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Annual Report 2014-15

ICAR-National Institute of
Animal Nutrition and Physiology
Bengaluru

ICAR

NIANP

वार्षिक प्रतिवेदन

Annual Report
2014-15

भाकृअनुप–राष्ट्रीय पशु पोषण एवं शरीर क्रिया विज्ञान संस्थान
बेंगलूरु

ICAR-National Institute of Animal Nutrition and Physiology
Bengaluru

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Cover page theme

The graphics depict basic and fundamental research endeavour of the Institute to deliver environment friendly green livestock production

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Preface

Food/nutritional security have to be met through increasing livestock production, using less land, less water and in an environmentally sustainable fashion. Growing demand of livestock products with simultaneous shrinking of feed resources compounded by large livestock population, low productivity, export of feed resources, raising feed costs competing demand for land and water by food/commercial crops are some of the immediate major concerns for livestock rearing. Feeding livestock is a major component in livestock husbandry that accounts for 60-70% of the cost of production. Livestock sector plays a pivotal role in the socioeconomic development in India by providing cheap nutritious food to the population in addition to generating employment in the rural and urban areas. Changing climate has already affected the livestock production and feed availability, which in turn influences the economics of livestock production. In the present scenario, we need to focus on climate resilient practices and technologies in line with impending challenges to meet nutritional needs for improving productivity of the animals to cope with the demands of the population. The task requires well-directed efforts in understanding the basic biology of nutrient biophysical translation, understanding and optimizing the nutrient interactions, biotechnological and physiological investigations to understand and correct/optimize the biochemical milieu in the animal body.

During the last 19 years, ICAR-NIANP has proven itself to be the leading Institution in Animal Nutrition and Physiology. Our focus of research has been on improving production and reproductive efficiency through basic physiological and nutritional approaches. The current research activities are grouped under six well developed research programmes to deliver on deconstruction of lignocellulosic biomass for improving feed utilization, biogeography of gut microbes, novel approaches for assessing and improving nutrient bio-availability, animal reproduction and productivity, feed informatics, feed quality and safety and value addition, climate change impact on livestock and technology translation to connect discovery with application. The institute has played a vital role in developing livestock feed inventory of India, inventory on enteric methane emissions, feeding standards for different species of livestock, providing need based technologies, and development of quality human resource base in niche areas.

The Institute continues to receive overwhelming support from ICAR in terms of resources, guidance and various other facilities. I sincerely thank the constant support and guidance from Dr. S Ayyappan, Secretary, DARE and Director General, ICAR. I gratefully acknowledge the encouragement from Prof. KML Pathak, DDG (AS). I thankfully acknowledge the support of Dr. BS Prakash, ADG (AN&P), Dr. Rajan Gupta, Pr. Scientist (AN) and Dr. Vineet Bhasin, Pr. Scientist (APB) for their constant support and coordination at the ICAR level. Warm thanks are due to Dr. KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat and Chairman Research Advisory Committee and the members of the august body for critical review and constructive suggestions in the research endeavor. It will be unfair not to put on record the untiring efforts of the scientists and other staff of the Institute. Their hard work and dedication has been duly reflected in this report. I congratulate the entire team of the Editorial board for bringing out this report as per the schedule.

It is my privilege to present you the salient achievements of the Institute in the form of annual report 2014-15 for your perusal and critical comments. The report will serve as a reference to those in the field of animal nutrition and physiology.

Raghavendra Bhatta

Executive Summary

The ICAR-National Institute of Animal Nutrition and Physiology has added one more vibrant and fruitful year to its 19-year old endeavour since November 1995, in catering the farmers, educationists, extension workers, policy makers and industries associated with livestock production and its continual improvement in the country. During the financial year 2014-15, the Institute functioned with 39 scientists, 9 technical staff, 15 administrative and accounts personnel and 6 skilled supporting staff under the dynamic leadership of the Directors, Dr. CS Prasad (until August, 2014) and Dr. R Bhatta (since August, 2014). The total plan and non-plan budget allocations were Rs. 1730.05 lakhs and the total expenditure was 1729.61 lakhs (99.97%) during the financial year. The institute could generate Rs. 50.03 lakhs as revenue during the period. The scientists of the Institute relentlessly worked for achieving the various targets related to research and technology demonstrations, defined under the 6 major programmes of the Institute as per its mandate.

Deconstruction of ligno-cellulosic biomass for improving feed utilization

The traditional ruminant feeding system in India is crop residue based, which usually contains high ligno-cellulosic content leading to its poor digestibility. Therefore developing suitable strategies for deconstruction of ligno-cellulosic biomass has been identified as a flagship research programme of the Institute during the XII plan.

Efforts were made to screen various matrices for immobilizing white rot fungi for obtaining maximum yields of the lignolytic enzymes (MnP, LiP and laccase) under different culture conditions. PUF cubes were found most effective biocatalyst for repeated usage and maximum production of enzymes. Seven days of immobilization was found to be optimum for enzyme production and it yielded heat and pH stable enzymes with superior kinetic properties. *In vivo* studies conducted in sheep and cattle showed that treatment of ragi straw with lignolytic enzyme could improve the digestibility of the straw and growth performance.

Cloning of laccase enzyme gene from *Schizophyllum commune* into pPIC9K vector and subsequent production of the recombinant laccase in *Pichia pastoris* were attempted. The recombinant enzyme was produced extracellularly in the culture medium of the genetically modified *Pichia pastoris* and the enzyme was found bioactive. The identity of the enzyme was confirmed by LC/MS-MS analysis.

Lignocelluloytic enzymes have significant potential for their applications in various industries, including animal feed. However, huge quantities of enzymes are required to degrade lignin from crop residues. This demands an inexpensive and readily available supply of these enzymes with efficient lignolytic activity. Therefore, a project has been initiated for identifying novel lignocellulolytic enzymes and production of engineered enzymes with improved activities suitable for industrial-scale applications.

Biogeography of gut microbes in animals

The digestive tract of animals harbours numerous microbes and they complement the physio-metabolic capacity of the animal to deconstruct the ingested materials and synthesis of nutrients. The rich biodiversity of microbes in the Indian livestock have role in conferring unique qualities to the indigenous livestock including disease resistance, adaptability to extreme environmental conditions and sustenance with low inputs. Therefore, characterizing the gut microbes of the Indian livestock species has also been identified as a flagship research programme of the Institute during the XII plan.

Rumen methanogenesis is a necessary process as it ensures the disposal of excess hydrogen, but it is a wasteful process simultaneously as it leads to the loss of dietary energy. Interestingly, reductive acetogen of rumen have the capability to utilize H_2 bypassing the methane production. A study was conducted to establish molecular profile of rumen acetogens in sheep during different developmental stages. The results indicated the presence of acetogens in the rumen of Indian sheep as early as 10 days of age.

Efforts have been initiated to establish species specific microbiome in animal gut and identification of the microbes associated with Indian species with special reference to fibre digestion and methane reduction. The investigation aims to characterize the whole gut microbiome using the metagenomic approach. Efforts were made to standardize a common protocol for collecting and processing of rumen liquor for the isolation of metagenomic DNA. The 16S rRNA gene sequence information is recognized as the "gold standard" for the identification and taxonomic classification of bacterial species. In an effort to create a collection and establishing a rumen microbe specific 16S rRNA/DNA database, more than 4.7 lakhs sequences were collected from various

public resources. A repository of rumen microbes has been established with the aim to isolate and purify anaerobic gut microbes, study the micro-morphological and biochemical characteristics, establish molecular identity and submit the purified and characterized cultures to the repository. A total of 30 bacterial isolates were accessioned during the reported period and currently the repository contains 270 accessions. Whole Metagenome analysis was also carried out for rumen samples obtained from cross bred steers fed different types of diets.

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

Improving the bio-availability of nutrients for different productive and reproductive processes and augmenting the reproductive performances are the keys for profitable livestock farming. Extensive research investigations were carried out in these aspects during the reported period.

Copper chaperone for SOD (CCS) was evaluated as a sensitive biomarker of copper deficiency in sheep. The presence of CCS and SOD1 transcripts in whole blood and RBC was confirmed. The expression of CCS gene was found upregulated significantly, but SOD1 gene expression remained unaffected in the copper deficient sheep. Mineral solubility in rumen from mixed rations and its effect on rumen fermentation and animal performance were assessed. Increased release of Ca, Mg, Cu, Fe, Mn and Co in the rumen (*in sacco*) was observed with the supplementation of microbe-specific mineral mixture. A body weight gain of 30g/d in the animals supplemented with 1% microbe-specific mineral mixture over control was evident in sheep. Precision feeding with strategic nutrient increased FCM yield, reduced feed cost and increased overall income in medium yielding crossbred cows fed with grass based diets. The effect of dietary natural antioxidants supplementation on the production performance and meat quality of linseed oil fed chicken was evaluated. Significantly higher total body weight gain was observed in the birds fed linseed oil and natural antioxidants. Linseed oil feeding improved the omega-3 content of meat by more than two folds and the supplementations of curry leaf, turmeric and commercial antioxidant enhanced shelf life of meat. The role of boron on the calcium utilisation associated gene expression, immune response and anti-oxidant mechanism was investigated. Boron level was found higher in leguminous fodders and tree leaves and a positive effect of boron supplementation on calcium utilisation, calmodulin gene expression in liver and immune status was observed in rats. Nanoparticles exhibit many unique properties relative to bulk material and its bioavailability is expected to be higher due to greater surface area. In an attempt to synthesize ZnO nanoparticles, it was observed that chemical pyrolysis was suitable to generate the nanoparticles and desired particle size could be obtained at 300°C for 4h of pyrolysis. To assess the effect of dietary selenium on selenoprotein genes in lambs, the methods for assessing the expression of various selenoprotein genes in whole blood and white blood cells were optimized in sheep. The impact of feed restriction on the somatotrophic axis in goat was evaluated. The results indicated that the plasma GH, IGF-1 and leptin levels may be considered as blood biochemical markers, while the expression of GH and GHR, HSP70 and HSP90 genes may be considered as molecular markers for assessing the impact of nutritional stress. In an attempt to apply statistical and bioinformatics tool for analysing and modelling of genes related to production and reproduction in livestock, Hidden Markov Models were found to be suitable in searching the various data bases for finding out appropriate gene sequences.

Drug residues and environmental pollutants in feed, milk and water were monitored in the Gulbarga district of Karnataka. A total of 19 green fodder, 47 dry fodder, 19 grain, chunni and oil cake, 16 milk and 5 water samples were collected and analysed for different pesticide residues and heavy metals. Agricultural wastes were used to produce nutraceuticals for their intended use to improve the gut health in animals. Xylan was extracted from cotton, tobacco and bajra stalks. The extracted xylan was subjected to hydrolysis by exogenous xylanase enzyme and xylo-oligosaccharides with different degree of polymerization such as xylopentose (X5), xylotetrose (X4), xylotriose (X3) and xylobiose (X2). Xylo-oligosaccharides were also produced from green coconut husks that mainly comprised of higher degree oligomers such as xylopentose and xylohexose. The supplementation of coconut xylo-oligosaccharides (0.5%) in the diet of broiler birds increased beneficial microbes in the caecum. Research investigation has been initiated to biotransform D-galactose into D-tagatose and evaluate its application as nutraceuticals. Phytase was produced from the fungal isolate *Aspergillus foetidis* (MTCC 11682) employing immobilization technique. Incorporation of the partially purified fungal phytase in the diet (1000FTU/kg) of broiler chicken was found effective in replacing 0.12% non-phytate phosphorus. The dietary levels of copper affected the expression profiles of copper-related transporters and chaperone genes in sheep. The expression of ATOX1, SCO1, SOD and CCS genes was upregulated and CTR2, ATP7B, SCO2, COX11

and COX17 genes was downregulated in whole blood and RBC samples in copper deficient animals. In liver tissues, the expression of SCO1, SCO2, SOD and CP genes was upregulated and ATOX1, ATP7B, CCS, CTR2 and COX17 genes was downregulated in copper deficient animals, but MURR1, COX11 and NRF1 gene expressions remained unchanged.

A new AICRP project has been started with 12 collaborating centres from the different regions of the country. The project aims to assess the extent of infertility conditions and possible interventions through nutritional and physiological means to improve fertility. During the reported period, infertility status of animals was assessed in the villages and, the effect of synchronization treatment and area specific mineral mixture supplementation for improving fertility was evaluated. Further, the seminal protein profiling was carried out in bulls to identify semen fertility markers and attempts were made to select a suitable molecule for protecting sperm from cryoinjury.

Experiments were conducted to suggest suitable fertility diagnostic test(s)/kit for bulls. A synthetic media for sperm penetration test was developed as an alternative to cervical mucus and the sperm penetration distance was found significantly correlated with fertility. The differentially expressed 11kDa protein in buffalo seminal plasma (TIP39) was found to influence sperm function. LC/MS-MS analysis of major sperm proteins revealed the presence of 21 putative proteins, which were found to be associated with energy metabolism and fertilization. Expression of the abundant sperm protein PDC109 was found significantly greater in low compared to high fertile bulls. The potentiality of selected putative fertility/motility associated proteins (CatSper3, TIMP-2 and BSP5) was assessed for using as motility/fertility markers of buffalo semen. For the first time, recombinant buffalo TIMP-2 protein was produced in the laboratory and is being used for the production of homologous polyclonal antibody for its future use in a bioassay for quantitation of TIMP-2 in seminal plasma. Efforts were made to identify the fertility regulating transcripts for selecting highly fertile bulls. The profiling of sperm RNA using IonProton platform suggested that the bull spermatozoa could have 12000-13000 transcripts. Relative expression of IGF1, EIF1 and CCT8 transcripts was found greater in high fertile as compared to low fertile bulls, which indicates that these transcripts might have the potential to influence bull fertility. Investigation on the effect of organic zinc and copper supplementations on advancing puberty, spermatozoal transcript expression and fertility in goat has been initiated. The association between graded doses of arsenic induced testicular oxidative damage and sperm functional attributes in mice was assessed. Higher doses of arsenic (100 and 200ppm) were found to be testicular toxicants, and the impaired semen quality and testicular architecture were due to oxidative stress.

The efficacy of siRNA to knock down prolactin in *in vitro* cultured hen anterior pituicytes was assessed. It was observed that RNA interference could specifically suppress prolactin without exerting any effects on pituitary IGF1, GH, FSH, E2β and PRLR. Amelioration of oxidative stress to prevent apoptosis of *in vitro* derived sheep embryos was attempted. It was observed that carnitine and ergotheoneine exerted antioxidant effect, when supplemented into culture media and resulted in better cleavage and superior quality and development of embryos. The effect of different spectrum of light on body weight gain, feed intake and feed conversion efficiency was assessed in broiler birds. It was observed that green spectrum of LED lighting advanced body weight gain by two weeks and could reduce the feed costs as compared to control birds reared under incandescent bulbs. The effect of copper and selenium supplementations on *in vitro* cell survival and estradiol synthesis of ovarian granulosa cells in goats was studied. It was found that selenium supplementation in culture media significantly improved the survival rate of the cells. Investigation has been initiated to study the role of Wnt signal in granulosa estradiol synthesis from the preantral and different-size follicles, and a 6-day culture system has been standardized for ovarian granulosa cells of buffalo and goats. The assessment of oocyte competence under metabolic stress revealed that β-hydroxybutyrate, total NEFA, ammonia and urea can be considered as biomarkers of reduced fertility in metabolically stressed ewes. Ovarian follicles' growth even at their earlier stage was compromised by changes in the metabolic status of the animals. Oleic acid was beneficial to the oocyte and granulosa cell growth, while stearic acid was most inhibitory among the different NEFA to oocyte and granulosa cell growth. Supplementation of ITS and FGF2 in the maturation medium improved the maturation and cleavage rates of sheep oocytes, but the supplementations in embryo culture medium did not improve the development of sheep embryos. Development competence of metabolically active and silent sheep oocytes was assessed. GDF9 was found crucial for the maturation of metabolically active sheep oocytes. Poor development of the metabolically active sheep oocytes was attributed to disrupted activin/BMP signalling. Whole transcriptome analysis revealed 914 and 945 significantly up regulated and down regulated genes

respectively, in the metabolically active compared to silent oocytes. In an attempt to develop pregnancy associated glycoprotein (PAG) based immunodiagnostic in buffaloes, the PAG7 was found to be expressed predominantly during early pregnancy in buffaloes. The recombinant protein and synthetic peptide corresponding to PAG7 were generated and used for anti-sera production, which were found suitable for immunoassay development. Multiple early pregnancy specific miRNA and proteins were identified in the serum and urine samples of buffalo that can be exploited for the further development of early pregnancy bio-markers. Protocol for deriving mesenchymal stem cells from the bone marrow of goat and pig was standardized, the expressions of cell surface marker genes was confirmed, and differentiation potential of the selected porcine cell lines was assessed.

Feed informatics, feed quality and safety and value addition

Refinement of the feed resource database was updated for all districts across various agro-ecological regions of the country integrating the 18th livestock census data. The data base was improved with geographical representation of various states with district information and strengthened with tabular, map and graphical format with intelligent interactive version. The impact of climate variation on the production of feed resources in different states was assessed and models for predicting the impact of climate variation on animal feed resources were developed. Methodology to assess the impact of long term rainfall variability on the production of various crop residues and the crop-wise models for various states to quantify the impact of rainfall on production were developed. Investigation has been initiated to evaluate the nutrient composition of value added cereals (VAC), compare nutrient utilization of VAC with conventional cereals using *in vitro*/ *in sacco* study, and compare VAC with conventional cereals for nutrient utilization in animals.

Climate change impact on livestock

The expression of HSP70 mRNA and protein in visceral organs of broiler chickens under acute heat stress was assessed. HSP70 level was found higher in visceral organs of 5h and 10h heat exposed birds. Histo-pathology data indicated immuno-suppression of birds under heat stress. The result suggests that the kinetics of HSP70 is tissue and time dependent under hyper-thermic state. The effect of tanniniferous tree leaves on the amelioration of methane emission was assessed in adult sheep. It was observed that the tanniniferous leaves in complete feed block did not alter the DM intake and digestibility, but resulted in significant reduction in enteric methane emission. The effect of different dosages of hydrolysable and condensed tannin on *in vitro* methane production was investigated. The results indicated that the *in vitro* production of total gas and methane was not affected by the tested tannin dosages. Investigation has been initiated to analyse the diversity and abundance of rumen archaea through molecular approaches, formulate species specific vaccine for active immunization of cattle and buffaloes, and evaluate the effect of active immunization and secondary metabolites combo preparation on *in vivo* methane emission. Study is going on to decipher the mechanism of aberrant maternal recognition of pregnancy (MRP) in sheep and buffalo under heat and nutritional stress. It was observed that nutritional stress modulated the expression of COX-II, PGES, PGFS, HSP70, iNOS, osteopontin and integrin mRNA in the sheep uterine endometrium on Day 13 of pregnancy.

Technology translation to connect discovery with application

The sustainability of dairy farming as a means of livelihood was evaluated. Sustainability index was found greater for the groups with milk yield above 10lit and for medium holders maintaining 3 to 6 animals. A positive correlation between sustainability and livelihood security was observed. The training needs as well as constraints in dairy farming were identified and prioritized. Efforts were made to disseminate livestock related information and technical inputs to the farmers in the adopted villages. Technical workshop was conducted for the farmers on balanced feeding and field demonstrations on azolla cultivation, silage making and urea ammoniation of straw were conducted. Ration balancing was popularised through the use of "Feed Chart" tool. Under the ARChE_Net collaborative project, a regional network of Indian Ocean Countries was established for exchanging the skills on dynamic adaptation of ruminant production systems to a changing environment. Efforts were made to assess the vulnerability of crop-livestock farming system in Karnataka to climate variability and global economic change. It was observed that farmers rearing single livestock species were highly vulnerable to climate vagaries and integrated farming system with a few cattle, sheep or goat was found to be the least vulnerable system. By and large, the farmers changed their livelihood pattern as a coping strategy to climate change.

Human resource development

During the reported period, the Institute was actively involved in various human resource development activities. A total of 31 students registered under different universities used laboratory facilities of the Institute for perusing their MSc and PhD dissertations. Various trainings, workshops, meeting and technology awareness programs were organized for the scientists, academicians, extension professionals, policy makers and farmers. Three month attachment trainings were organized for seven newly recruited ARS scientists. The scientists of the Institute received professional training from various national and overseas Institutes/ organizations and attended various workshops, conferences, seminars, symposia and krishi mela/ expos. The administrative and accounts staff also received various professional trainings for skill development.

Others

The Institute in association with the ANSI, CLFMA and VIV India organized the 'Global Animal Nutrition Conference (Glance-2014)' from 20-22 April, 2014, in Bengaluru. The conference provided an exceptional platform for more than 550 delegates to share, exchange and update the latest developments, opportunities, challenges of the livestock sector and livelihood.

The prestigious ICAR Award for the outstanding interdisciplinary team research in agriculture and allied sciences for the biennium 2011-12 was conferred to the scientists for their outstanding research work on prebiotics production from agricultural wastes. The scientists also received several awards and recognitions from various professional societies for significant scientific contributions.

The Institute also observed various official functions; Republic Day, Independence Day, Hindi Pakhwada, National Integration Day, ICAR Foundation Day, Institute Foundation Day and National Science Day. Various social events were also organized by the 'Staff Welfare Club' for the staff and their families.

The Institute officially launched the campaign "Swachh Bharat Abhiyan" on 2nd Oct, 2014 with the resolution to work towards realizing Mahatma Gandhi's dream of "Swachh Bharat". Various initiatives were taken to maintain the office and campus premises clean and environment friendly. On the occasion of "National Science Day" celebration, Swachh Bharat campaign was also promoted at D.Nagenahalli village, Tumkur District, Karnataka.

Introduction

The ICAR-National Institute of Animal Nutrition and Physiology (ICAR-NIANP) was established in 1995 under the aegis of the Indian Council of Agricultural Research (ICAR) to conduct 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.

Faculty

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

Staff position as on 31-03-2015

Category	Sanctioned posts	Staff in position
Director	01	01
Scientific	40	39
Technical	12	9
Administrative and Accounts	17	15
Skilled supporting staff	06	06
Total	76	70

Priority setting and management

The Institute has a high powered Research Advisory Committee (RAC) comprising of eminent scientists and professor, who guide the research agenda of the institute and set research priorities. Dr. K.M. Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat is the chairman of the committee. The other members include scientists and professor from the field of Animal Nutrition, Physiology, Biotechnology, Reproductive Biology and Social Science.

The functioning of the institute is supervised by Institute Management 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, ISO 9001-2008 Implementation, Grievance, Publication, Priority Setting Monitoring and Evaluation Cell, RFD 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 projects (both internal and external based on the mandate) and identifying thrust areas. Moreover it has forward and backward linkages with RAC, IRC and HYPM in project monitoring and evaluation.

In the XII plan, new thrust areas have been identified to strengthen the basic and fundamental research in niche areas and six major programmes have been identified. A new AICRP on "Nutritional and physiological interventions for enhancing reproductive performance in animals" with 12 centres has been started in the XII plan. The institute is coordinating an Outreach project on "Methane emission in ruminants" with seven centres and is a partner in the Outreach project on drug residues and environmental pollutants. Besides, the institute scientists have been associated two projects funded by NASF, twelve projects funded by DBT and one project funded by NICRA, Coconut Development Board and ICSSR each. Translation of discovery into application through technology transfer is being effectively carried out through the knowledge management and biostatistics section.

Vision: Productivity enhancement for profitable and sustainable livestock production

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

Mandate

The mandate of the institute is to conduct fundamental studies on basic physiological and nutritional problems related to biophysical translation of nutrients for productive functions in livestock by

- Unravelling basic physiological and nutritional principles and conducting research on fundamental aspects arising out of research in animal production in the country.
- Effectively utilizing the scientific manpower at specialized level at one place and demonstrating how nutrition and physiology principles function in practice and thereby improve rural economy through better livestock feeding and management approaches.

Objectives

- To achieve the mandate of the institute the following broad objectives and programmes have been outlined
- To carry out qunatitative and qualitative assessment of feed resources and to develop district-wise information system
- To enhances 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 the issues of feed quality and safety
- To develop strategies for validation of evolved technologies at user's level for production enhancement

Institute Programmes

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

Expenditure Statement

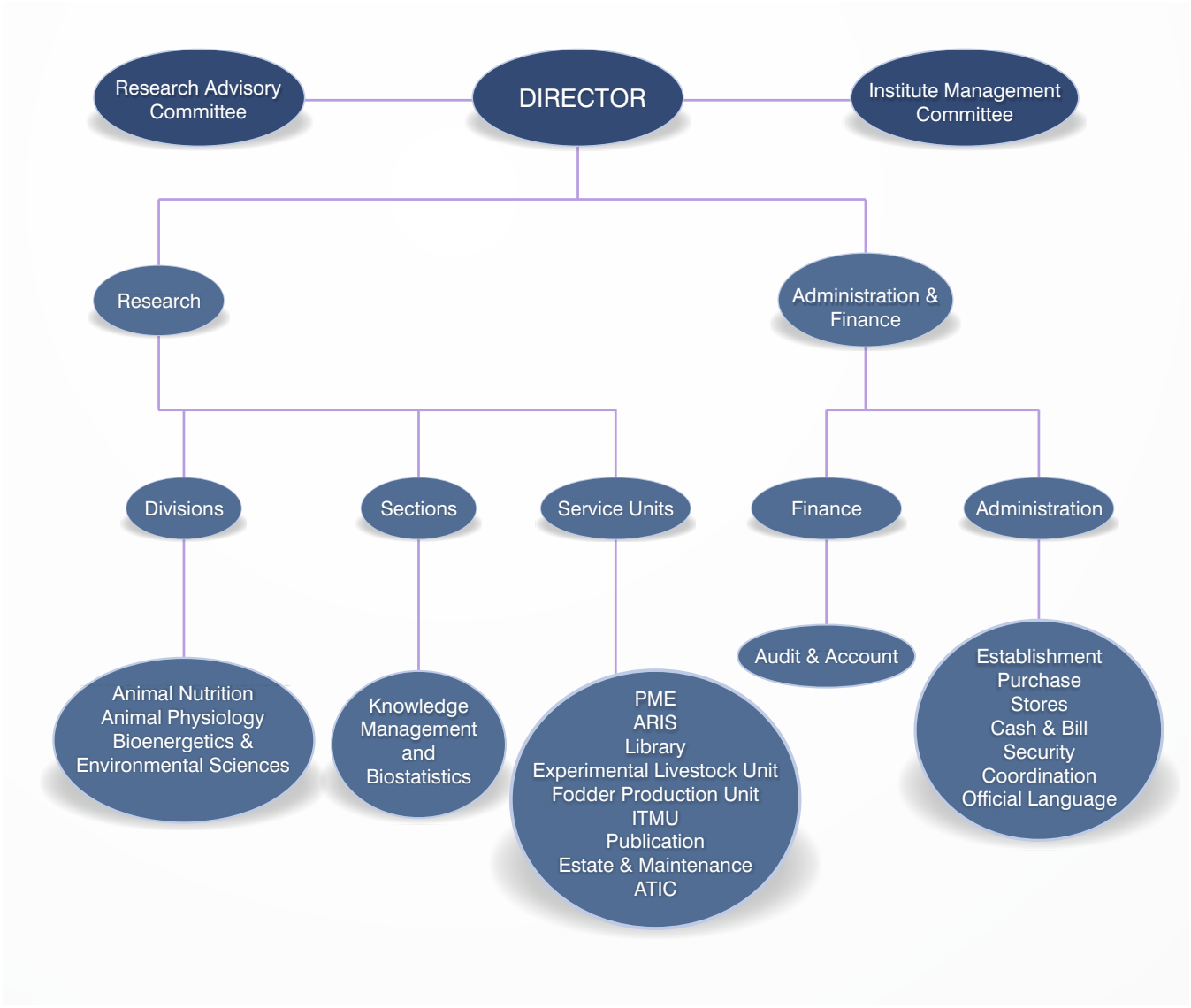
Statement showing the sub head wise expenditure under plan and non-plan budget (Rs. in lakhs)

Sl. No.	Sub Heads	Plan 2014-15		Non Plan 2014-15		Externally funded projects 2014-15	
A.	Institute	RE	Expenditure	RE	Expenditure	Funds available	Fund utilized
1	Establishment charges	0	0	822	822	-	-
2	Travelling expenses	6	6	3	3	-	-
3	Other charges including equipments	241.05	240.88	193	193	-	-
4	HRD	3	3	0	0	-	-
5	Works	34.96	34.96	0	0	-	-
6	Utilized from IRGS	0	0	37	37	-	-
	Total (A)	285.01	284.84	1055	1055	-	-
B.	AICRP and Outreach Projects	311.73	311.73	0	0	-	-
C.	Other plan schemes	73.17	73.17	0	0	-	-
D.	Other non plan schemes	0	0	5.14	4.87	-	-
E.	External funded project	-	-	-	-	281.76	182.81
	Grand total	**669.91**	**669.74**	**1060.14**	**1059.87**	**281.76**	**182.81**

Revenue generation (Rs. In lakhs)

Sl. No.	Particulars	Amount
1	Sale of livestock, farm products etc.	0.93
2	Other receipts	
	Sale of publications	4.18
	Analytical testing fees	3.83
	Other receipts including LF/ interest/ IRGS/LS/PC	41.09
	Total	**50.03**

Organizational Setup



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

Institute
Research Projects

Programme 1

Deconstruction of Ligno-cellulosic Biomass for Improving Feed Utilization

Production of lignolytic enzymes from white rot fungi through immobilization and their efficacy in enhancing digestibility of crop residues

M Sridhar, R Bhatta and A Dhali

The project aims to screen various matrices for immobilization of white rot fungi for obtaining maximum yields of the lignolytic enzymes. To enhance production of secreted lignolytic enzymes from promising fungi *Pycnoporous sangeus, Coriolus versicolor, Pleurotus flabellatus*, *Pleurotus floridanus, Lenzites striata* and *Poria plascenta,* they were immobilized on various matrices; wood shavings, sugarcane bagasse, areca sheath, loofa sponge (natural matrices) and polyurethane foam (PUF) cubes (synthetic matrix) and lignolytic enzyme secretion was estimated up to 20d. PUF cubes were found most effective biocatalyst for repeated usage for maximum production of lignolytic enzymes from these fungi, giving the highest production of lignolytic enzymes and seven days of immobilization was found to be appropriate in case of all the fungi screened. The best purification (~5 fold) for laccase from *T. ressei* and *V. displacia* and of lignin peroxidase from *P. florida* and *P. chrysosporium* was obtained after immobilization on PUF cubes.

The enzyme media from the six selected fungi was concentrated and used for application to ragi straw 2.3 cm length at ratios of 1:5, 1:2.5, 3:5 and 4:5 and subjected to both enzyme treatment as well as supplementation. *Poria plascenta* recorded the highest activities (U/mg) of laccase and lignin peroxidase of 70.2 and 82.1 respectively, followed by *Coriolus versicolor* which recorded 57.2 and 63.2 of laccase and lignin peroxidase activity respectively. As *G. lucidum* also showed very high lignolytic enzyme activities of 280.6 and 297.3 respectively for laccase and lignin peroxidase, it was also selected for the *in vivo* feeding trials. *Pycnoporous sangeus* recorded 195.2 and 266.7 of laccase and lignin peroxidase activity respectively. The IVDMD values for the ragi straw after enzyme treatment showed *G. lucidum* to record the highest digestibility followed by *C. versicolor.* Changes in the proximate composition of ragi straw after enzyme treatment at a ratio of 1:2.5 accorded the most promising results for all the fungi studied. Enzyme supplementation failed to give positive results with any of the fungi with regard to either changes in proximate composition or the IVDMD.

Feeding trials of enzyme treated ragi straw at a ratio of 1:2.5 in sheep recorded 7% enhancement in digestibility in case of *C. versicolor* yielding the best results followed by *G. lucidum.* Rumen enzyme analysis showed variations in the levels of CMC, MCC, Amylase, Xylanases, FPase, proteases, acetyl esterases and β-D-Glucosidases of the control and enzyme treated straw fed groups with higher values being obtained in the latter group. Higher protein content was also recorded in the three experimental groups as compared to the control group. Combination of media from both the fungi in a 1:1 ratio failed to yield positive results in this experiment.

A second feeding trial to study the effect of feeding ragi straw treated with lignolytic enzymes harvested from *P. chrysosporium* and *T. versicolor* in a 1:2.5 (w/v) ratio both individually and in combination for 40d recorded body weights of 2.57 kg in the control and 2.5 kg and 2.7 kg respectively in groups 2 and 3 fed with straw treated with enzymes. Treatment of ragi straw with a mixture containing enzymes from both the fungi recorded a body weight of 2.7kg. A DMD of 72 and 70% was obtained in groups 2 and 3 while both the control and group 4 recorded 68%. Rumen fermentation pattern failed to show any significant difference. However, favourable changes were obtained in the fibre degrading enzymes in sheep fed the supplemental enzymes.

A third feeding trial to study the effect of treating ragi straw with lignolytic enzymes harvested from *P. chrysosporium* at three ratios of 1:2.5, 3:5 and 4:5 (w/v) on *in vivo* digestibility and body weight changes in sheep was also carried out. After 40d feeding trial, the body weights recorded were 32.3±10.8kg in the control and 31.4±7.2, 31.9±4.5 and 32.3±3.5kg respectively in groups 1, 2 and 3 fed with straw treated with enzymes harvested from immobilized *P. chrysosporium* at varying ratios. DMD of 76±10.5 and 76±12.2% was recorded in the control and group 1, while group 2 and 3 recorded 72±9.1 and 65±5.2% respectively.

A fourth trial in cattle, to study the effect of feeding ragi straw treated with lignolytic enzymes harvested from *Schizophyllum commune,* a novel isolate rich in laccase enzyme and isolated by our laboratory, was also conducted (Fig. 1 A and B). Heifers were fed the enzyme treated straw at two ratios of 3:5 and 4:5 (w/v) and the effect on *in vivo* digestibility and body weight changes was studied. Though variation was obtained in body weight of control animals and animals fed the enzyme treated straw (Table 1), no significant variation was observed with regard to DMD between the groups.

The results indicate that treatment of coarse roughages such as ragi straw with enzyme media from white rot fungi improves digestibility and performance of sheep and cattle. Application of purified enzymes may accord still better results with regard to both growth performance and digestibility.

