system was found to be 97 lit/day and the respective

value was 17 lit/day for commercial dairy farms. The calculated water use efficiency for small holder system was 0.85 and for commercial dairying it was 1.62.

A study has been initiated to assess the economics of milk production under different systems of dairy farm management in Karnataka. The initial observation of intensive dairy farms in urban and rural scenario reflected the biased use of concentrate feed over roughages, non-commensurate sanitation to long hours tethering, but better housing and access to health facilities, in comparison to semi-intensive and extensive farms that extend in rural vicinities.

Under the Farmer FIRST Projects, Baseline survey was conducted in primary project intervention areas. Awareness campaign and capacity building programs were organized for selected technological interventions and animal health camps were also organized. Critical inputs like mineral mixture and protein supplements were distributed to the small ruminant producers. Considerable improvements in the income and livelihoods of the farmers following the interventions were noticed.

Training and capacity building

During reported period, the Institute was actively involved in various human recourse developmental activities. A total of 26 students registered under different universities conducted their MSc and PhD research works at various laboratories of the Institute. Different trainings, workshops, meeting and technology awareness program were organized for the scientists, academicians, extension professionals, policy makers and farmers. The scientists attended various workshops, conferences, seminars, symposia, krishi mela and expos. The technical, administrative and supporting staff also received various professional training for skill development.

The Institute in collaboration with all the ICAR institutes located in Bengaluru organized the mega event "Farmers' Conclave" on 16-17 February, 2018. The event was attended by more than 1500 farmers, and professionals from different ICAR Institutes and KVKs located in Karnataka. Honourable Union Minister of Agriculture and Farmers Welfare, Shri Radha Mohan Singh, Union Minister of Statistics and Programme Implementation, Shri DV Sadananda Gowda, Union Minister of Skill Development and Entrepreneurship, Shri Anant Kumar Hegde, Union Minister for Parliamentary Affairs and Chemicals and Fertilizers, Shri Ananth Kumar, Secretary, DARE and Director General, ICAR, Dr Trilochan Mohapatra and DDG (Agricultural Extension), ICAR, Dr AK Singh attended the inaugural function of the event and graced the occasion.

Others

The 4th Quinquennial Review Team (QRT) evaluated the performance of the Institute for the period of April, 2012 to March, 2017. The team was headed by Prof. (Dr) MP Yadav, former Vice-Chancellor, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut. The team also visited different centres and made field visits to observe the impact of the technologies at end-users level under the AICRP and Outreach programme. The concluding meeting of the team was held on 18-20 January, 2018 and the review report was submitted by the team to the ICAR Head Quarter, New Delhi.

The Institute in association with the Indian Poultry Science Association (IPSA) organized the XXXIV Annual Poultry Science Conference (IPSACON 2017) from 28-30 November, 2017 in Bengaluru. The conference was attended by more than 400 delegates.

The Institute was previously an ISO 9001:2008 certified organization and accordingly the required principles of quality management system were implemented. The certification was further upgraded to ISO 9001:2015 on 30 August, 2017.

During the reported period, the Institute released two technologies on the occasion of "Farmers' Conclave" and three patent applications filed earlier were granted to ICAR.

The Institute observed various official functions such as Republic Day, Independence Day, Hindi Pakhwada, Institute Foundation 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 realizing the Mahatma Gandhi's dream of "Swachh Bharat". Various initiatives were taken to maintain the office and campus premises clean and environment friendly. The scientists were also actively involved in the programme "Mera Gaon Mera Gaurav" for extending technical expertise for the benefit of farmers.

Introduction

Genesis

The National Commission on Agriculture recommended the creation of the ICAR-National Institute of Animal Nutrition and Physiology (ICAR-NIANP) during 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 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 problems 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 kms away from the Bengaluru City Railway Station and 40 kms from the Kempegowda International Airport.

Staff

The Institute is headed by the Director and currently 39 scientists including five women scientists are in position.

Staff Position as on 31 March, 2018

Category	Sanctioned Posts	Staff in position
Director	1	1
Scientific	40	39
Technical	12	7
Administration and Accounts	17	13
Skilled supporting staff	6	3
Total	**76**	**63**

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 KM Bujarbaruah, Vice-Chancellor, Assam Agricultural University, Jorhat is the chairman of the committee. The other members of the committee were scientists, professors and industry personnel from the field of animal nutrition, physiology, biotechnology and reproductive Biology.

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 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 has been constituted for promoting 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 Priority Setting, Monitoring and Evaluation Cell headed by two principal scientists 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.

Recently, the Quinquennial Review Team (QRT) evaluated the performance of the Institute for the period of April, 2012 to March, 2017. The ICAR-NIANP in collaboration with all the ICAR institutes located in Bengaluru organized the mega event "Farmers' Conclave" on 16-17 February, 2018. The Institute gave priority to the newly identified thrust areas to strengthen the basic and fundamental research. The Institute coordinated 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 five collaborating centres. The prestigious Farmer FIRST Project on "Improving Livelihood Security of Farmers through Technological Interventions for Sustainable Livestock Farming" was implemented at two different locations in Bengaluru. The Institute was 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 also initiated international research collaborations with Germany and Hungary. 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.

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.

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

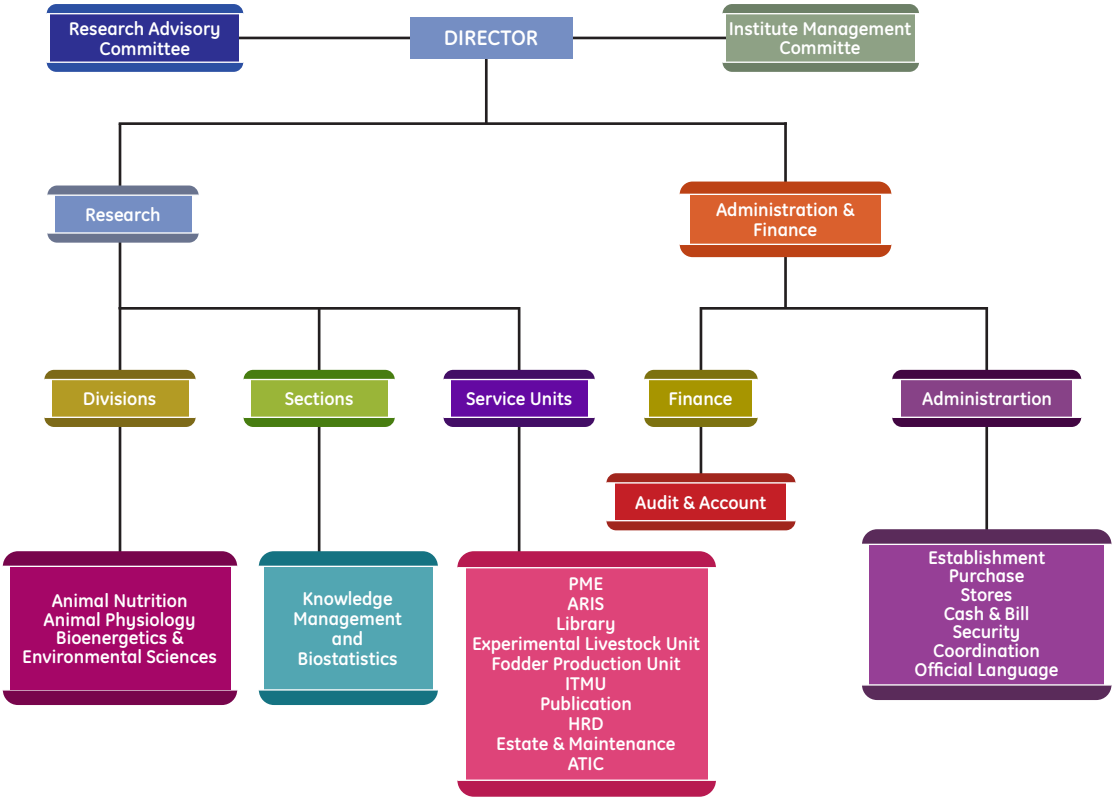
Statement showing the sub head wise allocation and expenditure of fund during 2017-2018 (in lakh).

Sub heads	Budget 2017-18	
	RE	Expenditure
A. Institute		
1. Works	82.50	82.49
2. Equipment and other capital expenditure	132.00	130.24
3. Establishment charges	1050.00	1049.43
4. Pension and other retirement benefits	116.00	116.00
5. Travelling allowances	10.50	10.49
6. HRD	3.00	3.00
7. Research and operational expenses	100.00	100.00
8. Administrative expenses	259.50	259.23
9. Miscellaneous expenses	8.00	7.98
10. Loans and advances	0.50	0.50
Total A	1762.00	1759.36
B. AICRP and Outreach projects	181.20	180.52
Grand total (A+B)	1943.20	1939.88

Revenue generation

Sub heads	Amount (in lakh)
A. Sale of farm products, livestock etc.	1.3
B. Other receipts	
1. Sale of publications, CDs etc.	0.5
2. Analytical testing fees	1.66
3. Other receipts including LF/Interest/IRGS/LS&PC	35.67
Grand total (A+B)	39.13

Organizational Setup



The matrix mode of management is adopted in the research activities which provides 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.

Research Projects

Programme 1
Deconstruction of Ligno-Cellulosic Biomass for Improving Feed Utilization

DBT Project : Biomining of selected white rot fungi (WRF) for novel lignin peroxidase and manganese peroxidase for enhancing digestibility of crop residues

M Sridhar, S Senani and AK Samanta

High lignin content and low digestibility of crop residues hinder their use as the sole animal feed. Among the various methods to remove lignin, biological alternatives have gained wide acceptance, since these methods are efficient, environment friendly and contribute lesser green house gases. Earlier studies on lignolytic enzymes in ruminants have proven beneficial for oral dosing of animals/treating straw for feeding without any side effects. Although known to be responsible in delignification, the precise role of lignin peroxidase (Lip) and manganese peroxidase (MnP) enzymes in deconstruction of lignocellulosic bonds of crop residues remains unclear. The successful application of LiP's and MnP's in ruminant nutrition for enhancing digestibility of lignocellulosic biomass by cost effective means will pave the way for their incorporation in the diets of livestock to improve their productivity vis a vis enhancing digestibility of crop residues. The objectives of the study were: 1) to determine the ability of LiP obtained from white rot fungi (WRF) and testing efficacy in enhancing the *in vitro* and *in vivo* digestibility of straw; 2) to determine the ability of MnP obtained from WRF and testing efficacy in enhancing the *in vitro* and *in vivo* digestibility of straw.

LiP amino acid sequences obtained from different WRF of various strains were selected for comparison with the amino acid sequences of Lip B and Lip J of *Phanerochaete chrysosporium*. The phylogenetic relationship of the novel LiP sequence with all the LiP sequences of Basidiomyceteus available in NCBI were established using BLAST. The LiP gene from *P. chrysosporium* was successfully cloned into *E. coli* DH5α cells. The annotation of the *P. chrysosporium* genome revealed a total of three LiP (B1, B2 and J). The LiP protein structure of *P. chrysosporium* was modelled through CPH server (Fig. 1). 13C-NMR was adopted for lignin structural analysis and the peaks of chemical shifts of 13CNMR in control and LiP treated straws elucidated. Chemical analysis showed that the quantity of lignin was decreased in the treated straw and the lignin was changed into pseudo-lignin, with change in structural components.

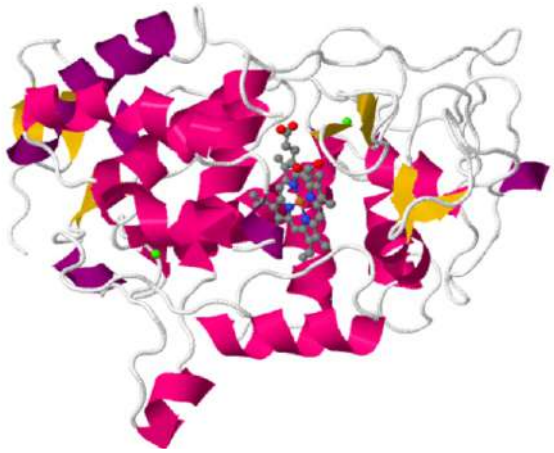


Fig. 1: Structure of the LiP protein of *P. chrysosporium*.

Sheep were fed ragi straw treated with LiP enzyme at the concentrations of 10 (G2), 20 (G3) and 40 (G4) %. After 40 days of feeding, 5, 10 and 12 % increase in dry matter digestibility (DMD) was evident in the G2, G3 and G4 groups. An ADG (g/d) of 52.4 ± 3.22, 60.5 ± 2.04 and 67.5 ± 1.95 was obtained in the G2, G3 and G4 groups as compared to the control group (G1, 36.0 ± 4.45) that fed untreated ragi straw. LiP activity was detected in rumen liquor of sheep

fed treated straw. Except for the G2, total protozoal count was found higher at 0 h in the treated as compared to control groups. A significant decrease in lignin content (1.86 - 3.37 %) was observed in the treated as compared to control groups. Correlation graph plotted for ADL v/s DMD was found to be highly significant (Fig. 2).

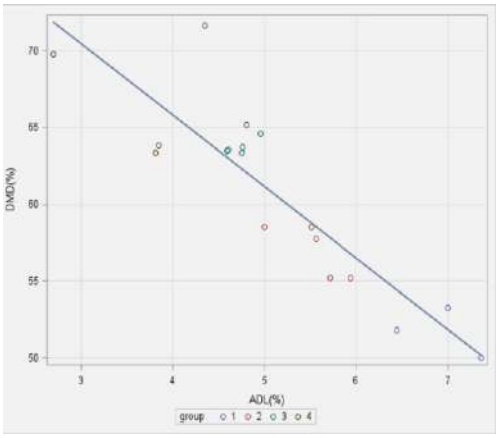


Fig. 2: Correlation graph for ADL v/s dry matter digestibility (r^2 = -0.89, p< 0.001) for the feeding trials.

A statistical approach to screen the significant factors from the pool of components was adopted to optimize the production of MnP by WRF (Fig. 3). The fungal mycelia of various unknown as well as known isolates of WRF, after alternative washing with TE buffer and sterile water were suspended in TE buffer. Fungi in solution were then exposed to microwave. The extract contained genomic DNA which was extracted and amplified using ITS primers for further identification. Based on sequencing results, the identity of known cultures was confirmed, while the unknown cultures were identified as *Clitopilus scyphoides* (AGUM004 BankIt2098576 MH172163); *Ganoderma rasinaceum* (AGUM007 BankIt2098576 Mh172163); *Schizophyllum sp* (KONA001 BankIt2098576 MH172164, AGUM011 BankIt2098576 MH172165 and AGUM021 BankIt2098576 MH172166), *Coprinellus disseminatus* (BANG001 BankIt2098576 MH172167) and *Lentinus squarrosulus* (TAMI004 BankIt2098576 MH172167).

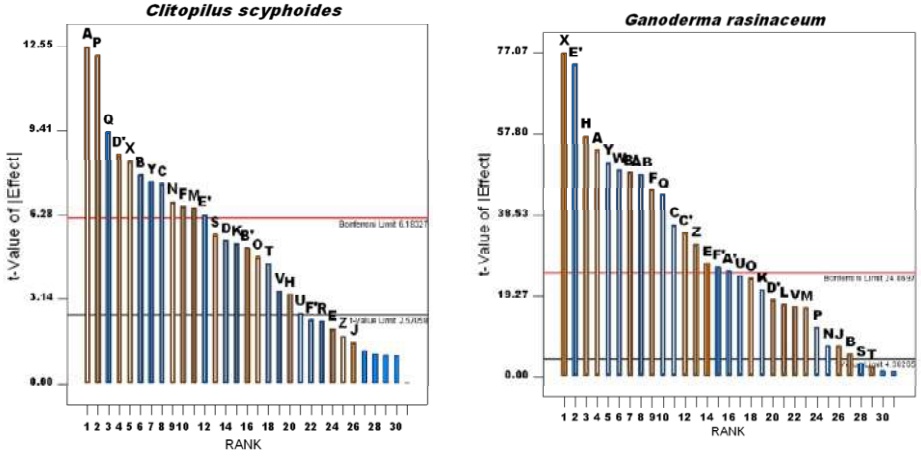


Fig. 3: Pareto charts showing positive and negative effects of factors on MnP production by *Clitopilus scyphoides* and *Ganoderma rasinaceum*.

In vivo experiments in sheep fed ragi straw treated with LiP enzyme at the concentrations of 10, 20 and 40 % showed a 5, 10 and 12 % increase in DMD as compared to the control. A simple and quick method to isolate genomic DNA from WRF aided in quick identification of MnP producing fungi *Clitopilus scyphoides* and *Ganoderma rasinaceum*. NMR spectroscopic studies employed for ascertaining the structural changes in the nine crop residues treated with LiP from *P. chrysosporium* and standard enzyme showed moderately significant difference in the intensity of obtained peaks, confirming the occurrence of degradation process upon treatment.

Programme 2
Biogeography of Gut Microbes in Animals

BGM 2.2: Comparative rumen metagenomics of domestic ruminants

AP Kolte, A Dhali, R Bhatta and AK Samanta

Ruminants acquired the ability of using roughages and fibrous feeds by virtue of the rumen microflora. The microflora is involved in deconstruction of the ingested feed and synthesis of nutrients for the animals. The knowledge of microflora involved in rumen fermentation could be useful for bioprospecting of microbes for nutrient synthesis. Although, a large proportion of diversity contains uncultured bacteria, the comparisons among the species might reveal their ecological niche and roles in rumen function. The project aimed to reveal a core microbiome, microbiome diversity for each species vis-à-vis for rumen function. Identification of differentially present microbes may reveal new information that could be useful in explaining species wise differences among livestock species.

The paired end reads generated from the metagenome 16s rDNA libraries were merged, chimeric sequences were removed and reference based OTUs were picked up from the data. The Greengenes database was used as reference for picking up the OTUs at 97 % similarity defined in the reference database. Apart from the reference based OUT, the software was allowed to create new OTUs from the data. The percent of mapped merged pairs were independent of the data generated and more amount of data generated has more number of chimeric reads, indicating the increasing depth is directly proportional to the chimeric reads detected and discarded. The data mapped to the greengene database was treated as expression values as it represents the proportion of the mapped features within the metagenome. The sample averages were used to compare among the samples and the features (OTUs) that are differentially changed between compared species (cutoff 1.5 fold and FDR <10 %). The comparison of cattle and buffalo revealed 19 OTUs that were changed between these species and were not shared by sheep and can be characteristic of buffalo metagenome. Similarly, the comparison of the cattle and buffalo with sheep revealed larger differences in terms of significantly different OTUs and 615 OTUs were different in sheep and buffalo that were not shared by cattle and 379 OTUs different in sheep and cattle that were not shared by buffalo. There were 320 common OTUs which were not different in all the three species analyzed (Fig. 1).

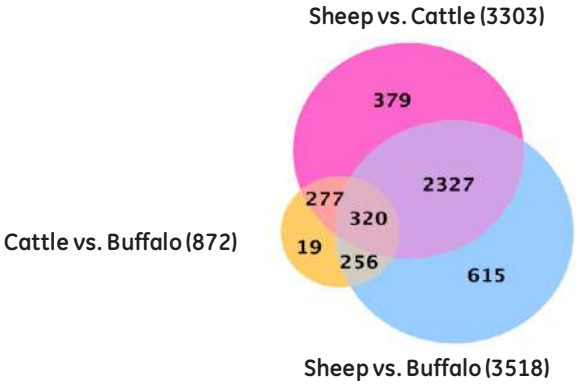


Fig. 1: Comparison of the OTUs differentially changed in comparison of the data among cattle, sheep and buffalo rumen metagenome.

The OTUs generated from cattle, buffalo and sheep metagenome were clustered using unsupervised machine learning algorithm of K means to cluster the data into K number of groups (K = 6) based on the closeness of the group means. The clustering algorithm showed 5 distinct groups with different features (Fig. 2).

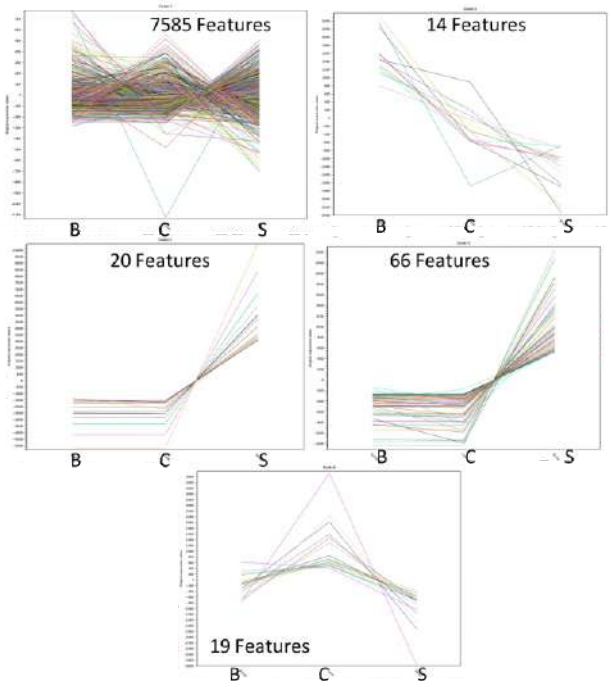


Fig. 2: Clustering of the metagenome data based on K means unsupervised machine learning algorithm. Data were clustered based on the mean abundance values for each OTU.

Majority of the OTUs (7585) were not different and closely abundant among the three species of the ruminants. Fourteen OTUs were high in buffalo as compared to the cattle and lowest in the sheep metagenome. Twenty OTUs were low in cattle and buffalo, but higher in sheep rumen metagenome. Similar trend was observed in 66 OTUs, but the changes were less in amplitude. Nineteen OTUs were low in buffalo and sheep, but higher in cattle.

The class level comparison between the cattle and buffalo metagenomes was performed after the amplicon sequences were mapped with the 16s rDNA database (GreenGenes). The microbes that were variable more than one and half fold were considered to be different among the metagenomes and the other microbes were treated as the core metagenome of both species. The comparison revealed that the buffalo has less methanogens and fibre degrading bacteria at this level of comparison. However, cattle has predominance of several organisms with equal proportions over the buffalo metagenome (Fig. 3).

The class level comparison between Sheep and Goat metagenomes was performed after the amplicon sequences were mapped with the 16s rDNA database (GreenGenes). The microbes that were variable more than one and half fold were considered to be different among the metagenomes and the other microbes were treated as core metagenome of both the species (Fig. 4). The results revealed that sheep had more number of methanogenic archaea as compared to goat. The proportion of Desulfovibrionanes was found more in sheep, but goat had more proportion of Fibrobacteriales, Enteriobacteriales and Aeromonadales.

The class level comparison of rumen metagenomes between the large and small ruminants was also performed. The large and small ruminants appear to be closer than expected, however there are differences in the certain bacterial classes which could probably explain the differences in their species

characters. The large ruminants have more number of archaea as compared to the small ruminants and the fibre degrading bacteria, that explains the adaptability of the large ruminants to the fodder and fibrous feeds than the small ruminants. Even the large ruminants produce more enteric methane emissions due to more fibre handling and is also substantiated by the higher number of archaea in the metagenome. The small ruminants on the other hand has more Bifidobacteria, Aeromonadales and Elusimicrobiales. The common metagenome members among the large and small ruminants are Acidobacteriales, Syntrophobacterales, Lactobacillales, Rhizobiales, Actinomycetales, Solibacterales, Brachyspirales, Sphingobacteriales, Solirubrobacterales, Sphingomonadales, Thermogemmatisporales, Chromatiales, Oceanospirillales, Thiotrichales, Gemmatimonadales, Holophagales, Rhodobacterales, Rhodocyclales, Neisseriales, Pedosphaerales, Chroococcales, Erysipelotrichales, Campylobacterales and Entomoplasmatales (Fig. 5).

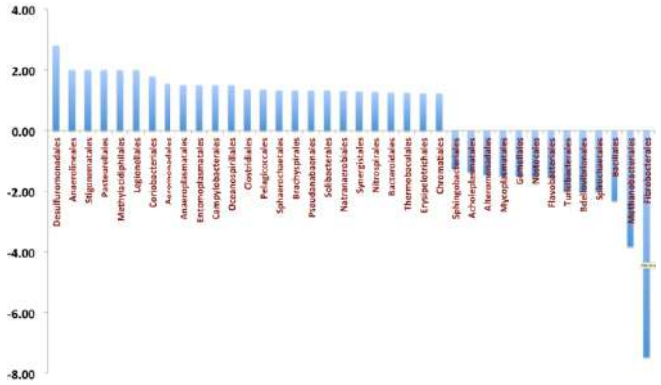


Fig. 3: Class level comparison of rumen metagenomes between cattle and buffalo.

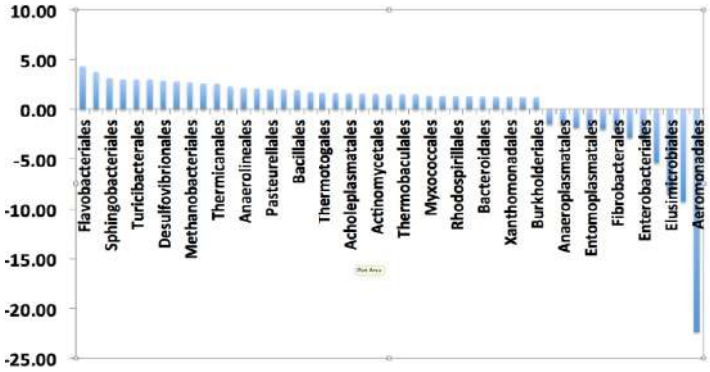


Fig. 4: Class level comparison of rumen metagenomes between sheep and goat.

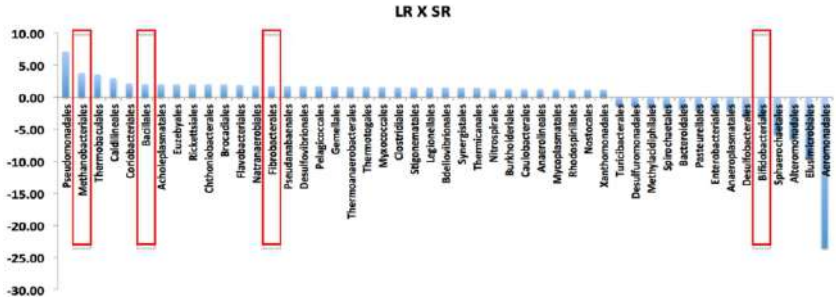


Fig. 5: Class level comparison of rumen metagenomes between large (cattle and buffalo) and small (sheep and goat) ruminants.

Cattle, buffalo, sheep and goat metagenomes were profiled based on 16s rRNA amplicon sequencing. Metagenome diversity among cattle, buffalo, sheep and goat was compared. The phyla Fermicutes and Bacteroides have dominated all the metagenomes. However, the proportions are different among the species. The metagenomes of the cattle and buffalo are found closer than the sheep and goat in terms of microbial diversity. It is observed that buffalo has less methanogens and fibre degrading bacteria as compared to cattle.

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 and M Bagath

Fat in general does not form bulk of ruminant's diet, but all the feedstuffs consumed by ruminants contain lipids to some extent. Lipids from the diet enter the rumen and are hydrolyzed into their constituent components by the enzyme lipase secreted by the lipolytic bacteria. The hydrolyzed products glycerol and sugar moieties are further fermented and the fatty acids that are released are either sequestered by microbial cells or undergo biohydrogenation to convert toxic unsaturated fatty acids into their nontoxic saturated forms. Both lipolysis and biohydrogenation occur simultaneously in the rumen ecosystem mediated exclusively by the resident bacterial species. In recent years, increasing awareness about the content of beneficial fats including unsaturated fatty acids and conjugated linoleic acids (CLAs) in food of animal origin (milk and meat) in lowering coronary heart diseases in human has increased the curiosity among the scientists to explore if biohydrogenation process can be controlled in the rumen.

The major biohydrogenation intermediate present in rumen is trans-vaccenic acid, which serves as a precursor for the synthesis of saturated fatty acids and CLAs at the tissue level. If biohydrogenation process of unsaturated fatty acids in the rumen can be controlled, then it may be possible to increase the level of unsaturated fatty acids and CLAs in ruminant products. Thus identification of newer bacteria involved in the biohydrogenation process in the rumen will help to identify the different metabolic pathways involved in the process, intermediate metabolites formed and their manipulation in controlling the biohydrogenation process may help to increase the level of unsaturated fatty acids and CLAs in ruminant products in future. Therefore, efforts are being made to isolate and characterize lipolytic and lipid biohydrogenation bacteria from the rumen of sheep supplemented with different types of fat.

Table 1: Body weight and dry matter (DM) intake in different experimental groups.

Attribute	Treatments			SEM
	T0	T1	T2	
Initial BW (kg)	11.7	11.5	12.1	0.42
BW 6th fortnight (kg)	17.0	17.3	17.6	0.44
Weight gain (kg)	5.3	5.8	5.5	0.14
Average daily gain (g)	64	69	66	1.6
Average daily DM intake (g)				
Concentrate	249	247	241	7.9
Roughage	222	226	212	10.7
Total	471	473	453	18.2

Eighteen male sheep (Bannur×local) of 8-10 months of age and 11.8 kg BW were divided equally into three groups and allocated to three dietary treatments: T0 (control without any fat supplementation); T1

(saturated fat; coconut oil) and; T2 (unsaturated fat; flaxseed oil). The oils were supplemented at 5 % level in the concentrate. The DM requirement was met as per the ICAR standard. The experimental animals were offered a diet containing concentrate and finger millet straw (50:50). Feed offered and residues left over were recorded daily. Live weight was recorded at fortnightly interval. The initial and 84-day body weight and ADG was similar among the experimental groups (Table 1). The average daily DM intake was also found similar among the groups.

Efforts are being made to isolate and characterize lipolytic and lipid biohydrogenation bacteria from the rumen of sheep supplemented with different types of fat. The diets of the experimental animals were supplemented without or with saturated and unsaturated fats. Preliminary results indicate that following the 84-day feeding trial, body weight, daily weight gain and DM intake did not differ significantly among the experimental groups.

ICAR-Network Project: Veterinary type culture - rumen microbes

D Rajendran, M Chandrasekharaiah and NM Soren

ICAR has initiated the veterinary type culture collection and rumen microbe culture collection comes under this as a part. Rumen microbes are strict anaerobes and isolation and purification required specialized techniques. In this project SOP was developed and distributed among the partner Institutes for collection and isolation of rumen or gut microbes from various livestock and wild animals. The major activities under this project are to isolate and purify anaerobic gut microbes, study the micro-morphological and biochemical characteristics, establish molecular signatures of the purified gut microbes, accession the cultures submitted to the repository from various centres following characterization and revive the cultures periodically to check their viability. Collected microbes are isolated and characterized by biochemical and culture characteristics and confirmed by molecular signatures.

A total of 19 bacterial cultures from various sources were isolated, characterized and submitted to the repository. Nine bacterial species were isolated from the wild sloth bear (4) and captive leopard (5) faeces and DNA was extracted for identification. The bacterial strains collected from goat rumen liquor were *Streptococcus parasanguinis*, *Acinetobacter baumannii*, *Lachnospiraceae bacterium*, *Prevotella ruminicola*, *Clostridium aminovalericum*, *Ruminococcus flavefaciens*, *Anaerosalibacter massiliensis*, *Enterobacter xiangfanensis*, *Clostridiales bacterium* and *Stretococcus infantarous*. The identity of these microorganisms was further confirmed by molecular characterization. *Clostridium butyricum*, *Enterococcus faecium* and *Clostridium beijerinckii* were isolated from Equine and preserved in the repository. *Streptococcus lutetiensis* FDBB158, *Succinivibrio dextrinosolvens* FDBB159, *Streptococcus lutetiensis* BRB9, *Clostridium difficile* AABB8, *Bacteriodes pyogenes* AABB6 and *Clostridium diffficile* AABB 7 were accessioned and stored in repository.

