Annual Report
2016-17

भा.कृ.अ.प.–केन्द्रीय बकरी अनुसंधान संस्थान
मखदूम, फरह – 281122 मथुरा (उ.प्र.), भारत

ICAR-Central Institute for Research on Goats

(An ISO 9001:2008 Certified Organization)
Makhdoom, Farah - 281122 Mathura (U.P.) India

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PREFACE

Annual Report 2016-17 is presented with a note of satisfaction on various activities of the Institute.The present report focuses on the progress and various activities of the institute in the field of research, technology dissemination, technology development, training and education. ICAR-CIRG is working on different dimensions by contributing towards research in different aspect as well as strategy on goat production in different agro climatic zone by providing suitable technologies.

ICAR-CIRG works at the interface of scientific goat rearing using modern management techniques, good practices, and better welfare practices. As a major initiative, CIRG has adopted a better quality policy for continual improvement in research and capacity building.

Our research programme are organized in five different dimensions–genetic improvement of goat breeds, providing better nutrition and its utilization, reproductive management, efficient healthcare and technology validation in different agro-ecological condition. We have strengthened our research programme through multidisciplinary approach and teamwork and tried to develop a better learning environment for all our staff. We are committed to bring efficiency in our research environment as well as popularizing the goat farming through viable enterprise. During the end of last year we have planned our activities for the next 3 years (2017-2020) strategies for future goat production to improve the goat keeper's income and their nutritional security.

Besides technology oriented research, selective breeding has been carried out to improve the body weight, milk yield in Barbari, Jamunapari and Jakhrana goats. Under AICRP we have 14 units at different locations across the states to improve the performance of goats in their natural habitat. AICRP Units have validated different management technologies in the field flock and have increased their income. We have given greater attention to the biological attributes of indigenous breeds and need to exploit them for local advantage and future global application. Research on adaptability of goats in changing climate scenario is being carried out. Furthermore, we are working towards providing different interventions to alleviate abiotic and biotic stress. AI technology is being used as tool for conservation and improvement of breed performance at the farmer's flock.

By continuous innovative research intervention we can increase the production efficiency of goats by reducing input cost through improved buck supply, feed formulation and health care. CIRG has worked towards better control of diseases in farmer's flock and thereby increasing farmer's income. Health care methodology and diagnostics are being developed regularly for the benefit of goat as well as goat keepers. Surveillance and monitoring of goat diseases are being carried out with significant research output. Herbal formulations are being developed against diarrhea, coccidiosis, wound healing and control of ticks and mites. Research on feed formulation, agroforestry development, feed storage and methane emission is being carried out and has significant output and impact. A Moringa based

complete feed formulation has been successfully tested for growth and milk yield. Different feed ingredients have been analyzed for methane gas emission for further processing and utilization. The Institute has developed several meat and milk products and also carrying out research towards nutritional benefits and safety standard of goat meat and milk products.

Skill development in goat farming is one of the major thrust of CIRG. We have achieved significantly by organizing several training programme at national level, as well as sponsored training requested by different state government and private agencies.

If you want to care for poor people, then you must concentrate on goat farming. I hope we are working towards increasing the income of goat farmers for their better life and nutritional security. I am sure that with the available dedicated team of researchers and technical manpower, we will achieve the desired results. Finally, I feel honoured to express my deep sense of gratitude to Dr. Trilochan Mohapatra, Hon'ble Secretary DARE, and Director General, ICAR, New Delhi and Dr. J.K. Jena, Deputy Director General (Animal Science), ICAR, New Delhi for their leadership and strong support for the overall development of this Institute. I am also grateful to Dr. B.S.Prakash, ADG (Animal Nutrition & Physiology), and all other SMD staff, Chairman and members of QRT, RAC, and IMC for their valuable suggestions and guidance to gather knowledge to enhance the productivity and profitability of goat production in this country. A word of appreciation for editorial team – Dr. P.K. Rout, Dr. Ashok Kumar, Dr. R.V.S. Pawaiya, Dr. S.D. Kharche, Dr. A.K. Dixit, Dr. V. Rajkumar and Dr. M.S. Dighe for their untiring efforts for compiling this document and to the Head of Divisions, Section in charges, all scientists, staffs of PME Cell, technical, ministerial and supporting staffs for their support in success of different programmes taken up at the institute.

(M. S. Chauhan)

Director

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Goat provide livelihood security to under resourced farmers and contributes significantly to income and better nutrition for their family. In most region of the country, goats are mainly reared for meat and milk purposes. Goat enterprise is developing with a significant pace and had an important and significant role in empowering rural youth, unemployed person and women, which will surely be a factor in transformation of socio-economic status of rural people.

Goat farming with modern scientific inputs will bring social transformation by providing livelihood security to poorest people in most disadvantage places, thereby fulfilling the objective of "Inclusive growth" in our society. Himalayan region, goats are especially important for fibre (pashmina), meat production and transportation. Goat milk is very important for home consumption and plays a pivotal role in fulfilling the nutritional requirement of older people, pregnant women and children in the remote corner of the country. Goat,therefore a potential pathway from poverty to prosperity for resource poor farmer by providing income, food security and reducing vulnerability due to crop failure. Women are also benefitted by goat rearing being the main custodian in rural areas, especially in Bihar, Jharkhand, West Bengal, Rajasthan, NEH and many tribal regions of the country. In the recent years, commercial goat farms have emerged in different parts of the country providing substantial income to the progressive farmers.

Animal Genetics and Breeding

Selective breeding of goats have shown significant improvement in body weights and milk yield. In Barbari goat , the overall least squares means of body weight of kids at birth, 3, 6, 9, and 12 month of ages were 1.91±0.01, 7.71±0.08, 12.34±0.15, 16.47±0.22 and 21.94±0.34 kg, respectively during the year 2016-17. The estimates of heritability (h_2) for body weight of kids at birth, 3, 6, 9, and 12 month of ages were 0.106±0.045, 0.230±0.073, 0.210±0.07, 0.267±0.077& 0.171±0.066 indicating moderate level of additive genetic variance for growth traits in this Barbari flock. The milk yield at 90 days and 140 days milk were 52.71±1.00 and 67.65±1.44 liters, respectively. Higher lactation performance of Barbari goats was obtained from second parity and this superiority persists up to 6th parity.The overall mortality and culling was 2.9% and 6.8%.

In Jamunapari goat, the least squares means of body weights of kids at birth, 3, 6, 9 and 12 months of age during the year were 3.167kg, 10.005kg, 17.814kg, 22.460kg and 27.164kg, respectively . The least squares means for body weight under intensive management at 12 months of age was 45.154 kg and the highest body weight was 52.0 kg. The Average daily weight gain (ADG) of the kids under intensive management was 107.88, 120.78, 107.86, 133.69 and 107.85 g/day, respectively during 3-6, 3-9, 3-12, 6-9, and 6-12 month age group. The means for milk yield at 90, 140 and total milk yield were 80.2, 114.0 and 124.8 Kg, respectively for Jamunapari goat. The average lactation length was 179.5 days, which was longer than other Indian breeds. Jamunapari goats were productive until seventh parity.

The genetic trend in Jamunapari goat at 9 months of age and 12 months of age was 0.14 kg and 0.19 kg per year. The genetic trend at all the ages was very specific and positive during the study period. A positive genetic trend was observed for milk yield at 90 days, 140 days and TMY in Jamunapari goat population .

There are 29 multiplier flocks of Barbari goats adopted to popularize scientific goat farming. Various Interventions were provided to these flocks for development of livelihood model and agri-business models as breeding and goat production. These flocks were established in UP, Haryana, Rajasthan. Most of these farms are maintained on stall feeding with optimum feed inputs. All improved management practices (breeding calendar, feeding, housing and health care) are adopted. Overall survivability at multiplier flocks was 93.3%. Most of such farms focussing on increasing flock size; and sale are restricted to 15-40%. The cost of production per goat/year varied from Rs. 3260 to Rs. 7800 and profit from Rs. 4300 to 9600 with an average of Rs. 5280.

In Jakharana goat, Least squares means for body weight at birth ,3, 6, 9 and 12 months of age were 2.38±0.04,8.51±0.19, 13.21±0.52, 16.91±1.90 and 24.13±2.23 kg, respectively during the year. Average lactation milk of Jakharana does was 205.93±11.8 litres during 2016-17. In Muzzafarnagari sheep, the overall least-squares means of body weights of lambs at birth, 3, 6, 9 and 12 month age were 3.40±0.04, 15.13±0.25, 24.93±0.39, 27.22±0.60 and 35.18±0.60 kg, respectively during the 2016-17. Male lambs

gained higher body weight as compared to female lambs at all growth stages. The average daily gain of Muzaffarnagari lambs during 0-3, 3-6 and 6-12 months were 130.17±3.87, 100.04±3.35 and 63.83±1.93g/day under semi-intensive feeding management.