***In vivo* feeding trials conducted in sheep and cattle showed treatment of ragi straw with lignolytic enzyme could improve digestibility and growth performance in ruminants.**

Table 1. Changes obtained in body weight of cattle fed lignolytic enzymes harvested from *S. Commune*.

Treatment	Exp erimental groups		
	Control [1]	Group -I[2]	Group -II[3]
Initial weight	276.7±64. 5	275 .0 ±47.1	276 .0 ±37.1
End of 1st week	273.7±68.1	274.9±44.9	271.5±34.3
End of 2nd week	277.9±68. 5	283.5±46.4	278.8 ±37.2
Initial variation in body weight	0.0	1.75	0.75
Final weig ht	277.9±68. 5	277.5±46.4	278.8±37.2
Difference	1.15	2.50	2.85
Over All Difference	1.15	4.25	3.60

[1] *animals fed straw treated with production media alone;* [2] *animals fed enzymes harvested from Schizophyllum communeat at 3:5 ratio;* [3] *animals fed enzymes harvested from Schizophyllum communeat at 4:5 ratio.*

Figure 1. A: Treated ragi straw being packed in bags for feeding; B: Group wise feeding of cattle in progress.

Programme 2

Biogeography of Gut Microbes in Animals

Comparative rumen metagenomics of domestic ruminants

AP Kolte, A Dhali, R Bhatta and AK Samanta

The digestive tract of animals harbours numerous microbes; bacteria, archaea, fungi, protozoa and bacteriophages. The microbes complement the physio-metabolic capacity of the animal to deconstruct the ingested materials and synthesis of nutrients. The rich biodiversity of microbes in the Indian livestock may have role in conferring unique qualities to the indigenous livestock including resistance to diseases, parasites, extreme environmental conditions, sustainability at lower levels of inputs, maintenance in environmental friendly and ecologically sustainable way. Recent techniques of 16s rDNA amplification, cloning and sequencing has established identity of many microbes which were earlier not known to be existing in the rumen. The gut microflora continuously interact with the host genome, feed ingested, exogenous microbes and environment. Although dynamic, studies have found that the microflora has individual and species specificity that affects nutrient utilization, physiological and immunological status of the animals. The project aims to establish the species specific microbiome in animal gut and identification of the microbes associated with Indian species with special reference to fibre digestion and methane production.

A common protocol has been standardized initially for collection and processing of rumen liquor required for isolation of metagenomic DNA sample. The liquor samples were processed after clarification by passing through the muslin cloth. The strained rumen liquor was stored in frozen and freeze dried and grounded forms. The neat rumen liquor was also preserved in refrigerator until DNA isolation. Freeze drying protocol using vacuum concentrator was standardized for the clarified and frozen rumen liquor. The metagenomic DNA was isolated using standard kits. The quality of the isolated DNA was checked using nanodrop spectrophotometer (ND6000). To maximize the DNA extraction from the ruminal microflora, bead beating protocol was used with the kits. Although, the results of the bead beating protocol revealed poor 260/230 ratios, they are acceptable since the metagenomic DNA isolated from environmental samples always co-precipitate with the polyphenols. However, the yield as assessed by OD260 was maximum for lyophilized samples but the quality ratios were poor with bead beating protocol indicating further purification of isolated DNA.

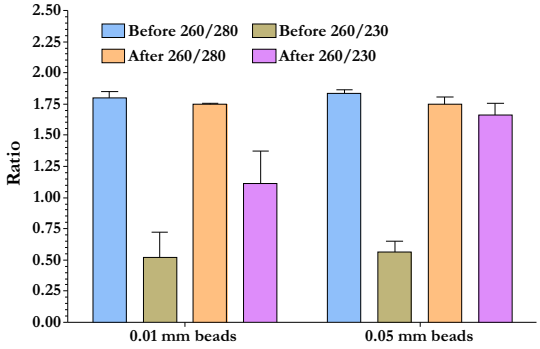


Figure 2. Quality of rumen metagenomic DNA isolated by bead beating method.

Isolation methods affected the DNA quality and quantity; Bead beating yielded higher DNA recovery but with polyphenolics and salts impurities.

Molecular profiling of rumen acetogens at different developmental stages in sheep

PK Malik, A Thulasi and NM Soren

Rumen methanogenesis is a necessary but wasteful process for the animal as its emission from animal leads to loss of dietary energy. Methane emission from animal system ensure the safe disposal of excess hydrogen, which otherwise would accumulate in the rumen and will be fatal for the animal system. In recent years with advancement of research, other hydrogenotrophic microbes having superior capability for H_2 utilization is also reported. One category of such hydrogenotrophs is reductive acetogen that are capable of utilizing H_2 as a basal substrate for reducing the conversion of CO_2 into methane. There are only a few reports on the presence of reductive acetogens in rumen. The study aims molecular profiling of rumen acetogens in sheep during different developmental stages and, exploring the termite hindgut acetogens' diversity and comparing it with the acetogens of ruminants.

Rumen liquor from 8 sheep was collected at various developmental stages from birth to adult stages. Genomic DNA was isolated and amplified using *fhs* gene specific primers. The amplicons were cloned and sequenced and the bioinformatic analysis was performed. Eight sequences of fully annotated gene were submitted to the genbank with the accession numbers KP294513, KP294514, KP294515, KP294516, KP294517, KP294518, KP294519, and KP294520. There are two published signature sequences of *fhs* gene (Prosite accession no. PDOC00595) and our amplicons had signature 2 V-[ASV]-[TS]-[IVLA]-[RQ]-[AGS]-[LIM]-[KER]-x-[HN]-[GAS]-[GLKD] of *fhs* gene. Four different kind of signature sequences were found within the cloned sequences. Majority of our sequences on placing in phylogenic tree showed a distant relationship with known rumen acetogens. However, 30% of the sequences were grouped with known rumen acetogens. Around 1/5th of total sequences were grouped with Panda *(Ailuropoda melanoleuca)* homoacetogens, where the presence of acetogens is recently established. Volatile fatty acid analysis from post-weaning samples revealed no significant change in acetate, propionate, butyrate and A: P ration between the two developmental stages of 180 and 365 days (Fig. 3).

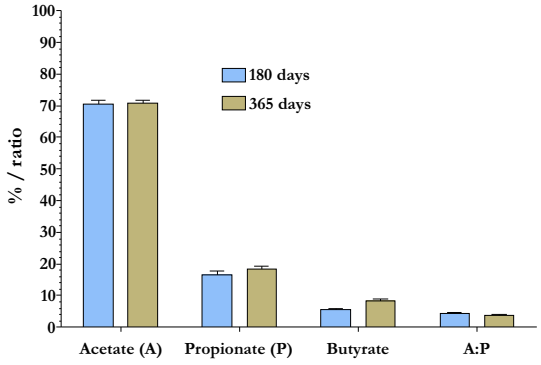


Figure 3. VFA production in two post-weaning stages.

The presence of acetogens was demonstrated in Indian sheep from 10 days of age onwards.

Development of 16S rDNA rumen specific microbes database

M Bagath, AP Kolte, UB Angadi and M Grover

The 16S rRNA gene sequence information have 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. With the recent advances in molecular research and information technology, the 16s rRNA sequence data are available in diversified format and in various public databases. The 16s rRNA data is a quite large and dynamic data. Therefore, there is a need to develop 16s rRNA database for rumen specific microbes for wide and comparative analysis of microbes within and between species. Currently, there is no such rumen specific database available with web tools for analysis of 16s rRNA sequences.

The project aims to create a collection of rumen microbes' sequence -16 s rRNA/DNA from the available public database, to standardise and pre-process the data, and develop database. Further, the web tools for searching and analyzing sequences/microbes will be developed and integration of the web tools with the database as reference web solution for rumen metagenomic analyses will be done. The scope of specific the database in the domain rumen microbes is to assist for understanding of the diversity of ruminal microbes. This database will provide a valuable means of web solution among microbiologists, who are working on rumen microbes. This will include similarity search of unknown sequence in the database and reviewing nearby similarly sequence with published details, analysis tools and visual presentation for easy understanding.

More than 4.7 lakhs sequences were collected from various databases such as NCBI, MG-RAST, RDP etc.

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

Evaluation of copper chaperone for SOD (CCS) as a sensitive biomarker of copper deficiency in sheep

DT Pal and J Ghosh

Accurate and timely diagnosis of micronutrient deficiency could help in improving the animal productive and reproductive performances. The existing indicators available for detection of copper deficiency are not sensitive enough to detect the marginal deficiencies. Therefore there is a need to establish a suitable sensitive biomarker. The genes affected by dietary copper availability may constitute potential biomarkers of copper status. The copper chaperones – a new family of intracellular copper binding proteins that insert copper into the active sites of specific partners (copper-dependent enzymes), escort the metal to appropriate targets and directly transfer the copper ion. Copper chaperone for SOD (CCS) is one such molecule which inserts Cu into the SOD1 (superoxide dismutase-1) protein, a copper dependant enzyme and it could be used as sensitive biomarker of Cu status in animals. The study aimed to evaluate the CCS as a sensitive molecular marker of Cu deficiency in sheep.

The sequence of CCS, SOD1 genes and internal control gene β-actin was determined in sheep liver sample. As our targeted biological sample was blood, the presence of transcript of the targeted genes (CCS and SOD1) in cellular fractions of peripheral blood sample was also confirmed.

A feeding trial in sheep fed Cu-adequate and Cu-deficient diets was conducted. Once the animals showed symptoms of Cu deficiency, blood samples were collected, RNA was isolated and analysed for the expression profiles of the target genes. Additionally, three sheep from each group were slaughtered and liver samples were collected, RNA was isolated and analysed for the expression of targeted genes in Cu-adequate and Cu-deficient sheep.

The dynamics of Cu-deficiency on the onset of Cu-deficiency was determined in blood samples collected at 15d intervals from both the groups. The total RNA was isolated from whole blood and RBC fractions. The relative quantification of SOD1 and CCS gene was done by qPCR ($2^{-\Delta\Delta CT}$ method). It was found that copper deficiency significantly up-regulated (3.9 fold) the CCS, but not the SOD1 gene expressions in whole blood (Table 2). The expression of SOD1 and CCS genes in erythrocyte fraction was not affected by the dietary treatment and it was statistically similar between the sheep fed either copper adequate or copper deficient diets (Table 2). The results of the study indicated the CCS gene expression in whole blood was affected by the dietary levels of copper and its expression could be used to assess the copper deficiency in animals.

In contrast, when the expression of CCS gene was studied in large population, the abundance of CCS transcript in peripheral blood cells was found very low with the existing assay system. Hence, further study is needed to modify the assay system so that sensitive CCS expression can be captured in peripheral blood samples before using it as molecular marker for detecting copper deficiency in massive animal population.

Sequence of CCS gene from sheep liver was determined and submitted to GENBANK; Presence of CCS and SOD1 transcripts in whole blood and RBC fractions was confirmed; Expression of CCS gene was significantly up-regulated, but SOD1 gene expression remained unaffected in Cu-deficient sheep.

Table 2. Expression profile of CCS and SOD1 genes in whole blood and erythrocytes.

Gene	Cu-Adequate (Cu+) ΔCT		Cu Deficient (Cu-) ΔCT		Fold change	*P-value*
	Mean	SE	Mean	SE		
Whole blood						
CCS	17.6 (n=11)	0.6	15.6 (n=13)	0.5	3.9	0.02
SOD1	3.7 (n=18)	0.3	3.5 (n=18)	0.2	1.1	0.79
Erythrocytes						
CCS	17.6 (n=11)	0.7	15.6 (n=13)	0.3	0.4	0.11
SOD1	4.0 (n=18)	0.1	4.1 (n=18)	0.2	0.9	0.58

CCS: Copper chaperone for superoxide dismutase; SOD1: Superoxide dismutase 1.

Mineral solubility in rumen from mixed rations and its effect on rumen fermentation and animal performance

KS Prasad and DT Pal

In practical feeding, animals are offered mixed ingredients consisting of roughage and concentrate feeds. The concept of total mixed ration (TMR) is picking up and it enhances the digestibility of feed in rumen, but the studies on rumen release of minerals in total mixed rations are scanty. The project aimed to study the release of minerals from total mixed rations of different roughage to concentrate ratios and their performance in ruminants' production.

In sacco trail was conducted with 70:30, 60:40, 50:50 roughage-concentrate ratios, paddy straw and concentrate as such and in 60:40 (rough:conc) with 1.5% and 2.0% rumen microbe-specific mineral mixture was incubated for 72h except concentrate mixture (24h). The study showed an increased release of minerals in rumen except Zn in microbe-specific mineral supplementation group after 72h in 60:40 roughage concentrate diet (Fig. 4). A feeding trial was conducted on sheep for finding out the effect of supplementing microbe-specific mineral mixture at two levels (1 and 1.5%). Twenty four sheep were divided into four groups of six animals each. Dietary treatments were: i) Group-I, basal diet without minerals (Control); ii) Group II, basal diet supplement with normal 1% mineral mixture; iii) Group III, basal diet supplement with microbe-specific mineral mixture (1%); iv) Group IV, basal diet supplement with microbe-specific mineral mixture (1.5%). Sheep were fed basal diet consisting of paddy straw and concentrate mixture (CP: 21% and TDN 68%) at 60:40 ratio. Feed residue was noted down every day and body weight of the animals was taken fortnightly and rumen liquor was collected from each group for the analysis of TCA ppt N_2, TVFA, ammonia nitrogen and total nitrogen.

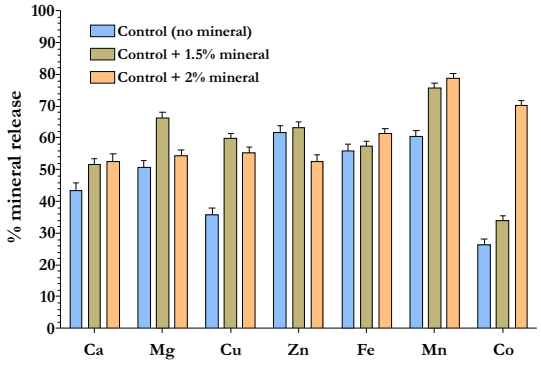


Figure 4. Effect of rumen microbe-specific minerals supplementation on mineral release in the rumen (*In Sacco*).

The sheep supplemented with mineral mixture showed the highest body weight gain than unsupplemented control group. The body weight gain of sheep fed control diet was 43.47g/d and it was 73.73 and 73.20g/d in sheep fed 1.5% conventional mineral mixture and 1% microbe-specific mineral mixture, respectively. The feed intake was almost similar in all groups.

Increased release of minerals in rumen (*in sacco*) except Zn in microbe-specific mineral mixture supplemented group after 72h in 60:40 roughage concentrate diet was observed; Body weight gain of 30g/d in sheep supplemented with 1% microbe-specific mineral mixture over control was observed.

Precision feeding for enhancing milk production performance in cattle

M Chandrasekharaiah, NM Soren, SBN Rao and IJ Reddy

Strategic nutrient supplements to provide limiting nutrients were formulated for precise feeding of nutrients in order to enhance milk production performance in cattle and reduce the cost. Five strategic nutrient supplements were prepared with locally available bypass rich protein/amino acid supplements, bypass fat and area specific mineral mixture. On-farm lactation trial of 4-month duration was conducted in Anagalpura and Menesi villages to study the effect of feeding strategic nutrient supplements on the milk production performance of crossbred cows. Thirty six crossbred cows were divided into six comparable groups (control and experimental) of six each based on lactation number, milk yield and stage of lactation. 1st group served as control as practiced by the farmers, 2, 3, 4, 5 and 6th groups were fed with supplements 1, 2, 3, 4 and 5 respectively. These limiting nutrient supplements were used 200g/day/animal in experimental groups by replacing the double quantity of protein supplement (GNC) in the control group. The on-farm lactation trial showed the trend of 16.3, 13.8, 8.7, 9.5 and 2.4% increase in FCM yield in animals fed with limiting nutrient supplements 1, 2, 3, 4 and 5 respectively as compared to control (Fig. 5). The feed cost was reduced to the tune of Rs 2.00 to 7.00 and the overall income of the farmers was increased by Rs 15.00 to 50.00 /animal /day by feeding these strategic nutrient supplements (Fig. 6). Plasma levels of growth hormone (GH), prolactin (PRL), insulin like growth factor 1 (IGF1), insulin, triiodothyronine (T3), thyroxine hormone (T4), estradiol-17β (E_2β) and progesterone (P_4) were estimated by radioimmuno assay. Plasma hormonal profiles of GH, IGF1, E_2β, P_4, T3 and T4 were positively correlated with (r=0.69, p<0.05) milk yield in cows fed with strategic nutrient supplements

compared to control. However, PRL and insulin concentration was marginally higher in control. The study indicated that feeding of strategic nutrient supplements increased FCM yield, reduced the feed cost in cows producing 8-10 lit of milk/day on local mixed grass based diets and increased the overall income of the farmers.

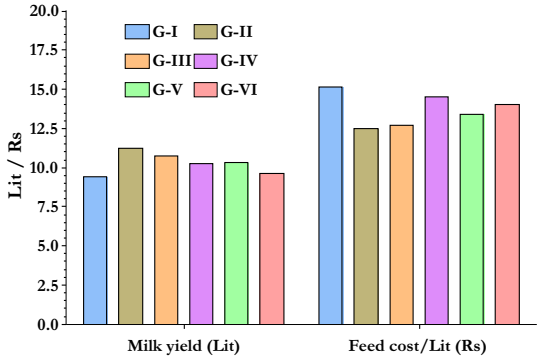


Figure 5. Effect of incorporation of strategic nutrient supplement on milk yield and feed cost/lit of milk.

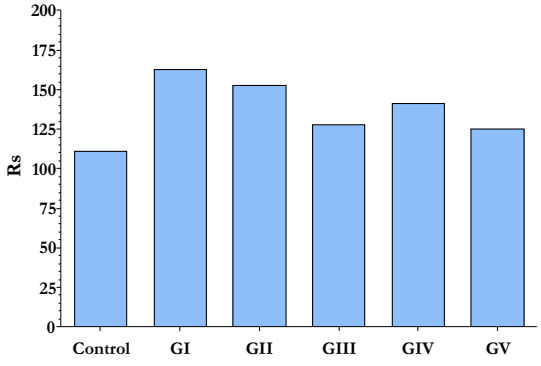


Figure 6. Effect of incorporation of strategic nutrient supplement on overall income (Rs) of the farmers.

Precision feeding with strategic nutrient supplements increased FCM yield from 2 to 16%, reduced feed cost by Rs 2 to 7 and increased overall income of the farmers by Rs 15 to 50 /animal /day in medium yielding cows fed on grass based diets.

Effect of dietary natural antioxidants on production performance and meat quality of linseed oil fed chicken

A Mech, CG David, RU Suganthi and V Sejian

Study was conducted to evaluate the effect of dietary natural antioxidants on the production performance and meat quality of linseed oil fed chicken. Three groups of day old broiler chicks were supplemented with 2% vegetable oil (G-I), 2% linseed oil (G-II) and 2% linseed oil along with 0.5% commercial antioxidant (G-III). Simultaneously other three groups of chicks were fed with 2% linseed oil and 0.5% natural antioxidants; curry leaf (G-IV), ginger (G-V) and turmeric powder (G-VI) for a period of six weeks. There were five replications for each feeding treatment with six birds in each replication (n=180).

Significantly higher total body weight gain (g) was observed in linseed oil+natural antioxidant supplemented groups (2502.6±38.2 to 2536.6±67.8) as compared to G-II (2251.5±25.5) and G-III (2262.4±34.1). The FCR was significantly higher in linseed oil and ginger supplemented (G-V) group. Evaluation of meat shelf life by determining the concentration of 2-TBA reactive substances (malondialdehyde (MDA) in ng/g wet tissue) at 4, 7 and 14 days of storage at 4°C revealed enhancement in meat shelf life in curry leaf, turmeric and commercial antioxidant supplemented groups (Fig. 7). The total antioxidant activity in blood was estimated highest in curry leaf supplemented group (8.3±0.3µmol/ml). The analysis of meat fatty acid profile showed that linseed oil feeding improved the omega-3 content in meat by at least 2.5 fold (Table 3).

In conclusion, the dietary supplementation of natural antioxidants like curry leaf and turmeric powder in combination with linseed oil to broiler chicks for a duration of 6-week produced omega-3 enriched meat with better keeping quality. Consequently, an additional production cost of Rs.18 to 32/kg meat was calculated. Considering 70% higher market value for such product, a cost benefit ratio of 1.91 to 2.64 was calculated for the natural antioxidant supplemented groups as compared to only linseed oil (1.79) or commercial antioxidant (1.66) supplemented group.

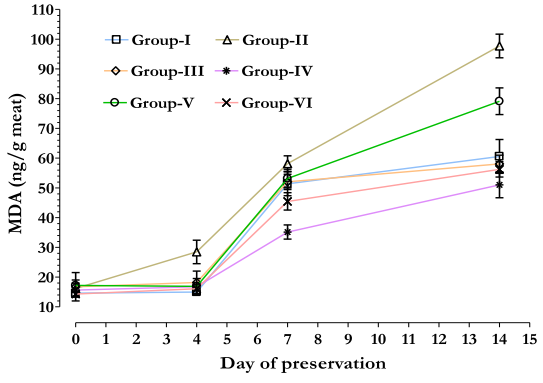


Figure 7. Rate of lipid oxidation measured as concentration of MDA in chicken meat stored at 4°C for 14 days.

Significantly higher total body weight gain was observed in linseed oil+natural antioxidant supplemented groups; Linseed oil feeding improved the omega-3 content of meat by at least 2.5 fold; Curry leaf, turmeric and commercial antioxidant supplementations enhanced meat shelf life.

Table 3. Fatty acid composition of chicken meat in different treatment groups.

Treatment Groups	Fatty acid (mg/100 g wet tissue)					
	SFA	MUFA	PUFA **	Omega -6 FA	Omega -3 FA**	omega -6: Omega3
Control (vegetable oil)	629 ±71	679±132	1021 ±129 [a]	822±83	182 ±73 [a]	4.5
Linseed oil	607 ±71	631±132	1334 ±129 [a]	829±83	504 ±73 [c]	1.6
linseed oil+Redox	569 ±71	645±132	1185 ±129 [a]	718±83	466±73 [b]	1.5
Linseed oil+Curry leaf	718 ±78	547±144	1874 ±142 [b]	999±91	614 ±80 [c]	1.6
Linseed oil+Ginger	696 ±78	667±144	1230 ±142 [a]	778±91	471±80 [b]	1.6
Linseed oil+Turmeric	438 ±71	453±132	1265 ±129 [a]	838±83	426±73 [b]	2.0

*** indicates p<0.01.*

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

A total of 150 feed and fodder samples were analysed for boron content. The level of boron ranged from 3 to 69ppm in green fodder, legumes and tree leaves had highest boron content and grains/milling by-products had lowest boron content. An experiment in rats using purified diets supplemented with graded level of boron for 90-day period was conducted to assess the effect on bone calcification, gene expression, immune response and anti-oxidant status. Results showed a positive trend in calmodulin gene expression in liver and immune status with higher level of boron supplementation in rats. The gut absorption and serum level of calcium was more in rats supplemented with boron. No change was observed in feed intake and growth response in rats due to boron supplementation.

Boron level was higher in legume green fodders and tree leaves; Positive trend in calcium utilisation, calmodulin gene expression in liver and immune status was observed with boron supplementation in rats.

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

D Rajendran, SBN Rao, NKS Gowda and S Selvaraju

Nanoparticles (NPs) exhibit unique properties in terms of chemical, physical, photo-electrochemical and electronic properties when compared to their respective bulk materials. Nanoparticles have higher surface area with decreasing size of the particles. Hence its bioavailability might be higher and possibly level of requirement for particular purpose may be low. Studies describing the effect of nanoparticles on growth and reproduction are scanty.

Zinc plays a major role in growth and development. Zinc has a recognized action on the metalloenzymes since it participates in their structure, catalytic and regulatory actions. It is the only trace mineral with a critical structural or enzymatic function in at least one enzyme in each of the six enzyme classes. Zinc plays an essential role in male reproduction. It is necessary for gonadal differentiation, testicular growth, formation and maturation of spermatozoa, testicular steroidogenesis and fertilization.

ZnO NPs were synthesized by chemical pyrolysis methods at laboratory. An attempt was made to produce ZnO NPs with varying temperature and time duration using microwave muffle furnace. The ZnO nanoparticles were produced by adding 2.2g of zinc acetate ($Zn(CH_3COO)_2.2H_2O$) and 2g of sodium bicarbonate ($NaHCO_3$) and heated in the muffle furnace for different durations and temperatures to assess the effect of temperature and time on particle size of ZnO (Fig. 8). The samples were kept in duplicate for 3 and 4h in the muffle furnace at 300°C and 400°C and were analysed for their particle size and zeta potential. The result revealed that the average particle size (nm) of ZnO at 300°C was 264.1 and 72.5 and at 400°C were 165.8 and 132.3 for 3h and 4h of pyrolysis respectively. The average zeta potential (mV) was found to be -34.8, -0.15, -16.7 and -7.3 mV, respectively for the above said conditions (Fig. 9). It was observed that smaller particles were obtained as the duration was increased keeping the temperature constant. The desired sized NPs were obtained at 300°C for 4h of pyrolysis.

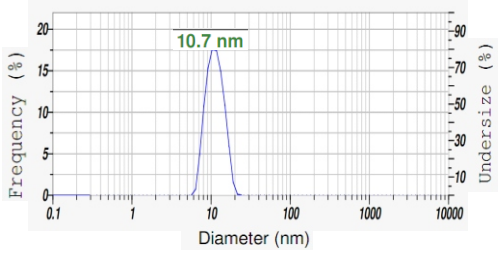


Figure 8. Average particle size (nm) of Zinc Oxide nano particles synthesized by chemical pyrolysis

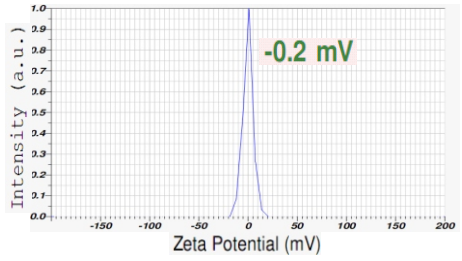


Figure 9. Average zeta potential (mv) of Zinc Oxide nano particles synthesized by chemical pyrolysis

Chemical pyrolysis method can be used for preparation of ZnO nano particles; Desired sized nano particles could be obtained at 300°C for 4h of pyrolysis by micro wave programmed muffle furnace.

Effect of dietary selenium on selenoprotein genes in lambs

RU Suganthi, PK Malik and P Krishnamoorthy

Selenoproteins regulate redox reactions and other important cellular reactions in a variety of tissues that includes cell growth, apoptosis and regulation of transcription. Supplementation of selenium has been reported to improve immune response in cows, meat quality in pigs and reproductive function in sheep. Therefore, it is critical to understand the interaction between selenium intake and molecular events at the genetic and cellular level. The project aimed to investigate the influence of dietary selenium on the expression of selenoprotein genes in lambs and reveal the interaction between selenoprotein gene expression and the antioxidant and immune status and meat quality in lambs.

Methods for assessing the expression of various selenoprotein genes in white blood cells (WBC) and whole blood of sheep were optimized. Blood samples were collected and WBC were separated from the whole blood. RNA was isolated from WBCs and agarose gel electrophoresis of PCR products indicated the expression of four isoforms of GPx in sheep WBC namely, Glutathione peroxidase 1 (GPx1), Glutathione peroxidase 3 (GPx3), Glutathione peroxidase 4 (GPx4), Glutathione peroxidase 7 (GPx7) with amplicon sizes of 525, 843, 454 and 672 bp respectively (Fig. 10). Further, the mRNAs of Glutathione peroxidases (GPx4), thioredoxin reductases (TXNRD1, TXRD2), iodothyronine deiodinases (DIO1, DIO2), selenoprotein W, 15kDA selenoprotein like protein and Toll like receptor 4 were found to be expressed in the whole blood of sheep.

Glutathione peroxidase-1, Glutathione peroxidase-3, Glutathione peroxidase-4, Glutathione peroxidase-7 mRNAs were detected in sheep WBC.

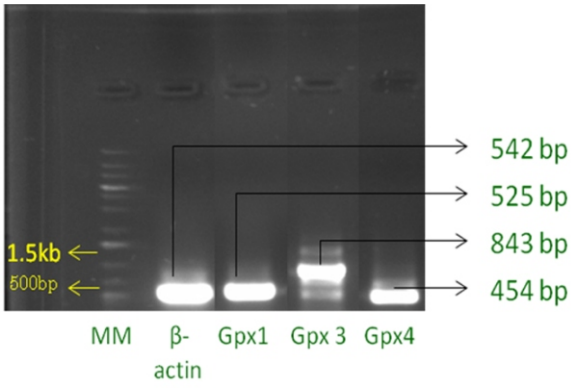


Figure 10. Expression of selenoprotein mRNAs in sheep WBCs

Development of fertility diagnostic test(s)/ kit in assessing bull fertility

S Selvaraju, JP Ravindra, D Rajendran and A Arangasamy

Low fertility, especially sub-optimal fertility is a concern in artificial insemination programme especially in buffalo. Detecting high fertility bulls is the key to increase livestock production and thus profitability. Cows bred to high-fertile bulls bear more calves earlier, resulting in more calf and milk marketed per cow. Since the bulls with identical semen quality vary in actual fertility, the study unraveling the basic physiological and nutritional principles/factors influencing fertility could optimize reproductive efficiency in dairy animals. Hence the study was designed with the objective to suggest suitable fertility diagnostic test(s)/kit for assessing bull fertility.

The semen samples were collected from 18 bulls undergoing progeny testing. The conception rates were obtained from approximately 1000 inseminations from each bull. The functional parameters such as progressive forward motility, rapid progressive forward motility, plasmalemma integrity, functional membrane integrity, acrosomal integrity and mitochondrial membrane potential were estimated. The results revealed that the membrane integrity parameters did not differ significantly between buffalo bulls and serum Zn level in blood was correlated with conception rate.

The seminal plasma protein profile was carried out in bulls differing in conception rate to relate the seminal proteins quantity with sperm attributes and conception rate. The results revealed that the sperm membrane proteins such as CCDC19, FH, CLU, ACR, PGK2, SPACA1, ELSPBP1, TIMP2 and NPC2 and the seminal plasma proteins such as ATP6V1H, BPIFB1, RCN2, OGN, TIFP2 and TIMP2 expression pattern might influence the sperm function and fertility in bulls.

In the sperm membrane, fumarate hydratase (FH) 55-56 kDa, clusterin (CLU) 50-51 kDa, acrosin (ACR) 45-46 kDa, phosphoglycerate kinase 2 (PGK2) 43-44kDa, sperm acrosome membrane associated protein 1 (SPACA1) 31-32 kDa and in seminal plasma, V-type proton ATPase subunit H (ATP6V1H) 54-55kDa, BPI fold-containing family B member 1 isoform X3 (BPIFB1) 42-43 kDa, Reticulocalbin-2 isoform X2 (RCN2) 36-37kDa, Mimecan precursor (OGN) 33-34kDa, were positively correlated to sperm attributes. In sperm membrane, SPACA1 and in seminal plasma, ATP6V1H were positively correlated to conception rate. In sperm membrane 31-32kDa protein, sperm membrane–egg interacting protein quantity was found to have significant positive association with bull fertility. The study revealed that in the sperm membrane protein high ratio of CLU/ACR protein quantity could be used for selecting high fertile bulls leaving apart low/sub-fertile bulls. The number of acidic (pI; 3.0-5.6, 37% distribution in spermatozoa) and basic (pI; 7.9-10.0, 27% distribution in spermatozoa) protein spots varied between high and low fertile groups. The negative association of PDC-109 expression level with pregnancy rate suggested that this protein expression levels negatively influenced bull fertility.

Attempt was made for the first time to demonstrate the presence of TIP39 in buffalo seminal plasma. TIP39 positively influences the sperm functional parameters and may be used to assess bull fertility along with standard semen analysis.

The HOS-G test developed at ICAR-NIANP was found to have correlation with conception rate. A synthetic media for sperm penetration was developed as an alternative to cervical mucus. The sperm penetration distance was found to have significant correlation with fertility. These tests can be recommended to screen semen samples.

The suggested tests for prediction of bull fertility might be the combination of: 1) kinetic parameters, 2) Sperm penetration test and 3) HOS-G test. The sperm proteins, clustrin and acrosin ratio might determine the fertility status of semen and can be used for selecting high fertile bulls leaving apart low/sub-fertile bulls.

Alternative to cervical mucus, synthetic media for sperm penetration was developed; The sperm penetration distance was found to have a significant correlation with fertility; One of the differentially expressed 11kDa protein in buffalo seminal plasma, TIP39, could influence buffalo bull sperm function.

Suppression of prolactin gene expression during the ex ova period in birds

IJ Reddy, A Mishra and S Mondal

Prolactin (PRL) is a peptide hormone synthesized and secreted by lactotroph cells in anterior pituitary of the hen. In aves, up-regulation of the chicken prolactin (chPRL) has been implicated in decreased secretion of gonadotrophic and gonadal hormones, ovarian regression, delayed ovulation, gonadal involution and broodiness/incubation behavior with concomitant decrease in egg lay.

In this study, we evaluated the knock down of PRL in hen anterior pituicytes cultured *in vitro* by small-interfering RNA (siRNA) targeting of chPRL, as well as the efficacy of this treatment on PRL gene expression, prolactin receptor (PRLR), insulin like growth factor I (IGF-I), growth hormone (GH), pituitary content of estrogen (E2β),estrogen receptor (ERα), follicle stimulating hormone (FSHβ), protein content of PRL and GH. The chPRL-targeted siRNA were chemically synthesized and constructed based on chicken and turkey PRL mRNA. Expression of chPRL was analyzed by polymerase chain reaction with designed primers. Culture media were assayed for IGF-I, GH, FSH, E2β content utilizing the radio immune assay Kit. Results indicated a significant ($P<0.05$) reduction (60%) in PRL mRNA following chPRLsiRNA transfection into primary cultured anterior pituicytes. Protein content of PRL was clearly suppressed in siRNA transfected cells without showing any effects on protein content of GH. Levels of IGF1, GH, FSH, E2β and PRLR mRNA were not significantly different between treated and non-treated cells. This analysis was carried out to study the effects of chPRL siRNA on the expression profiles of pituitary IGF1, GH and PRLR which are similar to the biological actions of PRL. Treatment of cultured cells with varying doses of vasoactive intestinal peptide (VIP) stimulated PRL levels in the control group. Treatment of cultured cells with varying doses of E2 stimulated PRL with decreased FSHβ levels in the control group. The results suggest that the siRNA designed in this study were effective in suppressing PRL gene expression specifically and that the levels of IGF1, GH, FSH, E2β and PRLR mRNA expression were not associated with PRL in anterior pituitary.

