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Annual Report 2016-2017

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

वार्षिक प्रतिवेदन

Annual Report
2016-17

भाकृअनुप-राष्ट्रीय पशु पोषण एवं शरीर क्रिया विज्ञान संस्थान
बेंगलूरु

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

Citation
ICAR-NIANP Annual Report 2016-2017

Compiled and edited by
Dr A Dhali-Chairman
Dr AP Kolte
Dr CG David
Dr RU Suganthi
Dr PK Malik

Published by
Dr Raghavendra Bhatta
Director, ICAR-NIANP
June, 2017

Cover page theme
The graphic depicts our efforts for ensuring the livelihood of farmers through profitable and sustainable animal husbandry practices.

ICAR-National Institute of Animal Nutrition and Physiology
Adugodi, Hosur Road, Bengaluru - 560 030, Karnataka, India

Tel. No + 91-80-25711304, 25711303, 25702546
Fax + 91-80-25711420
Email directornianp@gmail.com
Website http://www.nianp.res.in

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Preface

In India, animal husbandry has remained as an integral part of agriculture since time immemorial. Substantial diversity exists in the population of the Indian livestock and the potential is yet to be exploited fully. The contributions of the livestock sector to the national and agricultural GDP are approximately 4 and 30 percent respectively. The livestock sector provides livelihood security and employment to millions of small, marginal and landless farmers. Remarkable growth in the total production of different livestock products has been witnessed in the country over the last 50 years. Nevertheless, the per capita availability of many of the livestock products is less in India as compared to that of the developed countries. At this context, the basic and fundamental research in the area of animal nutrition and physiology is highly critical and can provide solutions to the problems related with low performance level of Indian livestock and feed and fodder scarcity.

Our country will definitely be a much different place by next two to three decades in terms of population, economy, climate and consumer preferences as evident from the fast changing scenarios at the national as well as global level. Therefore, conscious efforts will be required to meet the demand in those days. It is essential to visualize the impending challenges and work hard towards achieving them.

The Institute is relentlessly working in understanding the various basic and fundamental aspects of animal nutrition and physiology. Since last two decades, we are primarily focusing to improve the performances of different livestock species through basic nutritional and physiological approaches and to develop appropriate user friendly technologies. During the reported period of 2016-17, we have directed our research endeavours under six well conceptualized research programmes. Our efforts have been well recognized through publications and awards and honours. It is my privilege to present you the salient achievements of the Institute in this report for your perusal and critical comments. I believe that this report will serve as a reference to the personnel involved in the field of animal nutrition and physiology.

The ICAR-NIANP team is extremely thankful to the Council for receiving overwhelming supports in terms of resources, guidance and various other facilities. I sincerely thank Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR for constant support and guidance. We are grateful to Dr KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat and Chairman of the Research Advisory committee and the members of the august body for reviewing our research projects and for providing constructive suggestions. I gratefully acknowledge the encouragement and support from Dr Habibur Rahman, former DDG (AS), ICAR. I thankfully acknowledge the support of Dr BS Prakash (ADG, AN&P), Dr Rajan Gupta (Principal Scientist, AN) and Dr Vineet Bhasin (Principal Scientist, AGB) from the Council for their constant support and coordination at the ICAR level.

It will be unfair not to put on record the untiring effort of the scientists and other staff of the Institute. Their hard work and dedication have been duly reflected in this report. I congratulate the entire team of the editorial board for bringing out this report as per the schedule.

Raghavendra Bhatta

Executive summary

The ICAR-National Institute of Animal Nutrition and Physiology has successfully completed 21 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 2016-17, the Institute functioned with 40 scientists, 9 technical staff, 11 administrative and accounts personnel and 5 skilled supporting staff. The total plan and non-plan budget allocations were Rs 1877.00 lakh and the total expenditure was Rs 1864 lakhs (99.3%) during the financial year. The institute generated Rs 62.2 lakh as revenue during the period. The scientists of the Institute relentlessly worked for achieving the various targets related to research and technology 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.

White rot fungi are known for their ability to produce the lignin degrading enzymes. The purified Lignin peoxidase (LiP) was produced through immobilization of white rot fungi. The LiP was used for enhancing digestibility of various cereal crop residues. FTIR study provided new information towards elucidation of the mechanisms involved in the biological degradation processes of straws. *In vivo* feeding trials in sheep with purified LiP to improve digestibility resulted in enhanced growth performance and digestibility. These studies demonstrated the potential use of this enzyme for feeding/oral dosing in ruminants.

Biogeography of gut microbes in animals

The microbial assemblage in the rumen have been identified as an important constituent in digestive process and helps in nutrition, immunity and other physiological functions in animals. Knowledge of the microbial communities in the gut could help in understanding the unexplored potential of animals to improve the animal production systems, amelioration of the methane emissions form ruminants and bioprospecting newer genes for industrial applications.

Cattle, buffalo, sheep and goat rumen metagenomes were profiled using 16s rRNA amplicon sequencing using illumina sequencing chemistry. The phyla Fermicutes and Bacteroides dominated the cattle, buffalo and sheep rumen microbiome. However, the goat rumen had abundance of Fermicutes, Bacteroides and Proteobacteria in equal proportions.

The glycosyl hydrolases in the rumen of cross bred steers fed finger millet straw were studied. Distinct classes of CAZymes belonging to three CAZy families (GHs, CBMs, and CEs) were found in the metagenome of crossbred steers fed finger millet straw, concentrate and paragrass. The studies revealed that Glycoside Hydrolases (GHs) were the most abundant in cattle rumen metagenome.

The 16S rRNA gene sequence information has been used as the "gold standard" for identification and taxonomic classification of bacterial species. Analysis and comparison of the bacterial 16S rRNA sequence is a valuable genetic technique and can lead to the recognition of novel species. In an effort to build a database, sequences from existing repositories were identified and pooled in structured databases and web tools were developed. A database of 16S rDNA of the rumen specific microbes was developed and hosted at ICAR-IASRI, New Delhi.

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. Unique cultures from the genera Paenibacillus, Flavobacterium, Bifidobacterium, Shewanella, Campylobacter were submitted to the repository.

Molecular characterization of cultures submitted by collaborating institutes of ICAR has been completed. Metagenome analysis predicted the presence of Unique CAZymes in crossbred steers.

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

Boron is a less studied element in animal nutrition. To establish the role of boron in calcium homeostasis, effect of boron supplementation was studied in white leghorn layers. Boron supplementation (40ppm) to diets with inadequate Ca improved the egg production, shell thickness and reduced the number of cracked eggs. Immune response was found better in birds fed diets supplemented with boron.

Nanominerals are superior to the inorganic and organic mineral supplements in animal diet. The effect of nano zinc supplementation was studied in goats. Average daily gain and feed conversion ratio were better in group supplemented with Nano-ZnO-25ppm and had an edge over Nani-ZnO-50ppm and Inorganic-ZnO-50ppm compared to control. Humoral and cell mediated immunity was better in Zinc supplemented animals. Sperm quality was improved by supplementation of Nano-Zno in bucks without affecting the semen volume and total semen production.

Dietary Selenium (Se) is essential for growth, immunity and reproduction and is an important factor in determining optimal health and disease susceptibility of sheep. Dietary supplementation of organic Se at supranutritional levels improved the antioxidant capacity of liver and muscle tissues and the regulation of selenoprotein genes by Se was associated with the level of supranutritional Se supplied and the type of selenoprotein and tissue.

Neonatal supplementation of amino acids and trace minerals was studied on developmental patterns of gastrointestinal and immune system in poultry. Series of experiments were conducted to assess the effect of amino acids and mineral combination supplements at the day-18 of embryonic age. The results indicated that *In ovo* supplementation of amino acids and minerals were beneficial for gut development in broilers.

The dietary level of copper affects the expression profiles of copper-related transporters and chaperone genes in sheep. To identify copper deficiency biomarkers by comparing the differential expression status of selected copper transporter and chaperone genes in sheep, transcriptomic profile was generated and validated by qPCR. The study revealed that *CTR2*, *ATP7B* and *COX17* genes were up-regulated and *ATOX1*, *SCO1* and *CCS* genes were down-regulated in blood as well as liver tissue in the Cu-deficient animals. Differential liver gene expression analysis compared to adequate group revealed that deficient animals had 58,700 transcripts with >1.5 fold over expression out of which 988 were significantly up-regulated. Among 69,071 down-regulated transcripts (<0.66 fold), 357 were significantly down-regulated.

A study was initiated to extract mannan from guar seed for the production of mannan oligosaccharides (MOS) and to elucidate the therapeutic value of MOS in peninsular freshwater fishes. Five varieties of guar *(Cyamopsis tetragonoloba)* seed were evaluated. Stirring of guar seed in water for 30 minutes resulted in 25% mannan yield that was free from protein or soluble sugars.

The All India coordinated research project is in progress with 12 centres throughout the country, led by ICAR-NIANP to assess the extent of infertility conditions and possible interventions through nutritional and physiological means in animals. Salient achievements during the reported period were: IGF1 improved post-thaw sperm functional parameters and reduces oxidative stress of buffalo spermatozoa; A total of 66 and 54 proteins were found to be unique to good and poor quality spermatozoa respectively; Feed supplement comprising a source of energy, protein and an antimicrobial agent formulated by ICAR-NIANP increased average level of milk fat from 2.59 to 3.85%, resulted in conception in 76% animals that had reproductive problems; The 'Doublesynch' and the 'Estra-doublesynch' estrous synchronization protocols along with fixed time AI were carried out in cows with more than 80% success in conception rate in problematic animals.

Studies on the of role of Wnt signal in FSH mediated ovarian granulosa cell estrogen synthesis from

pre-antral follicles in buffalo indicated that the Wnt signal was crucial for the synthesis of estradiol, even in early folliculogenesis. Additional feeding of organic Zn and Cu to growing male goats advanced the onset of puberty and improved quantitative and qualitative characteristics in fresh semen, and also protected sperm cells against cold shock induced cryoinjury during pre-freeze and in post-thawed semen.

Exposure to monochromatic green LED light at 575nm of wavelength during *in ovo* and *ex ovo* period effectively stimulated the hypothalamic-pituitary-gonadotrophic-somatotrophic-thyrotrophic axis resulting low feed consumption, low FCR and increased muscle mass and body weight gain in broiler chicks.

Experiment was conducted to assess the effect of inhibiting caspase-9 and -8 on the development competence of sheep oocytes. The results indicated that the Inhibition of caspase-9 and -8 during *in vitro* maturation significantly improved the *in vitro* development of sheep oocytes and embryos.

Supplementation of carnitine and ergothioneine to *in vitro* culture medium created beneficial micro-environment for better development and survivability of sheep embryos with favourable expression of certain genes related to apoptotic and antioxidant systems.

Studies on the effect of copper and selenium on estradiol synthesis in the granulosa cells of goat indicated that these minerals up-regulated the expression of genes responsible for estradiol synthesis, anti-oxidant mechanism, FSH receptor synthesis and anti-apoptosis. The mRNA expression of development related genes *(GDF9, IGF1, FSHr, FGF8, EGF, Aromatse P4500* and *G6PD)* in metabolic stressed pre-antral follicles, COCs, two cell embryos and blastocysts was down regulated as compared to normal ones. Addition of Cathepsin B Inhibitor in embryo culture medium improved the developmental competence of metabolic stressed COCs during IVM.

Semen cryopreservation is an indispensable tool to preserve and propagate elite germplasm for breeding and improvement of farm animal species. Nevertheless, in buffalo, the process of cryopreservation induces significant bio-molecular changes in proteins and lipids of sperm and this may be one of the major causes of reduced post-thaw motility and fertility of semen. Few agents were found to have the potential and can be used as sperm motility enhancer, while developing a species-specific semen extender for buffaloes.

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 SSCs provide an ideal model to understand the molecular mechanism involved in spermatogenesis, regulation of male fertility and also to improve male fertility by transplantation of superior quality SSCs. Differential plating using laminin in combination with BSA significantly improved the purity of spermatogonial stem cells as compared to lectin and gelatin.

Early diagnosis of pregnancy is important for better managemental practice in buffaloes. Nevertheless, no buffalo specific pregnancy detection kit is available currently. The majorly expressed transcript (PAG) in early buffalo cotyledon were identified and recombinantly produced. Availability trend of a specific isoform could be established using PAG peptide epitope in buffalo plasma. Further, sub cloned a desired PAG sequence in mammalian vector for expression.

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.

Preservation of surplus fodder during the periods of abundance can bridge the gap during scarcity periods, especially for high yielding animals. Preservation of fodder crops by making silage can ensure regular supply throughout the year. Studies were undertaken for the preparation of high quality silage from grasses, fodder crops and crop residues. Para grass, Rhodes grass and Hybrid Napier were

ensilaged individually or as a mixture for 30 or 45 days. A reduction in the NDF%, but not in the ADF% and ADL% was observed following the process. Duration of ensiling process did not influence silage qualities.

Biofortification is the method for increasing the content of a particular nutrient, which is deficient in cereals, but critical to animal performance. ICAR-NIANP, Bengaluru was entrusted with the responsibility of quality evaluation of biofortified cereals and byproducts as compared to their conventional varieties in terms of nutrient utilization in livestock. During the reported period, straw samples of different verities of fortified foxtail millet, little millet and finger millet from various locations were analyzed for nutritional qualities.

Correction of nutrient deficiencies in soil is expected to improve the health of crops as well as livestock. A field study was taken up in Zinc deficient soils in Durga Nagenhalli village of Tumkur district with twin objectives of studying the effect of correction of Zinc deficiency in soils on the yield as well as quality of fodder maize crop and evaluating the impact of resulting zinc fortified maize fodder on improving the zinc status of sheep. The study revealed that correction of zinc deficiency in soil resulted in improved zinc content in maize fodder by more than 10ppm and feeding of fortified maize fodder for 180 days enhanced the serum zinc level from 0.7 to 1.1ppm in sheep.

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 edible products of animal origin (milk, meat and eggs). Efforts were made to monitor environmental pollutants in soil, water, feeds, fodders and animal products in Dakshina Kannada district of Karnataka. In that location, soils were found to be deficient in organic carbon, potassium, phosphorus, boron, magnesium and zinc requiring additional supplementation. The samples of different feeds, water, milk and hair were screened for the presence of pesticide residues and heavy metals.

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. Byproducts from spent pupae of silk worm (SWP) are important in this regard. Study was initiated to evaluate the feeding value of byproducts of SWP in ruminants. Initial results indicated its potential to be used as a protein supplement for animal.

Climate change impact on livestock

Livestock accounts for approximately 18% of the global GHGs emissions. In India, the large ruminant population is usually fed with poor quality feeds, possesses low production potentiality and is often blamed as the major source of methane (CH4) emission. So far, the studies related to GHG emission from Indian livestock is mostly confined to enteric fermentation and manure management system. Life Cycle Assessment (LCA) of GHG emission is an approach that includes all emissions along the supply chain starting from land use, production of feed, emissions from animal production and emissions related to processing and transportation of products to the end users. LCA of GHG emission from the selected dairy farms in Karnataka was conducted. Preliminary results revealed that the total GHG emission (CO2, CH4 and N2O-N) for transportation of feed from 15km distance in tractor was 8.70 CO2 eq/kg DM transported.

Efforts were made to estimate methane emission form different feeding systems and develop suitable amelioration strategies. It was observed that supplementation of silkworm pupae oil at 2-4% level of basal diet decreased methane production by 30% *in vitro* without any reduction in dry matter digestibility. Similarly, in cattle, supplementation of tamarind seed husk alone or in combination with soapnut significantly reduced methane production and decreased the population of rumen protozoa and entodinomorphs ciliates. Sixteen plant sources from himalayan region were evaluated for methane reducing potential. The phytosources from the Himalayan region such as *Pittosporum eriocarpum, Terminalia chebula, Berberis lycium* and *Lannea coromandelica* produced less methane *in vitro*.

Diversity of rumen methanogens was studied in cattle and buffalo from different locations (Uttar Pradesh and Karnataka). The results revealed that the major methane emitting methanogens species were different in buffalo and cattle. *Methanobrevibacter*

smithii and *Methanobrevibacter thaueri* were the most abundant methanogens in buffalo. In contrast, *Methanobrevibacter millarae* was the prominent methanogen in cattle.

A joint Indo-German collaborative project has started 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 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.

Technology translation to connect discovery with application

The area specific mineral mixture (ASMM) technology for different agro-climatic zones of Karnataka was developed by the Institute and is being used by the farmers for over 8 years. A project was initiated to study the socio-economic impacts of this technology. It was observed that the average monthly production of ASMM was increased over the years (32.89 tonnes in 2007 to 260.89 tonnes in 2015). It was also noticed that average milk yield increased by 0.5lit/day/animal and a net profit of Rs 11.2/animal/ day was earned due to the adoption of the ASMM technology.

Water availability and quality has a direct impact on health and production performance in dairy cattle. Study was undertaken to understand water use efficiency of different dairy production systems and to develop model for improving the water use efficiency. The water use efficiency in different dairy production systems was assessed in Kolar district. The results indicated that the water inputs through forage and other feed ingredients were more as compared to the inputs through drinking water and that used for on farm servicing operations. The use efficiency for small holders was found 0.85 and for the commercial farms, it was 1.45.

Indian livestock farmers face challenges in accessing information and services via digital tools that are crucial for decision-making. Structuring scattered information in searchable interactive system, delivery by proper channel and creating trustworthy data are major challenges. Therefore, a web based livestock advisory and information portal has been developed for delivering information related to feeding, breeding, health care and management of cattle, sheep, goat and buffalo to the livestock farmers. The portal was also evaluated for its user friendliness at the field level.

The prestigious Farmer First project on "Improving Livelihood Security of Farmers through Technological Interventions for Sustainable Livestock Farming" was launched by the Institute at South and North Bengaluru in the month of January, 2017.

Human resource development

During this year, the Institute was actively involved in various human recourse development activities. A total of 39 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 received professional trainings from various national and overseas Institutes/organizations and attended various workshops, conferences, seminars, symposia, krishi mela and expos. The technical, administrative and supporting staff also received various professional training for skill development.

Others

The Honourable Secretary (DARE), Govt of India and Director General, ICAR, Dr T Mohapatra laid the Foundation Stone for construction of the Laboratory Animal House at the Institute. The project, expected to be completed by the end of 2017 at a cost of ₹15.00 crores, will facilitate the scientists to conduct fundamental research involving laboratory animals. He also visited the Institute on 14 January, 2017 to take part in an interactive meeting with all the scientists of the Animal Science Institutes of ICAR located in Bengaluru. During the meeting, he critically reviewed Institute-wise research outputs during the past one year and identified the future road map for specific research targets.

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 is regularly conducting activities under "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.

The Institute received the ICAR Best Annual Report Award for the year 2015-16 under the Small Institute Category.

Dr NKS Gowda was awarded the prestigious Fellowship of the National Academy of Agricultural Sciences (NAAS) under the category of Animal Sciences for the year 2016.

Dr S Selvaraju received the prestigious ICAR National Fellow (2017-2022) for the project entitled "Development of Buffalo Bull Fertility Diagnostic Chip Based on Sperm Transcripts Signatures".

Introduction

Introduction

Genesis

Genesis of the ICAR-National Institute of Animal Nutrition and Physiology (ICAR-NIANP) is dated back to 1976, when the National Commission on Agriculture recommended its creation to work on the fundamental and the basic principles involved in optimum nutrient utilization. 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. In October, 1992, ICAR constituted a committee of experts to suggest location, structure, function and other related issues for the establishment of the ICAR-NIANP. On 24 November 1995, as per the recommendations of the stripe review committee, the institute was established. In 2012, the Institute was conferred the Sardar Patel Outstanding ICAR Institution Award. The Institute 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 No.7 on 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 six women scientists are in position.

Staff Position as on 31 March, 2017

Category	Sanctioned Posts	Staff in Position
Director	01	01
Scientific	40	39
Technical	12	09
Administration and Accounts	17	11
Skilled Supporting Staff	06	05

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 include scientists, professors and industry personnel from the field of Animal Nutrition, Physiology, Biotechnology, Reproductive Biology and Social Science.

The functioning of the institute is supervised by 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, 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 RAC, IRC and HYPM in project monitoring and evaluation.

During the reported period, 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 12 collaborating centres and an Outreach project on "Methane Emission in Ruminants" with seven collaborating centres. The prestigious Farmer First Project on "Improving Livelihood Security of Farmers Through Technological Interventions for Sustainable Livestock Farming" was launched 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" and ICAR-Network project on "Veterinary Type Culture Collection". Besides, the scientists were also involved with several externally funded research projects. The institute also 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

- Basic and strategic research on physiology and nutrition for efficient livestock production.
- 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 (flagship programme)	Deconstruction of ligno-cellulosic biomass for improving feed utilization
2 (flagship programme)	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

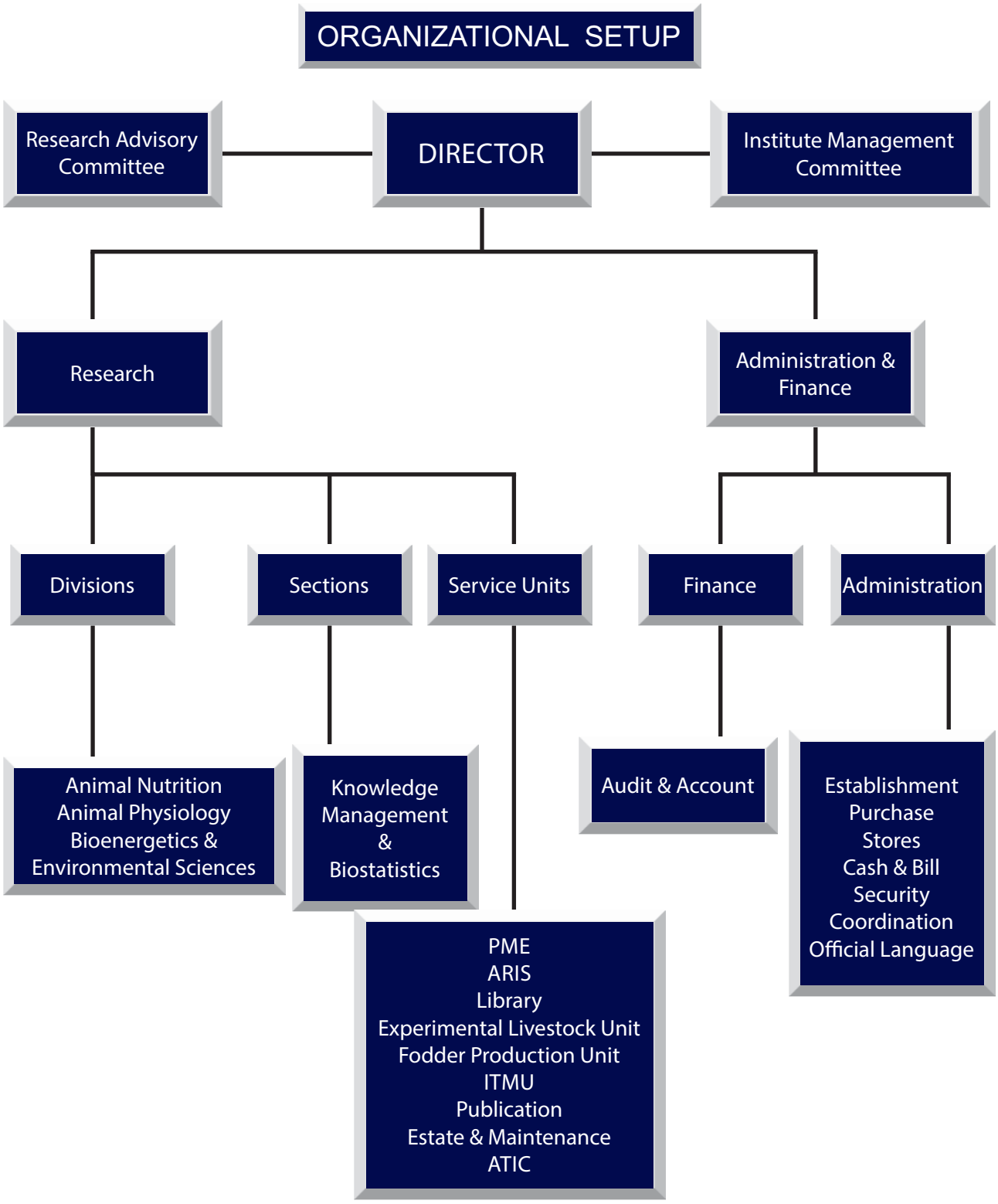
Expenditure statement

Statement showing the sub head wise expenditure under plan and non-plan budget (₹ in lakh)

Sl. No.	Sub heads	Plan (2016-17)		Non plan (2016-17)		Revenue resources (2016-17)	
A.	**Institute**	RE	Expenditure	RE	Expenditure	RE	Expenditure
1.	Works	36.02	33.99	0	0	-	-
2.	Equipment and other capital expenditure	91.60	90.17	2.00	1.98	-	-
3.	Establishment charges	0	0	1053.00	1053.00	-	-
4.	Pension and other retirement benefits	0	0	92.00	87.16	-	-
5.	Travelling allowances	7.00	7.00	5.00	4.98	-	-
6.	HRD	2.00	1.99	0	0	-	-
7.	Research and operational expenses	60.00	60.00	11.00	11.00	-	-
8.	Administrative expenses	111.00	110.95	162	158.43	-	-
9.	Miscellaneous expenses	0	0	4.00	3.98	-	-
10.	Loans and advances	-	-	0	0	4.00	2.18
B.	**AICRP and Outreach projects**	240.00	238.65	0	0	0	0
Grand total (A+B)		547.62	542.75	1329.00	1320.53	4.00	2.18

Revenue generation

Sub heads	Amount (₹ in lakh)
A. Sale of farm products, livestock etc.	4.77663
B. Other receipts	
1. Sale of publications, CDs etc.	0.34345
2. Analytical testing fees	4.70730
3. Other receipts including LF/Interest/IRGS/LS&PC	52.40876
Grand total (A+B)	62.23614



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

S Manpal, AK Samanta and S Senani

Crop residues, generally in the form of straws and stovers receive considerable attention for feeding ruminants due to scarcity of green fodder. However, rumen microbial utilization of energy-rich cell walls of these straws is hindered by the presence of lignin, which limits its overall digestion process and can significantly influence animal performance. A majority of the white-rot fungi (WRF) degrade lignin selectively with the help of their lignin degrading enzymes laccases, lignin peroxidise (LiP) and manganese peroxidise (MnP). Nevertheless, limiting amounts of lignocelluloytic enzymes are usually produced by the WRF, which impedes their commercial use and prevents to assess their true potential for various applications. The use of immobilization technique of whole cells is an effective, alternative and practical approach to enhance enzyme production and was studied using various inert matrices for its ability to overcome the production of limiting amount of enzyme by the native fungus and enhance production. Purification and elucidation of the properties of these enzymes will give us an idea for the development of stable and effective lignin degrading enzymes.

The project aims to determine the ability of LiP and MnP obtained from WRF and testing its efficacy in enhancing the *in vitro* and *in vivo* digestibility of straws.

LiP produced by immobilization of Phanerochaete chrysosporium on PUF cubes was purified 21 fold with a yield of 68.66%. The purified LiP showed pH stability at 3.5 retaining 72% of residual activity. The enzyme showed wide pH tolerance and also exhibited higher stability. The enzyme also exhibited

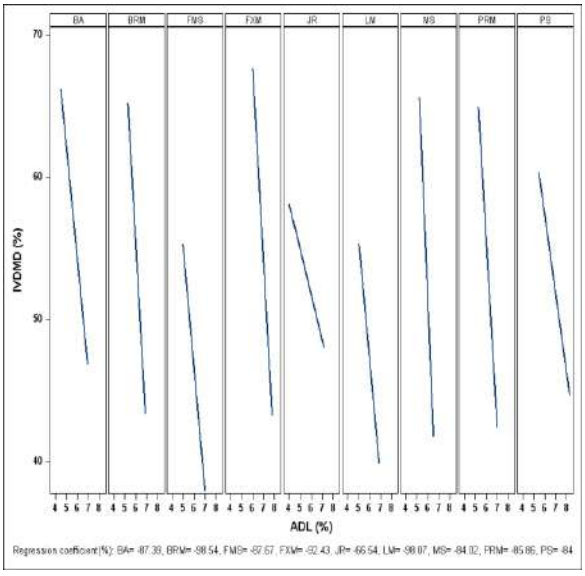


Fig. 1: Relationship between the digestibility and lignin degradation of nine common crop residues (BA: bajra, BRM: barnyard millet, FMS: finger millet, FXM: foxtail millet, JR: jowar, LM: little millet, MS: maize, PRM: proso millet, PS: paddy) upon treatment with purified Lip. The results indicated a strong negative correlation for all the crop residues studied.