Animal Physiology and Reproduction

Semen of Jamunapari, Barbari, Sirohi and Jakhrana goat breed was successfully frozen and kid have been born through AI. Scientist of this division achieved pregnancy of 37.57% on the basis of actual kidding rate in the above goats by modified freezing protocol. The poor freezable quality was observed in January and February month. This seems that THI was below the stress level (<72) during the November and December month as compared to moderate stress (>80) during May and June months. The comfortable THI during November and December month have beneficial effect on semen quality in spite of poor libido. A very high concentration of beta defensing 1 (pg/ml) in blood of Jakhrana (8267.90 2213.18) was found followed by Barbari (2640.88 128.44) and Jamunapari (2385.31 267.67) goat breed. Progesterone and Testosterone levels have shown an increasing trend with change of physiological/reproductive stages (pre-pubertal, pubertal and post-pubertal) in Jamunapari goats(male and female). Oestrus can be efficiently induced and synchronized in post-partum anoestrus Barbari goats (parous) by hormonal intervention (83.33%), thus making it feasible to augment post-partum reproductive performance in tropical goats of Indian origin. For Development and validation of peptide-based immunoassay an anti-peptide polyclonal antisera is being used for development of immunological assay (ELISA) for detection of specific PAG in goat samples. The overall 2-cell, 4-cell, morula, blastocyst and hatched blastocyst production following activation with 5 µM Ca Ionophore in mCR2aa medium for 5 min followed by treatment with 2.0 mM DMAP for 4 hr in mCR2aa medium of in vitro matured oocytes were 24.36±2.02%, 24.71±1.59%, 45.60±2.23%, 9.37±1.70% and 7.75±1.64%, respectively. The tetraploid embryos were produced by 5.0 V alternating current pulse for 5 second to orient the plane of contact between the blastomeres in parallel with the electrodes followed by a DC current with 1.2 kV/cm for 4 µsec by electrofusion. The chimeric embryos were produced by aggregation of tetraploid embryos and parthenogenetic embryonic stem cell on granulosa cell monolayer. Chimeric goats embryos (3-4 embryos) at morula and blastocyst stage were transferred surgically at the tip of uterine horn ipsilateral to the ovary containing corpus luteum of 19 naturally synchronized surrogate does. Following transfer, 2 recipients initially diagnosed pregnant on day 35th post-transfer by ultrasonography. The mesenchymal cells were isolated from the bone marrow on the basis of plastic adherence property. Studies on improving on livelihood security of farmers the provision of fibre reimposed plastic roof as an alternate roofing material in goat shelters in semi-arid areas during winter season may not be beneficial in increasing production of lactating does. The analysis of recorded weather data indicated that the ambient temperature, dry bulb temperature, wet bulb temperature and Temperature-Humidity Index (THI) was significantly higher (P<0.05) under plastic shed as compared to asbestos roofed shed at 12 noon and 5 PM during winter months. Such difference was not observed in the morning at 9.00 AM. The relative humidity was similar in all three sheds during all the three recorded times. Therefore, the use of plastic materials in goat shed may be beneficial to protect kids from winter.

Animal Nutrition and Products Technology

Zyziphus sp. Based silvipasture system was found more productive to the goats in comparison to Morus alba based silvipasture.

Feeding of azolla based complete feed pellet to the goats under field conditions resulted in better growth rate. The cultivation of Moringa oleifera as fodder crop at CIRG was proved to be highly productive in terms of biomass production. The Moringa biomass based pelleted feed improved productivity of growing goats in terms of body wt. gain and other biochemical and reproductive traits.

Supplementary feeding of leaves of *L. leucocepala* to the goats resulted reduction in methane production in grazing goats. Based on the biochemical, heat shock protein status and gene expression it was found that the Sirohi, Jakhrana and Barbari goat breed was best suited for hot, humid and cold climate respectively. Jakhrana breed of goat was better adapted for grazing under humid period.

Twenty species/ isolates of effective fiber degrading bacteria were isolated and characterized from goat rumen and eleven cultures were submitted as repository to NIANP, Bangalore.Rapid testing of pathogenic microorganism in meat and meat products has been established and pesticide residue analysis in meat and meat product using GC/MS/MS has

been standardized. The elemental analysis of meat and milk products has been developed. Quality evaluation of goats meat nuggets added with litchi pericarp powder (LPP) and drumstick flower powder (DFP) as a source of antioxidant dietary fiber was standardized and stability was determined.

Animal Health

Anthelmintic efficacy of two herbal combinations against naturally Haemochus contortus infected animals revealed that both the prototypes were quite efficacious in clearing the infection. Of three potential plants tested for acaricidal efficacy against Rhipicephalus microplus, one showed highest efficacy, with lowest LC 50 and LC 90 at both 24 hrs and 15 days post treatment. A polyherbal formulation tested for ameliorative effectct in brucella positive animals exhibited encouraging results, and further investigations are on. Pathoepidemiological studies on kid mortality region-wise showed higher mortality in UP, Rajasthan, Haryana and West Bengal, (36.97-46.79 %) compared to southern States (15.73-27.79%). Season-wise, mortality was more in winter season in Northern states, whereas rainy season contributed to higher mortality in Southern states. Age-wise, the mortality was lower in hebdomadal age (1-7 days) than in 1-3 months age. Diarrhoea was the most common cause of mortality in all climatic zone followed by pneumonia. A total of 261 carcasses (240 goats & 21 sheep) from Institute farms were necropsied during 1st April, 2016 to 31st March, 2017. Of these, 77 animals (69 kids and 8 lambs) belonged to 0-3 month's age, with overall mortality rate of 29.50%, comprising of 59.74% males and 40.26% females. The major causes of deaths were diagnosed as enteritis (35.06%), pneumonia (27.27%), anemia/weakness (9.09%) and other diseases (23.76%). In pregnant goats, supplementation of herbal formulation consisting of four plants' powder modulated the transition of pregnancy by action as antistressor and thus, increased the kid's body weight significantly in treatment group. A total of six bacterial isolates were processed and assigned accession numbers by NCVTC repository during 2016-17. A total of 406 enterotoxaemia affected goats were examined, of which 238 were 0-3month old kids and 168 were post weaned kids. Based on culture and molecular diagnosis a total of 63 isolates were obtained. Of these 50 isolates were of C. perfringens type A and 13 isolates of C. perfringens type D isolated from overall clinical studies. On partial Epsilon toxin gene (etx) sequencing and evolutionary analysis, C. perfringens type D isolate CIRG-11015 was grouped in a different subclade compared to the IVRI VacI strain, which hinted that the pathogenic strains circulating in goats need to be incorporated for a better inclusive ET vaccine. Two diagnostic tests, indirect haemagglutination test (IHT) to assess the inter-vaccination interval against ET in goats, and indirect haemagglutination inhibition test (IHIT) to detect the presence of epsilon toxin in the necropsy samples were developed for diagnosis of field cases of ET. Of 613 samples tested for abortion causing pathogens 22.83% samples were positive for one or more abortion causing agents. Of 352 samples tested for brucellosis, 120 were screened by SAT, 50 by conventional PCR, 182 by using TaqMan PCR and 4 samples by culture isolation test. For other abortion causing agents, 108 samples were tested for Chlamydia, 54 for Campylobacter spp. and 92 for Coxiella burnetii.

Extension Education and Socio-Economics

The major thrust of extension approaches for dissemination of goat production technologies and their impact assessment in farmer's flock. Extension approach showed significant gain in income and better livelihood security. Twenty (20) visits were made of adopted villages. Six (6) health camps were organised in these villages. Two (2) demonstrations on artificial insemination and a demonstration on mineral mixture were conducted in adopted villages. Under the transfer of technology programme of Institute for women empowerment for breed improvement in the home tract of Barbari breed, three (03) Barbari breed bucks free of costs provided to women goat farmers of adopted villages. Three (3) Swachchh Bharat Mission camps were conducted in adopted villages. Impact of goat technologies in adopted villages revealed that attraction of youth towards goat farming has increased by 50% from base population (14 to 20%, below 30 yrs.) and average flock size increased from 5.9 to 7.9 (33.9%). Similarly, average family income increased from 78 to 91 thousands per year (16.6%). This may be due to reduction in mortality from 20.6 to 11.3% (45.14%) and more availability of kids for sale. To assess the impact of training programme, data collected from 20 trainees in Maharashtra, Karnataka, West Bengal, Kerala, Odisha, Andhra Pradesh and Tamil Nadu States. Analysis shows that about 30% trainees started their goat farms. Under model goat village study, a participatory rural appraisal, off campus training programme, health camp and advisory services were organised in village.

Assessment of economic losses due to disease in goat production was carried out in the villages of Uttarakhand. Study revealed that majority of the

respondents belonged to backward class (40%) social group followed by SC (12.5%), General (20%) and Minority (27.5%). Goat husbandry play an important role in livelihood security as contributed about 27% of total family income. The average flock size of goat was 26.55. The overall morbidity, mortality and case fatality rate due to goat PPR was found 79.71%, 37.97% and 47.64% respectively. The total economic loss per household due to PPR was Rs.20,309. A disaggregated analysis of economic losses in PPR affected households revealed that mortality loss contribute maximum share (85%) followed by morbidity loss (10.04%) which include weight loss, reduction in market value etc. and milk loss due to reduction in yield. The opportunity cost born by the goat farmer share 4.89% which include labour cost for extra care of ill goats and extra feed fed. Total economic loss per animal due to PPR was Rs.765. Considering 0.17 as probability of occurrence of PPR per year, per household per year economic loss was estimated to be Rs.4062 (Rs. 153/goat/year).

During the period under report 4 national and 1 sponsored training programmes on scientific goat farming were organized. In total, 326 farmers participated in these training programmes. To showcase goat technologies and best practices, ICAR-CIRG participated in 11 Kisan mela /exhibitions organised in different states. In all 3380 visitors were entertained and apprised them with research, extension and development activities of the Institute. 1262 calls were received regarding various aspects of commercial goat farming, improved goat production technologies, elite germ plasm andtraining programmes and replied suitably and 166 technical letters of which 146 in Hindi and 20 in English were received from different categories of aspirants covering different of parts of country on various aspects of goat production and replied suitably.