An understanding of the mechanisms which control incubation behaviour may provide the basis for the development of therapeutic techniques for the prevention and/or for selection against the trait.

RNA interference (RNAi) targeting chPRL specifically suppressed PRL without showing any effects on pituitary IGF1, GH, FSH, E2β and PRLR; The result indicates that siRNA against chPRL can be a potential therapeutic tool to control broodiness in domestic hens.

Amelioration of oxidative stress to prevent apoptosis of early sheep embryos

A Mishra, PSP Gupta and V Sejian

The study was designed to find out the antiapoptotic and anti-oxidant effect of Carnitine during *in vitro* sheep embryo development and to find out the Carnitine mediated alteration in the expression pattern of anti-apoptotic and anti-oxidant genes in different stages of developing embryos. Further the effect of Ergothioneine on growth and development of oocytes and embryos *in vitro* was also assessed. Anti-apoptotic effect of carnitine was observed by culturing 2-4 cell embryos with Actinomycin D (0.005µg/ml) an apoptotic agent with or without Carnitine. Anti-oxidant effect of Carnitine was observed by culturing oocytes and embryos with hydrogen peroxide (20µmol) with or without Carnitine. The results indicated that Carnitine (10mM) was able to neutralize the apoptotic effect of Actinomycin D supplementation in culture medium. Carnitine (10mM) was also able to neutralize the oxidant effect of hydrogen peroxide (20µmol) used both in maturation medium and culture medium that was evident from the subsequent embryo development. Hydrogen peroxide induced oxidative damage was assessed by commet assay. DNA damage was observed in the oocytes cultured with hydrogen peroxide without Carnitine, but when oocytes were cultured in hydrogen peroxide with Carnitine, DNA was found intact (Fig. 11).

Preliminary study on the expression pattern of genes related to anti-oxidant (GPX) and apoptosis (Bcl2) in different stages (immature oocyte to blastocyst stage) of developing embryos (Fig. 12) revealed that GPX was expressed in all stages of developing embryos and Carnitine up-regulated the expression of GPX. Bcl2 expression was observed in all stages of developing embryos with least expression in morula stage followed by abrupt up-regulation in blastocyst stage. Carnitine was found to up-regulate the expression of Bcl2.

Ergotheoneine (10mM) in maturation medium did not influence the maturation rate, but resulted in better cleavage (64% vs 42%) followed by morula (74% vs 56%) and blastocyst (33% vs 14%) rates as compared to control. It is concluded that Ergotheoneine in maturation medium might be reducing oxidative stress by decreasing ROS and increasing GSH to make suitable micromilieu for better cleavage followed by morula and blastocyst development.

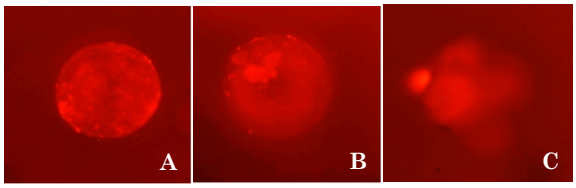


Figure 11. Degree of DNA damage by hydrogen peroxide in the cultured oocyte; A: intact oocyte with intact DNA (not exposed to Carnitine or H_2O_2), B: intact oocyte with intact DNA (exposed to Carnitine+H_2O_2), C: damaged oocyte with fragmented DNA (exposed to H_2O_2)

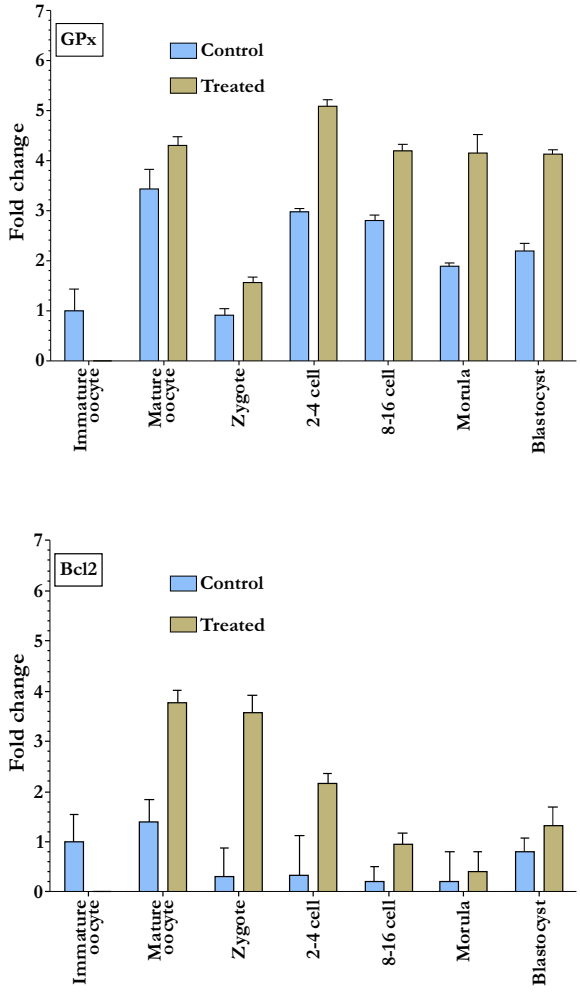


Figure 12. Expression pattern of genes related to antioxidant (GPx) and apoptosis (Bcl2) in different development stages of oocytes and embryos

Carnitine acted as an antioxidant and antiapoptotic compound that resulted in better cleavage followed by morula and blastocyst development; Carnitine supplementation up-regulated the expression of GPX and Bcl2 genes; Ergotheoneine supplementation resulted in better cleavage followed by morula and blastocyst development.

Elucidating the endocrine and molecular mechanisms of feed restriction impacting somatotrophic axis in goats

V Sejian, A Mech, NM Soren, CG David, SBN Rao and M Bagath

Genetic and environmental factors are largely translated in hormonal signals affecting growth processes involving a complex sequence of interactions between different hormones. The somatotrophic (growth hormone, GH; growth hormone receptor, GHR; insulin-like growth factor, IGF-I) axis is considered to be one of the most important among them, because of their broad range of effects and central role in growth. As growth related modulations in goat is also mediated through the biological mechanisms on the functioning of the somatotrophic axis, it is important to understand the underlying molecular and endocrine mechanisms by which growth is regulated. This in turn might pave the way for identification of suitable biomarkers from somatotrophic axis for feed restriction in goats. Hence the project has been formulated to investigate the effects of dietary restriction on haematological parameters, blood biochemical responses, growth, stress and metabolic hormone profiles in goat and to assess the expression changes in growth related genes in hepatic tissues. The study is expected to reveal if goat with less tolerant of feed restriction experience a greater degree of stress.

The results revealed that the nutritional stress model followed in the study could induce the stress effect and this was evident from the significant changes in the body weight, respiration rate, rectal temperature, plasma thyroxin, tri-iodo-thyronine and cortisol which are considered as nutritional stress markers for goat. Plasma growth hormone (GH), Insulin like growth factor-1 (IGF-1) and leptin concentration may be considered as ideal blood biochemical markers while GH and growth hormone receptor (GHR) genes may act as ideal molecular markers for assessing the impact of nutritional stress on the somatotrophic axis in goats (Table 4). The significantly lower level of leptin mRNA expression in 60% of *ad libitum* fed groups showed that these ewes were under extreme nutritional stress (Fig. 13). The investigation has revealed two heat shock proteins 70 (HSP70) and 90 (HSP90) to be the ideal molecular markers for feed deficit during summer season in goats (Fig. 13). Histopathological studies indicated degenerative changes in liver and kidney. Atrophic changes were also observed in the muscles while adrenal gland section of stress group showed high functionality (Fig. 14)

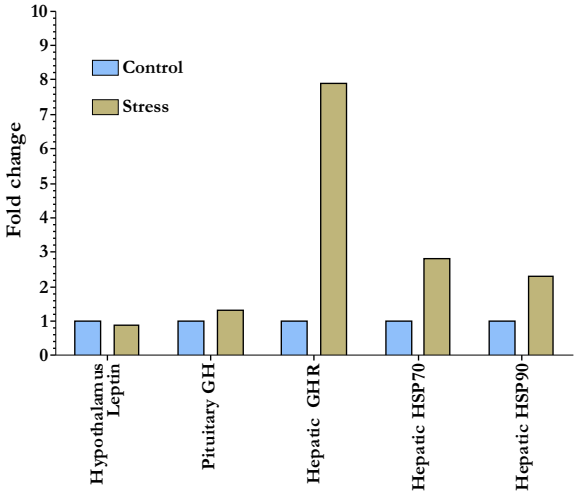


Figure 13. Relative growth related mRNA transcript expression in somatotrophic axis in goat.

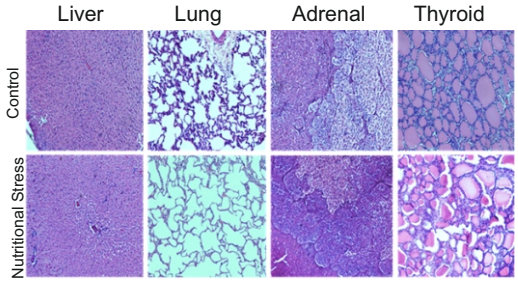


Figure 14. Histopathological observations between control and nutritional stress groups

Table 4. Plasma growth and stress related endocrine parameters in control and nutritional stress groups.

Groups	Leptin (ng/ml) *	GH (ng/ml) **	IGF-1 (ng/ml) **	T3 (ng/ml) **	T4 (µg/dl) **	Cortisol (µg/dl) *
GI	2.9±0.3 ^{a}	25.5 ±2.1 ^{c}	415. 2±51.9 ^{a}	2.1±0.1 ^{a}	11. 7±0.5 ^{a}	0.29 ±0.02 ^{a}
GII	2.1±0.3 ^{ab}	31.4 ±2.4 ^{b}	369.4±26.1 ^{a}	1.9±0.0 ^{a}	10.8 ±0.6 ^{a}	0.26 ±0.04 ^{ab}
GIII	1. 3±0.4 ^{b}	34.8 ±2.6 ^{a}	307. 2±27. 4 ^{b}	1.4 ±0.0 ^{b}	9. 1±0.5 ^{b}	0.23 ±0.03 ^{b}

*GH: growth hormone; IGF-1: insulin-like growth factor-1; T_3: Triiodothyronine; T_4: Thyronine; GI: control (ad libitum); GII: 20% less than ad libitum; GIII: 40% less than ad libitum; * p<0.05, ** p<0.01, Means with similar superscripts do not differ significantly.*

Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken

IJ Reddy, A Mishra, S Mondal and RK Gorti

In broiler chicken, it is reported that light illumination plays a role in proliferation and subsequent differentiation of adult myoblasts and influences myofiber growth. Further, broiler bird lighting programs in concert with the proper genetics, environment, nutrition, stimulation of hypothalamo-hypophyseal-gonadal axis and management create the best in welfare for the birds and performance. The overall objective of the study is to enhance skeletal muscle growth of broiler chicken by modulating the biological activity of myostatin, a novel negative growth factor in skeletal muscles. The specific objective of the study is to determine the effect of different spectrum of light to control myostatin on skeletal muscle growth during *in ovo* and *ex ovo* period of the offspring using the chicken as a model animal.

Day old broiler chicks (n=99) were randomly divided into three groups as control, group I and group II with each group consisting of 33 chicks and exposed to three different spectrum of wavelengths of light using LED lights. Chicks of control group were exposed to white (450nm), of group I were exposed to red (675nm) and of group II were exposed to green (575nm) spectrum of wave lengths of light for a period of 45d. Birds in all the groups were fed as per standard specifications. Blood samples were collected from all the birds at regular intervals without causing any stress. Body weight gain (kg), feed intake (kg) and feed-to-gain ratio (FCR) were recorded at regular intervals in all the groups. The effect of different wavelengths of light on broiler production parameters are described in Table 5. Desired live body weight was advanced by two weeks in birds exposed to green spectrum of light compared to the other two groups. Birds exposed to green spectrum of wavelength significantly improved the live body weight by 16% at 35th day and 22% at 45th day over controls. Conversely, no significant difference in feed intake and FCR was observed between control and treated groups. Endocrine and gene expression studies and carcass traits among the three groups are being done. In conclusion, broilers photo-stimulated with green spectrum of light shown to be effective in early weight gain, feed intake, feed utilization and quality of broiler meat.

Green spectrum of LED lighting in broilers advanced the early body weight gain by two weeks compared to control birds reared under incandescent bulbs; It was highly cost effective, could reduce the feed costs and also saved highly valuable feed ingredients; Broilers raised under green LED consumed same amount of feed and had 16% increase in body weight at 35th day and 22% increase at 45th day.

Modulation of granulosa cell estradiol synthesis using copper and selenium

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

Estrus synchronization is an effective tool for augmenting the reproductive efficiency in livestock and the success rate of the same can be improved with the modification of the existing protocols. To modify the protocols, we need to have complete understanding of the steroidogenic pathways in livestock, which still need to be studied further. Micronutrients like copper, selenium and Vitamin D were reportedly influenced the estradiol synthesis. Understanding the same may give clues to use newer inputs to modify the existing estrous synchronization protocols for augmenting the reproductive efficiency, with the following objectives: a) To study the effect of copper on granulosa cell estradiol synthesis and associated genes; b) To study the effect of selenium on granulosa cell estradiol synthesis and associated genes; c)To study the synergetic/antagonistic

Table 5.Effect of different wavelengths of light on broiler production parameters.

Parameter	Control 450nm (White LED)	Group I 675nm (Red LED)	Group II 575nm (Green LED)	Difference in weight gain
BWG[1] (7-14d, g)	360±11	386±41	450±12	90±19
BWG (0-35d, kg)	2.1±0.5^{a}	2.2±0.4^{a}	2.5±0.3^{b}	0.34±0.02^{b} (16%)
BWG (0-45d, kg)	2.5±0.1^{a}	2.5±0.7^{a}	3.0±0.5^{b}	0.56±0.01^{b} (22%)
FI (7-14d, g)	365±40	347±90	345±30	-
FI (0-35d, kg)	3.8±0.1	3.8±0.1	3.7±0.0	-
FI (0-45d, kg)	4.2±0.0	4.2±0.1	4.2±0.0	-
F:G1 (7-14d)	1.1	0.9	0.7	-
F:G (0-35d)	1.8^{a}	1.7^{a}	1.5^{b}	-
F:G (0-45d)	1.7^{a}	1.7^{a}	1.4^{b}	-

^{a,b}values within a row differ significantly (p<0.05); [1]BWG=body weight gain (kg), FI=feed intake (kg), F:G=feed-to-gain ratio (kg:kg).

effect of copper and selenium on granulosa cell estradiol synthesis and associated genes.

Effect of different doses (0.1, 0.5 and 1.0 mM) of copper on *in vitro* cell survival and estradiol synthesis of ovarian granulosa cells in goats was studied. Copper did not show any effect on ovarian granulosa cell survival rate (Fig. 15). The effect of different doses of selenium (10, 100 and 1000 ng/ml) on *in vitro* cell survival and estradiol synthesis of ovarian granulosa cells in goats was studied. Selenium significantly improved the cell survival rate when it was incorporated (10ng/ml) in cell culture medium (Fig. 15). A supplementary study on the effect of replacing foetal bovine serum with steer serum for arresting the trypsin digestion to harvest cells from the culture plates was also conducted.

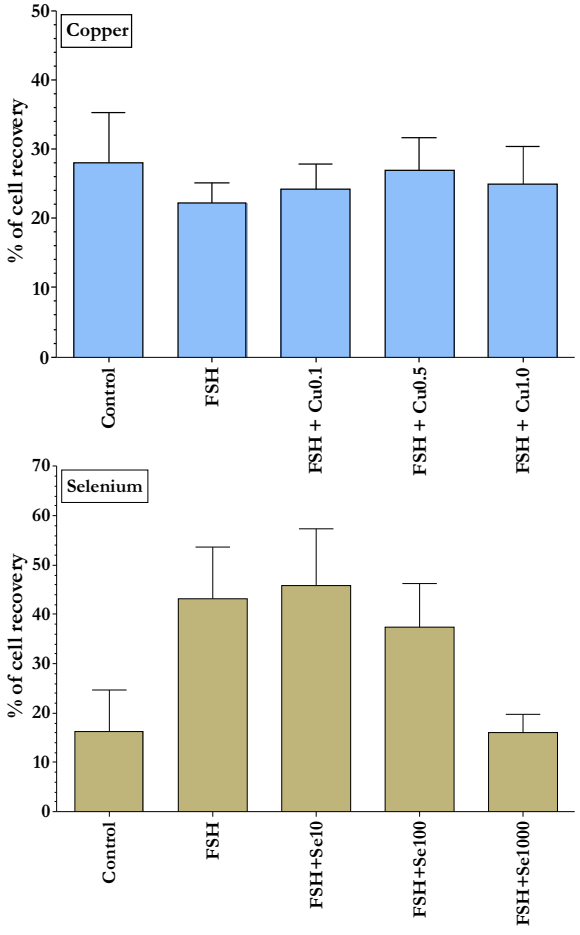


Figure 15. Effect of different doses of copper and selenium on ovarian granulosa cell survival

Studies on the effect of different doses of copper and selenium on in vitro cell survival rate indicated that selenium supplementation in culture media (10ng/ml) significantly improved the survival rate of ovarian granulosa cells in goats.

Application of statistical and bio-informatics tool for analysis and modelling of genes related to production and reproduction in livestock

RK Gorti and KP Suresh

The objectives of the project were to develop database of gene sequences available in the public domain on improving the productive and reproductive efficiency (Selected traits), to develop suitable statistical procedure to predict the class of genes associated with productive and reproductive traits and to develop statistical procedure to predict the pattern of gene sequence in predicted class.

Sequences related to bovine growth hormone were obtained from public database and analyzed using hidden markov models. Apart from GH, GH receptor, PROP paired-like homeobox1, insulin like growth factor 1 and insulin sequences were also analyzed (Table 6).

Table 6. Hidden Markov Models analysis of gene sequences related to livestock production.

Sequences (*Bos Taurus*)	Size (BP)	Chr. No.
Growth hormone	7048	19
Growth hormone receptor	5206	20
PROP paired - like homeobox 1	4018	1
Insulin- like growth factor 1	75857	5
Insulin	1161	29

Hidden Markov Models were found to be good tools in searching the various data bases for finding out appropriate gene sequences of importance to animal production.

Programme 4

Feed Informatics, Feed Quality and Safety and Value Addition

Refinement of livestock feed resources and development of dynamic database

S Jash, D Rajendran, SBN Rao, S Anandan and UB Angadi

Refinement of feed resource database was updated for all districts across various agro-ecological regions of the country. The recent 18th livestock census was integrated for assessing feed requirement and balances. Feed database was improved with geographical representation of various states with district information.

This database is being strengthened with recent data on biomass potential of grazing lands and taking into account newer feed resources and also alternate uses of feeds. "Feed Base" – a feed resource data base was prepared in visual basic platform and created in compact disc format (Fig. 16 and 17). It was strengthened with tabular, map and graphical format with intelligent interactive version.

The Feed Base updated with 18th Livestock census data and biomass potential of grazing land and newer alternate feed resources were included.

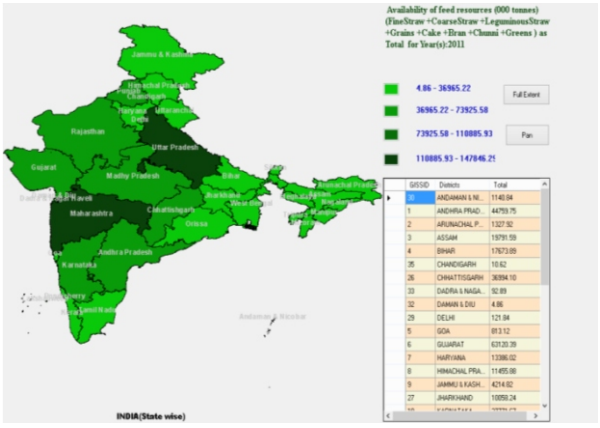


Figure 16. Cartographic representation of feed resources availability-2011 ('000 tonnes)

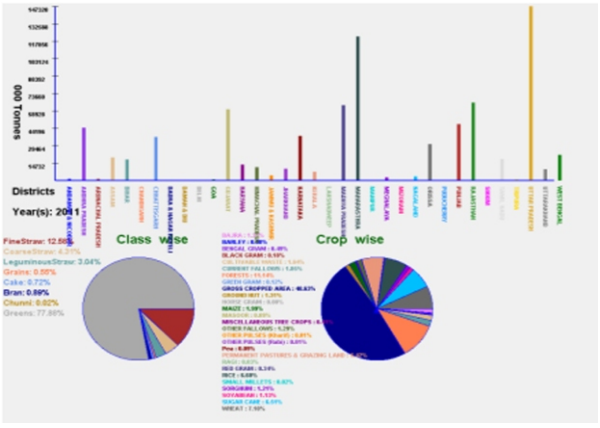


Figure 17. Snap-shot statistical signatures of the Feed Resource Database-12

Programme 5

Climate Change Impact on Livestock

Expression of HSP70 mRNA in visceral organs of broiler chickens under acute heat stress

KS Roy, SC Roy and J Ghosh

The objectives of the study were to detect the localization of HSP70 in visceral organs of broiler birds and to find out the relationship between the expression of HSP70 mRNA and protein. The *in-vivo* trials were completed as scheduled with or without supplementation of electrolyte and vitamin C. Detection of HSP70 through Western Blot techniques in 5h heat exposed samples was completed (Fig. 18). Quantification of HSP70 in 5h and 10h heat exposed samples of heart, liver and skeletal muscle was carried out (Fig. 19 and 20). It was observed that among all viscera, brain and skeletal muscle samples of 5h heat exposure showed 1.5 and 2.5 fold up-regulation respectively. Histo-pathological study illustrated (Fig. 21) that the heat stressed broiler spleen had starry sky appearance with loss of lymphocytes in the lymphoid follicles with reticulum cell hyperplasia as compared to control. Parameters of bird's micro-environment were recorded and THI was calculated. Data of feed consumption and body weight gain were also recorded.

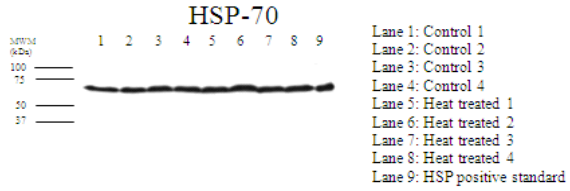


Figure 18. Detection of HSP70 in 5h heat exposed brolier birds through western blot.

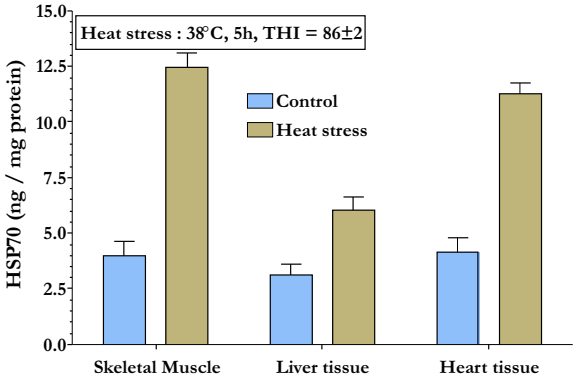


Figure 19. Mean level of HSP70 in total homogenate of skeletal muscle, liver and heart tissue of 5h heat treated (38°C, THI=86±2) and control (26°C, THI=69±2) broiler birds.

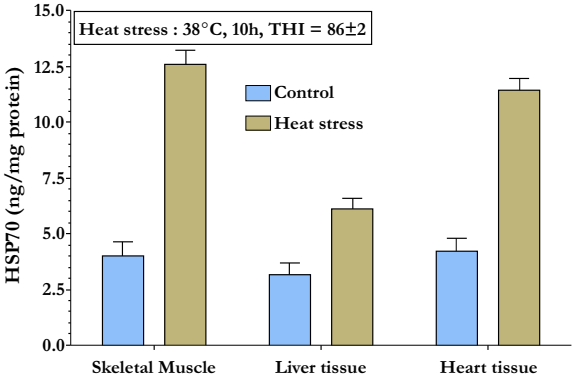


Figure 20. Mean level of HSP70 in total homogenate of skeletal muscle, liver and heart tissue of 10h heat treated (38°C, THI=86±2) and control (26°C, THI=69±2) broiler birds.

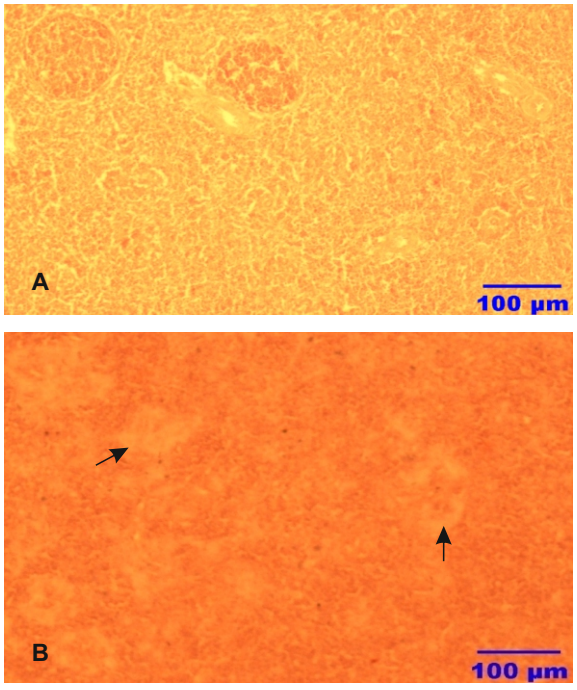


Figure 21. Histo-pathological changes in heat stressed brolier spleen in comparison to control birds. A: Control spleen showing normal architecture of lymphoid follicles and uniform distribution of lymphocytes. B: Heat stressed broiler spleen showing starry sky appearance with loss of lymphocytes in the lymphoid follicles with reticulum cell hyperplasia

HSP70 level was found higher in visceral organs of 5h and 10h heat exposed birds. Histo-pathology data indicated immuno-suppression of birds under heat stress. The result suggests that the kinetics of HSP70 is tissue and time dependent under hyper-thermic state.

Programme 6

Technology Translation to Connect Discovery with Application

Sustainability of dairy farming as a means of livelihood

Letha Devi G

Dairying is a major occupation in rural India providing substantial employment and income. It is realized that even though the economic growth has been achieved in most cases, standard of living has remained for the most part unchanged, signaling that something is off beam with this narrow definition of development. A better quality of life not only calls for higher income, it encompasses better education, higher standards of health and nutrition, less poverty, a cleaner environment, more equality of opportunity and greater individual freedom. The idea of a sustainable livelihood approach emphasizes the broader goals of rural poverty reduction, empowerment of people and the promotion of increased security of livelihoods of rural people. There is a need to understand livelihood security of the livestock farmer and its different dimensions to find out the lacunae and suggesting suitable measures for improving their quality of life. The project aimed to assess the socio-cultural, economic and ecological sustainability of dairy farming and level of livelihood security of dairy farmers in Karnataka and identification of extension needs in achieving livelihood security of dairy farmers.

Sustainability index was developed integrating components such as socio-cultural, economic and ecological sustainability, and equity for quantifying the sustainability of dairy farming for various groups of respondents. Sustainability index was found higher for groups with milk yield above 10 lit and for medium holders maintaining 3 to 6 animals (Fig. 22). There was a significant difference in sustainability and livelihood security between three groups (<5lit, 5 to 10lit and >10lit milk yield) in Managondanahalli, Narasapur and Huthur villages, and sustainability and livelihood security between the groups (medium holders maintaining 3 to 6 animals and small holders maintaining up to 3 animals) in all the four villages. There was a positive correlation between the sustainability and livelihood security. The extension/ training needs as well as constraints in dairy farming were identified and prioritized using Garrett's ranking techniques. A few trainings were organized in village on ration balancing for animals in association with KVKs. Ration balancing tools were popularized through KVKs, NGOs and Milk Cooperatives (Fig. 23).

Figure 22. Medium holding unit of dairy in rural Bengaluru.

Figure 23. Training organised at Sadenahalli on ration balancing.

Sustainability was higher for groups with milk yield above 10 litre and medium and large holders were more sustainable in dairy farming, as compared to small holders. There was positive correlation between sustainability and livelihood security Dairy farming is still considered as a sustainable and provides regular income even in times of adversity.

Externally Funded Research Projects

All India Coordinated Research Project

Nutritional and physiological interventions for enhancing reproductive performance in animals

Project Coordinator: Raghavendra Bhatta

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

To assess the extent of infertility and the interventions required for improving fertility, the data need to be collected from the different parts of the country. The in-/sub-fertility is a serious concern in animals and hence fertility assessment methods/tests may help to restore fertility in these animals. Since some of the high fertile buffalo bulls are found to be poor freezer and one of the reasons could be poor cryo-survival. Some of the methods like, nutritional supplementation, synchronization treatments, etc might help to improve fertility under Indian conditions. Hence AICRP 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 with the following objectives.

1. Documentation of current status/extent of infertility and various causes of reproductive failures in both native and crossbred cattle and buffaloes including development of markers.

2. Ameliorative measures for overcoming infertility conditions (puberty, postpartum fertility and early embryonic mortality) in cattle, buffaloes, sheep and camel through studies on nutritional interventions and follicular dynamics.

3. To validate ameliorative measures/technologies and to develop package of practices for application under field conditions for overcoming reproductive problems in cattle and buffaloes.

The data were collected from the Karepura village, Doddaballapura and the extent of infertility was assessed in this village. Frequent visits have been carried out to the village to assess the extent of infertility. Out of 157 animals surveyed, 31% of the animals were found to have reproductive problems (Fig. 1). Among the reproductive problem animals, 46% were anoestrus and 44% were repeat breeding animals. The infertility due to delayed puberty was observed to be 8% in this village. Blood samples were collected from these reproductive problem animals and these animals were selected for the synchronization treatment and area specific mineral mixture supplementation.

The seminal protein profiling was carried out from bulls of varying functional parameters, abnormalities and freezing capacity in order to develop semen fertility prediction marker. The seminal plasma was collected and analyzed for the protein profile based on 2D analysis. The protein profiles varied (r=0.4) among bulls. The results revealed varied expression pattern in extreme pH range (Fig. 2).

In order to select a molecule for protecting sperm from cryoinjury, IGF-I and sericin were selected. The addition of IGF-I (50, 100 and 150 ng/ml of the extender, n=6) to the buffalo semen extender could protect ($p<0.05$) sperm motility upto 4h. The IGF-I significantly ($p<0.05$) reduced the damage to sperm functional membrane integrity, acrosomal integrity and mitochondrial membrane potential in post thaw semen suggested that IGF-I could protect spermatozoa during cryoinjury. The initial trials on the effect of sericin on ram semen revealed that sericin protects ($p<0.05$) sperm motility and plasmalemma integrity when cooled at 4C for 2h suggesting that this molecules may protect sperm from cryo-injury. Further studies are being carried out in large number of samples to confirm the preliminary observations.

The infertile animals have been selected (n=30) to assess the effect of synchronization treatment and area specific mineral mixture for improving fertility. The mineral mixture supplementation has been carried out in reproductive problem animals (n=10) and the effect is being observed. Another group of animals (n=7) has been subjected to synchronization treatment. The blood samples have been collected in these animals at 10d interval for confirmation of cyclicity.

The ram lambs are being fed TMR as per ICAR recommendation (control) and also supplemented with graded levels of boron to assess the effect of boron on male fertility. At the end of experimental period (180 days of feeding), the semen samples and testicular tissues will be collected for assessing the effect of boron on male fertility.

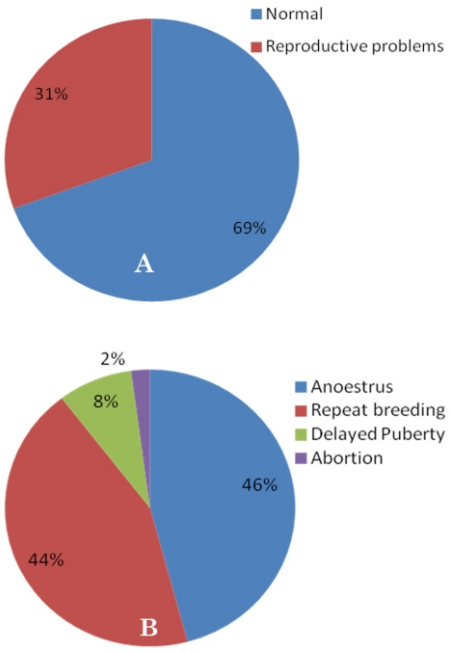


Figure 1. Extent of reproductive problems (A) and the major reproductive problems (B) in the Karepura Village, Doddaballapura (TK), Karnataka.

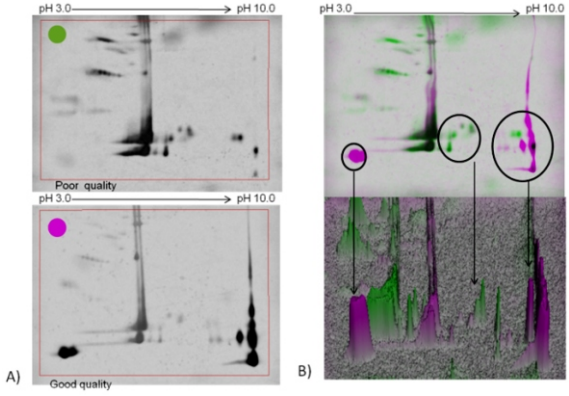


Figure 2. A: Seminal plasma protein profiling was carried out using 2D analysis for predicting buffalo bull fertility. B: The differentially expressed proteins (circled) were analysed and could be a potential proteins to assess semen quality.