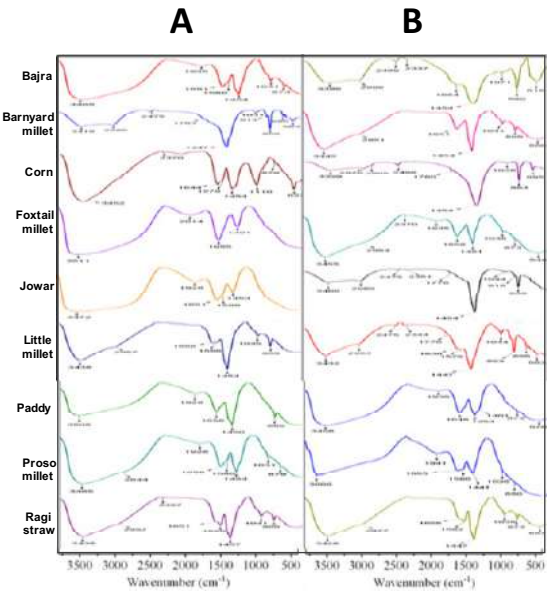


Fig. 2: FTIR spectra of straws treated with purified (A) and commercial LiP (B) showed reduced absorbance as free carboxyl groups were released along with hydroxyl groups due to oxygenation reaction.

strong affinity for veratryl alcohol recording V_{max} and K_m values of 142.86µM and 65µM.

The relationship between the digestibility and lignin degradation of the various straws (%) upon treatment with LiP was established. The ADL and IVDMD values obtained upon treatment of the nine crop residues with both crude (T1) and purified (T2) LiPs were considered for the study (Fig.1).

Correlation graph indicated that with increase in digestibility there was a linear decrease in lignin content and vice versa.

Fourier transform infrared (FTIR) spectroscopic studies were employed for ascertaining the structural changes in nine crop residues treated with LiP from P. chrysosporium and commercially available LiP in order to reveal the lignin biodegradation mechanisms and variations obtained thereof. Both samples showed moderately significant difference in their intensity of peaks, thus confirming the occurrence of degradation process. At the spectral wavelengths ranging from 500-3500cm-1, there was a decrease in the absorbance of peaks in all the nine different straws compared to the control sample due to different stretching vibrations (Fig. 2).

The study confirmed the successful application of LiP for enhancing digestibility of various cereal crop residues. The stable enzyme could be produced in bulk by immobilization of the fungus. FTIR study provided new information towards elucidation of the mechanisms involved in biological degradation processes on different straws.

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 is expected 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 rumen liquor samples were collected from cattle, buffalo, sheep and goat and preserved at -800C before analysis. The 16s rRNA gene were amplified using universal primers and NGS amplicon libraries were prepared. The paired end 2x300 bp sequencing generated amplicon sequencing data for cattle, buffalo, sheep and goat pooled samples. The sequenced reads were joined, checked for quality and chimera and analyzed using the MG-RAST pipeline. Most of the reads could be mapped to available SSU RNA databases. The archaeal population was observed highest in buffalo as compared to the other three species of ruminants. More than 80% of the sequenced reads could be mapped to genus level. The four metagenome data was analyzed using MG-RAST, MEGAN, Illumina base space and CLC genomics workbench (10.1) with microbial genomics module. The abundances of species and Shannon diversity estimates were calculated. Number of species detected in the various rumen metagenomes were ranged from 897-1468. Highest in Goat and lowest in Buffalo. The phyla Fermicutes and Bacteroides dominated the cattle, Buffalo and Sheep rumen microbiome, however, the Goat had abundance of Fermicutes, Bacteroides and Proteobacteria in equal proportions. The variation in microbial distribution between large and small ruminants are presented in Fig. 1.

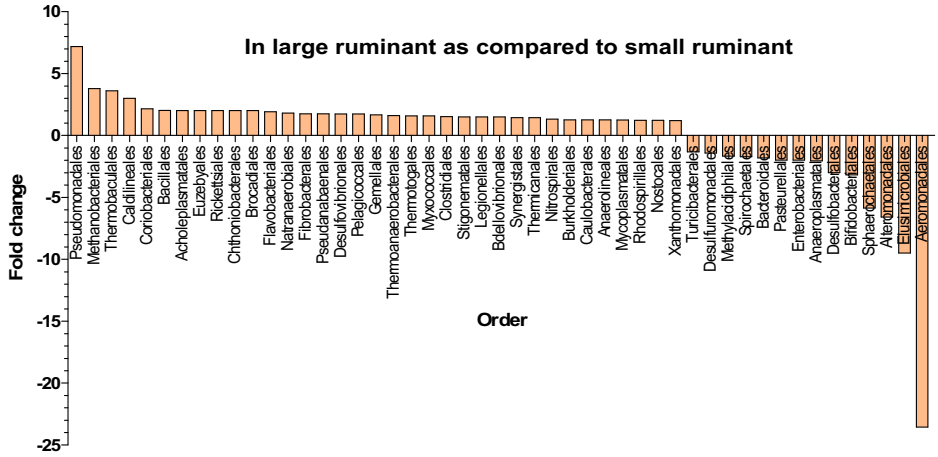


Fig. 1: Percentage fold change in microbial distribution among the large (cattle and buffalo) and small ruminants (sheep and goat) at class level.

Sheep whole metagenome was investigated in pooled sample. Approximately 2µg pooled gDNA was used for preparation of Paired end illumina library. Cluster generation was performed by in the illumina flow cell using TruSeq PE Cluster Kit v3 –cBot-Hs kit and TruSeq SBS v3-HS kit was used for sequencing the DNA clusters on HiSeq 2000 sequencer. A total of 53 million paired end reads were generated. The reads were filtered using Trimomatic using parameters: minimum length 50 bp and average mean quality 20. The metagenome data was assembled into contigs using MetaVelvet software. The software generated 2,69,281 contigs with N50=824. MG-RAST analysis revealed the Sheep rumen metagenome Diversity = 409.100 species. The contigs were assembled with abundance of the microbial population *Prevotella ruminicola, Selenomonas ruminantium, Synergistetes bacterium* SGP1, *Succinivibrionaceae bacterium* WG-1 *Methanobrevibacter smithii*. SEED analysis shown that maximum contigs were assigned to DNA Metabolism, Protein Metabolism, RNA Metabolism, Motility and Chemotaxis categories. Large number of hits are assigned to pathways Carbohydrate Metabolism, Nucleotide Metabolism, Amino Acid Metabolism, Translation and Membrane Transport. The overall microbial characteristics of the sheep rumen microbiome are presented in Fig. 2.

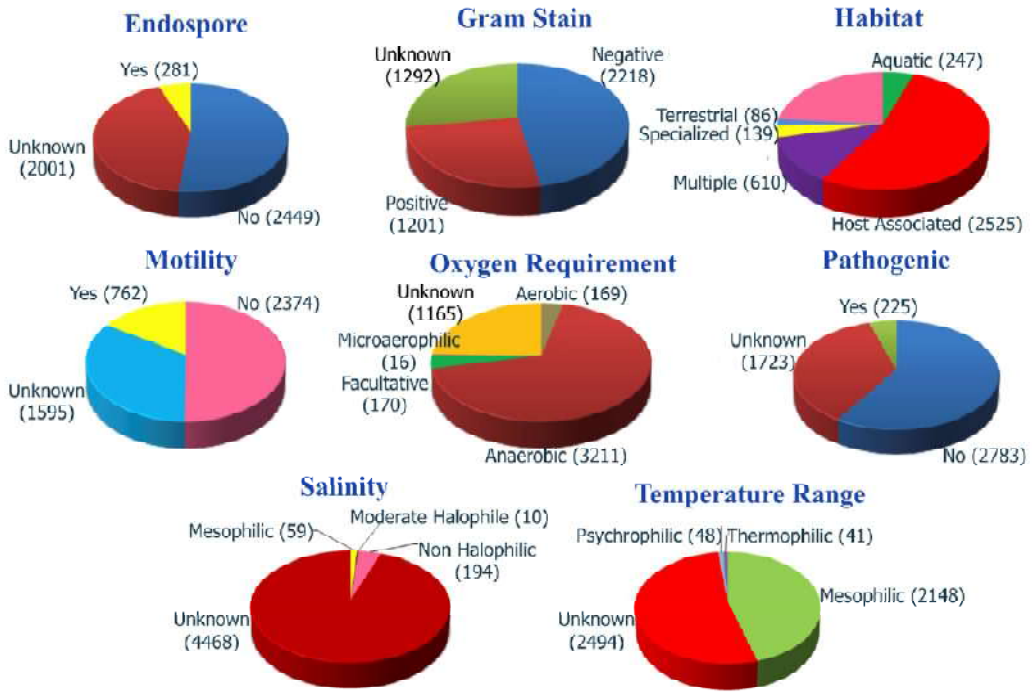


Fig. 2: The microbial characteristics in sheep rumen metagenome.

Cattle, Buffalo, Sheep and Goat metagenomes were profiled using 16s rRNA amplicon sequencing using illumina sequencing. The phyla Fermicutes and Bacteroides dominated the cattle, Buffalo and Sheep rumen microbiome, however, the Goat had abundance of Fermicutes, Bacteroides and Proteobacteria in equal proportions.

BGM 2.3: Development of 16s rDNA rumen specific microbes database

M Bagath, AP Kolte, UB Angadi and M Grover

Several sequences were downloaded from various databases such as NCBI, MG-RAST, RDP etc. The downloaded sequence was screened and standardized by converting them into suitable data tables appropriate for database model. Further the sequence data was integrated using the rational suitable data model. All the tables were created in relational database management system (RDBMS) using MYSQL software. The website has been created and is being hosted using super computer ASHOKA from ICAR-IASRI. Salient features of the database are: RDBMS based database containing pre-processed manually curated 10539 sequences; Tools for searching/browsing information from the database; Reference phylogenetic tree of the database sequences; Database website hosted (http://webtom.cabgrid.res.in/rumen_16s_rRNA/) with five major web pages Home, BLAST Search, Phylogenetic Tree View, Help and Contact; The PHP codes to search a desired sequence in the BLAST database and present the results as text and among nearest microbes in the phylogenic tree.

Rumen 16s Ribosomal RNA

The rumen is a complex natural ecosystem contains number of bacterial fungal, protozoal and archaeal species that is biological network to break down plant material. Ruminant animals obtain most of their nutrients from fermentation of plant products produced by rumen microbes such as bacteria, archaea, protozoa and fungi. Bacteria, along with protozoa, form the predominant microbes accounting for 40-60%, fungi accounts for 5-10 percentage of total microbial matter in the rumen and Rumen Archaea, approximately forms 3% of total microbes. Bacteria play a very important role in rumen digestion. In rumen, 80% contribution for degradable of plant cell walls is by a combination of bacteria and fungi and remaining is by protozoa. There is both negative and positive effect on fiber digesting in ruminant environment. Studies on these microbes will provide further insights into various diets and integration with nutrients. Although many studies have been published that characterize the ruminal microbes using cultivation-based methods. The presence of hyper variable regions in the 16S rRNA gene provides a species specific signature sequence which is useful for bacterial identification process. 16S Ribosomal RNA sequencing is widely used in microbiology studies to identify the diversities in microbes.

This work aims at development of user-friendly and freely accessible Rumen 16s rRNA database. 16S rRNA gene sequences information has been used as the gold standard for identification and taxonomic classification of bacterial species. Analysis and comparison of the bacterial 16S rRNA sequence is a valuable genetic technique and can lead to the recognition of novel pathogens species. Recent advances in molecular research and IT technology, 16s rRNA sequence data is available in diversified format and in various public databases. The 16s rRNA data is a quite large and dynamic data, there is need to develop rumen specific microbes 16s rRNA database for wide comparative and analysis of microbes within and between species. This database will provide a valuable means of web solution among microbiologists who are working in rumen microbes. This includes similarity search of unknown sequence in the database and reviewing nearby similarly sequence with published details, analysis tools and visual presentation for easy understanding.

Disclaimer

National Institute of Animal Nutrition and Physiology, Bangalore and Indian Agricultural Statistics Research Institute,New Delhi are not responsible for the contents or reliability of the linked websites and does not necessarily endorse the views expressed within them. Listing shall not be taken as endorsement of any kind. We cannot guarantee that these links will work all the time and we have no control over the availability of the linked pages.

A database of 16s rDNA of the rumen specific microbes has been developed. Website (http://webtom.cabgrid.res.in/rumen_16s_rRNA/) created for accessing the database is being hosted using the super computer ASHOKA located at the ICAR-IASRI, New Delhi.

Network Project: Veterinary type culture - rumen microbes

A Thulasi, D Rajendran and M Chandrasekharaiah

The rumen microbe culture collection is a part of the ICAR initiative for 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. 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.

A total of 115 cultures from various sources were isolated and characterized based on morphology and 16S rRNA sequence homology and the unique bacteria were characterized and submitted to the repository. These include members from the genera Paenibacillus, Flavobacterium, Bifidobacterium, Shewanella and Campylobacter. Molecular characterization of cultures submitted by sister institutes of ICAR completed. Initiated the revival of stored microbes. Enterococci were found to be predominant in captive sloth bears and Streptococci were found to be predominant culturable organisms in ruminants.

The glycosyl hydrolases in the rumen of cross bred steers fed ragi straw were studied. Distinct classes of CAZymes belonging to three CAZy families (GHs, CBMs, and CEs) were found in the metagenome of crossbred steers fed finger millet straw, concentrate and para grass. The Venn diagram clearly depicts the exclusivity and uniqueness of three classes of CAZymes in HF crossbreds, Angus cross, Jersey cow and termites (Fig. 3). This figure also throws light on the various families of CAZymes shared by the cattle breeds or the cattle breed and termite. The CAZyme families from HF cross, and other published studies Angus cross, Jersey cow, and termite reported 107, 38, 71, and 45 families of CAZymes, respectively. The comparative analysis using jvenn revealed that 20 families of CAZymes were shared by HF crossbred, Angus cross, Jersey cow, and termite. However, the relative proposition of a majority of predicted GH families differed significantly among individual metagenomes. Further, the comparative metagenome study shows GH5 and GH9 families as the common cellulases in all four metagenomes. Interestingly, HF cross metagenome had 31, 5 and 1 unique GHs, CBMs and CE families, respectively.

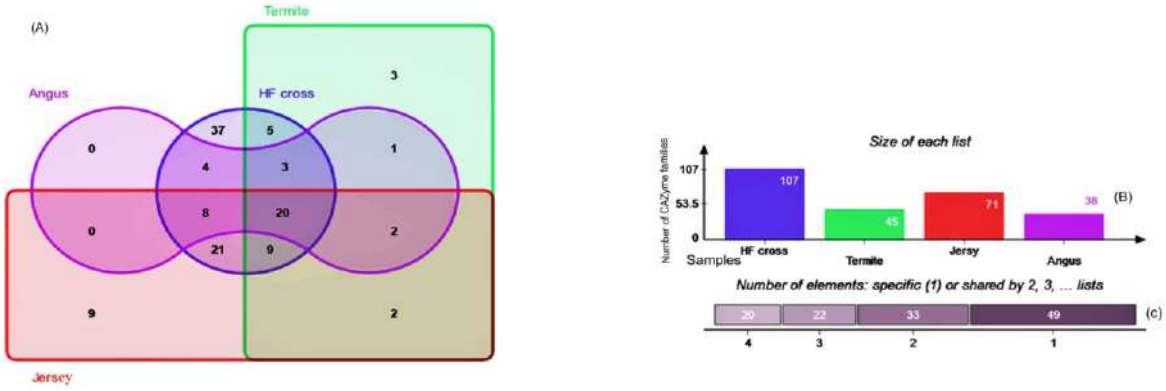


Fig. 3: Unique CAZymes and shared CAZyms in cross bred steers fed ragi straw, para grass and concentrate.

Unique cultures from the genera Paenibacillus, Flavobacterium, Bifidobacterium, Shewanella, Campylobacter submitted to the repository. Molecular characterization of cultures submitted by sister institutes of ICAR completed. Metagenome analysis predicted the presence of Unique CAZymes in crossbred steers.

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

APR 3.2: Amelioration of oxidative stress to prevent apoptosis of early sheep embryos

A Mishra, PSP Gupta and V Sejian

Carnitine is a water-soluble quaternary ammonium compound mainly synthesized from amino acids lysine and methionine in the liver, acts as an antioxidant that neutralize free radicals especially superoxide anion, to protects cell against oxidative damage. Ergothioneine is a thiourea derivative of histidine, found mainly in mushrooms. Ergothioneine neutralize oxidative stress by scavenging reactive oxygen species (ROS) and reactive nitrogen species (RNS) and is a powerful scavenger of hydroxyl radicals. The study was designed to assess the intra cellular oxidative stress during *in vitro* embryo development and to ameliorate the stress to prevent apoptosis of early embryos by using free radical scavengers like carnitine and ergothioneine.

Carnitine and ergothioneine when supplemented to *in vitro* maturation (IVM) medium did not influence maturation percentage but resulted in better cleavage rate followed by morula and blastocyst development (Fig. 1). Both the free radical scavengers in culture medium were able to decreases ROS and increases GSH in the matured oocytes and embryos. Further, carnitine and ergothioneine supplementation during maturation period significantly ($P<0.05$) improved cleavage, morula and blastocysts percentage than supplementing during post fertilization period.

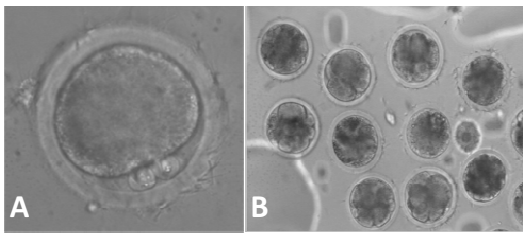


Fig. 1: Sheep matured and fertilized oocyte (A) and embryos at different developmental stages (B).

It was observed that carnitine, but not ergothioneine altered the expression of apoptotic and antioxidant enzyme genes at the different developmental stages of embryos. The difference in role of both free radical scavengers towards altering the expression of genes might be due to presence of OCTN2, an integral carnitine transporter in the membranes of both oocytes and embryos and the absence of OCTN1, a highly specific transporter for the uptake of ergothioneine across the membrane in oocytes and embryos. It is thus concluded that carnitine and ergothioneine supplementation during *in vitro* embryo production acted as an antioxidant, antiapoptotic and proliferative compound and improved developmental potential of developing embryos.

Supplementation of carnitine and ergothioneine to IVC medium created beneficial micro-environment for better development and survivability of sheep embryos through favourable expression of apoptotic and antioxidant function related genes.

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

Of late, there are increasing reports suggesting the role of Boron (B) in animals and humans. Boron has an atomic number of 5 with atomic weight of 10.81 and is the fifth element in the periodic table of Group IIIA elements, which possess the property of both metal and non-metals. The compounds of B (boric acid, borax) are generally used for bleaching, as fungicide and as micronutrient supplement for plants. The current study has been initiated to quantify B in animal feeds and to understand its role in calcium

(Ca) utilisation and immunity in animals.

Experiment was conducted in white leghorn layers supplemented with B (40ppm) to diets with adequate (3.50%, control) and inadequate (3.15%) level of (Ca) for a period of 120 days. Eighty birds (White leghorn layers, 25 week age) of similar hatch were allotted to 4 dietary groups of 20 in each. Results of feeding experiment indicated lower (P<0.05) hen day egg production, shell thickness and higher cracked eggs in layers fed diet with inadequate Ca level compared to control. Boron supplementation (40ppm) to Ca inadequate diet showed improved (P<0.05) hen day egg production and less cracked eggs and the values were comparable to control. The humoral immune response was found better in the birds fed diets supplemented with B. The analysis of samples for nutrient utilization, serum mineral profile, shells and bone mineral content is under progress.

Boron supplementation at 40ppm to the diet with inadequate Ca improved the egg production, shell thickness, reduced the number of cracked eggs. Immune response was found better in the birds fed diets supplemented with boron.

APR 3.5: Utilization of nano zinc and its impact on growth and reproduction in goats

D Rajendran, SBN Rao, NKS Gowda and S Selvaraju

To study the effect of nano zinc oxide, an *in vivo* trial was conducted with male goats. Bucks were divided into four groups. They were fed with control (No Zinc supplementation) diet, 50ppm inorganic zinc oxide supplemented (IZnO-50), 50ppm nano Zinc (NZnO-50) and 25ppm nano Zinc (NZnO-25) diet. Growth trial was conducted for period of 112 days. The blood was collected at beginning and 90 days of experimental feeding trial. The effect of supplementation of nano Zn on growth performance of goats is provided in Table 1.

Similar trend was observed in case of ADG and feed conversion ratio. Thus, in the present study, NZnO at reduced level (25ppm) has an edge over NZnO (50ppm) and IZnO (50ppm) compared to control. Digestion trial was conducted at the day-75 of experimental feeding. Results showed that there was no significant difference in the digestibility of DM, OM, CP, EE, TCHO and NDF. However, ADF and cellulose digestibility was significantly higher in the zinc supplemented groups than control group.

Table 1: Effect of supplementation of two levels of NZn (50 and 25 ppm) on growth performance of goats.

Attributes	Experimental groups			
	Control	IZnO-50	NZnO-50	NZnO-25
Initial BW (Kg)	18.9±0.67	18.8±0.93	19.7±0.59	18.9±0.41
Final BW (Kg)	24.6±0.97	25.1±1.07	26.3±0.67	26.3±0.53
Total Wt. gain (Kg)	5.7±0.42^{a}	6.38±0.46^{ab}	6.65±0.23^{ab}	7.37±0.20^{b}
ADG (g)	51.2±3.73^{a}	56.9±4.12^{ab}	59.4±2.08^{ab}	65.8±1.81^{b}
Total DM consumed (kg)	67.8±2.86	67.4±3.45	69.3±1.85	67.4±1.28
FCR (Kg DM feed consumed per Kg BW gain)	12.0±0.54^{a}	10.8±0.80^{ab}	10.5±0.37^{ab}	9.16±0.14^{b}

^{a,b} indicates means with different superscript within row differ significantly (P<0.05). Each value is average of six observations. IZnO-50: (Inoganic ZnO, 50ppm); NZnO-50: (Nano ZnO, 50ppm); NZnO-25: (Nano ZnO, 25ppm).

The average initial and final body weight was found to be same in all treatment groups. The overall body weight gain was found to be higher in the group that received nano zinc at reduced level (NZnO-25) compared to control. Inorganic and nano zinc groups supplemented at 50ppm remained intermediary.

The effect of supplementation of nano Zn on hormonal profile of goats is provided in Table 2. Haematology results revealed that there was no significant difference in blood cell counts, haemoglobin, ALT, AST, ALP, creatinine, albumin values among various groups. However, level of

globulin and total protein was found significantly higher in all zinc supplemented groups than control. Humoral immunity study was conducted at day-21 after vaccination and significantly higher titre value was found in NZnO-50 (80.58±2.36) than control (74.90±1.01) group. The other two groups (IZnO-50, 80.58±2.36 and NZnO-25, 81.33±2.81) had intermediary titre values. Cell mediated immunity status of goats was measured by difference of skin fold thickness after injecting concanavalin A (Con A) intradermally. Skin thickness was found similar in all the groups at 0h. However, the skin thickness at 6h after injection was highest (P<0.05) in NZnO-50 (2.58±0.18), followed by NZnO-25 (2.14±0.17) and IZnO-50 (2.08±0.18) group compared to control (1.41±0.06). Similar trend was also observed at 12h and 48h after injection.

Semen was collected at the end of feeding trial and total semen volume and total sperm production was found similar among the experimental groups. The effect of supplementation of nano Zn on sperm characteristics is depicted in Fig. 2. The progressive motile sperms in both the NZn supplemented groups (NZnO-50 and NZnO-25) were found significantly higher as compared to both the control and IZnO-50 group. The total motile sperm was observed highest in NZnO-50 group. The rapid motile sperms were also observed significantly higher in both NZnO-50 and NZnO-25 groups.

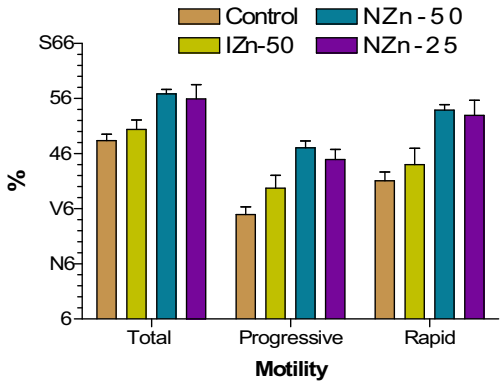


Fig. 2: Total motility, progressive motility and rapid motility of bucks sperm fed with two levels (50ppm and 25ppm) of nano zinc as zinc supplement.

Table 2: Effect of supplementation of two doses (25 ppm and 50 ppm) of NZn on hormonal profile of goats.

Attributes		Experimental groups			
		Control	IZnO-50	NZnO-50	NZnO-25
T3 (nmol/L)	Day-0	3.69±0.19	3.54±0.17	3.37±0.06	3.45±0.09
	Day-9	4.17±0.20	4.29±0.19	4.41±0.14	4.33±0.16
T4 (nmol/L)	Day-0	106±13.3	104±10.1	99.5±6.40	107±7.21
	Day-9	90.9±5.50	101±7.82	116±7.98	111±15.1
Testosterone (ng/ml)	Day-0	3.72±1.49	3.42±0.88	3.32±1.54	3.71±1.40
	Day-9	2.65±0.46^{a}	4.35±0.56^{b}	6.79±0.37^{c}	7.48±0.54^{c}
IGF1 (ng/ml)	Day-0	126±10.8	166±26.0	131±26.1	141±30.5
	Day-9	248±28.5^{a}	356±30.6^{b}	378±35.9^{b}	386±39.2^{b}

^{a,b,c} indicates means with different superscript within row differ significantly (P<0.05); Each value is average of six observations; IZnO-50: (Inorganic ZnO, 50ppm); NZnO-50: (Nano ZnO, 50ppm); NZnO-25: (Nano ZnO, 25ppm).

Average Daily gain and feed conversion ratio was better in the NZnO-25 and has an edge over the NZnO-50 and IZnO-50 as compared to control. Humoral and cell mediated immunity was higher in the Zinc supplemented groups than the control . The sperm quality was improved by the supplementation of NZn without affecting the semen volume and total semen production.

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 for augmenting the reproductive efficiency of domestic animals has led to undertake the current study to investigate the effect of copper and selenium on granulosa cell estradiol synthesis and the expression of associated genes. The results indicated that there was an additive effect of copper and selenium on estradiol synthesis and its associated gene aromatase (CYP19A1). The effect of copper and selenium either alone or in combination on the expression of genes associated with apoptosis (BCL2), DNA methylation (DNMT1), FSH receptor (FSHR) and anti-oxidative functions (SOD1 and SOD2) in ovarian granulosa cells were also studied. Copper, selenium and FSH had

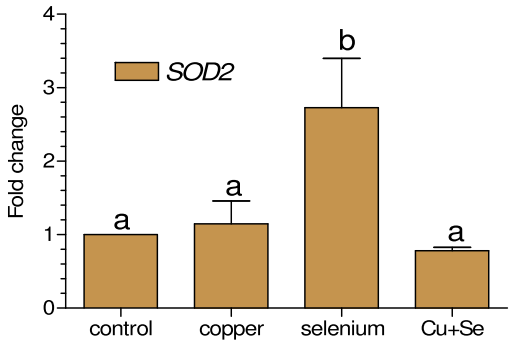


Fig. 3: Effect of copper and selenium on the expression of SOD2 gene in the ovarian granulosa cells of goat.

shown to up-regulate the expression of SOD1 and SOD2, but the combination of copper and selenium did not show any further synergetic effect on the up-regulation of SOD1 and SOD2 gene expressions in the ovarian granulosa cells (Fig. 3). Both copper and selenium, and FSH up-regulated the expression of FSHR and anti-apoptotic BCL2. The effect of copper and selenium on the up-regulated expression of FSHR was more pronounced than FSH itself. Further, the combination of copper and selenium had shown synergetic effect on the up-regulated expression of FSHR in the ovarian granulosa cells. It was also found that both minerals decreased lipid peroxidation in the cultured ovarian granulosa cells.

Studies on the effect of copper and selenium on estradiol synthesis in the ovarian granulosa cells of goat indicated that these minerals up-regulated the expression genes responsible for estradiol synthesis, anti-oxidant mechanism, FSH function and anti-apoptotic process.