A total of 19 bacterial cultures from various sources were isolated, characterized and submitted to the repository. Nine bacterial species were isolated from wild sloth bear (4) and captive leopard (5) faeces and DNA was extracted for identification.

Programme 3
Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

APR 3.4: Elucidating role of boron on gene expression for calcium utilisation, immune response and anti-oxidant mechanism

NKS Gowda, DT Pal, S Mondal and P Krishnamoorthy

The project was started to quantify the boron content in various feeds and fodders and to understand its physiological and biochemical role in farm animals. The salient findings are given below.

The mean boron content of 17 ppm in the feedstuffs suggests the presence of appreciable quantity of boron in common animal feeds, which warrants for further studies on dietary sufficiency in farm animals to further strengthen the utility boron.

Improvements in gut absorption of calcium, increase in calcium levels in serum and bone coupled with enhanced hepatic mRNA expression of calmodulin, vitamin D-binding protein and thyroid receptor-binding protein clearly deciphers and confirms the role of boron in calcium homeostasis and bone formation. This fact is further confirmed by the observed ameliorative effects of boron on tissue changes in liver and reduced immune response with reduced calcium level in the diet.

Improved antioxidant and immune status accompanied with increased hepatic mRNA expression of superoxide dismutase due to boron supplementation suggest a definite role of boron in ameliorating stress and improving health in animals.

Based on the overall findings, it can be deduced that a dietary level of 40 ppm boron could be effective in improving the bone function, immunity and antioxidant status.

Boron could be considered as a beneficial micronutrient, particularly in situations of peak production like early lactation, stress and immune compromised status.

APR 3.6: Modulation of granulosa cell estradiol synthesis using copper and selenium

PSP Gupta, S Nandi, A Mishra, CG David and RU Suganthi

Recent interest on the use of minerals in the reproduction management programs of domestic animals led to the interest in studying the effect of copper and selenium on estradiol synthesis with the following objectives: 1) to study the effect of copper on granulosa cell estradiol synthesis and associated genes; 2) to study the effect of selenium on granulosa cell estradiol synthesis and associated genes and; 3) to study the synergetic/antagonistic effect of copper and selenium on granulosa cell estradiol synthesis and associated genes.

After acclimatization, Salem Black goats were synchronized using two PGF2α program, but the animals did not show good response to the synchronization protocol. Later the animals were induced to estrus using ovsynch protocol, but the response rate was 51.7 %. Finally, good estrus induction/synchronization response came with the PRID devices (AVIKESIL) procured from the ICAR-CSWRI, wherein 74 % of the animals could be induced to estrus. There was no significant effect of

cupric chloride (20 mg/animal) and sodium selenite (10 mg/animal) on estradiol synthesis, but both were equally effective as GnRH in induction of estrus (Fig. 1). There was no significant difference among the GnRH, copper, selenium or copper with selenium treatments on the time to onset of estrus. Similarly, no significant difference was observed in the duration of estrus among these treatments in the experimental animals. The *in vitro* studies on the effect of copper and selenium on anti-oxidant effect during the culture of ovarian granulosa cells revealed that selenium had exhibited considerable anti-oxidant effect in the culture system as indicated by the estimation of MDA by TBARS assay. Copper and selenium in combination upregulated the FSH receptor gene expression of ovarian granulosa cells in the presence of FSH. Copper alone and also in combination with selenium had significantly upregulated the FSH receptor gene expression in the absence of FSH in in vitro culture of ovarian granulosa cells.

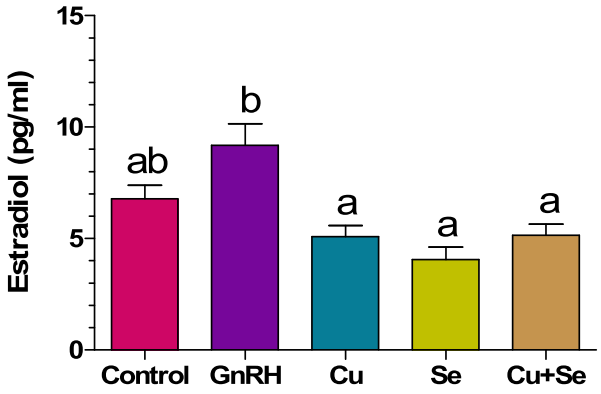


Fig. 1: Effect of copper, selenium and combination of both on estradiol synthesis in Salem Black goat.

Copper and selenium either alone or in combination promoted the ovarian granulosa cell estradiol synthesis and up-regulated estradiol synthesis associated genes, hence can be used in reproductive management programme in goats along with hormones.

APR 3.7: Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken.

IJ Reddy, A Mishra, S Mondal , VB Awachat and RK Gorti

It has been reported that light manipulation has been an effective measure to improve poultry production. The only light source for chickens in commercial poultry farms is an artificial one. The source, spectra, intensity and regimen of light supplementation have become major factors in modern meat type bird management. Among all light sources, light-emitting diode (LED) is a unique type of semiconductor diode. Compare to incandescent light's 1000-h and fluorescent light's 8000-h life span, LEDs have a very significantly longer life of 100,000 h. In addition to their long life, LEDs have many advantages over conventional light source. These advantages include small size, specific wavelength, low thermal output, adjustable light intensity and quality, as well as high photoelectric conversion efficiency. Such advantages make LEDs perfect for supporting chick growth in commercial poultry farms. Studies in our laboratory indicated that light period and light intensity emitted by green LEDs showed a significant influence on the growth and production of the broiler chicken. Further, we reported that monochromatic green LED light during embryogenesis also affect growth of the broiler chickens. Especially, monochromatic green LED light stimulated the growth of broilers as compared to the normal white light.

In our study, fertile broiler eggs were pre-weighed and randomly assigned to three incubation treatment groups: i) normal condition (control group 450 nm); ii) monochromatic green light (575 nm) and; iii) monochromatic red light group (675 nm). The monochromatic LED lighting systems sourced from light-emitting diode lamps were equalized at the intensity of 15 lx at eggshell level. The dark condition was set as a

commercial control from day-5 until hatching. Hatched pullets were exposed to the normal wavelengths of light with an intensity of 30 lx at bird-head level for a period of 45 days to study effects of different wavelength of light on myostatin, myo-D, myogenin, actin, leptin, GnRH, GnIH, FSHβ, LHβ and GH receptor expression, GH, IGF-1, IGF-II, FSH, LH, estradiol-17β, E2β Receptor alpha, progesterone (P4), P4 Receptor, testosterone and nutritional parameters between the different groups of birds. The relationships between the green light spectra, red spectra and normal spectrum of light on growth performance of chicks were investigated.

Light spectra affected growth in broiler type birds both *in ovo* and post hatch. Broilers photo-stimulated *in ovo* with green light gained significantly more weight than birds incubated under normal conditions. *In ovo* photo-stimulation had a stimulatory effect on the proliferation and differentiation of satellite cells and a promoting effect on the uniformity of the muscle fibers in the early post-hatch period. How does *in ovo* photo-stimulation affect various intracellular events, such as proliferation and differentiation of muscle cells, leading to post-hatch muscle growth? It is possible that the monochromatic green light penetrates the eggshell and has a direct effect on the embryo's muscle. A more likely explanation is that green light indirectly affects myoblast proliferation by activating the endocrine system and the latter receives photic cues from the retinal or extra-retinal photoreceptors. We gathered some evidence to support these findings. A higher level of GH in embryonic cells derived from green light illuminated chicks was evident. In addition, plasma GH and IGF-I levels in muscle tissue were found higher in the green group as compared to the control in early post-hatch. Another possible explanation for this phenomenon could be that IGF-I and IGF-II secretions are activated in response to green light photo stimulation. GH, GH receptor and GnRH expression was found higher in green illuminated group. In contrast, MSTN and GnIH gene expression was found low in birds exposed to green spectrum of light. The results suggest that green light at 575 nm of wavelength during *in ovo* and *ex ovo* periods effectively stimulated the HPG and somatotrophic axis, ultimately resulting in early body weight gain in the birds.

We designed chMSTN-siRNAs based on turkey and chicken MSTN mRNA to study the suppression of MSTN gene expression in the primary cultured cells obtained from breast muscles. Approximately 46 % reduction of MSTN mRNA was observed following siRNA transfection of muscle cells. Moreover, the protein content of MSTN was also clearly suppressed in the siRNA transfected cells. Conversely, the levels of myogenin and MyoD mRNA were not significantly different between treated and non-treated cells. These results suggest that the siRNA designed in this study suppressed MSTN gene expression specifically and that the level of myogenin, myoD, actin and leptin mRNA expressions were not associated with MSTN in muscle cells.

In conclusion, a new method to advance the chick body weight gain early by one week with more muscle mass could be established by the growth-advantage monochromatic green LED light. The chicks exposed to green LED light during embryogenesis attained stimulatory effects on body weight than birds exposed to normal light during embryogenesis. Broilers incubated *in ovo* with green LEDs consumed less feed and grew most during the test period; 383.4 ± 1.05g increase in body weight at day-35 as compared to control group. Green LED lighting during *in ovo* period in broiler chicken advanced the early body weight gain by one week relative to control. Moreover, the percentage of carcass was found significantly greater in the green light when compared with normal light group. A significant decrease in the abdominal adipose weight was observed in the green light group. Testosterone, E2β, P4, GH, IGF-1, T3 and T4 were higher in birds exposed to green spectrum of light and were found positively correlated with weight gain. At the market age of bird (day-35), a significant improvement in feed conversion (1.59 ± 0.02) was found in green group compared with normal LED light group (1.70 ± 0.01). The approach was highly cost effective and could reduce the feed costs and saved highly valuable feed ingredients.

Exposure to green LED light during *in ovo* period showed stimulatory effects on body weight in post hatch birds over controls. Chicks obtained from green LED illumination during embryogenesis showed 2 to 2.4 times more breast muscle satellite cells as compared to white and red photo stimulated chicks. Since satellite cells are members of myoblast family, any rise in their level may indicate the stimulation of muscle growth and a possible mechanism explaining the elevation in body weight associated with green monochromatic light. Green LED lighting during *in ovo* period in broiler chicken advanced the early body weight gain by one week relative to controls. Broilers incubated *in ovo* with green LEDs consumed less feed and grew most during the test period; 1.94 % increase in body weight at day-35 and 8.41 % increase at day-45. This technology is highly cost effective and can reduce the feed cost and save highly valuable feed ingredients.

APR 3.8: Effect of dietary selenium on selenoprotein genes in lambs

RU Suganthi, PK Malik, J Ghosh, VB Awachat and P Krishnamoorthy

Selenium (Se) is an essential micronutrient for livestock being required for proper antioxidant defence, thyroid function, reproduction, immunity and health and, diet is the major source of Se. The biological functions of Se are accomplished by selenoproteins that are characterized by the presence of selenocysteine residue (Sec). Supplementation of Se has been reported to improve immune response in cows, meat quality in pigs and reproductive function in sheep. Therefore, the project was formulated to investigate the influence of dietary Se on the expression of selenoprotein genes in lambs and reveal the interaction between selenoprotein gene expression and the antioxidant and immune status and meat quality in lambs.

An experiment was conducted in lambs by feeding basal diet (control) or basal diet supplemented up to 4.5 ppm of organic Se for 90 days. Results showed significantly higher serum PPR antibody titre and antioxidant status in liver of lambs supplemented with the 1.5 and 4.5 ppm of Se as compared to control. The pH of LD muscles measured in situ, 15 min and 24 h post slaughter did not differ among the treatments and were within the acceptable limit of consumers. Supranutritional Se had negligible effect on the water holding capacity of meat recorded on different days of storage post slaughter. Supranutritional Se supplementation resulted in significant improvement in antioxidant status ($p < 0.01$). A significant reduction ($p < 0.05$) in lipid oxidation was observed in meat on day 0. However, the concentration of lipid peroxidation products did not differ among the treatments in vacuum packed and refrigerated meat after 3 and 7 days of storage. Microscopic studies of liver, kidney, thymus, spleen and LD muscle tissues showed normal architecture, indicating the absence of toxic or adverse effects of supranutritional levels of Se. Feeding suparanutritonal Se influenced the mRNA expression of hepatic glutathione peroxidase 1 (GPX1), Glutathione peroxidase 3 (GPX3), Thioredoxin reductase 1 (TXNRD1), Iodothyronine deiodinase 3 (DIO3), Selenoprotein P1 (SEPP1) and Selenoprotein W (SEPW) and had limited influence on Iodothyronine deiodinase 1 (DIO1) and selenoprotein 15 (SEP15). The mRNA expression patterns of the isoforms of GPXs, TXNRDs and DIOs and, SEPP1, SEPW1 and SEP15 in liver and LD muscles were observed to be dose and tissue specific, when Se was fed at different supranutritional levels. The results indicate the involvement of intricate regulatory mechanisms in SEP gene expression in lambs based on Se status.

Supranutritional Se supplementation improved immune response, antioxidant status, reduced lipid peroxidation and did not induce any pathological changes in studied organs. The mRNA expression patterns of the isoforms of GPXs, TXNRDs and DIOs and, SEPP1, SEPW1 and SEP15 in liver and LD muscles were observed to be dose and tissue specific, when Se was fed at different supranutritional levels. The results indicate the involvement of intricate regulatory mechanisms in SEP gene expression in lambs based on Se status.

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

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

The project was formulated with 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.

An experiment was conducted employing combination of amino acids (Thr, 16; Arg, 25; Glu, 25; Lys, 22; Met, 10 mg) and trace mineral (zinc, 80 ug; copper 16 ug; selenium, 0.3ug) for *in ovo* and post hatch supplementation. Uniform sized Cobb broiler eggs (N = 372) were procured from commercial hatchery and incubated. On embryonic day-18, fertile eggs were divided into two groups: one without supplementation and another supplemented *in ovo* with selected amino and trace elements solution. The dietary treatments consisted of one normal starter diet for group I (WoPHS) and group II (WPHS) with post hatch supplemented diet fed for first 3 days, from day 4 till 5 wk of age, the chicks were fed similar starter (4 to 21 days) and finisher diet.

There was a complete hatch failure due to combination of amino acids and minerals. Post hatch supplementation of combination of amino acids (Lys, Met, Arg and Thr) and minerals (zinc, copper and selenium) enhanced growth performance (feed intake, body weight gain and FCR) and cell mediated immune response in broiler chickens.

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

SC Roy, A Dhali and KS Roy

The viability, motility and fertility of mammalian spermatozoa are significantly reduced when semen is cryo-preserved. As compared to the cattle semen, the post-thaw viability, motility and fertility of buffalo semen have been reported to be substantially low. Thus, there is an urgent need for the development of a suitable and specific semen extender for buffalo semen. Over the decades, the composition of semen extender used for diluting of buffalo semen and protocols used for subsequent cryopreservation remain primarily similar to that of the cattle, even though it has been aptly reported that the composition of sperm structure and seminal plasma of these two species are different. In view of this, the effects of incorporation of three agents viz., Agent-A, α-tocopherol (vitamin-E, a chain-breaking antioxidant) and genistein (a DNA stabilizer) to the semen extender on post-thaw sperm viability, motility, percentages of sperm with acrosome reacted/lost (AR), MDA formation (an indicator of lipid peroxidation), formation of oxidized protein products such as advanced oxidation protein products (AOPP), carbonylated proteins (CP) and DNA fragmentation of cryo-preserved sperm were studied. For determination of number of sperm that are live or dead, AR and sperm with fragmented DNA after cryopreservation of buffalo semen, three different fluorescent stain-based microscopic methods were standardized in the laboratory (Fig. 2, 3 and 4). The effect of the above agents on sperm kinematics was also studied by Computer Assisted Semen Analyzer (CASA).

Of the three agents tested, the pre-freeze addition of Agent-A and genistein at specific concentrations in the semen extender increased the post-thaw viability and motility of buffalo sperm as compared to control (semen without any agent) with significant reduction in cryopreservation-associated AR and DNA fragmentation. Agent-A also reduced MDA level in post-thawed semen and sperm and CP content in sperm

as compared to control group. Agent-A and genistein could reduce to some extent the level of AOPP in cryopreserved seminal plasma as compared to that of the control semen. However, the addition of α-tocopherol could only decrease the post-thaw DNA fragmentation significantly with non-significant increase in curvilinear velocity (VCL) and amplitude of lateral head displacement of cryopreserved buffalo sperm.

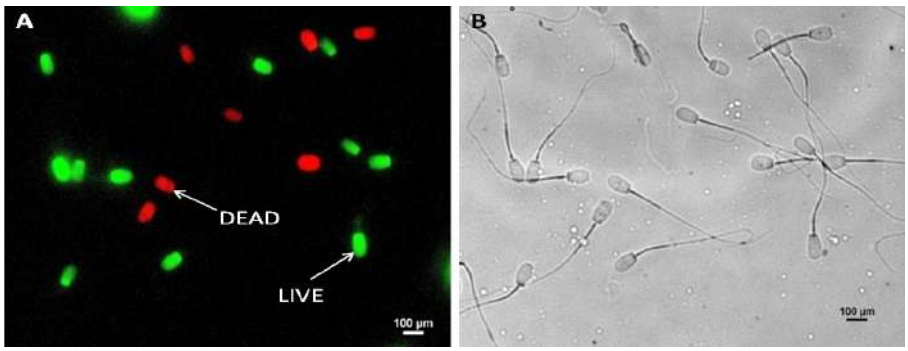


Fig. 2: Representative images depicting sperm viability in buffalo semen determined using the SYBR 14/PI staining method. A) viable cells appear green; dead cells appear red in colour; B) corresponding differential interference contrast (DIC) image of the same field.

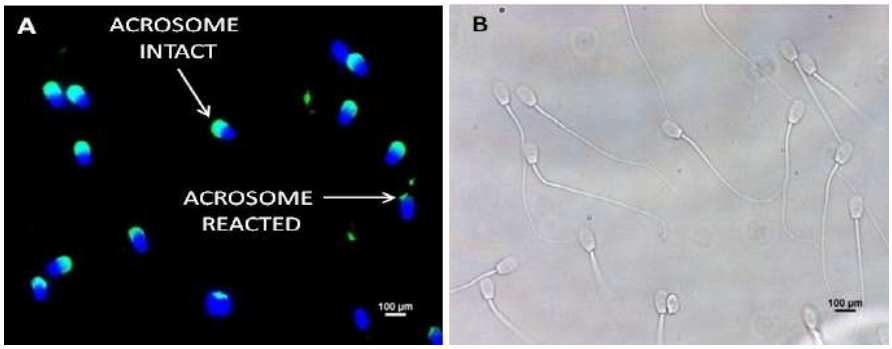


Fig. 3: Representative images showing acrosome reacted sperm determined using Lectin-PNA Alexafluor/DAPI fluorescent stains. A) acrosome on sperm is stained with green fluorescent stain and blue fluorescent stain on sperm represents the position of sperm nucleus; B) corresponding differential interference contrast (DIC) image of the same field.

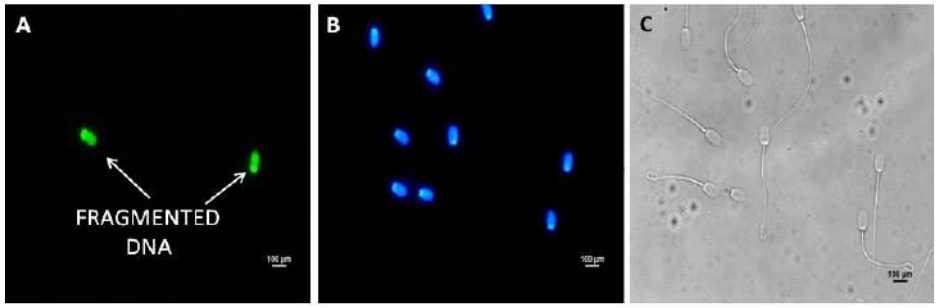


Fig. 4: Representative images depicting DNA fragmentation in buffalo sperm determined by TUNEL assay counter-stained by DAPI. A) green fluorescent stain on sperm heads indicate fragmented DNA; B) blue fluorescent stain indicate intact DNA; C) corresponding differential interference contrast (DIC) image of the same field.

Agent-A and genistein have the potential to reduce cryopreservation-associated loss of post-thaw viability and motility and can minimize other oxidative biomolecular changes in buffalo semen/sperm.

APR 3.11: Development of ideal protocol for isolation and culture of ram spermatogonial stem cells

BK Binsila, S Selvaraju and A Arangasamy

The spermatogonial stem cells (SSCs) are unique testicular cells having the ability to regenerate their own pool of cells and alternatively differentiate into functional spermatozoa. The major areas of the SSCs application in livestock are the preservation of genetic material of elite or superior animals, and improving fertility through transplantation of SSCs, production of transgenic animals, understanding the molecular mechanism involved in spermatogenesis and regulation of male fertility. The current study aims to develop suitable protocol for isolation and purification of SSCs from sheep testicular tissue for the culturing of SSCs.

In order to improve the purification efficiency, a double purification procedure was adopted. Ficoll enrichment was carried out using 10 and 12 % gradient (selected based on the better purification efficiency) in the initial isolate. Ficoll purified fraction was plated on laminin coated plates. The double enriched SSCs fraction was cultured for 7 days at 37˚C with 5 % CO2 on laminin coated plates. Culture medium consisted of stem cell specific medium, additives, FBS (10 %) and without (control) or with growth factors at various doses (20 ng/ml of EGF and 40 ng/ml of GDNF). The medium was changed after every 48 h. The seeding density for the culture was 0.05×10^6 cells/well in the 48-well plate. After 7 days of culture, the cells were harvested from the 48 well plates by enzymatic method. The viability, concentration of cells and cells positive for SSC markers PLZF, from all groups of the culture were calculated.

Double purification method yielded 61 % putative SSCs with 66 % viability. The purity and viability of the cells were sufficient for the culturing of SSCs. The viability of the cultured cells (%) after 7 days was high in all the groups (Control: 93.2 ± 2.60; EGF20: 90.7 ± 2.80; GDNF40: 93.0 ± 2.90). The cells proliferated in the culture and there was significant ($p < 0.01$) fold increase in the number of cells on day 7 of culture in EGF20 and GDNF40 as compared to the control (Fig. 5). Within 4 days of culture, SSCs colonies started developing from the initial cell densities and the colony size increased by the 7 days of culture. At the end of 7 days of culture, the cells supplemented with growth factors were doubled in the culture. The harvested cells were round in shape with a significantly higher nucleus to cytoplasm ratio. The percentage of PLZF+ cells in the cultured medium did not differ significantly among the groups (Control: 77.7 ± 2.30; EGF20: 79.6 ± 4.90; GDNF40: 82.0 ± 1.80) studied. However, there was a significant ($p<0.01$) increase in the total number of PLZF+ cells (10^6) in EGF20 (0.12 ± 0.0) and GDNF40 (0.14 ± 0.0) as compared to the control (0.06 ± 0.0). The representative image for the SSCs culture, harvested cells following culture, viability and stemness (PLZF+) is presented (Fig. 6).

The present study revealed that double purification method is effective for enrichment of SSCs for culture. EGF (20 ng/ml) and GDNF (40 ng/ml) exhibited higher proliferation and stemness *in vitro* as detected by the putative stem cell marker PLZF.

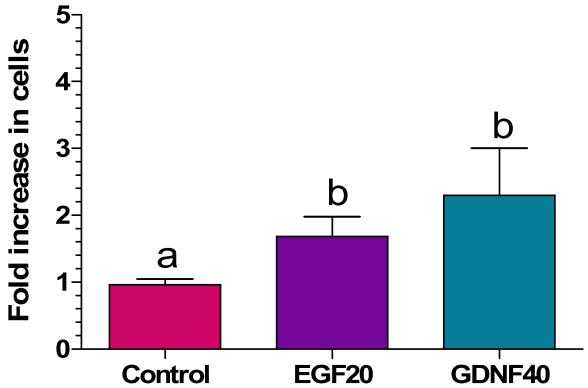


Fig. 5: Effect of growth factors EGF (20 ng/ml) and GDNF (40 ng/ml) on the proliferation (fold increase of the harvested cells) of putative SSCs following 7 day of culture.

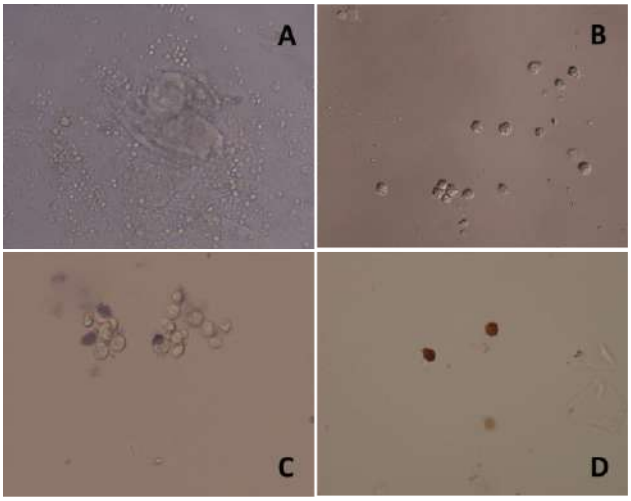


Fig. 6: Representative photographs depicting SSC colony (A), harvested cells (B), viable cells (C) and PLZF+ cells (D) following the culture of ram spermatogonial stem cells for seven days. Magnification: 400x.

Double purification method, ficoll density gradient separation followed by differential plating using laminin in combination with BSA was found effective for enrichment of ram SSCs. Culture medium supplemented with EGF (20 ng/ml) and GDNF (40 ng/ml) exhibited higher proliferation and stemness of SSCs under *in vitro* culture system.

APR 3.12: Development of pregnancy associated glycoprotein (PAG) based immunodiagnostic for buffaloes (*Bubalus bubalis*).

J Ghosh, KS Roy and CG David

There is an urgent need of an early pregnancy diagnosis assay in buffaloes for a better reproductive management. This is because existing indirect test are unreliable and the direct test such as trans-rectal determination is late and ultrasound imaging is technically demanding for the buffalo farmers. Long demand of a direct conceptus specific buffalo test kit based on PAG detection, as available in other ruminant species, is not yet met. The reasons could be these proteins are expressed as multi-isoform and the isoforms has species and pregnancy stage specificity in terms of expression patterns. In the earlier studies we established predominant availability of two PAG isoforms during the early pregnancy in buffalo placenta. Currently, attempt was made to clone and express the full PAG protein in mammalian expression system using two different approaches. Cloning was successful with both the approaches, but expression was successful with the second approach. Testing of the expressed protein is in progress. Four different immuno-capture ELISA formats were developed and tested with non-pregnant and pregnant animal blood samples. All the tested formats were found suitable for detection of pregnancy specific PAG signals, however captured basal signal in non pregnant animals as well. In conclusion, buffalo PAG was successfully cloned in two different vectors for expression in mammalian cells. PAG signals were tested in pregnant and non pregnant serum samples using four different immuno-capture ELISA formats. Successfully expressed and purified recombinant buffalo PAG protein expressed in suitable mammalian cells.

Recombinant buffalo PAG protein expressed in suitable mammalian cells were purified and employed in four different immuno-capture ELISA formats to detect pregnancy in buffaloes.

APR 3.13: Manipulating apoptotic signalling to improve oocyte development competence in sheep

A Dhali, AP Kolte, SC Roy and A Mishra

There are several interconnected cellular processes that determine the development competence of an oocyte and in turn its ability to develop into a competent embryo. Previous studies at our laboratory indicate that stimulating PI3K-AKT signal or inhibiting caspase cascade to evade apoptotic signal could be the possible targets for improving oocyte development competence. The project aims to investigate the effect of stimulating PI3K-AKT signal and inhibiting caspase-9 and caspase-8 on the development competence of sheep oocytes.

The effect of caspase 9/8 inhibition during IVM on gene expression in sheep oocytes and morula was assessed. Sheep COC were matured *in vitro* without or with supplementing 50 µM of caspase9/8 inhibitor into IVM medium and denuded matured sheep oocytes were collected for assessing gene expression. Further, sheep morula were produced *in vitro* without or with supplementing 50 µM of caspase9/8 inhibitor into IVM medium and were collected for assessing gene expression. The samples were subjected to RNA isolation, cDNA synthesis and qPCR for assessing gene expression. The expression of Caspase9, Caspase8, Caspase3, Caspase6, Caspase7, DFFA, DFFB, BID, RIPK1, PARP1, BAX and BCL2 was assessed in the oocytes and morula in response to caspase9/8 inhibition as compared to control. The results (Fig. 7) indicated that caspase9/8 inhibition during maturation exerted a favourable effect on the expression of caspase cascade/apoptosis associated genes in sheep matured oocytes and morula.

The effect of supplementation of different dosages of AKT activator into IVM medium on the maturation rate of sheep oocytes was assessed. IVM medium was supplemented with 5, 10 and 20 µg/ml of AKT activator. The results indicated that 20 µg/ml of AKT activator significantly reduced the oocyte maturation rate as compared to the control and supplementation of 5 or 10 µg/ml of AKT activator. In contrast, although not significant, 10 µg/ml of AKT activator marginally improved the maturation rate as compared to control and supplementation of 5 µg/ml of AKT activator.

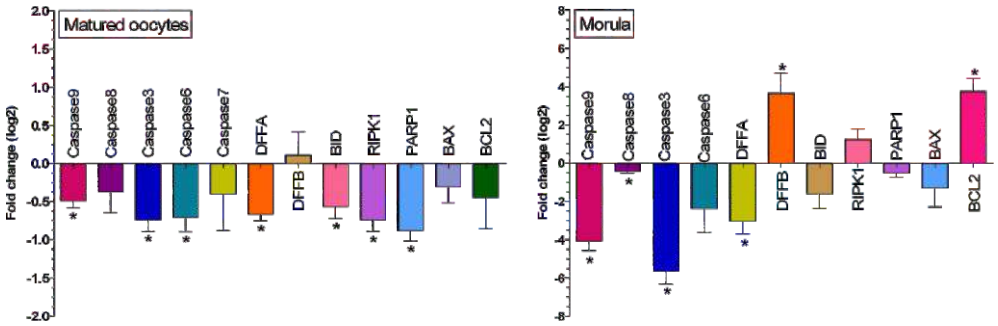


Fig. 7: Effect of caspase 9/8 inhibition during IVM on the expression of caspase cascade/ apoptosis associated genes as compared to the control in matured oocytes and morula in sheep.

Caspase9/8 inhibition during maturation exerted a favourable effect on the expression of caspase cascade/apoptosis associated genes in sheep matured oocytes and morula in vitro. Supplementation of 10 µg/ml of AKT activator in IVM medium marginally improved the maturation rate of sheep oocytes *in vitro*.

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 and R Bhatta

This project has been designed to study the following objectives: a) to evaluate the resilience capacity of different indigenous goat breeds to heat stress; b) to compare differences in economically important thermo-tolerant gene expression in different indigenous goat breeds exposed to heat stress; c) association analysis of gene expression data with different phenotype traits related to heat stress during summer season.

A study was conducted to evaluate the differences in the productive responses and thermo-tolerant abilities of three indigenous goat breeds (Osmanabadi, Malabari and Salem Black) to heat stress challenges (Fig. 8). One year old female goats (N = 36) were randomly allocated into six groups of six animals each (OCON, Osmanabadi-control; OHS, Osmanabadi-heat stress; MCON, Malabari-control; MHS, Malabari-heat stress; SCON, Salem Black-control; SHS, Salem Black-heat stress). The OCON, MCON and SCON animals were maintained in the shed, while OHS, MHS and SHS animals were exposed outside to summer heat stress between 10:00 to 16:00 h to expose them to heat stress during the experimental period. All animals had access to ad-libitum feed and water. The duration of the study was 45 days.

Fig. 8: Indigenous goat breeds used in the study.