CIRG CHARTER

VISION

To develop - the Goat- as a source of livelihood and nutritional security for the prosperity of India.

MISSION

Improvement in productivity of goat through research, extension and HRD support.

MANDATE

To undertake Research, Training and Extension Education Programmes for improving milk, meat and fiber production of goats and to develop processing technologies of goat products.

QUALITY POLICY

CIRG is committed to enhance goat productivity through research, extension and HRD support for the benefit of society, industry and scientific community.
Towards this, we shall,

- Continue to align our actions with organizational values
- Implement QMS as a platform for improving performance standard
- Continually improve our performance by periodical review of quality objectives and RFD documents
- Actively involve and adequately empower all personnel.

OBJECTIVES

- ⇨ To undertake basic and applied research in all disciplines relating to goat production and products technology.
- ⇨ To develop update and standardize area specific package of practices on breeding, feeding, management prophylactic and curative health cover of goats.
- ⇨ To impart National and International Trainings in specialized fields of goat research and development.
- ⇨ To transfer technologies for improving milk, meat and fiber production and value addition of goat products.
- ⇨ To provide referral and consultancy services on goat production and product technologies.

CIRG
A Brief Introduction

INTRODUCTION

The Indian Council of Agricultural Research established a National Goat Research Centre at Makhdoom, Farah in Mathura district of Uttar Pradesh on 12th July, 1976. The centre got the status of a full-fledged Institute on 12th July, 1979 and named as Central Institute for Research on Goats. The Institute is located almost at equi distance from two famous places – Mathura (22 Km), the birth place of Lord Krishna, and Agra (32 Km) the abode of world famous Taj Mahal. Director is the head of Institute and its apex body like IMC, RAC and QRT guide its research and other activities. This institute has four research divisions and one section including well equipped Library, AKMU, PME cell, Agricultural farm, ITMU, Livestock farm and Health Section to fulfil the madade and responsibilities.. The Coordinating unit of All India Coordinated Research Project on goat improvement is also located at CIRG. The project aims at improving production performance of different breeds of goats distributed in different regions of the country under farm and field conditions. The Institute is well connected with modern information and communication facilities comprising landline phones 0565-2763380, 2763323 and helpline 0565-2763320. The profile of the Institute can be visited at www.cirg.res.in.

Highlights of Achievements

The institute has developed number of pro farmer's pacjakges of practices&technologies; and commercially viable technologies for goat improvement in the country. 20 patents have been filed; eight technologies have been commercilaized for larger production. Other important technologies such as Value added goat meat and milk products, diagnostics for brucellosis and JD, herbal formulation, intra vaginal pessaries etc are under process of commercialization. Some of the major achievements are as follows :

- Multiplication and conservation of elite germ plasm of Jamunapari, Barbari, Sirohi and Jakhrana breed of goat for genetic improvement of indigenous goats.
- Improved reproductive performance resulting in higher population growth in Jamunapari (94.65%) and Barbari (183%) goat flocks.
- Positive genetic improvement trend in body weight at birth, at 3, 6, 9, and 12 month of age in Jamunapari goats, (0.12±0.03, 0.59±0.12, 1.58±0.19, 2.66±0.28 and 2.14±0.36, respectively) and at 9 month (0.999±0.213 kg) in Barbari goats.
- Significant improvement in milk yield in Jamunapari, Barbari and Jakhrana goats compared to their base population performance.
- Cryopreservation of semen of Jamunapari, Barbari, and Jakhrana and production of kids through AI in goats.
- Standardized Embryo Transfer and IVF technology in goats and successful production of kids through above technologies.
- Characterized heat stress tolerant genes i.e. AP-2 binding site in the promoter region of hsp70.1 gene, Melanocortin 1 receptor (MC1R) gene, Tyrosinase (TYR) gene and Signal transducer and activator of transcription 5 A (STAT5 A) gene to facilitate further studies on resilience of goat production system under changing climate.
- Established genetic origin of Indian goat breeds and genetic variation in Myf, leptin, Pit I, FecB, SCD gene and HSP genes in Indian goats.
- Developed complete feed pellet for efficient growth (80g/d) in finisher kids. Strategic supplementation of concentrate mixture @ 1.2 % of the body weight for better growth and meat quality of Barbari goats.
- Better dressing percentage and meat quality by supplementation of area specific mineral mixture under intensive goat rearing system.
- Identified anti-methanogenic feed resources for goat production system.
- Developed higher bio-mass producing fodder system (Guar+Lobia+Sunhamp) for goats under rain fed conditions and Morus alba based cost effective agro-forestry system for sustainable goat husbandry in semi-arid and rain fed areas.
- Developed package of practices and dynamic health calendar for goat farmers.
- Developed indigenous diagnostic kits for Brucellolsis and JD in goat.
- Herbal medicine formulations were developed for diarrhoea, septic wound, acaricide,

anthelminitic and stress management.

- Determined fatty acids and mineral status of milk of different Indian goat breeds. Standardized process for preparation of herbal functional milk, whey drinks, goat milk and meat based biscuits, and low fat cheese.
- Developed low cost-protein and mineral enriched value added goat meat products using fresh goat spleen and herb supplemented functional goat meat and milk products.
- Created baseline data on commercial goat farming.

The following technologies have been developed /commercialized.

Commercialized

- Alquit - a green drug technology for control of ecto-parasites has been commercialized to M/S Natural Remedies Pvt. Ltd, Bengaluru.
- Areamix- An area specific mineral mixture, commercialized to M/S Girraj Industries, Sirsaganj, U.P.
- Diarrionex-HS - an anti-diarrhoeal formulation commercialized to M/S Girraj Industries, Sirsaganj, U. P.
- HEALEX-FR - a skin gel commercialized to M/S Girraj Industries, Sirsaganj, U. P.
- Goat milk based soap (Ajas) – three variants of soap i.e. Ajas beauty, Ajas green and Ajas antiseptic soaps have been commercialized to M/S BVG Life sciences, Pune (M.S.).
- J.D. Vaccine –Mycobacterium avium subspecies paratuberculosis (Bio JD gel) commercialized by Biovet Pvt. Ltd., Bangaluru (Karnataka).

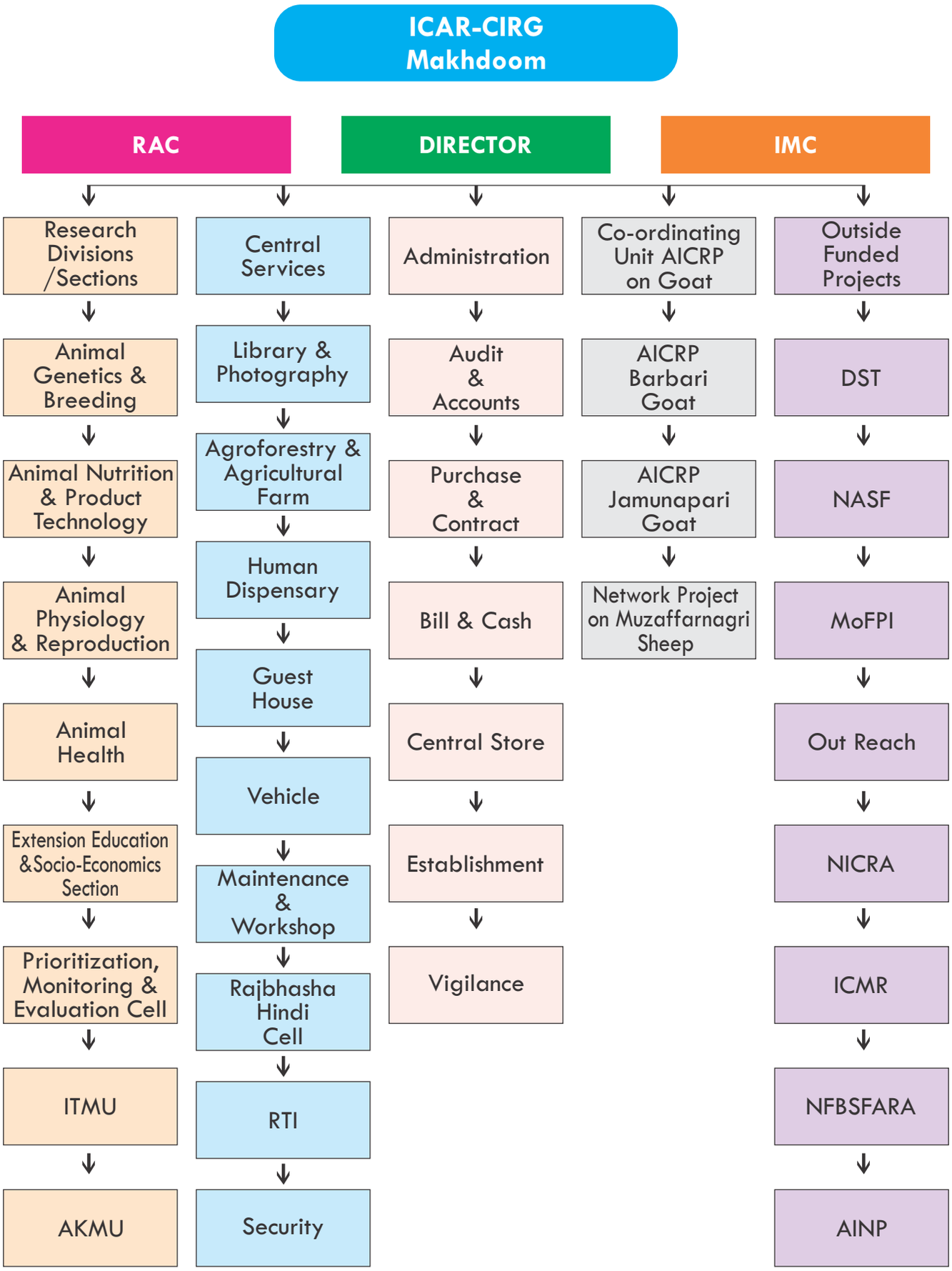
Under Commercialization

- BRUCHEK-Dot ELISA Kit for diagnostics for brucellosis in goats transferred to NRDC for commercialization.
- ELISA KIT for JD transferred to NRDC for commercialization.
- Stressol –G an herbal antistress formuation
- Intra vaginal pessaries for oestrus synchronization.
- Low cost complete feed pellet.
- Cost-effective milk replacers for kids.
- Goat meat Murukku: A crispy food product.
- Goat meat Nimkee: A snack food.
- Goat flavoured milk and whey drink.
- Cereal pop