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

Light stimulation is one of the effective ways to modulate the reproduction and growth in poultry. In the previous experiment we reported that intermittent monochromatic green light photostimulation during embryogenesis enhanced the embryo development and post hatch growth in broiler chicken. We also found that continuous monochromatic green LED light stimuli during embryogenesis accelerated body weight and post hatch pectoral muscle growth of broilers. However, whether this growth-promoting effect is mediated through regulation of endocrine axis (somatotrophic, thyroid hormone and gonadal axis) is still unknown. Therefore, the present study was undertaken for assessing the dynamic changes of plasma growth hormone (GH), thyroid hormones, and testosterone levels in late embryos and broiler chickens incubated under monochromatic green light to study the possible endocrine changes leading to early body weight gain in the experimental poultry birds.

The results of our previous studies indicated that monochromatic green light stimuli during embryogenesis accelerated the post hatch body weight and pectoral muscle growth in broilers. In the current experiment, we further investigated whether the regulation of broiler embryonic and post hatch growth by green light stimulus during incubation and post hatch period was associated with the changes of some important hormones and gene expression at different weeks of age in broiler chickens.

Fertile broiler eggs were pre-weighed and randomly assigned to 3 incubation treatment groups: Group-1 (control, 450nm), Group-2 (monochromatic green light, 575nm) and Group-3 (monochromatic red light, 675nm). The monochromatic lighting systems sourced from light-emitting diode lamps were equalized at the intensity of 15lx at egg level. The dark condition was set as a commercial control from day five until hatching. After hatch, day-old chicks from each group were housed under white light, green light and red light respectively, with an intensity of 30lx at bird-head level. Compared with the normal condition, chicks incubated under the green light showed significantly higher GH levels from day-5 of post hatch along with higher plasma IGF-I levels. Significant differences were found in plasma estradiol, progesterone, testosterone, FSH, T3, and T4 in hatched birds (green light stimulated; Group-2). However, the levels of corticosterone did not vary among the groups. The expression of GnRH, GnIH, cGH, myogenin, FSHβ, LHβ, IGF-1, IGF-II and myostatin (MSTN) genes was studied in tissues. The expression of MSTN was found to be low in the birds exposed to green spectrum of light.

Exposure to monochromatic green LED light at 575nm of wavelength during in ovo and ex ovo period effectively stimulated the hypothalamic-pituitary-gonadotrophic-somatotrophic-thyrotrophic axis resulting low feed consumption, low FCR and increased muscle mass and body weight gain in broiler chicks. In conclusion, the somatotropic axis hormones (GH and IGF-I) may be the most important contributors for growth and body weight gain when promoted by green light stimuli during embryogenesis.

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

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

The trace element Selenium (Se) is an essential nutrient for animals. Se is crucial for growth, immunity and reproduction and is an important determinant of health in sheep. The biological functions of Se are accomplished by selenoproteins that are characterized by the presence of selenocysteine residue. The selenoproteins with well characterized functions includes Glutathione peroxidases (GPXs), Thioredoxin reductases (TXNRDs), Iodothyronine deiodinases (DIO1s), 15 kDa selenoprotein (SEP15), Selenoprotein P1 (SEPP1) and Selenoprotein W1 (SEPW1). These selenoproteins are involved in antioxidant function, thyroid hormone metabolism, protein folding and selenium transport. The project aims to assess the influence of dietary Se on the expression of selenoprotein genes and its implications on the antioxidant and immune functions and meat quality in lambs.

Experimental lambs were fed different levels of organic Se for 90 days and different parameters were analyzed and recorded. The supplementation of supranutritional levels of organic Se had no influence on feed intake or body weight, but it significantly ($P<0.01$) increased the antioxidant capacity of liver and muscles. It was observed that pH and lipid oxidation of meat during storage were not influenced by Se and the MDA level in meat remained within the acceptable limits in the Se supplemented groups. Further, Se supplementation did not induce any pathological changes in major organs.

The expression of major selenoprotein genes was studied in liver and LD muscles. The hepatic *GPX1, GPX3, DIO3, SEPP1* and *SEPW* mRNA expressions were up-regulated at specific dose of Se, but the expression of *SEP15* and *DIO1* was not influenced by Se supplementation. The assessment of gene expression in LD muscle indicated that dietary Se did not influence the expression of GPX1, TXNRD3, DIO1 and *SEPW*, but significantly influenced the expression of *GPX2, GPX3, TXNRD1, DIO2, DIO3, SEPP1* and *SEP15* genes in the muscle.

In lamb, the dietary supplementation of organic Se at supranutritional levels improved the antioxidant capacity of liver and muscle tissues. The regulation of the expression of selenoprotein genes was influenced by the level of supranutritional Se supplied and the type of selenoprotein and the tissues.

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 aimed to explore the developmental patterns of gastrointestinal and immune system in response to pre-hatch and neonatal supplementation of amino acids and trace minerals.

An experiment was conducted to test the efficacy of amino acids (threonine, arginine and glutamine). On day-18 of embryonic age, eggs showing viable embryo were injected with amino acids into amnion using a 24G hypodermic needle. Post-hatch chick were distributed replicate wise into 4 experimental groups: 1) Control (normal hatch-normal broiler diet); 2) Normal hatch fed with scaled up nutrients for 3 days; 3) *In ovo* supplemented fed with normal diet; 4) In-ovo supplemented fed with scaled up nutrients for 3 days. The experiment was conducted up to 5wk of age. The results indicated that there was no significant improvement in body weight gain of chick's *in ovo* supplemented and scaled up nutrients. However, *in ovo* supplementation increased the gut development at the time of hatch.

A second experiment was conducted to test the efficacy of minerals (zinc and selenium).

Experimental design was similar to the previous experiment. The results indicated there was no significant improvement in body weight gain of chick's *in ovo* supplemented and scaled up nutrients. However, cell mediated immune response was better in the mineral supplemented group.

A third experiment was conducted to test the efficacy of minerals (zinc and copper). Experimental design was similar to the previous experiments. The results indicated there was no significant improvement in body weight gain of chick's *in ovo* supplemented and scaled up nutrients. However, *in ovo* supplementation increased the gut development during the early period of growth.

In another experiment, three hundred and thirty fertile eggs procured from commercial breeder hatchery were fumigated, weighed and distributed into two groups (control and *in ovo* supplemented groups) and set in incubator and hatcher. There were five treatments, one control without injection, followed by three individual trace mineral *in ovo* supplementations, viz., with 80µg/ egg of inorganic zinc (Zn sulphate 351.80µg/0.5ml deionised water), 0.3µg/egg of inorganic selenium (sodium selenite 0.657µg/0.5ml deionised water) and 16µg/egg of inorganic copper (copper sulphate 62.87µg/0.5ml deionised water). Fifth treatment was a combination of 80µg/egg of inorganic zinc, 0.3µg/egg of inorganic selenium and 16µg/egg of inorganic copper. The results indicated there was no significant improvement in body weight gain of chick's due to *in ovo* supplementation of zinc, copper or selenium.

In ovo supplementation of amino acids and minerals may be beneficial for gut development in broilers.

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

SC Roy, A Dhali and KS Roy

The average post-thaw motility and fertility of frozen-thawed buffalo spermatozoa is substantially low compared to that of cattle sperm. Over the decades, the composition of semen extender used for diluting of buffalo semen and protocols used for subsequent cryopreservation remains primarily similar to that of cattle even though it has been aptly reported that the composition of sperm structure and seminal plasma of these two species are different. Thus, one of the reasons may be, till now, we do not have a suitable and species-specific semen extender for cryopreservation of buffalo semen. Moreover, the exact molecular mechanism of this cryopreservation-associated loss of buffalo sperm functions is not very clear. We hypothesized that buffalo spermatozoa undergo a significant level of biomolecular changes after a cycle of cryopreservation due to cryopreservation-associated oxidative stress (OS). Thus, there is an urgent need to develop a species-specific semen extender for buffalo based on its sperm structure and seminal plasma composition and there remains is still a scope to improve the post-thaw motility and fertility of cryopreserved buffalo semen by incorporating some of the promising agents that can minimize the above-mentioned cryopreservation-associated changes in sperm.

To address the above issue, in this study, the extent of oxidative biomolecular changes in buffalo semen before and after a cycle of cryopreservation was assessed as well as the effect of addition of some promising agents on sperm kinematics was studied by Computer Assisted Semen Analyzer (CASA) to determine the effective non-lethal concentrations to be used in semen extender. The oxidation of buffalo sperm membrane lipids was assessed in terms of extent of phosphatidyl serine (PS) externalization using a fluorescent dye-based method of flow cytometry, whereas that of proteins was assessed by quantifying the formation of advanced oxidation protein products (AOPP) and carbonylated protein products (CPP) in extended semen.

It was observed that the levels of both AOPP and CPP levels were significantly ($P<0.05$) higher in cryopreserved extended seminal plasma (ESP) and cryopreserved sperm pellet compared to non-cryopreserved group.

Assay of PS externalization by flow cytometry indicated that a significant percentage of buffalo spermatozoa underwent early apoptosis after a cycle of freezing and thawing. Addition of some selected

agents in the culture media increased/ maintained the progressive motility of buffalo sperm *in vitro* as compared to control group. The effective non-lethal concentrations of agents that could modulate one or more sperm motility parameters were selected for subsequent incorporation in the buffalo semen extender.

The above results suggest that the process of cryopreservation induces significant bio-molecular changes in proteins and lipids of sperm and this may be one of important causes of reduced post-thaw motility and fertility of buffalo semen. A few agents have been found to have the potential and can be used as sperm motility enhancer while developing a of species-specific semen extender for buffaloes.

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

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. Hence the current study aims for isolation and purification of SSCs from sheep testicular tissue for the culturing of SSCs. SSCs were isolated from pre-pubertal ram testis using the enzymes collagenase and trypsin. A two step enzymatic method yielded SSCs with stem cell activity, which was confirmed by PLZF and alkaline phosphatase tests.

Obtaining sufficient population of SSCs is essential for developing suitable culture system. Various differential plating methods were tried to obtain maximum purity of SSCs by plating on laminin, lectin and gelatin coated plates. Laminin coated plates was used for the positive selection of SSCs whereas lectin and gelatin coated plates for negative selection of SSCs. The laminin plating yielded higher percentage of SSCs (PLZF +ve cells) as compared to lectin and gelatin enrichment methods (Fig 4). Coating of enrichment plates with BSA and extra cellular matrix

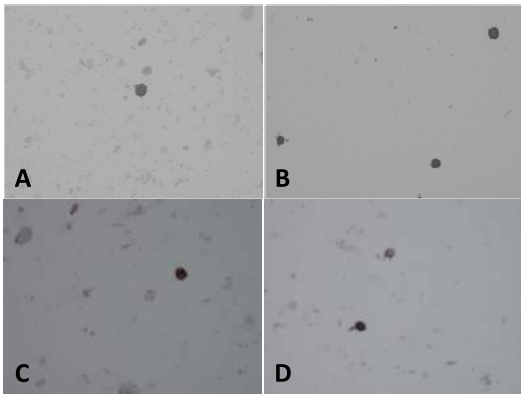


Fig. 4: The representative figure showing enrichment of SSCs by differential plating. A: without enrichment (initial isolate); B: enrichment with laminin; C: enrichment with lectin; D: enrichment with gelatin. The percentage of SSCs following enrichment was maximum in the laminin coated plates.

substrates (laminin) significantly improved the percentage of SSC enrichment (Table 3). It is concluded that differential plating using laminin in combination with BSA significantly improved the purity of spermatogonial stem cells when compared to lectin and gelatin.

Table 3: PLZF positive cells (Mean±SE) in the initial isolate (before enrichment) and those obtained after enrichment with laminin, lectin and gelatin.

Test code	Initial isolate (%)	Laminin (%)	Lectin (%)	Gelatin(%)
DP1	5.4±1.26[a]	24.4±5.60[b]	15.8±2.57[b]	15.2±2.17[b]
DP2	4.1±0.66[a]	36.0±12.54[b]	7.9±1.33[a]	7.8±1.97[a]
DP3	5.1±0.88[a]	34.8±5.11[b]	8.0±2.04[a]	7.5±1.94[a]

Values within a row with different superscript differ significantly (P<0.05). DP1: differential plating using laminin, lectin and gelatine. DP2: BSA coating before extracellular matrix substrate coating, DP3: BSA coating after extracellular matrix substrate coating.

Differential plating using laminin in combination with BSA significantly improved the purity of spermatogonial stem cells when compared to lectin and gelatin.

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

J Ghosh, KS Roy and CG David

There is an urgent need for early pregnancy diagnostic kit in buffaloes for a better reproductive management. This is because of the fact that existing indirect test are unreliable and the direct test such as transrectal determination is late and ultrasound imaging is technically demanding for the buffalo farmers. The long standing demand for a direct conceptus specific buffalo test kit based on PAG detection, as available in other ruminant species, is yet to be met. The reasons could be these proteins are expressed as multi-isoform and the isoforms have species and pregnancy stage specificity in terms of expression patterns.

In our earlier studies, we have shown that one particular isoform of PAG is expressed predominantly during early pregnancy in buffalo placenta. Theoretically there might be abundance of other isoforms even if less, which could serve as an early pregnancy biomarker and help in the development of early pregnancy diagnosis assay along with the other isoforms. Therefore an attempt was made to confirm the presence of a specific isoform of PAG. Accordingly antisera were raised in rabbit using a specific 20 amino acid epitope after suitable hapten conjugation. Rabbits were immunized using standard protocol, bled finally at the highest titre. The specific antibody was purified by affinity chromatography. The peptide was labelled with biotin and the optimum dilution of labelled antigen and unlabelled antibody was determined by checker board analysis. A competitive ELISA was developed using biotin labelled peptide and purified antibody

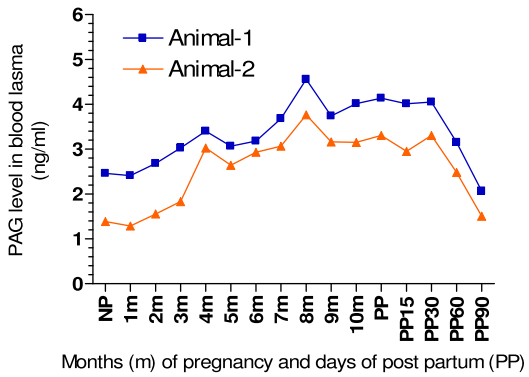


Fig. 5: Label of a specific PAG in different months of pregnancy in buffalo plasma of two different animals as compared to the level in non-pregnant and postpartum plasma samples.

to understand the trends of that isoform availability in buffalo plasma. Testing of samples in the pregnant and non-pregnant buffaloes showed a trend of availability for that specific isoform during different stages of pregnancy. However the pre-pregnancy level varied with the individual animals. The observed signals in non-pregnant vs early-pregnant animals indicated that the assay was not suitable for discrimination of early pregnant and non-pregnant buffaloes (Fig. 5). Further attempt will be made for the development of a different assay format which might help increasing the sensitivity and specificity of detection of PAG during early pregnancy.

Attempts were also made to develop an assay for the identified predominant early pregnancy specific PAG

isoform for buffaloes. The partial sequence of the early pregnancy specific PAG isoform was expressed in *E coli* system using pET28a expression system in a batch and purified using affinity chromatography. Purified antigen was labelled by radio iodine for RIA and biotin for ELISA. Biotinylated and radio iodinated antigens were tested for the confirmation and efficiency of labelling. Also the specific antibodies against a specific epitope and the recombinant proteins were labelled with biotin for testing the immuno reactivity of the placental proteins. These will further be used in different combinations for the development of assay for specific detection of this isoform presence in buffalo serum and plasma. The desired protein sequence is subcloned in another expression vector which will help developing a better antibody against this isoform.

Availability trend of a specific isoform could be established using PAG peptide epitope in buffalo plasma. Further, sub cloned a desired PAG sequence in mammalian vector.

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. Previously, the whole transcriptome analysis of GV stage sheep oocytes from our laboratory revealed that PI3K-AKT and caspase signalling play major role in determining sheep oocyte development competence. Therefore, 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 -8 on the development competence of sheep oocytes.

The effect of supplementation of the different dosages of the caspase9/8 inhibitor in the *in vitro* maturation (IVM) media on the maturation rate of ovine oocytes was assessed. Oocytes were aspirated from the visible surface follicles from abattoir derived sheep ovaries and were subjected to IVM for 24 h. The IVM media was supplemented without (control) or with 50, 100 or 200µM of caspase9/8 inhibitor. At the end of the IVM, oocytes were stripped of cumulus cells and nuclear maturation stages (germinal vesicle, GV; germinal vesicle break down, GVBD; matured at metaphase II, M-II) were assessed (Fig. 6).

The rate (%) of meiosis resumption (GVBD) was found significantly ($P<0.05$) greater in 50µM (99.1±0.8) and 100µM (98.0±0.9) groups as compared to the control (89.4±2.2) group. Similarly, the rate of oocyte maturation was also found significantly ($P<0.05$) greater in the 50µM (80.7±2.8), 100µM (75.6±2.7) and 200µM (76.5±2.3) groups as compared to the control

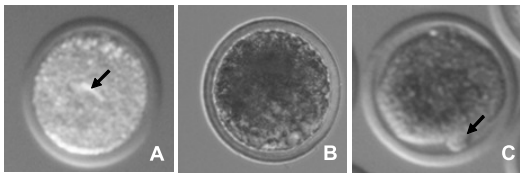


Fig. 6: Nuclear maturation stages of ovine oocytes after 24 h of IVM. A: immature, at GV stage; B: immature but underwent meiosis resumption, at GVBD stage; C: matured, at M-II stage with extruded polar body.

(63.0±1.6) group. The results indicated that the inhibition of caspase cascade mediated apoptosis was beneficial for *in vitro* maturation of ovine oocytes.

Based on the results of the previous experiment, 50µM concentration of the caspase9/8 inhibitor was supplemented into IVM media to assess its effect on the post fertilization embryo development. After the 24h of IVM, oocytes were fertilized *in vitro* for 24h and subsequently cultured for 8 days and embryo development was recorded. No significant difference was observed in the rate of cleavage and the formation of 4-8 cells and morula between the experimental groups. Nevertheless, the rate (% of total oocytes) of blastocyst formation was found significantly ($p<0.05$) greater in the caspase9/8 inhibitor supplemented group (17.7±2.4) as compared to the control (6.9±1.7) group. The results indicated that the inhibition of caspase9/8 mediated apoptosis during the maturation window was beneficial for post fertilization embryo development in ovine.

Inhibition of caspase-9 and caspase-8 during *in vitro* maturation significantly improved the *in vitro* development of sheep oocytes and embryos.

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

Coordinator: R Bhatta
JP Ravindra, IJ Reddy, NKS Gowda, DT Pal, KS Roy, S Selvaraju 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. The studies conducted under the objectives 2 and 3 during the reported year are: Effects of addition of IGF-1 and zinc to semen extender in enhancing post-thaw viability of cryopreserved of buffalo semen; Development of semen fertility prediction marker: Sequencing of seminal proteins; Identification of translated transcripts in spermatozoa; Trials on formulation and evaluation of suitable nutritional supplement for ameliorating infertility and improving reproductive efficiency; Implementation of synchronization and fixed time insemination protocols in reproductive problematic animals; Procurement of buffalo pituitaries for isolation of hormones. The salient findings are described below.

IGF1 as additive improved post-thaw sperm functional parameters and reduces oxidative stress of buffalo *(Bubalus bubalis)* spermatozoa (Fig. 7). The concentration of the DNPH was found significantly lesser on addition of zinc indicating its antioxidant protective role.

Sixty six and 54 proteins were found to be unique to good and poor quality spermatozoa respectively. 130 and 331 proteins were found up-regulated in good and bad quality spermatozoa, respectively. These results indicate the potential for using them as markers of fertility status.

Identification of translated transcripts in spermatozoa revealed 198 proteins, 121 (61%) of which were found to have corresponding transcripts. The translated proteins might play a significant ($P<0.05$) role in metabolic functions (p=1.4E-06, GAPDHS and ENO1), capacitation (p=7.70E-02, BSP3 and PRKACA), and events associated with fertilization (p=1.40E-06, BSP5 and SPADH2). The major pathway associations for the translated transcripts are in the categories of metabolic pathways, signalling cascades and oocyte meiosis.

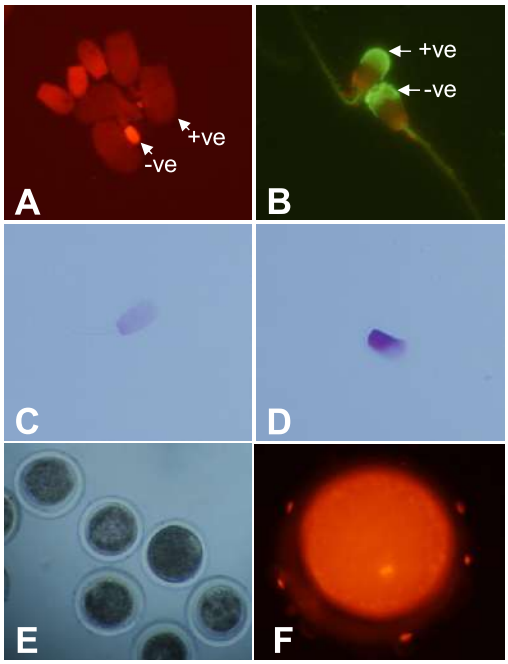


Fig. 7: A: decondensed (+ve) and condensed (-ve) spermatozoa; B: intact (+ve) and reacted (-ve) spermatozoa at 0h of incubation; C: uniform distribution of chromatin in spermatozoa with IGF-1 treatment; D: unevenly distributed chromatin in spermatozoa without IGF-1 treatment; E: sperm-oocyte complex without staining; F: sperm-oocyte complex stained with PI.

Feed supplement comprising a source of energy, protein and an antimicrobial agent formulated by ICAR-NIANP increased average level of milk fat (%) from 2.59 to 3.85, resulted in conception in 76% animals that had reproductive problems like repeat

breeding, delayed puberty and post-partum anestrus.

The 'Doublesynch' and the 'Estra-doublesynch' estrous synchronization protocols along with fixed time artificial insemination were carried out in cows with more than 80% success in conception rate in problematic animals.

For isolation and purification of buffalo pituitary gonadotropins, approximately 1Kg of pituitaries have been collected and the extraction process is in progress. The NIH method with modification is being followed.

IGF1 as additive improved post-thaw quality of buffalo spermatozoa. Unique proteins were identified for good and poor quality spermatozoa. Feed supplement comprised a source of energy, protein and an antimicrobial agent improved milk fat content and conception rate in cows. Identified the translated transcripts in spermatozoa. Doublesynch and Estra-doublesynch estrous synchronization protocols along with fixed time artificial insemination improved conception rate in problematic animals.

DBT Project: Expression of copper chaperones and transporters in copper deficient sheep

DT Pal, J Ghosh and CS Prasad

The objective of the project was to identify copper (Cu) deficiency biomarkers by comparing the differential expression status of selected Cu transporter and chaperone genes in sheep fed with Cu-adequate and Cu-deficient diets.

The RNA from whole blood, RBC and liver tissues from healthy sheep was isolated for the purpose of identifying the Cu related chaperone and transporter genes in those cells. The presence of the transcripts of *SOD, CCS, ATP7B, SCO1, SCO2, ATOX1, CTR2, MURR1, COX11, COX17, MT2A* and *MTF1* in whole blood and RBC was confirmed. The expression of *NRF1, HNF4α* and *Cp* was also detected in the liver tissues. After the feeding trial, the relative expression of genes was determined in whole blood, RBC and liver samples by qPCR. It was noticed that the expression of *CTR2, ATP7B* and *COX17* genes was up-regulated and *ATOX1, SCO1* and *CCS* genes was down-regulated in blood as well as in liver tissues of the Cu-deficient compared to Cu-adequate animals. Among the genes studied, there was a significant ($P<0.05$) up-regulation of *SCO2* in the Cu-marginally deficient and Cu-deficient sheep and down-regulation of CCS in the Cu-deficient sheep. In RBC, there was a significant ($P<0.05$) up-regulation of *CTR2, ATP7B, SCO2, COX17* and *SOD1* genes in the deficient group, but not in the marginally deficient group. In contrast, there was a significant ($P<0.05$) down-regulation of *SCO1* and *CCS* in the deficient compared to adequate group. In liver samples of the deficient group, there was a significant ($P<0.05$) up regulation of *HNF4α*.

For Transcriptome analysis, the total RNA from liver samples was isolated, quality tested, mRNA purified, paired end library prepared and sequenced using Illumina Hiseq 2000 platform. The data were subjected to quality checked and the reads with average quality scores <20 were filtered out. A total of 52,761,117 and 90,130,568 reads, respectively from the adequate and deficient liver samples were selected for de-novo transcriptome assembly. Out of the total 642,137 assembled transcripts, 225,627 (35.14%) had length of >150bp with a mean GC content of 47.32%. The largest transcript detected was 16,079bp in length. In the Cu-adequate liver sample 64.83% (30,762,599 reads) and in the Cu-deficient liver sample 69.57% (32,699,891 reads) of the total reads were aligned back to the assembled transcriptome. Overall, 38,437 unique transcripts had FPKM>1. Differential gene expression analysis revealed that deficient animals had 58,700 transcripts with >1.5 fold over expression out of which 988 were found significantly ($P<0.05$) up-regulated. Among the 69,071 down-regulated transcripts (<0.66 fold), 357 were found significantly ($P<0.05$) down-regulated.

Attempt was made to identify the Cu-deficiency biomarkers by comparing the differential gene expression profile in whole blood, RBC and liver tissues in the sheep fed with Cu-adequate and Cu-deficient diets. The qPCR as well as whole transcriptome analyses revealed a significant difference in the gene expression profile in blood, RBC and liver tissues between the experimental groups.

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

PSP Gupta, S Nandi, S Mondal and DT Pal

The role of Wnt signal in estradiol synthesis of rodents has been studied elaborately, but the understanding of the same in domestic animals is still obscure. The current research project has been taken up to establish its role in the estrogen synthesis in domestic ruminants with the following objectives: 1) To investigate the role of Wnt signal in Follicle stimulating hormone (FSH) mediated ovarian granulosa cell estradiol synthesis in the various size categories of follicles of ruminants; 2) To investigate the role of Wnt signal in FSH mediated ovarian granulosa cell estradiol synthesis in the pre-antral follicles of ruminants; 3) To investigate the role of Wnt signal in non FSH mediated ovarian granulosa cell estradiol synthesis in ruminants.

Studies were conducted to understand the role of Wnt signal in FSH mediated ovarian granulosa cell estrogen synthesis from ovarian follicles of various size in buffalo. Wnt signal was found to have a positive role in the synthesis of estradiol in medium and large size follicles. Ovarian granulosa cell lysates were subjected to the quantification of expression of various genes related to estradiol synthesis *(CYP19A1)*, granulosa cell proliferation *(CCND2)* and Wnt signal components *(WNT2, WNT4, FZD6, APC, AXIN2, DVL1* and *CTNNB1)*. The Inhibitor of Wnt response (IWR) had significantly reduced the expression of *CYP19A1* in large size category of ovarian follicles and significantly reduced the expression of *CCND2* in the medium and small follicles. IWR had significantly increased *FZD* expression in large follicles. IWR had significantly increased the expression of *CTNNB1* in the granulosa cells of medium sized ovarian follicles. IWR increased the expression of *DVL1* in large follicles and IWR+FSH had significantly increased the expression of *DVL1* in small follicles. Effect of IWR on the estradiol levels (Fig. 8) and the gene expression studies indicated that there was a positive effect of Wnt canonical signalling pathway on estradiol synthesis in both medium and large sized ovarian follicles. Studies on elucidation of the role of Wnt signal in FSH mediated ovarian granulosa cell estrogen synthesis from pre-antral follicles in buffalo indicated that the Wnt signal played a role in the estradiol synthesis even in early folliculogenesis.

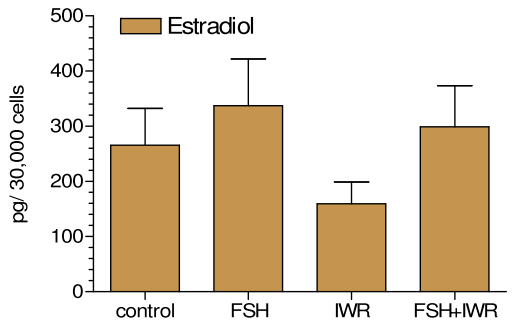


Fig. 8: Effect of Wnt inhibitor (IWR) on in vitro estradiol synthesis of granulosa cells of medium sized ovarian follicles in buffalo.

Studies on the of role of Wnt signal in FSH mediated ovarian granulosa cell estrogen synthesis from pre-antral follicles in buffalo indicated that the Wnt signal plays a role in the estradiol synthesis even in early folliculogenesis.