The results from the study indicated that heat stressed goats were trying to cope to the adverse environmental conditions through alterations in both behavioural and physiological responses. Further, the study clearly indicated the differences in the thermo-tolerant ability even among the indigenous breeds. These differences in heat stress response were observed even at cellular level as evident from the differences in HSP70 expression patterns among these breeds. The different thermo-tolerant gene expression patterns clearly indicated the superior thermo tolerant ability of Salem Black breed as compared to the other breeds (Table 1). In addition, the study also identified RR, RT and PBMC HSP70 to be the reliable biological markers for evaluating the thermo-tolerant capacity of indigenous goat breeds.

The current study provided an insight into the impact of heat stress on growth performance in indigenous goats. Based on the changes observed on various growth variables during heat stress exposure, it was evident that the Salem Black breed performed much better as compared to Osmanabadi and Malabari indicating the superior ability of this breed to adapt to heat stress challenges. The results also indicated that plasma GH and IGF-1 gene may act as ideal biomarkers for assessing the heat stress impact on growth performance in indigenous goats. The results indicated that summer season-related heat stress influenced the rhythmic pattern of metabolic activities and rumen fermentation profiles in all the three indigenous goat

breeds. However, these changes were of different magnitude among the breeds. On comparative basis, it was established from the results that the alterations in the rhythmic metabolic activity was less severe in Salem Black reflecting the superior adaptive capability of this breed to cope to heat stress challenges.

Table 1: Different thermo-tolerant gene expression patterns in PBMC of three indigenous goat breeds. ↑ indicates upregulated expression; ↓ indicates downregulated expression; ● indicates similar expression.

Gene	Goat breed		
	Osmanabadi	Malabari	Salem black
IL18	↓	↓	●
TNF α	↑	↓	↑
IL2	↓	↓	●
IL10	↓	↑	↑
IL6	●	↑	↑
IFN γ	●	●	↓
HSF1	↑	↑	↑
HSP70	↑	↑	●
HSP90	↑	↑	↑
Nramp 1	↓	↓	●
C NOS	↓	↓	●
E NOS	●	↓	●
I NOS	●	↓	●
SOD	↑	↑	↑
IGF1	↓	●	↑

were slaughtered at the end of study and their meat characteristics were assessed. The results indicated that heat stress induced deteriorating changes in the meat characteristics in all the three breeds. However, the magnitude of these changes was comparatively less severe in Salem Black. Moreover, the results from the study provided some crucial evidence for better resilience capacity of Salem Black as compared to Osmanabadi goats in maintaining the meat production during heat stress. This was evident from the non-significant influence of heat stress on vital meat quality parameter such as separable fat, meat pH, appearance and myostatin gene expression. Further, the comparatively lower expression of HSP70 gene in Salem Black than that of the other two breeds proved the superiority of this breed in maintaining the meat quality (Figure 9). Therefore, it could be concluded that shifting of Salem Black breed from a much harsher climatic condition to the lower magnitude heat stress location proved beneficial in terms of maintaining the meat production performance. Further, the study also revealed the scope of using plasma leptin, myostatin and HSP70 genes as biomarkers to assess the impact of heat stress on meat characteristics in indigenous goats.

Based on the observations on most of the variables studied, it was evident that Salem Black breed was able to cope with heat stress challenges efficiently as compared to Osmanabadi and Malabari breeds. Therefore, promoting Salem Black breed among the local farmers may prove beneficial to sustain their production in the changing climate scenario due to their higher thermo-tolerant ability. These findings are of higher significance as the scientific community battles in its effort to identify suitable agro-ecological zone specific breeds for sustaining livestock production in the changing climate scenario.

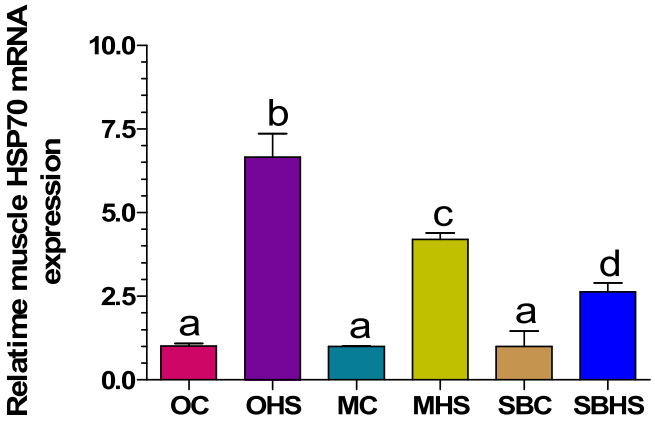


Fig. 9: Description of relative muscular HSP70 expression pattern of three indigenous goat breeds. OC: Osmanabadi, control; OHS: Osmanabadi, heat stress; MC: Malabari, control; MHS: Malabari, heat stress; SBC: Salem Black, control; SBHS: Salem Black, heat stress. Values bearing different superscripts both between and within breed differed significantly at $p < 0.05$.

Salem Black breed cope up with heat stress challenges efficiently due to their higher thermo-tolerant ability. Hence, promoting Salem Black breed among the farmers will prove beneficial to sustain their production in the changing climate scenario.

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

A Mishra, A Dhali, IJ Reddy and PSP Gupta

Embryos produced *in vitro* are not at par to *in vivo* derived embryos because *in vitro* setup can never mimic the exact physiological conditions of *in vivo* system. Success of *in vitro* embryo development depends upon factors like temperature, gas composition (O2/CO2), pH, media composition and air quality. There is generation of reactive oxygen species (ROS) from embryos and these factors resulting oxidative stress (OS) that adversely affects embryo survivability. Recent ambiguity is that whether all these factors affecting embryo survivability are biased survivability of particular sex of embryo or not. It is well documented that oxidative status of *in vitro* embryos are always more than that of the *in vivo* derived embryos. The most common difference in both the conditions are the O2 concentration at which embryos grow. Many reports indicate embryonic sex bias by these factors. Therefore, it is hypothesized that sex bias by these factors might be due to differences in ROS production by these factors, which might be hindering the developmental potential of particular sex of embryos. To find an answer, whether oxidative stress has any role on sex ratio of the embryos, a preliminary study was conducted to determine the sex ratio of sheep embryos produced *in vitro*. Sexes of the embryos were determined by the PCR based expression detection of sex specific genes present in genomic DNA of embryos (Fig. 10).

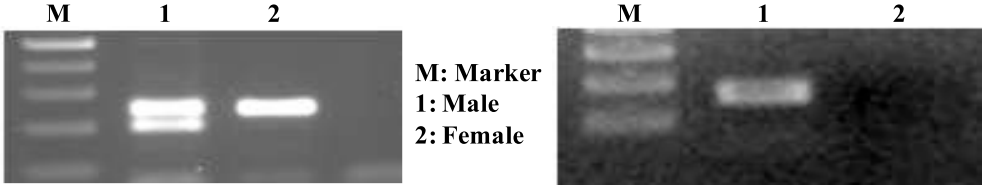


Fig. 10: Sex of embryos by PCR based detection of the expression of sex specific genes.

The results indicated that majority of the embryos produced *in vitro* are biased towards particular sex. Though O2 and CO2 are important for *in vitro* embryo production (IVEP) technology, much importance is not given to the O2 concentration unlike CO2 concentration during IVEP. Sex ratio of the embryos produced at 5 % O2 (uterine concentration) and 20 % O2 (atmospheric concentration) was compared. It was observed that majority of the embryos at cleavage stage in both the O2 concentrations were biased towards a particular sex. Further study is going on to find out the sex ratio of transferrable embryos at different O2 concentrations.

Sheep embryos produced *in vitro* were found biased towards a particular sex. Manipulation of oxidative status of culture medium may alter the sex ratio of transferable *in vitro* produced embryos.

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, NM Soren and RK Veeranna

The gastrointestinal epithelium contains specialized cells, which regulate chemosensing of lipids by enteroendocrine cells and G-protein coupled receptors of fatty acids (GPCRs), serving as a control of the intestinal content and facilitates the fat digestion and absorption in ruminants. Gastrointestinal tract (GIT) is the first site of interaction of ingested nutrients with enteroendocrine cells of the host which distinctively sense the ingested nutrients and initiates feedback systems that could control feed intake and absorption to sustain metabolic homeostasis. The gut nutrient chemosensing is accomplished by these cells via activation of cell membrane GPCRs, which trigger intracellular signalling pathways and ultimately result in the release of hormones. Therefore, the investigation on chemosensing of fatty acids in GIT by G-protein coupled receptors and gut hormones may provide a prospect to understand the ways of augmenting dietary energetic efficiency in ruminants, providing greater flexibility in feeding management. Further, the findings from the study may also extend the application of lipid metabolism manipulation strategies in livestock production. With this background, the study is being carried out with the following objectives: 1) to study the chemosensing of fat digestion and absorption by the level of gut hormones of enteroendocrine system of sheep; 2) to identify the expression patterns of different gastrointestinal tract G-protein-coupled receptors of free fatty acids in sheep and; 3) to establish the relationship between G-protein coupled receptors and gut hormones in chemosensing of fat digestion, absorption and energy homeostasis in sheep.

Epithelial tissue of rumen, abomasum, duodenum, jejunum, ileum, colon and caecum of sheep were collected immediately after slaughter. The collected tissue samples were snap-frozen in liquid nitrogen and stored at –80°C until total RNA isolation. Total RNA was extracted from the collected epithelial tissues of gastrointestinal tract (GIT) by using RNA purification kit and the RNA quality and quantity were determined. Subsequently, the extracted total RNA was reverse transcribed to cDNA and the prepared cDNA samples were stored at –80°C until quantitative real-time PCR analysis of G-protein coupled receptor (GPR120). The primers for GPR120 (F: 5'-GCCCAGTATTGGCGGAGAAA-3', R: 5'- GCCCAGTATTGGCGGAGAAA-3'; amplicon 120 bp) was designed by NCBI primer blast using the predicted GPR120 gene sequences specific to *Ovis aries* (GenBank XM_012102571.2).

Quantitative real-time PCR was performed using SYBR Green PCR Master Mix. Primer pairs of GPR120 were used for quantitative real-time PCR analysis and quantification of the PCR products of the GPR120 gene were evaluated in comparison with the PCR products of GAPDH. Further, immunohistochemistry was carried out to confirm GPR120 (Fig. 11) in the segments of GIT. The antigen-antibody reaction was visualized

by 3,3'-diaminobenzidine staining and the slides were observed using a light microscope. The results indicated that GPR120 was expressed in all the collected tissue samples.

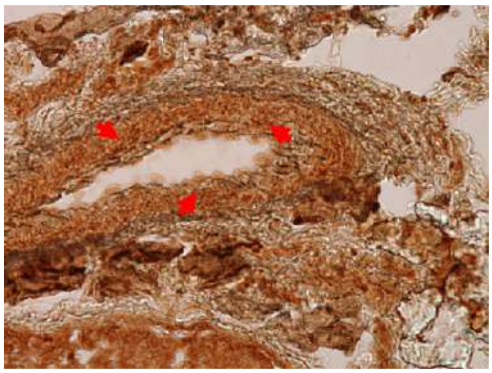


Fig. 11: Immunohistochemistry analysis for detecting the G-protein coupled receptor 120 (GPR120, red arrow) in sheep duodenum. Magnification: 20X.

G-protein coupled receptor 120 was characterized in various segments of digestive tract of sheep and confirmed by immunohistochemistry analysis.

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

M Bagath, V Sejian, D Rajendran and G Krishnan

Critical implication of nutrients on the immune system is an important adoption of animal during the scarcity period as well as during the high production periods. Animals with insufficient body reserves might compromise their immune system in long run during the deficiency conditions. Animal body reserve provides energy requirement by mobilizing the fat reserves from the body, which in turn help the affected immune system during the lean periods. Similarly, the protein requirement plays a vital role in the synthesis and function of the immune system in animal's life. Protein or the amino acids support the synthesis of T-cell- and B-cell-mediated immunity, immunoglobulins and they are catabolized for energy production. Impairment in the protein availability affects the immunoglobulin production and cell-mediated immunity. In animals, negligible reports are available currently on the impact of different proportion of energy, protein or their combination in relation to immune system.

The current project has been designed to understand the impact of protein, energy or their combination on the immune system and to comprehend how the regulations of the immune system related genes are affected by these factors. Such information will pave the way for better understanding of the immune regulation. The activities of the project have been initiated and 40 healthy 8-10 months old female Salem Black goats were procured (Fig. 12) for experimentations. The animals are currently under the acclimatization period

Fig. 12: Salem Black goats under experimentation.

The project has been initiated to understand the impact of protein, energy or their combination on the immune system and to comprehend how the regulations of the immune system related genes are affected by these factors.

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 and M Sridhar

Production cycle induces certain level of stress in animals including poultry. The balance between production of oxidants and the antioxidant defence is pivotal to achieve improved and sustained production of animal produce such as meat and eggs. The efficient use of feed nutrients is therefore primary in these production cycles. Mitochondrial conversion of energy as NADH and FADH to ATP is an important contributor to energy supply accounting for 20 to 30 % of resting energy requirements. Feeding high energy diets have a negative effect on the structural and membrane homeostasis, thereby affecting mitochondrial functions. Therefore, changes in the mitochondrial efficiency have large impact on energetic and feed efficiency. Our earlier work indicates that feeding layer hens with 1 % garlic (a rich source of organosulphur compound allicin) enhances the productive potential of the birds well through 90 weeks of age and the plasma uric acid level increases in these birds. Uric acid is suggested to be the most important factor in the amelioration of oxidative stress in birds. This project is undertaken to undertsand how cumulative effect of oxidative stress and age related changes in the mitochondrial function impacts production performance in egg type chicken and, to establish the role of uric acid in combating mitochondrial ROS production. Under the project, feeding studies have been initiated in layer hens using garlic (1 %) and allicin (0.5 %) and is in progress.

The project is undertaken to understand the role of uric acid in alleviating oxidative stress induced mitochondrial dysfunction during different production cycles in poultry. Feeding studies have been initiated in layer hens using garlic and allicin.

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

DT Pal, NKS Gowda and D Rajendran

The advantages of using chelated minerals for animal feeding are higher bioavailability, less interactions with other minerals and nutrients, enhanced immunity and anti-oxidant status in animals and positive impact on environment due to higher absorption and lower excretion of minerals. The present project has been taken up to study the carnitine chelated minerals for improving the bioavailability and tissue level utilization of trace minerals and tissue content of carnitine and to determine the energy status, milk yield and composition in dairy cows on supplementing metal carnitine chelates during early lactation.

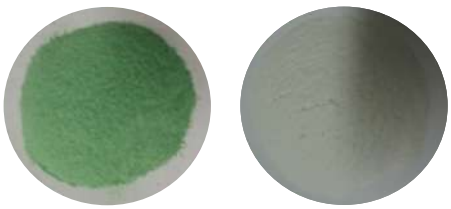


Fig. 13: Cu-carnitine (A) and Zn-carnitine (B) chelates prepared in the laboratory.

Cu-carnitine and Zn-carnitine were prepared in the laboratory using Cu and Zn metals in a particular molar

ratio and specific condition (Fig. 13). The prepared products were evaluated for solubility test of abomasums and intestinal pH conditions. The Cu and Zn content in the above products were determined by analysing in ICP-OES. Cu-carnitine chelate contained 50000 ppm of Cu and Zn-carnitine chelate contained 160000 ppm of Zn. Both the Cu- and Zn-carnitine chelate products were completely soluble in both acid and alkaline pH solution.

Cu-carnitine and Zn-carnitine were prepared in the laboratory using Cu and Zn metals in a particular molar ratio and specific condition. The products were found to be completely soluble in both acid and alkaline pH solution.

APR 3.20: Evaluation of grain sprouts as fodder for livestock

NKS Gowda, S Anandan, K Giridhar and NM Soren

Green fodder deficit is a very common problem in villages, especially during the summer months, affecting the livestock production. In recent years, hydroponic units for production of green fodder are being established in different states of the India. These units have problems like high cost and risk of mold growth. This project is taken up to evaluate the grain sprouts as fodder source for livestock. A modified hydroponic way to produce mold-free sprouts on local crop residue bedding was tested (Fig. 14). Good quality maize grains were cleaned with water and soaked in a bucket of water for a day. Later, these grains were removed from the bucket and kept tightly packed in wet cloth for about 36 h in a dark place to ensure rapid germination. Germinated grains were taken out of the cloth and placed in 4 % vinegar solution for about 30 minutes to prevent the mold growth. Later, these grains were transferred on to half inch thick straw beds made with paddy straw and placed in plastic trays with fine holes at the bottom and on sides. The trays were housed in a shelf, made with locally available bamboo poles for corner support, and split bamboo sticks for racks. The expenditure for making the shelf with 4 racks secured on all sides with PVC coated galvanized iron was 3000. Germinated grains were placed on straw beds and water was sprayed 4 times a day. The grains were grown in sun light for 6 days till the seedlings attained a height of 5 inches. The thick mat of grain sprouts along with straw bed was relished by the livestock.

The crude protein content of maize sprouts was 12.80 % as compared to 9.10 % in the grains. Approximately 8 lit of water were needed to obtain 3.95 kg of wet sprouts from 1 kg of maize grains in the modified hydroponic method of sprouts production. The cost of production was approximately 4 /kg of wet sprouts of maize.

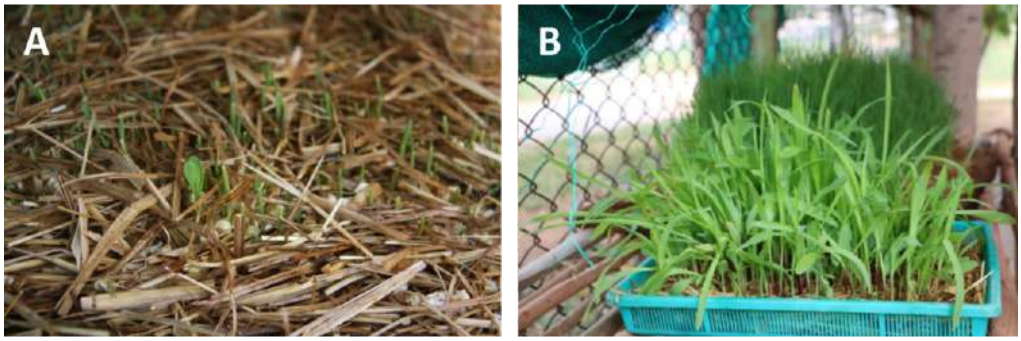


Fig. 14: Germinating maize grains on straw bed (A). Maize sprouts ready for feeding (B).

A modified hydroponic way to produce mold-free sprouts on local crop residue bedding has been developed. Approximately 8 lit of water are required to obtain 3.95 kg of wet sprouts from 1 kg of maize grains. The cost of production is approximately 4 /kg of wet sprouts of maize.

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

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

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 had been found to occur between day-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. 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 the maternal recognition of pregnancy. Impaired progesteron secretion from corpus luteum (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 like lipopolysaccharide, TNFα, hormones (oxytocin, estrogen and progesterone) and FGF2 alter the prostaglandin and progesterone biosynthesis by CL through 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. Keeping this in view, the present project has been initiated to delineate the effect of oxytocin and LPS on prostaglandin production and embryo survivability in sheep.

Project has been initiated to understand the effect of oxytocin and LPS on prostaglandin production and embryo survivability in sheep.

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

S Anandan, NM Soren, T Chandrappa and VB Awachat

Growing demand for meat and the sub optimal performance of sheep under field conditions provide the ideal background for improving the performance of sheep through better breed, feeding and management. The project aims at developing appropriate feeding modules for different stages of growth to maximize the meat production potential.

Towards achieving this objective, weaned lambs of Avishaan breed (with high prolificacy and better potential for meat production) were procured from ICAR-CSWRI, Avikananagr (Fig. 15). Eighteen animals comprising of four males and fourteen females were randomly divided into two equal groups and were fed intensively on high concentrates (70 % of the diet) and para grass hay (30 % of the diet) at 4 % of dry matter intake to achieved 150 g daily gain. Control group was devoid of bypass fat, while treatment group had 5 % of bypass fat to achieve higher energy density. Growth performance of the lambs in either group indicated that dietary treatments did not have any significant effect on the average daily gain (Table 2). Nevertheless, the treatment group having bypass fat had marginally better performance. Wool yield did not differ significantly as well between the groups.

Fig. 15: Weaned lambs of Avishaan breed procured from ICAR-CSWRI, Avikananagr.

Irrespective of the treatments, males (171 g/day) tended to have significantly ($p < 0.05$) higher ADG than the females (128 g/day).

Table 2: Performances of Avishaan breed.

Parameters	Control	Treatment	Significance
Weight gain (kg)	9.89	11.1	NS
Average daily gain (g)	116	130	NS
Wool yield (g)	787	782	NS

Efforts are being made to develop appropriate feeding modules for different stages of growth to maximize the meat production potential. Weaned lambs of Avishaan breed were fed high concentrates and para grass hay based diet without or with bypass fat. Higher ADG observed in male Avishaan lambs during the post weaning. Although not significant, marginally better ADG was observed with bypass fat supplementation

AICRP Project: Nutritional and physiological interventions for enhancing reproductive performance in animals

Coordinator: R Bhatta

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

Reduced fertility is a serious concern in animals. Some of the approaches like, nutritional supplementation, heat/ovsynch treatments, improving quality of semen etc. might help to improve fertility under Indian conditions. This AICRP project, coordinated by the ICAR-NIANP, has been designed with 12 centres throughout India to assess the extent of infertility conditions and possible interventions through nutritional and physiological means to improve fertility.

This project has been designed to meet the following objectives: 1) documentation of current status/extent of infertility; 2) ameliorative measures for overcoming infertility conditions and; 3) to validate ameliorative measures/technologies and to develop package of practices for application under field conditions for overcoming reproductive problems. Salient findings of the project are given below.

Bull fertility marker study revealed that in sperm, the proteins involved in glycolytic process and ATP biosynthetic process were associated with high semen quality, whereas, the proteins associated with hexose catabolic process and purine nucleotide binding were involved in low semen quality.

Validation of effects of IGF-1 addition in semen extender has been conducted at BAIF and CIRB, and found to improve semen quality during cryopreservation.

Out of the total 124 dairy cows used for estrus synchronization study, 113 animals responded positively to synchronization protocol.

A total of 20 crossbred dairy cows were used in the special nutritional supplementation study comprising cows with low milk fat (< 3.2 %, N = 10), post partum anestrus (N = 7) and repeat breeding (N = 3) problems. After supplementing the special nutritional supplement, seven cows responded positively for increasing milk fat (> 3.60 %), five cows exhibited estrus symptoms and three cows conceived. There was a net positive response of 70 % due to feeding of special nutritional supplement to dairy cows under field conditions.

Boron supplementation (40 ppm) significantly improved the sperm concentration, motility and seminal plasma calcium level in bucks and it also enhanced antioxidant status as indicated by the glutathione reductase level.

Bull fertility markers identified that can be used to select the bull for higher semen quality. Estrus synchronization protocols were found effective in improving conception rate. Supplementing special nutrient supplement improved milk quality and reproductive efficiency. Boron supplementation indicated encouraging results in improving semen quality in bucks.

DBT Project: Organic zinc and copper supplementation on advancing puberty, spermatozoal transcription expression profile and fertility in goat

A Arangasamy, IJ Reddy, S Selvaraju, NM Soren and JP Ravindra

Attainment of puberty in small ruminants depends on age, body weight, nutritional status, genetics and environmental conditions. Organic minerals have been found to be more efficiently utilized in the body due to increased bioavailability and a better absorption rate, and organic minerals have been suggested to improve semen production, sperm motility and male fertility. In this regard, the present study was undertaken with the following objectives: 1) to assess the influence of organic trace mineral (Zn and Cu) enriched diet on early onset of puberty, sexual maturity and circulating hormonal levels and trace minerals; 2) to evaluate the relationship between trace mineral and seminal characters, sperm quality via *in vitro* fertility test, CASA analysis and freezability of buck semen and; 3) to evaluate the effect of altered nutrition on changes in sperm transcriptomic pattern.

Pre-pubertal supplementation of organic Cu and Zn advanced the puberty by 28-35 days in indigenous bucks as compared to control group. The testosterone concentration was higher in mineral treated groups especially with Cu supplementation ($p < 0.05$). Mineral supplementation protected the qualitative (higher sperm motility, plasma membrane and acrosome integrity) and quantitative (volume and sperm concentration) characteristics of semen. Supplementation of organic zinc and copper to growing male goats responded well in protecting the sperm cells against cold shock during cooling cum equilibration and cryopreservation and, maintained significant level of semen parameters (sperm motility, liveability (Fig. 16), plasma membrane and acrosome integrity) along with a reduced level of oxidative stress in both pre freeze and post-thawed semen as indicated by the reduced LPO in plasma and spermatozoa and, increased seminal and blood plasma SOD, CAT, GPx and GR activities.

A protocol was also standardized for semen cooling rate, which proved to be superior to other available protocols for buck semen cryopreservation in this study. The mineral treatment enhanced the *in vitro* fertilizing capacity (Fig. 17). A significantly higher level of binding of the sperm to the zona pellucida and cleavage rate were observed in groups supplemented with mineral, which varied in a dose dependent manner. The expression of the genes ZCCHC6, SOD, GPx4, CAT and MTF1 were found significantly higher in sperm cells and that of IGF1, CAT, SOD, NFE2L2 and GPx4 in blood following supplementation of minerals. 2D gel electrophoresis showed significant differences in the protein profile of semen following supplementation Cu and Zn either alone or in combination. Better results were obtained with supplementation of organic Cu than Zn and combination of Zn and Cu.

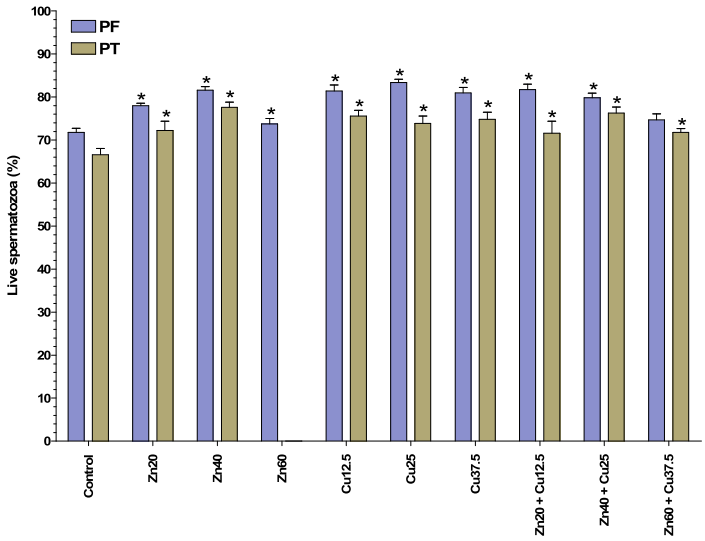


Fig. 16: Percentage of live spermatozoa during pre freeze (PF) and post thaw (PT) stages. The percentage of live spermatozoa at pre freeze stage was significantly ($p < 0.01$) higher in all supplemented groups except Zn60 + Cu37.5 as compared to control groups. The live spermatozoa percentage at post thaw stage was significantly ($p < 0.01$) higher in all supplemented groups as compared to control groups. A complete loss of viability in the Zn60 semen samples was observed following cryopreservation.

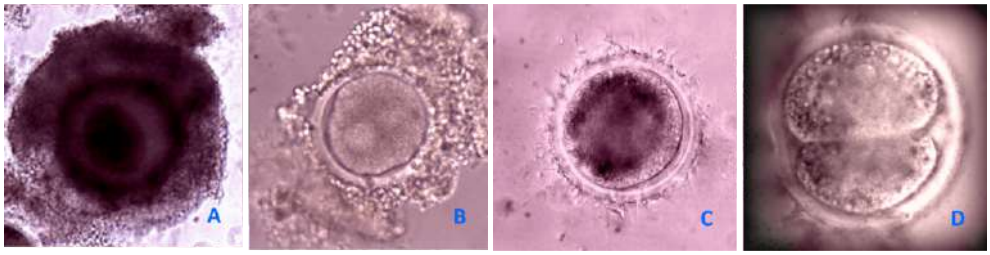


Fig. 17: Phase contrast micrographs (×400) showing immature cumulus-oocyte complex (A), cumulus-oocyte complex exhibiting cumulus expansion at 27 h of *in vitro* maturation (B), spermatozoa bound to the zona pellucida of a matured oocyte (C) and a 2-cell embryo (D) in goat.

The pre-pubertal supplementation of organic Cu and Zn advanced the puberty by 28-35 days in indigenous bucks and the quantitative and qualitative characteristics of semen improved at fresh, pre-freeze and post thaw stages, improved the antioxidant defense mechanism and resulted in significantly higher expression of selected genes in sperm cells and blood samples of treated bucks. Organic Cu supplementation was found to be better than the Zn and/or combination of Zn and Cu.

DBT project: Wnt signal mediated ovarian granulosa cell estrogen synthesis in ruminants

PSP Gupta, S Nandi, S Mondal and DT Pal

Wnt signalling has been shown to stimulate the estradiol synthesis and granulosa cell proliferation using canonical pathway. The positive role of Wnt signal in estradiol synthesis of murine granulose cells has been well established. The present research project was taken up to explore the role of Wnt signal in the ovarian granulosa cell estradiol synthesis in ruminants (buffalo/ goat) with the objectives to investigate the role of Wnt signal in FSH mediated ovarian granulosa cell estradiol synthesis in the various size categories of

follicles of ruminants, FSH mediated ovarian granulosa cell estradiol synthesis in the pre-antral follicles of ruminants and non-FSH mediated ovarian granulosa cell estradiol synthesis in ruminants.

Role of Wnt signalling was studied in buffalo and goat. Ovarian granulosa cells were collected from different sized categories of follicles from the abattoir derived ovaries. The cells were *in vitro* cultured to study the effect of Wnt inhibitor (IWR) on estradiol synthesis and expression of genes related to estradiol synthesis (CYP19A1), granulosa cell proliferation (CCND2) and Wnt signalling pathway (WNT2, WNT4, FZD6, DVL1, CTNNB1, APC, AXIN2). Role of Wnt signalling in early folliculogenesis was studied by observing the effect of IWR on pre-antral follicles of goat and buffalo. Pioneering studies were conducted to explore the role of Wnt signal in Non FSH mediated estradiol synthesis in buffalo again by employing IWR. Ovarian granulosa cells were *in vitro* cultured in the absence of FSH and in presence/absence of IWR and Insulin. They were cultured in the presence of either IWR or Insulin or in combination of both. Role of Wnt signalling pathway in non-FSH mediated estradiol synthesis was studied by observing the gene expression of above mentioned genes in addition to PKA-R, PKA-C, CSKN1 and BCL2.

For the first time, we established the stimulatory role of Wnt signal in estradiol synthesis in goats and buffalo. Pioneering studies were made on the role of Wnt signal in the non-FSH mediated estradiol synthesis. Inhibitor of Wnt response (IWR) was used to study the role of Wnt signal in estradiol synthesis (Fig. 18). Estradiol synthesis pathways with special reference to Wnt signalling pathways were studied through the gene expression studies of the proteins involved in the pathways. Though there was no significant inhibition of estradiol production by IWR in ovarian granulosa cells or pre-antral follicles, based on gene expression studies it was noted that there was a positive effect of WNT canonical signalling pathway on estradiol synthesis in both medium and large sized ovarian follicles in buffalo. The results indicate that WNT signal has a positive role in FSH mediated estradiol synthesis during early as well as late folliculogenesis in buffalo/ goat. Studies conducted on the non-FSH mediated estradiol synthesis in buffalo indicated that Wnt signal may not have a significant role in the non FSH mediated estradiol synthesis in the presence of insulin.