Awards and Achievements

- ICAR's Sardar Patel Outstanding Institute 2010
- ICAR-Rajshri Tandan Rajbhasha award for two successive years 2008 and 2009 – for significant achievement in popularization and progressive use of Rajbhasha (Hindi).
- ICAR – Rafi Ahmad Kidwai Award 2016.
- केन्द्रीय गृह मंत्रालय भारत सरकार के अधीन कार्यरत् नगर राजभाषा कार्यान्वयन समितिः नराकास, मथुरा द्वारा वर्ष 2015–16 के दौरान राजभाषा हिन्दी में उत्कृष्ट कार्य हेतु संस्थान को प्रथम पुरस्कार के रूप में शील्ड व प्रशस्ति पत्र दिनांक 28.07.2015 को प्रदान कर सम्मानित किया गया ।

Organizational Setup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RESEARCH PROGRAMME

ANIMAL GENETICS AND BREEDING DIVISION

Improvement and Sire Evaluation of Jamunapari Goats for Milk Production (AICRP)

Principal Investigator
P. K. Rout

Co-Investigators
Mahesh Dige, Gopal Dass,
H. A. Tewari and Vijay Kumar

Research Findings

Jamunapari goat is one of the largest goat breeds of India, and is known milk production in the subcontinent. Jamunapari is a large white size goat in semi-arid region and is commonly known as "Pari" in its home tract due to its majestic appearance. The natural habitat of this breed is the Chakarnagar area of Etawah district in Uttar Pradesh State. This breed is highly adapted to the ravines of Yamuna, Chambal and Kwari rivers, which have dense vegetation for browsing. This breed seems to be more adapted to particular vegetation type as the breed is not seen in adjacent areas out of its specific home tract indicating the sensitivity and adaptability of the breed to specific agro-climate conditions.

Population growth: The opening balance of the nucleus herd was 719 and closing balance was 698. During the period 264 kids were born, in which 128 were males and 136 were females. The population growth of the flocks was 81.5% during the year. The overall mortality of the flock during the year 2016-17 was 5.69 % and annual culling rate was 5.79 %. The nucleus herd is maintaining about 311 bredable adult doe.

Growth performance

A. Semi- Intensive System of rearing

The least squares means of body weights of kids at birth, 3, 6, 9 and 12 months of age during the year were 3.16kg, 10.00kg, 17.81kg, 22.46kg and 27.16kg, respectively. Year and Parity of dam had significant effect (P<0.01) on kid's body weight up to 12 months of age. Sex had highly significant effect (P<0.01) on body at all the age group. Season of birth had highly significant effect (P<0.01) on body weight at 3 month of age only. Males had higher body weight than females at all the ages and the birth type also showed highly significant effect (P<0.01) at all the ages.

Year by parity interaction had significant effect (P<0.01) on body weight at the age of 3Month. Season by sex interaction and Season by birth type interaction had significant (P<0.01) effect on body weight at the age of 6month, 9month and 12 month. Year by Sex interaction had significant (P<0.01) effect on body weight at 6 month of age. The male had significant higher body weight then female.

B. Intensive System of rearing

The least squares means for body weight under intensive management at 12 months of age was 45.154 kg and the highest body weight vale was 52.0 kg. The Average Daily weight Gain (ADG) of the kids under intensive management was 107.88, 120.78, 107.86, 133.69 and 107.85 g/day, during 3-6, 3-9, 3-12, 6-9, and 6-12 month age group respectively. The highest value of ADG was 171g/d during 6-9months of age. The feed conversion ratio during 3-6 month, 6-9 month and 9-12 months of age was 154gm, 106gm and 52 gm respectively per kg of dry matter consumption.

Genetic parameter estimation of growth traits

➤ **Body weights at different ages**

The pedigree records for 5922 animals over 13 generations were used for genetic parameter analysis. The 6590 phenotypic records were obtained from 292 sires and 1819 dams during 31 years. The complete summary statistics for all growth trait analysed, as well as means and coefficient of variation (CV) are presented. There was wide range of variation in body weight gains during different growth periods over the years. There is a large scope for selection for all the traits analysed with a wide range of CV. The wide range variation in body weight at different ages was observed as there was no culling practiced till 12 months of age for obtaining information on all the individuals. The least squares analysis variance indicated that parity of dam, year, birth type and sex had significant effect (P<0.05) on body weight at different ages. Season of birth had significant effect (P<0.01) on body weight at 3 months of age.

The most "appropriate" model for growth traits was the complete model accounting for both permanent environmental effects due to the dam and the common environment for litter effects

from birth to 9 months when fitting an animal model and up to 12 months for sire model.

Estimates of direct additive heritability increased from birth to between 6 and 9 months of age and decreased subsequently during 9 month and 12 months of age irrespective of the model fitted. The estimates of heritability for the sire model were higher between 3 and 6 months of age. The common environment for litter effects were higher across models (0.27-0.39) during birth to 3 months of age and decreased thereafter during 6-12 months of age (0.12 to 0.16). The variance component due to permanent environment due to dam are generally important earlier in life at birth to 3 months of age and decreased subsequently during 6 to 12 months of age observed for the animal model

➢ Average daily gain during different growth phase in Jamunapari goats

The "best" model for ADG in early life (0-3 and 0-6 months of age) for both animal and sire models included both common environmental effects due to dam and litter. However, in the sire model, other models containing earlier growth effects (3-6, 0-9 and 0-12 ADG) had the "best" model containing both environmental (pe and litter) effects. Litter effects persisted during all other ages of ADG traits for the models fitting animal as a random effect.

To allow for comparisons between the animal and sire models, the variance components presented in Tables 9 and 10 for ADG were for the model with the highest variance terms in either model. The highest estimates for ADG (0.18-0.20) were observed for earlier growth rates (0-3, 0-6 months) in the animal model, otherwise all other estimates were lower (0.04-0.15). The estimates of direct additive heritability in the sire model were much higher (0.41-0.47) in the earlier growth traits (0-3 and 0-6 ADG) than those observed in the animal model. In general, the reminder of estimates from the sire model were higher (0.1-0.37) than those observed in the animal model. Higher estimates of litter effects were observed from birth to 3 months of age irrespective of the model used (0.27-0.29). However, these diminished in the other ADG traits analysed (0.11-0.19) across the two models assessed. The estimates environmental effects due to dam were relatively low (0.01-0.11) across the models.

➢ Survival potential

In general, the most appropriate model for survivability of kids at different ages were when we included PE and litter effects in sire model fitted as linear or logit transformed. The estimates of heritability were very low (0.0-0.03) when assessed at 3 months of age for both linear and transformed models, and were highest (0.39) at 9 months of age and decreased to 0.31-0.33 at 12 months of age for both analyses. Litter effects were higher (0.20-0.21) in the untransformed data at 3-6 months of age. In general, the estimates of environmental effects due to the dam were low (0.01-0.06) across all models.

Genetic trend estimation

Genetic trends in body weight at various ages are illustrated in Figure 1 and 2. The direct genetic trend at birth, 9 month and 12 months of age are shown in Figure 1. The genetic trend due to sire effect for 3 month and 6 months of age is presented in Figure 2. The genetic trend at 9 months of age and 12 months of age was 0.14kg and 0.19 kg per year. Similarly, the genetic trend at 3 month and 6 months of age was 0.08kg and 0.12 kg per year. The genetic trend at all the ages was

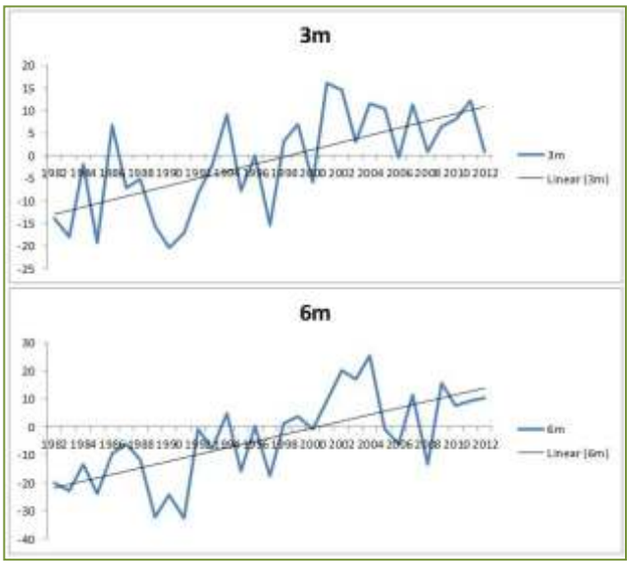


Figure 1 : Direct Genetic trend of body weight at birth weight, 9 month and 12 months of age in Jamunapari goats.

very specific and positive during the study period. The genetic trend for birth weight was positive but almost static in nature.