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

Metabolic stress hinders ovarian follicular development and cause diminished reproductive competence. To examine the effect of metabolic stress on preantral follicles, granulosa cells, oocytes, early embryos the quantitative analysis of apoptosis, lipid peroxidation, global DNA methylation and DNA damage as well as gene expression profiling was performed. The preantral follicles, granulosa cells, cumulus oocyte complex, early embryos were cultured as per standard procedure. The cells were exposed with ammonia (0, 100, 150, 200, 250 300 and 400µM), urea (0, 4, 4.25, 4.5, 5, 5.5 and 6mM), NEFA (control: no NEFA; basal: 70µM, medium combo: 140µM, high combo: 210µM, very high combo: 280µM), and β-OHB (0, 0.5, 0.75 and 1.0µM). Gene expression analysis was performed on target genes *(OCT4, IGF1, FSHr, BAX, BCL2, SOD1, SOD2, DNT1, DMT3a* and *DMT3b)* with reference to the one

housekeeping gene (RPS) in GCs by qPCR. The mRNA expression of *OCT4, GDF9* and *IGF1* significantly decreased in 200µM ammonia, 6mM urea, high combo NEFA, whereas higher expression of *SOD2* was observed compared to other lower levels. No changes were observed in case of *BCl2* and *SOD1* expression, while higher expressions of BAX and lower expression of *SOD1* were observed in ammonia and high combo NEFA compared to other lower levels.

In conclusion, elevated ammonia and NEFA levels altered expression of genes involving growth, apoptosis and oxidative stress and involved in ovarian dysfunction suggestive of a molecular mechanism responsible for the low fertility during metabolic stress condition.

The quantity of cathepsin transcripts in cumulus cells was found to be associated with low-developmental competence of oocytes. We investigated the effect of a cathepsin B inhibitor (E-64) on embryo development and quality derived from metabolic stressed oocytes. We found that treatment of oocytes with E-64 during in vitro oocyte maturation did not affect the percentage of oocytes reaching the metaphase II stage. The oocytes were matured under control conditions and in medium consisted of 250µM ammonia or 8mM urea or very high combo NEFA or 1µM β-OHB. The cleaved embryos were cultured in the presence of E-64 at the level of 0, 0.5, 1.0, 1.5, 2.5 and 5.0µM. The development to the morulae and blastocyst stage embryos were significantly higher in 2.5 and 5.0µM E-64 treatment groups. However, we did not record the stimulatory effect of E-64 in the absence of a surrounding cumulus cell layer. This indicated that a cathepsin B inhibitor (E-64) can be used to improve the developmental competence of stressed oocytes and the stimulatory effects of E-64 on oocyte developmental competence were mediated through the cumulus cell layer.

The expression of development related genes *(GDF9, IGF1, FSHr, FGF8, EGF, Aromatse P4500I* and *G6DP)* in metabolic stressed pre-antral follicles, COCs, two cell embryos and blastocysts was down-regulated compared to the normal ones. Addition of Cathepsin B Inhibitor (2.5µM) in embryo culture medium improved the developmental competence of metabolic stressed COCs during IVM.

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 rate of absorption and have been suggested to improve semen production, sperm motility and male fertility. In this regard, the role of organic zinc (Zn) and copper (Cu) in advancing male puberty and semen characteristics at pre freeze and post thaw stage was studied in Osmanabadi goats. Male kids (n=40) were divided into ten equal groups (n=4) and feeding study was conducted for 6 months. The dietary treatments included a control group (G1) fed on basal diet (without additional trace mineral supplementation) and treatment groups G2 to G 10. The kids in the treatment groups were fed basal diet and one of the following levels of trace minerals added on per kg dry matter basis viz. G2: (Zn 20mg), G3: (Zn 40mg); G4: (Zn 60mg), G5: (Cu 12.5mg), G6: (Cu 25mg), G7: (Cu 37.5mg) and G8: (Zn 20mg + Cu 12.5mg), G9: (Zn 40mg + Cu 25mg) and G10: (Zn 60mg + Cu 37.5mg). The kids fed organic trace

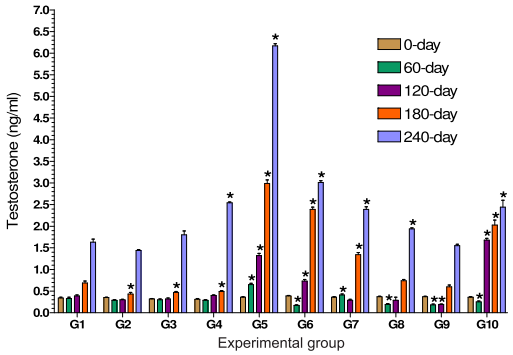


Fig. 9: Plasma testosterone levels in control and organic zinc/copper treated bucks. G1: Control, G2: Zn20, G3: Zn40, G4: Zn60, G5: Cu12.5, G6: Cu25, G7: Cu37.5, G8: Zn20+Cu12.5, G9: Zn40+Cu25, G10: Zn60+Cu37.5; * indicates a significant difference (P<0.05).

minerals from the 5th month of age attained puberty 28-35 days (at 112-117 day) earlier than the control group (at 140-147 day). Trace mineral treated goats also exhibited intense sexual behavior. In addition, significant improvements in testosterone levels ($P<0.01$, Fig. 9), semen production capacity (sperm concentration, volume, mass motility) and semen quality (higher progressive motility, velocity, sperm membrane integrity and acrosome integrity at pre freeze and post thaw stage) were recorded in supplemented groups ($p<0.05$) compared to the control goats. A new protocol for effective goat semen cryopreservation was identified and validated.

Dietary supplementation of organic Zn and Cu to growing male goats advanced the onset of puberty and improved quantitative and qualitative semen characteristics in fresh semen, and also protected sperm cells against cold shock induced cryoinjury during pre freeze and in post thawed semen.

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

AK Samanta, M Sridhar and AP Kolte

Aquaculture is the one of the fastest food production sector across the world and past efforts were directed to enhance the fish growth efficiency through application of several additives including antibiotics. Application of antibiotics as growth promoters has been extensively criticized because of potential development of antibiotic resistant bacteria and destruction of environmental microflora. This led to the restriction of antibiotics in aquaculture production. In this line prebiotics are emerging as alternative front runner to conventional feed additives. Among the catalogue of prebiotics, mannan oligosaccharides (MOS) occupies significant niche as it take care of both consumer concerns and environmental issues. The project aims to evaluate the efficacy of mannan oligosaccharides (MOS) in promoting fish health and productivity in freshwater aquaculture, to fractionate mannan from guar seed for production of mannan oligosaccharides (MOS) and to elucidate the therapeutic value of MOS in peninsular freshwater fishes.

Five different varieties of guar *(Cyamopsis tetragonoloba)* seeds (HC-2-20, RGM-112, RGC-1017, RGC-1038 and RGC-936) were procured from ICAR-CAZRI, Rajasthan. The seeds were sun dried and grounded to have uniform particle size <1mm. The compositional analysis of the five varieties of guar seed is given in Table 4.

Evidently, the mannan content (hemicellulose levels) in the different varieties ranged from 33.7- 42.9% and found highest in RGC-936. The seeds were subjected to mannan extraction under different conditions (ultra-sonication, stirring, stream application and incubation at room temperature for overnight with or without alkali). The actual yield of mannan from RGC-936 ranged from 4.5-14.0% and found highest with 1% NaOH treatment after stirring for 30 minutes. The relative yield of mannan varied from 10-32% of the original contents depending upon the method of extraction. The results indicated that it was possible to extract mannan from the guar seed with water or NaOH treatment.

Table 4: Compositional analysis of Guar Seed varieties.

Fractions	Guar variety				
	HC-2-20	RGM-112	RGM-1017	RGC-1038	RGC-936
Dry matter	91.7±0.01	91.4±0.03	92.1±0.10	91.5±0.18	91.9±0.15
Organic matter	96.9±0.09	95.8±0.09	96.0±0.29	96.1±0.11	96.5±0.14
Ash	3.04±0.45	4.18±0.09	3.97±0.29	3.87±0.11	3.53±0.14
NDF	49.5±2.58	51.4±4.39	49.6±0.22	48.2±0.20	60.8±2.05
ADF	14.3±0.01	14.7±0.14	15.4±0.16	14.4±0.46	17.9±0.79
Hemicellulose	35.2±2.57	36.7±4.25	34.2±0.38	33.7±0.66	42.9±1.64
Protein	29.4±0.02	31.4±0.04	31.4±0.04	33.8±0.09	32.1±1.33

Out of the five varieties of guar seeds, RGC-936 contained highest (42%) concentration of hemicellulose. Stirring of guar seed in water for 30 minutes resulted 25% mannan yield that was free from protein or soluble sugars.

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

Feed and fodder plays an important role in animal production with feed alone constituting more than 60% of the cost of animal products. Hence, it is important to know in advance about the surplus/deficit of feed and fodder resources in different parts of India. At present feed and fodder resources availability projections are being made for the country as a whole. This is partly due to the fact that data at micro level is not readily available. Another handicap in this process is the non-availability of data in time. India is a vast country with 35 states and union territories comprising 635 districts. Collecting primary data regarding the livestock population and its compilation is a huge task. To estimate the feed and fodder requirements for livestock population, the timely availability of livestock census data is a prerequisite. The present system of livestock census enumeration is a time consuming process entailing approximately 2 years. If the census data enumeration and compilation can be made real time, the forecasting of the feed and fodder resources can be made in real time or in advance. Once a forecast of the requirements is available, it is easy to identify the surplus/deficit areas and movement of the feed resources can be planned accordingly. Advances in the field of information technology have made the real time collection and compilation of data pertaining to livestock feed resources possible. The objectives of the project were to use information technology 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 and forecast the surplus or deficit at micro level in real time to assist the planners and administrators.

To ensure real time collection and compilation of livestock data, website was designed, based on open source software platform. The website was designed on Java platform using HTML 5 standard. It is a clustered MYSQL DB solution, which can be extendable and configurable, so that future modification can be done easily. This would enable the use of the program across platforms in PC or mobile.

Website is currently hosted at Ashoka server of ICAR-IASRI, New Delhi (http://webtom.cabgrid.res.in/lcde/). The demonstration of the website has also been done at a meeting of ICAR officials at NASC complex, New Delhi, on 24th March, 2017 emphasising its possible implementation through DAHDF, Govt. of India.

A website has been designed and is currently hosted at Ashoka server of ICAR-IASRI, New Delhi to facilitate real time collection and compilation of livestock data (http:// webtom.cabgrid.res.in/lcde/).

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

S Manpal, 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. Also on account of ever growing human need for food, only limited cultivated land can be allocated to fodder production. Also low yield of fodder per acre and fodder scarcity periods aggravates the situation. Manipulating surplus fodder during periods of abundance can bridge the gap during scarcity periods especially for high yielding animals. Preservation of nutritional fodder crops by silage making can ensure regular feed supply throughout the year, especially during the lean season. The objectives of the current project are to standardize different microbes and enzyme consortia that will boost up the fermentation process of silage within 2-3 days, to minimize loss of nutrients during the fermentation process, to reduce the period required for stabilization of silage and to provide a set of

practical recommendations for the preparation of high quality silage from grasses, fodder crops and crop residues.

Para grass, Rhodes grass and Hybrid napier grown in the experimental fodder farm were harvested after 60 days of growth and ensilaged individually as well as in the mixed form, at small scale (plastic air tight containers) in the laboratory for the durations of 30 and 45 days. Physical aspects of silage quality like colour change, odour and texture were recorded and the keeping quality was studied by analysis of pH, acidity, buffering capacity (BC), Water soluble carbohydrates (WSC), ammonia nitrogen and lactic acid content in silage. The fibre (ADF, NDF and ADL) and protein contents were also analyzed employing standard methods. The colour in all silages turned from light green to dark/bright green with no visible mold growth or blackening and had a strong fruity odour/sweet fermented smell (Fig. 1).

Fig. 1: Silage prepared from different grasses.

A 17% DM loss was observed in Para grass, while in Rhodes it was 3% after ensilaging for 30 days. A reduction in the NDF% was obtained, but there was no change in the ADF% and ADL%. The decreased pH value (4.93 and 4.66 respectively in Para and Rhodes silages as compared to their fresh counterpart with 6.28 and 5.58 respectively) in the ensiled samples indicated acid fermentation during the process (Fig. 2).

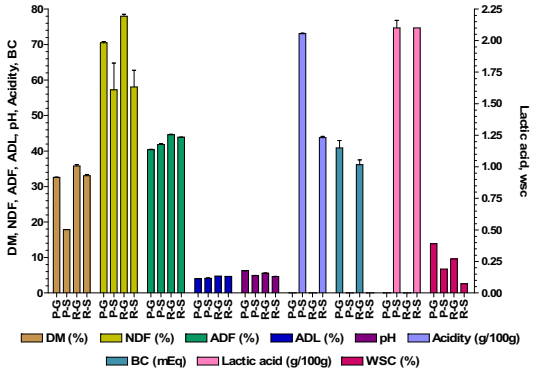


Fig. 2: Changes in the composition, buffering capacity and acidity of the two fodders after 30 days of ensiling. P-G: para grass; P-S: para silage; R-G: rhodes grass; R-S: Rhodes silage.

The low WSC% and acidity% in silage was due to low DM% in the silage sample. Higher buffering capacity in the grass showed higher acidity. Lactic acid content in both the silages was found similar (2.1g/100gm). A similar trend was also observed, when silages were prepared for the duration of 45 days (Table 1).

Table 1: Changes in the composition and buffering capacity (BC) of different fodders after 45 days of ensiling.

Sample	DM%	NDF%	ADF%	ADL%	pH	WSC%	BC (mEq)
Grass							
Para	21.0±0.32	65.6±9.12	40.1±0.04	4.63±0.08	6.28±0.02	0.39±0.00	40.9±2.05
Rhodes	27.3±0.48	78.7±0.66	44.8±1.95	5.50±0.28	5.58±0.01	0.27±0.00	36.2±1.32
Hybrid napier	15.6±0.45	64.4±3.89	37.5±2.27	3.28±0.06	5.60±0.06	0.27±0.00	39.5±0.00
Mixed	21.9±2.89	69.8±7.94	42.8±3.22	5.14±0.03	6.23±0.00	0.24±0.00	23.5±0.00
Silage							
Para	19.6±0.06	64.7±0.52	43.3±0.32	4.96±0.31	5.43±0.01	0.24±0.01	-
Rhodes	24.3±0.04	73.4±0.14	47.2±0.51	5.61±0.29	4.78±0.02	0.18±0.00	-
Hybrid napier	14.7±0.17	57.2±0.01	40.1±0.21	4.21±0.01	4.90±0.00	0.38±0.01	-
Mixed	16.9±0.04	66.9±0.64	43.6±0.04	4.99±0.11	4.78±0.02	0.14±0.00	-

Para grass, Rhodes grass and Hybrid napier were ensilaged individually or as a mixture for 30 or 45 days. A reduction in the NDF% but not in the ADF% and ADL% was observed following the process. Duration of ensiling process did not influence silage qualities.

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

Under the 'one health' concept, correction of nutrient deficiencies in soil will help in improving the health of crops as well as livestock. A field study was taken up in Zinc deficient soils in Durga Nagenhalli village of Tumkur district with the objectives of studying the effect of correction of Zinc deficiency in soils on yield as well as quality of fodder maize crop and evaluating the impact of resulting zinc fortified maize fodder on improving the zinc status in sheep.

With the application of zinc sulphate (25kg/ha), mean zinc content in fodder maize improved considerably to 36.9ppm as compared to 26.6ppm in control plots without Zn application. The stover yield of maize in zinc applied plot was 26.3t/ha compared 22.4t/ha in control plot. Two groups of 10 growing sheep, deficient in zinc were fed maize stover without and with zinc fortification (Table 2). The fodder and concentrate ratio was 80:20 of the total dry matter requirement and the animals were maintained under stall fed conditions for 180 days. The average serum zinc content of sheep significantly improved by 0.4ppm due to feeding of zinc fortified stover. Average daily gain was found higher in the fortified group (83g) as compared to control (70g). Similarly, at the end of the feeding period, after 180 days of study, the humoral immunity in fortified group of sheep against PPR vaccine was 92.6 (antibody titre, % inhibition) as compared to 85.5 in unfortified sheep.

Table 2: Effect of zinc fortification on the performance of sheep.

Particulars	Experimental group	
	Zinc fortified	Control
Initial body weight (kg)	14.2±0.44	14.1±1.06
Final body weight (kg)	29.2±1.53^{a}	26.7±1.41^{b}
Total weight gain (kg)	15.0±1.03^{a}	12.6±0.91^{b}
Average daily gain (g/day/sheep)	83±4.01^{a}	70±3.94^{b}
Plasma zinc level in serum on day zero (mg/L)	0.72±0.05	0.51±0.04
Plasma zinc level in serum on day 180 (mg/L)	1.12±0.07^{a}	0.78±0.05^{b}

Values within a row with different superscript differ significantly (P<0.05).

Correction of zinc deficiency in soil resulted in improved zinc content in maize fodder by more than 10ppm and feeding of fortified maize fodder for 180 days enhanced the serum zinc level from 0.7 to 1.1ppm in sheep.

CRP Project: Biofortification-Evaluation of value addition cereals (vac) and cereal by products for animal feeding

KS Prasad, SBN Rao and NM Soren

Biofortification is the process by which the nutritional quality of food crops that is deficient in one or more nutrient(s) is improved by using advanced agronomic practices, conventional plant breeding or modern biotechnological tools. The nutrient content in cereal crops or its by-products varies considerably from region to region and biofortification can be one of the means to improve the critical nutrient(s), which are required to enhance the productivity of livestock. In the 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 was entrusted with the responsibility of quality evaluation of VAC and their by-products.

Straw samples of foxtail millet (*Setaria italica;* TNAU-59, SiA-3088), little millet (*Panicum sumatrense;* JK-8, OLM-203) and finger millet (*Eleusine coracana;* GPU-67, KMR-216) from GKVK, Bengaluru, samples of wheat by-products (straws and wheat brans; DBW71, DBW16, DBW110, DBW88, DBW621-50 and DBW90) from ICAR-IIWBR, Karnal and straw samples of pearl millet (86M86, 86M84, JKBH676, BIO8145 and

XMT1497) from AICRPPM, Jodhpur were evaluated for chemical composition, content of macro and micro minerals, gas production (GP), digestibility (DM and OM), rumen fermentation and individual fatty acids.

The CP content in foxtail millet was found similar in both the varieties, while Ca, Mg, 24h GP and digestibility were found higher for TNAU-59. The SiA-3088 variety had higher concentration of NDF, P, Fe and Mn. The concentration of acetate, propionate, butyrate, valerate and TVFA was found higher in TNAU-59 and lower in SiA-3088 variety. In little millet, the content of CP, Fe, Zn and Mn, digestibility (DM and OM) and 24h GP was found higher in JK-8, while OLM-203 variety had more NDF, ADF, ADL and P. The concentration of propionate and butyrate was found higher in OLM-203 and lower in JK-8 variety. Among the finger millet straws, the KMR-216 variety had higher CP, EE, P and Mg, while GPU-67 variety had more Ca, Fe, Zn and Mn. Although GP was found higher in GPU-67, digestibility (DM and OM) was found similar among the finger millet varieties. The concentration of NH3-N, acetate, propionate, butyrate and TVFA was found similar in both the varieties finger millet straw.

The content of CP ranged from 3.46-4.60% and 14.9-17.1%, respectively in the wheat straw (WS) and wheat bran (WB) samples. The concentration of Ca, P and Mg was found higher in DBW 16 and lower in DBW90 variety of WS, while DBW16 had lower level of Ca and P among the WB varieties. The GP was found higher in DBW88 and lower in DBW90 WB, but it was similar for all the WS varieties. The WS varieties DBW110, DBW621-90 and DBW90, and WB variety DBW71 showed higher DM and OM digestibility. Higher acetate and propionate level was found in DBW71 and DBW16 WS samples respectively. Among the WB samples, DBW110 and DBW71 yielded more acetate and propionate. However the TVFA was found higher in DBW71 variety for both WS and WB samples. The total protozoa count was found higher in DBW16 variety of both WS and WB samples.

Among the pearl millet straw samples, CP was found higher in 86M86 variety, while BIO8145 had higher NDF level. The 86M84 variety yielded more gas after 24h of incubation, while the XMT1497 variety had significantly higher DM and OM digestibility. The NH3-N concentration was found highest in 86M86 and lowest in 86M84 variety, while the concentration of individual VFA was found similar in all the varieties of pearl millets straw. The protozoa count was found higher in JKBH676 and lower in BIO8145 varieties.

The foxtail millets TNAU-59 and JK-8 can be used as staple roughage source for feeding of ruminants. The DBW16 variety was found superior compared to all other varieties of wheat bran in terms of CP content. In terms of mineral content the DBW110 was found rich in Ca, P and Zn. The pearl millet straws 86M86, JKBH676 and BIO8145 varieties were found superior compared to other varieties in terms of CP content.

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 are directly or through soil, water and feeds lead to the presence of these residues in edible products of animal origin (milk, meat and eggs). The project aims to monitor environmental pollutants in soil, water, feeds, fodders and animal products in the selected areas of Karnataka using modern and precision methods.

During the reported period, a survey was conducted in Dakshina Kannada (DK) district of Karnataka to find about the feeding practices and to collect samples for pesticide residue and heavy metal estimations. A total of 219 samples of soil, water, paddy straw, green fodder, concentrates, rice and wheat bran, maize powder, til cake, hair and milk samples were collected from 20 households located in 10 villages of Puttur, Sulia and Bantwara taluks of DK district.

The pH, electrical conductivity (EC, ds/m), organic carbon (OC, %), Potassium (kg/ha), Phosphorus (kg/ha) Ca (%), Mg (%) and Fe (%) and, micro elements such as sulphur (ppm), boron (B, ppm), copper (Cu, ppm), Zinc (Zn, ppm) and Manganese (Mn, ppm) were estimated in soil (n=10). In general, soils were found to be low in organic carbon (0.48-1.7%), potassium (40-157kg/ha) and Phosphorus (1-39kg/ha) requiring addition of organic manure and fertilization. Soils also contained low levels of B (0.22-

0.64ppm), Mg (0.005-0.027%) and Zn (0.12-16.64 ppm) hence, requires application 10, 80 and 10kg/ha of borax, magnesium sulphate and zinc sulphate, respectively for amelioration of B, Mg and Zn.

Information with regard to feeding status of the dairy animals were collected using questionnaire. In general, dairy animals were found to be low-medium yielders (5-8lit milk/day). The animals fed mostly on seasonal grass harvested from areca gardens and limited amount (1-2kg) of paddy straw, concentrates, oil meal (Sesamum), rice bran and powdered maize grain. Farmers also feed local resources like areca sheath, cocoa shells, banana stem, banana leaves etc.

A total of 104 feed (paddy straw, green fodder, concentrates, rice bran, wheat bran, maize grain and til cake), 19 water and 58 milk samples were screened for various pesticide residues using gas chromatography. The presence of chloropyriphos and BHC was detected in a few of the water, feed and milk samples. Similarly, a total of 59 roughage, 45 concentrate, 14 soil, 58 milk and 24 hair samples were screened for the contamination of heavy metals. The presence of arsenic, lead and cadmium was detected in a few of the analyzed samples.

In Dakshina Kannada district, soils were found to be deficient in organic carbon, potassium, phosphorus, boron, magnesium and zinc requiring additional supplementation. The samples of feeds, water, milk and hair were screened for the presence of pesticide residues and heavy metals.

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

Feed cost accounts for more than half of the cost of dairy production. Due to the shortage of feed resources in the country, there is a huge gap in the availability and requirement of concentrate ingredients for feeding the livestock. The cost of the feed ingredients in particular, oilseeds and oil meals have increased considerably in the recent past. Therefore it has become necessary to explore the usage of alternate oilseed meals/protein/energy supplements from non-edible sources to bridge the gap between availability and requirements. By-products from spent pupae of silk worm (SWP) are some of such alternate supplements, which can be explored and used as a livestock feed with a high nutritional value. Limited research work has been conducted on the utilization of SWP by-products in ruminants. Therefore, this project has been initiated to evaluate the feeding value of the by-products of SWP in ruminants. The chemical composition of silkworm pupae and different feed ingredients were analyzed. The defatted variety of SWP (DSWP) contained more CP (68.7%) than that of non-defatted SWP meal (FSWP) (60.93%). The kinetic parameters of two varieties of SWP meals and soybean meal (SBM) were assessed through *in vitro* ruminal incubation for 96h (Fig. 3). The potential gas production was found highest in SBM followed by DSWP and FSWP meals. The gas production rate constant was also found highest in SBM followed by FSWP and DSWP meals. The T½ was found highest for DSWP meal and lowest for SBM.

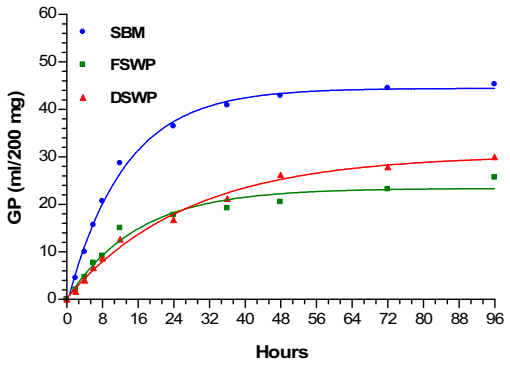


Fig. 3: In vitro gas production kinetics of defatted and non-defatted silkworm pupae meal and soybean meal at different hours.

In vitro nutritional evaluation of DSWP with ragi straw at 30:70 ratio was carried out. Accordingly, ten isonitrogenous concentrated mixtures (CP: 17.35-17.43%) were formulated with graded levels of DSWP meal to replace the nitrogen moiety of the SBM of the control concentrate mixtures at 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100% (T1-T10). The 24h gas production (ml/200mg DM) was ranged from 35.57 (T1) to 40.40 (T10), which was significantly higher than the control (T0). The calculated values of short chain fatty acids

(SCFA) (mmol/30ml of the incubation media) of different diets was increased with the graded level of SWP meal in different diets. The metabolizable energy content of the different diets increased linearly with the increase in the level of DSWP meal in different dietary treatments. The in vitro study with different inclusion levels of SWP is in under progress.

The potential gas production was found highest in SBM followed by DSWP and FSWP meals. The T½ was found highest for DSWP meal and lowest for SBM.

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

Despite of being the highest milk producer in the world, the performance of Indian cattle has been found to be very poor. The rapidly changing livestock sector in the country is crucial for food security and sustainability issues with respect to the present scenario of economy and climate change. In India, the methane emission profile is agriculture dominant and the large bovine population of the country that are fed mostly on low quality crop residues are often blamed as the major source of methane emission. The livestock sector representing 14.5 percent of total 7.1 gigatonnes (Gg) CO2-eq per annum human-induced greenhouse gas (GHG) emissions plays an important role in climate change. According to the latest report, 45% of the country's total methane emission is from livestock. However, nitrous oxide emission from livestock manure management system is reported to be negligible.

So far, most of the works conducted in GHG emission from dairy system in the country are limited to the emissions from enteric fermentation and manure management system. Whereas, Life Cycle Assessment (LCA) of GHG emission includes all emissions along the supply chain starting from the land use and production of feeds, through emissions from the animal production to the emissions related to processing and transportation of products to the end users. LCA has been described as a useful tool to assess global warming potential of dairy production system. The present study has been undertaken to conduct LCA of GHG emission from selected dairy farms of Karnataka State with the objectives of identifying and estimating the major sources of GHG and developing models for estimating the GHG emission.

Data were collected from six large, five medium and 26 small dairy farms located at the villages in Mandya, Tumkur and Kolar districts (Fig. 1). The characteristics of different categories of dairy farms were analyzed from the collected data (Table 1).

Fig. 1: Data collected from the marked districts of Karnataka.

Preliminary analysis indicated that dairy is the main occupation for 11.1% farmers of the total farm surveyed. The average agricultural land owned was 6.00, 2.40 and 1.50 acres by large, medium and small dairy farmers respectively. It was observed that 9.40% of the total cultivable land was used for fodder production and the individual area under fodder production varied from 0.25-2 acres among the farms.

The average numbers of adult female cattle in the large, medium and small dairy farms were found to be 13.5, 5.60 and 2.30 respectively. Whereas, the numbers of calves maintained by the large, medium and small farms were 6.80, 2.00 and 1.60 respectively. In all the large dairy farms, there were 5-44% dry animals, in 33% medium farms there were 25-33% dry animals, whereas in 35% small farms there were 25-50% dry cows. The average milk yield (lit/head/d) and the total milk yield (lit/farm/d) were 10.6, 9.50, 9.70 and 120, 45.0, 21.6 litres in large, medium and small dairy farms.