In the village, 31% of the animals were found to have reproductive problems. The addition of IGF-I in the extender could protect buffalo spermatozoa from cryodamage.

Integrated farming systems (IFS)

NKS Gowda, KS Prasad, K Giridhar, D Rajendran and Letha Devi G

Under this scheme, livestock related information and technical inputs have been provided to farmers in the adopted villages under IFS. One technical workshop for farmers on balanced feeding was conducted at KVK, Chintamani and three field demonstrations on azolla cultivation, silage making and urea ammoniation of straw were conducted. Ration balancing was popularised through the use of "Feed Chart" tool.

Outreach Project

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

Project Coordinator: Raghavendra Bhatta

PK Malik and AP Kolte

Livestock sector is one of the major sources of anthropogenic methane emission and contributes around 105Tg methane annually worldwide. Of the total methane emission from livestock, over 90% comes from the enteric fermentation only. Various International agencies quoted the Indian livestock contribution to enteric methane emission is in the range of 9-12Tg per year, but the exact emission considering the different feeding regimens and actual data is not known till now. Methanogenesis is thought to be a necessary, but wasteful process for the animal system and its complete inhibition is neither recommended nor possible. Therefore, efforts are continuously being on to mitigate the enteric methane emission to a desirable and significant extent for saving the biological energy for animal use and keeping these facts in view, the project was undertaken. The objectives of the project are to generate a database for the enteric methane emission from Indian livestock and to develop mitigation strategies for enteric methane emission.

To assess the effect of tanniniferous tree leaves on methane emission amelioration an experiment was conducted in 20 adult male sheep (Mandya, 3½yr, BW 32.0±0.2kg) divided into four groups of five animals each. The animals were fed as per the ICAR standard and requirement was fulfilled through a basal diet comprising of roughage and concentrate in the ratio of 70:30. Complete feed block were made by mixing of ragi straw (roughage) and concentrate. Concentrate mixture across the treatments had fixed amount of maize grain, mineral mix and salt, while level of wheat bran and soybean meal in concentrate mixture varied among the test groups depending on the composition of three tanniniferous leaves in treatments T_1, T_2 and T_3 respectively. A SF6 trial (Fig. 3) was conducted and five successful gas collections from each animal maintained under different groups were taken and analysed for CH_4 and Sf_6.

Table 1. Effect of tanniniferous leaves on enteric methane emission in sheep.

Attributes	Treatment				SEM	Significance
	Control	T_1	T_2	T_3		
BW (kg)	31.4	32.2	32.2	32.4	0.2	NS
DMI (g/d)	739.7^{a}	764.5^{b}	745.9^{ac}	774.3^{bd}	2.5	0.00
CH_4 (g/d)	24.6^{b}	19.5^{a}	19.5^{a}	18.1^{a}	0.5	0.00
CH_4 (g/100g DDM)	4.0^{b}	3.1^{a}	3.2^{a}	2.9^{a}	0.1	0.00
TVFA (mM/dl)	10.1^{a}	12.0^{b}	11.6^{ab}	10.5^{ab}	0.3	0.00

Results indicated that there was no adverse impact of the inclusion of tanniniferous leaves on dry matter intake in adult sheep. Data revealed higher dry matter intake in treatment T_1 and T_3 than that recorded in control group. Similarly, the dry matter digestibility was also not affected by the inclusion of tanniniferous leaves in complete feed block. However, the digestible dry matter availability in group T_1 and T_3 was significantly higher than that in group T_2.

The data presented in Table 1 revealed significant reduction in enteric methane emission from adult sheep fed on tanniniferous leaves based complete feed block. The enteric methane emission was highest in control group and lowest in group T_3, while the emission for rest of the two groups was in between. The variation in enteric methane emission among the test groups was not significant.

Figure 3. Sheep fitted with SF_6 assembly.

The inclusion of tanniniferous leaves in complete feed block led to 20-26% reduction in enteric methane emission as compared to control group. The highest reduction was achieved in group T_3 (26.2%) followed by T_2 (20.7%) and T_1 (20.5%). The enteric methane emission ranged between 2.9-4.0g/100g DDM; highest emission from the sheep maintained on control diet and lowest from those kept under group T_2. The results revealed that the addition of selected tanniferous leaves in ragi straw and concentrate based complete feed block led to a significant reduction in enteric methane emission without affecting the dry matter intake and digestibility adversely.

The tanniniferous leaves in complete feed block did not affect the DM intake and digestibility, but resulted in 20-26% reduction in enteric methane emission from sheep fed straw based diet.

Monitoring of drug residues and environmental pollutants

KS Prasad, SBN Rao and DT Pal

The samples were collected from 12 villages; Old Hebbal, Koddur and Gundugurthi in Chithapur taluk; Malkhed village in Sedam taluk; Kodaganji, Golabe, Narona, Lord Chincholi, Malkunda villages in Aland taluk; Farthabad village in Gulbarga taluk and Kellur and Govahara villages in Jewargi taluk (Fig. 4). A total of 106 samples (19 Green fodder; 47 dry fodder; 19 grains, chunnis and oil cakes; 16 milk samples; 5 water samples) were collected and analysed for pesticide residues and heavy metals. Green fodder includes maize, sugarcane tops and grasses. Under dry fodder category, paddy straw, gram husk, jowar stover were the major sources. Concentrate samples available were oilcakes, chunnis, grain mixtures and bran. Milk samples were collected from peri-urban dairy farms or directly from milk cooperatives.

Chloropyriphos was found to be present in all the collected samples including milk. However, no clear trend was evident across the taluks in the extent of

contamination. No residue of γ-BHC was present in any feedstuff analyzed. However, it could be detected in 9 milk samples (2 samples from Chittapur taluk, 4 samples from Aland taluk, 1 sample from Gulbarga taluk and 2 samples from Jewargi taluk). In Aland taluk, 3 fodder samples recorded isomers of DDT, whereas one sample shown the presence of endosulphan residues indicating minimum usage of these pesticides. Three milk samples showed the presence of either β- endosulphan (2) or DDT residue (1). One sample had shown the presence of DDT isomer. All the paddy straw samples (4) collected in Jevargi and one jowar straw had shown the presence of DDT residues. All samples of feeds and fodders contained arsenic. Arsenic content in green fodders was found almost similar in all taluks except in Gulbarga taluk. Lead and cadmium content in feeds and fodders samples collected from different areas of Gulbarga district was found to be negligible except in few samples.

Figure 4. The study area in different taluks of Gulbarga district.

Network Project

Veterinary type culture – Rumen Microbes

A Thulasi, D Rajendran and M Bagath

The symbiotic relationship of microbes and the ruminant animal gives great benefits. These microorganisms, predominantly bacteria, protozoa and anaerobic fungi, depend on the ruminant to provide the physiological conditions necessary for their existence. In turn, these microorganisms are essential for digestion and fermentation of the large amount of fibrous feeds that the ruminant consumes, but otherwise cannot utilize. By providing a suitable habitat for these microorganisms, the ruminant is able to utilize the end products of microbial fermentation and microbial cells to meet its own nutritional needs for energy and protein. With this background it was decided to establish repository of rumen microbes with an aim to isolate and purify anaerobic gut microbes, study the micro-morphological and biochemical characteristics, establish molecular identity and submit the purified and characterized cultures to the repository.

Several classes of rumen associated microbes were isolated and characterized that included sulphate-reducing *Desulphovibrio* from the rumen contents of cross bred cattle, fumarate-reducing *Selenomonas ruminantium*, *Fibrobacter succinogenes*, *E. coli*, *Veillonella parvulum from the rumen digesta of cross bred steers.* Nitrate-reducing strain of *S. ruminantium* and *V. Parvula were isolated and characterized from cattle.* Anaerobic, non-motile, asaccharolytic bacilli belonging to *Pyramidobacter piscolens* that produce acetic and isovaleric acids was isolated from the rumen of sheep. The bacterium isolated showed 99% sequence homology with the *Pyramidobacter piscolens* inhabiting the oral cavity of humans. A total of 30 bacterial isolates were accessioned during the reported period and currently the repository contains 270 accessions.

Whole Metagenome analysis was carried out for rumen samples obtained from cross bred steers fed maintenance level ration comprising of paddy straw, para grass and concentrate (PSC) or paddy straw and concentrate (SC) on Illumina platform. A total of 1.9, 1.81 and 1.7GB data were generated for Metagenome samples obtained from PSC, SC and RS respectively. MG-RAST analysis showed that PSC Metagenome exhibited an α-diversity equalling 425.325 species, SC Metagenome showed an α-diversity of 188.912 species and RS Metagenome had an α- diversity of 378.520 species. In crossbred steers fed PSC, it was found that 96.9% sequences belonged to Bacteria and 1.7% sequences belonged to Archaea. At the phylum level it was found that 38.3% sequences belonged to Bacteroidetes, 31.7% sequences belonged to Firmicutes and 9.3% belonged to Proteobacteria. The genus level distribution demonstrated that 15.6% sequences were affiliated to Prevotella, 12.7% sequences to Bacteroides and 5.8% sequences to Clostridium. The KEGG abundance analysis showed that large amount of the enzymes helicase, polymerase and synthase were present. In cross bred steers fed SC, 98.3% sequences obtained belonged to Bacteria and 0.8% sequences to Archaea. At the phylum level it was found that 57.5% sequences were affiliated to Bacteroidetes, 27.2% sequences to Firmicutes and 5.2% to Proteobacteria. Genus level distribution of sequences showed that 31.7% sequences belonged to Prevotella, 15.7% sequences to Bacteroides and 5.4% sequences to

Clostridium. The KEGG abundance analysis showed the abundance of enzymes such as polymerase, helicase, β-glucosidase. In cross bred steers fed RS, 97.5% sequences obtained belonged to Bacteria and 1.3% sequences to Archaea. At the phylum level it was found that 46.3% sequences were affiliated to Bacteroidetes, 31.2% sequences to Firmicutes and 8.5% to Proteobacteria. Genus level distribution of sequences showed that 18.5% sequences belonged to Prevotella, 18.4% sequences to Bacteroides and 6% sequences to Clostridium. The KEGG abundance analysis showed the abundance of enzymes such helicase, DNA polymerase, RNA polymerase etc.

Non fibrolytic *Selenomonas ruminantium* were found to have fumarate and nitrate reducing characteristics; One strain of Selenomonas exhibited weak xylanolytic and CMCase activity; *Selenomonas ruminantium* from the same source and from various animal source could be diverse phylogenetically and functionally; Analysis of PSC with SC and RS Metagenome showed that Proteobacteria, Streptophyta, Eukaryota and Chordata phylum were present in high abundance; The enzymes of hydrolase family were identified in all the 3 samples, which included phosphoribosyl-AMP, cyclohydrolase, hydroxyacylglutathione hydrolase, hippurate hydrolase, cobalt-precorrin 5A hydrolase etc.

NASF Project

Enhancing development competence of oocytes for better *in vitro* fertilizing ability

A Dhali, AP Kolte, SC Roy and V Sejian

The project aims to elucidate the functional biology of sheep oocytes by synergizing oocyte's cellular, transcriptional and molecular interaction networks to design strategies for providing artificial competence to oocytes for enhancing their fertilizing ability and post-fertilization development.

The expression of 13 development related genes was assessed in the metabolically active and silent GV stage sheep oocytes and linked with their *in vitro* development. The results indicate that GDF9 was crucial for maturation and was probably even critical at late stage of maturation of metabolically active oocytes. Moreover, the poor development competence of the metabolically active oocytes was attributed to disrupted activin/BMP signalling at least partly.

To optimize the sheep IVP protocol several attempts were made. It was found that IVM of sheep oocytes aspirated from 2-6 mm follicles was satisfactory. Sperm preparation through percoll gradient gave better fertilization efficiency compared to that prepared through swim up method. Storage of extended ram semen at 4°C for 4h yielded better cleavage rate than fresh or stored semen (overnight or more). Several in vitro culture systems were tried for in vitro culturing of sheep zygote until balstocyst stage (Fig. 5) and the SOF system was found to be satisfactory.

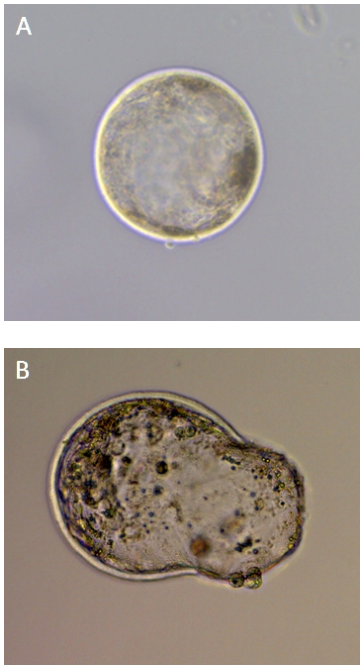


Figure 5. Expanded (A) and hatching (B) sheep blastocysts derived *in vitro* in SOF system.

To assess the entire biological functional process, whole transcriptome analysis was performed from the 10 metabolically active and silent sheep oocytes using 2×150 PE chemistry on Illumina platform. A total number of 7789 and 8316 genes were detected in the active and silent oocytes respectively. A total number of 914 and 945 genes were found significantly ($\geqslant$ 2 fold, $p<0.05$) up regulated and down regulated, respectively in the metabolically active oocytes compared to their silent counterpart (Fig. 6). It was observed that in active oocytes, the over represented genes were mostly traced under the cellular molecules' localization and transport (Fig. 7). In contrast, in silent oocytes, over represented genes were mostly traced under the cellular component organization and assembly, cell cycle, various metabolic and biosynthetic processes and transcription and translation related activities (Fig. 8).

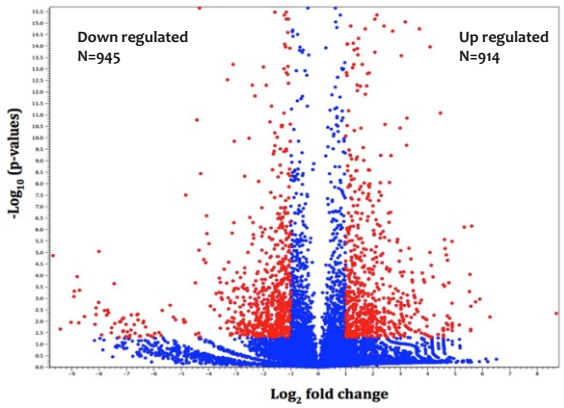


Figure 6. Volcano plot for differentially expressed genes in metabolically silent compared to active sheep oocytes. Red dot represents differentially expressed (p<0.05) genes.

The results indicate that the silent oocytes are more advanced towards the completion of the development process for undergoing fertilization and further development. The total number of KEGG pathways detected was 333 and 327, respectively in silent and active oocytes. It was observed that the representation of 23 pathways was not different between the groups. However, 13 pathways were found more prominent in active oocytes and 242 pathways were found more prominent in silent oocytes.

Figure 7. Functional grouping of significantly up regulated genes in metabolically active oocytes into GO terms biological processes.

Figure 8. Functional grouping of significantly up regulated genes in metabolically silent ocytes into GO terms biological processes.

GDF9 was found crucial for the maturation of metabolically active sheep oocytes; Poor development competence of the metabolically active sheep oocytes was attributed to disrupted activin/BMP signalling; Whole transcriptome analysis revealed 914 and 945 significantly up regulated and down regulated genes respectively, in the metabolically active compared to silent sheep oocytes.

Deciphering the mechanism of aberrant maternal recognition of pregnancy (MRP) events in sheep and buffalo under heat and nutritional stress

S Mondal, IJ Reddy, PSP Gupta and S Nandi

Early embryonic mortality and aberrant maternal recognition of pregnancy (MRP) causes substantial loss in productive longevity of animals incurring into heavy economic losses. Heat and nutritional stresses have been found to alter the maternal uterine micro-environment and thereby affect MRP by modulating ovarian, luteal and endometrial function. The study aimed to assess the effect of heat and nutritional stresses on ovarian function and *in vivo* production of embryos and fertility, delineating the modulation of peripheral endocrine profiles as well as characterization and expressional profiling of genes involved in MRP during heat and nutritional stress and study the effect of heat and nutritional stress on gene expression changes during late transition stages of embryonic development.

To study the impact of Fibroblast Growth Factor 2 (FGF2) and Insulin Transferrin Selenium (ITS) on *in vitro* maturation, fertilization and embryo development in sheep oocytes having more than 5 layers of unexpanded cumulus cells and granular homogenous ooplasm were cultured in 8 different culture systems: (*i*) TCM-199; (*ii*) TCM-199+10ng/ml FGF2; (*iii*) TCM-199+20ng/ml FGF2; (*iv*) TCM-199+30ng/ml FGF2; (v) TCM-199+10ng/ml ITS; (*vi*) TCM-199+20ng/ml ITS; (vii) TCM-199+30ng/ml ITS and (viii) TCM-199+20ng/ml ITS+20ng/ml FGF2 in a CO_2 incubator at 38.5°C for 24h. All oocyte culture media were supplemented with 10% FBS, FSH (10µg/ml) and gentamicin (50µg/ml). The matured oocytes were inseminated with 1 to 2 million spermatozoa/ml in Brackett and Oliphant medium and the cleavage rate was checked after 42-48h post insemination and further cultured for 6-7d. Maturation and cleavage rates were found significantly higher in oocytes cultured in TCM-199+10% FBS+FSH (10µg/ml) supplemented with both 20ng/ml ITS and 20ng/ml FGF2 as compared to control (Table 2).

Table 2. Effect of supplementation of different doses of ITS, FGF2 and combination of ITS+FGF2 in maturation and embryo culture medium on maturation rate, cleavage rate and embryo development of sheep oocytes.

Treatments	Oocyte Cultured (no)	Maturation Rate (%)	Cleavage rate (%)	Embryo development (%)	
				Morula	Blastocyst
TCM -199+FBS (10%)+ FSH (10µg/ml) : Control	158	63.8±0.5 [a]	58.3±4.1 [a]	18.8±4.9 [a]	11.5±1.5 [a]
Control+ITS (10ng/ml)	133	75.7±1. 9 [b]	53.2±4.5 [a]	17.7±3. 5[a]	11.1±0.0 [a]
Control+ITS (20ng/ml)	124	81.3±1.6 [b]	69.7±4.9 [ae]	20.0±4.9 [a]	19.1±3.2 [a]
Control+ITS (30ng/ml)	131	76.9±1.4 [b]	57. 9±4.5 [a]	23.6±1. 4[a]	12.2±2.2 [a]
Control+FGF2 (10ng/ml)	165	65.7±1. 3[a]	46.3±2.1 [acf]	17. 9±2.0 [a]	0.00 [abcfh]
Control+FGF2 (20ng/ml)	139	77.3±2. 9[b]	53. 2±2.3 [a]	20. 8±3.1 [a]	14.0±2.4 [ad]
Control+FGF2 (30ng/ml)	167	64.7±1.1 [a]	51.1±2.7 [adf]	17. 5±4. 1[a]	12.4±2.0 [ag]
Control + ITS (20ng/ml) + FGF2 (20ng/ml)	155	82.4±1.8 [b]	85.2±4.6 [be]	15.9±1.9 [a]	15.1±1.8 [a]

The brilliant cresyl blue (BCB) staining evaluates the activity of glucose-6-phosphate dehydrogenase (G6PDH). The activity of this enzyme is greatest in growing oocytes, but it declines as the oocyte mature. The aim was to increase the efficiency of blastocyst production from sheep after *in vitro* maturation/fertilization (IVM/IVF) by oocyte selection before maturation. Oocytes were selected on the basis of BCB staining and exposed to 13, 26 or 39µM BCB (Fig. 9). The maturation and cleavage rate of

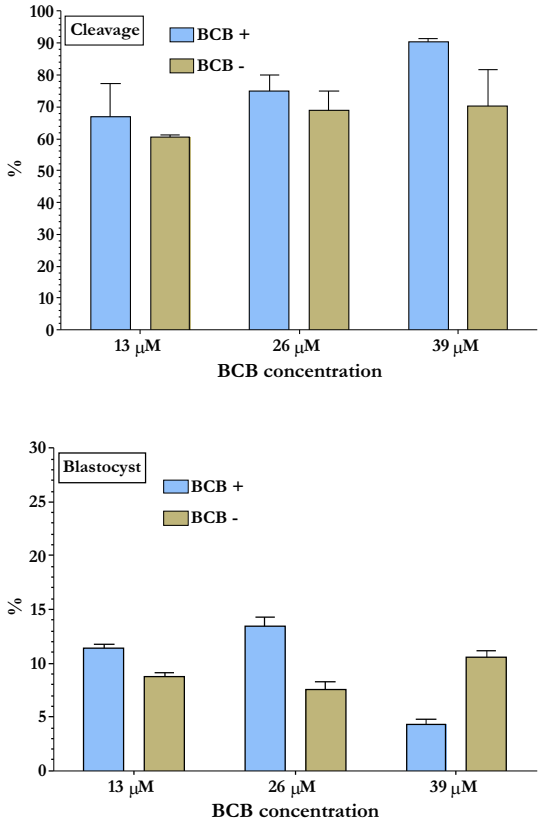


Figure 9. In vitro development of BCB screened sheep oocytes.

13, 26 and 39µM BCB+ sheep oocytes was higher than those in 13, 26, 39µM BCB- oocytes and control group. The blastocyst development rate of 26 and 39µM BCB+ oocytes was higher than those in 26 and 39µM BCB- oocytes suggesting that the staining of sheep cumulus oocyte complexes with BCB before *in vitro* maturation may be used to select developmentally competent oocytes for IVF.

The expression of COX-II, PGFS and integrin mRNA in sheep uterine endometrium increased following nutritional stress as compared to control group on Day 13 of pregnancy. However, mRNA expression of PGES and osteopontin decreased following nutritional stress as compared to control group.

Supplementation of ITS and FGF2 in maturation medium improved the maturation and cleavage rates of sheep oocytes, but the supplementations in embryo culture medium did not improve the development of sheep embryos; Nutritional stress modulated the expression of COX-II, PGES, PGFS, HSP70, iNOS, osteopontin and integrin mRNA in sheep uterine endometrium on Day 13 of pregnancy.

DBT Funded Project

Bioconversion of agricultural wastes for production of nutraceuticals to improve the gut health in animals

AK Samanta, M Sridhar and CS Prasad

Diverse nature of agricultural waste is available in large quantity throughout India and these are inexpensive and renewable in nature. Most of these wastes are left in the field or burnt. Both the activities are undesirable as it

causes damage to the environment. On the other side, theses agricultural wastes are rich in several biomolecules such as cellulose, hemicellulose, pectin etc., which could be translated into value added products like nutraceuticals. Among the nutraceuticals, prebiotic xylooligosaccharides could be prepared from agricultural waste because these are rich in xylan. The project aimed to develop the process for maximizing xylan yield from agricultural waste, to manufacture Xylooligosaccharides from extracted xylan of agricultural waste, and to elucidate the efficacy of Xylooligosaccharides against gut pathogen of animals.

Three agricultural wastes, cotton, tobacco and bajra stalks were considered for xylan extraction followed by production of nutraceuticals xylooligosaccharides. Among the three agricultural wastes, hemicellulose content was found highest in bajra stalks (27.9%±1.6), followed by tobacco stalks (16.7±0.7) and cotton stalks (14.9±0.7). Potassium hydroxide coupled with steam application enabled highest (>90% of original contents) yield of xylan from all the wastes. FTIR and TGA analysis of extracted xylan revealed absence of cellulose or lignin. The Xylan thus obtained all the three wastes was powdered and subjected to hydrolysis by commercial xylanase. The xylooligosaccharides thus produced from the xylan were quantified by estimating reducing sugars as well as HPLC analysis. In case of cotton stalks xylan, the highest concentration (7.9±0.1mg/ml) of reducing sugars was detected at a temperature of 50°C, with 50 Units of xylanase enzyme in 50 mM of citrate phosphate buffer of pH 5.0 for 8h of hydrolysis. The hydrolysis conditions such as pH 6.0, temperature 50°C, and enzyme dose 20U for 6h of incubation enabled maximum (8.8±0.1mg/ml) levels of reducing sugars from the xylan of tobacco stalks. However, in case of bajra stalks xylan, the maximum concentration of reducing sugars was found to be 10.2±0.1mg/ml at 50°C with 20U of enzyme in 50mM citrate phosphate buffer of pH 5.0 for 8h of incubation. Time of incubation and enzyme concentration had major impact on the enzyme hydrolysis of xylan. With the increasing time and enzyme concentration, the yield of reducing sugar increased. In contrast, pH of the buffer and temperature had no noticeable effect on the yield. HPLC analysis revealed the presence of xylopentose (X5), xylotetrose (X4), xylotriose (X3), xylobiose (X2) in addition to smaller quantities of xylose monomer (Fig. 10).

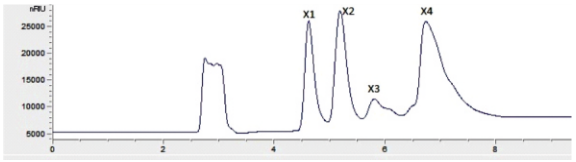


Figure 10. HPLC analysis of xylooligosaccharides generated from xylan of cotton stalks.

Xylan was extracted from the agricultural wastes such as cotton, tobacco and bajra stalks; The xylan of the agricultural wastes was subjected to hydrolysis by exogenous xylanase enzyme to yield xylooligosaccharides with different degree of polymerization such as xylopentose (X5), xylotetrose (X4), xylotriose (X3) and xylobiose (X2).

Livestock methane reduction through immunization based approach

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

Agricultural activities contribute approximately 40% of annual global methane emission of which, 20% comes from animals including domestic livestock. The major source of methane emission from livestock sector is enteric fermentation of structural carbohydrates. The need for curtailing the methane emission from ruminants is felt since long not only due to its global warming point, but also due to substantial loss of dietary energy in the form of methane. Several efforts were made previously to reduce the enteric methane emission, but most of them were failed or had limited success. The objectives of the project are: diversity analysis and quantitation of rumen archaea through molecular approaches, formulation of species specific vaccine for the active immunization of cattle and buffaloes, and evaluation of the effect of active immunization and secondary metabolites combo preparation on *in vivo* methane emission and fermentation pattern.

In vitro study was conducted to find the appropriate dosages of hydrolysable and condensed tannin for the inclusion in combo preparation of secondary metabolites to be tested both *in vitro* and finally *in vivo* in buffaloes (Fig. 11). Six graded levels of condensed (0, 0.8, 1.6, 2.4, 3.2

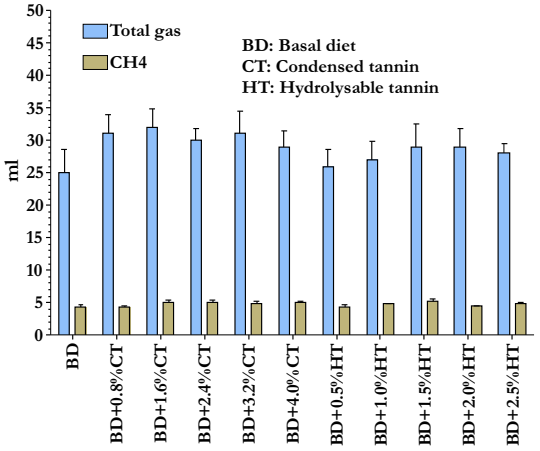


Figure 11. Effect of graded levels of condensed and hydrolysable tannins on *in vitro* methane and total gas productions.

and 4.0%) and hydrolysable tannin (0, 0.5, 1.0, 1.5, 2.0 and 2.5%) were tested for their effect on *in vitro* methane production during 24h incubation at 39°C. These levels of tannin were added over and above the basal diet comprising ragi straw and concentrate in the ratio of 70:30. It was observed that the production of total gas and methane was not affected by the tannin supplementations. The levels are now revised and being tested under *in vitro* to find the effect on methane production.

The effect of different dosages of hydrolysable and condensed tannin on *in vitro* methane production was investigated; The *in vitro* production of total gas and methane was not affected by the tannin dosages tested.

Immobilized fungal phytase production and its dietary evaluation in broiler and layer chicken

AV Elangovan, M Sridhar and J Ghosh

The objectives of the project were to screen *Aspergillus niger* and other promising species for phytase activity, immobilization and production of phytase enzyme, determination of application rate and efficacy of phytase enzymes through feeding trials on broilers and layers and economics of raising poultry birds through the use of supplemental phytase enzymes.

The fungal isolate *Aspergillus foetidis* (MTCC 11682), deposited at MTCC, Chandigargh was used for phytase production (laboratory phytase) employing immobilization technique. Small scale fermentation was carried out for a period of 6-10d with periodic replenishment of the production media. The proteins with the phytase enzyme in the spent media of fungal culture were precipitated by 85% ammonium sulphate and desalted by dialysis using 10-14kDa cut off membrane. The dialyzed precipitated protein was subjected to separation by size exclusion chromatography using Sephacryl 200 HR column in a suitable buffer. The column eluants showing maximum phytase activity were pooled, concentrated and tested for purity by separating the protein under reducing and non reducing SDS-PAGE. The separated proteins were visualized by Coomassie brilliant blue R250 staining. A single protein band in non reducing SDS-PAGE gel indicated that the enzyme preparation was free from contaminating proteins.

To assess the efficacy of laboratory produced phytase and super dosing of commercial phytase on growth performance, calcium and phosphorus utilization in broiler chicken, a feeding trial of 5-week duration was conducted. The dietary treatments consisted of one positive control Group I, without any phytase enzyme (0.45% available P during starter and 0.40% during finisher phase), five negative control diets (0.32% available P during starter and 0.28% during finisher phase) with supplemented enzymes, Group II and Group III supplemented with laboratory phytase at the rate of 500FTU and 1000FTU respectively and Group IV, Group V and Group VI supplemented with 500FTU, 2500 FTU and 5000 FTU commercial phytase, respectively in the diet to meet the phosphorus requirements. The results indicated that the partially purified fungal phytase at the rate of 1000FTU was effective in replacing 0.12% non-phytate phosphorus in the diet for growth performance and mineral utilization in broiler chicken. Super dosing of commercial phytase in broiler chicken was prominent for growth performance, amino acid digestibility as well as mineral utilization.

Response of super dosing of phytase in normal or low phosphorus-calcium diet of broiler chicken was assessed. A feeding trial of 5-week duration was conducted in a completely randomized design with four dietary treatments: 1) Normal diet without supplementation of phytase; 2) Normal diet with supplementation of commercial phytase (2500FTU/kg); 3) Low P diet with supplementation of commercial phytase (2500FTU/kg); 4) Low P and Ca diet with supplementation of commercial phytase (2500FTU/kg). The results indicated that super dosing of phytase was beneficial in the lower Ca and P fed groups of broiler chicken. Super dosing of phytase may completely reduce inorganic P supplementation in the finisher diet. Super dosing of phytase did not have any influence in the normal broiler diet with inorganic P supplementation.

Partially purified fungal phytase at the rate of 1000FTU/kg diet was found effective in replacing 0.12% non-phytate phosphorus in the broiler diet.

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

M Sridhar, S Senani and AK Samanta

Lignocelluloytic enzymes have significant potential for their applications in various industries including chemical, fuel, food, brewery, animal feed, textile, paper and agriculture. It may be noted that a huge quantity of

these enzymes will be required if they are to be used to degrade lignin of crop residues for improving their digestibility in the rumen. This will demand an inexpensive and readily available supply of these enzymes with efficient lignolytic activity. Therefore, bulk production of these enzymes through immobilization by cost effective means will pave the way for their incorporation in the diets of livestock to improve their productivity and enhancing digestibility of crop residues. The project is initiated with an integrated approach using advanced proteomics technologies for identifying novel lignocellulolytic enzymes and producing engineered enzymes with improved activities suitable for industrial-scale applications. The objectives of the project are to determine the ability of lignin peroxidase (LiP) and manganese peroxidase (MnP) obtained from the white rot fungi and testing their efficacy in enhancing the *in vitro* and *in vivo* digestibility of straw.

Development of pregnancy associated glycoprotein (PAG) based immunodiagnostic in buffaloes (*Bubalus bubalis*)

J Ghosh, SC Roy, KS Roy and A Dhali

Availability of conceptus released biomarker, pregnancy associated glycoproteins (PAG), in blood circulation of cattle and other ruminant species has changed the whole concept of pregnancy diagnosis in farm animals. Pregnancy diagnosis method based on this molecule is not available in buffaloes that limits the optimization of reproductive management in this species. The project was thus undertaken to produce the recombinant pregnancy associated glycoproteins and to develop a specific immunoassay based on the recombinant protein molecules.

The full open reading frame of predominantly expressed buffalo PAG transcript was cloned in pJET1.2 blunt end cloning vector, sequenced and confirmed by database comparison. Initial attempts to express the protein with or without signal peptide in *E coli*, yeast and mammalian system remained unsuccessful. Subsequently, the protein was successfully expressed in synthetic pET back bone based vector system which had N-terminal GST and C-terminal His tags. Although, the yield was very low, the recombinant protein was used for epitope mapping and production of polyclonal antisera. The bulk recombinant PAG7 partial 372bp sequence (124aa) was produced after partial modification of the sequence as per the *E.coli* system codon usage pattern. Polyclonal anti-sera against this protein were developed against the recombinant protein. In addition, polyclonal antisera were also produced against two best epitopes of 20aa lengths. Different antigens were labelled with biotin for use in quantitative ELISA development. All three anti-sera were tested for the immuno-reactivity against the pregnant placentome and non-pregnant caruncular tissue by dot blot and Western blot. The Pep41 and recombinant partial PAG7 antibodies showed minimal reactivity with the non pregnant caruncular proteins as compared to the crude pregnant placentome protein. Native buffalo PAG was purified preparing the immuno affinity column with the developed antisera against recombinant protein.

The PAG7 was found to be expressed predominantly during early pregnancy in buffaloes; The recombinant protein and synthetic peptide and their anti-sera were found suitable for immunoassay development.