Lactation Performance of Jamunapari Goats : Least squares means of part lactation milk yield in 90 days and 140 days were 71.361 and 111.583liters, respectively during the year 2016-17(Table 3). Year of kidding had highly significant (P<0.01) influence on both the milk yields. Parity had significant effect on milk yield over the years. The season of kidding had highly significant (P<0.01) on 90days milk yield. The doe, which had multiple births, produced more milk in comparison to doe having single kid.

Genetic parameter estimation of Milk traits: The summary statistics for milk yield traits are presented in Table. The means for MY90, MY 140 and TMY were 80.2, 114.0 and 124.8 Kg, respectively for Jamunapari goat. The average lactation length was 179.5 days, which was longer than other Indian breeds. Jamunapari goats were productive until seventh parity; however, some goats were still productive until 11th parity. It has been observed that the influence of the season of kidding on milk yield at MY90, MY140 and TMY was significant (P<0.01). Parity had significant effect (P<0.01) on milk yield over the years. The year of birth and kidding year had significant effects (P<0.01) on milk yield traits. Does with multiple births produced more milk compared to those bearing singles.

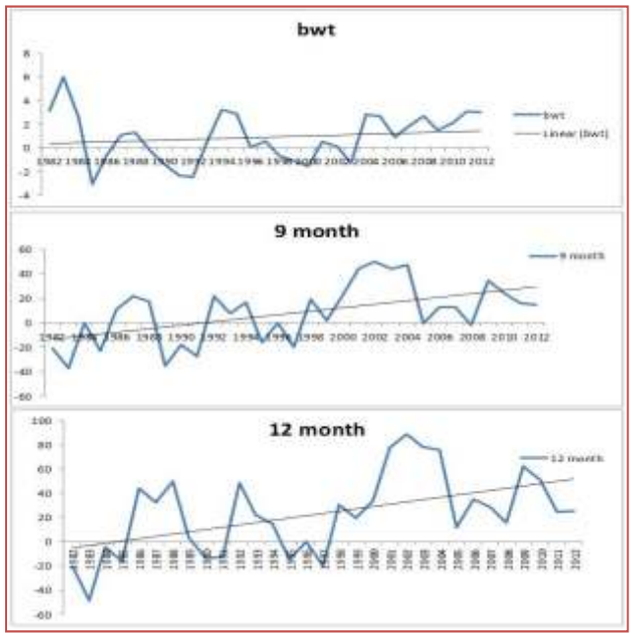
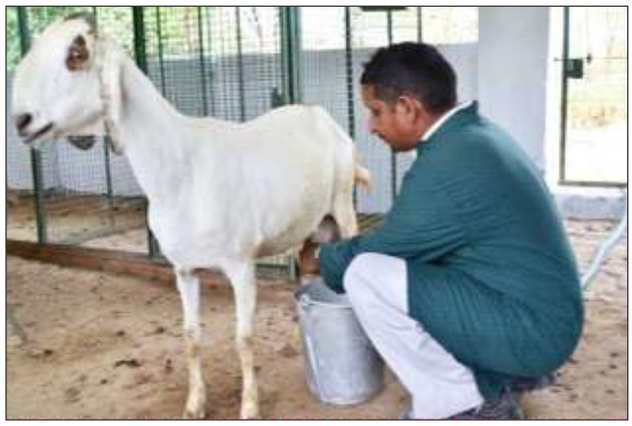


Figure 2 : Genetic trend of body weight due to sire effect at 3 month and 6 months of age in Jamunapari goats



The animal model (Model 1) fitting the permanent environment due to the animal was the most appropriate model for milk yield at 90 and 140, and LL with model 2 only most appropriate for TMY (Table 5). The estimates of direct additive heritability for MY90, MY140 and TMY were low to moderate and ranged from 0.15 to 0.28 (Table 5). The maternal variance contributed significantly for TMY and was low for MY90 and MY 140. The permanent environmental component due to animal and litter contributed negligibly. The heritability estimates across different traits were significantly (P<0.05) different from zero with small standard errors (varies from 0.02 to 0.08). This is mainly because of large sample size and indicating that the genetic improvement by selection for milk production for 90 days and 140 days is likely to be successful.

Genetic and Phenotypic Trend of Milk Yield

A positive genetic trend was observed for milk yield at 90 days, 140 days and TMY in Jamunapari goat population. Genetic trends for milk yield traits MY90, MY140 and TMY are presented in Figure 3. There was increase in mean milk yield of 0.25, 0.70 and 0.72 Kg/year at 90 days, 140 days and TMY, respectively in Jamunapari goat. The maximum limit of increase in milk yield was 0.70, 1.63 and 1.99 Kg per year in MY90, MY140 and TMY, respectively. The maternal genetic trend was positive and was 0.42 Kg/year for TMY. Genetic trends and phenotypic trends for MY90, MY140 and TMY were positive and indicated significant improvement in milk traits due to selective breeding (Figure 3). The total genetic progress was estimated as total change in mean estimated breeding values in 2013 from those estimated in 1990 expressed as proportion of genetic standard deviation. The total genetic gain as proportion of genetic standard deviation (σA) for TMY was 1.76. Genetic trend of milk production in Alpine and Saannen goats was 13.6 litre/year and 12.5 litre/year in France during 1990-2000.

Table The summary statistics (means, standard deviations and standard errors) for milk yield traits (liters, l) and lactation length (in days)

	MY 90 days	My140 days	Total Milk yield	Lactation Length
No. of Records	2217	1788	2099	2099
No. of years	24	24	24	24
Mean	80.18	113.98	124.82	179.50
SD	33.3	38.1	51.06	42.17
Standard error	0.71	0.90	1.11	0.92
CV (%)	41.6	33.48	40.90	23.49
Range	21.8-168.0	46.8-233.6	33.0-273.7	70-277

Table Model effect and genetic parameters of milk yield traits in Jamunapari goats

Models Parameter	MY90 1	MY140 1	LMY 2	LL 1
σ^2_a	5703.29	27002.8	35325.8	33.4
$\sigma^2_{repeatability}$	20250.4	43445.9	61547.6	245.9
$\sigma^2_{maternal}$	-	-	18404.6	-
$\sigma^2_{residual}$	12155.5	26077.3	24724.5	1128.4
$\sigma^2_{phenotypic}$	38109	96526.0	140000.0	1407.6
se	1613.1	4950.0	7550.7	46.1
$h^2_{additive}$	0.15	0.28	0.25	0.02
se	0.05	0.07	0.08	0.03
repeatability	0.68	0.73	0.69	0.20
se	0.02	0.02	0.05	0.03
mat^2	0.13			
se	0.05			
Log L	-2182.50	-10561.6	-2492.28	-8544.21

Where σ^2a~ direct additive variance, σ^2maternal~maternal variance, σ^2pe~ variance of permanent environment due to the animal, σ^2residual~residual variance, σ^2phenotypic~ total phenotypic variance, -2logL ~ Log likelihood ratio test; s.e. ~ standard error; h^2additive~ direct additive heritability; h^2maternal~ maternal heritability; pe^2~ permanent environment due to animal variance.
Model 1~ fitting additive and permanent environment due to the animal, model2 ~ fitting additive and maternal effects

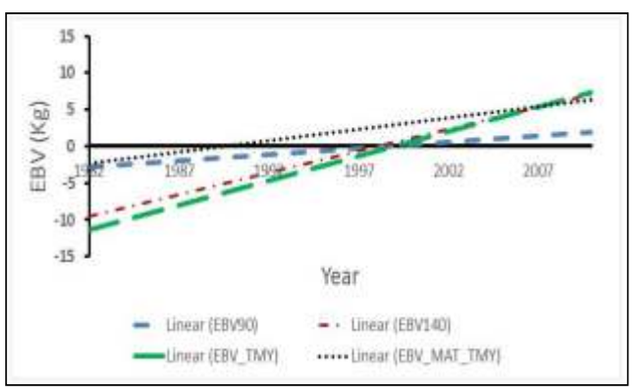


Figure 3 Direct and maternal genetic trends of milk yield traits in Jamunapari goats in semi-arid tropic (black dotted line for MY90 (EBV90), red dashed and dotted line for MY140 (EBV140), green dashed line for TMY (EBV_TMY) and a black dotted line maternal genetic trend of total milk yield (EBV_MAT_TMY) from 1982 to 2013 period).

Reproduction Parameter: During this year, a total of 196 does kidded 264 kids, out of which single, twin and triplet born kids were 130, 64 and 02 respectively. Reproductive performance of Jamunapari goats in terms of breeding efficiency and kidding percent on the basis of does selected for breeding were 95.88% and 106.88%, respectively. The kidding rate was 1.34.