With regard to the mechanization, tractor was used in two large farms for feed and fodder transportation. The average run time of tractor was noted as 40-50min per day. These two farms used tractor to carry concentrate feed from 15km distance. Considering a total load of 3000kg per trip, the total GHG emission (CO2, CH4 and N2O-N) for feed transportation was calculated as 8.70 CO2 eq/kg DM transported. The emission factor for tractor in Indian condition was referred from published literature. Milking machine was used in two large dairy farms and in one farm it was run with solar energy. The milking was done two times per day and it took 4min per cow at a time. Chaffing machine was there only in two large dairy farms and was used for 1-2h per day for chaffing fodder.

Table 1: Basic characteristics of small medium and large dairy farms analyzed on the basis of survey.

Particulars	Small dairy farm (1-3 cattle)	Medium dairy farm (4-10 cattle)	Large dairy farm (>10 cattle)
No of farms surveyed	26 (70.3%)	5 (13.5%)	6 (16.2%)
Average agricultural land owned (acres)	1.50	2.40	6.00
Average no of adult female cattle	2.30	5.60	13.5
Average no of lactating cattle/farm	2.00	4.80	11.5
Milk yield (lit/head/d)	9.70	9.50	10.6
Total Milk yield (lit/farm/d)	21.6	45.0	120
Milk retained for use at home (%)	4.80	2.90	0.05
Average no of calves/farm	1.60	2.00	6.80

Dairy is the main occupation for 11.1% farmers of total farms surveyed. The average milk yield (lit/head/d) and total milk yield (lit/farm/d) were found to be 10.6, 9.50, 9.70 and 120, 45.0, 21.6, respectively in the large, medium and small dairy farms. The total GHG emission (CO2, CH4 and N2O-N) for transportation of feed from 15km distance in tractor was found to be 8.70 CO2 eq/kg DM transported.

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

Coordinator: R Bhatta

PK Malik and AP Kolte

Due to the substantial loss of biological energy (6-12% of intake) and high global warming potential of methane (25 times of CO2), the enteric methane emission from ruminants in the country warrants urgent attention. Therefore, the current project has been undertaken to generate a database for the enteric methane emission from Indian livestock and to develop mitigation strategies for enteric methane emission.

In vitro studies were conducted in a series to explore the anti-methanogenic potential of silkworm (*Bombyx mori*) pupae oil by supplementing it at variable levels in finger millet straw and concentrate based diet. The pupae oil was supplemented at variable levels of 2, 4, 6, 8, 10 and 20% of the basal diet. The results from the *in vitro* studies indicated a reduction of 15-50% in methane production, when the pupae oil was supplemented in the diet as anti-methanogenic agent (Fig. 2). However, the methane reduction was accompanied with the concurrent reduction in dry matter digestibility, when the oil was added at higher level (>6%). It was established from the study that silkworm pupae oil at 2-4% of basal diet decreased methane production by 30% without any meaningful reduction in the dry matter digestibility.

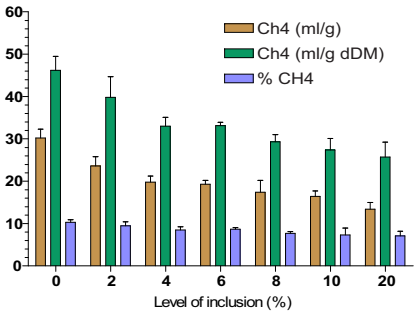


Fig. 2: Effect of variable levels of silkworm pupae oil on methane production *in vitro*.

Another study was conducted to compare the efficacy of tamarind seed husk (*Tamarindus indica*), soapnut (*Sapindus mukorossi*) and their variable combinations for *in vitro* methane reduction. Tanniferous and saponiferous sources alone or in variable proportions constituted 17% of the concentrate or 5.1% of the total diet. Variable ratios of tamarind seed husk:soapnuts (100:0, 75:25, 60:40, 50:50, 40:60, 25:75, 0:100) were studied. Tannin and saponiferous phyto-sources either alone or in combination replaced equal parts of wheat bran in concentrate mixture. Different combinations of tamarind seed husk and soapnuts in present study revealed variable reduction in methane (8-30%). The highest reduction (29.8%) was recorded when tamarind seed husk alone was used. Comparison of methane reduction envisaged the maximum reduction with 60:40 of tamarind seed husk and soapnuts. There was a significant ($P<0.05$) reduction in total protozoal population in all the treatments as compared to control.

In a follow up *in vivo* study in 20 adult male crossbred cattle, the effect of tamarind seed husk and soapnuts supplementation on enteric methane emission was assessed using SF6 tracer technique. The results indicated no adverse impact of tamarind seed husk, soapnut and combo supplementation on the intake and digestibility of dry matter. A decreasing ($P<0.05$) ruminal protein degradation substantiated with less ammonical-N was recorded with tamarind seed husk (T1) and combined supplementation of tamarind seed husk and soapnut (T3). In contrast, soapnut supplementation (T2) alone had no measurable ($P>0.05$) impact on rumen protein degradation. The findings of the study established that tamarind seed husk and soapnut supplementation alone or in combination decreased ($P<0.05$) the population of rumen protozoa as well as entodinomorphs ciliates as compared to the control group (Fig. 3).

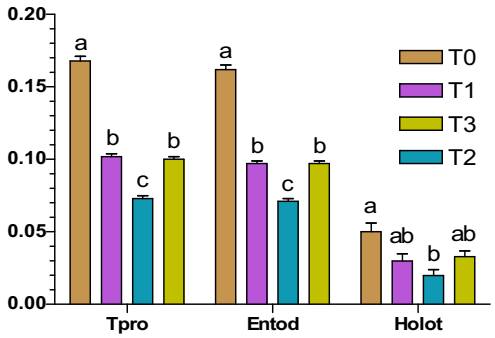


Fig. 3: Effect of tannin and saponin source supplementation on rumen protozoa. Tpro: Total protozoa ($\times 10^5$), Entod: Entodinimorphs ($\times 10^5$), Holot: Holotrichs ($\times 10^4$). a,b, c indicates a significant difference ($P<0.05$).

Supplementation of silkworm pupae oil at 2-4% level of basal diet decreased methane production by 30% *in vitro* without any reduction in dry matter digestibility. Similarly, in cattle, supplementation of tamarind seed husk alone or in combination with soapnut significantly reduced in vitro methane production. In cattle, tamarind seed husk or soapnut supplementation alone or in combination, significantly decreased the population of rumen protozoa and entodinomorphs ciliates.

DBT Project: Livestock methane reduction through immunization based approach

PK Malik, R Bhatta, AP Kolte, S Manpal and A Dhali

Enteric methane emission constitutes 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 fraction of biological energy that is otherwise lost in the form methane. The search for a suitable, effective and safe methane mitigating approach is still on the radar of researchers. An attractive and novel option for reducing the enteric methane emission may be the immunization of animal system against their own methanogens inhabiting in the rumen. At this background, the project has been undertaken with the objectives to perform diversity analysis and quantitation of rumen archaea through molecular approaches, formulate species specific vaccine(s) for the active immunization of cattle and buffaloes, and evaluate the effect of active immunization and secondary metabolites combo preparation on *in vivo* methane emission and fermentability pattern.

The 16s rRNA gene was amplified using archaeal specific primers from the rumen metagenomic DNA isolated from cattle and buffalo belonging to different geographical locations (Uttar Pradesh and Karnataka). The amplified fragments were cloned into pJET vectors and sequenced bi-directionally using Sanger sequencing. Data from the sequence chromatograms was manually checked for quality and contigs were prepared using Codon Code

Aligner v4.0.4. Clone libraries revealed *Methanobrevibacter smithii* was the principal methanogens in buffaloes irrespective of the geographical locations. *Methanobrevibacter smithii* represents about 1/2 of the total archaeal population in the rumen, while the genus Methanobrevibacter alone constitute more than 2/3 of the total archaea in buffalo rumen. Further, the comparison of rumen methanogens in buffalo and cattle established that the prominent methanogens were different in these two major methane emitting species. *Methanobrevibacter millarae* was the primal methanogens in cattle, while *Methanobrevibacter* smithii formed the largest population. However, *Methanobrevibacter thaueri* was the second most abundant (37%) methanogens in buffalo (Fig. 4), whilst in cattle it represented 1% of the archaeal population.

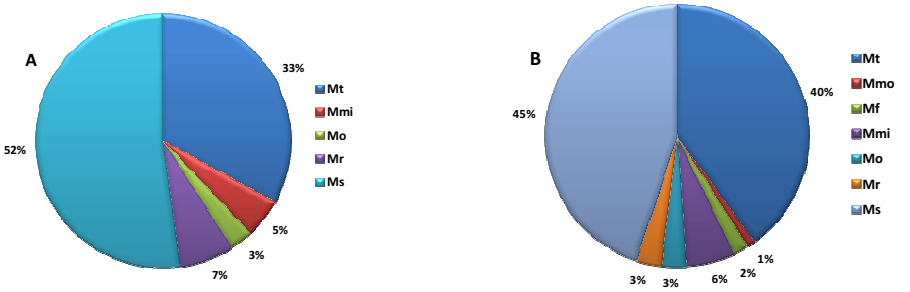


Fig. 4: Rumen methanogens distribution in buffaloes in Karnataka (A) and Uttar Pradesh (B). Mt: *Methanobrevibacter thaueri*, Mmi: *Methanobrevibacter millerae*, Mo: *Methanobrevibacter oralis*, Mr: *Methanobrevibacter ruminantium,* Ms: *Methanobrevibacter smithii,* Mmo: *Methanomicrobium mobile,* Mf: *Methanobacterium flexile.*

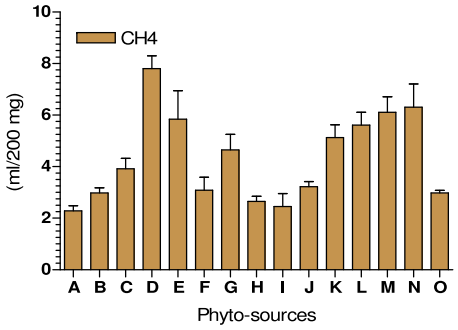
Irrespective of the geographical locations (Uttar Pradesh and Karnataka), *Methanobrevibacter smithii* was found to be the principal rumen methanogen in buffaloes. Prominent rumen methanogens were found different in buffalo and cattle. *Methanobrevibacter smithii* and *Methanobrevibacter thaueri* were the most abundant methanogens in buffalo, whilst *Methanobrevibacter millarae* was the primal methanogen in cattle.

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

The enteric methane emission from ruminants is a global problem and its intensity vary in accordance with the quality of feed and fodders, germplasm of the livestock and their productive performances. Indian livestock emits about 10Tg methane annually from enteric fermentation. This methane, apart from the global warming impact, has additional disadvantage of energy loss from animal's biological system. India and Japan both are making attempts to reduce the enteric methane emission from livestock by using some selective unexplored phyto-sources as dietary ingredient. This joint Indo-Japan project has been undertaken with the objective to ameliorate enteric methane emission from livestock by evaluating various phytosources from natural plants and food industrial byproducts for inhibiting methane emission from ruminants and to elucidate responses of the microbial communities inhabiting the rumen of adult ruminants and comparing kinetic differences of nutrients digestion.

A total of 16 Samples were collected from Himalayan region (Nainital district, Uttarakhand), air dried, and brought to the laboratory. Air dried samples were processed to explore their methane reduction potential. Samples were initially screened for the presence of plant secondary metabolites. It was found that 12 out of 16 samples were positive for tannin content, but no sample contained saponin. Most of the studied samples were found positive for the flavinoids and terpenoids. However, the presence of phlobatannin could not be detected through qualitative screening in any sample. These samples were evaluated *in vitro* for the comparative methane production and results indicated that *Pittosporum eriocarpum, Terminalia chebula, Berberis lycium* and *Lannea coromandelica* comparatively produced less methane than the other phyto-sources (Fig. 5).



A: *Pittosporum eriocarpum*, B: *Asparagus racemosus*, C: *Prunus domestica*, D: *Prunus persica*, E: *Dalmori*, F: *Juglans regia*, G: *Melia azedarach*, H: *Terminalia chebula*, I: *Berberis Lycium*, J: *Zanthoxylum alatum*, K: *Agni*, L: *Artemisia vulgaris*, M: *Punica granatum*, N: *Acacia Catechu*, O: *Lannea coromandelica*

Fig. 5: Comparative evaluation of phyto-sources for in vitro methane production.

The phytosources from the Himalayan region such as *Pittosporum eriocarpum, Terminalia chebula, Berberis lycium* and *Lannea coromandelica* produced less methane *in vitro.*

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 adopt as such and there is a need to devise the location specific strategies for enteric methane amelioration, when intensification of livestock production in a must. The project has been undertaken 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 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 near Bengaluru.

The project is just started and so far 30 villages in the North as well South transacts (15 in each) have been surveyed for collecting the information on livestock holding, feeding practices, seasonal variation in feed availability, selling of product etc. Further, 20 feaces samples collected from the cattle during ongoing experiments under different projects were processed in the laboratory for the lipid extraction using Bligh dyer method to develop an direct method (archaeol estimation) of estimating methane emission from livestock. The GC-MS analysis of the processed samples is in progress.

The joint Indo-German project has just started and 30 villages have been surveyed for collecting information on livestock holding, feeding practices, seasonal variation in feed availability and selling of products.

Programme 6
Technology Translation to Connect Discovery with Application

TTA 6.1: Socio-economic impact of area specific mineral mixture technology in Karnataka

T Chandrappa, G Letha Devi and S Jash

An understanding of the effect of a new technology on productivity is crucial for a better understanding of the potential diffusion of the technology among farmers and to establish the output and revenue changes from the technology. The technology "Area Specific Mineral Mixture (ASMM)" developed by this Institute has been widely adopted by the farmers during last eight years and shown positive results in the field. The current project aims to study the socio-economic impacts of this technology with the objectives to assess the adoption pattern of ASMM in Karnataka, to study the impact of ASMM on production and profitability of dairy farming and to document the farmers perceptions of ASMM technology.

Secondary data on various aspects related to ASMM were collected from Karnataka Cooperative Milk Producers Federation Ltd (KMF) Bengaluru, Karnataka state District Milk Unions, Village Milk Co-operative Societies and other agencies. For primary data collection, the sample respondents of both ASMM technology adopter and non-adopter through personal interview method was fallowed (Fig. 1).

Fig. 1: Collection of primary data from farmers at field level.

The results have revealed that the average monthly production of ASMM has increased from 32.89 tonnes in 2007 to 260.89 tonnes in the year 2015. The number of ASMM production plant have also increased from 1 to 3 between the period 2007-2014. The average milk yield has increased to 0.5lit per day per animal among the ASMM technology adopters. In comparison to adopter and non adopter's net profit, adopters are getting a net profit of Rs 11.20 per animal per day because of the adoption of ASMM. It has been found that 83% of the adopters have used ASMM for milch animals, 85% have perceived that ASMM increases milk yield and 89% have shown willingness to buy ASMM, even if its price increases in future.

Average milk yield has been increased by 0.5lit/day/animal and a net profit of Rs 11.2/animal/ day has been realized due to the adoption of the ASMM technology adopters.

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

G Letha Devi, A Mech, G Ravikiran and V Sejian

Water is a nutrient that is required in largest quantity by livestock. Drinking water provides 60-80% of dry and lactating cows' water needs and feed provides the rest of the water needed. Water quality is equally important as quantity or availability. Water 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 gradually. 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 livelihood, 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 in different dairy production systems.

A semi structured interview schedule was prepared for collecting data regarding water use efficiency in different dairy production systems. Primary data was collected from 90 small and medium sized dairy farms in Kolar district. The water inputs (by animals) considered were drinking water, water contained in forages, water for on-farm servicing, water for crop irrigation and water for all upstream inputs other than feeds and the water output (by animals) considered were urine and milk. The initial observation shows that water inputs through forage and other feed ingredients are more as compared to water inputs through drinking water and that used for on farm servicing operations such as cleaning etc. Water use efficiency of small holders in Kolar district was found to be 0.85 and that of commercial farms was found to be 1.45.

The water use efficiency in different dairy production systems was assessed in Kolar district. The results indicated that the water inputs through forage and other feed ingredients were more as compared to the inputs through drinking water and that used for on farm servicing operations. The use efficiency for small holders was found to be 0.85 and for the commercial farms, it was found to be 1.45.

Extramural Project: Need assessment, development and evaluation of web based livestock advisory and information system

G Letha Devi, A Mech, S Senani, M Kumar and A Bharadwaj

Indian livestock farmers face challenges in accessing information and services via digital tools that are crucial for decision-making. Structuring scattered information in searchable interactive system, delivery by proper channel and creating trustworthiness of data is a challenge. A multi linguistic web based Livestock Advisory and Information System may help to address these issues. A web based Livestock Advisory and Information System that will cater as one stop source of information delivery of to end users like livestock farmers, students, veterinarians, scientists, policy makers and livestock industries is very much needed. The project is framed with the objectives to assess and map farmers' capability, awareness and preparedness about IT tools for livestock farming, to design and develop a multi linguistic web based Livestock Advisory and Information system for delivery of information to end users and to test and evaluate the developed web based Livestock Advisory and Information system

A semi structured interview schedule was prepared for collecting data regarding farmer capability, awareness and preparedness about IT tools for livestock farming. The data collection was completed from 60 respondents regarding awareness about IT tools, attitude of farmers towards IT tools, constraints in using IT tools and expectations of farmers in the development of IT tools. Technical content under feeding, breeding, health care and general management of four species cattle, sheep, goat and buffalo were organized into different modules with different formats like text, images etc. A portal is developed for uploading the information and it has been evaluated for its user friendliness at the field level.

A web based Livestock Advisory and Information portal has been developed for delivering information related to feeding, breeding, health care and management of cattle, sheep, goat and buffalo to the livestock farmers.

Extramural Project: Climate vulnerability mapping of dairy farming in Karnataka and adaptation strategies

G Letha Devi, A Mech, M Sivaraman and P Adhiguru

An assessment of the impact of climate change on dairy farming is of utmost importance as dairying is a major income generating activity of rural population and Karnataka is one of the high milk producing states in India. Vulnerability of communities and production systems are required to be assessed at the district, village and household levels to identify and rank the most vulnerable communities and sectors and develop vulnerability maps. Currently, farmers and rural communities are exposed to inter- and intra-annual variability of the climate. Vulnerability to climate change varies across regions, sectors, and social groups, especially increases the inequalities in society. In this context, the current coping strategies and their adequacy to deal with current climate variability can also be assessed as an indication of their vulnerability to future climate change risks. The study was conducted with the objectives of mapping the vulnerability of livestock farming in the study area to climate variability and formulating adaptation strategies that would enhance adaptive capacity to climate variability.

Most of the households reported that they suffered crop loss and loss of animals due to extreme climatic conditions. The major loss was due to field crops and vegetables, which are much sensitive to climatic conditions. Cross bred cattle was most vulnerable as compared to sheep and goat. Animal feeding and management were the worst affected in case of climate vagaries. In extreme climate affected situations, livestock was the first option to encash, followed by cash crops and trees. Shelter, food and basic sustenance were the most essential needs in case of climate vagaries, both for human and animal. Most of the respondents (95%) reported that fulfilling the water requirement of animals was a major challenge during the drought periods. Negligible compensation was received for the loss of livestock and crop due to natural disasters. Most of the respondents (98%) were not able to repay the agricultural loans during climate disasters and 79% of the total respondents changed their livelihood pattern as a coping strategy to climate changes (species of crops and livestock, management practices, housing of animals etc).

A study was conducted to map the vulnerability of livestock farming to climate variability in Karnataka for formulating adaptation strategies. It was observed that field crops and vegetables were more sensitive to climatic conditions than livestock and fulfilling the water requirement of animals was a major challenge during drought.

Farmer First Programme: Enriching knowledge and integrating technology and institutions for holistic village development in horticultural based farming system

D Rajendran

A survey was conducted in the five villages in Kanakapura block, Vasappanadoddi, Yeremgere, Balepura, Kebbedoddi and Chikalegowdanadoddi and nearly 100 farmers practicing dairy and rearing sheep and goat were identified as beneficiaries for the program.

It was found that the farmers practising dairy as the subsidiary occupation along with agriculture as the main occupation and only 8-10 farmers were rearing sheep and goat in large numbers compared to other farmers rearing only 2-3 animals. The feeding practices followed for the crossbred were stall feeding and for the local cows, sheep and goat were grazing in open field. In the study area, the green fodder cultivated were bajra-napier cross, jowar and maize, dry fodders used were ragi and paddy straws and concentrates used were ground nut cake, maize bran and broken seeds. Common problems faced by the dairy farmers in the study area were shortage of feeds and fodders due to drought conditions, lack of knowledge about balanced feeding, mineral imbalance, malnutrition and mastitis and reproductive problems. A camp was conducted to deliver suitable technologies at the selected villages.

Nearly 100 farmers rearing dairy animals and small ruminants were identified as beneficiaries under the Farmer First Programme at selected villages in Kanakapura. Common problems face by the farmers for rearing livestock were documented and a camp was conducted to deliver suitable technologies to them.

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

Team Leader: R Bhatta
S Senani, DT Pal, K Giridhar, S Selvaraju, A Mech, G Letha Devi, B Narainaswamy, MA Kataktalware and M Reddy

ICAR-NIANP launched the Farmer First Project at two different locations in South and North Bengaluru. A launch workshop was held on 29 January, 2017 at Ragihalli village near Bannerghatta, Bengaluru district. A total 75 farmers including farm women from Ragihalli and Somanahalli villages attended the workshop.

Another workshop was conducted at Hodanahalli KVK on 10 February, 2017, where 70 farmers from Doddaballapura and nearby villages were informed about this project. Feed chart, pamphlets and NIANP Calendar-2017 with technical details on livestock farming were distributed to the farmers. Under the project, eight modules of area specific mineral mixture, silage making, azolla cultivation, ration Balancing, hydroponics, vegetable and fruit crops and two enterprise based modules on small ruminant and backyard poultry rearing would be given to the interested farmers. A scientist-farmer interface meeting was also organized for the farmers of both the locations. During the reported period, through a series of visits and interactions with farmers, problems related to livestock rearing were identified and interventions such as hydroponics and horticultural crops had been initiated.

The project was launched at two different locations in South and North Bengaluru. Through a series of visits and interactions with farmers, problems related to livestock rearing were identified and interventions such as hydroponics and horticultural crops had been initiated. Printed technical literatures were also distributed to the farmers.

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Bhatta R, Malik PK and Sejian V. Global warming and methane emission: Strategies to mitigate the methane emission from ruminants. In: X Biennial Animal Nutrition Association Conference, 9-11 November, 2016, SVVU, Tirupati. pp: 72-91.

Chandrasekharaiah M, Siddaramanna and Thulasi A. Use of bypass nutrients as strategic supplements for improving the productive performance of dairy animals. In: State Level Technical Seminar of KVA, 22-23 May, 2016, Bengaluru. pp: 34.

Chandrasekharaiah M, Thulasi A and Siddaramanna. Rumen biotechnology: challenges and opportunities in enhancing the utilization of crop residues in ruminants. In: State Level Technical Seminar of KVA, 22-23 May, 2016, Bengaluru. pp: 45-51.

Chandrasekhariah M, Thulasi A and David CG. Micronutrient–gene–interactions: exploring the nutrigenomics for livestock production. In: X Biennial Conference of the Animal Nutrition Association, 9-11 November, 2016, SVVU, Tirupati. pp: 102-115.

Chandrasekhariah M. Improving the utilization of roughage/agriculture by-product based diets to augment efficiency of livestock production - certain basic and applied studies. In: International Conference on "Agricultural Sciences and Food

Technologies for Sustainable Productivity and Nutritional Security", 25-27 August, 2016, UAS, GKVK, Bengaluru. pp: 4.

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Gowda NKS. Success story of using areca sheath and pineapple fruit residue silage as fodder for livestock. In: State Level Technical Seminar of KVA, 22-23 May, 2016, Bengaluru. pp: 177-178.

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Malik PK, Bhatta R, Kolte AP, Dhali A, Negi M, Poornachandra KT, Thirumalaisamy G, Baruah L and Goyal P. Feeding strategies for ameliorating methane emission in small ruminants. In: Annual Conference and National Seminar of the Indian Society for Sheep and Goat Production and Utilization, 9-10 March, 2017, ICAR-CSWRI, Avikanagar. pp: 138.

Maurya VP, Sejian V, Singh G, Sarkar M, Samad HA and Dangi SS. Transition phase stress in ruminants and its amelioration. In: Annual Conference and National Seminar of the Indian Society for Sheep and Goat Production and Utilization, 9-10 March, 2017, ICAR-CSWRI, Avikanagar. pp: 101.

Mishra A, Reddy IJ, Mondal S and Gupta PSP. Impact of oxidative stress on animal health and production. In: XXV Annual Conference and National Symposium of the Society of Animal Physiologists of India, 21-23 December, 2016, Mhow, MP. pp: 88-91.

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Mondal S. Climate change and embryo loss: what we have achieved so far? In: XXVIII Annual Conference of the Physiological Society of India, 18-20 November, 2016, Midnapore College, West Bengal. pp: 65.

Mondal S. Improving early embryonic survival through targeted genome editing. In: International Conference on "Reproductive Biology and Comparative Endocrinology", 9-11 February, 2017, University of Hyderabad, Hyderabad. Abstract IL16.

Naqvi SMK and Sejian V. Strategies to improve livestock production and reproduction in the changing climate scenario. In: XXV Annual Conference and National Symposium of the Society of Animal Physiologists of India, 21-23 December, 2016, Mhow, MP. pp: 6-15.

Reddy IJ, Mishra A and Mondal S. Neuroendocrine control of production and reproduction in poultry-recent updates. In: XXV Annual Conference and National Symposium of the Society of Animal Physiologists of India, 21-23 December, 2016, Mhow, MP. pp: 177-182.

Roy KS. Reproductive health management in cows and buffaloes: some associated knowledge and tools for its augmentation under recent climate change scenario. In: XXV Annual Conference and National Symposium of the Society of Animal Physiologists of India, 21-23 December, 2016, Mhow, MP. pp: 141-146.

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Sejian V, Maurya VP, Kumar D, Bagath M, Krishnan G, Bhatta R and Naqvi SMK. Impact of multiple stresses on small ruminant production and adaptation. In: Annual Conference and National Seminar of the Indian Society for Sheep and Goat Production and Utilization, 9-10 March, 2017, ICAR-CSWRI, Avikanagar. pp: 100.

Sejian V. Climate change impact on livestock: Concept of multiple stresses and its amelioration. In: National Seminar on "Newer Approaches in Cow Comfort Systems for Better Productivity", 25 June 2016, College of Veterinary and Animal Sciences, Thrissur.

Sejian V. Climate change physiology – An emerging area in veterinary physiology education. In: Regional Seminar of the Society of Animal Physiologists of India, 25 November, 2016, NTR College of Veterinary Science, Gannavaram.

Invited lectures

Sridhar M

We can make it happen in the Indian context. Lecture delivered on the International Womens Day at the ICAR-NBAIR, Hebbal, Bengaluru, 8 March, 2017.

Giridhar K

Novel technologies of ICAR-NIANP for improving livestock productivity. Lecture delivered at the Annual Review Workshop of South zone KVKs, RARS, Ambalvayal, 21 April, 2016.

ICAR-NIANP method of fodder sprouts production. Lecture delivered at the Workshop for Dairy Farmers, KVK, Ramanagara, 21 September, 2016.

New technologies in green fodder production. Lecture delivered at the Workshop on "Organic Dairy Farming: New Innovations", ICAR-NIANP, Bengaluru, 25-26 October, 2016.

Fodder production technologies. Lecture delivered at the Workshop for Extension Officials of KMF, ICAR-IIHR KVK, Hirehalli, 26 December, 2016.

Hydroponic fodder cultivation and other fodder sources suitable for dairy and other animals in Kodagu district. Lecture delivered at the Agriculture Technology Week Celebrations, ICAR-IIHR KVK, Gonikoppal, 29 December, 2016.

Fodder sprouts production technology for livestock. Lecture delivered at the Workshop for Dairy Farmers, KVK, Hasan, 24 Janaury, 2017.

Integrated fodder management. Lecture delivered at the Scientist-Farmer Interface Meeting under the Farmer First Program, ICAR-NIANP, 15 March, 2017.

Arangasamy A

Bull fertility evaluation and quality semen production. Lecture delivered at the training programme on "Cattle Rearing and Livestock Management", ICAR-NDRI SRS, Bengaluru, 23-28 May, 2016.