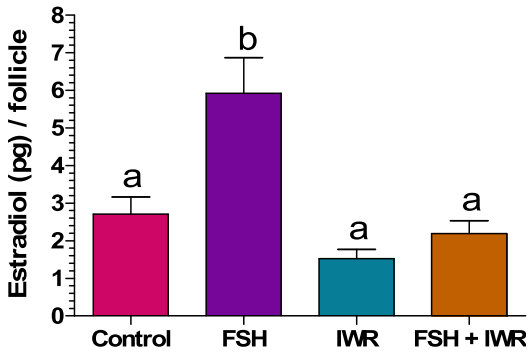


Fig. 18: Effect of IWR mediated inhibition of WNT signalling on estradiol synthesis in goat pre-antral follicles. Groups with common superscript did not differ significantly ($p < 0.05$)

Wnt signal has a positive role in ovarian granulosa cell estradiol synthesis in buffalo, though it is not as pronounced as in cattle. Wnt signalling pathway is involved even in the early folliculogenesis in buffalo and goat. However, Wnt signal may not have a discern role in the non FSH mediated estradiol synthesis in buffalo.

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

A Arangasamy and BK Binsila

In livestock industry pre-selection of sex is important from the economic and social point of view, as female calves are preferred for milk production and male offspring are desired for beef production. Sex-selection to suit the farmers need is not only of economic importance, but also will enable selective breeding to improve

the genetic potential. 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-sperm to result in a likelihood of a female or male offspring. In this study, we targeted the sperm cell surface proteins (SAM proteins) to identify novel candidate proteins. The specificity of the identified SAM proteins localized on the sperm will be checked between X and Y bearing spermatozoa. Such novel proteins will be used for developing aptamer to isolate sex specific spermatozoa.

The quality of the frozen thawed sorted and unsorted HF bull semen samples were analyzed using computer assisted semen analyzer (CASA) following standard procedures, live and dead by eosin and nigrosine staining, acrosome and functional membrane integrity by hyposomotic swelling and giemsa test. The membrane proteins were isolated using a detergent (Triton-X-100) and protein concentration was quantified by bicinchoninic acid assay. The isolated proteins were acetone precipitated and used for 2-Dimensional electrophoresis followed by silver staining. The unique and differentially expressed spots between the sorted and unsorted HF semen were analyzed using Dymension software. The concentration of the sperm cells was approximately 20 million cells/ 0.25 ml straw in case of unsorted semen and live spermatozoa proportion was 77 %. The concentration of sexed semen was found to be approximately 2.5 million cells/ 0.25 ml straw with 52 % live spermatozoa. The protein expression profiles between the groups (unsorted and sorted) were compared (Fig. 19). Seven protein spots were found to be up regulated in the unsorted semen as compared to the sexed (X) semen. A total of 135 protein spots in the unsorted semen, 103 protein spots in the sexed (X) semen and 55 common protein spots in both the groups were noticed.

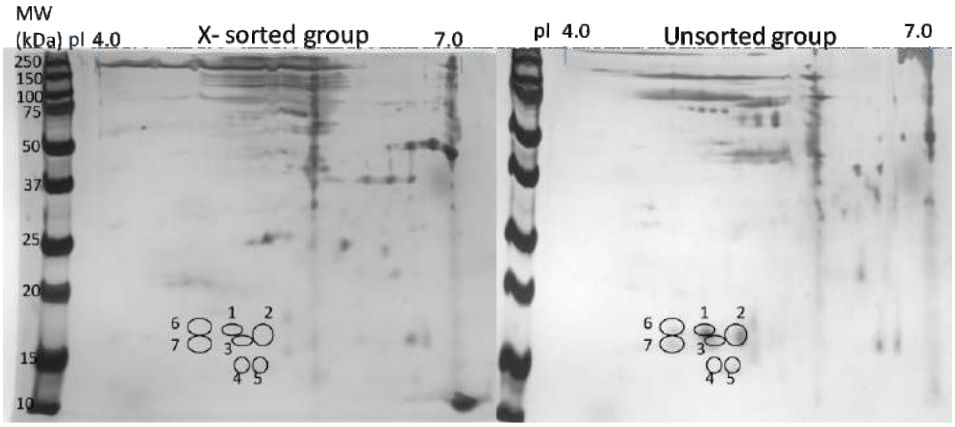


Fig. 19: Differential protein spots expressed between the HF Bull unsorted and sexed (X) spermatozoa.

The sperm membrane proteins were isolated from the unsorted and sorted semen of HF bulls. The protein expression profiles of the two groups (unsorted and sorted) were compared. Seven protein spots were found to be up regulated in the unsorted semen as compared to the sexed (X) semen.

DBT Project: Transcript profiling and functional significance of molecular determinants of follicular and oocyte competence under metabolic stress

S Nandi, PSP Gupta and S Mondal

The metabolic stressors concentration was determined in ovine serum, ovarian follicular fluid, uterine and oviductal fluid and urine samples. Estimation of plasma concentrations of TSH, T3, T4, IGF-I and Insulin in normal and metabolic stressed ewes was done. Metabolic changes were mimicked in preantral follicle (PF) and IVM ovine model was set up to study the effects on the quality of the preantral follicle, oocyte and of the

resulting embryo. Ovarian follicles growth even at their earlier stage was compromised by changes in the metabolic status of the animals. The effect of metabolic stress on granulosa cell growth and metabolic hormone profile were also determined. The oocyte morphology, its fertilizing ability and granulosa cell functions in ewe (obese, normal, metabolic stressed and emaciated) models were investigated. The quantitative expression of growth, metabolism and apoptosis related genes in the preantral follicles, oocytes and embryos were investigated separately during the *in vivo* development and such expressions were compared at corresponding stages of development of the cultured follicles, follicles and embryos in sheep. The incidence of apoptosis, lipid peroxidation and oxidative DNA damage in oocyte-cumulus complexes exposed with metabolic stressors were studied. Oocytes markers (Cathepsins and lysyl oxidase-LOX) were examined for their efficacy in metabolic stress scenario. The results suggest that β-hydroxybutyrate, total NEFA, ammonia and urea in serum, follicular, uterine and oviduct fluid and urine samples can be considered as biomarkers of metabolic stressed ewes. Significant decrease in TSH, T3, T4, IGF-I and insulin was recorded in metabolic stressed ewes. Oocyte morphology and fertilizing capacity were found to be dependent on body status and feeding status of the animals. The cleavage and blastocyst production rates were different for the various body condition classifications and when ranked were: normal > obese > metabolically stressed > emaciated. Ammonia, urea, NEFA and BHB were found to cause inhibition of survival and growth of in vitro cultured ovine PFs and enclosed oocytes at the levels of 300 mM, 8 mM, high combo level of NEFA and 0.75 mM respectively. The maturation, cleavage and morulae/ blastocyst production rates were significantly lowered in media containing 200 µM ammonia, 5 mM urea, high combo NEFA and 1 µM BHB. Apoptosis, lipid peroxidation and oxidative DNA damage in preantral follicles and oocytes increased with increased dose in the order ammonia > NEFA > β-OHB > urea. Elevated concentration of metabolic stressors significantly upregulated the expression of *de novo* DNA methyl transferase gene (Dnmt3) along with differences in global cytosine methylation level. A significant increase in relative mRNA abundance of the elevated metabolic stressors treated oocytes and embryos was found for the Bax, Dnmt1, Dnmt3a and Dnmt3b genes and down regulation in IGF-I, EGF and FSHR genes. Our results suggested that cumulus cell cathepsin mRNA abundance (Cathepsin B, Cathepsin K, Cathepsin S and Cathepsin Z) may be predictive of oocyte quality under metabolic stress. Cathepsin activities in metabolic stressed oocytes were in the order: Cathepsin B > cathepsin K > Cathepsin S > Cathepsin Z. We found that addition of cathepsin inhibitor (E-64, 1.5 µM) significantly decreased the activities of cathepsin and caspase3 activities and also improved both developmental competence and quality of the embryos. Lysyl oxidase (LOX) in IVM culture media was found to be associated with reduced apoptosis of COCs and could improve the developmental competence of metabolic stressed COCs during IVM. Metabolic stressed COCs showed significantly less activities of Lysyl oxidase (LOX) compared to normal COCs. Addition of Lysyl oxidase (LOX, 20 µg/ml) in oocyte culture medium was associated with reduced apoptosis of COCs and could improve the developmental competence of metabolic stressed COCs during IVM.

β-hydroxybutyrate, total NEFA, ammonia and urea in serum, follicular, uterine and oviduct fluid and urine samples can be considered as biomarkers of metabolic stressed ewes. Significant decrease in TSH, T3, T4, IGF-I and insulin was recorded in metabolic stressed ewes. Elevated concentration of metabolic stressors inhibited the survival and growth of *in vitro* cultured ovine PFs and enclosed oocytes and, significantly upregulated the expression of *de novo* DNA methyl transferase gene (Dnmt3) along with differences in global cytosine methylation level.

DBT Project: Production of plant sourced mannan oligosaccharides for improving the productivity of freshwater aquaculture

AK Samanta, M Sridhar and AP Kolte

Prebiotics are class of short chain oligosaccharides that manipulates the gastrointestinal microflora of higher vertebrates towards beneficial direction in addition to improvement of several physiological functionalities. Therefore, the usages of prebiotics has been regarded as an alternative viable therapy in aquaculture, appearing as promising biological control strategy and becoming as an integral part of the aquaculture practices for improving growth and disease resistance. It also offers several advantages to overcome the limitations and side effects of antibiotics and other medicines leading to higher production. In the list of prebiotics, mannan oligosaccharides (MOS) are one that addresses both consumer concerns and environmental issues. Keeping in mind the above perspectives, the current research proposal is working with the objectives: 1) to evaluate the efficacy of mannan oligosaccharides (MOS) in promoting fish health and productivity in freshwater aquaculture; 2) to fractionate mannan from guar seed for production of mannan oligosaccharides (MOS) and; 3) to elucidate the therapeutic value of MOS in peninsular freshwater fishes.

Guar (*Cyamopsis tetragonoloba*) seed were subjected to mannan extraction by magnetic stirring (24 h) in the presence of water with a solid to liquid ratio 1:16. After solubilisation, the content was filtered by muslin cloth and volume was measured. Three volumes of ice cold rectified spirit were added to this for precipitating the mannan. It was dried in forced hot air oven at a temperature of 60 ^{0}C till constant weight. The yield of mannan was calculated and it ranged from 38 to 40 % of the original content and was found to be free from reducing sugars. Fourier Transform Infrared Spectroscopic (FTIR) analysis revealed the true nature of mannan (Fig. 20).

The water extracted mannan (~200 mg) was hydrolyzed with 10 ml of 0.25 M sulfuric acid in shaking water bath maintained at 60^{0}C. The hydrolysate was withdrawn at different time intervals to see the production of mannan oligosaccharides (MOS). Colorimetric analysis indicated reducing sugar production ranged from 0.07 to 0.27 mg/ml in the time intervals of 15 to 60 min. Further optimization of variables for MOS production is under progress.

Labeo Fimbriatus (average weight 49.7 ± 12.5 g) were maintained in 12 aerated FRP tanks. The basal diet consisted of fishmeal, soya, groundnut cake, rice bran, finger millet (binder) and vitamin- mineral mixture which served as the control. To the basal diet, commercial MOS was added at two levels of 0.5 and 1.0 %. After 90 days of experimental feeding, gut samples were collected for microflora analysis by next generation sequencing. Supplementation of MOS leads to increase in the gut microbial population of Verrucomicrobiae, Rhodobacteraceae, Gammaproteobacteria, followed by reduction in the population of Fusobacteriaceae. While comparing between control and 0.5 % MOS supplementation, 27 were found unique to the MOS supplementation out of 55 bacterial phylotypes. Between 1 % MOS supplementation and control, 28 were found unique to the MOS supplementation out of 71 bacterial phylotypes.

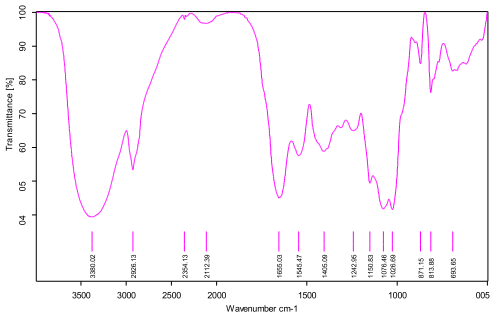


Fig. 20: FTIR analysis of water extracted mannan

It was possible to extract the mannan from guar seed following stirring for 24 h with water and it was free from reducing sugars. Next generation sequencing analysis of the fish gut samples indicated selective manipulation of gut bacteria owing to the MOS supplementation in *Labeo fimbriatus*.

Indo-Hungary Collaborative Project (DST): 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 and S Mondal

Cryopreservation/ vitrification of pre-antral follicle technology has applications both in animal sciences and human medicine for the conservation of animals and for creating hope for the women affected with ovarian cancer to have children at later date after their cure from cancer. Hence the project was taken up with the following objectives: 1) to study the effect of vitrification on the survival rate of oocytes in pre-antral follicles of sheep; 2) to study the addition of anti-oxidants and cytoskeleton stabilizing substances to vitrification medium on the survival rates of oocytes retrieved from the vitrified pre-antral follicles of sheep and; 3) to study the addition of anti-oxidants and cytoskeleton stabilizing substances to vitrification medium on the genomic changes with special reference to apoptosis and developmental competence of oocytes in the pre-antral follicles of sheep.

Three types of vitrification protocols were tested for their effect on the vitality of ovine oocytes in pre-antral follicles (PFs). First two protocols A and B had common method except the change in the composition of vitrifcation and thawing media. Base Medium was TCM-199 supplemented with FBS (20 %), gentamycin (50 µg/ml) and HEPES (25 mM). Vitrification medium (in base medium) I: for Protocol A: EG (10 %), DMSO (10 %), sucrose (0.3 M); for Protocol B: EG (7.5 %), DMSO (7.5 %). Vitrification medium (in base medium) II: for Protocol A: EG (25 %), DMSO (25 %), sucrose (0.3 M); for Protocol B: EG (15 %), DMSO (15 %), surcrose (0.5 M). Thawing medium (in base medium) I: for Protocol A: sucrose (0.3 M); for Protocol B: sucrose (0.5 M). Thawing medium (in base medium) II: for Protocol A: sucrose (0.15 M); for Protocol B: sucrose (0.25 M). Thawing medium (in base medium) III: for Protocol A: sucrose (0.075 M); for Protocol B: sucrose (0.125 M). Third protocol employed the usage of glycerol in place of DMSO. The mean percentage of live oocytes after vitrification of ovine pre-antral follicles was > 73 %. There was no significant difference in the post thaw survival rates of oocytes in the vitrified PFs among the three media. However, highest survival rate of 79 % was obtained with the vitrification protocol A (Fig. 21). Gene expression studies pertaining to apoptosis and steroidogenesis in both the fresh and vitrified PFs were conducted (BCL2, caspase3, Oct4, GDF9 and STAR). In addition, studies were also conducted on the effect of vitrification in the gene expression related to apoptosis and oocytes growth factors (ANNEXIN, BAD, BCL-2L1, BMP15, CASP-3, GDF9, Oct4, ATM). Exchange visit to Hungary was made by two scientists from Indian Side.

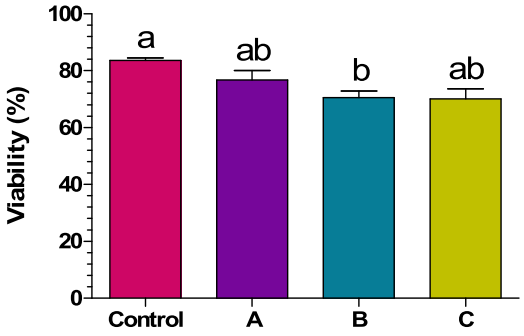


Fig. 21: Effect of three different vitrification media (A, B and C) on survival rates (%) of oocytes in pre-antral follicles of sheep.

Vitrification protocols were standardized for the ovine pre-antral follicles. There was no significant difference in the post thaw survival rates of oocytes in the pre-antral follicles among the three protocols.

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

S Selvaraju

Reduced fertility is a serious problem in Indian dairy animals. The low fertility in dairy animals is attributed to male, female and managemental factors. Recent studies suggested that approximately 20 % of the bulls are sub-fertile and may majorly account for low fertility in dairy cows. Since one bull produces semen which can approximately inseminate 3 lakhs cows, selection of superior quality fertile bulls are important for augmenting fertility in dairy cows. Though various functional tests for assessing semen quality have been developed, none of them are accurate in predicting fertility of the semen and ultimately the bull fertility. Molecular biological approaches through 'Omics' technologies are employed to identify signature molecules for predicting bull fertility accurately. In this regard, the current project is aimed to develop fertility diagnostic chip based on transcriptomic profiling approach with the following objectives: 1) to correlate sperm transcripts signatures with sperm function and bull phenotype and fertility and; 2) to develop bull fertility chip for selection of superior bulls for artificial insemination programme.

The standardization of bioinformatics workflow is essential for sperm RNA profiling as the sperm RNAs are biologically fragmented and shorter in read length. In this regard, the already available data on cattle were used to standardize the bioinformatic workflow. The analysis revealed that for trimming of reads of spermatozoal RNA seq data, Cutadapt was better than Trimmomatic for the shorter fragments of sperm mRNA samples. Further HISAT mapping algorithm was efficient as compared to BWA and Bowtie2 for better mapping percentage of the reads to the genome. Differential gene expression was studied with Cuffdiff to measure the fold change of the genes (Fig. 22). The preliminary study revealed that genes from a few chromosomes are rich with a high transcriptomic activity in spermatozoa. The sites of expression of these transcripts were found to be in testis ($p < 1.085E-08$), epididymis ($p < 1.385E-07$) and fallopian tubes ($p < 1.759E-06$).

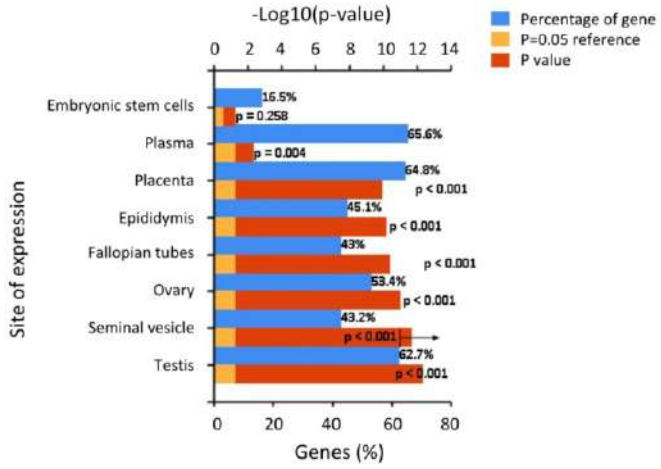


Fig. 22: The site of expression of spermatozoal transcripts.

Cutadapt was found to be better than trimmomatic for the shorter fragments of sperm mRNA samples and HISAT mapping algorithm was found efficient as compared to BWA and Bowtie2 with better mapping percentage of the reads to the genome. Genes from few chromosomes are rich with a high transcriptomic activity in spermatozoa and preliminary analysis indicated the presence of differentially expessed genes between high and low fertile animals.

Programme 4
Feed Informatics, Feed Quality and Safety and Value Addition

FQS 4.1: Real time estimation of livestock feed and fodder resources availability in India

RK Gorti, KP Suresh, K Giridhar and R Bhatta

Sixty percent of the livestock production cost is due to feed and fodder. Advance information regarding the availability of this crucial component of animal production will help in long term planning and sustaining the animal production. The two important components animal feed resources are feed requirements and feed resources. Animal feed requirements are estimated from the livestock population data. Accurate forecast of feed requirements depends upon the availability of data over a period of time and also in real time. Current system of livestock census is quinquennial. The entire process of collection, compiling and report peroration of livestock census is approximately 2 years. Therefore, the project was undertaken to reduce this time lag to a few months. This will enable real time forecasting the feed requirements. In addition, forecasting can also be done at micro level.

The objectives of the project were to use information technology to improve datacollection and compilation, estimate feed and fodder resources availability in terms of concentrates, green and dry fodder in all the mandals/taluks of India and to forecast the surplus or deficit at micro level in realtime to assist the planners and administrators.

As a part of the project, a website was designed on Java platform using HTML 5 standard. It's a clustered YSQL database solution, which can be extendable and configurable, to enable future modifications. The website can be used across platforms in PC or mobile. Date entry in respect of livestock or crops can be made village wise as well. If required, house hold wise livestock holding can also be collected. Website is currently hosted at Ashoka server of ICAR-IASRI, New Delhi (http://webtom.cabgrid.res.in/lcde/). The website was demonstrated to the ICAR officials at NASC complex, New Delhi, emphasizing its possible implementation through DAHDF, Govt of India.

A website has been designed for real time estimation of livestock feed and fodder resources availability in India. It has also been demonstrated to the ICAR officials emphasizing its possible implementation through DAHDF, Govt of India.

FQS 4.2: Development of a universal inoculum/s for production of quality silage

M Sridhar, AV Elangovan, S Senani, AK Samanta, RK Gorti and G Maya

The performance and growth of livestock depends on the availability of quality fodder throughout the year. Because of ever growing human need for food, only limited cultivated land can be allocated to fodder production. Further, low yield of fodder per acre and fodder scarcity periods aggravate the situation. Manipulating surplus fodder during the periods of abundance can bridge the gap during scarcity periods especially for high yielding animals. Preservation of fodder crops by silage making can ensure regular supply throughout the year. Silage can provide uniform feed pattern to livestock throughout the year, which is necessary for growth of rumen microbes, a source of protein for animal growth and production. By economical silage feeding we can obtain maximum profit from our animals in terms of better growth and production. Although known to farmers, silage making is not popular because of one or more of the

following reasons: lack of know-how and finance; cumbersome and labour intensive; benefits are not commensurate with effort and time; lack of available feedstuffs of good quality; lack of a suitable, effective and efficient inoculum. The major objectives of the project are to formulate an ideal microbial inoculum/s to boost up the fermentation process of silage within 2-3 days, to minimize loss of nutrients during the fermentation process, to reduce the number of days required for stabilization of silage and to provide a set of practical recommendations to farmers for the preparation of high quality silage from grasses, fodder crops and crop residues.

Fodder crops and grasses analyzed for their native microflora showed the presence of low counts of LAB in most of the cases. No significant variation was observed between 30 and 45 days of silaging of Rhodes grass, hybrid Napier, para grass and a combination of all. Four pure cultures (10 µl of 24 h active culture) of Lactic acid bacteria procured from MTCC, Chandigarh (C1: *Lactobacillus bulgaricus*, C2: *Lactobacillus helveticus*, C3: *Lactobcillus lactis* and C4: *Lactobacillus pentosus*) were co-cultured in 20 ml nutrient broth in different combinations, initial pH (blank) was noted and incubated at room temperature for different time intervals (24, 48 and 72 h). At the end of each incubation time, the pH of the broth culture was measured and quantification of organic acid was performed. In each of the 16 combinations of lactic acid bacteria, a decrease in pH was observed indicating acid production. At the end of 24 h incubation, pH varied from 5.94 to 6.0, but the titer value and the organic acid quantity did not vary substantially (Table 1). Interestingly, there was no increase in the production of acid with increase in time that attributed to the low media quantity.

Table1: Content of organic acid and pH in the 24, 48 and 72 h broth LAB cultures (incubated at room temperature).

Culture combinations	pH at end of Incubation period	Organic acid %		
		24 h	48 h	72 h
Blank	7.01	-	-	-
C1	5.99	3.6	3.6	3.6
C2	6.43	2.7	2.7	-
C3	5.96	3.6	3.6	3.6
C4	6.00	3.6	3.6	3.6
C1+C2	5.98	3.6	3.6	3.6
C1+C3	5.99	3.6	3.6	-
C1+C4	6.02	3.6	3.6	-
C2+C3	5.94	3.6	-	3.6
C2+C4	6.05	3.6	3.6	0.9
C3+C4	6.84	0.9	-	4.5
C1+C2+C3+C4	5.92	3.6	3.6	3.6
C1+C2+C3	5.94	4.5	-	-
C1+C2+C4	5.96	3.6	3.6	3.6
C2+C3+C4	5.98	3.6	3.6	3.6
C1+C3+C4	5.94	3.6	2.7	-

Chaffed maize fodder (2 to 2.5" length) was silaged in plastic containers in two phases. Cut-I was harvested at 60 days and Cut-II was harvested at 75 days (Fig. 1). Inoculum size, molasses, sucrose, glucose, lactose, urea, ammonia, lignin modifying enzymes (LME) mixture, ammonium dihydrogen phosphate, CM Cellulase and propionic acid were taken as the independent variables as per the Placket Barmun Design Matrix with variables in -1 and +1 levels (12 treatments in total). Evaluation of quality of maize silage based on physical appearance, nutritional aspects and lactic acid contents at both 15 days and 30 days is under progress.

Fig. 1: Maize fodder of Cut-I after 30 days (A) and Cut-II after 15 days (B) of silage making with various additives.

LAB was detected as major native microflora in fresh grasses and fodders. Inoculation with lactic acid bacteria caused a decrease in pH indicating acid production. There was no increase in production of acid with increase in time. Addition of microbial culture would help to enhance the silage quality.

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

RU Suganthi, J Ghosh and VB Awachat

Driven by population growth, rising incomes and urbanization, the demand for world's poultry meat, mainly chicken is projected to increase over the next 10 years. However, the use of antibiotics as growth promoters (AGPs) in feed has been criticized for the emergence of antibiotic resistance in pathogens and carryover of residues in poultry products intended for human consumption. Use of AGPs in livestock feed is currently banned in many countries. In the near future, the use of antibiotic growth promoters may prove impractical both at the health and economic front, necessitating research to find replacements for AGPs. Around the globe, plant and plant-derived substances are well accepted and few of them show positive impacts. Therefore, the present project was proposed to identify a novel phytogenic blend as a replacement to AGP in broiler production and a study was carried in an attempt to achieve the goal.

Day old broiler chicks were purchased from a commercial hatchery used for the study. Birds were divided into four treatments and fed with basal diet supplemented with feed grade antibiotic (chlortetracycline), basal diet without antibiotic or phytogenic blend and basal diet with 1 and 2 % phytogenic blend. The experiment was conducted for 42 days. The phytogenic blend was supplemented throughout the study period. Production parameters and mortality were recorded. At the end of study, birds representing each treatment were selected and slaughtered by cervical dislocation and blood, tissue and ileal digesta samples were collected. Carcass characteristics, apparent ileal nutrient digestibility, intestinal morphometry, blood biochemistry, haematology, caecal microbiota and meat proximate composition and meat quality parameters were determined. Supplementation of the 1 % phytogenic blend in broiler feed improved growth performance, serum protein and gut histomorphometry and, reduced drip loss in breast meat as compared to the antibiotic supplementation. Additional studies for evaluating and ascertaining the efficacy of the phytogenic blend as an alternative to AGPs under different management conditions are in progress.

Supplementation of the 1 % phytogenic blend in broiler feed improved growth performance, serum protein and gut histomorphometry and, reduced drip loss in breast meat as compared to the antibiotic supplementation. Therefore, the phytogenic blend can be used as a potential replacer to antibiotic growth promoters in broilers.

ICAR-Outreach Project: Monitoring of drug residues and environmental pollutants

KS Prasad, SBN Rao and DT Pal

The widespread use of pesticides in agricultural practices and ectoparasiticides in livestock and other environmental pollutants like heavy metals either directly or through soil, water and feeds are leading to the presence of these residues in edible products of animal origin such as milk, meat and eggs. These issues are very important with respect to consumers and international trade that relate to public health. In this context, monitoring of drug residues and environmental pollutants in livestock products for human consumption is becoming necessary. This centre is monitoring environmental pollutants in soil, water, feeds, fodders and animal products with the following objectives: 1) standardization of extraction and clean up for determination of pollutants in soil, feeds, fodders and animal products in selected areas and; 2) analysis of environmental pollutants in the above samples using modern and precision methods.

A total of 182 samples of soil, water, paddy straw, green fodder, concentrates pellets, oil cakes, rice bran, hair and milk samples were collected from four mandals covering eight 8 villages representing irrigated and dry areas of Guntur district. All water, paddy straw, green fodder, concentrate pellet, oil cakes, rice bran, hair and milk samples were extracted using QUEChERs kits and analysed in Gas Chromatography fitted with Electron Capture Detector. Standards used were γ-BHC, chlropyriphos, endosulphan-α and -β, o,p'-DDT, cypermethrin and deltamethrin. None of the samples was found positive for the above pesticides. It was observed that in the field, farmers are using new generation pesticides such as flubendiamide, novaluron, indoxacarb, monocrotophos, flonicamid, dinotefuron, profenophos and Imidacloprid. Detection of these pesticides have been out sourced and data compilation is in progress.

Except soil samples, all other samples were also analyzed for heavy metals such as arsenic, lead and cadmium using ICP-OES. The results indicated that among the 175 collected samples, 15 roughage, 2 water, 3 hair and 21 milk samples were positive for arsenic content. Similarly, 61 roughage, 35 concentrate, 3 water, 16 hair and 33 milk samples were positive lead content. Further, 61 roughage, 25 concentrate, 6 water, 14 hair and 39 milk samples were positive for cadmium content

Water, paddy straw, green fodder, concentrates pellets, oil cakes, rice bran, hair and milk samples were collected and analysed for γ-BHC, chlropyriphos, endosulphan-α and -β, o,p'-DDT, cypermethrin and deltamethrin. None of samples were found positive for above pesticides. Except soil, all other samples were analyzed for heavy metals (arsenic, lead and cadmium). Some of these samples were found positive for the content of the analyzed heavy metals.

ICAR-CRP Project: Biofortification of cereals -evaluation of value addition cereals (VAC) and cereal by products for animal feeding

KS Prasad, SBN Rao and NM Soren

Bio-fortification is the process by which the nutritional quality of food crops, which is deficient in one or more nutrients, is improved by using advanced agronomic practices, conventional plant breeding or modern biotechnology tools. The content of nutrients in cereal crops or its by-products varies considerably within varieties and from regions to regions. Bio-fortification can be one of the means to improve the critical nutrients that are required to enhance the productivity of livestock. In XII plan, under the leadership of ICAR-IIRR, systematic studies were planned to evaluate the value added cereals (VAC: rice, wheat, maize, sorghum, pearl millet and small millets) and their by-products developed by various Institutes. In this

context, ICAR-NIANP has been entrusted with the responsibility of quality evaluation of VAC and their by-products as compared to their conventional ones for livestock in terms of nutrient utilization. The objectives are to evaluate nutrient composition of VAC and to compare nutrient utilization of VAC with conventional cereals using in vitro/ in sacco study.

Grains, straws and brans of six promising wheat varieties (WB-2, DBW-39, DBW-88,WH-1105, HD-3059 and HD-3086) were received from the ICAR-IIWBR, Karnal and analysed for nutrient composition. The nutrient compositions of straws indicated that the WH-1105 variety contained lowest CF (40.4 %) and highest NFE (46.6 %). Wheat bran of the HD-3059 variety contained higher CP (16.4 %) than the other verities. The content of micro minerals (Zn, Fe, Mn and Cu) was also determined in these varieties. Marginally higher Zn and Fe contents were found, respectively in the HD-3086 and WB2 wheat straws varieties. Among the brans, DBW-39 contained higher Zn. Among the grains, Zn was higher in HD-3059. Other micro minerals were found similar in the samples.

Ten samples of sorghum stover varieties (AKSV-388, AKSV-278, AKSV-346, AKSV-395, AKSV-314, AKSV-387, AKSV-318, AKSV-382, AKSV-161 and PVK-801) were received from the PDKV, Akola and analysed for nutrient composition. The CF was higher in the AKSV-314 and AKSV-382 varieties, whereas NFE was found highest in the AKSV-395 and lowest in AKSV-314 varieties.