Supplyof Improved germplasm: Improved animals were supplied to various developmental agencies, farmers and state governments, Non-Government Organizations and progressive breeders for genetic improvement in the field conditions. During year, 154 improved animals were distributed to goat breeders for breed improvement of their flocks. During the year 2016-2017, 154 superior germplasm (111 bucks and 43 does) were provided to breeders for breed improvement.

Genetic Improvement of Barbari Goats for Meat and Milk Production (AICRP)

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Barbari is a dual purpose goat breed and possesses many desirable characters of meat goat such as higher body weight gain, high prolificacy, high reproductive efficiency and sufficient milk to nourish high litter size. Goats of Barbari breed are in huge demand for commercial goat production due to their high productivity, adaptability in entire semi-arid regions of India and suitability for stall feeding. The home tract of the breed is Agra, Aligarh, Kanpur regions of Uttar Pradesh, and Dholpur, Bharatpur region of Rajasthan. The Barbari farm of the Institute is one of the research units of All India Coordinated Research project on Goat Improvement from October, 1993 with prime aim to provide proven sires for breed improvement, conservation and development of technologies and package of practices for farmers flock for enhancing income. During last two years activities have been intensified for development of business and livelihood models in farmers flock through establishment of multiplier flock with the aim to promote scientific/commercial goat farming along with development of development of germplasm resource centers.

Flock Management: The goats are kept separately according to sex, age and production/ reproduction stages. Goats are maintained under semi-intensive management system under which concentrate ration, dry and green fodders are major items of supplementary feeding and provided to goats considering their age, sex and production/reproduction stage. Goats were also sent to 5-6 hr. grazing; however grazing area is deficient in biomass and heavily dependent upon rainfall. There are10 sheds with the unit each of 60' x 20' covered space and 60'x40' open corral space including two kidding shed. Out of 10 shed two sheds are fitted with individual cages which serve the purpose of individual suckling. The floors of sheds are kachcha and soil of floor is scratched, removed and refilled with fresh soil one to two times in a year. Lime treatment performed 4 to 6 time and white washing of sheds is done annually. Watering channel is made of bricks and are open.

The breeding is carried out seasonally from 15th April to 15th June in summer and from 15th September to 30th November in autumn seasons of the year. Kids were weaned at 3 months of age and housed separately as per sex. Male and females are selected on the basis of respective selection index. Goats are breed according to mating plan and precaution is taken to avoid inbreeding. All the goats were vaccinated for PPR, ET, HS, FMD, Goat Pox and dewormed as per the goat health calendar and FAMACHA of the Institute.

Flock population dynamics: The annual flock strength of Barbari goats for the year 2015-16 was 825 (closing balance) and it was 716 (opening balance) in the year 2016-17. Three hundred seventy nine kids were born out of 251 does. The population growth of goats was 145% in 2016-17. Three hundred eight goats were provided to farmers and development agencies. Eighty two goats were culled during the year. Overall mortality and culling of the flock was 2.9 and 6.8% of flock strength.

Reproductive and breeding performance: Least squares means for weight at first mating, age at first mating, weight at first kidding and age at first kidding, first kidding interval & gestation period were 19±4kg, 368±16 days, 21.7±7.2, kg 509±10 days, 217±11 days and 145±0.33 days, respectively (table 1). There is significant gradual reduction in age at first service and age at first kidding over the last few however, weight at first service and weight at first kidding shown increasing trend over the years indicating significant improvement in body weight at first mating and age at first kidding. Breeding efficiency on the basis of doe's available and doe's tupped were 72 and 78%, respectively and kidding % on the basis of does available and doe's tupped were 109 and 140% respectively. Kids born as multiple for this year were 65.4% of total kids born. The kidding rate was 1.51.

Growth performance (body weights): The data on body weight at birth, 3, 6, 9, and 12 month of ages

recorded from 2012 to 2016 were analysed for effect of year, season of birth, sex of kids, type of kidding, parity and body weight of doe at kidding. Year, sex of kid, type of birth and parity has significantly affected body weight at different ages. The overall least squares means of body weight of kids at birth, 3, 6, 9, and 12 month of ages for the kids born in year 2016 were 1.91±0.01, 7.71±0.08, 12.34±0.15, 16.47±0.22 and 21.94±0.34 kg, respectively (Table-1). Single born kids were significantly heavier than those born as multiple and superiority for body weight remain up to 12 month however, magnitude of difference in body weight between single and multiple declines with the advancement of age. Similarly males were significantly heavier than their counterpart's right from birth to 12 months of ages. Kids born from primiparous (Ist parity) were of lesser birth weight as compared to multiparous goats however, slightly declined growth performance observed after Vth parity. The body weight of Barbari kids has showed fluctuating growth performance over the years though; improvement was recorded in body weights over previous year. The estimates of heritability (h^2) for body weight of kids at birth, 3, 6, 9, and 12 month of ages were 0.106±0.045, 0.230±0.073, 0.210±0.070, 0.267±0.077& 0.171±0.066 indicating moderate level of additive genetic variance for growth traits in this flock. The covariance components and genetic parameter for growth traits were estimated by REML fitting six animal models. The maternal component contributes 32% for birth and 4-10% post weaning. The heritability estimated was found low to moderate (0.12 for birth weight to 0.19 for 12 month weight).

Lactation performance: The data on lactation performance of does kidded during 2016 were analysed for non-genetic effects i.e. year, season, type of kidding, parity and polynomial regression of weight of dam at kidding using mixed model least square techniques. Overall mean for 90 days milk yield, 140 days milk, total lactation yield, average daily milk yield and lactation length were

52.71±1.00, 67.65±1.44, 63.02 ±1.30 liters, and 130±1.52 days, respectively (Table). Effect of year and season of kidding on different lactation traits was significant. There was significant improvement in performance of lactation traits in 2016 as compared to previous year. However, there is significant decline in performance in 2015 and 2016 kidding's as compared to 2014 which might be due decline in age at first kidding, scarcity of biomass in grazing area on account of less and limited period rainfall and shortage of concentrate feed during lactation periods in 2015 and 2016. Effect of parity was also significant on lactation traits but magnitude of difference was quite less. Doe's kidded during spring season performed significantly better for lactation traits than those which kidded in autumn season; however effect was quite less in magnitude (5-8% over different lactation traits). Higher lactation performance of Barbari goats was obtained from 2rd parity and this superiority persists up to 6th parity.

The estimates of h^2 for MY 90, LMY and LL were 0.142±0.131, 0.109±0.108, 0.106± 0.109 and 0.309±0.115, respectively indicating low additive genetic variance for lactation traits. Thus, there is necessity to introduce high potential animals as this flock is closed for breeding from last 20 generations.

Selection Differential: The selection differential for 9 months body weight was 6.08 kg (% above population mean) and that of the dam's 90 days milk yield was 20.3 liters (%above population mean). The high selection differential indicates the further scope of improvement through selective breeding in these goats.

Mortality: The overall mortality and culling was 2.9 and 6.8%. The major causes of death diagnosed were weakness/ anemia followed by enteritis, pneumonia, pregnancy toxicaemia, haemonchosis, pulmonary congestion, pnemoenteritis, JD etc.

Germplasm Supplied (Technology transfer): During the year 308 superior goats (193 male and 115 female) were supplied for breed improvement and conservation of Barbari goats and popularization of commercial and livelihood goat models among farmers. Farmers reported its good adaptability and productivity of Barbari goats in Haryana, Madhya Pradesh, eastern Rajasthan, and Punjab besides entire Uttar Pradesh.

Multiplier Flocks (Technology validation and Model development): There are 29 multiplier flocks of Barbari goats which were created to start-up scientific goat farm for genetic

improvement, conservation and agri-business among educated youths and farmers. These flocks were supported by pure-bred Barbari goat unit with 17 animals besides technical support from time to time. Various Interventions were provided to these flocks for development of livelihood model and agri-business models as breeding and or broiler goat production. These flocks were established in UP, Haryana, Rajasthan. Most of these farms are maintained on stall feeding with optimum feed inputs. All improved management practices (breeding calendar, feeding, housing, health care and marketing) are by and large optimally adopted. Overall survivability at multiplier flocks was 93.3%. Most of such farms focusing on increasing flock size and sale are restricted to 15-40%. The cost of production per goat/year varied from Rs. 3260 to Rs.7800 and profit from Rs 4300 to 9600 with an average of Rs 5280. The prices of quality breeding bucks and well fed castrated male at such farms however, gone up to Rs 22000 and Rs 18000.