Selvaraju S

Breeding bull management and methods for screening bulls for improving fertility of dairy cows. Lecture delivered at the training programme on "Cattle Rearing and Livestock Management", ICAR-NDRI SRS, Bengaluru, 9 May to 1 June, 2016.

Semen evaluation and quality improvements in domestic animals: recent trends. Lead paper presented in the National Seminar on "Advancement in Bovine Reproduction Biotechnologies to Increase Breeding Efficiencies", IMV Technologies, India, Bengaluru, 21 October, 2016.

Reproductive management of animals. Lectures delivered to the farmers from KVK, Tamilnadu, 20 December, 2016.

Sejian V

Experimental design and data analysis with respect to impact of climate change on animal production. Lecture delivered in the ICAR Sponsored Short Course on "Advances in Livestock Disease Surveillance: Integration of Molecular Biology and Statistical Methods in Veterinary Virology", ICAR-NIVEDI, Bengaluru, 2 September, 2016.

Role of livestock in climate change and mitigation strategies. Lecture delivered in the training programe on "Biology of Physiological Adaptation and Production Stress in Farm Animals", CAFT, Veterinary Physiology, ICAR-IVRI, Izatnagar, 11-31 January, 2017.

Effect of stress on production and reproduction of animals. Lecture delivered in the training programe on "Biology of Physiological Adaptation and Production Stress in Farm Animals", CAFT, Veterinary Physiology, ICAR-IVRI, Izatnagar, 11-31 January, 2017.

Gupta PSP

Recent trends in reproductive biotechnology of farm animals. Lecture delivered in the Regional Seminar on "Concepts of Physiology in Augmenting Animal Production", NTR College of Veterinary Sciences, Gannavaram, 25th November, 2016.

Gowda NKS

Ways to improve small production systems. Lecture delivered in the National Consultation on Small Farmer Production Systems, ICAR-NDRI SRS, Bengaluru, 22-23 December, 2016.

Local feed resources for dairy animals (talk in Kannada). Lecture delivered in the Workshop on "Organic dairy farming: New innovations", ICAR-NIANP, Bengaluru, 25-26 October, 2016.

Role of micronutrients in dairy production. Lecture delivered in the Workshop for Extension Officials of KMF, IIHR-KVK, Hirehalli, 26 December, 2016.

Feeding for improved dairy production (talk in Kannada). Lecture delivered in the Workshop organised by NABARD at UAS-KVK, Magadi, Ramanagara taluk, 27 January, 2017.

Improving milk quality by scientific feeding (talk in Kannada). Lecture delivered at Bidarakaanu Dairy Society, Siddapura taluk, 8 February, 2017.

Feeding of livestock (talk in Kannada). Lecture delivered at at UAS-KVK, Vijayapura, 10 March, 2017.

Feed management of livestock during summer (talk in Kannada). Lecture delivered in the Scientist - Farmer Interface meeting under Farmer - First Program, ICAR-NIANP, 15 March, 2017.

Rajendran D

Role of Balanced feeding in animal Reproduction. Lecture delivered at the Livestock Research and Information Centre, Konehalli, Tiptur, 21 December, 2016.

Farmer friendly ration balancing tools for dairy animals. Lecture delivered in the Interstate Exposure Visit of Livestock Farmers, ICAR-NDRI SRS, Bengaluru, 14-17 June, 12 July, 19 July, and 03 September, 2016.

Samanta AK

Prebiotics and gut health of animals. Lecture delivered in the Short Ccourse on "Clinical Nutrition Approaches for Gut Health of animals", Animal Nutrition Division, ICAR-IVRI, Izatnagar, 16-25 March, 2017.

Application of TRFLP in gut health research. Lecture delivered in the Short Ccourse on "Clinical Nutrition Approaches for Gut Health of animals", Animal Nutrition Division, ICAR-IVRI, Izatnagar, 16-25 March, 2017.

Lecture notes

Compendium of Winter School on "Novel Paradigms and Technologies for Augmenting Livestock Fertility Under Climate Change Scenario", 4-24 November, 2016, ICAR-NIANP, Bengaluru

Arangasamy A, Selvaraju S, Binsila BK and Krishnaiah MV. Skewing sex ratio in farm animals. pp: 56-62.

Bagath M, Sejian V, Krishnan G and Bhatta R. Heat shock protein in livestock and their primer designing. pp: 63-69.

Bhatta R, Malik PK and Sejian V. Climate smart animal-agriculture: paradigm shift. pp: 7-14.

Binsila BK, Selvaraju S, Arangasamy A, Somshekar L, Archana S and Sunil P. Stem cells and its potential applications in reproduction. pp: 162-166.

Chandeasekharaiah M, Soren NM and Thulasi A.

Strategic supplementation of bypasss protein and limiting nutrient supplements for optimizing the milk production perfrormance in dairy animals. pp: 70-74.

Chandrappa T and Jash S. Sustainability indicators for livestock farming. pp: 235-239.

David CG. Hormonal modulation for enhancing egg production. pp: 75-80.

Dhali A, Kolte AP, Javvaji PK and Francis JR. Whole transcriptome analysis: a new perspective for understanding oocyte biology. pp: 178-180.

Elangovan AV. Nutritional interventions during heat stress in chicken. pp: 181-186.

Ghosh J, Vikram R and Shree Vidhya S. Pregnancy biomarkers in large ruminants. pp: 107-110.

Giridhar K, Suresh KP and Ravikiran G. Impact of climate variability on feed resources production. pp: 87-90.

Girish Kumar V, Pavanna US, Ramesh HS, Tripathi SK and Nandi S. Novel signalling pathways in ovarian follicle and oocyte development. pp: 187-191.

Gorti RK, David CG, Reddy IJ and Suresh KP. Low cholesterol egg production. pp: 200-204.

Gowda NKS and Anandan S. Reactive nitrogen in environment: implications on livestock and possible remedies. pp: 91-97.

Gowda NKS, Pal DT and Rajendran D. Improving mineral utilization for reduced excretion to environment. pp: 24-28.

Gupta PSP, Nandi S, Mondal S, Jeevan M, Tripathi SK and Mishra A. Recent updates on the role of Wnt signal in estradiol synthesis. pp: 29-33.

Gupta PSP, Nandi S, Mondal S, Jeevan M, Tripathi SK and Mishra A. Isolation and culture of granulosa cells. pp: 274-278.

Jash S, Chandrappa T, Letha Devi G, Rajendran D and Rao SBN. Garnering nectar: nutrition waltz in biome. pp: 240-243.

Kolte AP, Dhali A, Mailk PK, Selvaraju S and Javvaji PK. RNA sequencing: opportunities and challenges. pp: 225-227.

Krishnaiah MV, Somashekar L, Manohar N, Pushpa Rani G and Arangasamy A. Protein profiling of semen/sperm using sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE). pp: 288-292.

Krishnan G, Sejian V, Bagath M and Mishra A. Impact of heat stress on immune status of livestock. pp: 111-114.

Letha Devi G, Mech A and Kataktalware MA. Vulnarabilities to challenges of climate change and strategies for building resilience. pp: 174-177.

Malik PK, Sejian V and Bhatta R. Strategies for mitigating methane in livestock. pp: 192-199.

Mech A, Dhali A, Suganthi RU, Awachat B and Veeranna RK. Effect of dietary poly unsaturated fatty acids in animal reproduction. pp: 123-127.

Mishra A, Reddy IJ, Krishnan G, Mondal S and Gupta PSP. Oxidative stress on embryo survivability. pp: 51-55.

Mishra A, Reddy IJ, Mondal S and Gupta PSP. Intracellular oxidants and antioxidants levels in oocytes and embryos. pp: 293-294.

Mondal S, Mor A, Reddy, IJ, Gupta PSP, Nandi S and Mishra A. Techniques in gene cloning. pp: 269-273.

Mondal S, Reddy IJ, Mor A, Gupta PSP, Nandi S, Mishra A, Veerana RK, Suresh PA and Tripathi SK. RNA isolation and synthesis of cDNA using RT-PCR. pp: 255-257.

Mondal S, Reddy IJ, Mor A, Gupta PSP, Nandi S, Mishra A, Veerana RK, Suresh PA and Tripathi SK. PCR and quantitative PCR (qPCR). pp: 258-263.

Mondal S, Reddy IJ, Nandi S, Gupta PSP and Mishra A. Climate change impact on livestock fertility. pp: 19-23.

Nandi S, Gupta PSP, Tripathi SK, Jeevan M and Mondal S. Transgenic livestock production. pp: 34-38.

Nandi S, Tripathi SK, Gupta PSP, Jeevan M and Mondal S. Metabolic stressors on oocyte and uterine cell growth: practical demonstration. pp: 279-282.

Pal DT, Gowda NKS, Karthik Bhar S and Vijay A. Mineral analysis by inductively coupled plasma-atomic emission spectrophotometer. pp: 264-268.

Prasad KS. Nutrient utilization and enhancement of production in livestock. pp: 128-132.

Rajendran D, Swain PS, Rao SBN and Selvaraju S. Nanotechnology in animal production and reproduction. pp: 133-138.

Rao SBN, Rajendran D, Swain PS and Soren NM. Emerging concepts in feed quality and safety. pp: 146-153.

Ravindra JP. Ovarian follicle development: impact of environmental stress and nutrition. pp: 1-6.

Reddy IJ, Mishra A, Mondal S and Suresh PA. Radioimmunoassay of hormones. pp: 250-254.

Reddy IJ, Mishra A, Mondal S and Suresh PA. RNA interference to enhance reproductive efficiency in animals. pp: 15-18.

Roy KS. Heat stress impact on broiler bird and its amelioration. pp: 81-86.

Roy SC and Divyashree BC. Western blotting: principles and applications. pp: 283-287.

Roy SC. Oxidants and antioxidants in male fertility: the balancing act. pp: 39-50.

Samanta AK and Kolte AP. Role of nutraceuticals for enhancing productivity in livestock. pp: 228-234.

Sejian V, Bagath M, Krishnan G, Mishra A, Soren NM, Malik PK and Bhatta R. Heat stress impact on livestock production. pp: 167-173.

Selvaraju S, Binsila BK, Arangasamy A and Somashekar L. Recent advances in bull semen evaluation. pp: 205-209.

Senani S, Samanta AK, Kolte AP and Sridhar M. Functional and fortified foods in optimizing reproduction. pp: 154-161.

Soren NM, Rao SBN, Sejian V, Terhuja M, Dominic G, Chandrasekharaiah M and Swain PS. Impact of nutritional stress on reproduction. pp: 98-106.

Sridhar M, Thammaiah V, Rao RG, Senani S and Samanta AK. Biotechnological approaches for enhancing productivity in livestock with reference to fibre digestibility of crop residues. pp: 115-122.

Suganthi RU, Malik PK, Ghosh J, Gupta PSP and Shem N. Role of selenium and selenoproteins in reproduction and production of livestock. pp: 139-145.

Compendium of Model Training course on "Climate Smart Novel Approaches and Technologies for Sustainable Livestock Production", 22 February - 1 March, 2017, ICAR-NIANP, Bengaluru

Bhatta R, Malik PK and Sejian V. Global warming and methane emission: Strategies to mitigate the methane emission from ruminants. pp: 1-16.

Elangovan AV. Nutritional means of amelioration of heat stress in chicken. pp: 85-87.

Ghosh J, Shree Vidhya S and Roy KS. Current approaches on pregnancy diagnosis in large ruminants and the future. pp: 31-35.

Giridhar K, Ravikiran G and Suresh KP. Impact of climate variability on feed resources production. pp: 88-92.

Gupta PSP, Tej JNK, Nandi S and Mondal S. Oestrous synchronization in livestock: recent concepts. pp: 36-46.

Malik PK, Bhatta R, Kolte AP, Thirumalaisamy G, Poornachandra KT and Dhali A. Methane emission and mitigation. pp: 54-57.

Mishra A, Reddy IJ and Mondal S. Oxidative stress and animal reproduction. pp: 58-63.

Mondal S, Reddy IJ, Nandi S, Gupta PSP, Mishra A, Suresh A and Tripathi SK. Climate smart approaches for minimizing early embryonic loss. pp: 17-25.

Nandi S, Tripathi SK, Farman M, Gupta PSP and Mondal S. Metabolic stress and its impact on fertility. pp: 26-30.

Reddy IJ, Mishra A and Mondal S. RNA interference to enhance productive and reproductive efficiency in ruminants and poultry. pp: 64-67.

Roy KS. Effect of heat stress impact on broiler production and some amelioration strategies. pp: 47-53.

Samanta AK and Kolte AP. Nutritional management

of dairy animals. pp: 68-72.

Sejian V, Bagath M, Krishnan G, Soren NM, Malik PK and Bhatta R. Environmental stress and livestock production: Impact and adaptation. pp: 77-84.

Selvaraju S, Binsila BK, Arangasamy A and Ravindra JP. Recent trends and advances in semen evaluation for augmenting fertility in livestock. pp: 73-76.

Soren NM, Terhuja M, Sejian V and Mondal S. Climate smart strategies for sustainable livestock production. pp:93-100.

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Bagath M, Sejian V, Krishnan G and Bhatta R. Stress immune system relationship in livestock. pp: 116-119.

Bagath M, Sejian V, Krishnan G, Veeranna RK and Bhatta R. ELISA methodology of growth, stress and reproductive hormones estimation. pp: 160-162.

Bagath M, Sejian V, Krishnan G, Veeranna RK and Bhatta R. Expression of Toll-Like receptors (1-10) in goat mesenteric lymph node by Real-time PCR. pp: 163-166.

Bakshi B, Baruah L, Malik PK, Sejian V and Bhatta R. Enteric methane estimation using SF6. pp: 128-131.

Baruah L, Bakshi B, Malik PK, Sejian V and Bhatta R. Estimation of ruminal methanogenesis using in vitro gas production test. pp: 120-123.

Bhatta R, Malik PK and Sejian V. Enteric methane emission and recent strategies for their mitigation from ruminants. pp: 36-44.

Bhatta R. Measurement of methane production from ruminants. pp: 26-35.

Giridhar K and Anandan S. Impact of climate change on forage availability for livestock. pp: 65-69.

Kolte AP, Dhali A, Malik PK, Javvaji PK and Bhatta R. Metagenomic survey for studying complex and dynamic rumen microbial population. pp: 61-64.

Krishnan G, Sejian V, Bagath M and Bhatta R. Climate change and livestock reproduction: Impact and amelioration. pp: 93-96.

Krishnan G, Sejian V, Bagath M and Bhatta R. Impact of climate change on high altitude livestock production. pp: 105-108.

Malik PK, Bhatta R, Sejian V and Kolte AP. Alternate H2 sinks for reducing rumen methanogenesis. pp: 45-51.

Malik PK, Bhatta R, Sejian V and Kolte AP. Enteric methane emission in livestock: Process and factors influencing the emission. pp: 19-25.

Mech A. Life cycle assessment for livestock related GHG emission. pp: 137-140.

Reddy IJ, Mishra A and Mondal S. RIA method of stress and metabolic hormone estimations. pp: 153-159.

Roy KS. Environmental stress impact on poultry production and its amelioration. pp: 109-112.

Sejian V, Bagath M, Krishnan G, Malik PK, Soren NM and Bhatta R. Global warming: role of livestock. pp: 8-18.

Sejian V, Bagath M, Krishnan G, Malik PK, Soren NM and Bhatta R. Significance of climate change modeling in livestock farms. pp: 52-60.

Sejian V, Bagath M, Krishnan G, Malik PK, Soren NM and Bhatta R. Respiratory chamber model, in vitro gas production model (Bioreactor model) and dairy GHG model to predict GHG emission from livestock farm. pp: 132-136.

Sejian V, Krishnan G, Bagath M, Soren NM, Malik PK and Bhatta R. Climate change and livestock production: concept of multiple stresses. pp: 70-78.

Sejian V, Krishnan G, Bagath M, Soren NM, Malik PK and Bhatta R. Salient adaptation, mitigation and amelioration strategies to improve livestock production under the changing climatic scenario. pp: 79-92.

Sejian V, Lees AM, Sullivan M and Gaughan JB. Significance of recording rumen and skin temperature measurements in cattle. pp: 113-115.

Sejian V, Malik PK and Bhatta R. Global climate change: an overview. pp: 1-7.

Soren NM and Rao SBN. Volatile fatty acid estimation using gas chromatography. pp: 124-127.

Soren NM, Sejian V and Malik PK. Nutritional manipulation to counter environmental stresses in farm animals. pp: 97-104.

Veeranna RK, Krishnan G, Bagath M, Sejian V and Bhatta R. Body condition scoring system- A simple tool to optimize productive and reproductive efficiency in small ruminants. pp: 144-152.

Veeranna RK, Krishnan G, Bagath M, Sejian V and Bhatta R. Physiological responses recording in goat. pp: 141-143.

Compendium of Training Programme on "Cattle Rearing and Livestock Management" for the Field Veterinary Extension Officers of the Department of Animal Husbandry, Tamil Nadu, 9 May - 1 June, 2016, ICAR-NDRI SRS, Bengaluru

Giridhar K. Fodder production and its conservation for livestock production in dry lands. pp: 35-37.

Kataktalware MA, Letha Devi G and Ramesha KP. Precision dairy farming- Present status and future scopes. pp: 71-77.

Letha Devi G, Kataktalware MA and Adhiguru P. Application of ICTs in livestock extension: Drivers of development and way forward. pp: 102-106.

Selvaraju S, Somashekar L, Binsila BK, Arangasamy A and Ravindra JP. Breeding bull management and methods for screening bulls for improving fertility of dairy cows. pp: 64-70.

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Kataktalware MA, Letha Devi G and Ramesha KP. Dairy farming scenario in India. pp: 11-17.

Kataktalware MA, Letha Devi G and Ramesha KP. Recent trends in precision dairy management. pp: 62-67.

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Kataktalware MA, Letha Devi G and Ramesha KP. Commercial dairy production: Opportunities and issues. pp: 105-110.

Letha Devi G and Kataktalware MA. Policy support and funding opportunities for dairy entrepreneurship development. pp: 49-55.

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Maurya VP, Bhimte A, Konyak Y, Domple V, Patel P, Samad HA, Sejian V, Singh G and Sarkar M. Physiological adaptation during transition phase production stress and its amelioration. pp: 15-17.

Maurya VP, Singh G, Konyak Y, Bhimte A, Domple V, Dangi SS, Samad HA, Sejian V and Sarkar M. Impact of heat stress on milk production and its constituents in dairy animals. pp: 18-20.

Sejian V, Maurya VP , Krishnan G, Bagath M and Bhatta R. Effect of stress on production and reproduction of animals. pp: 130-134.

Sejian V, Maurya VP, Bagath M, Krishnan G and Bhatta R. Role of livestock in climate change and mitigation strategies. pp: 123-129.

Others

Bhatta R, Malik PK and Selvaraju S. 2016. Physio-nutritional approaches for enhancing reproduction in dairy animals. In: Brain storming session, 20 April, 2016, ICAR-NDRI ERS, Kalyani.

Kataktalware MA, Nazar S, Letha Devi G and Ramesha KP. 2017. Commercial dairy production in India: present status, opportunities and challenges. In: Compendium of National Training Programme on "Commercial Dairy Production", for Technical Staff of the ICAR Institutes, 27 February - March 04, 2017, ICAR-NDRI SRS, Bengaluru. pp: 1-7.

Compilations

Ayyappan S, Letha Devi G, Subash S, Devi MCA and Dixit PK. Proceedings of the National Consultation on "Small Farmer Production Systems: Way Forward". pp: 1-74.

Mondal S, Reddy IJ and Gowda NKS. Compendium of ICAR sponsored winter school on "Novel Paradigms and Technologies for Augmenting Livestock Fertility Under Climate Change Scenario". pp: 1-294.

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Ghosh J and Shree Vidhya S. Strengths and opportunities of buffalo farming in India. pp: 1-2.

Ghosh J and Nazar S. Structure of buffalo reproductive tract and its functional significance. pp: 6-7.

Ghosh J, Nazar S, David CG and Arangasamy A. Stages of estrus cycle, hormonal regulation and artificial control. pp: 8-15.

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Media

K Giridhar delivered a talk on "Azolla cultivation" on 16 April, 2016, Krishidarshan programme of Doordarshan, Bengaluru.

NKS Gowda participated in a interview in Kannada on "Fodder management during summer" on 10 March, 2017, All India Radio, Bengaluru.

NKS Gowda, S Anandan and DT Pal prepared Video Documentary on "Pineapple fruit residue silage as fodder for livestock". Hosted in FAO (Rome) Feedipedia website, September 2016.

Awards and honours

Best Annual Report Award 2015-16

The Institute received the ICAR Best Annual Report Award for the year 2015-16 under the Small Institute Category.

NAAS Fellow

Dr NKS Gowda was awarded the prestigious Fellowship of the National Academy of Agricultural Sciences (NAAS) under the category of Animal Sciences for the year 2016.

ICAR National Fellow

Dr S Selvaraju received the prestigious ICAR National Fellow (2017-2022) for the project entitled "Development of Buffalo Bull Fertility Diagnostic Chip Based on Sperm Transcripts Signatures". The project aims to establish the basic understanding of the molecules involved in gametes fusion and embryonic development and to develop transcripts based diagnosis of male fertility in buffalo and other domestic animals. The expected outcome of the project is the development of a fertility chip for selecting superior buffalo bulls for artificial insemination programme.

DN Mullick Memorial Award

Dr A Mishra was bestowed with the DN Mullick Memorial Award (2016) by the "Society of Animal Physiologists in India" for his contribution in the field of Animal Physiology.

Fellow of Animal Nutrition Association

Dr M Sridhar received the prestigious Fellowship of the Animal Nutrition Association (FANA), 2016-17.

Endeavour Executive Fellowship

Dr S Nandi received the Australian Government sponsored Eedeavour Executive Fellowship to visit Monash University, Australia

Saroj Jakhmola award for best Ph D Thesis

Dr Vijay Bhasker T, PhD Scholar from ICAR-NIANP

received the award for best PhD Thesis in Animal Nutrition for the biennium 2015-16 by the "Animal Nutrition Association".

GB Singh Memorial Award (2016)

The award was bestowed by the "Indian Society for Study of Animal Reproduction" for the research paper "Parthipan S, Selvaraju S, Somashekar L, Kolte AP, Arangasamy A and Ravindra JP. 2015. Spermatozoa input concentrations and RNA isolation methods on RNA yield and quality in bull *(Bos taurus)*. Analytical Biochemistry, 482:32-39".

ISSAR Young scientist Award (2016)

Mr L Somashekar, PhD Scholar, received the Award for presenting the research paper entitled "Transit proteins from seminal plasma guides bovine spermatozoa fertilization", XXXII Annual convention of the "Indian Society for Study of Animal Reproduction", 6-8 December, 2016, SVVU, Tirupati.

Awards by TOLIC

The article entitled "भैंसों के प्रजनन पर मातृ पोषण का प्रभाव और इष्टतम प्रजनन के लिए आहार के बुनियादी दिशा निर्देश" by Ghosh J, David CG, Roy KS, Dhara S, Senani S and Pal DT was awarded the first prize by TOLIC, Bengaluru for Hindi Technical Writing, December, 2016.

Dr KS Roy received Encouragement Award from TOLIC, Bengaluru for Hindi Technical Writing, December, 2016.

Dr S Jash and Dr K Giridhar received Encouragement Award from TOLIC, Bengaluru for Oral Quiz Competition, November, 2016.

Dr S Selvaraju

Opted as a member of the Young Scientist Expert Committee-Life sciences, Science and Engineering Research Board, Government of India, New Delhi.

Dr V Sejian

Selected as Field Editor for Animal Science for the International Journal of Biometeorology, Springer Publisher, USA.

Received travel grant by the Department of Foreign Affairs and Trade, Government of Australia to attend the International River Symposium held at New Delhi, 12-14 September, 2016.

Dr KS Prasad

Opted as a member of the scientific panel for contaminants in food chain by the "Food Safety and Standards Authority of India, Ministry of Health and Family Welfare, Govt of India".

Dr M Chandrasekharaiah

Received the Distinguished Agricultural Scientist Award at the International Conference on "Agricultural Sciences and Food Technologies for Sustainable Productivity and Nutritional Security", UAS, GKVK, Bengaluru, 25-27 August, 2016.

Conference Awards

Conferences	Awards
X Biennial conference of Animal Nutrition Association on "Newer Perspectives in Animal Nutrition Research for Augmenting Animal Productivity", 9-11 November, 2016, SVVU, Tirupathi.	Best oral presentation award for "Boron supplementation improves performance in lambs with abiotic stress induced by feeding calcium deficit diets" by Vijay BT, Gowda NKS, Pal DT, Karthik BS, Krishnamoorthy P, Mondal S, Pattanaik AK and Verrma AK. Best oral presentation award for "Effect of agricultural waste tamarind seed husk inclusion on ruminal methanogenesis and methanogens diversity in crossbred cattle" by Malik PK, Bakshi BS, Kolte AP, Baruah L, Dhali A and Bhatta R. Best oral presentation award for "Effect of supplementation of feruloyl esterase enzyme on microbial diversity and rumen

	fermentation in crossbred steers fed on paddy straw based ration" by Chandrasekharaiah M, Thulasi A, Palanivel C, Santosh SS and Prasanna Kumar D. Best poster presentation award for "Purification and characterization of Lignin Peroxidase from Phanerochaete chrysosporium and it's efficacy in delignification of cereal crop residues" by Vandana T, Ramya GR, Samanta AK, Senani S and Manpal S. Best poster presentation award (Third Prize) for "Effect of feeding graded doses nano Zinc on immunity and intestinal architecture in wister albino rat" by Swain PS, Rajendran D, Rao SBN, Krishnamoorthy P, Dominic G and Soren NM. Best poster presentation award (Second Prize) for "Enzymatic production of xylooligosaccharides from agricultural wastes" by Samanta AK, Chikkerur J, Roy S, Kolte AP, Sridhar M, Giridhar K, Dhali A and Senani S.
National Seminar on "Climate Change: Challenges and Solutions", 23 January, 2017, EMPRI, Bengaluru.	Best paper presentation award for "Enteric methane emission from Indian livestock: quantification and mitigation". Malik PK, Kolte AP, Poornachandra KT and Bhatta R.
XIII Agricultural Science Congress 2017, 21-24 February 2017, UAS, GKVK, Bengaluru.	Best poster presentation award for "Stress related endocrine changes and HSP70 gene expression profiling as effective biomarkers of acute thermal stress and adaptation in broiler chickens under recent climate change scenario" by Roy KS, Roy SC and Ghosh J.
National Symposium on "Climate Driven Food Production Systems: Agrometeorological Interventions", 20-22 December, 2016, TNAU, Coimbatore.	Best oral presentation award for "Effect of heat stress, nutritional stress and combined stresses (heat and nutritional stress) on growth performance of Osmanabadi bucks" by Abdul Niyas PA, Sejian V, Bagath M, Selvaraju S, Kurien EK, Varma G and Bhatta R. Best oral presentation award for "Significance of metabolic response in livestock for adapting to heat stress challenges" by Aleena J, Pragna P, Archana PR, Sejian V, Bagath M, Krishnan G, Manimaran A, Beena V, Kurien EK, Varma G and Bhatta R. Best poster presentation award for "Heat stress and dairy cow: Impact on both milk yield and composition" by Pragna P, Archana PR, Aleena J, Sejian V, Krishnan G, Bagath M, Manimaran A, Beena V, Kurien EK, Varma G and Bhatta R.
State level Technical Symposium on "Innovative Strategies for Quality Livestock Production in Augmenting Rural Economy", 22-23 May, 2016, KVA, Bengaluru.	Best paper presentation award for "Use of bypass nutrients as strategic supplements for improving the productive performance of dairy animals" by Chandrasekharaiah M, Siddaramanna and Thulasi A.

Patent Filed

Malik PK, Bhatta R and Kolte AP. 2016. Enteric methane emission reduction using silkworm *(Bombyx mori)* pupae oil. Patent application no. 201641027475; Dated: 11 August, 2016.

Training and Capacity Building

Training/Workshop organized

Industrial experience training on "Climate Change and Livestock Production", 1-21 June, 2016

An industrial experience and training as a part of elective courses in veterinary and animal sciences stream of KAU students on "Climate Change and Livestock Production" was conducted from 1-21 June, 2016. The training program aimed to provide equal exposure to theory and practical classes on the topic. The training covered two broader areas, "livestock

contribution to climate change" and "impact of climate change on livestock production". Following the training, the students were evaluated based on the assignment presentation and written examination. The training concluded with a valedictory function and distribution of certificates to the participants.