CF was lowest and NFE was highest in the wheat straw of WH-1105 variety. Wheat bran of the HD-3059 variety contained higher CP than the other verities. Zn was marginally higher in the HD-3086 and Fe was higher in the WB-2 wheat straws. Among brans, DBW-39 contained higher Zn. CF was higher in the AKSV-314 and AKSV-382 sorghum stover. NFE was highest in the AKSV-395 and lowest in the AKSV-314 sorghum stover varieties.

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

M Chandrasekharaiah, NM Soren, KS Prasad and A Thulasi

Studies were conducted in 3 phases to evaluate the feeding value of byproducts of silkworm pupae in crossbred cattle. In the first phase, the *in vitro* experiment was conducted to study the effect of supplementation of different inclusion levels of defatted silkworm pupae meal (DSWP) by replacing 0 (T0), 10 (T1), 20 (T2), 30 (T3), 40 (T4), 50 (T5), 60 (T6), 70 (T7), 80 (T8), 90 (T9) and 100 (T10) % soybean meal (SBM) in the concentrate mixture of finger millet straw (FMS) based diets on *in vitro* digestibility and rumen fermentation. The *in vitro* total gas production (IVTGP), pH, ammonia nitrogen (NH3-N), total volatile fatty acids (TVFA), partitioning factor (PF), microbial biomass production (MBB), metabolizable energy (ME), *in vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD) were determined. No significant difference was observed in pH, NH3-N, TVFA, PF, MBB, ME, IVDMD and IVOMD among the treatments (Fig. 2).

Experiments were conducted in the second and third phases to evaluate the effect of different inclusion levels of DSWP on rumen fermentation and nutrient utilization in cattle fed on FMS based diet. Four isonitrogenous concentrate mixtures were prepared with DSWP replacing SBM at 0 (T0), 10 (T1), 20 (T2) and 30 (T3) % level. In the second phase, rumen fermentation experiment was conducted in a 4×4 Latin switch over design using four crossbred steers to study the effect of different levels of DSWP (0, 10, 20 and 30%) on rumen fermentation. In the third phase, the digestibility trial was conducted in 20 crossbred cattle that 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 intake and nutrient utilization. All the animals in both phases

were fed with FMS as sole source of roughage. No significant difference was observed in rumen fermentation parameters such as pH, NH3-N and TVFA among the experimental groups in phase II. Further, the intake and digestibility of nutrients were not significantly different among the experimental groups in Phase II.

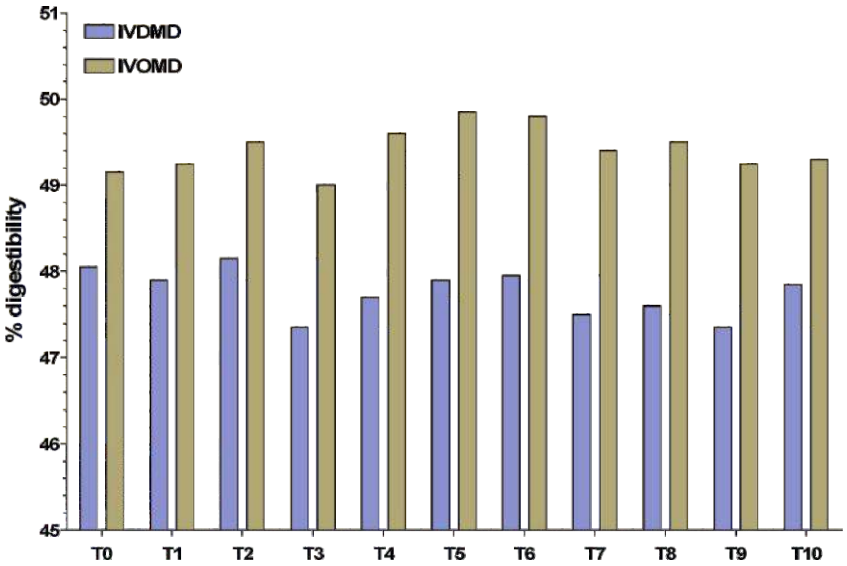


Fig. 2: Effect of incorporation of graded levels of DSWP by replacing SBM at 10, 20, 30, 40 50, 60, 70, 80, 90 and 100 % on IVDMD and IVOMD of finger millet straw based diet.

Supplementation of DSWP up to 100 % had no significant effect on in vitro rumen fermentation and digestibility on FMS based ration. DSWP can be incorporated in the ration of cattle up to 30 % by replacing SBM without compromising the rumen fermentation and nutrient utilization.

AICRP Project: Micro and secondary nutrients and pollutant elements in soil and plants: effect of zinc fortification of soil on zinc status in fodder and livestock

K Giridhar, NKS Gowda and DT Pal

The correction of micronutrient deficiencies in soil will help in improving the health of crops as well as livestock. As a follow up of six month sheep trial on zinc fortification, a study was taken up with five sheep farmers to evaluate the economic benefit of Zinc sulphate application to fodder maize and sheep at Durga Nagenhalli village of Tumkur district.

With zinc application, maize fodder yield was improved by 3 tons per hectare and feeding of zinc fortified fodder to sheep enhanced mutton yield by 1.2 kg per animal. The net profit was 12,700 for each farmer owning a flock of 20 sheep. The overall cost benefit ratio due to zinc application was 1 : 8.5, clearly showing the potential economic benefits of correction of deficiencies of micronutrients like zinc under field conditions (Table 2).

At the fodder farm of NIANP, a new study was taken up to assess the impact of zinc application on yield and quality of perennial fodder jowar. Soil application of 25 kg zinc sulphate per hectare coupled with foliar application of 0.5 % zinc sulphate improved zinc content in jowar stover to 36 ppm as compared to 14 ppm in control plot (no application of zinc). Green fodder yield of jowar was improved by more than 13 % to 34.3 q/ha as compared to control plot (Fig. 3).

Table 2: Economic analysis of zinc application by partial budgeting (for a flock of 20 sheep)

S.No	Debit side	Credit side
1	Additional cost: ₹ 1,700 (Cost of 25 kg Zinc sulphate and application charges)	Reduced cost : 0
2	Reduced returns: 0	Additional returns : ₹ 14,400 1. Additional fodder yield: 30 q/ha (₹ 6,000) 2. Extra mutton: 8,400 (1.2 kg per sheep × 20 sheep = 24 kg x ₹ 350 per kg)
Total	Rs. 1,700	Rs. 14,400
Net profit: ₹ 12,700 Cost Benefit Ratio: 1 : 8.5		

Fig. 3: A: control plot without zinc application; B: treatment plot with zinc application.

In the field study with 5 sheep farmers, the cost benefit ratio due to zinc application to soil was 1:8.5. The results clearly indicate the potential economic benefits of zinc fortification through soil application for improving yield of fodder as well as sheep mutton.

Programme 5
Climate Change Impact on Livestock

CCL 5.1: Life cycle assessment of green house gas emission from dairy farms of Karnataka State

A Mech, G Letha Devi, M Sivaram and S Sirohi

The Indian dairy farming has been able to make a significant contribution to the socio-economic development in the country. Concurrently increasing cattle population in the country has been adding to global warming. The green house gas (GHG) emissions from livestock are methane (CH4) emissions from enteric fermentation and manure management, nitrous oxide (N2O) emissions from animal manure and carbondioxide (CO2) emissions from land-use change (LUC). The existing poor feeding system, which is mainly based on crop residues added with small quantities of low-cost compound feed is regarded as the reason for source of high GHG emission rate from Indian ruminants. At this backdrop, a study was undertaken to analyze the GHG emissions occurring at different stages of dairy farming by conducting life cycle assessment of GHG emissions from selected dairy farms of Karnataka State. The two major objectives of the study were to identify and estimate the major sources of GHG in the selected dairy farms and to develop models for estimating GHG emission from the dairy farms of Karnataka State.

Data were collected from 69 farms of eight districts of Karnataka. Out of total farms surveyed, 59.4 % were small dairy farms, 26.1 % were medium dairy farms and 14.5 % were large dairy farms. Variations were observed in terms of dry matter (DM) intake (kg, cow^{-1} d^{-1}) of dairy cows in different categories of farms (6.58 - 9.29). The DE (digestible energy expressed as % of gross energy) content of different feed ingredients were recorded from feedipedia. Subsequently, the gross energy consumed (MJ, cow^{-1} d^{-1}) was calculated for dairy cows under different farm categories (116.63-81.14). Based on the above parameters and the type of manure management system, the volatile solid excretion rate (kg, cow^{-1} d^{-1}) was calculated as 1.97-2.48. Finally, the methane emission factor for enteric fermentation was calculated by using the equation 10.21 of chapter 10 of volume 4 of IPCC Guidelines of National Greenhouse Gas Inventories (2006). The methane emissions (kg, $head^{-1}$ yr^{-1}) from manure management system and the total managed manure N (nitrogen) available for application in the soil (kg N, yr^{-1} $farm^{-1}$) were also calculated (Table 1).

Table 1: Emission of enteric CH_4 (kg, $cow^{-1}year^{-1}$), manure CH4 (kg, $cow^{-1}year^{-1}$), N excretion (g, cow^{-1} d^{-1}), nitrous oxide (kg, $cow^{-1}year^{-1}$) and total managed manure N available (kg, $year^{-1}farm^{-1}$) for the different categories of farms.

Particulars	Dairy farm Category		
	Small	Medium	Large
Enteric CH4	38.7	33.4	42.3
Manure Ch4	3.21	3.13	3.26
N Excretion	106	115	111
Nitrous oxide	0.02	0.01	0.02
Total managed manure N available for application in the soil (kg N, $farm^{-1}$ $year^{-1}$)	43.4	110	209

The GHG emissions from concentrate transportation was calculated by using emission factor for Indian vehicles as reported previously (Ramachandra and Shwetmala, 2009). The distance travelled for feed transportation varied widely among the farms. The mode of transportation was either two wheeler or

autorikhshaw/ tempo for small and medium farms. Whereas, the large farms transported the feed either by truck or tempo owing to large feed quantity (Table 2). The dry matter quantity transported at one time varied depending on the farm size and interval between two transportations. The calculated emission intensity (CO_2 eq g, kg^{-1} DM) was lowest for small dairy farms, followed by large and medium dairy farms.

Table 2: Feed transportation mode, distance travelled (km), total DM loaded (kg, $time^{-1}$) and GHG emissions (CO_2 eq g, kg^{-1} DM) due to feed transportation.

Particulars	Dairy farm Category		
	Small	Medium	Large
Transport mode	Two wheeler / Autorikshaw	Two wheeler/ tempo	Truck/ tempo
Distance	0.5 - 1	0.5 - 25	5 - 15
Total DM loaded/ time	90 - 100	45*- 513	1098 - 2358
Average GHG emission	0.83	4.33	3.80
* Feed was transported on alternate day otherwise in most of the farms feed was transported twice in a month			

The two major water sources were bore well and panchayat supply. Although the water usage was more in large farms, but water usage was more judicious in large farms as in the large farms per head water usage was less then small dairy farms. The daily average total water usage (lit $farm^{-1}$) was calculated as 114, 282 and 654, respectively in the small, medium and large dairy farms. The total GHG emission intensity was calculated for dairy cows under different dairy farm categories by taking into consideration of the following emission sources: enteric CH_4, manure CH_4, manure N_2O and feed transportation. The total GHG emission was expressed as CO_2 eq kg^{-1} of fat protein corrected milk (FPCM). It was found low for small dairy farms as compared to large and medium dairy farms (Table 3). The FPCM was calculated as per the FAO (2010) using the following formula for dairy cows.

Fat Protein corrected Milk (FPCM, kg) = milk production (kg) × (0.337 + 0.116 × fat %) + 0.06 × protein %

Table 3. GHG emission intensities (CO_2 eq, kg^{-1} FPCM) of dairy cows by production system

Dairy farm Category	FPCM (kg)	GHG emission (CO_2 eq, kg^{-1} FPCM)
Small	10.7	0.58
Medium	9.3	2.03
Large	11.72	1.66

The total GHG emission expressed as CO_2 eq kg^{-1} of fat protein corrected milk was found low for small dairy farms (0.58) as compared to medium (2.03) and large (1.66) dairy farms.

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

Coordinator: R Bhatta

PK Malik and AP Kolte

Methane, due to its high global warming potential is a major greenhouse gas and stands second in the list after carbondioxide as far as concentration is concerned. Apart from global warming, enteric methane

emission from livestock is also accountable for the loss of biological energy (6-12 % of intake). There are many estimates available in the country for annual enteric methane emission from livestock. However, accuracy of prediction due to their dependency on a single IPCC factor is a concern. The efficacy of any ameliorative approach cannot be substantiated correctly until the quantification of methane emission before and after adaptation of measure under investigation is precise. Keeping this background in view, the project was undertaken with objectives to generate a database for the annual enteric methane emission from Indian livestock, development of the 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 explore the rumen methanogens plasticity and adaptation during long term evaluation of established methane mitigating phyto-sources.

An inventory on annual enteric methane emission from Indian livestock was developed under the project. ICAR-NIANP estimate revealed that the Indian livestock is emitting 9.253 Tg enteric methane annually. Based on the enteric methane emission from livestock, hotspots of the emissions were also identified for the immediate interventions. Uttar Pradesh is the largest enteric methane emitting state in the country (Fig. 1).

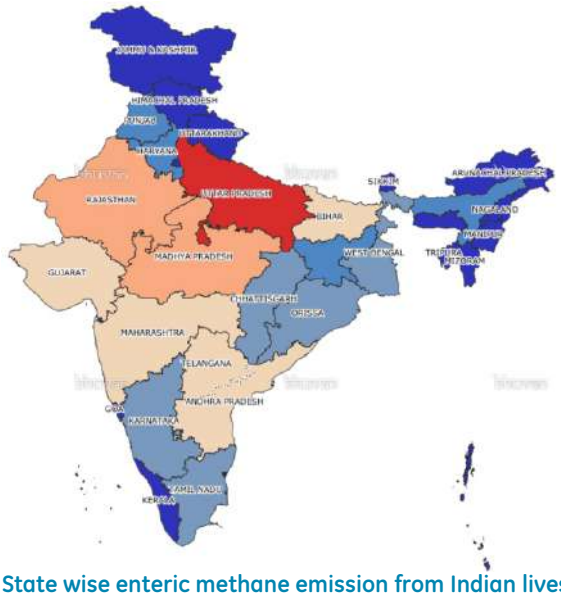


Fig. 1: State wise enteric methane emission from Indian livestock.

An *in vivo* experiment was conducted in growing male Mandya sheep (N = 18), divided into three groups of six animals each. The animals were fed on finger millet straw and concentrate at 55 : 45 ratio for 30 days to get them adapted to the basal and test diets. Silkworm *(Bombyx mori)* pupae oil was supplemented in the group T1 and T2 at 2 % of the basal diet and no oil was supplemented in the control group (T0). There was a continuous dosing of silkworm pupae oil in the group T1, while in the group T2, the oil was supplemented on alternate weeks (intermittent supply). The effect of oil supplementation on dry matter intake and enteric methane emission with continuous and intermittent oil dosing was investigated. Results from the study revealed a significant ($p < 0.05$) reduction in the enteric methane

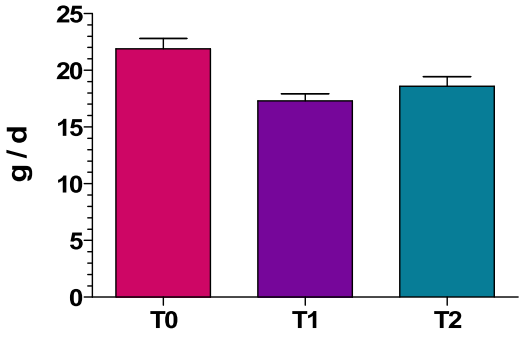


Fig. 2: Effect of continuous and intermittent supply of silkworm pupae oil on methane emission in sheep.

emission (g/d) from the sheep supplemented with silkworm pupae oil at 2 % of basal diet. Average enteric methane emission (g/d) in T0, T1 and T2 groups was 21.9, 17.3 and 18.7 respectively (Fig. 2). The study confirmed that the reduction in enteric methane emission in-group T2 (intermittent supply- alternate week) was equally effective to the continuous supplementation (T1) of silkworm pupae oil in sheep. No adverse affect of oil supplementation on dry matter intake was recorded in the test groups and in fact it was marginally higher in the test groups than that of the control.

For confirming the mechanism of reduction in methane emission with continuous and intermittent oil supplementation, total, entodinimorphs and holotrichs protozoal population were enumerated. Results confirmed an inhibitory action of silkworm pupae oil supplementation (Fig. 3) on rumen protozoa numbers (× 10^7). Rumen liquor samples were collected from all the six animals in each group and genomic DNA was isolated using repeat bead beating and column method. The integrity of DNA was confirmed with 1 % agarose gel electrophoresis.

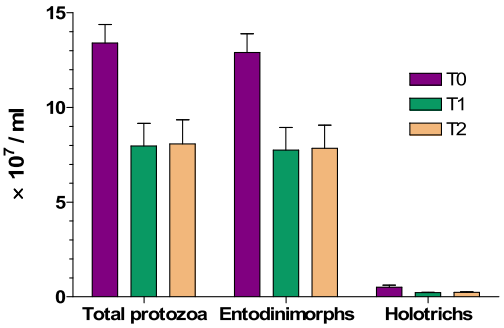


Fig. 3: Effect of silkworm pupae oil on rumen protozoa.

Rumen methanogens diversity in rumen liquor samples collected from the previous experiment conducted in sheep with two selected tanniniferous tree leaves was also accomplished by using next generation sequencing (NGS). The bioinformatics analysis was performed and diversity among the test and control groups was compared. NGS data revealed that methanobacteriales archaea were the prominent methanogens (87-92 %) irrespective of the treatments (Fig. 4) and tannins did not uniformly affect all the archaea in sheep. This study confirmed that condensed tannins, even at a much lower level than hydrolysable tannins was more effective in achieving almost similar methane reduction.

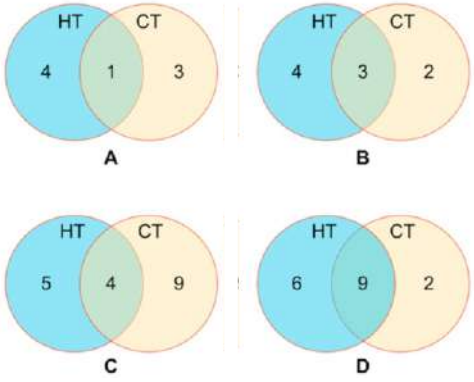


Fig. 4: The Venn diagram displaying number of Methanomassiliicoccaceae OTUs increased (A) and decreased (B); Methanobacteriaceae OTUs Increased (C) and decreased (D) due to hydrolysable (HT) and condensed (CT) tannins phyto-source supplementation over the control group.

Inventory of annual enteric methane emission form Indian livestock revealed Uttar Preadesh as the largest enteric methane emitting state in the country. In sheep, continuous and intermittent supplementation of silkworm pupae oil at 2 % level in basal diet significantly reduced methane emission and the population of rumen protozoa. In sheep, condensed tannins, even at a much lower level than hydrolysable tannins was more effective in achieving almost similar methane reduction.

DBT Project: Livestock methane reduction through immunization based approach

PK Malik, R Bhatta, AP Kolte, M Sridhar and A Dhali

Enteric methane emission constitute about 60 - 65% of the total methane emission from agricultural sector in the country. Reduction in enteric methane emission from the Indian livestock is urgently required to save a major fraction of the biological energy that is otherwise lost in the form of methane. The search for finding the suitable, effective and safe methane mitigating approach is still on the radar of researchers. One attractive and novel option for reducing the methane emissions from ruminants may be the immunization of animal system against their own methanogens inhabiting in the rumen. Therefore, the project was undertaken with the objectives of diversity analysis and quantitation of rumen *archaea* through molecular approaches, formulation of species specific vaccine(s) for the active immunization of cattle and buffaloes and to evaluate the effect of active immunization and secondary metabolites combo preparation on *in vivo* methane emission and fermentability pattern.

Rumen methanogens diversity in cattle and buffaloes was explored using 16S rRNA based next generation sequencing approach. Further, rumen methanogens diversity in buffalo from two distinct geographical locations was explored. Libraries were prepared using Nextera index kit and data were analysed using CLC genomics workbench. Comparison of rumen archaea in cattle and buffalo at class level revealed that Methanobacteria are major methanogens (96.2 %) in the rumen. Similarly, methanogens belonging to Methanobacteriaceae family were found to be the major archaea in both cattle and buffalo (Fig. 5). Methanobrevibacter was found as the major rumen methanogens in both cattle and buffalo at genus level (Fig. 6). Based on the 16S rRNA molecular diversity analysis, pure isolates of *Methanobacterium fexile, Methanobrevibacter thauri, Methanosphaera stadtmanae, Methanobrevibacter smithii, Methanobrevibacter ruminantium and Methanobacterium mobile* rumen methanogens were imported from DSMZ, GmBH, Germany. These microbes were cultured using specific media in our laboratory for the use in vaccine formulation.

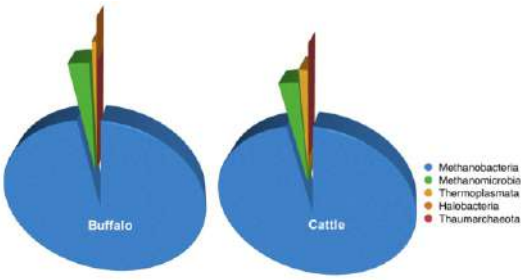


Fig. 5: Archaeal distribution in buffalo and cattle at class level.

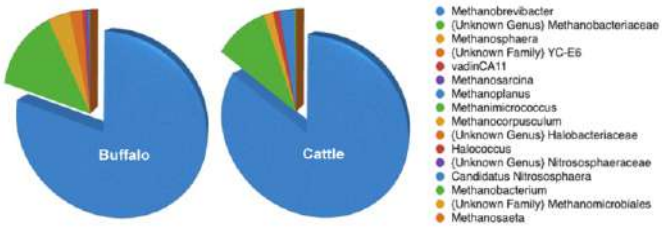


Fig. 6: Archaeal distribution in buffalo and cattle at genus level.

Rumen archaea in cattle and buffalo at class level revealed Methanobacteria as the major methanogens in rumen. At genus level, Methanobrevibacter were the major rumen methanogens in both cattle and buffalo.

DST-JSPS Project: Methane mitigation using unexplored phyto-sources in ruminants and their effect on rumen microbial diversity

R Bhatta, AP Kolte and PK Malik

Problem of enteric methane emission is ubiquitous and not restricted to one country, however, its intensity vary in accordance with the quality of feed and fodders available. Indian livestock emits about 9.253 Tg methane from enteric fermentation annually. This methane apart from global warming impact has additional disadvantage of energy loss from animal biological system. Both India and Japan are making attempts to reduce this enteric methane emission from livestock by using some selective unexplored phytosources as dietary ingredient. This joint Indo-Japan project was undertaken with the objective to ameliorate enteric methane emission from livestock by evaluating various phyto sources from natural plants and food industrial byproducts in view of whether these materials are effective for mitigating methane emission from ruminants and elucidating responses of the microbial communities inhabiting the rumen of adult ruminants and comparing kinetic differences of nutrients digestion.

Among the studied samples, Meliaazedarach contained maximum (78.7 g/kg) condensed tannin. The phytosources such as *Artemisia vulgaris*, *Pittosporum eriocarpum*, *Zanthoxylum alatum* and *Berberis lycium* also possessed appreciable amount of condensed tannin. Few phytosources such as *Terminalia chebula*, *Punica granatum*, *Zanthoxylum alatum* and *Acacia catechu* were found very rich in hydrolysable tannin. The leaves from *Prunus domestica* and *Berberis lycium* contained both condensed and hydrolysable tannin in almost equal proportion, however the level of both condensed tannin (CT) and hydrolysable tannin (HT) was low. In the present study, a large variation ($p < 0.05$) in methane production (ml/ 200 mg) was recorded. No definite trend was observed in methane production in respect to high condensed and hydrolysable tannin content among the studied phytosources. Nevertheless, the phytosources *Pittosporum eriocarpum*, *Prunus domestica* and *Berberis lycium* that contained both CT and HT in almost equal proportion produced comparatively less methane than phytosources containing appreciable amount of either CT or HT.

The phytosources *Pittosporum eriocarpum, Prunus domestica* and *Berberis lycium* containing both CT and HT in almost equal proportion produced comparatively less methane than phytosources containing appreciable amount of either CT or HT.

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 and A Mech

Increasing purchasing power and awareness of populace for balance diet demand for the intensification of livestock products such as milk and other processed material. To meet this increasing requirement for milk and milk products, the livestock sector is in tremendous pressure particularly in the peri-urban areas, where most of the produce is sold in urban market and dairy units are being affected with day to day fluctuations in feed availability, season and selling price. The intensification of dairies in peri-urban sector may also lead to 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 a must. Keeping these facts in view, the project has been initiated with the objectives to determine the methane production potential of conventional feedstuffs and diets and of alternative optimized/ balanced rations at peri-urban dairy farms, to develop a

model that predicts enteric methane emission from peri-urban dairy farms near Bengaluru, to develop an inventory of the methane emission potential of different feeds and ration and to compute a life cycle assessment of (primarily enteric) GHG emissions from peri-urban dairy farms near Bengaluru.

A total 30 villages located at the rural-urban interface of Bengaluru were surveyed for identifying the small, marginal and medium dairy farmers at the interface. Twenty eight dairy farms belonging to four clusters (two in each transacts) were selected for collecting the data related to dairy husbandry and feeding practices. From these farms, total 64 samples of feed, fodder and concentrate were collected and divided into two sub-sets. One set was preserved for nutrient monitoring and the other set for *in vitro* gas analysis. The samples were air dried first before transporting to the institute. The ash, organic matter and crude protein contents were determined in the collected feed samples. Breath samples were collected from 18 sheep and analyzed for the methane emission using laser technique (Fig. 7). The methane emission quantified with laser technique from the individual animal was compared with the emission quantified using SF6 technique.

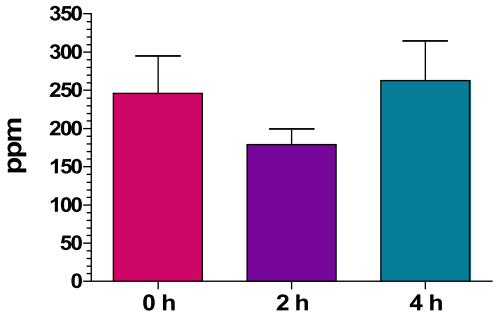


Fig. 7: Methane emission in sheep at different time points as measured by laser technique

Ash, organic matter and curde protein contents in the feed samples collected from 28 dairy farms from rural-urban interface of Bengaluru were determined. Methane emissions from sheep quantified by laser technique and SF6 technique were compared.

Programme 6
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 and V Sejian

Water is a nutrient that is required in largest quantity by livestock. Drinking water provides 60 to 80 % of dry and lactating cows' water requirement and feed provides the rest of the water needed. Water quality is equally important as quantity or availability. Water is needed to maintain blood volume, tissue function, rumen activity and proper flow of feed through the digestive tract. Hence, water availability and quality has 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 as animal growth and production. Modern dairy practices require considerable resources and it includes water intensive operations. Increased water use efficiency contributes to improved livelihoods, food security and household nutrition, while reversing land degradation and safeguarding environmental resilience. There is an urgent need to understand 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 of different dairy production systems.

Primary data was collected from 90 small and medium sized dairy farms in Shimoga district. Water inputs (by animals) being considered are 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 (through urine and milk). The water inputs through forage and other feed ingredients were found more as compared to water inputs through drinking water and that used for on farm servicing operations. The average direct consumptive water use by small holder system was found to be 97 lit/day and the respective value was 17 lit/day for commercial dairy farms. The calculated water use efficiency for small holder system was 0.85 and for commercial dairying it was 1.62.

Water use efficiency of different dairy production systems at the micro level was assessed. The average direct consumptive water use by small holder system was found to be 97 lit/day and the respective value was 17 lit/day for commercial dairy farms. The calculated water use efficiency for small holder system was 0.85 and for commercial dairying it was 1.62.

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

S Jash, T Chandrappa and G Ravikiran

With milk production bearing the buffer on surmounting natural vagaries and thereby, price uncertainties, it lies as cornerstone to national socio-agrarian economy. To assess the evolving situation of its production, economies based on farming system needs impetus to investigate the efficiency in use of available resource for optimal utilization and substantial income. This has necessitated evaluation of milk production cost, in the fulcrum of determinant factors under extensive, semi-intensive, intensive and organic farming systems

and provision of a SWOT analysis of the existing paradigm, with extrapolation of results for the future scenario.

A study has been initiated with the four envisaged farming systems. They are spread across the urban, peri-urban and rural tracts, across the districts of Bengaluru-urban, Bengaluru-rural, Kolar and Tumkur, which forms the principal milk-shed in Karnataka. Each of these investigative locales consisted of 30 households were chosen in uniform affirmation of the socio-economic status of the farmers. The study encompasses the evaluation of infrastructure, resources, conduits and market, to arrive on the farm-gate pricing mechanism of milk. The initial observation of intensive dairy farms in urban and rural scenario reflected the biased use of concentrate feed over roughages, non-commensurate sanitation to long hours tethering, but better housing and access to health facilities, in comparison to semi-intensive and extensive farms that extend in rural vicinities.

The certified organic milk farms of 'Akshayakalpa', fanned on 180 households around Tiptur, Arsikere, Channarayapatna, Chikkanayakana Halli, Kadur and Holenarasipura regions of Tumkur and Hassan districts. These organic dairy farms are located in pristine surroundings, at least three km away from nearest villages, completely automated and self-sustained. The fodder, cultivated under certified organic regime, is feed to the livestock. The farmers are taught closed loop soil health management and drudgery free farming operations. The packages of practices ensure clean and stress-free housing, grass-based diets and veterinary practices sans antibiotic and hormone, embracing indigenous and homeopathic treatment regimes. They make use of innovative technologies and process automation in terms of bio-gas generation and milking. Chilling of the milk is mandatory at farm level, which is collected and transported for process and distribution, under aseptic hygiene.

A study has been initiated to assess the economics of milk production under different systems of dairy farm management in Karnataka. The initial observation of intensive dairy farms in urban and rural scenario reflected the biased use of concentrate feed over roughages, non-commensurate sanitation to long hours tethering, but better housing and access to health facilities, in comparison to semi-intensive and extensive farms that extend in rural vicinities.

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

Team Leader: R Bhatta

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

Livestock production is an integral part of rural life and contributes significantly to rural economy. While we have achieved a horizontal growth 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 non economic roles in small-farm system. Livestock production is very diverse, not only for the animal, but also differs in each region depending on physical, economical, social and cultural influences. By integrating livestock into crop production, farming system can be made more efficient that lead to improved productivity and welfare.

The project under Farmer FIRST, 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 holder participation and technological interventions for sustainable livelihoods. The project has been undertaken in a cluster of 10 villages in Doddaballapura taluk of Rural Bangalore covering 1000 farm families.

Under FFP, baseline survey was conducted in primary project intervention area, of Doddaballapura village cluster and Ragaihalli and Shivanahalii villages, where improved technological interventions have been introduced. Farmers were identified for implementation of different modules and technology interventions. Awareness campaign and capacity building programs were organized for some of technologies like feeds and fodder, feed formulation, feeding management, feed/ fodder conservation, feed quality and safety, quality milk production, dairy production and management and reproductive health management. Fodder trees, grasses, vegetable, flower and fruit seeds were distributed in five villages. Eight health camps were organized and animals with reproductive and other problems were treated. More than 200 animals were screened for mastitis and lameness and interventions were planned and implemented to address identified problems. One day training for mushroom production was organized for farmers at ICAR-IIHR, Bengaluru. Farmer groups were organized under various enterprise-based modules like dairy goat producer's association. After a couple of months of technological interventions as well as institutional interventions, impact of interventions were analysed and quantified for the interventions like ASMM, mastitis, lameness, horticulture crops, quality milk production etc. Considerable improvements in the income and livelihoods of the farmers following the interventions were noticed.