Table 1 Least squares means of body weight (kg) in Barbari goats

Factor	Body Weight at Different Ages				
Overall mean	Birth 1.74±0.01 (1919)	3M 8.03±0.05 (1859)	6M 12.11±0.08 (1520)	9M 16.35±0.13 (1375)	12M 20.43±1.53 (1283)
Year of birth	**	**	**	**	**
2012	1.76a±0.01 (423)	7.39a±0.08 (318)	10.64a±0.13 (361)	15.09a±0.19 (327)	18.45a±0.23 (288)
2013	1.72b±0.01 (316)	8.47b±0.09 (308)	12.69b±0.13 (286)	17.35b±0.19 (284)	21.89b±0.23 (272)
2014	1.60c±0.01 (397)	8.66c±0.08 (386)	13.10c±0.13 (363)	16.92b±0.19 (346)	20.41c±0.22 (320)
2015	1.74d±0.01 (360)	8.12d±0.08 (359)	11.88ad±0.13 (306)	15.87c±0.19 (293)	20.04c±0.22 (280)
2016	1.91e±0.01 (423)	7.71e±0.08 (408)	12.34b±0.15 (204)	16.47b±0.22 (125)	21.94b±0.34 (123)
Season of birth					
1	1.73±0.01 (669)	7.95±0.07 (642)	11.87±0.12 (581)	16.24±0.15 (529)	20.22±0.19 (497)
2	1.74±0.01 (1250)	8.21±0.05 (1217)	12.03±0.10 (939)	16.46±0.14 (846)	20.63±0.18 (786)
Sex of kid	**	**	**	**	**
Male	1.79±0.01 (1004)	8.33±0.06 (969)	12.66±0.09 (801)	17.45±0.14 (715)	21.77±0.17 (661)
Female	1.69±0.01 (915)	7.76±0.07 (890)	11.54±0.09 (719)	15.39±0.15 (660)	19.08±0.18 (622)
Type of birth	**	**	**	**	**
Single	2.01a±0.01 (657)	8.91a±0.06 (643)	13.41a±0.11 (521)	17.83a±0.15 (481)	21.84a±0.19 (481)
Twin	1.74b±0.01 (1135)	7.87b±0.04 (1093)	12.10b±0.07 (890)	16.32b±0.11 (797)	20.44b±0.13 (797)
Triplet	1.50c±0.02 (127)	7.31c±0.13 (123)	10.94c±0.20 (109)	15.03c±0.30 (97)	19.31c±0.36 (97)
Parity of Dam	**	**	**	**	**
Parity-I	1.69a±0.01 (615)	7.60a±0.07 (581)	11.69a±0.10 (474)	15.33a±0.17 (421)	19.87a±0.21 (384)
Parity-II	1.72b±0.01 (458)	7.91b±0.07 (447)	12.09b±0.10 (348)	16.55b±0.18 (333)	20.54b±0.21 (311)
Parity-III	1.76c±0.01 (330)	8.01b±0.07 (327)	12.11b±0.12 (272)	16.40b±0.20 (239)	20.56b±0.24 (223)
Parity-IV	1.73b±0.02 (226)	8.24c±0.10 (223)	12.05b±0.13 (200)	16.84b±0.22 (188)	20.92b±0.27 (178)
Parity-V	1.76c±0.02 (153)	8.36c±0.13 (146)	12.60c±0.15 (121)	16.90b±0.29 (114)	21.03b±0.35 (109)
Parity-VI	1.73bc±0.02 (137)	7.88b±0.13 (135)	11.71a±0.21 (105)	15.89a±0.34 (80)	19.79a±0.40 (78)

**P<0.01, *P<0.05 (Values in parenthesis are number of observations)

Table 2 Lactation Performance of Barbari Goats

Factor	90- d milk yield (L)	140dmilk yield(L)	Lactation length (d)	Daily milk yield (ml)	Total milk yield (L)
Year of kidding		**	**	**	****
Mean	54.46±0.58 (1159)	76.72±0.95 (610)	120.00±0.86 (1217)	501.52±4.87(1217)	65.01±0.75 (1217)
2012	54.93a±0.95 (286)	80.70a±1.84 (97)	129.00a±1.48 (293)	503.34a±8.30 (293)	65.96a±1.28 (293)
2013	61.00b±1.08 (187)	82.47a±1.68 (113)	136.00b±1.68 (191)	545.95b±9.42 (191)	73.93b±1.45 (191)
2014	60.12b±1.07 (224)	87.12b±1.96 (94)	125.00c±1.61 (241)	545.08b±0.96 (241)	68.51c±1.39 (241)
2015	45.54c±1.06 (217)	62.65c±1.80 (108)	127.00c±1.52 (233)	439.02c±9.02 (233)	54.32d±1.39 (233)
2016	52.71d±1.00 (245)	67.65d±1.44 (198)	130.00a±1.52 (259)	496.45a±8.55 (259)	63.02a±1.30 (259)
Season of kidding		**	**	**	****
1	57.84±0.84(397)	79.49±1.42(313)	132.00±1.28(410)	521.06±7.12(410)	69.50±1.10(410)
2	51.10±0.62(762)	72.95±0.99(397)	127.00±0.93(807)	499.00±5.22(807)	61.07±0.84(807)
Type of birth					
1	54.92±0.78(608)	76.25±1.28(305)	131.00±1.20(628)	517.06±6.76(628)	65.69±1.04(628)
2	54.00±0.68(551)	76.18±1.13(305)	129.00±1.00(589)	513.30±5.64(589)	64.52±0.86(589)

**P<0.01, *P<0.05 (Values in parenthesis are number of observations)

Genetic Evaluation and Improvement of Jakhrana Breed for Milk and Growth Traits (AICRP)

Principal Investigator
Saket Bhusan

Co-Investigator
Gopal Dass

Jakhrana is a valuable milch breed and also used for meat due to its compact and large size body. The coat colour of the breed is black with white speckles on the ears. The breed derives its name from the name of village "Jakhrana" where it is found in most pure forms. A small unit of Jakhrana goats is maintained at CIRG, Makhdoom for genetic improvement of goats for milk and meat production. Animals were kept separately according to their reproductive and productive status like advance pregnant animals, breeding females, breeding bucks, sick animals, newly born kids and aged kids. All the animals were housed in the shed from 6 pm to 8 am in the winter and 7 pm to 7 am in the summer. These animals are maintained under semi-intensive system of feeding management where they allowed grazing 7 to 8 hours on natural pasture with supplementation of some amount of concentrate depending upon the status and age category of the animals. Three to four times milk was provided to the kids after birth to 15 days of age. After 15 days of age kids were provided only two times milk in the morning and evening. Every day fresh drinking water was provided adlib. Selective breeding was practiced in the flock. Five to ten percent animals are culled from the flock on the ground of health, low milk production and body weight. Bucks are selected on the basis of 9 months body weight and does are selected on the basis of 90 days milk yield. At kidding, kids and dams are weighted then kidding date, sex and birth status of each kids are recorded. Kids are weighted 15-day's interval from birth to weaning and thereafter at monthly interval up to 12 months of age. Weaning of kids is generally done at 3 months of age. Animals are vaccinated against all important diseases like PPR, enterotoxaemia and FMD.

Population Dynamics: Population strength of males and females of Jakhrana goats for 0-1, 1-3, 3-6, 6-9, 9-12 months and Jakhrana adults on dated 1st April, 2016 and 31st March, 2017 were recorded. Closing balance on 31.03.17 was total 238 animals in the farm on this date

Total 122 kids were born from 87 kidding in the year 2016-17. Out of 122 kids, 64 kids (52.46 %) were male and 58 kids (47.54 %) were female. Out of 87 kidding, 53 does (63.92 %) gave single birth, 33 does (37.93 %) produced twins and 1 does (1.15 %) gave triplet births. Over all multiple births were 34 (39.08 %). The kidding rate of Jakhrana goats in 2016-17 was 1.40.

Production of breeding bucks for breed improvement in the field and farm: Male and female kids were selected on the basis of their 9 month body weight as per parity and 90 days milk yield of their dams. Does were selected on the basis of 90 days milk yield as per parity. Total thirty seven (37) breeding males and 79 breeding does were supplied to the farmers/ other government and non-government agencies/ other department in 2016-17.

Weight of kids: Least square means for birth weight, 3, 6, 9 and 12 month were calculated for 2012-13, 2013-14, 2015-16 and 2016-17 and presented in the table 4. Males are selected on the basis of 9 month body weight for selective breeding. Average body weight at 3, 6, 9 and 12 months of Jakhrana kids born in 2015-16 and 2016-17 were increased than kids born in 2012-13. Years were found highly significant for all body weights of kids. Results indicated that selection of bucks at 9 month body weight also significantly affects the 3, 6, 9 and 12 month body weight.

Sex of kids: Birth weight, 3, 6, 9 and 12 month weight of male kids were to than female kids. Sex of kids was highly significant for all weights of kids.

Season of kidding: Kids born in summer season (Season-II) have higher body weight at 3, 6, 9 and 12- month of age than winter season(Season-I). Season was found highly significant for birth, 3 and 6 month body weight of kids.

Parity: Birth weight was highest in 5th parity followed by 4, 2, 1 and 1st parity. Three month body weight was highest in 3rd parity followed by 5, 4, 2 and 1st parity. Six month body weight was highest in 4th parity followed by 2, 1, 5 and 3rd parity. Nine month body weight was highest in 5th parity followed by 5th and above, 3, 4, 2 and 1st parity. Twelve month body weight was highest in 3rd parity followed by 5, 4, 2 and 1st parity. It seems that parity has positive correlation with litter size and litter size has positive correlation with body weight of individual kids up to 4th parity. Parity was found highly significant for only birth weights of kids.

Litter size: Birth weight, 3, 6, 9 and 12 month weight of single born kids were higher than multiple kids. Litter size was highly significant for birth, 3 and 6 month body weights of kids.