ICAR sponsored winter school on "Novel Paradigms and Technologies for Augmenting Livestock Fertility Under Climate Change Scenario", 4-24 November, 2016

A 21-day ICAR sponsored winter school on "Novel Paradigms and Technologies for Augmenting Livestock Fertility Under Climate Change Scenario" was organized at the Institute from November 4-24, 2016. A total of 25 Assistant Professors from various States such as Kerala (4), Andhra Pradesh (4), Tamil Nadu (6), Assam (2), Karnataka (3), Rajasthan (2), Uttar Pradesh (1), Nagaland (1), Maharashtra (1) and Puducherry (1) attended the training programme. The training covered the major upstream areas like climate change impact on fertility, climate smart

animal agriculture, gene silencing, oxidative stress on embryo development, early embryonic loss etc.

Model training course on "Climate Smart Novel Approaches and Technologies for Sustainable Livestock Production", 22 February - 1 March, 2017

A model training course on 'Climate Smart Novel Approaches and Technologies for Sustainable Livestock Production" was organized at the Institute from 22 February to 1 March, 2017. A total of 14 Veterinary Officers from various States such as Kerala (2), Andhra Pradesh (3), Tamil Nadu (4), Rajasthan (2), West Bengal (2) and Delhi (1) attended the training programme. The training covered various important

areas like global warming, methane emission and mitigation, climate smart approaches for minimizing early embryonic loss, metabolic stress and its impact on fertility, environmental stress and livestock production, climate variability on feed resources production, climate smart strategies for sustainable livestock production etc. Dr K Pradhan, Chancellor, Shiksha 'O' Anusandhan University, Bhubaneshwar,

in his valedictory address, highlighted the role of veterinarians in disease prevention and animal husbandry practices. He also stressed on woman empowerment and sustainable livestock production under changing climate.

Hands on-training programme on "Feed Assist for Ration Balancing in Dairy Cattle", 3-4 June, 2016

A two day Hands on-training programme "Feed Assist for Ration Balancing in Dairy Cattle" for the Veterinary Officers was organized at the Institute from 3-4 June, 2016. It was sponsored by the Animal Husbandry Department, Government of Andhra Pradesh. There

were 19 participants from 18 districts of Andhra Pradesh. The software is a simple and effective tool for formulating rations with locally available ingredients for cattle and buffalo with least cost. This would be immensely helpful for farmers, trainers, extension workers and field veterinarians for formulating rations for large ruminants.

Technical workshop for Progressive Dairy Farmers, 25-26 October, 2016

A technical workshop on "Organic Dairy Farming-Newer Innovations" for progressive dairy farmers was organized at the Institute from 25-26 October, 2016, in collaboration with the Bangalore Milk Union. Dr Raghavendra Bhatta, Director, ICAR-NIANP inaugurated the workshop. More than 200 progressive dairy farmers and entrepreneurs participated in this workshop. The experts working in the field of organic dairy farming, feeding and management of dairy animals presented newer innovations and adoptable technologies to make dairying a profitable and sustainable enterprise. Special emphasis was given on green fodder cultivation and conservation including novel method of green sprout production using low cost inputs. Ration balancing using feed chart, demonstration of silage making, cultivation of new varieties of fodder and tree leaves were demonstrated. Problems of low reproductive efficiency, common diseases and management of mastitis in dairy animals were

discussed in detail. Remedies for low milk-fat and solid-not-fat were explained to the farmers. Industry personnel presented their newer products on micronutrient supplementation and strategies for promoting birth of female calves. Farmer-Experts interaction was held to address the doubts and problems of dairy farmers. Based on the input of participants, it was decided to conduct such workshops at the District and Taluk levels with the collaboration of Milk Unions and State Animal Husbandry Department.

Training for skilled supporting staff on "Fundamentals of Computers", 13-18 March, 2017

A week long In-house computer training for the skilled supporting staff (SSS) of the Institute was conducted from 13-18 March, 2017. The training aimed to create computer awareness among the SSS and four employees participated in the training.

Emphasis was given on various parts of computers and how to handle them. Participants were trained from the preliminary aspect of proper switching on to shutting down a terminal. They were also taught how to create a new folder, delete a folder, access folder, open and to create documents in it etc. Preliminary typing aspect was also covered. As they are required to check their salary slips online, special emphasis was given to open their respective salary slip and to give print command. All the participants were provided training manual. They were also trained to access the ICAR, ICAR-NIANP and other important web sites.

Short term research cum training under "CV Raman International Fellowship"

Dr OM Sogunle, Senior Lecturer, Department of Animal Production and Health, Federal University of Agriculture, Abeokuta, Nigeria, completed his short term research cum training under the "CV Raman International Fellowship for African Researchers, DST, Govt of India". He worked on "Post-Hatch Growth Performance of Broiler Chickens on *In ovo* Supplementation of Inorganic Salts of Zinc, Selenium and Copper" under the guidance of Dr AV Elangovan.

Human resource development

Support extended to the scholars for conducting research with external grants

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

Scientist-National

Particulars	Participants
"Training-cum-awareness Workshop on J-gate@CeRA for Southern Region States", 27 January, 2017, Veterinary college, KVAFSU, Bengaluru	M Sridhar
"Competency Enhancement Programme for Effective Implementation of Training Functions by HRD Nodal Officers of ICAR", 13-15 February, 2017, ICAR-NAARM, Hyderabad	S Anandan
"Bioinformatics for Transcriptome Sequencing", 21-23 March, 2017, ICAR-IISR, Kozhikode	M Bagath
"Hands-on Training in Flow Cytometry", 14-17 June, 2016, C-CAMP, NCBS, Bengaluru	BB Krishnan

Scientist-International

Particulars	Participants
Australian Government sponsored "Endeavour Executive Fellowship" to work on "Mitochondrial Functions and Dysfunction in Mammalian Oocyte Development", 21 April to 21 May, 2016, Monash University, Australia	S Nandi

Technical personnel

Particulars	Participants
"Reproductive Health Management of Dairy Animals", 15-21 December, 2016, ICAR-NDRI, Karnal	V Kadakol
"Good Laboratory Practices", 17-22 October, 2017, ICAR-NDRI SRS, Bengaluru	G Maya

Administrative personnel

Particulars	Participants
"Implementation of NIC's E-procurement Solution Through CPP Portal", 25-26 April, 2016, ICAR-NAARM, Hyderabad	C Ekka, SR Sreenivasa, M Naveen Kumar
"Public Procurement", 23-28 May 2016 at NIFM, Faridabad	C Ekka

Skilled supporting staff

Particulars	Participants
"Computer Application Training for the Skilled Supporting Staff", 13-18 March, 2016, ICAR-NIANP, Bengaluru	Chennamaraiah, Mahalakshmi, K Narayana, Ningamma

Meeting/ Conference/ Symposium attended by the Director

Particulars	Date
48th meeting of Board of management of SVV University, held in the O/o the Principal Secretary, AH and Fisheries, Govt of AP, Hyderabad	13 April, 2016
Made presentation in the Workshop on "Livestock and Environmental Issues", TERI, Bengaluru	3 May, 2016
Annual Review Meeting of AICRP project, OUAT, Bhubaneshwar	12 May, 2016
5th Convocation of SVV University, Tirupati	30 May, 2016
Made presentation in the Joint Meeting of DAHDF and ICAR, New Delhi	10 June, 2016
Meeting held by the Honourable Union Minister for Agriculture and Farmers Welfare, Shri Radha Mohan Singh, on 'Mera Gaon Mera Gaurav" programme, Vijayapura	23 June, 2016
Annual Review Meeting of the Outreach Project on Methane, GADVASU, Ludhiana	8 July, 2016
Dairy CEO Enclave organized by AB Vista South Asia and Berg & Schmidt India to address the latest issues of the Indian Dairy Feed Industry	31 July, 2016
Karnataka Poultry Farmers and Breeders Association (KPFBA) Silver Jubilee celebrations, Bengaluru	6 August, 2016
Made presentation on ILRI-NIANP collaborative programmes at the "Food-Feed Crop Project Meeting of ILRI-ICAR", NDRI, Karnal	10 August, 2016
Made presentation to the Parliamentary Standing Committee on Agriculture on feed and fodder issues at the meeting called by the Secretary, DAHDF, Govt of India, New Delhi	23 August 2016
Meeting of National Steering Committee on Feed and Fodder Development (NSCFFD), New Delhi	6 October, 2016
Meeting of Roadmap for Optimization of Fodder Resources within the Country for Increasing Milk Production, ICAR, New Delhi	31 October, 2016
X Biennial ANA Conference 2016, Sri Venkateswara Veterinary University, Tirupati	9 November, 2016
Presented Key note address in the National workshop on "Mainstreaming Climate Change and Adaptation in Agriculture and Allied Sectors", MANAGE, Hyderabad	16 November, 2016
Joint International Workshop on "Production Welfare Research" organized by ICAR and University of Edinburgh, NASC Complex, New Delhi	2 December, 2016
Attended the Interface Meeting at ICAR Research Complex for Eastern Region, Patna	19 December, 2016
Attended the National Consultation on "Small Farmer Production Systems: Way Forward", ICAR-NDRI SRS, Bengaluru	22-23 December, 2016
Visited Japan to review the DST-JSPS Collaborative Project at Shinshu University, Nagano, Japan and National Institute of Livestock and Grassland Science, Tsukuba, Japan	5-11 March, 2017
Meeting of the Experts and Senior Officers to discuss the issues of urgent national importance NASC Complex, New Delhi.	23-24 March, 2017

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

Particulars	Participants
Annual review meeting of the AICRP on "Nutritional and Physiological Interventions for Enhancing Reproductive performance in Animals", 12 May, 2016, OUAT, Bhubaneswar	JP Ravindra
Annual Review Meeting of the Outreach Project on Methane, 8 July, 2016, GADVASU, Ludhiana	PK Malik, AP Kolte
XXV Annual Conference and National Symposium of the "Society of Animal Physiologists of India", 21-23 December, 2016, Mhow, Madhya Pradesh	A Mishra, IJ Reddy
27th Annual Meeting of the "Indian Society for the Study of Reproduction and Fertility (ISSRF)", 23-25 January, 2017, AIIMS, New Delhi	A Mishra, S Nandi
XXXII Annual Convention and National Symposium of the "Indian Society for Study of Animal Reproduction (ISSAR)", 6-8 December, 2016, Tirupati	A Arangasamy, BB Krishnan, S Selvaraju
X Biennial Conference of the "Animal Nutrition Association", 9-11 November, 2016, CVSc, Sri Venkateswara Veterinary University, Tirupati	Dhali A, AV Elangovan, G Ravikiran, PK Malik, S Manpal, RU Suganthi, AP Kolte, D Rajendran, KS Prasad, M Chandrasekharaiah, NM Soren, NKS Gowda, K Giridhar, SBN Rao
Brain storming session on "Scope of Indigenous Breeds of Cattle Towards Sustainable Production and Livelihood in the Current Climate Change Scenario", 1 July, 2016, ICAR-NDRI SRS, Bengaluru	S Manpal, RU Suganthi, KS Roy, DT Pal, D Rajendran
National Seminar of the "Indian Society for Sheep and Goat Production and Utilization", 9-10 March, 2017, ICAR-CSWRI, Avikanagar	A Dhali, AP Kolte, NM Soren
Interactive Meet of AS&FA, DARE/ICAR with Financial Heads of ICAR Institutes of South zone, 25 April and 23 September, 2016	AV Elangovan
XIII Agricultural Science Congress, 21-24 February, 2017, UAS, GKVK, Bengaluru	KS Roy, PK Malik, RU Suganthi, K Giridhar, S Jash, Letha Devi G, M Bagath, A Arangasamy, BB Krishnan, S Nandi, S Selvaraju NKS Gowda, D Rajendran
National Seminar on "Climate Change: Challenges and Solutions", 23 January, 2017, EMPRI, Bengaluru	PK Malik, S Mondal
National Consultation on "Small Farmer Production Systems: Way Forward", 22-23 December 2016, ICAR-NDRI SRS, Bengaluru	RU Suganthi, K Giridhar, Letha Devi G, NKS Gowda, DT Pal
Regional Horticulture fair, 15-19 Jan, 2017, ICAR-IIHR, Bengaluru	T Chandrappa, Letha Devi G, D Rajendran, S Selvaraju

Exhibition held during the XIII Agricultural Science Congress, 21-24 February, 2017, UAS, GKVK, Bengaluru	NKS Gowda, T Chandrappa, Letha Devi G, A Dhali, S Selvaraju, K Giridhar, PK Malik, DT Pal, NM Soren, A Arangasamy
National Seminar on "Advancement in Bovine Reproduction Biotechnologies to Increase Breeding Efficiencies" organized by IMV Technologies, India, 21 October, 2016, Bengaluru	A Arangasamy, BB Krishnan, S Selvaraju
"Hands-on workshop on NGS", conducted by Genotypic Technology Pvt Ltd, 11 June, 2016, Bengaluru	BB Krishnan
National Seminar on "Newer Approaches in Cow Comfort Systems for Better Productivity", 25 June, 2016, Thrissur	V Sejian
International River Symposium organized by "International River Foundation, Australia", 12-14 September, 2016, New Delhi	V Sejian
SAPI Regional Seminar on "Concepts of Physiology in Augmenting Animal Productivity", 25 November, 2016, NTR College of Veterinary Science, Gannavaram, Andhra Pradesh	V Sejian
National Symposium on "Climate Driven Food Production Systems: Agrometeorological Interventions", 20-22 December, 2016, TNAU, Coimbatore	V Sejian
National Conference on "Adaptation Interventions for Climate Resilient Agriculture in Coastal Agro-ecosystems", 9-10 March, 2017, ANGRAU, Guntur, Andhra Pradesh	V Sejian
Workshop on "High Resolution Respirometry", 7-8 February, 2017, CSIR-CCMB, Hyderabad	CG David
Meeting of FSSAI Scientific Panel on Contaminants in Food Chain, 10 February, 2017, New Delhi	KS Prasad
International Conference on "Agricultural Sciences and Food Technologies for Sustainable Productivity and Nutritional Security", 25-27 August, 2016, UAS, Bengaluru	M Chandrasekharaiah
Awareness workshop on "Guidelines for Access to Biological Resources Under the Biological Diversity Act, 2002", Organized by DBT, NBA and BCIL, 28 July, 2016, UAS, GKVK, Bengaluru	AP Kolte
Exhibition at KVK, 05 December, 2016, Hirehalli, Karnataka	T Chandrappa
Annual Zonal Review Workshop of KVKs of Zone VIII, 21 April, 2016, KVK Wayanad, Kerala	K Giridhar
Seminar on "NIR for Improving Feed Performance and Profitability", 7 June, 2016, Bengaluru	K Giridhar
Pre-action Plan Meeting of KVKs, 9 August, 2016, UAS, Bengaluru	K Giridhar

Rabi Campaign Workshop, 5 December, 2016, KVK ICAR-IIHR, Hirehalli, Tumkur district	NKS Gowda, K Giridhar
Annual Action Plan Workshop of KVKs, 2-3 March, 2017, UHS, Bagalkot	K Giridhar
National Seminar cum Workshop of AICRP on "Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants", 21-23 March, 2017, ICAR-IISS, Bhopal	NKS Gowda, K Giridhar
Foundation day seminar of "National Academy of Agricultural Sciences (NAAS)", 4-5 June, 2016, New Delhi	NKS Gowda
State level Technical Symposium on "Innovative Strategies for Quality Livestock Production in Augmenting Rural Economy", 22-23 May, 2016, KVA, Bengaluru	NKS Gowda, M Chandrasekharaiah, Letha Devi G
Veterinary Type Culture Consortium (VTCC) meeting, 8 January, 2017, ICAR-NDRI, Karnal	D Rajendran
TOLIC meetings, 22 July, 20 September and 26 December, 2016, NAL, Bengaluru	S Senani
International Conference on "Climate Change and Its Implications on Crop Production and Food Security", 12-13 November, 2016, BHU, Varanasi	Letha Devi G
Brainstorming meeting on "Developing Transparent Performance Indicators on Functioning of KVKs", 5 August, 2016, NASC Complex, New Delhi	Letha Devi G
Brainstorming meeting on "Strengthening Agricultural Extension Research and Education", 9 July, 2016, NASC Complex, New Delhi	Letha Devi G
Farmer First Review Meeting, 18 December, 2016, ATARI, Hyderabad	S Senani, Letha Devi G
Farmer First National Review cum Workshop, 18-19 March, 2017, ICAR-NAARM, Hyderabad	S Senani
"Meeting of Nodal officers, RTI", 25 October, 2016, ICAR-NAARM, Hyderabad	SBN Rao
10th Meeting of Science Engineering Research Board, DST, Govt of India, Young Scientist Life Sciences Committee and Group Monitoring Workshop, 9-11 March, 2017, Goa University, Goa	S Selvaraju

List of Workshop/ Training conducted for Stakeholders

Particulars	Date	Venue
Lecture cum demonstration on cultivation of perennial fodder crops	23 June, 2016	Urdigere, Tumkur
Reproductive problems in dairy cattle	30 June, 2016	Hadonahalli, Doddaballapura
Feeding of bypass nutrients for dairy cattle	5 July, 2016	Sarjapura, Anekal
Importance of optimum feeding for efficient milk production	8 July, 2016	Mylandahalli, Chintamani
Importance of green fodder in dairy cattle feeding	6 August, 2016	ICAR-NIANP, Bengaluru
Feeds and feed quality	25 August, 2016	Doddabommanahalli, Chintamani
Urea treatment of straw and use of California Mastitis Test kit for testing milk quality	31 August, 2016	Anagalapura, Doddaballapura
Ration balancing in dairy cattle for farmers from Tamil Nadu	7 and 14 September, 2016	ICAR-NIANP, Bengaluru
Synchronization and fixed time AI for improving fertility	6 October, 2016	Heelalige and Narayanhghatta village, Anekal
Workshop on organic dairy farming: new innovations	25-26 October, 2016	ICAR-NIANP, Bengaluru
Nutritional supplementation for improving milk fat and quality	28 October, 2016	Heelalige and Narayanhghatta villages, Anekal
Ration balancing with strategic supplementation	4 November, 2016	Hadonahalli, Doddaballapura
Fodder production and conservation	11 November, 2016	Sadenahalli, Tumkur
Improved production practices for perennial sorghum variety Co FS-31	25 November, 2016	Gollarahalli, Tumkur
Feeding and management of dairy animals	30 November, 2016	Sira, Tumkur
Feeding and management of small ruminants	3 January, 2017	B Doddi, Kanakapura
Importance of fodder trees	4 January, 2017	Veerapura, Tumkur
Clean milk production and care of new born calves	7 January, 2017	Hadonahalli, Doddaballapura
Fodder production	10 January, 2017	Gajalahalli, Chintamani
Silage making from green fodder	19 January, 2017	Ragihalli, Anekal
Silage making in plastic drums for small holders	24 January, 2017	Siddhanahalli, Tumkur
Evaluation of web based advisory and information system	25 January, 2017	Gollahalli, Kolar
Technological interventions for sustainable livestock farming	29 January, 2017	Ragihalli, Anekal
Evaluation of web based advisory and information system	29 January, 2017	Sriramapura, Rural Bengaluru
Hydroponic fodder and fodder cultivation packages	10 February, 2017	Hadonahalli, Doddaballapur
Fish farming in village ponds	15 March, 2017	Katharenahalli, Tumkur
Fodder block making	24 March, 2017	Khalarayanahalli, Anekal

Overseas visits by scientists

Particulars	Participants
Shinshu University, Nagano, Japan and National Institute of Livestock and Grassland Science, Tsukuba, Japan, under the Indo-Japan (DST- JSPS) collaborative project, 5-11Mar, 2017	PK Malik

Allocation and Utilization of HRD fund

HRD fund allocation 2016 -17 (₹ in lakh)			Actual expenditure 2016 - 17 (₹ in lakh)	Utilization (%)
Plan	Non Plan	Total		
2	0	2	1.99	100

Other Activities

Research Advisory Committee

Members	Designation
Dr KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat	Chairman
Dr BS Prakash, ADG (AN & P), ICAR, New Delhi	Member
Dr Kusumakar 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 BS Prakash, ADG (AN & P), ICAR, New Delhi	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 22nd meeting of the Research Advisory Committee (RAC) of the Institute was held on 3-4 February, 2017 at the ICAR-National Institute of Animal Nutrition and Physiology under the chairmanship of Dr KM Bujarbaruah. The other members attended the meeting were Dr BS Prakash, Dr R Bhatta, Dr Kusumakar Sharma, Dr KT Sampath, Dr G Dhinakar Raj, Dr (Mrs) G Taru Sharma, Dr DVR Prakash Rao and Dr JP Ravindra. All the Principal Scientists, Senior Scientists and Scientists were present for the meeting and presented progresses of various research projects and interacted with the committee.

Dr Raghavendra Bhatta welcomed the Honourable Chairman and Members of the RAC to the XXII meeting and briefed about the Institute activities and achievements. He highlighted the initiation of Indo-German collaborative project between University of Gottingen and Kassel and ICAR-NIANP, Farmers First project, progress about the Indo-Japan collaborative project, Organization of ADNAT conference, Foundation stone laying for the Small Animal House Facility and upcoming events such as the IPSACON-2017 conference. He also requested the committee to recommend the need for a student hostel and community hall for the Institute.

Subsequently the Chairman of RAC welcomed all the members of the committee and scientists of the Institute for the meeting. He expressed his satisfaction and happiness over the progresses and overall achievements of the Institute. He mentioned that emphasis should be given for strategic research aspects while keeping in mind their relevance with flagship programme of the Government of India for "Doubling the Farmers' Income". Following the presentations, the chairman and the members appreciated the good work being carried out by the scientists of the Institute.

Institute Research Committee

The Annual Institute Research Committee (IRC) meeting for the period April 2016 to March 2017 was held in the seminar hall under the Chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP on 25-27th May 2017. In opening remarks, the Chairman mentioned that scientists should conduct innovative basic and fundamental research keeping in view the Institute mandate and scientists should discuss thoroughly with the three identified core research groups (Feed Resources, Physiology and Reproduction and Climate Change) before proposing any new project in IRC. He also emphasized that every scientist should have at least one Institute or externally funded project as PI. Three new projects were discussed and approved during the period and nine projects were started from April 2017 after approval. Two Institute-funded and two externally-funded projects were completed and presented in the Annual IRC Meeting. In concluding remarks, the Chairman mentioned that all new projects should come out with deliverable out puts and all scientists should make efforts to come out with quality publications. He also insisted for proper recording and management of projects files and all RPPs to be available in hard and soft copies. He appreciated all the scientists for the progress and achievements in their research works.

Institute Management Committee

Members	Designation
Dr Raghavendra Bhatta, Director, ICAR-NIANP, Bengaluru	Chairman
Dr Mukund Gajendragad, Emeritus Scientist, ICAR-NIVEDI, Bengaluru	Member
Dr Sreenath Dixit, Director-ATARI, Zone-VIII, Bengaluru	Member
Dr KP Ramesha, Head ICAR-SRS-NDRI, Bengaluru	Member
Dr JP Ravindra, I/c HOD APD, ICAR-NIANP, Bengaluru	Member
Assistant Director General (Animal Nutrition and Physiology), 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
Dr AV Elangovan, I/c Assistant Finance and Accounts Officer, ICAR-NIANP, Bengaluru	Special Invitee
Shri Charles Ekka, Senior Administrative Officer, ICAR-NIANP, Bengaluru	Member Secretary

The 36th and 37th Institute Management Committee (IMC) meetings were held respectively on 05 August, 2016 and 01 February, 2017 under the chairmanship of Dr Raghavendra Bhatta, Director, ICAR-NIANP, Bengaluru. During both the meetings, 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 such as procurement of equipments, manpower, infrastructure development etc. were discussed in both the meetings and the proposals were recommended by the IMC.

In House Seminar

Date	Talk delivered	Speaker
17 Jun, 2016	Work done report and sharing the experience of deputation under Australian Govt sponsored Endeavour Executive Fellowship	Dr S Nandi, Principal Scientist, Animal physiology Division, ICAR-NIANP
22 Jun, 2016	Inflammatory responses in the feedlot cattle over summer in Queensland, Australia and Nebraska, USA	Dr Gene Wijffels, Principal Research Scientist, CSIRO, Australia
23 Jun, 2016	A Metabolomic study of *Haemonchus contortus* infection in genetically susceptible and resistant sheep	Dr Gene Wijffels, Principal Research Scientist, CSIRO, Australia
20 Oct, 2016	General Social Issues	Mrs Usha Nanaiah, Member, Karnataka Mahila Dakshata Samity, Bengaluru
28 Nov, 2016	Current report of broiler pectoralis major muscle affected by Wooden Breast myophaties in Japan	Dr Takafumi Watanbe, Shinshu University, Japan
17 Feb, 2017	Aadhar Based Biometric Attendance System	Dr Atul Kolte, Scientist, ICAR-NIANP
3 Mar, 2017	Procurement of items through government e-market place (GeM Portal)	Director (Quality Assurance) DGS&D, South Region, Bengluru

Linkage/Collaboration

- The Institute became 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 Japan and involved in the DST-JSPS funded collaborative Indo-Japan project entitled "Methane Mitigation Using Unexplored Phyto Sources in Ruminants and Their Effect on Rumen Microbial Diversity"
- Developed collaboration with Germany, formulated and subsequently granted a joint collaborative research project entitled "Optimized Use of Feed Resources for High Lifetime Productivity of Dairy Cows and Consequences on Enteric Methane Release"

Distinguished Visitors

Name of the visitor	Date
Shri Manash Choudhary, Dy. Adviser, Agriculture Vertical, NITI Ayog, New Delhi	28 Apr, 2016
Prof SK Sharma , CSIR- Emeritus Scientist and Former Vice Chancellor of CSIR-IHBT, Palampur	10 May, 2016
Dr T Mohapatra, Secretary DARE and DG, ICAR, New Delhi	19 May, 2016 14 Jan, 2017
Dr Gene Wijffels, Principal Research Scientist, CSIRO, Australia	24 Jun, 2016
Dr AK Srivastava, Director, ICAR-NDRI, Karnal	18 Oct, 2016
Dr Yutaka Uyeno, Shinshu University, Japan	21 Nov, 2016
Dr Takafumi Watanabe, Shinshu University, Japan	21 Nov, 2016
Mr Arvind Kaushal, Distinguished Fellow, The Energy and Resources Institute, New Delhi	24 Nov, 2016
Dr NV Patil, Director, ICAR-NRC on Camel, Bikaner	24 Nov, 2016
Dr Sunil Panwar, IFS, Secretary, Karnataka Information Services, Bengaluru	30 Sep, 2016
Dr JK Jena, DDG (Fisheries), ICAR, New Delhi	14 Jan, 2014
Dr KM Bujarbaruah, Vice Chancellor, AAU, Jorhat	3 Feb, 2017
Dr K Pradhan, Chancellor, SOA University, Bhubaneswar	25 Feb, 2017




Students' Research

Name	Degree/ University/ Academic year	Dissertation title
PK Javvaji	PhD/ Jain University/ 2013-2017	Effect of cytokine supplementation on the development and quality of in vitro cultured sheep oocytes and embryos
FJ Rabinson	PhD/ Jain University/ 2013-2017	Effect of season on oocyte developmental competence in sheep
L Jose	PhD/ Jain University/ 2013-2017	Rumen metatranscriptome analysis to identify the genes involved in the deconstruction of plant cell wall polysaccharide
J Chikkerur	PhD/ Jain University/ 2013-2017	Isolation of microbes for enzymatic production of short chain oligosaccharides and its evaluation as prebiotic
S Roy	PhD/ Jain University/ 2015-2018	Effective biological production of D-tagatose using D galactose and evaluation of its nutraceutical potentiality
D Shet	PhD/ Jain University/ 2012-2017	Production and evaluation of microbial phytase in the diet of layer chicken
A Sreeja	PhD/ Jain University/ 2012-2017	Purification and properties of fungal phytase and its evaluation in broiler chicken
BD Punith	PhD/ Jain University/ 2013-2017	Profiling liver transcriptome and defining the role of efflux transporter ATP7B during copper deficiency in sheep (*Ovis aries*)
S Srividhya	PhD/ Jain University/ 2012-2017	Heterologous expression and characterization of buffalo pregnancy associated glycoprotein (PAG)
S Nazar	PhD/ Jain University/ 2012-2017	Angiogenesis pattern and its related gene expression in endometrial tissues during different stages estrous cycle in goats (*Capra hircus*).
L Somashekar	PhD/ Jain University/ 2012-2017	Assessing bull fertility based on seminal and sperm membrane proteins
G Dominic	PhD/ ICAR-NDRI/ 2013-2016	Evaluation of ayurvedic medicinal residues as non conventional feed resource in goat
V Thammaiah	PhD/ Jain University/ 2012-2017	The production of lignin peroxidase from white rot fungi and its role in delignification of crop residues
RG Rao	PhD/ Jain University/ 2013-2017	Biochemical characterization and mechanism of lignin degradation in crop residues using manganese peroxidase of Basidiomycete
L Baruah	PhD/ Jain University/ 2012-2017	Metagenomic analysis of rumen methanogen and fermentation dynamics using plant phenolics
A Mor	PhD/ Jain University/ 2013-2017	Expression profiling of developmentally important genes in sheep embryos during different embryonic stages
K Sangeetha	PhD/ Jain University/ 2013-2017	Supplementation of asymmetric cell kinetic inhibitor on long term maintenance of porcine mesenchymal stem cell culture