Baseline survey was conducted in primary project intervention area, of Doddaballapura village cluster and Ragaihalli and Shivanahalii villages. Awareness campaign and capacity building programs were organized for selected technological interventions and animal health camps were organized. Considerable improvements in the income and livelihoods of the farmers following the interventions were noticed.

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

D Rajendran

A project has been initiated under Farmer FIRST programme on enriching knowledge, integrating technology and institutions for holistic village development in horticulture based farming system. It was observed that farmers were involved in sheep and goat rearing as the subsidiary occupation in the study area. Main occupation was sericulture and agriculture. Flock size ranged from 2-8 and a few large farmers maintained more than 20 animals (Table 1).

Three type of housing was followed (Fig. 1). 1) Open paddock system: in this housing system, animals were housed during night time in open paddock. Some farmer had small closed thatched roof. Some were open system and not covered by any material causing cold stress during winter season. 2) In-house rearing system: small farmers having 2-5 animals had kept their small ruminants inside their house with less ventilation. 3) Tied in open field: animals were tied in open field without any housing facilities.

Most of the animals were let loose for grazing from morning 9.00 AM to evening 6.00 PM based on the weather condition. Animals were grazed in nearby hillock and fallow land and road side grazing land. Most of

the farmer never fed extra concentrate to their animals. Some farmers also practiced hanging of tree fodder for feeding of goats. No mineral mixture feeding was practiced in small ruminant feeding system by any of the farmers.

Table 1: Small Ruminant population in selected village under Farmer FIRST Program

Village Name	Number of Beneficiaries	Sheep	Goat
Vasappanadoddi	14	65	114
Yeremegere	42	334	249
Kebbadoddi	4	17	30
Chikalagowdadoddi	9	6	16
Balepura	5	10	41
Total	74	432	450

Fig. 1: Animal housing system at the study area.

Deworming and vaccination were found to be dependent on the local veterinarian or animal husbandry assistant. Periodic deworming were practiced for most of the small ruminants and vaccination was performed when needed or during any outbreak.

Technological interventions for small ruminant production system were also arranged in the study area. It was observed that farmers were not supplementing adequate level of protein to their animals. Therefore, protein supplement namely sunflower DOC, soybean meal, groundnut DOC and cotton DOC each 500 kg were distributed among the beneficiaries. Mineral mixture was distributed for solving mineral deficiency and reproductive problem. Farmers having small ruminants were selected as beneficiaries and 400 kg of each sheep and goat mineral mixture were distributed to the beneficiaries. Small Ruminant rearing awareness program were also arranged as farmers were found rearing their small ruminants in traditional way and not following any scientific technologies. Biweekly and monthly awareness program were conducted and farmers were educated regarding to their problem faced for small ruminant production system.

Critical inputs like mineral mixture and protein supplements were distributed to the small ruminant producers. Biweekly and monthly awareness program were conducted and farmers were educated regarding to their problem faced for small ruminant production system.

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Roy SC, Dhali A, Divyashree BC, Javvaji PK, Roy KS, Gurupriya VS, Kolte AP, Mech A and Pal DT. Tissue Inhibitor of Metalloproteinase-2 (TIMP-2): A putative motility & fertility marker of buffalo semen; production of recombinant buffalo TIMP-2 and its applications" In: V Annual Conference of Society for Veterinary Sciences & Biotechnology (SVSBT), 22-23 September, 2017, OUAT, Bhubaneswar, pp14-16.

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Invited lectures

Malik PK

Livestock methane emission and its amelioration using different approaches. In: Training program on "Innovative approaches for conservation and improvement of indigenous bovine genetic resources in modern IPR era under changing climate scenario", 8-28 November, 2017, SRS of ICAR-NDRI, Bangalore.

Dhali A

Lecture and practical demonstration on qPCR. In: National Training Programme of the "ICAR-NAE Project on Centre for Zoonoses" on "Genomics and Zoonoses Research", 6-10 March, 2018, Nagpur Veterinary College, MAFSU.

Kolte AP

Invited expert lecture on 'Study of host-pathogen interactions using systems approach with special reference to Transcriptomics' In: National training on " Host-Pathogen Interaction," 12 February, 2018, Nagpur Veterinary College, MAFSU.

Invited expert talk on Bioinformatic software tools for analysing and comparing genomes. In: National Training Programme of the "ICAR-NAE Project on Centre for Zoonoses" on "Genomics and Zoonoses Research", 6-10 March, 2018, Nagpur Veterinary College, MAFSU.

Sejian V

Climate change related to impacts of environmental stress on small ruminant production and adaptation. Lecture delivered in the ARChE_Net ECLIPSE project workshop on "Impact of environmental changes on ruminants," Hyderabad, 13 November, 2017.

Climate change and poultry production: Impact and amelioration. Lecture delivered in the Training on "Advances in Poultry Production and its Impact on Changing Global Scenario", Veterinary College and Research Institute, Namakkal, Tamil Nadu, 27 February, 2018, pp 137-144.

Climate change and its impact on livestock production. Lecture delivered in the brainstorming session on "Climate

Change and its Impact on Livestock Production", Rajiv Gandhi Institute of Veterinary Education and Research (RIVER), Puducherry, 12 March, 2018.

Impact of climate change on animal production and health. In: National initiative on Climate Resilient Agriculture Workshop on "Livestock and Climate Change". Veterinary College, Karnataka Veterinary Animal and Fishery Sciences University, Hassan, Karnataka, 26 February, 2018.

Adaptation and mitigation policies and strategies for adapting livestock production to climate change. In: National initiative on Climate Resilient Agriculture Workshop on "Livestock and Climate Change". Veterinary College, Karnataka Veterinary Animal and Fishery Sciences University, Hassan, Karnataka, 26 February, 2018.

Gupta PSP

Pre-antral follicle technology: A new hope for the supply of oocytes for embryo resource generation. Lecture delivered in the South Zone Veterinary Physiology Quiz and Seminar of the Society of Animal Physiologists of India (SAPI), Veterinary College, Bengaluru on 4 December, 2017.

Selvaraju S

Recent advances in bull fertility evaluation. Lecture delivered in the Winter School on "Innovative Approaches for Conservation and Improvement of Indigenous Bovine Genetic Resources in Modern IPR era under Changing Climate Scenario", 8-28 November, 2017, SRS of ICAR-NDRI, Bengaluru. pp79-83.

Semen quality evaluation in livestock", Lecture delivered to the participants of South zone veterinary Physiology Quiz and Seminar of the Society of Animal Physiologists of India (SAPI), Veterinary College, Bengaluru, 4 December, 2017.

K Giridhar

Impact of climate change on feed resources. at NICRA Workshop on "Livestock and Climate Change" at Veterinary College, Hassan, 26 February, 2018.

Importance of fodder cultivation for livestock development in Odisha' at 'Krishi Odisha', Bhubaneswar, 7 March, 2018.

NIANP technologies for field adoption' at the Action plan meeting of KVKs at KVK, Gonikoppal, Kodagu, 22 March, 2018.

Business prospects for fodder production and conservation technologies. In: Training course on Agricultural Management at GPS Institute of Agriculture Technology, Peenya, Bengaluru, 10 November, 2017.

Rajendran D

Application of nanominerals in poultry production systems. In training Course "Advances in poultry production and its impact on changing global scenario" at CAFT in Avian Science, TANUVAS, Namakkal, 23 February, 2018.

Optimising ration in dairy animals by farmer friendly ration balancing tools. Lecture delivered for progressive farmer and dairy professionals at one day seminar organised by Dairy Connect 2018, at Erode, Tamilnadu, 26 January, 2018.

Samanta AK

Prebiotics from agricultural wastes. Talk delivered at MS University of Baroda, Vadodara, Gujarat. 18 July, 2017.

Scope of prebiotics in livestock following implementation of National Action Plan on antimicrobial resistance. Talk delivered at National Symposium on thrust areas of relevance to livestock research at National Institute of Animal Biotechnology, Hyderabad, 28 March, 2018.

Pal DT

Enhancing dairy production efficiency - Recent concepts. In Technical Compendium of BAIF's Golden jubilee workshop on 'Improving feed resources and feeding of dairy animals through integrated and innovative approaches' at BAIF, Pune, 2-3 May, 2017

Gowda NKS

Livestock feeding technologies and business opportunities. In: Training course on Agricultural Management at GPS Institute of Agriculture Technology, Peenya, Bengaluru, 10 August, 2017.

Ration balancing in dairy animals. In: Technical workshop for dairy farmers at Doddaballapur, organised by Bangalore milk union, 27 September, 2017.

Livestock production enterprises. In: Training course on Agricultural Management at GPS Institute of Agriculture Technology, Peenya, Bengaluru, 9 January, 2018.

Precision feeding for eco-friendly and economical dairy production. In : Technical workshop for Officers of Department of Animal Husbandry, Govt. of India, at CFSP & TI, Hessaraghatta, Bengaluru, 11 January, 2018.

Livestock and nitrogen pollution: Issues and Remedies. In: Advanced Faculty Training programme on Livestock Nutrition and Health at ICAR-IVRI, Izatnagar, 23 February, 2018.

Improving bioavailability of trace minerals for better livestock health and production. In: Advanced Faculty Training programme on Livestock Nutrition and Health at ICAR-IVRI, Izatnagar, 23 February, 2018.

Mineral status in different agro-climatic zones, deficiency, implications and amelioration. In: Golden Jubilee Workshop at BAIF, Pune, 2-3 May, 2017.

Feed resources and feed technologies. In: Golden Jubilee Workshop at BAIF, Pune, 2-3 May, 2017.

Livestock feed technologies for improving income of farmers. In: National Conference of Indian Veterinary Extension Forum, Veterinary college, Shimoga, 29-31 January, 2018.

Strategies for meeting the fodder requirement of dairy animals. In: 46th Dairy Industry Conference, Thrissur, Kerala, 8-10 February, 2018.

Lecture notes

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Bhatta R, Malik PK, Kolte AP and Sejian V. Livestock and climate change: an overview. pp01-06.

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Malik PK, Kolte AP, Thirumalaisamy G, Dhali A, Baruah L, Goyal P and Bhatta R. Enteric methane ameliorative measures and future prospects. pp19-22.

Malik PK, Kolte AP, Sejian V, Dhali A and Bhatta R. Alternative H2 sinks for rumen methane reduction. pp23-28.

Mech A, Letha G, Sivaram M and Sirohi S. IPCC methodology for assessing national GHG emissions from livestock. pp35-38.

Sejian V, Bagath M, Krishnan G, Malik PK, Archana PR and Bhatta R. Heat stress: causes, impact and ameliorative measures. pp39-48.

Sejian V, Malik PK, Bagath M, Krishnan G, Aleena J and Bhatta R. Nutritional stress impact and corrective measures in livestock. pp49-56.

Roy KS, Ghosh J and Pal DT. Abiotic stress on livestock: impact and implications in changing climate. pp57-62.

Bagath M, Sejian V, Krishnan G and Bhatta R. Heat shock proteins and their primer designing: standard PCR and real time PCR. pp63-72.

Mishra A and Reddy IJ. Impact of oxidative stress on livestock production. pp73-76.

Elangovan AV. Challenges for sustainable poultry production in changing climate. pp85-90.

Gowda NKS, Anandan S and Elangovan AV. Livestock vis-à-vis nitrogen and phosphorous pollution: implications on environment and possible remedies. pp91-96.

Anandan S. Challenges for livestock production under climate change: a global perspective. pp97-100.

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Soren NM, Chandrasekharaiah M, Rao SBN, Prasad KS and Sejian V. Importance of nutrient-reprodcution in changing climate. pp175-180.

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Devaraj C, Krishnan G, Bagath M, Sejian V and Malik PK. Energy management in dairy animals during transition phase. pp197-200.

Dhali A, Kolte AP, Javvaji PK and Francis JR. Future prospects of embryo transfer technology in changing climate. pp201-204.

Kolte AP, Malik PK, Dhali A, Samanta AK and Bhatta R. Techniques for exploring microbial diversity. pp201-204.

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Baruah L, Malik PK, Kolte AP, Thirumalaisamy G, Goyal P and Bhatta R. In vitro gas production technique. pp231-234.

Goyal P, Kolte AP, Malik PK, Dhali A and Bhatta R. Extraction of metagenmic DNA from rumen liquor samples. pp235-236.

Thirumalaisamy G, Malik PK, Baruah L, Goyal P and Bhatta R. Sulfur hexafluoride tracer technique for enteric methane measurement. pp237-240.

Kolte AP, Dhali A, Javvaji PK, Malik PK and Bhatta R. PCR amplification of 16s rRNA gene from metagenomic DNA of rumen microbes. pp241-242.

Dhali A, Kolte AP and Malik PK. Application of QPCT for quantification of rumen microbes. pp243-244.

Goyal P, Malik PK, Kolte AP and Bhatta R. Rumen metabolome analysis using NMR spectroscopy. pp245-246.

Mech A, Malik PK and Bhatta R. Assessment of GHG emissions using IPCC tier systems. pp 247-252.

Sejian V, Malik PK, Krishnan G, Bagath M, Pragna P and Bhatta R. GHG modeling in livestock farms. pp253-258.

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Baruah L, Malik PK, Kolte AP, Goyal P, Thirumalaisamy G and Bhatta R. Tannin estimation from phytosources. pp263-266.

Compendium of the Industrial Experience Training on Climate change and livestock production. Sejian V, Malik PK, Bagath M, Krishnan G and Bhatta R. (Eds) 28 July-17 August, 2017. ICAR-NIANP, Bengaluru

Sejian V, Malik PK and Bhatta R. Global climate change: An overview. pp1-7.

Sejian V, Bagath M, Krishnan G, Malik PK, Pragna P and Bhatta R. Global warming: Role of livestock. pp8-18.

Malik PK, Bhatta R, Sejian V, Goyal P, Thirumalaisamy G and Kolte AP. Enteric methane emission in livestock: Process and factors influencing the emission. pp19-25.

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Kolte AP, Dhali A, Malik PK, Javvaji PK and Bhatta R. Metagenomic survey for studying complex and dynamic rumen microbial population. pp61-64.

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Sejian V, Bagath M, Krishnan G, Malik PK, Archana RR, Pragna P and Bhatta R. Respiratory chamber model, in vitro gas production model (Bioreactor model) and dairy GHG model to predict GHG emission from livestock farm. pp132-136.

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Veeranna RK, Krishnan G, Bagath M, Pragna P, Aleena J and Sejian V. Body condition scoring system- A simple tool to optimize productive and reproductive efficiency in small ruminants. pp144-152.

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Bagath M, Sejian V, Krishnan G, Veeranna RK, Pragna P, Aleena J and Bhatta R. ELISA methodology of growth, stress and reproductive hormones estimation. pp160-162.

Bagath M, Sejian V, Krishnan G, Veeranna RK, Archana PR, Vidya MK and Bhatta R. Expression of toll like receptors (1-10) in goat mesenteric lymph node by real time PCR. pp163-166.

Technical seminar compendium on Feed and fertility management in dairy animals. Gowda, NKS and Selvaraju, S (Eds), 5 August, 2017, ICAR-NIANP, Bengaluru

Binsila BK, Selvaraju S, Arangasamy A, Ravindra JP and Bhatta R. Semen quality assessment and practical implications in farm animals. pp43-48.

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management (in Kannada) for distribution under MGMG programme. P 12, Published by Director, ICAR-NIANP, Bengaluru.

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Giridhar K, Elangovan AV, Samanta AK, Rabinson J and Bhatta R. 2018. CD on "Silage making in plastic drums- A simple method'. released by Shri. Radha Mohan Singh, Union Minister for Agriculture and Farmer Welfare during the Farmers Conclave at ICAR-NIANP, Bengaluru, 17-18 February, 2018.

Gowda NKS, Dhali A, Kolte AP, David CG, Letha Devi G and Bhatta R. 2017. Video documentary - Glimpses of ICAR-NIANP @2017.

Gowda NKS. Balanced animal feed and its proportion. Talk delivered on All India Radio, Bengaluru, 7 August, 2017.

Gowda NKS. Feed and fodder management during summer. Live program on Doordarshan, Bengaluru, 16 May, 2017.

Awards and honours

R Bhatta

Recepient of ISSGPU Fellow Award by Indian Society of Sheep and Goat Production and Product Utilization. 9 November, 2017.

Section Editor (Veterinary Sciences), Current Science, India.

Member of the Editorial board of Journal of Agricultural Sciences, Cambridge, UK.

Editorial board member of Intas Polivet, India.

Recipient of Sir CV Raman State Award for young scientists from hon. Chief Minister of Karnataka. 12 April, 2017

Recipient of Karuna Award for National Progress from Karuna Trust, Bengaluru. 17 December, 2017

Member of the Vol-XII: Sub-group on sustainable agriculture. Interim arrangement for preparation of report w.r.t. Doubling of Farmers' income, Ministry of Agriculture & Farmer's Welfare, Department of Agriculture, Cooperation & Farmers Welfare, Govt. of India, 2017

Member of the State-wise Coordination Committee (SCC) for doubling farmers' income, Indian Council of Agricultural Research, New Delhi, 2017

Member of the technical committee - Quality Mark, National Dairy Development Board, Anand

Member of the expert panel on Constitution of access and benefit sharing (ABS) to implement the Biological Diversity Act. 2002, Karnataka Biodiversity Board

Chairman of the Technical Committee on Feed and Fodder Development (TCFFD), DADF, Govt. of India, DADF

Member of the National Steering Committee on Feed and Development (NSCFFD), DADF, Govt. of India

Member of the Climate Change Advisory Committee of Environmental Management and Policy Research Institute (EMPRI), Department of Forest, Ecology and Environment, Government of Karnataka

Dr R Bhatta receiving Sir CV Raman State Award for young scientists from Honourable Chief Minister of Karnataka, 12 April, 2017

Dr R Bhatta Receiving Karuna Award for National Progress from Karuna Trust, Bengaluru, 17 December, 2017

M Sridhar

Dr. S Manpal received the prestigious ANSI Fellow Award (2017-18) of Animal Nutrition Association of India, at Junagadh on 1 February, 2018.

KS Roy

Third prize from TOLIC, Bengaluru for Hindi Technical Writing, January 2018.

IJ Reddy

Radiological Safety Officer (RSO) assigned by AERB, Mumbai

V Sejian

Faculty Research Award 2018 for top 10 "Most outstanding Researchers" in the field of Environmental Science category for the year 2018 by Careers 360.

Letha Devi G

Best Extension Research Award in for the work on climate Vulnerability and Dairy farming in First International Extension Congress 2017, held by ICAR, IARI and CIWA at CIWA, Bhuvaneshwar during 1-3 February, 2017.

NKS Gowda

Nominated as editorial board member for Indian Journal of Small Ruminants, ISSGPU, Avikanagar.

Awarded Third prize in FAO photo essay competition and story telling on the global theme "Good farming practices to promote infection prevention and control" on the occasion of Antibiotic awareness week, organised by FAO, United Nations, November 2017.

Conference Awards

Conferences	Awards
XVII Biennial Animal Nutrition Conference on "Nutritional challenges for raising Animal productivity to improve farm economy", 1-3 February, 2018, JAU, Junagad, India.	First best poster presentation award for "Bioprospecting of white-rot fungi for potential versatile peroxidases for enhanced delignification of crop residues" by Ravichandran A, Gopinath SM and Sridhar M. Third best oral presentation award for "Enhancing versatile peroxidase activity of a novel fungal isolate through media optimization for delignification of crop residues' by Ravichandran A, Gopinath SM and Sridhar M. First best oral presentation award for " Identification of white rot fungi (WRF) cultures for bio delignification of crop residues employing a rapid method for genomic DNA isolation by Rao RG, Ravichandran A, Thammaiah V, Giridhar K, Senani S, Samanta AK and Sridhar M. Third best poster presentation award for "Studies on elucidation of lignin biodegradation mechanism in crop residues employing Nuclear Magnetic Resonance (NMR) Spectroscopy's" by Thammaiah V, Rao RG, Samanta AK, Senani S and Sridhar M. Second best oral presentation award for "Effect of exogenous lignin peroxidase enzyme-treated ragi straw on DM intake, digestibility, rumen fermentation and rumen enzymes in sheep" by Thammaiah V, Rao RG, Samanta AK, Senani S, Baruha L and Sridhar M.
National Seminar on "Small ruminants: National scope on upscaling production to products value addition and their safety", 9-10 November, 2017, ICAR-CIRG, Makhdoom, Mathura.	Best paper award for "Effect of two selected tanninferous tree leaves on enteric methane amelioration and methanogens diversity in sheep" by Baruah L, Malik PK, Kolte AP, Dhali A and Bhatta R. Second best paper award for "Effect of supplementation of Nano Zinc supplementation on rumen fermentation characteristics and fibre degradability in goats" by Swain PS, Rao SBN, Rajendran D, Soren NM, Pal DT and Bhat SK.
National Symposium and XXXIII Annual Convention of The Indian Society for Study of Animal Reproduction 9-11 February, 2018, Kolkata	Young scientist award for paper "Most spermatozoal transcripts originate from a few chromosomes in *Bos taurus*: a new avenue to the fertility research" by Ramya L, Parthipan S, Arangasamy A, Binsila BK, Kolte AP, Ravindra JP and Selvaraju S.

XXVI Annual conference of SAPI 2017 at Veterinary College, Bidar, 21-22 December, 2017,	J N Pandey memorial best poster award for the paper "Antiapoptotic effects of L-carnitine on developmental potential of sheep embryos produced in vitro" by Mishra A, Reddy IJ, Gupta PSP and Mondal S. Best poster award for "Quantitative expression patterns of cytokines during exposure to different climate change related environmental stresses in Osmanabadi goats" by Bagath M, Sejian V and Bhatta R. Best orator award for the paper titled Myostatin, growth hormone expression and testosterone in broiler chicken exposed to green LED lights. Reddy IJ, Mishra A, Mondal S, Awachat V and Gorti RK.
XXXIV Annual Conference the Indian Poultry Science Association (IPSACON 2017) at NIMHANS convention centre), Bengaluru, 28-30 November, 2017.	Best Poster Award for the paper titled, *In vitro* suppression of chicken myostatin transcription and translation in post hatched broiler chicken pectoral muscles cells by RNA interference, by Reddy IJ, Mishra A, Mondal S, Awachat V and Gorti RK. Best poster award (third) for the paper titled "Performance of white leghorn layers fed diets supplemented boron with and without adequate dietary calcium" by Vijay A, Gowda NKS, Pal DT, Krishnamoorthy P, Bhat KS, Francis JR and Vijay Bhasker T.
II Annual Convention and National Symposium of Society of Veterinary Biochemists and Biotechnologists of India, at Veterinary College, KVAFSU, Bengaluru, 2-3 June, 2017.	Young scientist award to Tripathi SK for the paper "Effects of elevated protein metabolites on oocyte meiosis and subsequent embryo development: Integration of genetic signatures in resultant blastocyst" by Tripathi SK, Nandi S, Gupta PSP and Girish Kumar V. Best oral presenter award for the research paper presented "Effect of ergothioneine on relative abundance of apoptotic genes in developmental stages of in vitro sheep embryos" by Mishra A, Reddy IJ and Mondal S. Young Scientist Award for the paper entitled "Sexual influence on expression patterns of different Toll Like Receptors in Royal Bengal Tigers" authored by Vidya MK, Girish Kumar V, Bagath M, Krishnan G, Sejian V, Punneeth HJ, Ramesh HS, Srikanth R, Manjunath R and Nirupama J.
9th Kerala Veterinary Science Congress organized by Indian Veterinary Association, held at Flora International Hotel, Nedumbassery Cochin, Kerala, India,11-12 November, 2017.	Best Paper Award for the paper "Impact of heat stress on carcass traits, plasma leptin profile and skeletal muscle HSP70 gene expression pattern in Malabari goats" by Archana PR, Sejian V, Krishnan G, Bagath M, Ruban W, Manjunathareddy GB, Beena V, Devi PI and Bhatta R.
First International Extension Congress 2017, held by ICAR, IARI and CIWA at CIWA, Bhuvaneshwar during 1-3 February, 2018.	Best Poster award for the poster "Climate vulnerability mapping of dairy farming in Karnataka and adaptation strategies" by Letha Devi G, Mech A, Adhiguru P, Senani S and Sivaraman M. Best Poster Award for the poster "Climate smart dairy farming" by Kataktalware MA, Letha Devi G and Ramesha KP.

National seminar on "Food Adequacy & Climate Change: Strategies for Sustainable Food Production" Thrissur, Kerala, 3-4 November, 2017.	Best Poster presentation award for the paper "Assessing the physiological adaptability of Malabari goats when shifted from its native tract to different agro-ecological zone" by Aleena J, Sejian V, Bagath M, Krishnan G, Manjunathareddy GB, Beena V, Devi PI and Bhatta R. Best Paper award for the paper "Endocrine responses of goat to heat stress challenges" by Angel SP, Sejian V, Bagath M, Krishnan G, Devi PI and Bhatta R. Best Paper award for the paper "Impact of heat stress on meat quality as evidenced by changes in physico-chemical properties, proximate composition and organoleptic attributes in Malabari goats" by Archana PR, Sejian V, Ruban W, Bagath M, Krishnan G, Manjunathareddy GB, Beena V, Devi PI and Bhatta R.

Technology assessed and transferred

Bhatta R, Malik PK and Kolte AP. 2018. Developed an anti-methanogenic feed supplement 'Harit Dhara' under Indian Council of Agricultural Research sponsored project titled "Estimation of methane emission under different feeding systems and development of mitigation strategies", released by Shri. Radha Mohan Singh, Union Minister for Agriculture and Farmers Welfare during the Farmers Conclave at ICAR-NIANP, Bengaluru, 17 February, 2018.

Gowda, NKS, Pal DT, Arangasamy A, Ravindra JP and Bhatta R. 2018. 'BULLMIN' - Technology of Mineral mixture for breeding bulls released by Shri. Radha Mohan Singh, Union Minister for Agriculture and Farmers Welfare during the Farmers Conclave at ICAR-NIANP, Bengaluru, 17 February, 2018.

Patent Granted

Indian Patent No 282946. Shredded areca sheath in mixed ration as a dry fodder for livestock. Authored by Gowda NKS, Anandan S, Pal DT and Sampath KT. (Date of Grant: 28 April, 2017).

Indian Patent No 289668. An animal concentrate fed mix with Curcuma aromata for reduction of methane. Authored by Chandrasekharaiah M, Thulasi A, Bagath M and Jose VL (Date of Grant: 16 November, 2017)

Indian Patent No 294494. Mineral mixture as nutrients for small ruminants. Gowda NKS, Pal DT, Krishnamoorthy P and Sampath KT. 2017 (Date of Grant: 19 March, 2018)

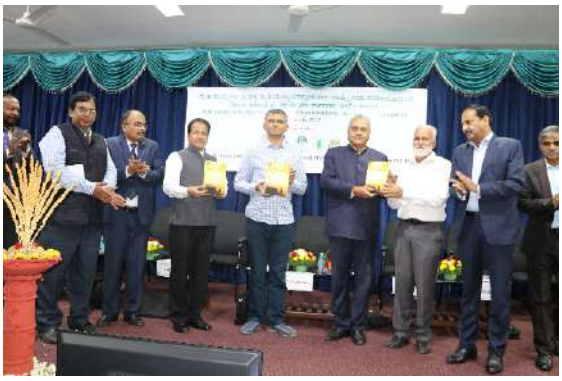
Training & Capacity Building

Training/ Workshop/ Meeting organized

Farmers' Conclave

The ICAR-NIANP in collaboration with all the ICAR institutes located in Bengaluru organized the "Farmers' Conclave" on 16-17 February, 2018. The event was attended by more than 2000 farmers, and professionals from different ICAR Institutes and KVKs located in Karnataka. Honourable Union Minister of Agriculture and Farmers Welfare, Shri Radha Mohan Singh, Union Minister of Statistics and Programme Implementation, Shri DV Sadananda Gowda, Union Minister of Skill Development and Entrepreneurship, Shri Anant Kumar Hegde, Union Minister for Parliamentary Affairs and Chemicals and Fertilizers, Shri Ananth Kumar, Secretary, DARE and Director General, ICAR, Dr Trilochan Mohapatra and DDG (Agricultural Extension), ICAR, Dr AK Singh attended the inaugural function of the event and graced the occasion. Shri Radha Mohan Singh mentioned in his speech that encouraging the young generation towards agricultural activities and increasing the farmers' income from small holdings are the major challenges of the Indian agricultural sector at present. He also mentioned that although the task is herculean, but it is not impossible if the technocrats, bureaucrats and politicians work together dedicatedly towards the targeted goal. Addressing the gathering at the event, Shri Anant Kumar Hegde and Shri Ananth Kumar mentioned that water is a scarce resource in Karnataka and therefore, appropriate policies are required to be implemented at the earliest to introduce and popularise profitable dry land agricultural practices in the State. During the Conclave 50 exhibitions stalls were setup by the ICAR Institutes and KVKs to display various technologies and products related to agriculture, animal husbandry and fisheries. Scientists-Farmers interactive meets on different aspects of agriculture and animal husbandry were organized on both days of the Conclave.

National Consultation on "Farmer Organizations: Status and Prospects", 25-26 July, 2017



The Institute organized a national consultation on "Farmer Organizations: Status and Prospects" in collaboration with the NABARD, ICAR-ATARI, ICAR-NDRI and ISEE (KC) during 25-26 July, 2017. Shri Krishna Byregowda, Honourable Minister of Agriculture, Govt of Karnataka was the Chief Guest of the inaugural session and Dr Maheswara Rao, Secretary, Agriculture, Horticulture and Sericulture, Govt of Karnataka presided over the function. Over 180 Professionals, including experts across ICAR Institutes, SAUs, NABARD, NGOs, DAHDF, Dept of Agriculture, representatives from SHGs, FPOs and FPCs and Farmers participated in the event, with lead talks, panel and group discussions, encompassing all forms of farmer organizations. Evolution of cooperatives, self help groups, origin of farmer producer organizations and their evolution into farmer producer companies were discussed in detail by the experts and other stakeholders in various sessions. Farmers and representatives shared their experiences and challenges faced and various models from private sector initiatives were discussed in a dedicated session. The deliberations brought out specific action points regarding capacity building, resource use efficiency, management, marketing and value chain and policy support for empowering farmer organizations for remunerative agriculture.

Winter School on "Livestock and Climate Change: Contributory Key Factors and Practical Amelioration Strategies", 1-21 September, 2017

A 21-day ICAR sponsored winter school on "Livestock and Climate Change: Contributory key Factors and Practical Amelioration Strategies" was organized at the Institute from September 1-21, 2017. Twenty four participants (15 male and 9 female) from nine different States attended the programme. Dr P Biswas, Vice Chancellor, West Bengal University of Animal and Fishery Sciences, was the chief guest of the inaugural programme on 01 September, 2017. A total of 43 lectures and 13 practical demonstrations were conducted for the participants in the related areas such as vulnerability of different agro-climatic regions to climatic change, enteric methane emission measuring techniques, enteric methane amelioration, life cycle assessment for GHG emission and carbon footprint from food of livestock origin. In addition to the internal resource persons, external experts from ICAR-NDRI, VCRI, EMPRI, ICAR-NIVEDI and Shiksha-O-Anusandhan University delivered lectures and interacted with the participants. Further, two lectures in related area were delivered on Skype by the renowned rumen microbiologist and animal nutritionist Dr Chris McSweeney from CSIRO, Australia and Dr Yutaka Uyeno from Shinshu University, Japan. Valedictory function of the training program was chaired by Dr AK Misra, Vice Chancellor, GB Pant University of Agriculture and Technology.