Mining markers of pregnancy in cell free body fluids of buffaloes *(Bubalus bubalis)*

J Ghosh, SC Roy, U Tatu and AJ Rao

The existing methods of early pregnancy diagnosis based on determination of non return to cycle and progesterone assays at the time of impending estrus are indirect and not suitable for buffaloes. Thus identification of conceptus specific proteins and miRNA biomarkers have better prospects as they directly confirm the presence of conceptus. Thus this project was designed to profile and identify pregnancy specific proteins and miRNA in early pregnant buffalo's urine, and to track the selected proteins and miRNA in maternal serum and urine samples throughout pregnancy, at parturition and post partum.

Profiling of soluble mature miRNA in the urine and serum samples of pregnant and non-pregnant buffaloes by next generation sequencing (NGS) technology in early pregnant (day-30) and luteal phase (day-10) samples revealed multiple pregnancy specific annotable and novel miRNA sequences. The list was confirmed in the term placental miRNA profile. The gene sequences of many miRNA could be traced back to the buffalo genome however, many could not be found because of gaps in the available buffalo genome sequence. The NGS data was validated by developing SYBR green and probe based qPCR assay for the selected annotable and novel miRNA of serum and urine (Table 3). Many of the miRNA could be found in term placenta, whereas many could not be traced. The levels of selected pregnancy specific miRNAs were screened in pregnant urine and serum throughout pregnancy, at delivery and post partum, and some of the candidates were found promising.

Suitable isolation protocol for buffalo urinary proteins was developed. Comparison of urinary protein profile revealed they are acidic in nature. The developed two-dimensional electrophoresis and silver staining protocols were suitable for mass spectrometry analysis (Fig.12). Many proteins were found differentially expressed in non-pregnant, early pregnant and post partum animals. The expression of serum albumin was found ubiquitous in all the urine samples irrespective of animals are pregnant or not. One of the differentially expressed pregnancy specific protein lactoferrin was found consistently present in urine even at late pregnancy. However it could not be considered as the best marker as their expression might vary in urine during other physiological and pathological conditions even in non pregnant animals.

Table 3. Number of miRNA candidate selected for NGS data validation on which probe and SYBR green based qPCR assays were designed with the number of responded candidates in probe based assays under each category.

Selected miRNA	Urine		Serum	
	Pregnant	Non pregnant	Pregnant	Non pregnant
Annotated (n=40)	19	18	10	10
Novel (n= 12)	6	6	9	9

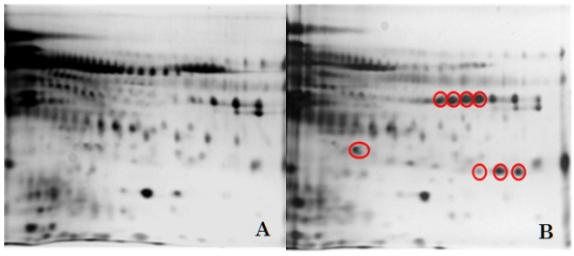


Figure 12. Two dimensional electrophoresis profiles of urinary proteins isolated from luteal phase non pregnant (A) and early pregnant (B) buffaloes. The differentially expressed seven protein spots in early pregnant urinary proteins are circled red.

Multiple early pregnancy specific miRNA and proteins were identified in the serum and urine samples can be exploited for further development of early pregnancy bio-markers in buffaloes; Developed a most suitable protein isolation protocol for urinary proteome analysis that helped in identification of multiple differentially expressed proteins in buffalo.

Expression of copper chaperones and transporters in copper deficient sheep

DT Pal, J Ghosh and CS Prasad

The copper transporter proteins/genes like CTR1, ATPase7A (ATP7A), ATPase7B (ATP7B), Cox17, and Cu chaperone of SOD1 (CCS) may have the potential to diagnose the Cu status in animals. Therefore, the expression levels of copper chaperones and related transporter genes which may be specific to dietary changes of copper could be used as sensitive biomarkers for assessing copper deficiency in sheep. Therefore, the study was aimed to identify the copper transporters and chaperones in different cellular fractions of peripheral blood and to determine the changes in Cu transporter and related genes and proteins expression in liver tissue and in blood circulation of Cu deficient sheep.

A 240-day feeding trial was conducted on sheep fed with three different levels of Cu containing diet (Cu-adequate, Cu-marginal and Cu-deficient; n=6 in each group). After the feeding trial, relative expression of copper chaperone and transporter genes were profiled in whole blood and RBC fraction using SYBR Green based qPCR assay. The sheep fed marginal level of copper did not show any significant changes in gene expression profiles and hence the expressions of genes have been compared between Cu-adequate and Cu-deficient groups. The expression profile of Cu-related transporters and chaperone genes in whole blood and RBC fraction has been depicted in Fig. 13 and Fig. 14. Up regulation of copper chaperones like ATOX1, SCO1, CCS and SOD were seen in whole blood of Cu deficient animals, but the significant up regulation was seen in RBC fraction ($p<0.05$). Whereas the expression of MURR1 was significantly up regulated in RBC fraction ($p<0.05$), but was down regulated in whole blood fraction. Cu chaperones like SCO2, COX11, COX17 and the transporters ATP7B and CTR2 were down regulated in whole blood and significantly down regulated in RBC fraction.

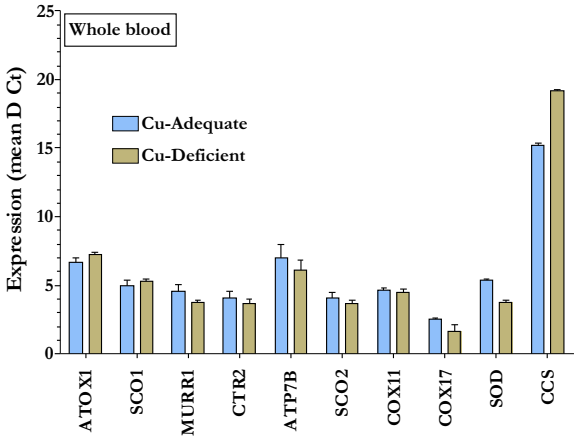


Figure 13. Expression profile of Cu-chaperones and transporters in whole blood of Cu-adequate and Cu-deficient sheep.

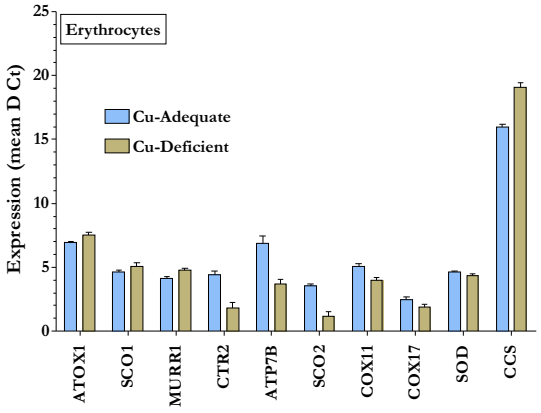


Figure 14. Expression profile of Cu-chaperones and transporters in erythrocytes of Cu-adequate and Cu-deficient sheep.

Liver samples were collected by slaughtering animals in adequate and deficient group (n=3 from each group). Gene expression profile in liver samples revealed that there was up regulation of Cu chaperones SCO1, SCO2, SOD, Ceruloplasmin and down regulation of Cu chaperones ATOX1, CCS, COX17 and Cu transporters ATP7B and CTR2. In contrast, the expression of MURR1, COX11 and NRF1 remained unchanged in both the groups.

The dietary levels of copper affected the expression profiles of copper-related transporters and chaperone genes in sheep; The genes like ATOX1, SCO1, SOD and CCS were up-regulated and genes like CTR2, ATP7B, SCO2, COX11 and COX17 were down-regulated in whole blood and RBC samples; In liver tissues, SCO1, SCO2, SOD and CP gene were up-regulated and ATOX1, ATP7B, CCS, CTR2 and COX17 were down-regulated, whereas MURR1, COX11 and NRF1 gene expression remained unchanged.

Molecular cloning and characterization of buffalo sperm CatSper and a few other fertility associated proteins for development of a fertility assay to screen sub-fertile buffalo bull semen

SC Roy, J Ghosh, KS Roy, A Dhali and A Mech

For screening sub-fertile buffalo bulls, some putative fertility/motility-associated proteins viz; cation channel of sperm (CatSper), tissue inhibitor of metalloproteinase-2 (TIMP-2), binder of sperm 5 (BSP-5) and phospholipase A2 (PLA2) were characterized for the first time in buffalo semen. The asthenozoospermic (sperm motility 40% as assessed by computer assisted semen analyzer CASA) buffalo semen were associated with significantly lower expression of CatSper3, TIMP-2 and BSP-5 proteins as compared with normozoospermic semen (sperm motility $\geqslant$ 70% as assessed by CASA). Rather, the expression pattern of CatSper3 proteins in asthenozoospermic buffalo sperm was surprisingly aberrant as two additional isoforms of CatSper3 (24.9 and 10.8kDa) were detected in these semen as compared to normozoospermic buffalo sperm. Asthenozoospermic seminal plasma with reduced level of TIMP-2 was also associated with significantly higher amount of matrix metalloproteinases (MMPs). Conversely, normozoospermic seminal plasma with increased level of TIMP-2 demonstrated significantly lower level of MMPs. Thus, out of the seven proteins screened, CatSper3 of sperm and TIMP-2 and BSP-5 proteins of seminal plasma were found to have potential to serve as motility/fertility marker for buffalo semen. TIMP-2 level in buffalo seminal plasma was significantly lower as compared to that of bovine seminal plasma making it difficult to develop a bioassay using commercially available heterologous polyclonal antibody. Hence, to use TIMP-2 and CatSper3 proteins as motility/fertility markers for buffalo semen, attempts were made to produce and purify homologous recombinant buffalo TIMP2 and CatSper3 proteins. For the first time, recombinant buffalo TIMP-2 protein was produced in *E. coli* and bulk production of recombinant buffalo TIMP-2 protein was achieved in the laboratory (Fig. 15). Attempts are being made to develop polyclonal antibody against recombinant buffalo TIMP-2 in rabbits for developing a bioassay to screen sub-fertile buffalo bulls. Currently, production of recombinant buffalo CatSper3 in *E. coli* is also in progress. In another experiment, BSP-5 protein was found to be a binding/interacting protein partner of TIMP-2 protein of buffalo seminal plasma. Whether binding of BSP-5 with TIMP-2 is essential for motility regulation of buffalo sperm remains to be elucidated.

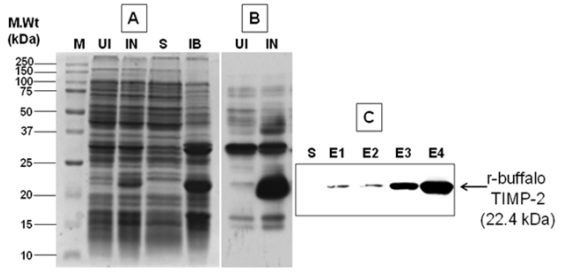


Figure 15. Production and purification of recombinant buffalo TIMP-2 protein. (A) SDS-PAGE of recombinant buffalo TIMP-2 expression in *E. Coli*, M: molecular weight markers, UI: un-induced bacterial lysate, IN: induced bacterial lysate, S: Soluble fraction, IB: inclusion body and nuclear fractions. (B) Western detection of recombinant buffalo TIMP-2. (C) Western detection of recombinant buffalo TIMP-2, S: soluble fraction, E1-E4: Eluents of pH 8.0, 6.3, 5.9 and 4.5, respectively.

CatSper3, TIMP-2 and BSP5 proteins appear to have potential to serve as motility/fertility markers of buffalo semen; For the first time, recombinant buffalo TIMP-2 protein has been produced in the laboratory. It is being used for production of homologous polyclonal antibody for its use in a bioassay for quantitation of TIMP-2 in seminal plasma.

Transcriptomic profiling of spermatozoa for selection of fertile bulls

S Selvaraju, JP Ravindra, AP Kolte, CG David and A Arangasamy

Studies suggest that spermatozoa deliver transcripts and proteins apart from DNA for successful fertilization and embryo development. Since the spermatozoal transcripts composition is not well established, correlation between transcripts (known and novel transcripts) and bull fertility will provide information on the role of these transcripts. Such transcripts can be used to diagnose bull fertility. The present study was designed to profile spermatozoal RNA using next generation sequencing in order to suggest markers for bull fertility. The project aimed to identify fertility regulating transcripts to assess potential fertile bulls before introducing into the AI programme.

The isolation of total RNA from spermatozoa with sufficient purity is prerequisite for studying transcripts and its functional relationship with fertility. The results suggested that lysis of spermatozoa with cocktail of lysis solution might provide sufficient quality and quantity of RNA with high purity for downstream analysis. The bioanalyzer profiling of the spermatozoal RNA revealed superior quality. Though the majority of the sperm RNA was fragmented (Fig. 16), intactness of the most abundant RNA, protamine-1 was intact. The sperm contain 20 to 30 fg of RNA/spermatozoon. The profiling of sperm RNA using IonProton platform suggests that the bull spermatozoa could have 12000-13000 transcripts. These transcripts may have roles in proteolysis, cell adhesion, metabolic activities, blastocyst development, organogenesis and anatomical structure development. The transcripts were involved in axon guidance pathway and significantly expressed in the placenta indicated their influence on the placental development. Some of the sperm transcripts might have function in spermatogenesis maturation process (SOHLH2, MLH1), sperm functional parameters (CXCR4, Catsper-3, ODF4), fertilization and embryo development (CRABP2, HNF1B, INVS, MYF5, TXNRD1) and placental development (PAG5, THSD4; CDH3 type 1, P-cadherin). Transcripts involved in oxido-reductase activity were observed to be higher in high fertile as compared to low fertile bull. In high fertile animal, the transcripts were involved in chemokine signalling pathway, such pathway was not observed in low fertile animals. The relative transcripts expression levels of IGF1, EIF1 and CCT8 were relatively higher in high fertile as compared to low fertile bulls indicated that these transcripts might have potential to influence on bull fertility.

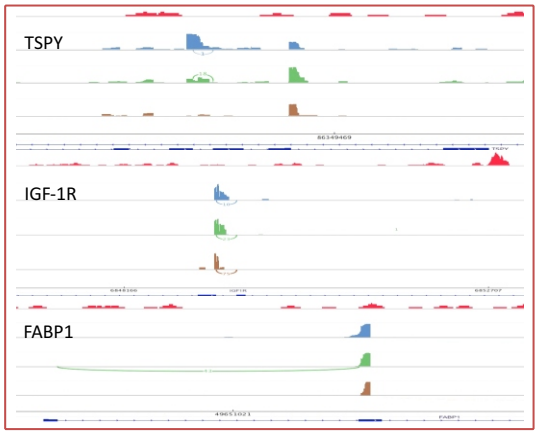


Figure 16. Bovine sperm contains RNA mostly with fragmented transcripts with both exonic and intronic reads.

The spermatozoal transcripts composition could be used to understand the past events associated with spermatogenesis and possible role on sperm function.

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

S Nandi, PSP Gupta and S Mondal

Diet and stress affect the metabolite levels of body fluids in ruminants. The changes in metabolic composition in serum, follicular fluid, urine, uterine and oviductal fluid may reflect the stress status in animals due to diet imbalance or physiological demand. The metabolic stressors concentration was determined in ovine ovarian follicular fluid, serum, urine, uterine and oviductal fluid. Result suggested that β-hydroxybutyrate (β-OHB), total non-esterified fatty acid (NEFA), ammonia, urea and glucose in follicular fluid, serum, urine, uterine and oviduct fluid may be considered as biomarkers of metabolic stressed ewes. Estimation of plasma concentrations of TSH, T3, T4, IGF-I and Insulin in normal and metabolic stressed ewes was done. The preantral follicles and oocytes were exposed to different concentrations of ammonia, urea and non esterified fatty acids. The effect of metabolic stress on granulosa cell growth and metabolic hormone profile were also determined.

The average physiological value for ammonia in sheep follicular fluid was found to be 130µM and it increased up to 300µM under metabolic stress. Similarly, the corresponding value for total NEFA was 70µM and it increased up to 220µM under stress. The average concentrations of oleic acid, palmitic acid and stearic acid in follicular fluid of normal ewes were found to be 27.5,

17.7 and 10.1µM respectively. Metabolic stressors like total NEFA, ammonia, urea and β-OHB concentrations were significantly higher and cholesterol and triglycerides concentrations were significantly lower in follicular fluid of metabolic stressed and emaciated ewes. β-hydroxybutyrate, NEFA and total protein concentrations were found significantly higher in uterine and oviductal fluid of metabolic stressed (post parturient) ewes compared to that of normal ewes. Total NEFA and β-OHB levels increased in post parturient stress, while ammonia and urea levels increased in uterine and oviductal fluid in case of high protein diet. A significant decrease in TSH, T3, T4, IGF-I and insulin was recorded in metabolic stressed ewes. Urea and ammonia levels in urine (Normal: 4.3mM, High Protein-Urea: 7.6mM; Normal-ammonia: 0.112mM, High Protein-ammonia: 0.152mM) were significantly increased in ewes with metabolic stress due to high protein diet. β-hydroxybytyric acid level in urine (Normal: 0.37mM, Post-parturient: 0.65mM) were significantly increased in ewes with post parturient metabolic stress. No significant changes in uric acid and creatinine levels were observed.

Metabolic changes were mimicked in preantral follicle and IVM ovine model was set up to study the effects on the quality of the preantral follicle, oocyte and of the resulting embryo. The effect of different doses of ammonia (0, 100, 150, 200, 250, 300 and 400µM), urea (0, 4, 4.5, 5, 5.5 and 6mM) and total NEFA (stearic, palmitic and oleic acid combination; 0, 70, 140, 210 and 280µM) were tested on preantral follicle, oocyte and granulosa cell growth. The preantral follicle growth both small and large was significantly decreased in ammonia (250µM), urea (6mM) and NEFA (210µM). Results suggested that ovarian follicles growth even at their earlier stage was compromised by changes in the metabolic status of the animals. The oocyte growth was measured in terms of the viability, maturation, cleavage, morulae/ blastocysts yield. The oocyte and granulosa cell growth was significantly decreased in ammonia (250µM), urea (5mM) and NEFA (210µM). It was found that Oleic acid (40 and 60µM) was beneficial to the oocyte and granulosa cell growth, Palmitic acids had no significant effect and stearic acid (30µM) was most inhibitory to oocyte and granulosa cell growth.

Metabolites like β-hydroxybutyrate, total NEFA, ammonia and urea can be considered as biomarkers of reduced fertility in metabolic stressed ewes; Ovarian follicles growth even at their earlier stage was compromised by changes in the metabolic status of the animals; Oleic acid was beneficial to the oocyte and granulosa cell growth, while stearic acid was most inhibitory among the different NEFA to oocyte and granulosa cell growth.

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

Genetic potential of the animals determine the production performance of livestock, however, if nutrition is inadequate, it will result in poor live weight gain, infertility and production performance. Mineral supplements, particularly organic molecules were found to be more efficiently utilized in the body for optimum productive function than inorganic molecules. In this regard, trace mineral supplementation has been found to be associated with rapid testicular growth, changes in LH secretory pattern, a gradual increase in blood testosterone, initiation of spermatogenesis and improvement of the semen quality and fertility. Developmentally regulated genes and/or sperm mRNAs may be useful predictors of male fertility and these sperm proteins and transcripts profiles are influenced by the environment especially, feed and nutrition. Hence, in the trace minerals supplemented animals, analysis of sperm membrane protein and spermatozoa transcripts may provide novel ways to assess sperm health and testis function and may help to enrich our understanding of biological changes in the testis/spermatozoa associated with mineral supplementation. Therefore, the present study is initiated the objectives: To assess the influence of organic trace mineral (Zn and Cu) enriched diet on early onset of puberty, sexual maturity and circulating hormonal levels (testosterone, T_4, T_3, T_4, IGF-1 and LH) and trace minerals; To evaluate the relationship between trace mineral and seminal characters, sperm quality via *in vitro* fertility test, CASA analysis and freezability of buck semen; To evaluate the effect of altered nutrition on changes in sperm transcriptomic activity.

Wnt signal mediated ovarian granulosa cell estrogen synthesis in ruminants

PSP Gupta , DT Pal, S Nandi and S Mondal

Till date, the pathways of estradiol synthesis in ovarian granulosa cells are not fully elucidated. There has been a recent interest on the role of Wnt signalling in the ovarian granulosa cell estradiol synthesis. Wnt signalling is reported to stimulate the estradiol synthesis and granulosa cell proliferation. Nevertheless, only one published report is available currently in farm animal that describes the role of Wnt signalling in estradiol synthesis in bovine. Till date, the role of Wnt signal in non-FSH

mediated estradiol synthesis has not been carried out in granulosa cells and different size categories of follicles or preantral follicles in any species. Hence, the current project is initiated to study the role of Wnt signal in granulosa estradiol synthesis from different size categories of follicles and preantral follicles in goats and buffalo. A 6-day culture system has been standardized for ovarian granulosa cells of buffalo and goats. Studies on the effect of different doses of Inhibitor of Wnt response-1 is initiated in goat and buffalo.

DST Sponsored Project

Women Scientist programme

A heterologous vector mediated transformation system of Laccase gene from a novel white rot basidiomycete into *Pichia pastoris* for effective degradation of crop residues

V Pradeep (Mentor: M Sridhar)

The improper utilization and poor digestibility of lignocellulosic feed is due to lignin, which surrounds and protects the cellulose from enzymatic hydrolysis. White rot fungi (WRF), the basidiomycetes, are ubiquitous in nature and grow as saprophytes on dead and decaying wood usually in the forest ecosystem. These fungi are endowed with the ability to degrade lignin selectively on account of their lignolytic enzymes viz. Laccases, Lignin peroxidases and Manganese peroxidases. Laccases have the ability to oxidize both phenolic and non phenolic lignin related compounds as well as highly recalcitrant environmental pollutants, which makes them very useful for their application to several biotechnological processes. The current investigation was conducted to produce laccase enzyme effective in biodelignification of crop residues.

Basidiocarps of wild isolates of WRF were collected and isolated from decaying wood and screened for laccase production. Laccase production from three selected isolates of WRF viz. NI-07, NI-09 and NI-04 was enhanced by immobilization of whole cells using Poly urethane foam cubes. The novel isolate NI-07, selected after immobilization was morphologically characterized. Morphological and molecular characteristics (Bank It1679236 *Schizophyllum* KF911323) of this autochthonous strain designated NI-07 identified as *Schizophyllum commune* and the same is deposited with MTCC, Chandigarh, India (Accession No. MTCC 11893).

The laccase from NI-07 was isolated and purified employing ammonium sulphate fractionation followed by gel filtration using G-50 Sephadex column and its properties were characterized. Laccase produced from this isolate was found to be highly pH stable and thermostable.

Cloning of laccase gene from *Schizophyllum commune* into pPIC9K vector was attempted. The crude media was subjected to ammonium sulphate fractionation/dialysis and used for SDS and Zymogram analysis (Fig. 17). SDS-PAGE and Zymogram showed a band with an apparent molecular weight of 48kDa corresponding to laccase from *T. versicolor*. The deduced protein sequence showed high similarity with other known fungal laccases with four copper binding conserved domains, typical of laccase protein. The activity staining confirmed that the Pichia clone produced laccase extracellularly and was biologically active. LC/MS-MS analysis was carried out for identification of the recombinant laccase produced extracellularly in the culture medium of *Pichia pastoris.* Effectiveness of laccase produced from *Schizophyllum commune* in its native state, after immobilizing, after purification as well as after transformation and expression in *P. pastoris,* in degrading the lignin of five different crop residues was evaluated and successfully proved.

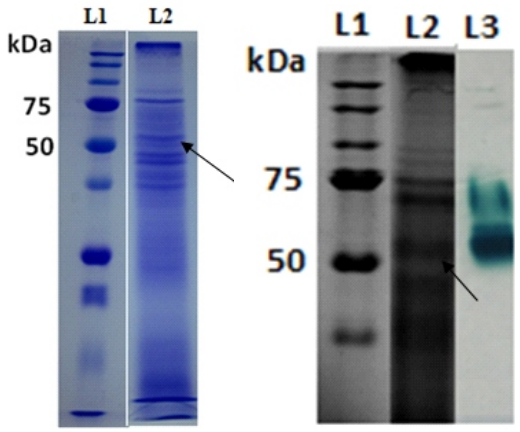


Figure 17. A: SDS-PAGE of crude recombinant laccase; B: Zymogram (L2) and activity staining (L3); L1: Protein standard marker.

Screening of numerous wild isolates yielded a promising laccase secreting strain of white rot fungi, *Schizophyllum commune*; The secreted laccase exhibited superior pH and thermostability. Recombinant laccase could be produced successfully in *P. pastoris* and was found biologically active.

Biotransformation of D-galactose into D-tagatose and its evaluation as nutraceuticals

S Roy (Mentor: AK Samanta)

D-tagtose is a ketohexose and C-4 epimer of D-fructose and is rarely found in nature. Recently, the D-

tagatose has attracted a great deal of attention because of its several beneficial effects like low calorific value, anti-diabetic property, prebiotic activity etc. This necessitates its production of either by chemical or by microbial process for meeting the demands. However, the chemical process of tagatose production is associated with several disadvantages such as complex purification steps, chemical waste formation and other unwanted by products generation. Therefore, the project has been initiated to screen microorganisms for the production of L-arabinose isomerase enzyme responsible for the isomerization of D-galactose into D-tagatose, optimize the variables to maximize the production of D-tagatose and evaluate the nutraceutical potential of D-tagatose.

For bioconversion of D-Galactose into D-Tagatose, L-arabinose isomerase enzyme is required. The particular enzyme is reported to be secreted by microorganisms inhabited in the hot spring. Therefore, water samples and sediments were collected from the hot spring located at Bakrashwar, Birbhum District, West Bengal. The temperature of hot spring varied from 65-72°C, while the pH of sample was 9.2. The water and sediments samples were cultured to isolate thermophilic bacteria and 16 isolates were obtained with different features. Currently, these isolates are under investigation for the production of L-arabinose isomerase enzyme.

Maintaining stemness of mesenchymal stem cells (MSC) on the supplementation of a novel asymmetric cell kinetic inhibitor

K Sangeetha (Mentor: J Ghosh)

Mesenchymal stem cells (MSC) lose their typical cell morphology, decrease proliferation ability, lose and gain chromosomes randomly, vary in protein profile and gene expression pattern, reduce telomerase activity thus have shorten telomeres and loses differentiation capacity to different lineage specific cells. A major contributing factor to the instability is the asymmetric cell division leading to reduction in stem cell population over the passages. Suppression of asymmetric cell kinetics by using some exogenous agents has been found to be beneficial in clonal expansion of rat liver and hair follicle stem cells and bovine mammary epithelial stem cells. It is not known, if these agents help in long term maintenance and culture of MSC. The study is designed in porcine MSC to test the suitability of different basal media, alone and in combinations, and to understand if suppression of asymmetric cell kinetics using some exogenous agents helps in long term culture of these cells.

Derivation of MSC, passaging and cryopreservation protocols initially were developed using goat bone marrow cells from slaughterhouse sample. Subsequently porcine MSC cell lines were derived following the same protocol from 3 different male pigs in six different media formulations with standard supplements. In that process a total of 11 goat and 13 pig bone marrow derived cell lines were developed in different media combinations and cryopreserved at low passage number. The evaluation of morphology, passaging of cells, screening of MSC specific markers by PCR and immuno staining are being done at low passages for selected cell lines. All the cell lines derived in different media showed typical morphology of classical MSC. Selected MSC lines are being tested at low passages for osteogenesis, adipogenesis and chondrogenesis differentiation potential (Fig. 18). However, testing of marker genes by PCR in a selected cell line showed CD105+, CD73+, CD14+, CD34+, CD90- and CD45- phenotype (Fig. 19). The marker expression in these cells are relatively different than the reported classical MSC thus needs further confirmation in other derived cell lines in different media combination.

Whether numbers of initial MSC cells are the function of calcium deposit is being tested in osteogenic differentiation model. Preliminary results proved that with the differentiation of MSC to osteocytes, amount of calcium increases. Doubling time of the cells whether changed due to the suppression of asymmetric cell kinetic inhibitor addition is tested for a selected porcine MSC lines.

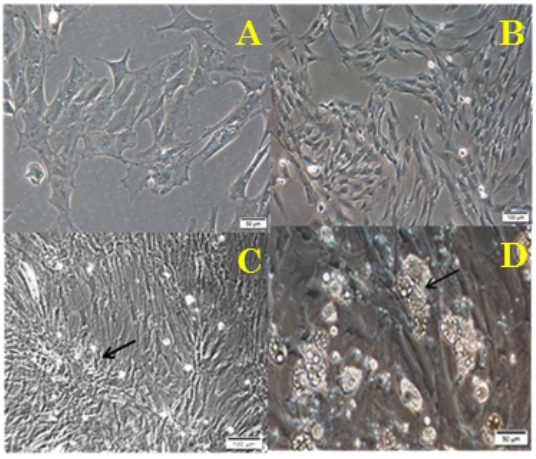


Figure 18. Phase contrast images of goat (A) and porcine (B) bone marrow derived cell line at passage 5 showing typical MSC morphology. Osteogenic differentiation (C) of MSC showed typical osteocyte morphology (arrow) and adipogenic differentiation (D) shows adipocytes morphology with lipid vacuole (arrow). Scale bar: 50µm for A and D, 100µm for B and C.

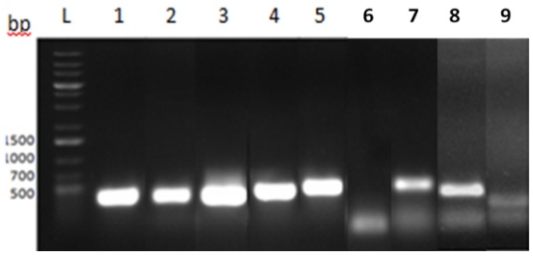


Figure 19. Expression of control and MSC specific cell surface marker genes in a selected bone marrow derived cell line. L: 1kb plus ladder, 1: GAPDH, 2: HPRT, 3: β-tubulin, 4: CD105, 5: CD73, 7: CD14, 8: CD34. No amplification of CD90 (6) and CD45 (9) genes was observed.

Standardized the derivation protocol of mesenchymal stem cells from bone marrow of goats and pigs; Confirmed the expressions of cell surface marker genes and tested the differentiation potential in selected porcine cell lines.

INSPIRE Fellowship

Assessing bull fertility based on seminal and sperm membrane proteins

L Somashekar (Mentor: JP Ravindra)

Assessing the quality of bull semen with the existing minimum standard protocols is not fully effective as the conception rate is very low (20-40%). Since the seminal proteins are involved in various facets of fertilization process, the present study focuses to profile the spermatozoa proteins via proteomic approach to suggest bull fertility markers.

Semen samples were collected from Holstein-Friesian bulls (n=12) maintained at Nandini sperm station, Bengaluru. Spermatozoa protein profiling was carried out by SDS-PAGE (6-16% gradient gel) and 2D-Gel electrophoresis (2DE). The major spermatozoa protein quantity had significant correlation with sperm attributes and bull fertility (19-20, 23-24, 25-26, 31-32, 43-44, 45-46, 50-51 and 65-66kDa in SDS-PAGE) and were excised from gel and subjected to LC/MS-MS analysis for identification. The abundant protein spots observed in 2DE, varied between fertility groups were excised and subjected to MALDI-TOF analysis.

Sperm functional parameters did not differ among bull fertility groups but sperm protein profiles and protein quantity (SDS-PAGE and 2DE) differed among the groups. LC/MS-MS analysis of major sperm protein bands (SDS-PAGE) revealed the presence of 21 putative proteins and the majority of the proteins clusters were found to be associated with energy metabolism and fertilization. In 2DE analysis, protein profile pattern towards acidic pH (pH 3.0 to 5.7) and basic pH (7.9 to 10.0) varied significantly ($p<0.05$) between high and low fertile bulls. The abundant sperm proteins were identified as binder of sperm protein isoforms (PDC109) and spermadhesin1 (SPADH1). The differentially expressed abundant sperm protein PDC109 was significantly higher in low fertile bulls as compared to high fertile bulls. The present study established the interrelationship among major sperm proteins with sperm attributes and fertility. The presence of these proteins and their quantity in spermatozoa might significantly influence sperm function and fertilization. The negative association of PDC109 expression level with pregnancy rate suggests that above certain threshold level this protein may negatively influence bull fertility.

LC/MS-MS analysis of major sperm proteins revealed the presence of 21 putative proteins, which were found to be associated with energy metabolism and fertilization; Expression of the abundant sperm protein PDC109 was found significantly greater in low compared to high fertile bulls.

UGC-women Post Doc Fellowship

Arsenic-induced reproductive and metabolic toxicity in mice: protective role of phytochemicals

G Pushpa Rani (Mentor: JP Ravindra)

Exposure to excess amount of Arsenic (As), a natural metalloid particularly from contaminated drinking water, is considered as one of the top environmental health threats worldwide. Inorganic forms of As are known for its carcinogenic effects and affects multiple organ systems including reproduction. Since limited data available on the effect of As on male reproduction, the aim of this study was to examine the association between graded doses of As-induced testicular oxidative damage and sperm functional attributes in mice. Thirty six adult male mice were randomly assigned to six groups (n=6). Group A served as control without test chemical. The groups B, C, D, E and F were administered As through drinking water with graded doses of arsenate (10, 25, 50, 100 and 200ppm respectively) for 40d. No significant differences were observed for the body weight gain or for relative testes weight among the groups. As dose dependant decrements have been observed in epididymal sperm count, motile sperms, viable sperms, plasma membrane functional integrity and mitochondrial membrane potential, whereas no changes were observed in sperm chromatin distribution. The histoarchitectural studies of testes showed progressive

loss of spermatozoa in the lumen of seminiferous tubules as the dose increased. In addition, an increase in the As level and lipid peroxidation (malondialdehyde, MDA) was observed in the testis of mice exposed to As in a dose dependant manner. In conclusion, higher doses of As (100 and 200ppm) were found to be testicular toxicants and impaired semen quality by affecting testicular architecture could be due to oxidative stress.

Higher doses of arsenic (100 and 200ppm) were found to be testicular toxicants and the impaired semen quality and testicular architecture were likely due to oxidative stress.