S Parthipan	PhD/ Jain University/ 2012-2017	Identification of functional transcripts involved in fertility regulation of bull spermatozoa
PS Swain	PhD/ ICAR-NDRI/ 2013-2016	Evaluation of nano zinc supplementation on growth, nutrient utilization and immunity in goats (*Capra hircus*)
BC Divyashree	PhD/ Jain University/ 2013-2017	Molecular characterization of some motility-associated proteins in buffalo (*Bubalus bubalis*) bull semen
SK Tripathi	PhD/Jain University/ 2014-2017	Metabolic stress on oocyte and uterine cell functions and its ameliorations: cellular and genomic approaches
VS Gurupriya	PhD/ ICAR-IVRI/ 2015- 2018	Molecular cloning and characterization of some of the proteases and protease inhibitors of buffalo bull semen
S Badami	PhD/ ICAR-IVRI/ 2015- 2017	Cryopreservation-associated biomolecular changes in buffalo semen
AA Sha	PhD/Jain University/ 2014-2017	Metagenomic profiling of fecal microbial community in carnivorous leopards (*Panthera pardus*) and omnivorous sloth bears (*Melursus ursinus*)
JNK Tej	PhD/ICAR-NDRI/ 2015-2018	Studies on the effect of copper and selenium on oestrous induction and estradiol synthesis pathways in goats
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
MV Krishnaiah	PhD/Jain University/ 2015-2018	Supplementation of organic zinc copper on spermatozoal gene and protein expression pattern in male goat *(Capra hincus)*
Rashmi KM	MVSc/ ICAR-NDRI/ 2015-2017	Effect of dietary incorporation of silkworm pupae meal on nutrient utilization in cattle
Poornachandra KT	MVSc/ ICAR-NDRI/ 2015-2017	Assessment of the combined effect of selected tanniniferous and saponin containing phyto-sources on enteric methane emission in crossbred cattle
Arul Suresh P	MVSc/ ICAR-NDRI/ 2015-2017	In vitro Suppression of Cyclooxygenase-2 mRNA in Goat Endometrial cells by RNA interference.
A Vijay	MVSc/ ICAR-IVRI/ 2015-2017	Effect of Boron supplementation on production performance, antioxidant activity and calcium utiliztion in laying hens
AP Panda	MVSc/ ICAR-IVRI/ 2015-2017	Effects of cryopreservation on buffalo (*Bubalus bubalis*) sperm nuclear and mitochondrial proteins
Manohar N	MVSc/ ICAR-IVRI/ 2015-2017	Supplementation of organic zinc and copper on seminal attributes of osmanabadi bucks
SS Nongkhlaw	Msc/ ICAR-NDRI/ 2015-2016	Effect of dietary selenium on mRNA expression of selenoproteins, antioxidant status and oxidative stability of muscle in lambs
N Jose	MVSc/ ICAR-IVRI/ 2015-2016	In ovo supplementation of zinc from different sources on post-hatch gut development, growth and immunity in broiler chicken

A Joy	Msc/ KVASU/ 2016-2017	Comparative assessment of the adaptive capacity of different indigenous breed goats to summer heat stress based on changes in phenotypic traits
Archana PR	MSc/KVASU/ 2016-2017	Evaluating the differences in meat characteristics between different indigenous breed goats subjected to summer heat stress
P Prathap	MSc/KVASU/ 2016-2017	Assessing the differences in body weight changes, rumen fermentation profile and metabolic activity between different indigenous breed goats subjected to summer heat stress

Others

Institute Technology Management Unit

The Institute Technology Management Unit 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 office of ADG (IP&TM), New Delhi and ZTMC, ICAR-IVRI, Bareilly, UP. The Institute Technology Management Committee is headed by the Director, ICAR-NIANP and members are drawn from different divisions/section with an external intellectual property expert. The unit helps Institute scientists for patent search and application procedures. A total of 12 patent applications were filed by the Institute in recent past and as per the National Biodiversity Act, the NBA clearance has been obtained for the patent applications. 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

An Online Examination Centre for Karnataka has been established at the Institute for ICAR NET/ARS Prelim exams conducted by ASRB. The centre has 100 terminals for taking exams and is also equipped with two servers, 30KVA online UPS and a dedicated 8 mbps internet connectivity housed in an air-conditioned hall. The examination hall is under the surveillance of 7 IP-based high definition CCTV cameras. All the 100 systems are connected to

servers, in which examination question paper can be downloaded and answer can be uploaded with the help of high-speed internet connection. For the smooth performance of examinations, supervisor, assistant supervisor and scientists and technical personals were nominated. Several mock tests were successfully conducted in the past and online examinations for the Net/ARS-2016 was successfully conducted from 1-6 August, 2016.

ARIS Cell

Agricultural Research Information Systems (ARIS) Cell was set up in 1998. The Cell maintains more than 200 systems and 100 printers. Most of the computers are internet connected. It is equipped with high speed 100Mbps NKN connectivity for internet usages. Maintenance activity of networking and all the computers and printers are under the control of the Cell, where complaints are made online and they are rectified as soon as possible. All the hardware and software troubleshooting services is also taken care

by the Cell. System security service in all the systems are maintained with server-based antivirus which can be controlled, maintained and viral rectification can be done from one place. Dedicated software is used for monitoring internet usage with separate logging in support for each user. The Website of the Institute is regularly updated and maintained. Software like Feed base and web portals like feed chart, Indian livestock Feed Portal were developed and being hosted at 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 2016-7, 27 Cattle, four Buffalo, 40 Sheep, 101 Goat, 960 Poultry and 80 Mouse were maintained for various experiments. During the reported period, different animal experiments were conducted under 14 different research projects. A total of ₹ 2,76,487/-

revenue was also generated from ELU by sailing of farm produce (meat, eggs and 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 the experiments are on progress.

Fodder Production Unit

This unit is entrusted with the responsibility of round the year supply of green fodder to the experimental livestock unit of the Institute. Demonstration plots of edge lucerne crop, sampoorna variety of napier bajra

hybrid and V-1 variety of mulberry were developed. Various crops like rhodes grass, guinea grass, perennial sorghum, hybrid napier bajra, maize, para grass were cultivated. The top feeds were regularly supplied from fodder trees like Sesbania and gliricidia. Prepared silage from various crops, stored in plastic drums and supplied during the lean months. Azolla cultivation continued in HDPE as well as silpaulin ponds for its use as supplemental feed. The stem cuttings of Co-5 variety of napier bajra hybrid, root slips of rhodes grass, seedlings of fodder tree (sesbania), stem cuttings of gliricidia, and the culture of azolla were supplied to several farmers. Method demonstrations were conducted on grain sprouts production from maize, wheat and horsegram on straw bedding in low cost bamboo shelves, azolla cultivation in HDPE ponds, preparing shade dried Azolla and silage making in plastic bins for the benefit of farmers.

Library

The library subscribes seven general magazines, seven newspapers and on date has received 284 gratis publications from India as well as from International Institutions/Organizations. The library has 3363 back volumes of Indian and Foreign journals. The Library facilities are also offered to the

officials, students of Veterinary Colleges, Universities, researchers and other ICAR Institute officials for their reference work. The library has developed and maintained Library Web Portal (http://www.nianp.res.in/index.php/library-and-information-center). The library portal contains library history, books in stack, journal holdings (since 1995), online journals, database collection, current subscribed journals, scholar publications (with abstracts), non-book materials etc., which are updated regularly. The library maintains computer terminals for readers' retrieval and dissemination, e-mail and other related purposes. During the reported period, the library catered requests from outside readers for sending articles of their interest by post/online under the Consortium for e-Resources in Agriculture (CeRA).

Further, all the publications of the scientists of the Institute have been collected since 1995 and an Institutional Repository comprised of title, author, source and abstract of the publications has been launched and made available for retrieval and dissemination purpose. It renders reprographic services to the staff, trainees, students and administration and account sections officials for official as well as personal purposes. The library also provides lamination services for official documents.

Official Language Implementation Cell

The Institute has a Raj Bhasha Anubhag for the implementation of Hindi as the official language. For effective implementation and guidance there is an Official Language Implementation Committee (OLIC) with the Director as its Chairman. Quarterly meetings of OLIC were held regularly to review the progress made in official language implementation. The decisions taken in OLIC meetings were implemented. Minutes of these meetings were sent to ICAR headquarter for further monitoring. Four Hindi Workshops were held one in each quarter June, September, December and March to iron out the difficulties of staff to work in official language. Emphasis in these workshops was on to make use of computers and software for carrying out routine office work in Hindi.

The Cell organized the Hindi Fortnight from 14-30 September, 2016 that included various competitions where staff participated with enthusiasm. Under the auspices of Town Official Language Implementation Committee (TOLIC), the Cell also organized Solo Song Competition on 28 October, 2016 that was attended by more than 40 participants from various central government organizations.

The Director and In Charge Rajbhasha attended the TOLIC meetings held on 22 July and 26 December, 2016. An inspection of the Institute was also done by the Regional Rajbhasha Implementation Office, Bangaluru on 22 February, 2017.

Agricultural Technology Information Centre

The Agricultural Technology Information Centre (ATIC) was established in November, 2011 to provide a single window delivery system of information and technology to end users and to facilitate direct access of farmers to institutional resources available in terms of technology advice, technology products etc. It also acts as a mechanism to provide feedback from the

users to the Institute. It facilitates direct access of farmers to institutional resources available in terms of technology advice and technology products. ATIC provides real time information and advices on livestock farming, appropriate species, breeds and management practices etc., for the farmers. Information dissemination is carried out through personal interaction with visitors, interaction through telephone, information through reply of letters and participation in exhibitions, farmer fairs etc.

Staff Welfare Club

The Staff Welfare Club (SWC) was actively involved in the various activities and organized several programme during the reported period. The Club bid farewell to Shri N Raghavan (Personal Assistant), Dr KS Ramachandra, PS and I/C HOD AND, former DDG(AS) Dr H Rahman and Shri Charles Ekka (SAO). A condolence meeting was arranged by the club to pay homage to the departed soul of Shri GSSR Krishnan (Technical Officer, T-7-8). The SWC also organized and celebrated several events such as Independence Day, Republic Day, Ganesh Chaturthi, Ayudh Puja, New

Year-2017, Makara Sankranti/Pongal and Kannada Rajyotsava". The 19th "Annual General Body Meeting" of the club was held on 22 October, 2016. During the meeting, the members were appraised of the various activities and financial matter of the Club.

Games and Sports

The Institute has a Games and Sports Committee to initiate various sports activities for the Institute staff to inculcate competitive spirit and to ensure welfare of the staff of the Institute. The Committee organized various sports events from 10-26 January, 2017 as a part of the Republic Day celebrations. A number of events such as 100m, shot put, discus throw, javelin throw, chess, carrom, rangoli, musical chair and

badminton singles and doubles were organized for ladies. For men, 100m, shot put, discus throw, javelin throw, volleyball, badminton, table tennis, carrom, chess and athletics events were organized. Some sports events were also organized on the Independence Day and Republic Day for the children, which included 50m running race, spoon and lemon

race, hit wicket and slow cycle race. A friendly T20 cricket match was played on 26 January, 2017 between the Director's eleven and Dr KS Ramachandra's eleven. The Institute was represented by a team of 14 members in the ICAR zonal sports held at ICAR-NAARM, Hyderabad from 22-26 August, 2016. The team participated in carrom, chess, table tennis, badminton and athletics events.

Complaints Committee/Women's Cell

The meeting of the women's cell of the Institute was held on 20 October, 2016. The meeting was chaired by the In Charge women cell and was attended by all the members of the cell including Mrs Usha Nanaiah, member of the Mahila Dakshata Samiiti, Bengaluru. The meeting started with welcome address by the chairperson followed by exchange of views regarding the basic mandate of a women cell and what may be the possible activities that a women's cell can carry out for betterment of the women employees as well as families of the workers of the Institute. Mrs Usha Nanaiah put forward her views with respect to significance of a women cell in an organization. She expressed that since women has to balance between both family and the workplace, their own welfare is often compromised. Besides they also face the gender discrimination in all spheres in the society and workplace. The women cell has been founded to address and resolve such type of discrimination. Following the meeting a talk was delivered by Mrs Usha Nanaiah to all the staff of the Institute on general societal issues prevalent in the Indian society. A written quiz competition was organized for all the women employees of the Institute on 23 March, 2017 in order to commemorate the International Women's Day.

Academic Cell

The Academic Cell facilitates MSc, MVSc and PhD students pursuing research work at the Institute for academics related matter. The Institute has signed MOU with several universities to offer research programs leading to MSc, MVSc and PhD degree. The Institute collaborated with KVASU (Kerala), KVAFSU (Bengaluru), ICAR-IVRI (Izatnagar), ICAR-NDRI (Karnal) and Jain University (Bengaluru) for guiding Masters and Doctoral students in various disciplines. During the period 2016-2017, one PhD and nine MVSc/MSc students completed their degree. Currently 27 PhD and 11 MVSc/MSc students from Jain University, ICAR-IVRI, ICAR-NDRI, KVAFSU and KVASU are pursuing their research work at the Institute.

Human Resource and Development Cell

The Human Resource and Development (HRD) Cell is actively involved in facilitating various HRD activities related to training programmes and workshops on the practical aspects of animal nutrition, physiology and reproduction. During the period 2016-17, the Cell helped in organizing various training programmes and workshops for the Veterinary and Agricultural University faculties, ICAR Scientists, farmers and extension workers. Institute scientists, technical and administrative personnel were encouraged and nominated for different capacity building programmes.

Celebration of Hindi fortnight

Hindi fortnight programme was inaugurated on 14 September, 2016. On this occasion Dr Raghvendra Bhatta, Director of the Institute stressed upon the need to carryout routine official work in Hindi and to make all efforts to meet the targets set under the Annual Programme. He requested scientists to bring out farmer oriented technologies and also to publish them in Hindi and regional languages for their popularization. During inaugural programme, Dr S Senani, In Charge Raj Bhasha, informed the house about various competitions to be organized from 14-30 September 2016. The fortnight was concluded with a valedictory function on 30 September, 2016, where Dr Sunil Panwar IFS, Secretary, Karnataka Information Services gave away prizes to the winners and addressed the gathering. In his address, he

stressed upon the need to popularize and adapt simple and easy version of Rajbhasha rather than more sanskritaized version of Hindi. Being an Urdu lover and poet himself, he recited a Nazm on this occasion.

Laying of foundation stone of Laboratory Animal House

Dr T Mohapatra, Secretary (DARE), Govt of India and Director General, ICAR visited the Institute on 19 May, 2016. The Honourable Director General laid the Foundation Stone for construction of the Laboratory Animal House at a cost of ₹15.00 crores. The project, expected to be completed by the end of 2017, will facilitate the scientists to conduct fundamental research involving laboratory animals. The Honourable Director General, ICAR and Dr H Rahman, DDG (AS), ICAR, who accompanied the Director General, planted saplings in the Institute campus to mark the occasion.

Noting that the Institute's mandate is to conduct basic and fundamental research in animal nutrition and physiology and the Institute having very good infrastructure facilities, he gave his valuable suggestions for taking up projects, which generate research results and which will have direct bearing on the enhancement of productivity of animals. Dr Raghavendra Bhatta, Director of the Institute explained the research activities of the Institute and various programmes being taken up and some of the research results, which have been applied at farmers' level as well as adopted by the feed industry.

Interactive meeting of DG-ICAR with scientists

Dr T Mohapatra, Secretary, DARE and Director General, ICAR, visited the Institute on 14 January, 2017 to take part in an interactive session with all the scientists of the Animal Science Institutes of ICAR located in Bengaluru. He critically reviewed Institute-wise research outputs during the past one year and identified road map for specific research targets for the coming 6 to 12 months period. Dr J Jena, Deputy Director General (Fisheries Science) also graced the occasion.

Celebration of Institute Foundation Day

The Institute celebrated its 21st Foundation Day on 24 November, 2016. Shri Aravind Kaushal, Distinguished Fellow, The Energy and Resources Institute, New Delhi and former Additional Secretary, DARE and Secretary ICAR, New Delhi in the Foundation Day lecture urged the scientists to address the issue of feed and fodder scarcity and the impending effect of climate change on livestock

production. He suggested making concerned effort to get funding from national and international agencies through collaborative research projects. He congratulated the Institute for its significant contribution in the field of animal nutrition and physiology for the last two decades. The Guest of Honour, Dr NV Patil, Director ICAR-National Research Centre on Camel, Bikaner speaking on the occasion reiterated the need for collaborative research in animal science especially in the basic and fundamental aspects of livestock production. He

urged that the research findings of ICAR-NIANP need to be made use of in species specific Institutes to develop strategies for improving their productivity.

Dr Raghavendra Bhatta, Director of the Institute highlighted some of the significant achievements including the new initiatives and vision of the Institute for the future. On this occasion, two technical books published in Hindi language on Buffalo Reproduction and Animal Nutrition Technologies were released by the dignitaries.

Mera Gaon Mera Gaurav Programme

Under the Mera Gaon Mera Gaurav (MGMG) programme, ten teams comprising of 4 scientists with one scientist as the team leader selected fifty villages within 100 km of radius of the Institute. Each

team periodically visited the villages to discuss with farmers about the existing problems and provide the suggestions and inputs for overcoming the problems related to animal husbandry. Inputs in terms of technical brochures, leaflets, azolla culture and fodder seeds and saplings were also provided. Technical workshops to demonstrate feed technologies, improving reproductive status of dairy animals, fodder cultivation and conservation, insemination practices, mineral mixture for sheep and goat, milk quality and clean milk production, stress management in livestock were conducted.

Scientist-Farmer Interface Meeting

A Scientist-Farmer Interface Meeting was organized at the Institute under the Farmer First project on 15 March, 2017. Dr S Ayyappan, Former DG, ICAR and Prof NABARD chair was the chief guest and Dr V

Veerabhadriah, Former Director (Extension), UAS, Bengaluru was the Guest of Honour. Dr S Ayyappan mentioned that Farmers experience is more valuable to come out with appropriate technologies. He also emphasized the importance of integrated farming systems in current scenario of green fodder shortage and climate conditions. The technical sessions included some of the topics on reproductive management of animals, animal disease control, fodder production and conservation, feeding management in summer season etc. Demonstrations of aeroponics, azolla cultivation and silage making were also organized during the event. Three publications were released on the occasion. The interface was attended by 189 farmers from Doddaballapur and Anekal.

Launching of Farmer First Project

ICAR- NIANP launched farmer first project "Improving Livelihood Security of Farmers Through Technological Interventions for Sustainable Livestock Farming" at two different locations Shivanahalli and Ragihalli in South Bengaluru, and Doddaballapura in North Bengaluru. The launch workshop was held on 29 January, 2017 at Ragihalli

village. Dr Raghavendra Bhatta, Director of the Institute inaugurated the workshop and appealed farmers to come forward and bring their problems to the notice of scientist so that a solution in the form of technology could be provided to them.

Swachh Bharat Abhiyan

Institute is implementing Swachh Bharat Abhiyan programme in accordance with the instructions of Govt of India and ICAR and actively adopted the Campaign. Several swachhata awareness programmes were organized under the campaign. Tree planting programmes at the Institute campus were jointly taken up with Toyota Kirloskar Ltd Bengaluru. Awareness was created in the Institute campus regarding the Campaign. As an initiation, tilting dust-bins were erected at designated points for the effective use by the campus residents and staff. As per the guidelines of ICAR, Swachhata Programme was arranged at the Institute campus on

2 October, 2016 to clean and weed the open area in front of the staff quarter blocks. Swachhata Pakhwada was also observed from 16-31 October, 2016 successfully. Swachhata pledge was taken and display boards and banners were erected to create awareness about the campaign. Yoga awareness programme for the staff was also conducted. Housekeeping activities in sections, laboratories, and office premises were monitored regularly with due priority to the cleaning of toilets. Cleaning of drinking water and bore-well water tanks was done regularly and solid waste was managed and disposed of systematically.

Right to Information

During the period 2016-2017, a total of 18 RTI applications were received. Requisite information was provided for all the queries.

Personnel

List of Employees

Name	Designation
Dr Raghavendra Bhatta	Director
Animal Nutrition Division	
Dr KS Ramachandra	Principal Scientist, I/C HOD (until 28-02-2017)
Dr KS Prasad	Principal Scientist, I/C HOD (w.e.f. 01-03-2017)
Dr SBN Rao	Principal Scientist
Dr S Senani	Principal Scientist
Dr M Chandrasekharaiah	Principal Scientist
Dr AK Samanta	Principal Scientist
Dr S Anandan	Principal Scientist
Dr DT Pal	Principal Scientist
Dr D Rajendran	Principal Scientist
Dr (Mrs) A Thulasi	Senior Scientist
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 IJ Reddy	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 ICG David	Principal Scientist
Dr S Selvaraju	Principal Scientist
Dr A Arangasamy	Senior Scientist
Dr V Sejian	Senior Scientist
Dr A Mishra	Senior Scientist
Dr G Krishnan	Scientist
Dr 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 A Dhali	Principal Scientist
Dr (Mrs) RU Suganthi	Principal Scientist
Dr G Ravikiran	Senior Scientist
Dr PK Malik	Senior Scientist
Dr (Mrs) A Mech	Senior Scientist

Knowledge Management and Biostatistics Section	
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	
Shri GSSR Krishnan	Assistant Chief Technical Officer, T-7/8 (Library, until 12-10-2016)
Shri V Ramesh	Assistant Chief Technical Officer, T-7/8 (Maintenance)
Shri BH Venkataswamy	Assistant Chief Technical Officer, T-7/8 (FPU)
Dr VB Awachat	Senior Technical Officer, T-6 (ELU)
Shri VR Kadakol	Technical Assistant, T-3 (APD)
Shri DR Govinda	Technical Assistant, T-3 (Estate and Maintenance)
Mrs Maya G	Technical Assistant, T-3 (BEES)
Shri Kamalesh KM	Technical Assistant, T-3 (Maintenance)
Shri HS Narayana Rao	Technical Assistant, T-3 (AND)
Shri M Shivarama	Senior Technician, T-2 (Maintenance)
Administration	
Shri Charles Ekka	SAO
Mrs R Kalaivani	AAO
Shri N Raghavan	PS (until 31-08-2016)
Shri SR Sreenivasa	Assistant
Shri R Suresh Babu	Assistant
Mrs JV Jyothi	Assistant
Shri A Neil Vincer	PA (on deputation)
Mrs Geetha B	UDC
Shri L Gowda	LDC
Shri A Murthy	LDC
Shri M Naveen Kumar	LDC
Accounts and Audit	
Mrs MP Mridula	Assistant
Mrs P Nagaraju	UDC
Supporting Staff	
Shri Chennamaraiah	SSS
Smt Ningamma	SSS
Smt Mahalakshmi	SSS
Shri K Narayana	SSS
Smt J Lakshmi	SSS

In Charges of Section/ Unit/ Cell

Section/ Unit/ Cell	In charge
Priority Setting, Monitoring and Evaluation Cell-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 M Bagath
Experimental Livestock Unit	Dr A Mishra
Fodder Production Unit	Dr K Giridhar
Women's Cell	Dr (Mrs) M Sridhar
Public Relation Officer	Dr AK Samanta
Public Information Officer	Dr SBN Rao
Citizen's Charter and Grievance Cell	Shri Charles Ekka
Institute Joint Staff Council	Shri DR Govinda
Radiological Safety Officer	Dr IJ Reddy
Member Secretary, Institute Animal Ethics Committee	Dr NKS Gowda

Relieving

Name	Particulars
Shri C Ekka	Relieved from the post of Senior Administrative Officer on 31-03-2017 to join ICAR-IIMR, Hyderabad

Retirement

Name	Particulars
Dr KS Ramachandra	Principal Scientist (retired on superannuation on 28-02-2017)
Shri N Raghavan	Private Secretary (retired on superannuation on 31-08-2016)

Obituary

Name	Particulars
Shri GSSR Krishnan	Assistant Chief Technical Officer, T-7/8 (expired on 13-10-2016)

Promotion

Name	Promoted to the next higher post of	With effect from
Dr S, Nandi, Senior Scientist	Principal Scientist (RGP 10000)	17-09-2013
Dr J Ghosh, Senior Scientist	Principal Scientist (RGP 10000)	02-12-2014
Dr S Selvaraju, Senior Scientist	Principal Scientist (RGP 10000)	09-10-2015
Dr RU Suganthi, Senior Scientist	Principal Scientist (RGP 10000)	15-03-2016
Dr A Dhali, Senior Scientist	Principal Scientist (RGP 10000)	04-11-2015
Dr ICG David, Senior Scientist	Principal Scientist (RGP 10000)	24-09-2015
Dr D Rajendran, Senior Scientist	Principal Scientist (RGP 10000)	11-01-2016
Dr V Sejian, Senior Scientist	Senior Scientist (RGP 9000)	04-06-2015
Dr A Mech, Scientist	Senior Scientist (RGP 8000)	01-01-2014
Dr G Letha Devi, Scientist	Senior Scientist (RGP 8000)	12-06-2016
Shri HS Narayana Rao, Senior Technician (T-2)	Technical Assistant (T3)	22-11-2015
Shri M Shivarama, Technician (T-1)	Senior Technician (T-2)	30-04-2016

List of Research Projects

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

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, 2017
Institute	BGM 2.3. Development of 16s rDNA rumen specific microbes database	Apr, 2014	Mar, 2017
ICAR-Network	Veterinary type culture – rumen microbes	Oct, 2009	Mar, 2017

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

Funding	Project Title	Duration	
		Start	End
Institute	APR 3.2. Amelioration of oxidative stress to prevent apoptosis of early sheep embryos	Apr, 2013	Sep, 2016
Institute	APR 3.4. Elucidating role of boron on gene expression for calcium utilisation, immune response and antioxidant mechanism	Apr, 2014	Mar, 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, 2017
Institute	APR 3.7. Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken	Jul, 2014	Mar, 2017

Institute	APR 3.8. Effect of dietary selenium on selenoprotein genes in lambs	Apr, 2014	Mar, 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
DBT	Expression of copper chaperones and transporters in copper deficient sheep	Apr, 2013	Apr, 2016
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, 2017
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
ICAR Inter-institutional	Studies on exploitation of insects as food and feed	Jan, 2017	Mar, 2018

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

ICAR-Outreach	Monitoring of Drug Residues and Environmental Pollutants	Nov, 2009	Mar, 2017
ICAR-CRP	Bio-fortification of cereals (Biofortification-evaluation of value addition cereals (vac) and cereal by-products for animal feeding)	Jan, 2015	Mar, 2017
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, 2018
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, 2017
DBT	Livestock methane reduction through immunization based approach	Aug, 2014	Aug, 2017
DST-JSPS (Indo-Japan collaborative project)	Methane mitigation using unexplored phyto-sources in ruminants and their effect on rumen microbial diversity	Aug, 2015	July 2017
DBT-DFG (Indo-German collaborative project)	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 6.1. Socio-economic impact of Area Specific Mineral Mixture Technology in Karnataka	May, 2015	Sep, 2016
Institute	TTA 6.2. A micro level assessment of water use efficiency in different dairy production systems	Apr, 2016	Mar, 2019

ICAR-Extramural	Need assessment, development and evaluation of web based livestock advisory and information system	Mar, 2016	Mar, 2017
ICAR-Extramural	Climate vulnerability mapping of dairy farming in Karnataka and adaptation strategies	Aug, 2016	Mar, 2017
ICAR (Farmer's First Scheme)	Improving livelihood security of farmers through technological interventions for sustainable livestock farming	Nov, 2016	Nov, 2018
ICAR (Farmer's First Scheme)- Collaborating centre	Enriching knowledge and integrating technology and institutions for holistic village development in horticultural based farming systems	Nov, 2016	Mar, 2018

ICAR-NIANP FAMILY

Save water

Adopt water efficient animal husbandry practices

ICAR-National Institute of Animal Nutrition and Physiology

Adugodi, Bengaluru - 560 030, Karnataka, India

Tel. No: +91-80-25711304, 25711303, 25702546. Fax: +91-80-25711420

Email: directornianp@gmail.com, Website: http://www.nianp.res.in