Industrial Experience Training on "Climate Change and Livestock Production", 28 July to 17 August, 2017

An industrial experience and training as a part of the elective courses of the students of the veterinary and animal sciences stream, Kerala Agricultural University, Thrissur on "Climate Change and Livestock Production" was conducted from 28 July to 17 August, 2017. The training was attended by five participants. It was organized to give equal exposure to theory and practical classes on climate change and livestock production. The students were deliberated in detail on two broader areas: livestock contribution to climate change and the impact of climate change on livestock production. The students were evaluated based on the assignment presentation and written examination. The training concluded with a valedictory function and certificate distribution to the students by the Director of the Institute on 17 August, 2017.

Technical Seminar for Veterinary Officers on "Feed and Fertility Management in Dairy Animals", 5 August, 2017

One day technical seminar on 'Feed and Fertility Management in Dairy Animals' was organized at the Institute on 5 August, 2017. Dr Suresh S Honnappagol, Animal Husbandry Commissioner, Govt of India, was the Chief Guest and Dr BS Prakash, ADG (AN&P), ICAR, New Delhi, was the Guest of Honour of the programme. More than 150 Veterinary Officers from the Department of Animal Husbandry and Veterinary Services, Govt of Karnataka, Karnataka Milk Federation and KVKs from Karnataka attended the seminar.

Training Program for Dairy Farmers of Kerala, 16-17 January, 2018

A two day training program for five elite dairy farmers of Kerala, sent under the "Agricultural Technology Management Scheme", was conducted at the Institute on 16-17 January, 2018. The traniees were accompanied by a veterinary surgeon from the Veterinary department. Topics relevant to practical management of dairy farms such as ration balancing using the locally available feed resources, prevention of mastitis, new fodder varieties suitable for the agro-climate of Kerala, usage of feed assist software and silage preparation in plastic drums were covered during the training. The famers were also given hands on training on azolla cultivation in HDPE ponds, pruning of fodder trees and silage making. Seeds of improved variety of perennial sorghum (Co FS-31) and root slips of guinea grass (DGG-1 and Co GG-3 varieties) were given to the farmers.

Orientation Program for Animal Science and Fisheries Scientists of KVKs Located in Karnataka, 6 February, 2018

One day orientation program was organized by the Institute in collaboration with the ICAR-ATARI, Bengaluru on 6 February, 2018 for the 25 animal science and fisheries scientists of KVKs located in Karnataka. The objective of the event was to create awareness about the latest technologies of ICAR-NIANP, ICAR-NDRI, ICAR-NIVEDI and ICAR-CIFA in order to test and demonstrate those in farmers' fields through the active involvement of KVKs. Resource persons from ICAR-NIANP explained in detail about the field oriented technologies and their likely benefits to the farmers. Demonstrations on silage making and grain sprouts production were also shown to the participants.

Interactive Meeting of Director General, ICAR with Heads of ICAR Institutes, 25 October, 2017

Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR, visited the Institute on 25 October, 2017 to take part in an interactive meeting with Heads of the ICAR Institutes located in Bengaluru. He reviewed the progress and addressed the critical issues of the Institutes during the meeting.

Review meeting of the Vigilance Officers, 24 August, 2017

A review meeting of more than 80 vigilance officers, administrative officers and finance and accounts officers of 24 ICAR Institutes located in Karnataka, Andhra Pradesh, Telangana, Kerala and Puducherry was held at the Institute on 24 August, 2017. Honourable Additional Secretary, DARE and Secretary ICAR, Shri Chhabilendra Roul, Director DARE and CVO ICAR, Shri Rajan Agrawal, Director Finance, Shri Devendra Kumar, Director Works, Shri VP Kotyal and Under Secretary Vigilance, Shri SK Sinha were present for the meeting. The senior officers of CPWD from southern states also participated in the review meeting.

Training for the Skilled Supporting Staff on "Basic Office Procedures", 17 to 22 March 2018

A five day training program on "Basic Office Procedures" for the skilled supporting staff was conducted from 17-22 March, 2018 under the HRD program. Three participants attended the training and faculty members were drawn from the staff working in the Purchase, Establishment, Cash and Bills and Audit wings of the Institute. The trainees were updated on the basic office procedures such as service book maintenance, leave rules, LTC and other allowances, purchase process and settlement of bills. The training concluded with the distribution of certificates and feedback from the trainees on utility of the imparted training.

Short term Research cum Training under "CV Raman International Fellowship"

Dr Abimbola Oladele Oso, Department of Animal Nutrition, Federal University of Agriculture, Abeokuta, Nigeria successfully completed his short term research cum training under the "CV Raman International Fellowship for African Researchers, DST, Govt of India", during the period of 30 December, 2017 to 28 March, 2018. He worked on the "Use of Phytogenic Blend as Alternative to In-Feed Antibiotics in Broiler Production" under the guidance of Dr RU Suganthi.

Dr Moustafa Mohamed Ahmed, Animal and Poultry Nutrition Department, Desert Research Center, Egypt, has joined from 1 February, 2018, for his short term research cum training under the "CV Raman International Fellowship for African Researchers, DST, Govt of India". He is working on the "Use of Cutinase Enzyme to Increase Utilization of Crop Residues and By-products Fed to Ruminants" under the guidance of Dr (Mrs) M Sridhar.

Hosting scholars with external grant for conducting research

Scholar	Title of the Research Project	Grant	Mentor
S Roy	Biotransformation of D-galactose into D-tagatose and its evaluation as Nutraceuticals	DST Women Scientist A	AK Samanta
K Sangeetha	Maintaining stemness of mesenchymal stem cells (MSC) on the supplementation of a novel asymmetric cell kinetic inhibitor	DST Women Scientist A	J Ghosh
G Pushpa Rani	Arsenic-induced reproductive and metabolic toxicity in mice: protective role of phyto chemicals	UGC Women Post Doc Fellow	JP Ravindra
L Somashekar	Assessing bull fertility based on seminal and sperm membrane proteins	DST INSPIRE Fellow	JP Ravindra
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 Yallappa	Studies on identification of food ingredients crossing over blood brain barriers with combat G-stress	ICMR Fellow	JP Ravindra
MV Krishnaiah	Supplementation of organic zinc copper on spermatozoal gene and protein expression pattern in male goat (*Capra hircus*)	CSIR Fellow	A Arangasamy

Training undergone by staff

Scientists

Particulars	Participants
Management Development Program on Leadership Development, ICAR-NAARM, Hyderabad, 13-24 June, 2017	I J Reddy, NKS Gowda
Impact Assessment of Agricultural Research, ICAR-NAARM, Hyderabad, 12-16 September, 2017	D Rajendran
Developing Winning Research Proposals in Agricultural Research, ICAR-NAARM, Hyderabad, 1-5 August, 2017	A Mishra
Management Development Program on Leadership Development, ICAR-NAARM, Hyderabad, 12-23 December, 2017	A Samanta, KS Roy
ICRISAT-ICAR workshop on Integrating Systems Modelling Tools to Support the Scaling of Climate Smart Agriculture in Semi Arid Regions, ICRISAT, Hyderabad, 3-5 May, 2017	PK Malik, AP Kolte

Administrative personnel

Particulars	Participants
GFR training, ISTM, New Delhi, 29 August to 01 September, 2017	SR Seenivasa
Enhancing Efficiency and Behavioural Skills for Stenographers of ICAR, ICAR-NAARM, Hyderabad, 25-31 October, 2017	Neil Vincer

Meeting/ Conference/ Symposium attended by the Director

Particulars	Date
Diamond jubilee celebration and foundation day celebration of the ICAR-CIFT, Kochi	29 April, 2017
Annual Review Meeting of AICRP on "Nutritional and Physiological Approaches for Enhancing Reproductive Performance in Animals", Veterinary College, TANUVAS, Chennai	17 May, 2016
National Workshop on "Augmenting Animal Productivity Through Emerging Technologies to Ensure Food Security in the Era of Climate Change", Chief Guest, Veterinary College and Research Institute, Namakkal	6 July, 2017
Annual Review Meeting of the Outreach Project on 'Estimation of Methane Emission under Different Feeding Systems and Development of Mitigation Strategies', Anand Agricultural University, Anand	11 July, 2017
ICAR Foundation Day, Award Ceremony 2017 and Directors Conference, NASC, New Delhi	16 July, 2017
National Symposium on "Role of Animal Agriculture in Doubling the Farmers Income", Golden Jubilee AGM of CLFMA, Mumbai	15-16 September, 2017
High level committee meeting under the Chairmanship of the Honourable Union Minister of Agriculture and Farmers Welfare to discuss the cultivation of moringa both as fodder for animals and as nutrient rich food	17 October, 2017
Technical committee meeting at National Dairy Development Board, Anand	22 November, 2017
XXXIV Annual Conference of the Indian Poultry Science Association (IPSACON-2017), Bengaluru	28-30 November, 2017
XVII Biennial Animal Nutrition Conference on "Nutritional Challenges for Raising Animal Productivity to Improve Farm Economy", Junagad, Gujrat	1-3 Februry, 2018
ICAR Director's Conference, NASC, New Delhi	8-9 March, 2018

Workshop/ Conference/ Seminar/ Symposium/ Krishi Mela/ Expo/ Meeting attended by the scientists/technical officers

Particulars	Participants
XXXIV Annual Conference of the Indian Poultry Science Association (IPSACON 2017) on "Innovations for Safe and Sustainable Poultry Production", 28-30 November, 2017, Bengaluru	S Manpal, KS Prasad, JP Ravindra, AV Elangovan, S Senani, S Anandan, NKS Gowda, AK Samanta, M Chandrasekharaiah, DT Pal, A Dhali, G Ravikiran, RU Suganthi, A Mech, KS Roy, PK Malik, C Devaraj, A Arangasamy, A Mishra, S Mondal, IJ Reddy, G Krishnan, SC Roy, PSP Gupta, S Nandi, S Selvaraju, J Ghosh, V Sejian, CG David, G Letha Devi, S Jash, K Giridhar, AP Kolte, NM Soren, D Rajendran, M Bagath, RK Veeranna, V Ramesh, Maya G, VB Awachat, DR Govinda
XVII Biennial Animal Nutrition Conference on "Nutritional Challenges for Raising Animal Productivity to Improve Farm Economy", 1-3 February, 2018, Junagad	S Manpal, KS Prasad, PK Malik, V Sejian, AP Kolte, AK Samanta, SBN Rao, S Anandan, S Senani
CLFMA Golden Jubilee National Symposium, 15-16 September, 2017, Mumbai	AV Elangovan
2nd Annual Convention of the Society of Veterinary Biochemists and Biotechnologists of India and National Symposium on "Innovative and Emerging Biochemical and Biotechnological Tools to Augment Animal Health and Production", 2-3 June, 2017, Bengaluru	RU Suganthi, A Arangasamy, A Mishra, S Nandi, SC Roy, IJ Reddy, S Selvaraju
UGC sponsored National Conference on 'Mind Body Matters: an Interdisciplinary Insight", 1-2 February, 2018, Bengaluru	A Mech, Maya G, RK Veeranna
Workshop on Methodological Framework for Implementation of Farmer FIRST project, 10-13 October, 2017, Madras Veterinary College, Chennai	A Arangasamy, G Letha Devi
Brain Storming Session on "Developing Sex Sorting Technology for Bovine Semen", organized by the Department of Biotechnology, Govt of India, 17 November, 2017, New Delhi	A Arangasamy, S Selvaraju
National Seminar on "Small Ruminants: National Scope on Upscaling Production to Products Value addition and Their Safety", 9-10 November, 2017, ICAR-CIRG, Makhdoom	M Chandrasekharaiah, SBN Rao, PK Malik, AP Kolte
Brain Storming Session on "Developing Sex Sorting Technology for Bovine Semen", organized by the Department of Biotechnology, Govt of India, 5 February, 2018, C-CAMP, Bengaluru	A Arangasamy
Brain Storming Session on "Climate Change and its Impact on Livestock Production", 12 March, 2018, Rajiv Gandhi Institute of Veterinary Education and Research (RIVER), Puducherry.	V Sejian

National Symposium and XXXIII Annual Convention of The Indian Society for Study of Animal Reproduction, 9-11 February, 2018, Kolkata	A Arangasamy, J Ghosh, S Selvaraju
XXV Annual Conference and National Symposium of the Society of Animal Physiologists of India, 21-22 December, 2017, Veterinary college, Bidar	A Mishra, IJ Reddy, G Krishnan, V Sejian, PSP Gupta, JP Ravindra, M Bagath
SVSBT Conference, 22-23 September 2017, Veterinary College, Bhubaneswar	A Mishra, SC Roy
International Conference FIPSPHYSIOCON-2017, 5-7 November, 2017, Vallabhbhai Patel Chest Institute, New Delhi	S Mondal
7th International Conference on "Silicon in Agriculture", 24-28 October, 2017, UAS, Bengaluru	K Giridhar, NKS Gowda
1st International Extension Congress, 1-3 February, 2017, ICAR-CIWA, Bhuvaneshwar	G Letha Devi
46th Dairy Industry Conference of the Indian Dairy Association, 7-10 February, 2018, Kochi	G Letha Devi
International Conference on "Invigorating Transformation of Farm Extension Towards Sustainable Development: Futuristic Challenges and Prospects", 9-10 March, 2017, TNAU, Coimbatore	G Letha Devi
National Conference on "Climate Change and Its Impact on Livelihoods", 19 March, 2018, IIPM, Bengaluru	G Letha Devi
Krishi Mela, 16-19 November, 2017, GKVK, Bengaluru	G Krishnan, CG David, A Mishra, G Letha Devi, T Chandrappa, NKS Gowda, K Giridhar
National Seminar on "Food Adequacy and Climate Change: Strategies for Sustainable Food Production", 3-4 November, 2017, Kerala	V Sejian
ARChE_Net ECLIPSE project workshop on "Impact of Environmental Changes on Ruminants", 13-15 November, 2017, Hyderabad	V Sejian
Workshop on "Livestock and Climate Change", 26 February, 2018, Veterinary College, Hassan	V Sejian, K Giridhar
Technical Workshop on "Developing Training Modules on Feed and Fodder Production and its Utilization in the Farmers' Fields", 27 February, 2018, ILRI, Bhubaneswar	K Giridhar
Meeting of Scientific panel on Contaminants in Food Chain as member at FSSAI, New Delhi, 17 November, 2017	KS Prasad
DST-Science Engineering Research Board Expert Committee and Workshop Meeting, 11-12 May, 2017, University of Kashmir, Srinagar	S Selvaraju
DST-Science Engineering Research Board Expert Committee and Workshop Meeting, 20-22 July, 2017, UAS, Bengaluru	S Selvaraju
DST-Science Engineering Research Board Expert Committee and Workshop Meeting, 15-16 September, 2017, ICGEB, New Delhi	S Selvaraju

Pashu Mela and Technical Exhibition, 4-6 January 2018, Arakalgud, Hassan	S Selvaraju, NKS Gowda, S Anandan, K Giridhar, RK Veeranna
Farmer FIRST Annual Review Meeting, 21-22 February, 2018, ICAR-IARI, New Delhi	G Letha Devi, S Senani
Farmer FIRST Project Review Meeting, 13 February, 2018, ICAR-ATARI, Bengaluru	S SenaniI
ICAR Review Committee's interactive Meeting with Subject Matter Divisions of ICAR, 24 April, 2017, ICAR-NAIP, New Delhi	K Giridhar
Interactive meeting with the veterinary and allied department officials and video conference with district collectors of AP, 1 July, 2017, Vijayawada	K Giridhar
Brainstorming session on State specific action plans on water, 24 August, 2017, National Water Mission, CGO Complex, New Delhi	K Giridhar
National group meeting of AICRP on forage crops, 4 September, 2017, UAS, Bengaluru	K Giridhar, NKS Gowda
National Workshop on "Augmenting Animal Productivity Through Emerging Technologies to Ensure Food Security in the Era of Climate Change", 6-7 July, 2017, Namakkal	D Rajendran
Institutional Ethical Committee Meeting of Regional Ayurveda Research Institute for Metabolic Disorders, 15 September, 2017, Bengaluru	AK Samanta
IMC meeting of ICAR-NIVEDI, 17 October, 2017, Bengaluru	AK Samanta
BAIF's Golden Jubilee workshop on "Improving Feed Resources and Feeding of Dairy Animals Through Integrated and Innovative Approaches", 2-3 May, 2017, Pune	DT Pal, NKS Gowda
Training for Internal Auditors for ISO 9001:2015 Certification, 7-8 August, 2017, ICAR-NIANP, Bengaluru	A Dhali, AP Kolte, A Mishra, BK Binsila, D Rajendran, G Krishnan, G Ravikiran, KS Prasad, NM Soren, SBN Rao, S Mondal, S Nandi
9th Asian Buffalo Congress, 1-4 February, 2019, Hisar	M Chandrasekharaiah
Meeting of Town Official Language Implementation Committee, 27 July, 2017 and 19 December, 2017, ISAC, Bengaluru	S Senani
Joint Hindi Divas Function organized by TOLIC, 10 January, 2018, ISAC, Bengaluru	S Senani
Liaison Officers Meeting organized by TOLIC, 14 March, 2018, ISAC, Bengaluru	S Senani, A Mech
Stakeholders meeting for identification of climate hotspot and innovative ideas for climate change proposals, 29 January, 2018, NABARD, Bengaluru	AP Kolte, PK Malik

List of Workshop/ Training conducted for stakeholders

Particulars	Date	Venue
Animal health camp	16 June, 2017	Hadonahalli, Bengaluru-Rural
Animal health camp	7 September, 2017	Hadonahalli, Bengaluru-Rural
Animal health camp	26 September, 2017	Ragihalli, Bengaluru
Animal health camp	9 July, 2017	S Nagenahalli, Bengaluru-Rural
Formation of goat farmers association for livestock based enterprise	13 September, 2017	Hadonhalli, Bengaluru-Rural
Demonstration on chaffing, silage making and azolla production	25 September, 2017	Ragihalli, Bengaluru
Training on mushroom production for farm women	7 October, 2017	ICAR-IIHR, Bengaluru
Animal health camp	8 November, 2017	Palpaldinne, Bengaluru-Rural
Field workshop on fodder production and conservation	11 November, 2017	S Nagenahalli, Bengaluru-Rural
Field workshop on feeding and management of dairy animals	20 November, 2017	Lakshmidevapura, Bengaluru-Rural
Animal health camp	11 January, 2018	Lakshmidevapura, Bengaluru-Rural
Quality milk production demonstration and kit distribution	27 January, 2018	Doddabalpur, Bengaluru-Rural
Animal health camp	2 February, 2018	Palpaldinne, Bengaluru-Rural
Awareness workshop on quality milk production	5 February, 2018	Hadonahalli, Bengaluru-Rural

Overseas visits by scientists

Particulars	Participants
University of Kassel, Germany to discuss the progress of the Indo-German Collaborative Project and to make presentation, 3-9 Oct, 2017	Raghavendra Bhatta
University of Veterinary Medicine, Budapest, Hungary, under the DST sponsored Indo-Hungary collaborative research project, 21-30 September, 2017	PSP Gupta, S Nandi.

Allocation and utilization of HRD fund

HRD fund allocation 2017-18 (lakh)	Actual expenditure 2017-18 (lakh)	Utilization (%)
3.00	3.00	100

Other Activities

Visit of Quinquennial Review Team (QRT)

The 4th QRT of the ICAR-NIANP was constituted by the Director General, ICAR, New Delhi, vide letter No. F. No. AS 29/1/17-IA-I dated 11.4.2017 for the period of April, 2012 to March, 2017 with the following members for evaluating performances of the Institute.

Name	Designation
Prof. (Dr) MP Yadav Former Vice-Chancellor, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut	Chairman
Dr KK Baruah Former Director, ICAR-NRC on Yak, Dirang	Member
Prof. (Dr) N Krishna Former Dean, Veterinary College, Hyderabad	Member
Dr G Dhinakar Raj Project Director, Translational Research Platform for Veterinary Biologicals, CAHS, TANUVAS, Chennai	Member
Dr JS Bhatia Former ADG (Edu.), ICAR, New Delhi	Member
Prof. (Dr) VH Rao Prof. and Head, Veterinary College, Tirupati	Member
Dr SK Agarwal Former Director, ICAR-CIRG, Makhdoom	Member
Dr DT Pal Principal Scientist, ICAR-NIANP, Bengaluru	Member

The first and second meeting of the team was held at ICAR-NIANP, Bengaluru on 12-13 October, 2017 and 18-20 January 2018, respectively. The Director of the Institute, Dr Raghavendra Bhatta briefed the Institute activities, proposed programs and thrust areas of the XIIth Plan including the AICRP and Outreach projects for the period from 2012 to 2017. The members of the team discussed at length on various issues related to the review process and made valid observations. The QRT visited the facilities of the institute including laboratories and experimental farm as well as new laboratory animal house and climate chamber under construction and interacted with the scientists as well as technical, administrative and supporting staff to have an overall view. The team also visited the adopted villages where the activities of the Farmer FIRST project are being concentrated.

Later, the team visited different centres and made field visits to observe the impact of the technologies at end-users level under the AICRP and Outreach programme. The QRT expressed their satisfaction on reviewing the progress of the AICRP and Outreach projects, carried out by the different centres located in various zones of the country. The team felt that the AICRP works should continue for the next five years to end up with logical conclusions and to achieve the targets including long term impact on socio-economic condition of the farmers.

Schedule of QRT Review Meetings

Event	Date	Venue/ Details
Preliminary Meeting	24 March, 2017	ICAR, New Delhi
First Meeting of QRT	12-13 October, 2017	ICAR-NIANP, Bengaluru
West Zone AICRP/ OTR Review	19-20 December, 2017	ICAR-CSWRI, Avikanagar (Review of all NZ Centres: ICAR-CSWRI, ICAR-IVRI, ICAR-NRC on Camel and field visit)
North Zone AICRP/ OTR Review	26-27 December, 2017	ICAR-CIRB, Hisar (Review of all WZ Centres: ICAR-CIRB, BAIF, AAU, GADVASU and field visit)
East Zone AICRP Review	4-5 January, 2018	OUAT, Bhubaneswar (Review EZ Centre: OUAT and field visit)
South Zone AICRP/ OTR Review	18-19 January, 2018	ICAR-NIANP, Bengaluru (Review of all SZ Centres: TANUVAS, ICAR-NIANP, AAU and field visit)
ICAR-NIANP Research Review	18-20 January, 2018	ICAR-NIANP, Bengaluru (Research results presentation and Field visit; Discussion for draft report preparation; Meeting with the administrative and accounts staff; Finalization of QRT draft report and its presentation to IMC)

The Chairman and Members of QRT made valuable observations and recommendations after reviewing the progress achieved by the ICAR-NIANP and different Centres of AICRP and Outreach programmes.

Meeting of QRT at ICAR-NIANP, Bengaluru

Scientist explaining low cost technology of silage making to QRT

Field visits of QRT and their interactions with farmers

Research Advisory Committee

Name	Designation
Dr KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat	Chairman
Dr BS Prakash, ADG (AN & P), ICAR, New Delhi	Member
Dr Kusmakar Sharma, Former ADG (Edn), ICAR, New Delhi	Member
Dr (Mrs) G Taru Sharma, Director CAFT and Head Physiology and Climatology Division, ICAR-IVRI, Izatnagar	Member
Dr G Dinakar Raj, Director, Translational Research Platform for Veterinary Biologicals, TANUVAS, Chennai	Member
Dr DVR Prakash Rao, Chairman and MD, Prakash Foods and Feed Mills Pvt. Ltd., Chennai	Member
Dr Raghavendra Bhatta, Director, ICAR-NIANP, Bengaluru	Member
Dr KT Sampath, Former Director, ICAR -NIANP, Bengaluru	Member
Shri Mahesh Patil, Kalaburagi, Karnataka	Member
Dr JP Ravindra, I/c HOD, Animal Physiology Division, ICAR-NIANP, Bengaluru	Member Secretary

The 23rd meeting of the Research Advisory Committee (RAC) of the institute was held on 19- 20 February, 2018. Dr KM Bujarbaruah could not attend the meeting due to health reason and as nominated by him, Dr KT Sampath acted as the chairman of the meeting.

Dr Raghavendra Bhatta, Director, ICAR-NIANP welcomed the honourable chairman and members of the RAC to the meeting and briefed about the institute activities and achievements during the reported period. He highlighted some of the achievements such as the award of ISO 9001-2015 certification, ICAR best annual report award, EFC approval for the student hostel and community hall for which he thanked RAC for its recommendation. On the research front, he indicated that apart from the institute projects, many externally funded projects including Indo-German, Indo-Japan, Indo-Hungary and ICARDA projects are in progress. He also mentioned about the other events including the AICRP and Outreach project review meetings, Farmers' Interface, Farmers' Conclave, Winter School, IPSACON2017 conference and celebration of Hindi Fortnight. He also informed that the QRT review for the period 2012-17 was completed.

Dr KT Sampath, Chairman, RAC welcomed all members of the committee and scientists of the institute for the meeting. He expressed his great satisfaction and happiness over the progress and overall achievements of the institute during the reported period.

The PIs presented new project proposals that were already discussed in the IRC for consideration by the RAC. Following this, brief presentations were made by the Heads of the Divisions and Section on the outcome of the completed research projects and progress of the ongoing projects.

Major recommendations of the RAC

- There are many projects on similar lines and suggested that the scientists should work as a group to address related problems.
- The basic research should aim at high impact publication and the applied projects should aim at generating technology or coming out with package of practices.
- Efforts should be made to spread technologies generated by the Institute rather than promoting the already existing technologies in the field.
- Efforts should be made to improve the overall impact factor of the research publications.
- More focus is needed on the research on ruminants and efforts should be made to improve FCR in ruminants.
- Work on production of nonhormonal galactogogues and induction of lactation may be taken up.
- The institute should interact with line departments and the stake holders to identify field problems and take up research to address those issues

Institute Research Committee

The Mid-term Institute Research Committee (IRC) was conducted on 5 December, 2017 and the annual IRC meeting for the period of April 2017 to March 2018 was held on 3-4 April, 2018 under the Chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP, Bengaluru. Dr Rajan Gupta, Principal Scientist, ICAR, New Delhi attended the annual IRC meeting as Expert Nominee from ICAR HQ. Director briefed about the latest development of the institute and apprised that the budget expenditure during the year 2017-18 was 99.83%. He also informed that the institute successfully organized the IPSACON2017 conference and Mega Farmers' Conclave attended by Honourable Minister of Agriculture and Farmers Welfare and Director General of ICAR. It was mentioned that 12 patents were filed by the Institute, of which 3 patents were granted during the year. He 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. Dr Rajan Gupta expressed his happiness for attending the IRC meeting and mentioned that research works and publications of the institute are of international quality. He mentioned that currently, many foreign visiting professors are coming to this institute from different parts of the world to pursue their fellowship programme, which indicates the Institute's reputation internationally. A total of 26 IRC approved institute projects, 17 externally-funded projects, two international collaborative and three DST-women scientist projects were presented and reviewed during the Annual IRC meeting. Four new projects were also discussed and approved and, five IRC approved institute projects and five externally-funded projects were declared completed in the Annual IRC Meetings.

Institute Management Committee

Members	Designation
Dr R Bhatta, Director, ICAR-NIANP, Bengaluru	Chairman
Dr PK Dixit, Principal Scientist, ICAR-NDRI SRS, Bengaluru	Member
Dr Rajendra Hegde, Head, ICAR-NBSSLUP, Bengaluru	Member
Dr Chandre Gowda, Principal Scientist, ICAR-ATARI, Bengaluru	Member
Dr AT Sadashiva, Principal Scientist and Head, ICAR-IIHR, Bengaluru	Member
Assistant Director General (AN & P), ICAR, New Delhi	Member
Shri Mahesh Patil, Kalaburagi, Karnataka	Member
The Director, Department of Animal Health and Veterinary Services, Govt of Karnataka, Bengaluru	Member
Dr Aswin Manubhai Thakkar, Dean and Principal, College of Veterinary Science and Animal Husbandry, AAU, Anand	Member
Dr S Yathiraj, Dean, College of Veterinary Science, KVAFSU, Bengaluru	Member
Dr KT Sampath, Former Director, ICAR-NIANP, Bengaluru	Member
The Finance and Accounts Officer, ICAR-NBAIR, Bengaluru	Member
Asst Administrative Officer, ICAR-NIANP, Bengaluru	Member Secretary

The 38th Institute Management Committee (IMC) meeting was held on 18 December, 2017, under the chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP. During the meeting, the Chairman briefed the various activities of the Institute including various research endeavours and, the action taken for the recommendations of the preceding meeting held was confirmed and agreed by the IMC. Different agenda items like procurement of equipments, manpower, infrastructure development etc. were discussed in the meetings and the proposals were recommended by the IMC.

Linkage/Collaboration

The Institute has become a partner of the ILRI-ICAR collaborative research project on "Multi-dimensional Improvement of Food-feed Crops Including Deconstruction of Ligno-cellulose Bonds for Improving Digestibility of Crop Residues". Participating organizations: ICAR-IGFRI, Jhansi; ICAR-NIANP, Bengaluru; ICAR-IIMR, Hyderabad and; ILRI, CGIAR.

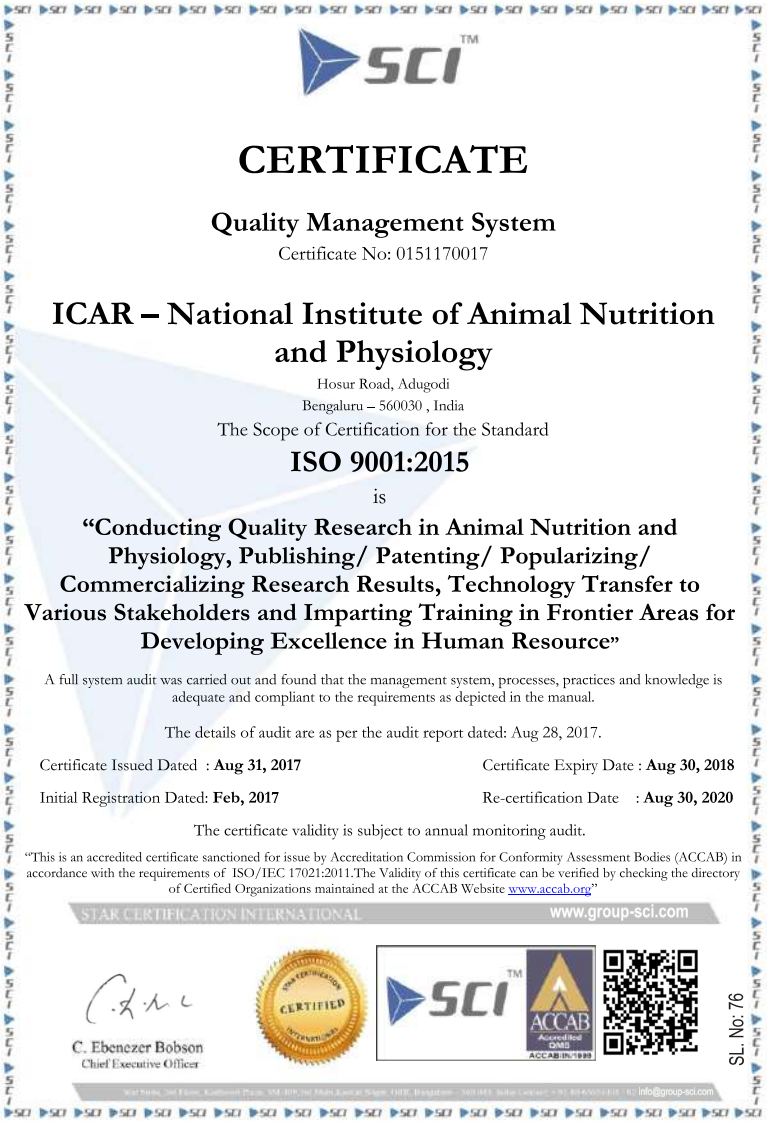
Developed collaboration with the University of Gottingen and University of Kassel, Germany for the joint

collaborative research project entitled "Optimized Use of Feed Resources for High Lifetime Productivity of Dairy Cows and Consequences on Enteric Methane Release".