NICRA Sponsored Project

Modelling the impact of climate variation on feed resources' availability for livestock

K Giridhar, G Ravikiran and KP Suresh

The objectives of the project were to assess the impact of climate variation on feed resources production in different States of India and to develop the models for predicting the impact of climate variation on animal feed resources in India. SAS time series Forecasting system and ARIMA (Auto regressive integrated moving average) models were used to analyze the effect of long-term rainfall variability on animal feed resources availability. Impact of rainfall variability on the production of various crop residues ranged from 1.1 to 9.1% in Andhra Pradesh, 2 to 12.4% in Karnataka, 1.4 to 11.4% in Tamil Nadu, 2 to 12.1% in Kerala and 0.3% to 9% in Goa.

The effect of long-term rainfall variability on residues production ranged from 1.2 to 4.3% in Punjab, 1 to 10.5% in Bihar, 0.3 to 13% in Haryana and 1.3 to 16.7% in Uttar Pradesh. Similarly, the impact of precipitation varied between 4.7 and 12.5% in Rajasthan, 3.7 and 8.6% in Maharashtra, 1 and 16.1% in Orissa, 0.3 and 15.2% in Gujarat and from 1.3 to 13.1% in West Bengal. The effect of rainfall variability on crop residues production in Gujarat and Karnataka is presented in Table 4 and on oil cakes production in Karnataka is depicted in Fig. 20. In general, among the major crop residues, rice straw and sugarcane tops were impacted relatively less as the acreage under irrigation is relatively more for these crops. Some of the oil cakes were affected more by rainfall variability, as the proportion of irrigated area under these crops, in general, is limited and they are mostly grown on marginal soils under rainfed conditions. Among various States, the impact of rainfall variability is low on crop residues production in the States like Punjab and Haryana due to the maximum coverage of cropped area under assured irrigation.

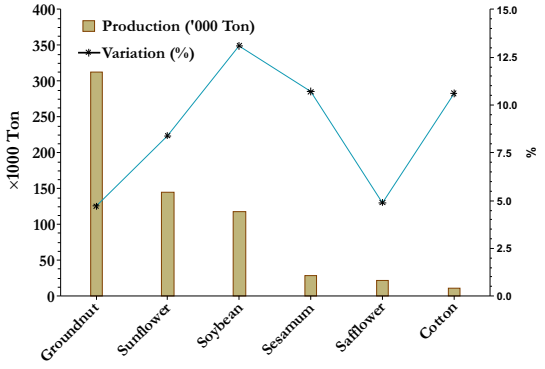


Figure 20. Effect of rainfall variability on oil cakes production in Karnataka.

Developed the methodology to assess the impact of long term rainfall variability on the production of various crop residues; Developed the crop-wise models for various states to quantify the impact of rainfall on production.

Table 4. Effect of rainfall variability on crop residues production in Gujarat and Karnataka.

Crop	Variation in residues production due to long term rainfall variability (%)		Residue production (Million Tons)	
	Gujarat	Karnataka	Gujarat	Karnataka
Bajra	7	-	1.7	-
Gram	4.4	6.3	0.3	0.8
Groundnut	6.9	4.7	7.1	1.0
Jowar	4.9	9.9	0.3	2.1
Maize	4.3	12.4	2.1	9.0
Rice	2.4	2	1.8	5.1
Wheat	0.3	7.2	4.2	0.3
Other pulses	3.5	-	0.3	-
Small millets	10.9	-	0.1	-
Sugarcane	2.4	-	8.2	-
Ragi	-	2.3	-	2.4

Coconut Development Board Sponsored Project

Generation of xylooligosaccharides from green coconut husk for augmenting gut health and function

AK Samanta and S Senani

Xylooligosaccharides (XOS) occupy significant niches in the functional food space because it can be produced from lignocellulosic biomass that are renewable and abundantly available. The project aimed to generate xylooligosaccharides from green coconut husks and assessment of its therapeutic/prebiotic value.

The green coconut husks were chopped into pieces and dried in an oven at 60°C for 4 to 5d, prior to grinding. The chemical analysis revealed that the husk contained 96.3% organic matter, 57.5% cellulose, 15.2% hemicellulose, 3.5% Klasson lignin and 3.6% crude protein. Xylan was extracted using 4% potassium hydroxide treatment followed by overnight incubation at room temperature. The xylan was subjected to Fourier Transform Infrared (FTIR) Spectroscopy and Thermo Gravimetric (TGA) analysis. FTIR spectra revealed the absence of either lignin or cellulose in the alkali extracted xylan. The TGA profile reflected the changes in weight resulting from gradual increment of temperature. The initial xylan degradation started at 100°C owing to the loss of water and the pyrrolytic process was completed in the range of 500-600°C. The alkali extracted xylan was enzymatically hydrolysed with endoxylanase from *Trichoderma viridae*. Xylooligosaccharides having higher concentration of xylohexose and xylopentose were detected through HPLC, when the xylan was hydrolysed at pH 5.0 for 3h in shaker incubator at 45°C. The xylooligosaccharides produced were fed to mice suffering from mild colitis to evaluate the ameliorative effect of XOS. Besides, the XOS were supplemented in the diet of broiler birds (0.5%) for a period of 4wk.

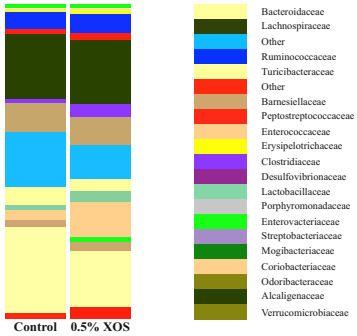


Figure 21. Effect of XOS supplementation on the proportion of different microflora (family level) in the caecal content of broilers.

The supplementation resulted in increased microbial diversity, especially the probiotic bacteria. No adverse effects were noticed either on final body weight or feed conversion efficiency of broiler birds. The microbial changes in the caecal flora are dipcted in Fig. 21.

The xylooligosaccharides generated from the xylan of green coconut husks is mainly comprised of higher degree oligomers such as xylopentose and xylohexose; The supplementation of the xyloligosaccharides (0.5%) in the diet of broiler birds increased beneficial microbes in the caecum.

ICSSR Project

Vulnerability of Crop-Livestock farming system to climate variability and global economic change: a perspective of Karnataka State

Letha Devi G

Vulnerability to climate change varies across regions, sectors and social groups. Understanding the regional and local dimensions of vulnerability is essential to develop appropriate and targeted adaptation efforts. The dramatic economic and social changes themselves present new risks as well as opportunities. Moreover, climate change and economic changes are two key processes of global change, and it is assumed that both have major impacts on Indian agriculture. Nonetheless, their combined impacts are rarely studied in conjunction. The study attempted to assess the vulnerability of crop-livestock farming to climate variability and economic change, assess the socio-economic impact of climate variability and economic change on crop-livestock farming, and study the coping strategies of farmers to impacts of climate vulnerability and economic change.

It was found that groups with single livestock species (cattle) were highly vulnerable to climate vagaries. Integrated farming system with a few cattle, sheep or goat was found to be the least vulnerable system. Farmers have adopted multi layer integrated cropping system for maximum utilisation of natural resources (Fig. 23). 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 meeting out the water

requirement of animals was a challenge during drought periods. There was very little compensation received for the loss of livestock due to natural disasters as compared to crops. It was found that 98% of the respondents were not able to repay the agricultural loans during climate disasters, and 79% of the total respondents changed their livelihood pattern as coping strategy to climate changes (species of crops and livestock, management practices, housing of animals etc).

Figure 23. Multi layer integrated cropping system for maximum utilisation of natural resources

Farmers rearing single livestock species were found highly vulnerable to climate vagaries and integrated farming system with a few cattle, sheep or goat was found to be the least vulnerable system; 79% of the farmers changed their livelihood pattern as coping strategy to climate changes.

ARChE_Net Project

Regional network for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment (ARChE_Net)

PSP Gupta, K Giridhar and S Jash

The project aimed to create a network for scientific exchanges among Indian ocean countries (Australia, India, Madagascar, Mozambique, Reunion (France), South Africa and Union of Comoros) to define regional strategies to manage ruminant farming systems adaptation to agro-ecological and socio-economic changes; to expand the possibilities of livestock production systems adaptation; to add value to animal and plant resources and to the existing management methods and to provide management tools of livestock production systems.

Hybrid napier, bajra fodder samples were collected from Bengaluru Rural, Tumkur and Chiradurga districts of Karnataka. The portable NIRS machine was used to record spectral data of fresh forages using 'unscrambler' software (version 10.3) for the analysis of spectral data. Under the project, an intern from Paris University collected over 170 samples of hybrid napier from various places and also interacted with the dairy farmers of Karnataka and recorded information on livestock farming.

Two trainings programmes were conducted under the project. Training cum workshop at BAIF, CRS, Uruli Kanchan, Pune was organized to impart knowledge on usage of NIRS for forage evaluation. Another training program on LASER SOFTWARE (support software for monitoring ruminant production) was organized at ICAR-NIANP, Bengaluru. Mr. Xavier Juanes, CIRAD, Reunion Island, France, the developer of the software imparted the training to scientists.

Forage samples from dairy farmers were collected from the local villages and analyzed for their quality using NIRS; Trainings were organized on NIRS at ICAR-NIANP and BAIF, Pune.

ICAR Consortium Research Platform

Bio-fortification of cereals

KS Prasad, SBN Rao and NM Soren

Quality feeds are most important for profitable livestock farming. Cereals and their byproducts are the major component of livestock feed for growth and production. Cereals are low in some minerals and proteins. Bio-fortification is one of the methods that uses advanced plant bio-technological tools to increase a particular nutrient, which is deficient in cereals, but critical to animal performance. In this direction, many transgenic varieties have been developed by ICAR under various research platforms. In the XII plan, under the leadership of ICAR-DRR, systematic studies are planned to evaluate the value added cereals (VAC; rice, wheat, maize, sorghum, pearl millet and small millets) developed by various institutes. ICAR-NIANP, Bangalore is entrusted with the responsibility of quality evaluation of VAC and by-products comparison to their conventional counterpart in terms of nutrient utilization. The project objectives are to evaluate nutrient composition of VAC, compare nutrient utilization of VAC with conventional cereals using *in vitro /in sacco* study, and compare VAC with conventional cereals for nutrient utilization in animals.

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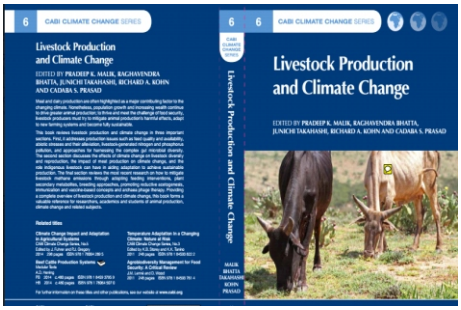

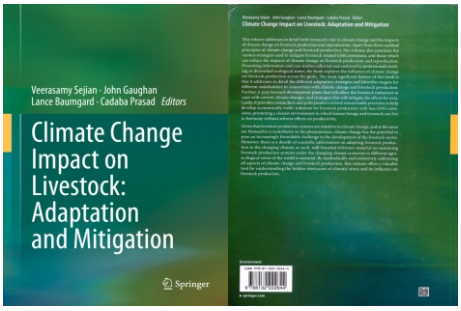

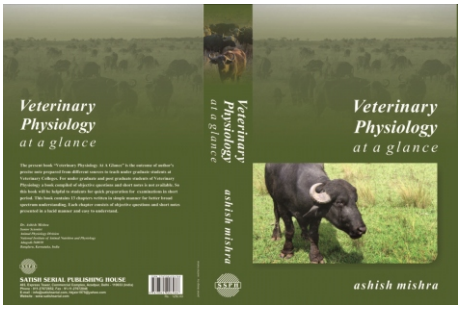

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Web/Mobile Applications

Rajendran D and Bagath M. 2014. Web application on ready reckoner for feeding of milch buffalo (English and Kannada). Published by the Director, ICAR- NIANP, Bengaluru.

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Guest Lectures

Gowda NKS

Pineapple fruit residue silage as fodder. Lecture delivered for dairy farmers in Workshop at Anavatti, organized by Shimoga milk union, 30 June, 2014.

Feed and fodder management during scarcity. Lecture delivered for farmers in workshop at KVK, Hadonahalli, 16 July, 2014.

Use of local fodder resources for livestock feeding. Lecture delivered during the workshop organized by Central Institute of Fodder Development, Hessarghatta, Bengaluru, 24 July, 2014.

Use of areca sheath and pineapple fruit residue silage. Lecture delivered at workshop organized by Dharwad Milk Union, Sirsi, 31 July, 2014.

Feeding value of fruit residues in livestock. Lecture delivered during National Seminar on Underutilised fruits at IIHR, Regional station of IIHR, Chettalli, Coorg, 3 December, 2014.

Feed resources and feeding of livestock. Lecture delivered at Workshop of KVK, Sirsi, 27 November, 2014.

Ration balancing in dairy animals. Lecture delivered at Seminar organized by Karnataka Veterinary Association, Tumkur, 20 December, 2014.

Selvaraju S

Role of immunohistochemistry in disease diagnostic applications. Lecture delivered in the training programe on "Advanced Techniques in Detection and Control of Parasitic Diseases", organized by the Centre of Advanced Faculty Training In Veterinary Parasitology, Veterinary College, KVAFSU Regional Campus, Hebbal, Bangalore, 10-30 November, 2014.

Newer techniques evolved in semen analysis. Lecture delivered to the trainees from the Central Frozen Semen production and Training Institute, Hessarghatta on 10 September, 2014.

Quality parameters of neat semen. Lecture delivered to the trainees from the Central Frozen Semen production and Training Institute, Hessarghatta on 12 December, 2014.

Sejian V

Effect of nutritional and thermal stress on small ruminant's production and reproduction. Lecture delivered at CAFT in Veterinary Physiology Short Course on "Physiological Capacity Building for Enhancing Reproductive Efficiency through Nutritional Interventions", Indian Veterinary Research Institute, Izatnagar, Bareilly, 17 September, 2014.

Effect of thermal stress on milk production in livestock. Lecture delivered at CAFT in Veterinary Physiology Short Course on "Physiological Capacity Building for Enhancing Reproductive Efficiency through Nutritional Interventions", Indian Veterinary Research Institute, Izatnagar, Bareilly, 17 September, 2014.

Strategic plans and scopes of climate resilient technologies in sustaining livestock production system. Lecture delivered at ICAR Sponsored Winter School on "Livestock Based Livelihood Options: Current Status, Emerging Issues and Future Scenario in Combating Agrarian Crisis", Veterinary College and Research Institute, Namakkal, Tamil Nadu, 17 November, 2014.

Soren NM

Improving the utilization of crop residues for livestock feeding. Lecture delivered at two day training programme on fodder development organized by Central Fodder Seed Production Farm, Hessarghatta, Bangalore, 24 July, 2014.

Feeding management of small ruminants. Lecture delivered to farmers at Krishi Vigyan Kendra, College of Agriculture, Bijapur, Karnataka at a field workshop on "contingency Measures for Livestock Feeding, Health and Management During Adverse Weather Condition", 22 August, 2014.

Prasad KS

Delivered lecture on the occasion of Milk World Day on "Feeding Strategies for Sustainable Dairy Production Systems", Ranchi, Jharkhand, 1 June, 2014.

Pal DT

Nutritional interventions for successful buffalo reproduction throughout the year. Lecture delivered at One day ICAR-NAVS Expert Consultation on "Strategies for Breeding Buffaloes Round the Year", NASC Complex, New Delhi, 4 July, 2014.

Rajendran D

Feeding of breeding bulls. Lecture delivered to the State officers working at semen station, organized by the Central Frozen Semen Production and Training Institute, Hessarghatta, Bangalore, 21 January, 2015.

Feeding of Azolla. Lecture delivered to the farmers at KVK, Chinthamani, Kolar, Karnataka, 1 July, 2014.

Technology Transfer

Red LED lighting to enhance egg production in layer hens (Inventor: IJ Reddy)

Technology has been transferred to commercial poultry farm. Incandescent bulbs were replaced with Red LED bulbs (4 Watts, 675nm). Red LED lighting in commercial poultry farm improved egg production by 2% in high performing WLH layers. The technology, in addition to improving egg production, also could reduce power consumption (energy saving) compared to incandescent light. The technology was found to be cost effective.

Media

NKS Gowda interacted on Live Phone in the program in Krishi Darshan as a subject expert on the topic "Use of local feed resources for cattle feeding", Doordarshan, Bengaluru, 29 July, 2014.

Patents Filed

No. 3475/CHE/2014, Dated 14.07.2014: Methane reduction using *Tamarindus indica* seed husk. (Bhatta R, Prasad CS and Sampath KT).

No. 5962/CHE/2014, Dated 28.11.2014: Thermostable and pH stable laccases. (Sridhar M, Vidya PK, Bhatta R, Dhali A and Kolte AP).

No. 1129/CHE/2015, Dated 09.03.2015: Mold-free fodder sprouts and method of producing the same. (Giridhar K and Elangovan AV).

Awards and Honours

ICAR Team Research Award

The scientists of the Institute received the prestigious ICAR Award for outstanding interdisciplinary team research in agriculture and allied sciences for the biennium 2011-12 for cutting edge research on the production of prebiotics from agricultural wastes like corn cobs, coconut pith, sugarcane bagasse, natural grass and tobacco and cotton stalks. The award was bestowed to AK Samanta, AP Kolte, S Senani, M Sridhar and CS Prasad on 29th July, 2014, during the celebration of ICAR foundation day in New Delhi, by the Honourable Minister of Agriculture, Govt. of India, Shri Radha Mohon Singh.

PK Malik

Received the 'Australian Ambassador Award' for the year 2015 by the Australian High Commission, New Delhi.

NKS Gowda

Received the 'Sir CV Raman Award for Scientists' for the year 2012-13 by the Council of Science and Technology, Govt. of Karnataka for outstanding achievements in the field of Agricultural Sciences and Animal Husbandry.

Acted as Co-Chairman of the technical session on 'Fodder and Forages for ruminants' in IX Biennial Conference of ANA on 'Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood', 22 to 24 January, 2015, Veterinary College, Guwahati

NKS Gowda, DT Pal, S Anandan, NC Vallesha, VB Awachat

Received the 'NIANP Innovation Award' in the Research Category for the Year 2013-14 for the study on Pineapple fruit residue silage as fodder for livestock.

K Giridhar and RK Gorti

Recognized as Research partner of Asia Pacific Animal Feed Network under the aegis of FAO.

S Mondal

Received the SIRI research award from the 'Indian Association of Biomedical Scientists' for the best research paper in abiotic stress.

Received the 'Best Citizens of India Award' by the 'International Publishing House', New Delhi for notable contribution for augmenting livestock fertility under climate change scenario.

KS Roy

Received the prestigious 'Dr. A Roy Memorial Award' from the 'Society of Animal Physiologists of India' for outstanding contribution in the field of Animal Physiology

Elected as the Executive Member, 'Indian Dairy Association-South Zone', for the period of 2014 to 2017.

SC Roy

Selected as a member of the editorial board of 'Asian Pacific Journal of Reproduction', Elsevier.

NM Soren

Selected as an editorial board member of the 'Indian Journal of Nutrition'.

Selected as an editorial board member of the 'International Journal of Dairy Science and Processing'.

Elected as an executive member of the 'Animal Nutrition Society of India'.

M Chandrasekharaiah

Selected as a Fellow of the 'Animal Nutrition Association of India', 2015.

Received the 'Bharat Shiksha Ratan Award' for the achievements in research and extension by the 'Global society for Health and Educational Growth'.

Acted as Co-Chairman of the technical session on 'Nutrition, Livelihood and Environment' in the IX Biennial Conference of ANA on 'Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood', 22 to 24 January, 2015, Veterinary College, Guwahati.

Conference Awards

Conferences	Awards
Global Animal Nutrition Conference (GLANCE-2014) on 'Climate Resilient Livestock Feeding Systems for Global Food Security', 20-22 April, 2014, Bengaluru.	First prize for the poster 'Whole transcriptome analysis of poultry hepatic gene expression in aflatoxicosis'. Sridhar M, Kolte AP, Dhali A, Thammaiah V, Suganthi RU and Elangovan AV. First prize for the poster 'Effect of rumen methanogenesis attenuation by *Ficus bengalensis* on fibre degrading bacteria'. Baruah L, Bhatta R, Saravanan M, Kolte AP, Dhali A and Prasad CS. First prize for the poster "Evaluation of *Chrysopogon fulvus* as raw material for prebiotic production". Sondhi N, Jayapal N, Samanta AK, Kolte AP, Senani S, Sridhar M and Prasad CS. First prize for the poster 'Cloning the genes encoding feruloyl esterase in *butyrivibrio fibrisolovens* and the effect of recombinants on *in vitro* straw digestibility'. Chandrasekharaiah M, Thulasi A, Bagath M, Prasanna Kumar D, Santosh SS, Palanivel C and Prasad CS. Second prize for the poster '16S rRNA gene based profiling of rumen bacterial community distribution in response to plant bioactive compounds'. Saravanan M, Bhatta R, Baruah L, Kolte AP, Dhali A and Prasad CS. Second prize for the poster 'Assessment of inhibitory potential of linalool, menthol and cuminaldehyde on *Aspergillus parasiticus*'. Umaya RS, Prasad KS and David ICG. Second prize for the poster 'Evaluation of improved dairying in Chitradurga district of Karnataka'. Giridhar K, Elangovan AV, Sharangouda, Pramod CM and Khandekar P.
International Symposium on 'Current Challenges and Translational Research to Augment Animal Reproduction', 4-5 December, 2014, Madras Veterinary College, Chennai.	First prize for the poster 'Regulatory role of tuberoinfundibular peptide of 39 residues (TIP39) in seminal plasma on spermatozoa function in buffalo (*Bubalus bubalis*)'. Binsila BK, Somashekar L, Parthipan S, Arangasamy A, Rajendran D, Ravindra JP and Selvaraju S. Second prize for the poster 'Spermatozoal transcripts in bovine: possible molecular and functional role in spermatogenesis, sperm function, fertilization and successful pregnancy'. Selvaraju S, Parthipan S, Kolte AP, Arangasamy A and Ravindra JP.

Conferences	Awards
IX Biennial Conference of ANA on 'Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood', 22-24 January, 2015, Veterinary College, Guwahati.	First prize for the poster 'Supplementation of recombinant mixed cultures encoding feruloyl esterase gene on digestibility of paddy straw'. Chandrasekharaiah M, Thulasi A, Palanivel C, Santosh SS, Prasanna KD, Bagath, M and Lyju, JV. First prize for the oral presentation 'Effect of dietary levels of copper on copper/zinc superoxide dismutase (SOD) and copper chaperone for SOD (CCS) genes expression in whole blood and erythrocyte of sheep'. Pal DT, Ghosh J, Punith BD, Shreevidhya S, Maity M. Second prize for the poster "An overview of boron content in commonly used feed and fodders'. Vijay Bhasker T, Gowda NKS, Pal DT, Karthik Bhat S and Pattanaik AK.
ISSAR XXX Annual Convention and National Symposium on 'Biotechnology in Animal Reproduction', 20-22 November, 2014, DUVASU, Mathura.	Best oral presentation award for 'Recombinant production of partial buffalo pregnancy associated glycoprotein 7 protein and testing immunereactivity in buffalo placental proteins'. Ghosh J, Kumar N, Chandan and Shreevidhya S.
I International Conference of the Indian Society of Genetics, Biotechnology Research and Development, 18-20 February, 2015, KVK, Banasthali University, Rajasthan.	Best poster award for 'Effect of different proportions of concentrate and roughage ratio on reproductive performance of Malpura ewes under semi-arid tropical environment'. Indu S, Sejian V, Kumar D, Pareek A and Naqvi SMK.
National Conference on 'Stress and Health: Frontiers of Research in Stress Related Diseases and Management', 12-13 February, 2015, Maharani's Science College for Women, Bengaluru.	Second prize for the poster 'Dose dependent impact of arsenic on oxidative stress and sperm functional attributes- an in *vivo study*'. Pushpa Rani G, Ravindra JP, Rajani CV, Parthipan S, Somashekar L, Arangasamy A and Selvaraju S.

Training & Capacity Building

Training Organized

ICAR Sponsored Short Course on 'Harnessing Intellectual Property in Animal Science Sector in the Changing Global Scenario', 18 - 27 August, 2014

The ICAR sponsored short course on 'Harnessing Intellectual Property in Animal Science Sector in the Changing Global Scenario' was conducted at the Institute from 18 - 27 August, 2014. The course was attended by 14 participants from various states. Dr CS Prasad, former Director, ICAR-NIANP and VC, MAFSU was the chief guest of the inaugural function. He released the course compendium and emphasized the role and relevance of intellectual property development and management in the ICAR institutions. Dr R Bhatta, Director, ICAR-NIANP highlighted the importance of continuing education and strengthening the ICAR institutions and KVK linkage. Certificates were distributed to the candidates at the valedictory session.

ARChE_Net Project Sponsored Training on 'LASER Software', 7 - 8 October, 2014

A 2-day training program on LASER Software (support software for monitoring ruminant production) was conducted at the Institute and attended by the scientists from various ICAR institutes. The LASER software facilitates the management and analysis of demographic, zoo-technical and epidemiological data, identified at the single animal scale within ruminant herds. The software is useful for collecting repeated data from a group of animals under field condition for any nutritional, reproduction or epidemiological study. The program was sponsored by the international collaborative project 'ARChE_Net' involving seven Indian ocean rim nations; France, Australia, South Africa, India, Madagascar, Mozambique and Union of Comoros. The inventor of the software Mr. Xavier Juanes, CIRAD, Reunion Island, France, imparted the training.

ICAR Sponsored Winter School on 'Advanced Concepts and Techniques to Augment Reproduction in Livestock', 12 November - 2 December, 2014

The ICAR sponsored winter school on 'Advanced Concepts and Techniques to Augment Reproduction in Livestock' was organized at the Institute from 12 November - 2 December, 2014. The training programme was inaugurated by Dr. Sudha Deshmukh, Dean, Jain University, Bengaluru. Dr. M.L. Madan, Former DDG (AS), ICAR graced the Valedictory function of the training. In his speech, he stressed on innovative thinking while taking up research projects. He asked the teachers from the University to impart high quality education to their students. He released the compendium in the CD format and distributed the certificates to the 25 participants from various ICAR institutes and Veterinary Colleges. The training programme encompassed recent topics on reproductive technologies such as cloning, transgenic animal production, stem cell technology, ovum pick up, preantral follicle technology etc.

Model Training Course on 'Recent Developments in Animal Feeding Practices', 13 - 20 January, 2015

The Model Training Course on 'Recent Developments in Animal Feeding Practices' was sponsored by the 'Directorate of Extension, Department of Agriculture and Co-operation, Government of India, New Delhi' and conducted at the Institute. The training was attended by 22 participants from 15 states. The training included theory and hands-on-practical in the areas of ration balancing, greenhouse gas mitigation, silage making, round the year fodder production, stress management, prebiotic and probiotics, solid state fermentation, complete feed blocks, feed chart, least cost feed formulation, prevention of mycotoxins in animal feeds, simplified azolla cultivation, hydroponics and role of nutrition on immunity and reproduction. The participants also attended an interactive field visit to the feed processing plant of 'Karnataka Milk Federation', Rajankunte. Dr. Abdul Rahman, President, Commonwealth Veterinary Association graced the valedictory session and awarded certificates to all the participants. He urged the participants to translate the knowledge gained during the training for the benefits of the end users.

KVC Sponsored Training Program on 'Feed Resources and Ration Balancing for Dairy Cattle' for the Officers of the Department of Animal Husbandry and Veterinary Services of Karnataka, 5 - 7 February, 2015

A training program on 'Feed Resources and Ration Balancing for Dairy Cattle' was organized at the Institute for professional efficiency development of the field veterinarians. The training was sponsored by the 'Karnataka Veterinary Council' under the 'Continued Veterinary Education Program'. Eight field veterinarians from different districts of Karnataka participated in the training. The programme offered training on various aspects of feeding management of dairy cattle emphasising the latest developments in the field of animal nutrition. The trainees were given hands-on training on ration balancing for dairy animals using user-friendly software-"FEED ASSIST" developed by the Institute and preparation of total mixed ration and feed block. Dr. M Devaraj, President of the 'Karnataka Veterinary Council, Bengaluru' addressed the trainees during the valedictory function and distributed certificates.

Stakeholders' Meeting/ Technology Awareness Program

Stakeholders' Meeting on Popularization of Feed Assist

A stakeholders' meeting on Popularization of touch screen based 'Feed Assist: A Farmer-Friendly Least Cost Ration Formulation Software' was conducted at the Institute on 29 May, 2014. Dr. S Dixit, Zonal Project Director, ZCU, Bangalore, Dr. TS Manju, JD (Farms) and Dr. S Udupa, Assistant Director (Dairy), Dept. of AH&VS, Karnataka, Dr. A Kolte, Manager, NABARD, Bangalore and Mr. Ismail, JD, KMF, attended the meeting. Dr. AV Elangovan, PS, ICAR-NIANP demonstrated the software and subsequently detail discussion and interactions were held. The modalities for disseminating the software to the farmers were discussed and action points were prepared.

Technology Awareness Program on Feed Assist: A Farmer-Friendly Least Cost Ration Formulation Software

A Technology awareness program on 'Feed Assist: A Farmer-Friendly Least Cost Ration Formulation Software' was organized at the Institute on 25 July, 2014. Twenty participants from the Department of Animal Husbandry and Veterinary Services, Karnataka, Karnataka Milk Federation and Krishi Vigyan Kendras of Karnataka participated in the program. Sessions on various topics such as practical considerations in animal feeding and management, concept of balanced feeding and TMR etc., were held apart from the demonstration of the software. A Hands on session of feed assist was also held and feedback were taken from the participants. In the concluding session, certificates were distributed to the participants along with copies of the software and its operation manual.

Human Resource Development

Education and training imparted by the staff

AV Elangovan

Imparted training to Prof. Dr. (Mrs.) Sayda Ali, Department of Animal Science, Faculty of Agricultural Sciences, Gezira University, Sudan, who joined the Institute for three months (20 October, 2014 to 20 January, 2015) under CV RAMAN International Fellowship for African Researchers. She undertook a short study on the response of super dosing of phytase in normal or low phosphorus-calcium diet of broiler chicken.

V Sejian

Imparted a 21-day industrial experience training on "Climate Change and Livestock Production" for the students of 'Kerala Agricultural University' from 26 September to 16 October, 2014.

Three-month attachment training programme for the newly recruited ARS scientists

Name of the scientist	Parent Institute	Training period	Mentor
M Raejsh	ICAR-DCFR, Bhimtal	08-05-14 - 07-08-14	NKS Gowda
JBS Kamalam	ICAR-DCFR, Bhimtal	08-05-14 - 07-08-14	A Thulasi
K Skendra	ICAR-CIFE, Mumbai	12-05-14 - 11-08-14	AK Samanta
T Varghese	ICAR-CIFE, Mumbai	12-05-14 - 11-08-14	SC Roy
N Shamna	ICAR-CIFE, Mumbai	12-05-14 - 11-08-14	S Selvaraju
NK Chandan	ICAR-CIFA, Bhubaneswar	12-05-14 - 11-08-14	J Ghosh
DV Kolekar	ICAR-ZPD, Bengaluru	13-11-14 - 12-02-15	NKS Gowda

Training Undergone by the Staff

Attended by the scientists

National

Particulars	Participants
Management Development Program (MDP) training for RMPs on 'Leadership Development', from 15-26 July, 2014 at ICAR-National Academy of Agricultural Research Management, Hyderabad.	PSP Gupta
ARChE_Net project sponsored training on 'LASER Software', from 7-8 October, 2014 at ICAR-National Institute of Animal Nutrition and Physiology, Bengaluru.	S Jash, A Mech, S Nandi, KS Roy, NM Soren, T Chandrappa, S Senani, RU Suganthi
Management Development Program (MDP) trai ning on 'Consultancy Project Management', from 22-27 August, 2014 at ICAR- National Academy of Agricultural Research Management, Hyderabad.	D Rajendran

International

Particulars	Participants
Six-Month Post-doctoral Research (01 August, 2014 - 31 January, 2015) on 'Isolation of Novel Methylotrophic Methanogens from Pasture Fed Sheep' at the University of Queensland, Department of Agriculture, Fisheries and Forestry, Queensland, Australia, supported by the 'Endeavour Fellowship' of the Australian Government.	PK Malik
Training on the 'Use of Near Infrared Spectrometry for Evaluation of Forage Quality' from 30 August -26 September, 2014 at CIRAD, St. Pierre, Reunion Island, France.	K Giridhar

Attended by the administrative personnel

Particulars	Participants
'Good Governance', 08-12 September, 2014 at ISTM, New Delhi.	S Athimoolam
'Management Development Programme of Procurement Policy of Division of Finance Ministry', 27 April-02 May, 2015 at NIFM, Faridabad.	S Athimoolam
'Training for ICAR Assistant', 10-21 November, 2014 at ISTM, New Delhi.	SR Sreenivasa
'Administrative Vigilance', 9-20 March, 2015 at ISTM, New Delhi.	R Anbu
'Workshop on Income Tax', 7 July-10 August, 2014 at ISTM, New Delhi.	A Murthy
'Digital Sign and Public Key Infrastructure', 27 November, 2014 at CDAC, Bangalore.	A Murthy
Awareness workshop on 'Biometric Attendance System for Nodal Officers', 4 March, 2015, at IT Department, CR Building, Bengaluru.	M Naveen Kumar

Meeting/ Conference/ Symposium Attended by the Director

Details of meeting/ conference/ symposia	Date
Global Animal Nutrition Conference (GLANCE-2014).	20-22 April, 2014
Interactive Conference of Directors of ICAR Institutes and Vice-Chancellors of SAUs, New Delhi.	28 April, 2014
1st meeting of the Theme-wise Expert Committee under the theme "Livestock and Poultry" at ICAR-NDRI, Karnal.	29 April, 2014
24th meeting of the ICAR Regional Committee No.VIII, ICAR-CPCRI, Trivandrum.	1-2 May, 2014
Brainstorming Workshop on the theme "Strategies for Enhancing Livestock and Fishery Production in the State of Chhattisgarh, Kamadhenu Vishwavidyalaya, Anjora, Durg.	12 May, 2014
Regional Meeting on Dairy Asia, organized by FAO Regional Office for Asia and the Pacific, Bangkok, Thailand.	22 May, 2014
Meeting of the National Academy of Agricultural Sciences, New Delhi.	4 June, 2014
Conference of Directors of ICAR Institutes, New Delhi.	6 June, 2014
Capacity Building Programme of NAIP, New Delhi.	7 June, 2014
Review Meeting of the Project CRC-1148, Witzenhausen, Germany.	24-25 June, 2014
ICAR-NAVS Expert Consultation on "Strategies for Breeding Buffaloes Round the Year", New Delhi.	4 July, 2014
3rd NICRA Review Workshop, and Brainstorming Session on Hydroponic Fodder Production in India, New Delhi.	5 July, 2014
Launch Workshop of AICRP on 'Nutritional and Physiological Approaches for Enhancing Reproductive Performance in Animals' and Review Meeting of project on 'Methane Mitigation', ICAR-NIANP, Bengaluru.	26-27 July, 2014
Directors' Conference and Interface Meeting of Directors of ICAR Institutes and Vice -Chancellors of SAUs, New Delhi.	29-30 July, 2014
National Seminar on "Technologies for Sustainable Production through Climate Resilient Agriculture", JNKVV, Jabalpur.	8 August, 2014
National Symposium of CLFMA and Brainstorming Session on 'Challenges and Opportunities' on the theme From Food to Nutrition Security, Kochi.	18-19 September, 2014
Delivered lecture on "Climate Change" to the students of Christ College, Bengaluru.	29 September, 2014
Meeting of Scientific Advisory Committee of KVK, organized at Hirehalli, Tumkur, Karnataka .	30 September, 2014
ICAR-NAVS Expert Consultation Meet organized by ICAR-NBAGR and ICAR-CICR, New Delhi.	20 October, 2014
6th meeting of GRA Livestock Research Group, organized by the Ministry of Agriculture, Indonesian Agency for Agricultural Research and Development, Yogyakarta, Indonesia .	13-16 November, 2014
Interactive meeting with Honourable Union Minister of Agriculture, Govt. of India at ICAR-NIVEDI, Bengaluru.	9 January, 2015
Workshop on Research and Extension Activities in the field of Animal Husbanry and Veterinary Science, organized by Karnataka Veterinary Council, Bengaluru.	12 January, 2015
Executive Development Programme, ICAR-NAARM, Hyderabad.	19-23 January, 2015
National Seminar on Present Status and Future Prospects of Sexed Semen in India, organized by the Alumni Association of ICAR-NDRI and KMF, Bengaluru.	24 January, 2015
Made presentations to the Honourable Parliamentary Committee on Agriculture comprising of 21 Honourable MPs from Lok Sabha and Rajya Sabha, under the Chairmanship of Shri Hukum Dev Narayan Yadav, Honourable Member of Parliament, ICAR-NIANP, Bengaluru.	2 February, 2015
Delivered lecture on "Climate Change and Livestock Population" for the trainees of "Training-cum-Workshop on Climate Change on Animal Husbandry – Risk Vulnerability and Adaptation Measure", organized by Environmental Management and Policy Research Institute, Department of Forest, Ecology and Environment, Govt. of Karnataka, Bengaluru.	10 February, 2015
13th Annual Conference and National Symposium on "Safety of Foods of Animal Origin for Domestic and Export Markets – Legal Perspectives, organized by the Indian Association of Veterinary Public Health Specialists and KVAFSU; Presented a lead paper on"Green House Gases and Carbon Credits", Veterinary College, Bengaluru.	11 February, 2015
6th Pan Commonwealth Veterinary Conference of the Commonwealth Veterinary Association and the 27th Congress of the Veterinary Association of Malaysia (PCVC6 and 27VAM), organized by Commonwealth Veterinary Association; Delivered keynote address on "Climate Change and Livestock Production: An Indian Perspective", Kuala Lumpur, Malaysia.	23-26 March, 2015

Workshop/ Conference/ Seminar/ Symposium/ Krishi Mela/ Expo Attended by the Scientists

Particulars	Participants
Launch workshop of AICRP on 'Nutritional and Physiological Interventions for Enhancing Reproductive Performance in Animals', 26-27 July, 2014, ICAR-NIANP, Bengaluru.	JP Ravindra, IJ Reddy, S Selvaraju, NKS Gowda, KS Roy, DT Pal
Global Animal Nutrition Conference (GLANCE-2014) on 'Climate Resilient Livestock Feeding Systems for Global Food Security', 20-22 April 2014, Bengaluru.	R Bhatta, JP Ravindra, AV Elangovan, AK Samanta, KS Prasad, NKS Gowda, S Senani, PK Malik, G Ravikiran, KS Roy, M Sridhar, RU Suganthi, A Dhali, IJ Reddy, PSP Gupta, S Mondal, SC Roy, S Nandi, J Ghosh, S Selvaraju, A Mishra, V Sejian, A Mech, A Arangasamy, CG David, Letha Devi G, K Giridhar, T Chandrappa, S Jash, AP Kolte, NM Soren, M Chandrakesharaiah, SBN Rao, DT Pal, D Rajendran, M Bagath
XII Agricultural Science Congress, 6-9 February, 2015, ICAR-NDRI, Karnal.	PSP Gupta, S Nandi
ILRI Workshop on 'Feed innovative Tool kit for Livestock in the Tropics', 22-24 September, 2014, Dak Lak, Vietnam.	D Rajendran
National Symposium on 'Physiological Determinants of Climate Resilient and Sustainable Animal Production', 27-28 November, 2014, ICAR-CIRB, Hisar.	IJ Reddy, A Mishra, KS Roy
International Conference on Reproductive Health, 14-17 February, 2015, Nehru Centre, Mumbai.	SC Roy, S Selvaraju
XXX Annual Convention of the Indian Society for Study of Animal Reproduction (ISSAR), 20-22 November, 2014, College of Veterinary Sciences and Animal Husbandry, Mathura.	A Arangasamy, J Ghosh
International Symposium on 'Current Challenges and Translational Research to Augment Animal Reproduction', 4-5 December, 2014, Madras Veterinary College, Chennai.	A Arangasamy, BK Binsila, S Selvaraju
National Seminar on 'Present Status and Future Prospects of Sexed Semen in India', 24 January, 2015, Bengaluru.	A Arangasamy, BK Binsila, S Selvaraju, PSP Gupta
IX Biennial Conference of ANA on 'Eco-responsive Feeding and Nutrition: Linking Livestock and Livelihood', 22-24 January, 2015, Veterinary College, Guwahati.	AV Elangovan, NKS Gowda, M Chandrasekharaiah, KS Prasad, DT Pal, AK Samanta
Rashtriya Krishi Mela, 19-21 November, 2014, GKVK, UAS, Bengaluru.	NKS Gowda, K Giridhar, Letha Devi G, T Chandrappa, D Rajendran, RU Suganthi
VIV India Expo 2014, 23-25 April, 2014, BIEC, Bengaluru.	K Giridhar, Letha Devi G, T Chandrappa, S Jash, D Rajendran
Interface Meeting of Stake Holders on 'Contingency Measures for Aberrant Rainfall Scenarios in Karnataka', organized by ICAR-CRIDA, 23 May, 2014, UAS, Bengaluru.	K Giridhar, NKS Gowda
Workshop on 'Impact of Capacity Building Programs', Jointly organized NAIP, ICAR and IFPRI, 6-7 June, 2014, NASC Complex, New Delhi.	AK Samanta, SBN Rao, R Bhatta
Annual Meeting of Zonal Technology Management Committee, 9-10 October, 2014, ICAR-IIHR, Bangalore.	AP Kolte, Letha Devi G
2nd Advisory Committee Meeting of NASF Project on 'Enhancing Development Competence of Oocytes for Better in vitro Fertilizing Ability', 1-2 December, 2014, ICAR-NDRI, Karnal.	A Dhali, AP Kolte
National Conference on 'Native Chicken Production: Challenges and Opportunities', 3-4 September, 2014, Veterinary College, Chennai.	IJ Reddy, AV Elangovan
2nd International Conference on Animal and Dairy Sciences, organized by the OMICS Group Conferences, 15-17 September, 2014, International Convention Centre, Hyderabad.	A Mech, RU Suganthi
Task Force Meeting of DBT, 10 June, 2014, New Delhi.	M Sridhar
Second Meeting for the year 2014 of the Town Official Language Implementation Committee, 19 December, 2014, CSIR-National Aerospace Laboratories, Bengaluru.	M Sridhar

Particulars	Participants
Seminar on "The Journey of a Woman from the Womb to the Tomb" conducted by the Mahila Dakshata Samiti in association with the Centre for Research Education Service and Training (CREST), 21 February, 2015, Police Commissioner's Office, Bengaluru.	M Sridhar
Institute Joint Staff Council Meeting as a Member (official side), 03 March, 2015, ICAR-NIANP, Bengaluru.	M Sridhar
Brain Storming Session on 'Insects Related to Veterinary and Fisheries Sciences', 26 July, 2014, ICAR-NBAII, Bengaluru.	AV Elangovan
Workshop for HRD Nodal Officers, 26 February, 2015, ICAR-NAARM, Hyderabad.	AV Elangovan
National Brain Storming Workshop on 'Strategies for Enhancing Livestock and Fisheries Production in the State of Chhattisgarh', 12-13 May 2014, Veterinary college, Kamadhenu Vishwavidyalaya, Durg.	NKS Gowda
National Seminar on 'Underutilised Fruits', 3 December, 2014, Regional station of ICAR-IIHR, Chettalli, Coorg.	NKS Gowda
RAC Meeting of ICAR-NRC Yak, 9-10 July, 2014, Dirang, Arunachal Pradesh.	NKS Gowda
International Workshop on 'Production, Animal Health and Welfare Research: Impact and Opportunities', jointly organized by ICAR and The University of Edinburgh's Royal (Dick) School of Veterinary Studies and Roslin Institute, 16-17 February, 2015, NASC Complex, New Delhi.	KS Roy
National Seminar on 'Clinical Proteomics for Veterinary and Allied Sciences', 18-19 July, 2014, Puducherry, Tamil Nadu.	RU Suganthi
4th Annual Review Meeting of NFBSFARA, 10-12 February, 2015, NASC Complex, New Delhi.	S Mondal
102nd Session of Indian Science Congress, 3-7 January, 2015, Mumbai University, Mumbai.	S Mondal
35th Annual Conference of Indian Association of Biomedical Scientists (IABMS), 14-16 November, 2014, CSK Himachal Pradesh Agricultural University.	S Mondal
2nd International Conference on 'Bio-resource and Stress Management', 7-10 Jan 2015, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad.	V Sejian
International Conference on AFHAFBC-2014, 30-31 August, 2014, JNU, New Delhi.	S Nandi
International Symposium on 'New Perspectives in Modern Biotechnology', 23-25 March, 2015, Puducherry, Tamil Nadu.	S Nandi
Brain Storming Session on 'Monitoring and Evaluation of Agricultural Research, Education and Extension for Development (AREE4D)', 28 June, 2014, ISEC, Agricultural Development and Rural Transformation Centre, Bengaluru.	S Selvaraju
Conference on 'Applying NGS: Basic Research, Agriculture and Healthcare', organized by Genotypic Technologies, 11 September, 2014, Bengaluru.	S Selvaraju
National Conference on 'Stress and Health: Frontiers of Research in Stress Related Diseases and Management', 12-13 February, 2015, Maharani's Science College for Women, Bengaluru.	S Selvaraju
83rd Annual Meeting of the Society of Biological Chemists (India) on 'Evolution: Molecules to Life', 18-21 December, 2014, KIIT University, Bhubaneswar.	SC Roy
Regional Workshop of AICRP on Integrated Farming Systems, 9 July, 2014, ANGRAU, Hyderabad.	K Giridhar
Seminar for Dairy Farmers organized by KMF (Dharwar Milk Union), 31 July, 2014, Sirsi, Karnataka.	K Giridhar
National Summit on 'Cerebration of Forage Issues', 17 November, 2014, ICAR-IGFRI, Jhansi.	K Giridhar
Workshop on 'Near Infrared Spectroscopy for Forage Quality Evaluation', 5-7 January, 2015, CRS of BAIF, Urulikanchan, Pune.	K Giridhar
Meeting of the Town Official Language Implementation Committee, 23 July and 19 December, 2014, Bengaluru.	S Senani

Particulars	Participants
Institute Animal Ethical Committee (IAEC) meeting of SRS of ICAR-NDRI as a member, 16 March, 2015, ICAR-NDRI-SRS, Bengaluru.	M Chandrasekharaiah
Meeting on Sheep and Goat Mineral Mixture Technology Promotion, organized by the Dept. of AH&VS, Govt. of Karnataka, 11 August, 2014, Bengaluru.	DT Pal
Institutional Ethical Committee Meeting of the National Ayurveda Dietetics Research Institute, 5 July, 2014 and 13 February, 2015, Bengaluru.	AK Samanta
Awareness Workshop on 'Biometric Attendance System for Nodal Officers', 4 March, 2015, IT Department, CR Building, Bengaluru.	AP Kolte

List of Workshop/ Training Conducted for Stakeholders

Particular	Date	Venue	Participants
Training on Vermicomposting and Azolla cultivation.	01.07.2014	KVK, Chintamani, Kolar	100
Hands on training in animal feeding technologies for officers from Hessaraghatta.	24.07.2014	ICAR-NIANP, Bengaluru	14
Technology Awareness program on Feed Assist.	25.07.2014	ICAR-NIANP, Bengaluru	20
Use of pineapple fruit residue silage as fodder.	31.07.2014	Sirsi, Shimoga	100
Contingency measures for livestock feeding, health and management during adverse weather condition.	30.06.2014	Anavatti, Shimoga	200
Contingency measures for livestock feeding, health and management during adverse weather condition.	16.07.2014	Hadonahalli, Rural Bengaluru	112
Contingency measures for livestock feeding, health and management during adverse weather condition.	22.07.2014	Hiriyur, Chitradurga	100
Contingency measures for livestock feeding, health and management during adverse weather condition.	23.07.2014	Taralabalu KVK, Davanagere	100
Contingency measures for livestock feeding, health and management during adverse weather condition.	12.08.2014	Chintamani, Kolar	100
Contingency measures for livestock feeding, health and management during adverse weather condition.	22.08.2014	Bijapur	127
Contingency measures for livestock feeding, health and management during adverse weather condition.	27.08.2014	Gulbarga	80
Feeding strategies for dairy animals.	04.11.2014	Hadonahalli, Rural Bengaluru	75
Fodder and Nutrient management in dairy farming.	27.11.2014	Sirsi, Uttara Kannada	75
Feed and fodder management for livestock.	12.12.2014	Hirehalli, Tumkur	100
Ration balancing and demonstration of feed assist.	20.12.2014	Tumkur	100
Workshop on 'Usage of Science in Animal Husbandry' as a part of National Science Week celebrations.	25.02.2015	D.Nagenahalli, Tumkur	60
Technology Awareness program on Feed Assist.	25.07.2014	ICAR-NIANP, Bengaluru	20

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. CS Prasad Director, ICAR-NIANP, Bengaluru	Member (Up to August, 2014)
Dr. R Bhatta Director, ICAR-NIANP, Bengaluru	Member (From August, 2014)
Dr. SV Deshmukh Associate Dean, Veterinary College, MAFSU, Parbhani	Member
Dr. G Verma Professor, Dept. of Vety. Physiology, CVASc, Mannuthy, Kerala	Member
Dr. G Dinakar Raj Head, Dept. of Animal Biotechnology, Madras Veterinary College, Chennai	Member
Dr. SS Raju, Principal Scientist, ICAR-NCAP, New Delhi	Member
Dr. PG Phalke CLFMA of India, Mumbai	Member
Shri SM Hegde Heranahalli, Sirsi, Karnataka	Member (Up to October, 2014)
Shri.V Kore MLA, Warana Milk cooperative, Kolhapur, Maharashtra	Member (Up to October, 2014)
Dr. JP Ravindra, PS and In charge, PME Cell, ICAR-NIANP	Member Secretary
The Secretary/Nominee DAHDF, Govt. of India, New Delhi	Special invitee

Highlights of the proceedings of the 20th meeting of the Research Advisory Committee of the Institute held on 27 February, 2015

The 20th meeting of the Research Advisory Committee of the Institute was held on 27th February, 2015 under the chairmanship of Dr. KM Bujarbaruah, Vice Chancellor, Assam Agricultural University, Jorhat. The other members present were Dr. R Bhatta, Director, ICAR-NIANP, Dr. G Verma, Dr. G Dhinakar Raj, Dr. SS Raju, Dr. PG Phalke, Dr. A Yadav (Special Nominee, DAHDF) and Dr. JP Ravindra (Member Secretary). Dr. CS Prasad, Former Director of ICAR-NIANP also attended the meeting as a special invitee. All the scientists of the Institute presented the progress of their research projects and interacted with the committee.

The Director of the Institute welcomed the chairman and members of the Committee to the 20th meeting and briefed about the achievements and related activities. Taking note of the achievements of the Institute over the last year as presented by the Director, the Chairman opined that the progress was good. He drew attention of the Institute to the issues like i) enhancing digestibility/ availability of nutrients as integral part of the postharvest processing, ii) preparing a roadmap for PG programme/ research in collaboration with universities/ colleges especially those with meager facilities, and iii) scientists after having updated their skills and knowledge during their overseas training, should make use of the same in framing newer research projects.

Brief presentations were made by the acting HOD/ In charge of Divisions/ Sections on the objectives, approach, progress and outcome of the completed, ongoing and newly proposed research projects. The chairman appreciated the efforts of the scientists and thanked them for excellent presentations. He thanked all the members of the Committee for their active participation in the discussions and providing valuable inputs. With the inputs from the other members of the committee, the Chairman emphasized that the newly proposed projects should have linkage with the Institute's vision document and techniques developed should be market driven. He also mentioned that the Insitute should take initiatives to work on traceability issues such as tracing out origin of feed and fodder, write policy papers on animal nutrition and physiology for planning commission journals and conduct basic research to fill gaps in science and strategic research to tutor needs of end users.

Major recommendations of the RAC are listed below.

- Institute may seek recommendation from DAHDF for updating the dynamic database information system and subsequently ICAR-NIANP may continue it as an institute activity.
- Challenging areas are to be looked at like culturing rumen bacteria, delivery of siRNA, development of stem cell lines through novel means etc.
- Writing policy papers on animal nutrition and physiology and publishing those in the planning commission journals.
- Venture into newer areas of research like pet and lab animal nutrition.
- Organizing training programmes and involving NGOs for effective dissemination of the technologies and knowledge developed by the Institute.
- Linking new research project proposals with the vision document of the Institute.
- Techniques developed should be market driven, both buyers' and sellers' market.
- Burning issues of industry like antibiotic residues, ban in the use of meat/ bone meal etc. are to be addressed by the Institute through research and development of specific standards.

Institute Research Committee Meeting

The midterm 'Institute Research Committee' meeting for the half yearly period of April to September, 2014 was held on 30 October, 2014, to discuss the progress of ongoing institute research projects. Dr. R Bhatta, Director and Chairman of the Committee presided the meeting and Dr. SBN Rao, Member-Secretary coordinated the deliberations. The Chairman, in his opening remarks, expressed that duplication of research activities and plagiarism must be avoided. He sensitized the scientists for brining as many as possible external funded projects. The chairman stressed the importance of bringing out quality publications in high impact research journals. He further expressed that the Instittte and external funded research projects should be fundamental and basic research oriented as per the mandate. It was proposed during the meeting to keep personal files for individual scientists for maintaining all RPPs for easy retrieval and assessment. The progress of 17 Institute research projects was presented during the meeting. Following each presentation, the scientists actively participated in discussing the progress critically and offered valuable suggestions and inputs for the future work. During the meeting, it was proposed to initate a research project for developing suitable inoculums for silage making for commercialization and Dr. M Sridhar and Dr. S Senani were entrusted with the responsibility.

Institute Management Committee

The 33rd Institute Management Committee meeting was held on 27 December, 2014. The meeting was attended by Dr. R Bhatta, Dr. S Dixit, Dr. M Gajendragad, Dr. KP Ramesha, Dr. JP Ravindra and Shri S Athimoolam. Besides, the officers from ICAR-NIANP, Dr. M Sridhar (I/C HOD, BES), Dr. KS Prasad (I/C HOD, AND) and Dr. NKS Gowda (I/C, KMBS) also attended the meeting as special invitees. The chairman presented various activities of the Instiute including various research endeavours. Different agenda items were discussed in details during the meeting and the committee prioritized the proposed works and procurement of instruments. Several important decisions related to infrastructure development and other institute activities were taken during the meeting.

Institute Management Committee

Name	Designation
Dr. Raghavendra Bhatta Director, ICAR-NIANP, Bengaluru	Chairman
Dr. M Gajendragad PS, ICAR-NIVEDI, Bengaluru	Member
Dr. KP Ramesha PS, SRS of ICAR-NDRI, Bengaluru	Member
Dr. S Dixit Zonal Coordinator, ZPD Unit VIII, Bengaluru	Member
Dr. JP Ravindra I/C HOD, APD, ICAR-NIANP, Bengaluru	Member
ADG (AN&P), ICAR, New Delhi	Member
Director, Department of Animal Husbandry and Veterinary Sciences Government of Karnataka, Bengaluru	Member
Dean, College of Veterinary and Animal Sciences, SVVU, Tirupati	Member
Dean, Veterinary College, KVAFSU, Bengaluru	Member
Finance and Accounts Officer, ICAR-NBAII, Bengaluru	Member
Shri. SM Hegde Farmer, Prashanta Nilaya, Heeranahalli, Sirsi, Karnataka	Member
Shri. V Kore MLA, Warana Milk Cooperative, Kolhapur, Maharashtra	Member
Shri. S Athimoolam, Administrative Officer, ICAR-NIANP, Bengaluru	Member Secretary

Launch Workshop of AICRP on 'Nutritional and Physiological Interventions for Enhancing Reproductive Performance in Animals'

The launch workshop of AICRP on 'Nutritional and Physiological Interventions for Enhancing Reproductive Performance in Animals' was held on 26-27 July, 2014. The workshop was inaugurated by Dr. BS Prakash, ADG (AN&P), ICAR, New Delhi on 26 July at ICAR-NIANP, Bengaluru. The workshop was chaired by Dr. BS Prakash and the Director of the Institute. Dr. R Gupta, Principal Scientist, ICAR, New Delhi and Dr. MR Garg, General Manager, NDDB, Gujarat were also present as guests of honour. Eighteen PIs and Co-PIs from the 12 different centres of the project actively participated in the workshop.

In House Seminar

Date	Talk delivered	Speakers
05-04-2014	Life-cycle analysis of agricultural greenhouse gasemissions.	A Mech
12-06-2014	Agricultural higher education system in the changing landscape of Indian education.	J Ghosh
16-07-2014	Role of ICAR on Development of Indian Agriculture andEducation.	J Ghosh
25-10-2014	Near Infrared Spectrometry (NIRS) for evaluation of foragequality.	K Giridhar
13-01-2015	Response of super dosing of phytase in normal or low phosphorus-calcium diet of broiler chicken.	Prof. (Mrs.) S Ali, CV RAMAN International Fellow for African Researchers
10-03-2015	Isolation of methylotrophic methanogens from pasture fed sheep	PK Malik

Linkages and Collaboration within India and Abroad

- Collaboration established with the Shinshu University, Nagano, Japan under the Indo-Japan (DST-JSPS) project on 'Methane mitigation using unexplored phyto sources in ruminants and their effect on rumen microbial diversity'.
- Collaboration established with CIRAD, France as a part of the ARChE_Net project.

Distinguished Visitors

Name of visitor	Date
Dr. RB Singh, former Chairman, ASRB	23.04.2014
Dr. (Mrs.) B Meenakumari, DDG (Fisheries), ICAR	24.05.2014
Honourable Justice Shri. SS Saron, Judge, Punjab and Haryana High Court, Chandigarh	23.06.2014
Shri V Acharya, IAS, Secretary to Govt. of Karnataka, Department of Environment and Ecology	09.07.2014
Mr. J Lagos, Agricultural Attache, USDA, American Embassy, New Delhi	10-07-2014
Ms. R Mani, Agricultural Specialist, USDA, American Embassy, New Delhi	10.07.2014
Dr. BS Prakash, Assistant Director General (AN&P), ICAR	26.07.2014
Dr. VK Taneja, Vice-Chancellor, GADVASU, Ludhiana	02.08.2014
Dr. R Rao, Registrar, RAJUVAS, Bikaner	02.08.2014
Dr. RN Sreenivas Gowda, former Vice-Chancellor, KVAFSU	27.08.2014
Shri T Nanda Kumar, IAS, Chairman, NDDB, Anand	15.09.2014
Dr. AK Rawat, Director, DBT, Govt. of India, New Delhi	26.09.2014
Ms. J Akhtar, IRS, Commissioner of Income Tax, Bengaluru	01.11.2014
Dr. (Mrs.) S Deshmukh, Dean, Jain University, Bengaluru	12.11.2014
Dr. K Pradhan, former Vice-Chancellor, OUAT and RAU	24.11.2014
Dr. M Mahadevappa, former Chairman, ASRB	24.11.2014
Dr. ML Madan, former DDG (AS), ICAR	02.12.2014
Dr. KML Pathak, DDG (AS), ICAR	18.12.2014
Shri R Manohar, IAS, Chief Executive Officer, Govt. of Karnataka, Karwar	02.01.2015
Dr. S Abdul Rahman, President, Commonwealth Veterinary Association	20.01.2015
Dr. DM Das, Director of Animal Husbandry and Veterinary Services, Govt. of Karnataka, Bengaluru	27.01.2015
Parliamentary Committee on Agriculture, comprising of 21 Honourable MPs from Lok Sabha and Rajya Sabha under the chairmanship of Shri Hukum Dev Narayan Yadav, Honourable Member of Parliament	02.02.2015
Shri SR Nagar, Manager, State Level Central Semen Station, MP Dairy Federation, Bhopal	05.02.2015
Dr. KM Bujarbaruah, Vice-Chancellor, AAU, Jorhat	27.02.2015
Dr. BSV Reddy, former Dean, Veterinary College, KVAFSU, Bengaluru	28.02.2015
Ms. B Adige, Social Activist for Welfare of Women	31.03.2015

Visitors

Dr. KML Pathak, DDG (AS), ICAR

Parliamentary Committee on Agriculture

Dr. (Mrs.) B Meenakumari, DDG (Fisheries), ICAR

Dr. AK Rawat, Director, DBT, Govt. of India

Shri T Nanda Kumar, Chairman, NDDB

Ms. J Akhtar, IRS, Commissioner of Income Tax

Ms.R Mani and Mr. J Lagos, USDA

Dr. S Abdul Rahman, President, CVA

Students' Research

Name	Degree/ University/ Academic year	Dissertation title
PK Javvaji	PhD/ Jain University/ 2013-2016	Effect of cytokine supplementation on the development and quality of in vitro cultured sheep oocytes and embryos.
FJ Rabinson	PhD/ Jain University/ 2013-2016	Effect of season on oocyte developmental competence in sheep.
L Jose	PhD/ Jain University/ 2013-2016	Rumen metatranscriptome analysis to identify the genes involved in the deconstruction of plant cell wall polysaccharide.
J Chikkerur	PhD/ Jain University/ 2013-2016	Isolation of microbes for enzymatic production of short chain oligosaccharides and its evaluation as prebiotic.
S Roy	PhD/ Jain University/ 2015-2018	Efective biological production of D-tagatose using D-galactose and evaluation of its nutraceutical potentiality.
D Shet	PhD/ Jain University/ 2012-2016	Production and evaluation of Microbial Phytase in the diet of layer chicken.
A Sreeja	PhD/ Jain University/ 2012-2016	Purification and properties of fungal phytase and its evaluation in broiler chicken.
BD Punith	PhD/ Jain University/ 2013-2016	Profiling liver transcriptome and defining the role of efflux transporter ATP7B during copper deficiency in sheep (*Ovis aries*).
VR Jithil	MVSc/ ICAR-IVRI/2014-2015	Comparative proteomic analysis of non pregnant and early pregnant buffaloes serum exosome fraction and urine.
S Shreevidhya	PhD/ Jain University/ 2012-2015	Heterologous expression and characterization of buffalo pregnancy associated glycoprotein (PAG).
S Kannan	PhD/ Jain University/ 2013-2016	Supplementation of asymmetric cell kinetic inhibitor on long term maintenance of porcine mesenchymal stem cell culture.
S Nazar	PhD/ Jain University/ 2013-2016	Angiogenesis pattern and its related gene expression in endometrial tissues during different stages estrous cycle in goats (*Capra hircus*).
L Somashekar	PhD/ Jain University/ 2013-2016	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/ 2012-2015	The production of lignin peroxidase from white rot fungi and its role in delignification of crop residues.
RG Rao	PhD/ Jain University/ 2013-2016	Biochemical characterization and mechanism of lignin degradation in crop residues using manganese peroxidase of Basidiomycete.
TV Bhaskar	PhD/ ICAR-IVRI/2012-2015	Study on influence of boron on bone mineralization, immunity and histopathology in rats and sheep.
R Soni	MVSc/ ICAR-NDRI/ 2015-2016	Studies on the effect of copper and selenium on granulose cell estradiol synthesis in goats.
M Saravanan	PhD/ Jain University/ 2012-2015	Attenuation of ruminal methanogenesis using sulphur containing compounds.
L Baruah	PhD/ Jain University/ 2012-2015	Metagenomic analysis of rumen methanogen and fermentation dynamics using plant phenolics.
A Mor	PhD/ Jain University/ 2013-2016	Expression profiling of developmentally important genes in sheep embryos during different embryonic stages.
M Shilpa	MVSc/ KVAFSU/2014-2015	Idenitifation of seminal RNAs as indicators of reproductive performance in bulls.
S Parthipan	PhD/ Jain University/ 2013-2016	Identification of functional transcripts involved in fertility regulation of bull spermatozoa.
TK Varun	MVSc/ ICAR-NDRI/ 2013-2015	Production of chitooligosaccharides from fishery waste, their characterization and evaluation as prebiotic.
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/ 2013-2016	Molecular characterization of some motility-associated proteins in buffalo (*Bubalus bubalis*) bull semen.
M Rana	MVSc / ICAR-IVRI/ 2014-2015	Status of antioxidant defences of epididymal fluid and sperm from caput to cauda in goat (*Capra hircus*).
S Kar	MVSc/ ICAR-IVRI/ 2013-2014	Effect of cryopreservation on antioxidant defences of buffalo (*Bubalus bubalis*) spermatozoa.
S Shaji	Integrated MSc/ KVASU/2014-2015	Impact of heat and nutritional stress on adaptive capability of bucks.
K Chaidanya	Integrated MSc/ KVASU/2014-2015	Impact of heat and nutritional stress on metabolic activity and rumen fermentation profile in bucks.
PA Abdul Niyas	Integrated MSc/ KVASU/2014-2015	Impact of heat and nutritional stress on the growth and reproductive performance of bucks.

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. During last year, ICAR sponsored short course on 'Harnessing Intellectual Property in Animal Science Sector in the Changing Global Scenario' was organized to enhance the awareness about IP initiatives undertaken by ICAR and information on intellectual property management and commercialization. The unit is guided by the 'Institute Technology Management Committee' headed by the Director of ICAR-NIANP and members from different divisions and an external IPR expert. Three patent applications were filed at Chennai patent office during the reported period. The sample analysis services available through the unit are feed analysis, mineral estimation in animal feeds, hormonal estimation and microbiological and toxicological analysis for animal feed and its components.

ASRB-ICAR Online Examination Centre

The 'Online Examination Centre for Karnataka' has been established at ICAR-NIANP for ICAR NET/ARS Prelim exams conducted by ASRB. The centre consists of 100 terminals for taking exams and also equipped with two servers, 30KvA online UPS and a dedicated 8Mbps internet connectivity housed in an air-conditioned hall. The examination hall is under the surveillance of 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. Several mock tests were successfully conducted in the past, and two NET/ARS (Net/ARS, 2014) and one Assistant Online Examination were successfully conducted during the reported period.

ARIS cell

Agricultural Research Information Systems (ARIS) was set up at ICAR-NIANP in the year 1998. The Cell maintains more than 200 computers and 100 printers. Most of the computers are internet connected. The Cell holds 100Mbps NKN connectivity in addition to 8Mbps and 1Mbps Bsnl connection, through which all the computers are availing internet facility. Maintenance activity of 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 trouble shooting services are taken care by the Cell. System security service in all the systems is 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 personnel. The web site of the Institute is maintained by the Cell and regularly updated. Software like 'Feed Base' and web portals like 'Feed Chart' and 'Indian Livestock Feed Portal' have been developed and are hosted on the ICAR-NIANP website.

Experimental Livestock Unit

During the year 2014-15, at the 'Experimental Livestock Unit', four buffaloes, 21 cattle, 80 sheep, 52 goats, 250 poultry birds and 135 rats were maintained for experimental purpose. During the period, animal experiments were conducted under ten different research projects.

Fodder Production Unit

The unit is entrusted with the responsibility of round the year supply of green fodder to the Experimental Livestock Unit of the Institute. During the year, various forages like Maize, Jowar (variety: CoFS-29), Rhodes grass, Hybrid Napier Bajra, Guinea grass and Para grass were cultivated. Demonstration plots of Mulberry and Guinea grass were developed. The top feeds were

regularly supplied from Sesbania and Gliricidia trees raised on the field bunds. Azolla cultivation continued in shallow ponds and portable HDPE containers for its use as supplemental feed. The seedlings of fodder trees like Melia and Sesbania, stem cuttings of Gliricidia, root slips of Hybrid Napier Bajra and the culture of azolla were supplied to several farmers. Silage was prepared using Maize, Rhodes grass and Hybrid Napier Bajra in the plastic bins as well as HDPE bags. Method demonstrations were conducted on azolla cultivation in HDPE containers, and silage preparation in plastic bags and bins for the benefit of trainees and farmers.