Developed collaboration with Hungary for the DST funded collaborative Indo-Hungary Project entitled "Strategic Improvement of Efficiency of Vitrification of Preantral Follicles and Embryos of Sheep: Genomic Changes with Reference to Apoptosis and Developmental Competence".

ISO 9001:2015 Certification

The Institute was previously an ISO 9001:2008 certified organization and accordingly the required principles of quality management system were implemented. The certification was further upgraded to ISO 9001:2015 on 30 August, 2017 with the scope of "Conducting Quality Research in Animal Nutrition and Physiology, Publishing/ Patenting/ Popularizing/ Commercializing Research Results, Technology Transfer to Various Stakeholders and Imparting Training in Frontier Areas for Developing Excellence in Human Resource".



SCI™

CERTIFICATE

Quality Management System

Certificate No: 0151170017

ICAR – National Institute of Animal Nutrition and Physiology

Hosur Road, Adugodi
Bengaluru – 560030 , India

The Scope of Certification for the Standard

ISO 9001:2015

is

"Conducting Quality Research in Animal Nutrition and Physiology, Publishing/ Patenting/ Popularizing/ Commercializing Research Results, Technology Transfer to Various Stakeholders and Imparting Training in Frontier Areas for Developing Excellence in Human Resource"

A full system audit was carried out and found that the management system, processes, practices and knowledge is adequate and compliant to the requirements as depicted in the manual.

The details of audit are as per the audit report dated: Aug 28, 2017.

Certificate Issued Dated : **Aug 31, 2017** Certificate Expiry Date : **Aug 30, 2018**

Initial Registration Dated: **Feb, 2017** Re-certification Date : **Aug 30, 2020**

The certificate validity is subject to annual monitoring audit.

"This is an accredited certificate sanctioned for issue by Accreditation Commission for Conformity Assessment Bodies (ACCAB) in accordance with the requirements of ISO/IEC 17021:2011.The Validity of this certificate can be verified by checking the directory of Certified Organizations maintained at the ACCAB Website www.accab.org"

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C. Ebenezer Bobson
Chief Executive Officer

CERTIFIED

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SL. No: 76

Distinguished Visitors

Visitors	Date of visit
Dr Suresh S Honnappagol (Animal Husbandry Commissioner, Govt of India)	5 August, 2017
Prof. Purnendu Biswas (Vice Chancellor, West Bengal University of Animal and Fishery Sciences)	1 September, 2017
Shri Chhabilendra Roul (Secretary, ICAR)	24 August, 2017
Prof. AK Misra (Vice Chancellor, GB Pant University of Agriculture and Technology)	21 September, 2017
Dr Sreeni Kaveri (Director, CNRS Office, French Embassy in India) Dr Jerome BOVE (Scientific and Academic Attache, French Embassy in India) Mr Chandan Atreya (Scientific Coordinator, French Embassy in India)	3 November, 2017
Padma Bhushan Dr M Mahadevappa (former Vice Chancellor, UAS, Dharwad and former Chairman, ASRB) Dr H Rehman (former DDG, Animal Science, ICAR)	24 November, 2017
Dr Joykrushna Jena (DDG, Fisheries Science and Animal Science, ICAR)	28 November, 2017; 26-28 January, 2018
Dr J Radhakrishnan (Principal Secretary, Health and Family Welfare Department, Govt of Tamil Nadu)	28 November, 2017
Dr Trilochan Mohapatra (Secretary, DARE, Govt of India and DG, ICAR)	25 October, 2017; 30 November, 2017; 16 February, 2018
Shri Radha Mohan Singh (Honourable Union Minister of Agriculture and Farmers Welfare) Shri Ananth Kumar (Honourable Union Minister for Parliamentary Affairs and Chemicals and Fertilizers) Shri DV Sadanand Gowda (Honourable Union Minister of Statistics and Programme Implementation) Shri Anantkumar Hegde (Honourable Union Minister of Skill Development and Entrepreneurship)	16 February, 2018
Dr Howard Batho (Member, OIE Team for Evaluating Performance of Veterinary Services) Dr Susanne Munstermann (Member, OIE Team for Evaluating Performance of Veterinary Services)	7 March, 2018
Dr Steve Blezinger (VIRBAC Animal Health)	9 January, 2018
Dr Eva Schlet (University of Gottingen and University of Kassel, Germany)	17 February, 2018
Mr Christian Wagner (University of Gottingen, Germany)	15-25 March, 2018

Honourable Shri Radha Mohan Singh, Honourable Shri Ananth Kumar, Honourable Shri DV Sadanand Gowda and Honourable Shri Anantkumar Hegde

Dr Suresh S Honnappagol

Prof. Purnendu Biswas

Prof. AK Misra

Shri Chhabilendra Roul

Padma Bhushan Dr M Mahadevappa

Dr H Rehman

Dr Trilochan Mohapatra

Dr Joykrushna Jena

Dr Steve Blezinger

Mr Christian Wagner

Dr J Radhakrishnan

Dr Howard Batho and Dr Susanne Munstermann

Students' Research (2017-18)

Name	Degree/ University/ Academic year	Dissertation title
A Afsal	MSc/ KVASU/ 2017-2018	Heat Shock Protein 70 expression in different vital organs of heat stressed Malabari goats.
A Mor	PhD/ Jain University/ 2013-2018	Expression profiling of developmentally important genes in sheep embryos during different embryonic stages
A Sreeja	PhD/ Jain University/ 2012-2018	Purification and properties of fungal phytase and its evaluation in broiler chicken
AA Sha	PhD/ Jain University/ 2014-2018	Metagenomic profiling of fecal microbial community in carnivorous leopards *(Panthera pardus)* and omnivorous sloth bears *(Melursus ursinus)*
AJ Pai	Msc/ KVASU/ 2017-2018	Effect of heat stress on the expression patterns of different reproduction related gene expression in Malabari goats
BC Divyashree	PhD/ Jain University/ 2013-2018	Molecular characterization of some motility-associated proteins in buffalo (*Bubalus bubalis*) bull semen
D Shet	PhD/ Jain University/ 2012-2018	Production and evaluation of microbial Phytase in the diet of layer chicken
FJ Rabinson	PhD/ Jain University/ 2013-2018	Effect of season on oocyte developmental competence in sheep
G Dominic	PhD/ ICAR-NDRI/ 2013-2018	Evaluation of ayurvedic medicinal residues as non conventional feed resource in goat
G Ramesh Kumar	MVSc/ ICAR-IVRI/ 2016-2018	Impact of oxygen mediated oxidative stress on sex ratio of sheep embryos produced *in vitro*
J Chikkerur	PhD/ Jain University/ 2013-2018	Isolation of microbes for enzymatic production of short chain oligosaccharides and its evaluation as prebiotic
JNK Tej	PhD/ ICAR-NDRI/ 2015-2018	Studies on the effect of copper and selenium on oestrous induction and estradiol synthesis pathways in goats
K Sangeetha	PhD/ Jain University/ 2013-2018	Supplementation of asymmetric cell kinetic inhibitor on long term maintenance of porcine mesenchymal stem cell culture
L Jose	PhD/ Jain University/ 2013-2018	Rumen metatranscriptome analysis to identify the genes involved in the deconstruction of plant cell wall polysaccharide
L Baruah	PhD/ Jain University/ 2012-2018	Metagenomic analysis of rumen methanogen and fermentation dynamics using plant phenolics
KM Rashmi	MVSc/ ICAR-NDRI / 2016 - 2017	Effect of dietary incorporation of silkworm pupae meal on nutrient utilization in cattle

MV Krishnaiah	PhD/ Jain University/ 2015-2018	Supplementation of organic zinc copper on spermatozoal gene and protein expression pattern in male goat *(Capra hircus)*
SP Angel	Msc/ KVASU/ 2017-2018	Effect of heat stress on the expression patterns of different growth related gene expression in Malabari goats.
PK Javvaji	PhD/ Jain University/ 2013-2018	Effect of cytokine supplementation on the development and quality of *in vitro* cultured sheep oocytes and embryos
RG Rao	PhD/ Jain University/ 2013-2018	Biochemical characterization and mechanism of lignin degradation in crop residues using manganese peroxidase of Basidiomycete
S Roy	PhD/ Jain University/ 2015-2018	Effective biological production of D-tagatose using D-galactose and evaluation of its nutraceutical potentiality
S Srividhya	PhD/ Jain University/ 2012-2018	Heterologous expression and characterization of buffalo pregnancy associated glycoprotein (PAG)
SK Tripathi	PhD/ Jain University/ 2014-2018	Metabolic stress on oocyte and uterine cell functions and its ameliorations: cellular and genomic approaches
Thirumalaisamy G	PhD/ ICAR-NDRI/ 2015-2018	Evaluation of silkworm pupae (*Bombyx mori*) oil with continuous and intermittent dosing as methane suppressant in cattle and sheep
V Thammaiah	PhD/ Jain University/ 2012-2018	The production of lignin peroxidase from white rot fungi and its role in delignification of crop residues
VG Das	Msc/ KVASU/ 2017-2018	Impact of heat stress on different toll like receptors gene expression in Malabari Goats
VP Rashamol	Msc/ KVASU/ 2017-2018	Influence of heat stress on the expression patterns of different cytokine gene expression in Malabari goats

Others

Institute Technology Management Unit

The Institute Technology Management Unit (ITMU) maintains intellectual property (IP) portfolio and services provided by the Institute scientists and laboratories for sample analysis, 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. A total of 13 patent applications were filed by the Institute in

recent past and as per the National Biodiversity Act, the NBA clearance was obtained for the patent applications. Examination request was filed for the patent application on silk worm pupae oil as methane suppressant through the empanelled patent attorney. Examination report response was filed for three patents during previous year and all the three patent applications were granted. Additionally, two new patent applications filing has been initiated. The sample analysis services available through this unit are feed proximate analysis, mineral estimation in animal feeds and biological samples, hormone estimation by RIA and microbiological and toxicological testing of feeds and feed components.

ASRB-ICAR Online Examination Centre

ICAR ASRB Online Examination Centre for Karnataka has been established at the Institute for conducting ICAR NET/ ARS examination. The centre has 100 terminals along two servers, UPS backup for conducting examination. IP based CCTV surveillance was installed at the examination centre. Recently, the centre has been further strengthened with the installation of appropriate individual partitions. The following online examinations were conducted at the centre during 2017-18: Online ARS-2016 (Preliminary) and NET(1)-2017 conducted on 16-21 May, 2017; Online exam for the post of LDC, conducted on 24 February, 2018.

ARIS Cell

Agricultural Research Information Systems (ARIS) Cell was set up in 1998. The responsibilities of the ARIS cell include proper maintenance of more than 200 computer systems including their peripherals like printers and scanners. The entire process of maintaining is outsourced and monitored by ARIS cell. The information security of institute is ensured with a centralised network based security system comprising a Cyberoam firewall and antivirus software. Institute is a part of the National Knowledge Network initiative of the Government of India. As an hub of NKN, the institute is provided with 100 mbps link. The institute hosts and maintains it website in house. The website is being regularly updated with information like recruitment, tenders etc. Software like Feed Base and web portals like Feed Chart and Indian Livestock Feed Portal have been developed and are being hosted on the ICAR-NIANP website.

Experimental Livestock Unit

The Experimental Livestock Unit (ELU) has the facilities for housing experimental animals like large and small ruminants, poultry bird and mouse and rat. The unit also possesses a small scale feed processing and storage facility. During the period from 2017-18, 25 cattle, 15 buffalo, 81 sheep, 75 goats, and 444 poultry were maintained for various experiments. During the reported period, different animal experiments were conducted under 14 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 constructions of climatic chambers and new small ruminant and poultry houses at ELU campus to facilitate various experiments are on progress.

Fodder Production Unit

This unit is ensuring regular supply of green fodder to the experimental livestock unit of the Institute. Demonstration plots of Marvel grass, multicut Bajra (variety: BAIF Bajra-1), perennial Jowar (variety: Co FS-

31) and Guinea grass (variety :Co GG-3) were established during the reported period. Different forage crops such as Rhodes grass, Guinea grass, Perennial Sorghum, Hybrid Napier-bajra, Maize and Para grass were cultivated. The top feeds were also supplied from the fodder trees such as Melia, Sesbania and Gliricidia. Silage from various forage crops was prepared in plastic drums to ensure adequate green fodder during the

Demo plot of multicut Bajra (variety: BAIF Bajra-1)

Demo plot of Marvel grass *(Dicanthium annulatum)*

lean months. Azolla cultivation continued in HDPE as well as Silpaulin ponds for its use as supplemental feed. The stem cuttings of Sampoorna variety of Hybrid Napier-bajra and Marvel grass, root slips of Guinea grass, Seedlings of Sesbania, stem cuttings of Gliricidia, and Azolla culture were supplied to several farmers. Method demonstrations were conducted on seed treatment of Hedge Lucerne seeds for improving germination, production of Maize sprouts on straw beds in low cost bamboo shelves, Azolla cultivation in ready to use PVC ponds, preparing shade dried Azolla and silage making in plastic drums for the benefit of 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 83 scientific and administrative reference books and 42 books on Rajbhasha (Hindi). It also received 324 gratis publications from India and abroad. The library subscribed 19 scientific journals published from India. The library and the staff of the institute have online access of most of the required foreign research journals though Consortium of e-resources in Agriculture (CeRa)/ J-Gate Plus platform of ICAR. In addition, the library subscribed 12 general magazines and eight newspapers in English, Hindi and Kannada for the readers.

The Library facilities are also offered to the officials 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. Presently, majority of the operations of the library including issue of books/ journals/ reading materials and its records have been digitalized.

Official Language Implementation Cell

The Official Language Section of the Institute is dedicated for the implementation of Hindi as Official Language. For emphatic implementation and guidance, there is an Official Language Implementation Committee (OLIC) with the Director as its Chairman. The quarterly meetings of OLIC were held regularly to review the progress made in Official Language implementation. The decisions taken in the OLIC meetings were implemented in the day to day work and the meeting minutes were sent to the ICAR headquarter, New-Delhi, Town Official Language Implementation Committee (TOLIC), Bengaluru and Regional Implementation

Office (South) for further monitoring. Four workshops were organized every quarter (June, September, December and March) for Scientists/ Officers/ Employees for removing any hesitation to work in Hindi. Emphasis in these workshops was on to make use of computers and Hindi software for carrying out routine work in Hindi. A workshop was also organized on 23 December, 2017 in the form of an "Oral Quiz". Hindi Pakhwada was celebrated from 14-28 September, 2017. During the Pakhwada, various competitions such as letter writing, antaakshari, translation, paper presentation, slogan writing, quiz, extempore and poem reading were organized. Prizes were distributed to the winners during the valedictory function held on 28 September, 2017.

Under the aegis of TOLIC, ICAR-NIANP organized a 'Hindi Solo Song' competition on November 16, 2017 and 16 participants from various Central Government organizations participated in the event. Three scientists from the ICAR-NIANP received TOLIC third prize for writing technical article in Hindi. The Director and In-charge of the Official Language Section of the Institute attended the TOLIC Meetings on 27 July, 2017 and 19 December, 2017. In addition, the In-charge of the Official Language Section also represented the Institute in the Liaison Officers meeting held on 14 March, 2018. Technical articles in Hindi were published in the Rajbhasha Aalok, New-Delhi by the scientists of this Institute.

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 Shri BH Venkataswamy (Chief Technical Officer), Smt Ningamma (Skilled Supporting Staff) and Smt Mahalakshmi (Skilled Supporting Staff). Condolences meetings were organized to pay homage to the departed souls of Dr (Mrs) A Tulasi (Senior

Scientist) and Shri Narayana Rao (Technical Officer). The SWC also organized several events such Independence Day, Ganesh Chaturthi, Ayudh Puja, New Year 2018, Makara Sankranti, Kannada Rajyotsava and Republic Day. As a part of the International Yoga Day Celebration, SWC organized a yoga program for the staffs in collaboration with the Isha Foundation. The club also recognized the children of permanent staff, who have passed the board examinations (10th and 12th) with outstanding grades/ marks.

Women's Cell

The meeting of the Women's Cell of the Institute was held on 23 March, 2018. It was chaired by the In-charge of the Cell and was attended by all members including a member of the Mahila Dakshata Samiiti,

Bengaluru, Mrs Usha Nanaiah. It was decided during the meeting that annually four programmes will be organized by the Cell for the Institute staff and their family. A tentative list of the proposed events was chalked out for the year 2018-2019 that includes talks on important social issues like good parenting, dealing with elderly people in the family, importance of interpersonal relationship in families, in work and in society at large and dealing with children with special needs as well as demonstrations on preparation of juices and jams, designing and painting of diyas for festive occasion, how to make chocolates at home and making and designing greeting cards. Smt Mahalakshmi (Skilled Supporting Staff) was also felicitated by the Cell on her superannuation.

Games and Sports

The Sports Section of the institute organized various sports events to inculcate competitive spirit and to ensure welfare of the staff of the institute. The Section organized various sports meets both during the

Independence Day as well as Republic Day celebrations. For ladies, badminton, chess, carrom, rangoli, 100 M race, discuss throw, javelin throw, shot put, spoon lemon race, musical chair and tug of war were organized. For men, badminton, table tennis, chess, carrom, 100 M race, discuss throw, javelin throw, shot put, hit wicket and tug of war were organized. The Institute also represented the ICAR Zonal Sports Meet organized by the ICAR-Sugarcane Breeding Institute, Coimbatore by sending eight contingents.

Celebration of Institute Foundation Day

The Institute celebrated its 23th Foundation Day on 24 November, 2017. Padma Bhushan Dr M Mahadevappa, former VC, UAS, Dharwad and former Chairman, ASRB was the Chief Guest of the event. Dr H Rahman, Regional Representative for South Asia, ILRI and Former DDG (AS), ICAR was the Guest of Honour.

Dr Raghavendra Bhatta, Director of the Institute highlighted various ongoing activities and recent

developments of the Institute. He also expressed his earnest gratitude and appreciation to all the existing and retired staff including former directors and well wishers of the Institute for their significant contributions towards the development of ICAR-NIANP. Speaking on the occasion, the Chief Guest lauded the contributions of the Institute. Noting the highly significant contributions of the Institute in the field of animal nutrition, animal physiology and related areas, Dr M Mahadevappa encouraged the scientists to establish closer connection between the scientific outcome and its potential beneficiaries. He expressed his

happiness for being associated with the development of this institute since its inception and assured his willingness to facilitate this Institute in the coming days. Addressing the gathering, the Guest of Honor Dr Rahman mentioned the significant contributions of ICAR-NIANP as a unique and outstanding research Institute in the area of animal science of this country. He also mentioned that more international research collaborations are required for this Institute to increase its visibility beyond the national boundary. The latest printed version of "NIANP at a Glance" and DVD of the short documentary film "A Glimpse of ICAR-NIANP" were also released on this occasion. A cultural extravaganza was performed by the staff of the Institute.

XXXIV Annual Conference of the Indian Poultry Science Association (IPSACON 2017)

The Institute in association with the Indian Poultry Science Association (IPSA) organized the XXXIV Annual Poultry Science Conference (IPSACON 2017) from 28-30 November, 2017 at NIMHANS Convention Centre,

Bengaluru. During the event, five technical and three poster sessions were organized covering all the areas of poultry science including a panel discussion on marketing strategies in poultry sector and scientist-industry interface involving eminent poultry professionals. The conference was attended by more than 400 delegates.

Visit of Delegates from French Embassy in India

Delegates from the French Embassy in India Dr J Bove (Scientific and Academic Attache), Dr S Kaveri (CNRS Office, Service for Science and Technology) and Mr C Atreya (Scientific Coordinator) visited the Institute on 16 November, 2017 and interacted with the scientists. During the meeting, the team appraised about the possible scientific collaborations with the academicians of France and various funds and opportunities available for the researchers and students.

Swachh Bharat Abhiyan

As a part of implementation of the Swachh Bharath Abhiyan and as per the guidelines of ICAR, The Institute observed the "Swachhata Hi Seva" during the period from 15 September to 2 October, 2017. The Seva Diwas was celebrated on 17 September and thorough cleaning of the Institute premises was performed. The "Samagra Seva Diwas" was celebrated on 24 September and all the staff participated in cleaning, plantation of tree sapling and disposal of organic wastes at the Institute campus. The Institute celebrated "Sarwatra Swachhta" on 25 September and all the permanent and contractual staff participated in swachhatha of the

office building surroundings. Foundation was also laid for developing proper toilet facility for differently able persons. Swachhata abhiyan was conducted by the Institute staff at neighbourhood, Lakshmi Devi Park, Koramangala on 1 October and cleaning of the premises was performed. Additionally, other regular activities were conducted throughout the year under the mission.

Mera Gaon Mera Gaurav Programme

Under MGMG program, the Institute has made 10 teams and selected 50 villages within 100 km distance from Bengaluru. The teams regularly visited the villages and interacting with farmers to appraise about scientific feeding, reproduction, fodder cultivation and management of livestock. Literature were printed in local language and distributed to farmers. Technical information were also provided through workshops

Right to Information

During the reported period of 2017-2018, a total of 29 RTI applications were received. And requisite information were provided to all the queries as per the provision of RTI Act. .

Personnel

List of Employees

Scientific personnel

Name	Designation
Dr Raghavendra Bhatta	Director
Animal Nutrition Division	
Dr KS Prasad	Principal Scientist, I/C HOD
Dr SBN Rao	Principal Scientist
Dr M Chandrasekharaiah	Principal Scientist
Dr AK Samanta	Principal Scientist
Dr S Senani	Principal Scientist
Dr S Anandan	Principal Scientist
Dr DT Pal	Principal Scientist
Dr D Rajendran	Principal Scientist
Dr (Mrs) A Thulasi	Senior Scientist (until 13-06-2017)
Dr NM Soren	Senior Scientist
Dr AP Kolte	Scientist
Dr M Bagath	Scientist
Animal Physiology Division	
Dr JP Ravindra	Principal Scientist, I/C HOD
Dr JR Ippala	Principal Scientist
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 CG David	Principal Scientist
Dr S Selvaraju	Principal Scientist and National Fellow
Dr V Sejian	Senior Scientist
Dr A Arangasamy	Senior Scientist
Dr A Mishra	Senior Scientist
Dr G Krishnan	Scientist
Dr (Mrs) BB Krishnan	Scientist
Bioenergetics and Environmental Sciences Division	
Dr (Mrs) M Sridhar	Principal Scientist, I/C HOD
Dr AV Elangovan	Principal Scientist
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)
Shri BH Venkataswamy	Assistant Chief Technical Officer, T-7/8 (FPU, until 31-05-2017)
Dr VB Awachat	Senior Technical Officer, T-6 (ELU)
Shri VR Kadakol	Senior Technical Assistant, T-4 (APD)
Shri DR Govinda	Senior Technical Assistant, T-4 (Estate and Maintenance)
Mrs G Maya	Technical Assistant, T-3 (BEES)
Shri KM Kamalesh	Technical Assistant, T-3 (Maintenance)
Shri HS Narayana Rao	Technical Assistant, T-3 (AND, until 03-10-2017)
Shri M Shivarama	Senior Technician, T-2 (Maintenance)

Administrative Personnel

Name	Designation
Administration	
Mrs S Shashikala	AO
Mrs R Kalaivani	AAO
Shri SR Sreenivasa	Assistant
Shri R Suresh Babu	Assistant
Mrs JV Jyothi	Assistant
Shri A Neil Vincer	PA (on deputation)
Mrs B Geetha	UDC
Shri L Gowda	LDC
Shri M Naveen Kumar	LDC
Accounts and Audit	
Mrs PP Sheeja	AFAO
Mrs MP Mridula	Assistant
Mrs P Nagaraju	UDC
Shri A Murthy	LDC

Supporting Staff

Name	Designation
Shri Chennamaraiah	SSS
Smt Ningamma	SSS (until 31-07-2017)
Smt Mahalakshmi	SSS (until 28-02-2018)
Shri K Narayana	SSS
Mrs J Lakshmi	SSS

In Charges of Section/ Unit/ Cell

Section/ Unit/ Cell	In charge
Priority Setting, Monitoring and Evaluation Cell-I	Dr JP Ravindra
Priority Setting, Monitoring and Evaluation Cell-II	Dr KS Prasad
Institute Research Council	Dr DT Pal
Official Language Implementation Cell	Dr S Senani
HRD Nodal Officer	Dr S Anandan
Academic Cell	Dr KS Prasad
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 VB Awachat
Fodder production Unit	Dr K Giridhar
Women's Cell	Dr (Mrs) M Sridhar
Public Relation Officer	Dr AK Samanta
Public Information Officer	Dr KS Roy
Radiological Safety Officer	Dr IJ Reddy
Citizen's Charter and Grievance Cell	Mrs S Shashikala
Institute Joint Staff Council official / staff	Mrs R Kalaivani / Shri DR Govinda

Recruitment / Appointment / Joining

Name	Promoted to the next higher post of	With effect from
Dr C Devaraj	Scientist, transferred from ICAR-CIFA, Bhubaneswar to ICAR-NIANP, Bengaluru	06-07-2017
Mrs PP Sheeja	Promoted from the post of JAO, ICAR-CPCRI, Kasargod to the post of AF&AO at ICAR-NIANP, Bengaluru	17-11-2017
Mrs S Shashikala	Promoted from the post of AAO, ICAR-NDRI (SRS), Bengaluru to the post of AO at ICAR-NIANP, Bengaluru	01-01-2018

Promotion

Name	Promoted to the next higher post of	With effect from
Dr G Ravikiran	Principal Scientist	06-10-2013
Dr J Ghosh	Principal Scientist	02-12-2014
Dr CG David	Principal Scientist	24-09-2015
Dr S Selvaraju	Principal Scientist	09-10-2015
Dr A Dhali	Principal Scientist	04-11-2015
Dr D Rajendran	Principal Scientist	11-01-2016
Dr RU Suganthi	Principal Scientist	15-03-2016
Shri VR Kadakol	Senior Technical Assistant (T-4)	14-09-2014
Shri DR Govinda	Senior Technical Assistant (T-4)	06-08-2017

Retirement

Name	Particulars
Shri BH Venkatasamy	T-7/8, superannuation retirement on 31-05-2017
Mrs Ningamma	SSS, superannuation retirement on 31-07-2017
Mrs Mahalakshmi	SSS, superannuation retirement on 28-02-2018

Obituary

Name	Particulars
Dr A Thulasi	Expired on 14-06-2017
Shri HS Narayana Rao	Expired on 04-10-2017

List of Research Projects

Prog. 1: Deconstruction of Ligno-Cellulosic Biomass for Improving Feed Utilization

Funding	Project Title	Duration	
		Start	End
DBT	Biomining of selected white rot fungi (WRF) for novel lignin peroxidase and manganese peroxidase for enhancing digestibility of crop residues	Mar, 2015	Mar, 2018
ILRI	Multidimensional improvement of food-feed crops including deconstruction lignocelluloses bonds for improving digestibility of crop residues	Apr, 2016	Mar, 2019

Prog. 2: Biogeography of Gut Microbes in Animals

Funding	Project Title	Duration	
		Start	End
Institute	BGM 2.2. Comparative rumen metagenomics of domestic ruminants	Apr, 2014	Mar, 2018
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

Prog. 3: Novel Approaches for Assessing and Improving Nutrient Bioavailability, Animal Reproduction and Productivity

Funding	Project Title	Duration	
		Start	End
Institute	APR 3.4. Elucidating role of boron on gene expression for calcium utilisation, immune response and antioxidant mechanism	Apr, 2014	Sep, 2017
Institute	APR 3.5. Utilization of nano zinc and its impact on growth and reproduction in goats	May, 2014	Apr, 2017
Institute	APR 3.6. Modulation of granulosa cell estradiol synthesis using copper and selenium	Jul, 2014	Jun, 2018
Institute	APR 3.7. Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken	Jul, 2014	Nov, 2017
Institute	APR 3.8. Effect of dietary selenium on selenoprotein genes in lambs	Apr, 2014	Sep, 2017
Institute	APR 3.9. Nutritional conditioning for neonatal programming in broiler chicken: Gut development and immunity	May, 2015	Apr, 2018

Institute	APR 3.10. Development of a novel semen extender for improved post-thaw motility of cryopreserved buffalo semen	Jul, 2015	Jun, 2019
Institute	APR 3.11. Development of ideal protocol for isolation and culture of ram spermatogonial stem cell	May, 2015	Mar, 2018
Institute	APR 3.12. Development of pregnancy associated glycoprotein (PAG) based immunoassay for buffaloes *(Bubalus bubalis)*	May, 2015	Apr, 2018
Institute	APR3.13. Manipulating apoptotic signalling to improve oocyte development competence in sheep	May, 2016	Apr, 2018
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, 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
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 as food and feed	Jan, 2017	Mar, 2018

DBT	Transcript profiling and functional significance of molecular determinants of follicular and oocyte competence under metabolic stress	Sep, 2013	Sep, 2017
AICRP	Nutritional and physiological interventions for enhancing reproductive performance in animals	Apr, 2014	Mar, 2020
DBT	Wnt signal mediated ovarian granulosa cell estrogen synthesis in ruminants	Nov, 2014	Nov, 2017
DBT	Organic zinc and copper supplementation on advancing puberty, spermatozoal transcription expression profile and fertility in goat	Nov, 2014	Nov, 2017
DBT	Production of plant sourced mannan oligosaccharides for improving the productivity of freshwater aquaculture	Jun, 2016	Jun, 2019
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	Selective isolation of sex specific spermatozoa in bovines using novel biomarkers identified through an integrated proteomic and genomic approach	May, 2017	May, 2020

Prog. 4: Feed Informatics, Feed Quality and Safety and Value Addition

Funding	Project Title	Duration	
		Start	End
Institute	FQS 4.1. Real time estimation of livestock feed and fodder resources availability in India	May, 2015	Apr, 2018
Institute	FQS 4.2. Development of a universal inoculum/s for production of quality silage	Apr, 2015	Mar, 2018
Institute	FQS 4.3. Development of a novel phytogenic blend to replace antibiotic growth promoters in broiler production.	Dec, 2017	Mar, 2021
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

Prog. 5: Climate Change Impact on Livestock

Funding	Project Title	Duration	
		Start	End
Institute	CCL 5.1. Life cycle assessment of green house gas emission from dairy farms of Karnataka State	Mar, 2015	Mar, 2018
ICAR-Outreach	Estimation of methane emission under different feeding systems and development of mitigation strategies	Apr, 2008	Mar, 2020
DBT	Livestock methane reduction through immunization based approach	Aug, 2014	Feb, 2018
DST-JSPS (Indo-Japan)	Methane mitigation using unexplored phyto-sources in ruminants and their effect on rumen microbial diversity	Aug, 2015	July 2017
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

Prog. 6: 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	Mar, 2019
Institute	TTA 6.3. Economics of milk production under different systems of dairy farm management in Karnataka	Apr, 2017	Mar, 2020
ICAR (Farmer FIRST)	Improving livelihood security of farmers through technological interventions for sustainable livestock farming	Nov, 2016	Mar, 2020
ICAR (Farmer FIRST)	Enriching knowledge and integrating technology and institutions for holistic village development in horticultural based farming systems	Nov, 2016	Mar, 2018

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ISBN 9788193231258