Library

An amount of Rs. 25.2 lakhs was incurred during the reported period towards the development of library and information resources infrastructure. Presently, the Library is subscribing to 27 Foreign (including 6 Online, 13 free online along with print version and 8 solely printed Journals) and 22 Indian Journals to keep the scientists and technical staff abreast of the latest scientific and technical developments. Additionally the library subscribes seven general magazines, seven newspapers and has received 276 gratis publications from India as well as from International Institutions/ Organizations. The library has 3111 back volumes and 40 unbound titles of Indian and Foreign journals. The Library facilities are also offered to the officials and students of the Veterinary Colleges, Universities, researchers and other ICAR Institute officials for their reference work. The library has developed and maintains Library Web Portal, which 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. The portal is updated regularly. Computerization of the Library is under progress. Notably, the Library has fulfilled 167 requests from the outside readers by sending articles of their interest by post/ online under the 'Consortium for e-Resources in Agriculture'. Library has collected all the publications of the Institute's scientists since 1995 and launched 'Institutional Repository' comprised of title, author source, abstracts of all the scholar publications that have been made available for retrieval and dissemination purpose. Library has also rendered reprographic services to the staff, trainees and students.

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, an Official Language Implementation Committee (OLIC) works under the chairmanship of the Director. The progress of official language implementation is monitored through quarterly meetings of OLIC. Minutes of these meetings are sent to ICAR headquarter for information and monitoring. Four Hindi Workshops were conducted, one in each quarter to resolve the difficulties of staff to work in official language. These workshops emphasized the use of computers and software for carrying out routine office work in Hindi. The Institute celebrated Hindi Fortnight from 14 - 30 September, 2014. Various competitions were organized for the staff. In the valedictory function, Dr. J Akhtar, Income Tax Commissioner, Bengaluru, was the chief guest. She enthralled the gathering with her scintillating speech. On this occasion prizes were distributed to the winners of various competitions.

Staff Welfare Club

The Staff Welfare Club was actively involved in the various welfare activities of the staff. During the reported period, the Institute bid farewell to Dr. CS Prasad, Director and Shri N Shivkumar, Assistant Chief Technical Officer on superannuation. The Club heartily welcomed Dr. R Bhatta as the new Director of the institute to continue the legacy of his predecessors. The Club also welcomed newly joined scientist Dr. (Mrs.) BB Krishnan and two technical officers, Mrs. G Maya and Mr. KM Kamlesh. The Club paid respectful homage to Late Dr. P Khandekar, Principal

Scientist and I/C KMBS and Late Shri PS Jadaya, Supporting Staff. The Independence Day and Republic Day were celebrated with grandeur, and various sports activities, drawing competition etc. were organized for the staff and the children. The staff paid devotion to Lord Ganesha on Ganesh Chaturthi for the prosperity and wellbeing of all. The 'Ayudh Puja-worship of implements', 'New Year-2015' and 'Pongal' were celebrated with equal festive fervor. The 'Annual General Body Meeting' of the Club was held on 3 September, 2014 and all the members profusely appreciated various activities of the Club. Two movie shows were screened on holidays for the entertainment of the staff and their family members. To keep the staff hearty and healthy a free "Yoga and Health" seminar was organized.

Complaints Committee/ Women's Cell

The complaints committee/ Women's Cell of the Institute has been reconstituted on 22 March, 2014 and is currently functioning with Dr. M Sridhar, as chairperson, and Dr. A Mech, Mrs. Kalaivani and Dr. S Senani (Male representative) as Members. Mrs. U Nanaiah, Secretary, Mahila Dakshata Samiti, Bengaluru is the external member of the Cell. The Cell meets regularly and looks into the welfare of the women employees, both permanent and contractual worker as well as the students working in the various laboratories of the Institute. The cell celebrated the Women's Day on 31 March, 2015. A Common Room Facility housed on the second floor of the Institute building exclusively meant for the women staff, was inaugurated by the Chief Guest Ms. B Adige, a renowned social activist and honorary director of the 'Global Concerns India'. The senior most woman staff of the Institute, Mrs. Ningamma, SSS was felicitated on the occasion.

Academic Cell

The Institute has signed MOU with Jain University, Bengaluru and Bangalore University to offer research programs leading to PhD degree. The Institute has also collaborated with KVASU (Kerala), KVAFSU (Bengaluru), ICAR-IVRI (Izatnagar) and ICAR-NDRI (Karnal) for guiding PG and PhD students in various disciplines. At present, there are 22 Ph.D and 6 PG students, who are registered at different universities/ Institutes and perusing their dissertation work at ICAR-NIANP.

HRD Cell

The Cell is actively involved in facilitating various HRD activities related to training programmes and workshops on the practical aspects of animal nutrition and reproduction. During the reported period, the Cell helped in organizing various training programmes and workshops for the Veterinary and Agricultural University faculties, ICAR scientists, farmers and extension workers. The 'Attachment Training' under the orientation training programme in ARS for 3 months for the newly recruited ARS Scientists from different ICAR Institutes was also organized by the Cell.

Global Animal Nutrition Conference (Glance-2014)

The Institute in association with the 'Animal Nutrition Society of India (ANSI)', 'Compound Livestock Feed Manufacturers Association (CLFMA)' and 'VIV India' organized the 'Global Animal Nutrition Conference

(Glance-2014)' from 20 - 22 April 2014 at 'Vivanta by Taj', Bengaluru. The Global conference was attended by scientists, academicians, government officials from the Ministry of Agriculture, Govt. of India, feed industry, development agencies engaged in the livestock sector, Research Scholars and Students from India and abroad. The theme of GLANCE-2014 was climate resilient livestock feeding systems for global food security. The conference provided an excellent platform for around 550 delegates to share, exchange, and update with the recent developments and forge new alliances/ partnerships in addressing the present and future problems and contribute to the betterment of the livestock sector and livelihood.

Celebration of ICAR Foundation Day

The ICAR foundation day was celebrated at ICAR-NIANP as well as in the village on 16 July, 2014. An interactive farmer's meet was arranged at Krishi Vigyan Kendra, Hadonahalli village, Doddaballapur, Bengaluru Rural as a part of advisory and technical support to farmers to be in preparedness for facing the challenges of low rainfall. A multidisciplinary team of scientists visited and interacted with the farmers and provided inputs in the area of animal feeding, management and health.

At the institute, a quiz competition was arranged for the students and the project research associates. A talk was delivered by Dr. J Ghosh, Senior Scientist, on the activities of 'Indian Council of Agricultural Research' in the development of Indian agriculture and education. A video on 'Drivers of Change', published by the ICAR was also screened. This was followed by the Director's address, where he reiterated the commitment of the institute for the welfare of livestock farmers. He congratulated the team of scientists who were awarded the best 'ICAR Team Research Award' in animal sciences. He also stressed the need for teamwork and inter-institutional collaborative research endeavours.

Celebration of Institute Foundation Day

The '19th Foundation Day' of the Institute was celebrated along with '59th Kannada Rajyotsava' on 24 November, 2014. As a part of the celebration, the forenoon session was observed as "Open Day" for the undergraduate and postgraduate students from the College of Veterinary Sciences, Hebbal, Bengaluru to provide them an exposure of the research activities of the Institute and encourage them for pursuing research career in the field of animal nutrition and physiology.

The legendary Animal Nutritionist Dr. K Pradhan and Plant Breeder Padma Bhushan Dr. M Mahadevappa were the Chief Guests for the programme. In the inaugural lecture, the Director of the Institute Dr. R Bhatta mentioned how the Institute has laid a strong foundation and flourished under the leadership of the previous Directors and seniors professionals associated with the institute. He also mentioned that the visibility of the Institute can only be amplified through quality publications and technology developments. The Innovation Award 2003-14 in the Scientific Category and Awards for excelling in the Secondary Examination were also given to the scientists and children of the staff. In the foundation day lecture, Dr. K Pradhan emphasized that the future research endeavours should be oriented to the climate change issues taking into consideration the conservation of environment and water. In the Kannada Rajyotsava day lecture, Dr. M Mahadevappa urged to the scientists to write technical books and bulletins in

different Indian languages for better understanding and adoption of the agricultural technologies by the Indian farmers.

Celebration of National Science Day

As per the directives from the Ministry of Science and Technology, Govt. of India/ICAR, the Institute observed National Science Day-2015 on the theme "Science for Nation Building". The Institute organized several events during 23rd to 28th February 2015 to commemorate the occasion. The scientists from the Institute visited village and interacted with the livestock farmers and imparted training on the feeding practices, shelter management, maintainance of hygienic environment etc. The Institute invited students from several Kendriya Vidyalayas to participate in events like elocution, quiz and science fair. Essay writing competition for the staff on the theme of importance of science was held. The celebrations concluded on 28th February, 2015 with the address by the chief guest, Dr. BSV Reddy, former Dean, Veterinary College, Bengaluru, who spoke about the need for pursuing science and encouraged the gathering to give importance to the study of science for nation building.

Right to information

A total of 11 RTI applications were received during the reported period. Among those, 10 applications were accepted and requisite information was provided. In one case, the information was not provided by invoking the section 8(3) of the RTI Act, 2005. Dr. SBN Rao, PS, acted as 'Public Information Officer' and Shri S Athimoolam, AO, acted as 'Assistant Public Information Officer' for the Institute during the reported period.

Swachh Bharat Abhiyan

In accordance with the instructions of the GOI/Council, the institute participated in the Swacch Bharat andolan/cleanliness drive. Initiating the programme, the Director, ICAR-NIANP, Bengaluru administered a Pledge on 2nd October 2014, to all the staff of the Institute as well as the research scholars, contractual workers and students. All the staff members and residents of the Institute campus including children took out a parade with slogans pertaining to cleanliness and hygiene. Subsequently, they voluntarily participated in cleanliness drive in the campus of the Institute with much enthusiasm. Appropriate posters were also placed in different places in the campus to create awareness. The Institute campus was spruced up and was given a fresh look. Further, on the occasion of "National Science Day" celebration, Swachh Bharat campaign was also promoted at D.Nagenahalli village, Tumkur District, Karnataka.

Personnel

List of Employees

Name	Designation
Dr. Raghavendra Bhatta	Director
Animal Nutrition Division	
Dr. KS Ramachandra	Principal Scientist, I/C HOD
Dr. KS Prasad	Principal Scientist
Dr. SBN Rao	Principal Scientist
Dr. M Chandrasekharaiah	Principal Scientist
Dr. AK Samanta	Principal Scientist
Dr. S Senani	Principal Scientist
Dr. S Anandan	Principal Scientist (on EOL)
Dr. NKS Gowda	Principal Scientist
Dr. DT Pal	Principal Scientist
Dr. (Mrs.) A Thulasi	Senior Scientist
Dr. D Rajendran	Senior Scientist
Dr. NM Soren	Senior Scientist
Dr S Jash	Scientist
Dr. AP Kolte	Scientist
Dr. M Bagath	Scientist
Animal Physiology Division	
Dr. JP Ravindra	Principal Scientist, I/C HOD
Dr. JR Ippala	Principal Scientist
Dr. PSP Gupta	Principal Scientist
Dr. S Mondal	Principal Scientist
Dr. SC Roy	Principal Scientist
Dr. S Nandi	Principal Scientist
Dr. J Ghosh	Senior Scientist
Dr. S Selvaraju	Senior Scientist
Dr. ICG David	Senior Scientist
Dr. V Sejian	Senior Scientist
Dr. A Arangasamy	Senior Scientist
Dr. A Mishra	Senior Scientist
Dr. (Mrs.) A Mech	Scientist
Dr. (Mrs.) BB Krishnan	Scientist
Bioenergetics and Environmental Sciences Division	
Dr. (Mrs.) M Sridhar	Principal Scientist, I/C HOD
Dr. AV Elangovan	Principal Scientist
Dr. KS Roy	Principal Scientist
Dr. G Ravikiran	Senior Scientist
Dr (Mrs) RU Suganthi	Senior Scientist
Dr. A Dhali	Senior Scientist
Dr. PK Malik	Senior Scientist
Knowledge Management and Biostatistics Section	
Dr. NKS Gowda	Principal Scientist, Section I/C
Dr. K Giridhar	Principal Scientist
Dr. (Mrs.) Letha Devi G	Scientist
Shri. T Chandrappa	Scientist
Technical Officers / Assistants	
Shri. GSSR Krishnan	Assistant Chief Technical Officer, T -7/8 (Library)
Shri. BH Venkataswamy	Assistant Chief Technical Officer, T-7/8 (FPU)
Shri. V Ramesh	Assistant Chief Technical Officer, T -7/8 (Maintenance)
Dr. VB Awachat	Senior Technical Officer, T-6 (ELU)
Mrs. Maya G	Technical Assistant, T-3 (BES)
Shri. DR Govinda	Technical Assistant, T-3 (Estate and Maintenance)

Name	Designation
Shri. KM Kamalesh	Technical Assistant, T-3 (Estate and Maintenance)
Shri. HS Narayana Rao	Senior Technician, T-2 (AND)
Shri. M Shivarama	Technician, T-1 (Estate and Maintenance)
Administration	
Shri. S Athimoolam	AO
Mrs. R Kalaivani	AAO
Shri. N Raghavan	PS
Shri. SR Nataraj	Assistant
Shri. SR Sreenivasa	Assistant
Shri. R Suresh Babu	Assistant
Mrs. JV Jyothi	Assistant
Shri. Anbu R	Assistant
Mrs. Geetha B	UDC
Shri. L Gowda	LDC
Shri. A Murthy	LDC
Shri. M Naveen Kumar	LDC
Accounts and Audit	
Shri. J George	SFAO
Mrs. MP Mridula	Assistant
Mrs. P Nagaraju	UDC
Supporting Staff	
Shri. Chennamaraiah	SSS
Shri. KS Srikanta Sastry	SSS
Mrs. Ningamma	SSS
Mrs. Mahalakshmi	SSS
Shri. K Narayana	SSS
Mrs. J Lakshmi	SSS

In Charges of Section/ Unit/ Cell

Section/ Unit/ Cell	In charge
Priority Setting, Monitoring and Evaluation Cell-I	Dr. JP Ravindra
Priority Setting, Monitoring and Evaluation Cell-II	Dr. KS Ramachandra
Institute Research Council	Dr. DT Pal
Official Language Implementation Cell	Dr. S Senani
RFD Cell	Dr. SC Roy
HRD Nodal Officer	Dr. AV Elangovan
Academic Cell	Dr. KS Prasad
Library and Auditorium	Dr. (Mrs.) M Sridhar
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 NKS Gowda
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. S Athimoolam
Institute Joint Staff Council	Shri. DR Govinda

Recruitment/ Appointment/ Joining

Dr. R Bhatta	Joined as Director on 14-08-2014
Dr. (Mrs.) BK Binsila	Joined as Scientist on 27-10-2014
Mrs. Maya G	Joined as Technical Assistant T-3 (Lab Technician) on 29-09-2014
Shri. KM Kamalesh	Joined as Technical Assistant T-3 (Electrical Foreman) on 29-01-2015

Retirement

Dr. CS Prasad	Director (retired on superannuation on 31-05-2014)
Shri. N Shivakumar	Assistant Chief Technical Officer T-7/8 (retired on superannuation on 30-06-2014)

Deceased

Dr. P Khandekar	Principal Scientist (passed away on 29-07-2014)

Promotion

Name	Promotion to next higher post	With effect from
Dr. K Giridhar, Senior Scientist	Principal Scientist (RGP 10000)	25-07-2011
Dr. S Nandi, Senior Scientist	Principal Scientist (RGP 10000)	17-09-2013
Dr. RU Suganthi, Senior Scientist	Senior Scientist (RGP 9000)	15-03-2012
Dr. S Selvaraju, Senior Scientist	Senior Scientist (RGP 9000)	09-10-2012
Dr. A Dhali, Senior Scientist	Senior Scientist (RGP 9000)	04-11-2012
Dr. AP Kolte, Scientist	Scientist (RGP 9000)	05-02-2014
Dr. ICG David, Scientist	Senior Scientist (RGP 8000)	24-09-2009
Shri. J George, Finance and Accounts Officer	Senior Finance and Accounts Officer	01-08-2012

List of Research Projects

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

Institute Project

Project name	Duration	
	Start	End
Production of lignolytic enzymes from white rot fungi through Immobilization and their efficacy in enhancing digestibility of crop residues	Jun, 2008	Dec, 2014

Externally funded project

Project name	Funding agency	Duration	
		Start	End
Biomining of selected white rot fungi (WRF) for novel lignin peroxidase and manganese peroxidase for enhancing digestibility of crop residues	DBT	Mar, 2015	Mar, 2018
A heterologous vector mediated transformation system of laccse gene from a novel white rot basidomycete into *Pichia pastoris* for effective degradation of crop residues	DST (Woman scientist)	Mar, 2011	Jun, 2014

Prog. 2 Biogeography of Gut Microbes in Animals

Institute Project

Project name	Duration	
	Start	End
Comparative rumen metagenomics of domestic ruminants	Apr, 2014	Mar, 2017
Molecular profiling of rumen acetogens at different developmental stages in sheep	Jul, 2012	Mar, 2015
Development of 16s rDNA rumen specific microbes database	Apr, 2014	Mar, 2017

Externally funded project

Project name	Funding agency	Duration	
		Start	End
Veterinary type culture – rumen microbes	ICAR -Network	Oct, 2009	Mar, 2017

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

Institute Project

Project name	Duration	
	Start	End
Evaluation of copper chaperone for SOD (CCS) as a sensitive biomarker of copper deficiency in sheep	Oct, 2009	Jun, 2014
Mineral solubility in rumen from mixed rations and its effect on rumen fermentation and animal performance	Jul, 2009	Sep, 2014
Precision feeding for enhancing milk production performance in cattle	Jun, 2012	Sep, 2015
Effect of dietary natural antioxidants on production performance and meat quality of linseed oil fed chicken	Dec, 2011	Sep, 2014
Elucidating role of boron on gene expression for calcium utilisation, immune response and anti-oxidant mechanism	Apr, 2014	Mar, 2017
Utilization of nano zinc and its impact on growth and reproduction in goats	May, 2014	Apr, 2017
Effect of dietary selenium on selenoprotein genes in lambs	Apr, 2014	Mar, 2017

Project name	Duration	
	Start	End
Development of fertility diagnostictest(s)/ kit in assessing bull fertility	May, 2010	Apr, 2014
Suppression of prolactin gene expression during the ex ova period in birds	Mar , 2012	Nov , 2014
Amelioration of oxidative stress to prevent apoptosis of early sheep embryos	Apr, 2013	Mar, 2016
Elucidating the endocrine and molecular mechanisms of feed restriction impacting somatotrophic axis in goats	Apr, 2013	Mar, 2016
Modulation of myostatin through different wavelengths of light and RNAi in broiler chicken	Jul, 2014	Mar, 2017
Modulation of granulosa cell estradiol synthesis using copper and selenium	Jul, 2014	Jun, 2017
Application of statistical and bioinformatics tool for analysis and modelling of genes related to production and reproduction in livestock	Oct, 2011	Sep, 2014

Externally funded project

Project name	Funding agency	Duration	
		Start	End
Monitoring of Drug Residues and Environmental Pollutants	ICAR-Outreach	Nov, 2009	Mar, 2017
Bioconversion of agricultural wastes for production of nutraceuticals to improve the gut health in animals	DBT	Feb, 2013	Feb, 2016
Immobilized fungal phytase production and its dietary evaluation in broiler and layer chicken	DBT	Feb, 2012	Feb, 2016
Expression of copper chaperones and transporters in copper deficient sheep	DBT	Apr, 2013	Apr, 2016
Generation of xylooligosaccharides from green coconut husk for augmenting gut health and function	CDB	Oct, 2011	Apr, 2015
Nutritional and physiological interventions for enhancing reproductive performance in animals	AICRP	Apr, 2014	Mar, 2017
Molecular cloning and characterization of buffalo sperm CatSper and a few other fertility associated proteins for development of a fertilty assay to screen sub-fertile buffalo bull semen	DBT	Feb, 2012	Feb, 2015
Transcriptomic profiling of spermatozoa for selection of fertile bulls	DBT	Feb, 2012	Feb, 2016
Wnt signal mediated ovarian granulosa cell estrogen synthesis in ruminants	DBT	Nov, 2014	Nov, 2017
Transcript profiling and functional significance of molecular determinants of follicular and oocyte competence under metabolic stress	DBT	Sep, 2013	Sep, 2017
Organic zinc and copper supplementation on advancing puberty, spermatozoal transcription expression profile and fertility in goat	DBT	Nov, 2014	Nov, 2017
Development of pregnancy associated glycoprotein (PAG) based immunodiagnostic in buffaloes (*Bubalus bubalis*)	DBT	Jun, 2011	Jun, 2014
Mining markers of pregnancy in cell free body fluids of buffaloes (*Bubalus bubalis*)	DBT	Feb, 2012	Feb, 2015
Enhancing development competence of oocytes for better*in vitro* fertilizing ability	ICAR-NASF	Apr, 2013	Mar, 2016
Biotransformation of D-galactose into D-tagatose and its evaluation as nutraceuticals	DST (Woman Scientist)	Oct, 2014	Sep, 2017
Assessing bull fertility based on seminal and sperm membrane proteins	DST (INSPIRE Fellowship)	Feb, 2013	Feb, 2018
Maintaining stemness of porcine mesenchymal stem cells (MSC) on the supplementation of a novel asymmetric cell kinetic inhibitor	DST (Woman Scientist)	Sep, 2014	Sep, 2017
Arsenic-induced reproductive and metabolic toxicity in mice: Protective role of phytochemicals	UGC (Women PDF)	Nov, 2013	Nov, 2018

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

Institute Project

Project name	Duration	
	Start	End
Refinement of livestock feed resources and development of dynamic database	Jul, 2010	Dec, 2014

Externally funded project

Project name	Funding agency	Duration	
		Start	End
Modelling the impact of climate variation on feed resources availability for livestock	ICAR-NICRA	Sep, 2011	Sep, 2014
Bio-fortification of cereals	ICAR-CRP	Jan, 2015	Mar, 2017
Integrated Farming Systems	AICRP	Oct, 2013	Mar, 2017

Prog. 5 Climate Change Impact on Livestock

Institute Project

Project name	Duration	
	Start	End
Expression of HSP70 mRNA in visceral organs of broiler chickens under acute heat stress	Sep, 2011	Sep, 2015

Externally funded project

Project name	Funding agency	Duration	
		Start	End
Estimation of methane emission under different feeding systems and development of mitigation strategies	ICAR-Outreach	Apr, 2008	Mar, 2017
Livestock methane reduction through immunization based approach	DBT	Aug, 2014	Aug, 2017
Deciphering the mechanism of aberrant maternal recognition of pregnancy (MRP) events in sheep and buffalo under heat and nutritional stress	ICAR-NASF	Jan, 2011	Dec, 2015

Prog. 6 Technology Translation to Connect Discovery with Application

Institute Project

Project name	Duration	
	Start	End
Sustainability of dairy farming as a means of livelihood	Dec, 2011	Mar, 2015

Externally funded project

Project name	Funding agency	Duration	
		Start	End
Regional network for skills exchanges on dynamic adaptation of ruminant production systems to a changing environment	ARChE_Net (CIRAD)	Apr, 2013	Jun, 2015
Vulnerability of crop-livestock farming system to climate variability and global economic change : a perspective of Karnataka State	ICSSR	Aug, 2012	Jul, 2014

Annexure-I

RESULTS-FRAMEWORK DOCUMENT FOR ICAR- NATIONAL INSTITUTE OF ANIMAL NUTRITION AND PHYSIOLOGY (2013-2014)

RFD
Results-Framework Document
For
ICAR- National Institute of Animal Nutrition and Physiology
(2013-2014)

Section I
Vision, Mission, Objectives and Functions

Vision

Productivity enhancement for profitable and sustainable livestock production

Mission

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

Objectives

1. Improving nutrient assimilation and physiological functions for enhancing livestock production
2. Feeding strategies for reducing climate change impact on livestock
3. Human resource development

Functions

1. Conduct basic and fundamental research to address physiological and nutritional problems related to biophysical translation of nutrients for productive functions in livestock
2. Developing quality human resource in frontier areas of animal nutrition and physiology
3. Research translation to connect discovery with applications

SECTION 2

Inter se priorities among key objectives, success indicators and targets

Sl. No.	Objective (s)	Weight	Action (s)	Success Indicator(s)	Unit	Weight	Target /Criteria Value				
							Excellent 100%	V. Good 90%	Good 80%	Fair 70%	Poor 60%
1	Improving nutrient assimilation and physiological functions for enhancing livestock production	40	Identification of factors / bio-molecules influencing production and reproduction in livestock	Factors / bio-molecules identified	Number	25	5	4	3	2	1
			Development of repository of anaerobic rumen microbes for better feed utilization	Anaerobic rumen microbes catalogued	Number	15	25	22	18	16	12
2	Feeding strategies for reducing climate change impact on livestock	31	Developing models for assessing climate change impact on feed resources in different states	States covered	Number	11	6	5	4	3	2
			Cataloguing of feeds based on methane production potential	Feed resources catalogued	Number	20	30	25	22	20	15
3	Human resource development	18	Capacity building and skill development	Trainings / workshops conducted	Number	18	8	7	6	5	4
4	Efficient functioning of RFD System	3	Timely submission of Draft RFD (2013-2014) for approval	On-time submission	Date	2	5.0512013	16.05.2013	17.05.2013	20.05.2013	21.05.2013
			Timely submission of Results for RFD (2012-13)	On-time submission	Date	1	01.05.2013	02.05.2013	05.05.2013	06.05.2013	07.05.2013
5	Administrative Reforms	4	Implement ISO 9001 as per the approved action plan	% Implementation	%	2	100	95	90	85	80
			Prepare an action plan for innovation	On-time submission	Date	2	30.07.2013	10.08.2013	20.08.2013	30.08.2013	10.09.2013
6	Improving internal efficiency / responsiveness / service delivery of Ministry / Department	4	Implementation of Sevottam	Independent audit of implementation of Citizen's Charter	%	2	100	95	90	85	80
				Independent audit of implementation of public grievance redressal system	%	2	100	95	90	85	80

SECTION 3

Trend values of the success indicators

Sl. No.	Objective(s)	Action(s)	Success indicator(s)	Unit	Actual Value for FY 11-12	Actual Value for FY 12-13	Target Value for FY 13-14	Projected Value for FY 14-15	Projected Value for FY 15-16
1	Improving nutrient assimilation and physiological functions for enhancing livestock production	Identification of factors /bio-molecules influencing production and reproduction in livestock	Factors / bio-molecules identified	Number	-	-	4	4	4
		Development of repository of anaerobic rumen microbes for better feed utilization	Anaerobic rumen microbes catalogued	Number	-	-	22	25	30
2	Feeding strategies for reducing climate change impact on livestock	Developing models for assessing climate change impact on feed resources in different states	States covered	Number	-	4	5	6	-
		Cataloguing of feeds based on methane production potential	Feed resources catalogued	Number	25	25	25	-	-
3	Human resource development	Capacity building and skill development	Trainings / workshops conducted	Number	8	7	7	7	7
4	Efficient functioning of RFD System	Timely submission of Draft RFD (2013-2014) for approval	On-time submission	Date	-	-	16.05.2013	-	-
		Timely submission of Results for RFD (2012-13)	On-time submission	Date	-	-	02.05.2013	-	-
5	Administrative Reforms	Implement ISO 9001 as per the approved action plan	% Implementation	%	-	-	95	-	-
		Prepare an action plan for innovation	On-time submission	Date	-	-	10.08.2013	-	-
6	Improving internal efficiency / responsiveness/ service delivery of Ministry / Department	Implementation of Sevottam	Independent audit of implementation of Citizen's Charter	%	-	-	95	-	-
			Independent audit of implementation of public grievance redressal system	%	-	-	95	-	-

SECTION 4

Description and definition of success indicators and proposed measurement methodology

Objective 1. Improving nutrient assimilation and physiological functions for enhancing livestock production

Acute shortage of quality inputs is affecting production and reproduction in livestock and poultry. There is a need to understand basic mechanism of the nutrient uptake and different physiological functions so as to optimize production and reproduction in livestock. In this context, factors that influence nutrient bioavailability and utilization, production and reproductive processes need to be explored in livestock.

Efforts will be made to identify factors/bio-molecules influencing production and reproduction in livestock. Repository of anaerobic rumen microbes for better feed utilization will be developed. These will be measured by the numbers of factors/bio-molecules identified and anaerobic rumen microbes characterized/catalogued.

Objective 2. Feeding strategies for reducing climate change impact on livestock

Climate change can strongly affect the availability of feed resources in different regions of the country. Hence, there is a need to develop methods to assess the availability of feeds, which in turn will help in taking strategic measures to address the problem of feed deficiency. Enteric methane emission from livestock is one of the major problems for global warming and thus mitigation strategies need to be worked out by understanding the methane production potential of various feeds and cataloguing them.

Models will be developed for assessing climate change impact on feed resources in different states. Cataloging of feed resources based on their methane production potential will be done. These will be measured by the number of models developed for different states and feed resources catalogued based on methane production potential.

Objective 3. Human resource development

Due to significant growth of animal husbandry sector in the country, there is increased demand for trained human resources. To maintain this demand, development of quality human resource is important which could be achieved by providing training and developing skills. As feeding and management of animals accounts for about 60-70% of the total cost of livestock production, providing training and skill development will help the various stakeholders including farmers to adopt to recent techniques for improving production and get better economic returns.

Various trainings/workshops in frontier areas of animal nutrition and physiology will be conducted. This will be measured by the number of trainings/workshops conducted and manpower trained.

Objective 4. Efficient functioning of RFD System

For the efficient functioning of the Institute towards the agreed objectives, policies, programs and projects, and the subsequent evaluation of the institute performances it is important to implement the efficient functioning of RFD system.

The Draft RFD (2013-2014) and results RFD (2012-13) will be submitted to the Council for approval within the stipulated time period. The functioning of the RFD system will be measured by the dates of submission of these documents to the council.

Objective 5. Administrative Reforms

The efficient functioning of an organization depends on timely and need-based reforms of its administrative policies. It is important for an organization to introduce new thoughts and suitable modifications of the existing procedures based on the current demand for making the system more efficient.

The ISO 9001 will be implemented as per the approved action plan. An action plan for introducing innovations into the institute functioning will be prepared. The implementation of ISO 9001 action plan will be monitored with due auditing and certification of the procedures. Similarly, the innovation action plan of the Institute will be measured by awarding the winners of innovation.

Objective 6. Improving internal efficiency / responsiveness/ service delivery of Ministry / Department

It is important for a government organization to be transparent, accountable and citizen friendly to ensure citizen centric administration. To ensure the service delivery excellence, it is important for an organization to clearly define and communicate service standards and take necessary steps to ensure the standards are consistently met. These will be achieved through the implementation of SEVOTTAM.

Independent audit of implementation of Citizen's Charter and grievance redressal system will be conducted to measure their performances.

SECTION 5

Specific performance requirements from other departments

1. Efficiency of cataloguing of anaerobic rumen microbes will depend on the collaborators (National Institutes/ SAUs) for timely submission of rumen bacteria.

2. The number of trainings/ workshops that will be conducted will depend of the nominations of trainees from their parent departments (SAUs/Director of extension/ DAHDF, GOI).

SECTION 6

Outcome / Impact of Organization / Ministry

Outcome / Impact of Organization	Jointly responsible for influencing this outcome/impact with the following organization (s) / ministry (ies)	Success indicator (s)	Unit	2011-12	2012-13	2013-14	2014-15	2015-16
Improved productive/reproductive efficiency of livestock	Livestock farmers, State Agricultural Universities, milk federations / feed industries	Animals displayed estrous/ conceived by supplementing area specific mineral mixture (ASMM)	Percentage	30%	35%	40%	45%	50%
		Increase in egg production by using red spectrum light	Percentage	-	2.0%	2.25%	2.5%	3.0%
		Reduction in the cost of feeding of dry fodder by replacing paddy straw with areca sheath	Percentage	-	35%	40%	45%	50%
Development of quality human resources	State Agricultural Universities, /Animal Husbandry departments	Persons trained	Number	100	150	200	200	200

Performance Evaluation Report

Sl. No	Objective(s)	Weight (%)	Action(s)	Success Indicator(s)	Unit	Weight (%)	Target /Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score
							100%	90%	80%	70%	60%			
1	Improving nutrient assimilation and physiological functions for enhancing livestock production	40	Identification of factors / bio-molecules influencing production and reproduction in livestock	Factors / bio-molecules identified	Number	25	5	4	3	2	1	**6**	**100**	25
			Development of repository of anaerobic rumen microbes for better feed utilization	Anaerobic rumen microbes catalogued	Number	15	25	22	18	16	12	**25**	**100**	15
2	Feeding strategies for reducing climate change impact on livestock	31	Developing models for assessing climate change impact on feed resources in different states	States covered	Number	11	6	5	4	3	2	**6**	**100**	11
			Cataloguing of feeds based on methane production potential	Feed resources catalogued	Number	20	30	25	22	20	15	**31**	**100**	20
3	Human resource development	18	Capacity building and skill development	Number of trainings / workshops conducted	Number	18	8	7	6	5	4	**9**	**100**	18

Sl. No	Objective(s)	Weight (%)	Action(s)	Success Indicator(s)	Unit	Weight (%)	Target /Criteria Value					Achievements	Performance	
							Excellent	Very Good	Good	Fair	Poor		Raw Score	Weighted Score
							100%	90%	80%	70%	60%			
4	Efficient functioning of RFD System	3	Timely submission of Draft RFD (2013-2014) for approval	On-time submission	Date	2	15.05.13	16.05.13	17.05.13	20.05.13	21.05.13	**04.05.13**	**100**	2
			Timely submission of Results for RFD (2012-13)	On-time submission	Date	1	01.05.13	02.05.13	05.05.13	06.05.13	07.05.13	**15.04.13**	**100**	1
5	Administrative Reforms	4	Implement ISO 9001 as per the approved action plan	% Implementation	Percent	2	100	95	90	85	80	**100**	**100**	2
			Prepare an action plan for innovation	On-time submission	Date	2	30.07.13	10.08.13	20.08.13	30.08.13	10.09.13	**10.07.13**	**100**	2
6	Improving Internal Efficiency / responsiveness / service delivery of Ministry / Department	4	Implementation of Sevottam	Independent audit of implementation of Citizen's Charter	Percent	2	100	95	90	85	80	**99**	**99**	1.98
				Independent audit of implementation of public grievance redressal system	Percent	2	100	95	90	85	80	**100**	**100**	2

Total Composite Score: 99.98

ICAR Rating: Excellent

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