Improvement in milk production and effect of non-genetic factors on milk production: Milk production of Jakhrana does was recorded in liter

Table 1 Least Square Means of Body Weight of Jakhrana Kids

Traits	Birth Wt.	3 M Wt.	6 M Wt.	9 M Wt.	12 M Wt.
Overall mean	2.50±0.32(627)	9.31±0.14(559)	13.86±0.28(448)	19.33±0.69(370)	24.89±0.80(338)
2012-13	2.52±0.04(137)	8.19±0.19(116)	11.02±0.42(83)	15.91±0.82 (56)	22.46±1.09 (39)
2013-14	2.49±0.05(109)	10.63±0.20(107)	14.97±0.39(105)	2.36±0.70 104)	28.20±0.86 101)
2014-15	2.59±0.05 (104)	8.93±0.19 (97)	13.87±0.38 (90)	20.08±0.65 (85)	24.97±0.80 (82)
2015-16	2.55±0.04(150)	10.29±0.19(137)	16.24±0.38(129)	21.38±0.67(118)	24.72±0.83(109)
2016-17	2.38±0.04(127)	8.51±0.19(102)	13.21±0.52(41)	16.91±1.90 (77)	24.13±2.23 (7)
Male	2.60±0.04(303)	9.56±0.15(260)	15.13±0.33(191)	21.80±0.71 169)	27.93±0.88 149)
Female	2.41±0.03(324)	9.06±0.15(299)	12.60±0.30(257)	16.87±0.68 (201)	21.86±0.83(189)
Season	**	**	**	NS	NS
1	2.62±0.03 (522)	9.58±0.13 (472)	14.56±0.26(388)	20.13±0.56 (329)	25.04±0.71(299)
2	2.39±0.05 (105)	9.04±0.20 (87)	13.17±0.43 (60)	18.53±0.95 (41)	24.75±1.13 (39)
Parity	**	NS	NS	NS	NS
1	2.39±0.04 (189)	9.05±0.18 (167)	13.42±0.38(138)	18.34±0.82 (118)	23.72±0.99(113)
2	2.50±0.48 (153)	9.22±0.18 (236)	13.49±0.39 104)	18.81±0.79 (85)	24.19±0.97 (75)
3	2.48±0.04 (103)	9.66±0.20 (93)	14.28±0.42 (74)	20.18±0.85 (58)	26.12±1.04 (51)
4	2.57±0.05 (84)	9.30±0.22 (78)	13.79±0.46 (65)	19.10±0.94 (56)	24.99±1.14 (51)
>5	2.59±0.04 (98)	9.32±0.18 (85)	14.37±0.39 (67)	20.24±0.82 (53)	25.46±1.01 (48)
Type of Birth	**	**	*	NS	NS
Single	2.75±0.03 (252)	9.54±0.13 (227)	13.99±0.27(187)	19.00±0.63 (157)	24.54±0.75(148)
Twins	2.55±0.03 (350)	9.03±0.11 (311)	13.28±0.25(241)	18.50±0.60 (196)	24.38±0.71(177)
Multiple	2.21±0.08 (25)	9.37±0.35 (21)	13.20±0.70 (20)	18.32±0.66 (17)	23.76±1.69 (13)

(*P< 0.05, **P<0.01)

Table 2 Least Squares Means of Milk Production (liter) of Jakhrana goats.

Traits	30 d	60 d	90 d	120 d	140 d
mean	50.86±2.16(385)	95.54±3.61(367)	140.62±4.62(309)	181.49±6.31(229)	219.35±9.31(133)
Year	**	**	**	**	**
2012-13	47.75±2.55(90)	87.98±4.30 (86)	124.32±5.42 (78)	159.27±7.65 (52)	149.49±11.76 (25)
2013-14	49.35±2.64(71)	94.70±4.47 (69)	138.24±5.67 (65)	174.28±7.58 (59)	216.54±11.26 (37)
2014-15	53.13±2.63(71)	101.09±4.44(68)	143.25±5.54(63)	180.72±7.46(41)	216.32±10.47(28)
2015-16	55.45±2.63(82)	104.18±4.43(79)	146.78±5.54(76)	187.23±7.32(65)	243.68±11.22(37)
2016-17	48.61±2.67(71)	98.77±4.57 (65)	150.51±7.16 (27)	205.93±11.85 12)	225.73±19.13 (6)
Season		*	*	NS	NSNS
1	53.41±2.10(316)	98.97±3.53(299)	143.60±4.44(260)	183.14±5.63(206)	213.95±8.62(117)
2	48.32±2.64(69)	92.11±4.43(68)	137.64±5.88(49)	179.84±9.09(23)	224.75±13.30(16)
Parity	**	**	NS	*	NS
1	44.79±2.52(128)	86.53±4.56(120)	125.81±5.50(105)	165.06±7.73(72)	208.98±12.06(39)
2	50.24±2.63(94)	94.92±4.43(91)	140.52±5.80(75)	180.01±7.85(60)	222.42±11.78(37)
3	47.60±2.69(66)	91.08±4.54 (64)	140.26±6.03 (50)	178.34±8.39 (36)	217.30±13.57 (18)
4	54.25±3.07(43)	101.25±5.17(42)	151.78±6.72(37)	194.28±8.96(31)	230.65±13.01(19)
>5	57.42±2.50(54)	103.94±4.24(50)	144.73±5.40(42)	189.74±7.87(30)	217.40±10.96(20)
Single	48.29±1.23(216)	88.81±2.10(203)	130.40±2.88(170)	173.64±5.11(119)	202.24±9.31(67)
Twins	52.23±1.31(163)	97.31±2.21(158)	141.23±3.09(133)	182.13±5.00(104)	219.03±7.44(62)
Triplet & above	52.06±6.07(6)	100.5±10.18(06)	150.23±12.61(6)	188.69±15.64(6)	236.78±23.24(4)

and average milk production for 2012-13, 2013-14, 2014-15, 2015-16 and 2016-17 is presented in Season of kidding: Milk production of summer (season-I) was higher than winter (season-II) for 30, 60, 90 and 120 days milk production. However, season of kidding was significant for only 30 and 60 days milk production.

Parity of dam had significant effect on all the milk production traits. Comparison of milk yield in different parities indicated that milk yield increased up to 4th parity and then it decreased. However, parity kidding was significant for only 30 and 60 and 120 days milk production.

Does born as multiple births produced more milk than does born as single. However type of birth of kids had significant impact on the 30, 60, 90 and 120 days milk yield.

Genetic Evaluation and Improvement in Muzaffarnagari Sheep for Body Weight (AICRP)

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Co-Investigators
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Muzaffarnagari, the heaviest mutton breed of the country, is mainly distributed in and around Muzaffarnagar and Mathura district of Uttar Pradesh and also in some parts of Rajasthan, Haryana and Delhi states. The breed is generally reared for mutton production as wool production is low with course quality, thus not suitable for carpet manufacture. The breed is considered as less known genotype exhibiting better growth and good adaptability than other Indian sheep breeds. The institute has been maintaining a pure bred flock of Muzaffarnagari sheep under a "Network Project on Sheep improvement" since 1992 and presently the efforts are being made to improve the breed for higher mutton production through selective breeding.

Management of flocks: Flocks were maintained under semi-intensive system of feeding management with 6-7 hours grazing supplemented with 100-500 concentrate in various stage and age group of the animals. Dry and green fodder was also offered as per the requirement. Controlled breeding was practiced to improve the managemental efficiency. Ewes were bred during May-June and October-November followed by lambing in the months of October–November and March-April, respectively. The lambs were weaned at 2 months of age due to poor milk production as well short lactation period of their dams. All the sheds and corrals were disinfected frequently with lime. Regular treatment and strict prophylactic measures were practiced for vaccination against Enterotoxaemia, Foot and Mouth Disease, Sheep Pox, H.S., PPR etc. De-worming with different anthelmintic was practiced at pre-monsoon and post monsoon seasons and as and when required. Dipping was done after 15-20 days of each shearing. On the first day of the year the opening balance was 644 which comprised of 209 males and 435 females and closing balance of 639 sheep had a stock of 185 males and 454 females. During this year a total of 268 lambs born and overall mortality was recorded 2.19%.

Fig 1Muzaffarnagari Rams

Production performance: The overall least-squares means of body weights of lambs at birth, 3, 6, 9 and 12 month age were 3.40±0.04, 15.130.25, 24.93±0.39, 27.22±0.60 and 35.18±0.60 kg, respectively during the year under report. The effect of sex, year of lambing, parity of dam and type of birth was highly significant (P<0.01) on all body weights except non-significant effect of year of lambing on 6 month body weight and parity of dam on 3, 6, 9 and 12 month body weights. Male lambs gained higher weights as compared to female lambs at all growth stages. Lambs born as twins and triplets had significantly lower body weights at all stages as compared to those lambs born as single. The average daily gain of Muzaffarnagari lambs during 0-3, 3-6 and 6-12 months were 130.17±3.87, 100.04±3.35, 45.63±2.42 and 63.83±1.93g under semi-intensive feeding management. The average adult body weights of males and females respectively 50.9 and 41.6kg.

The overall least squares means for lambs 1st and 2nd six monthly and adult annual clips were calculated to be 553.66±11.39, 539.11±10.19 and 1261.43±17.49g, respectively. Sex and year of lambing had highly significant (P<0.01) influence on all the lambs and adult clips except non-significant influence of sex on lambs first clip, year of lambing on second clip and significant effect (P<0.05) of year of lambing on adult annual clip. The males produced significantly higher greasy fleece yield than females in all the clips which might be due to larger surface area for wool growth in males as compared to females.

Reproduction performance: The twinning rate in Muzaffarnagari sheep is comparatively low due to large body size. But due to the intensive breeding of those rams and ewes responsible for producing twins and triplets, the twinning rate improved tremendously. The annual tupping and lambing on available basis were 100.0 and 93.7%. During

Table 1: Growth performance of Muzaffarnagari lambs (kg)

Particulars	Birth Wt.	3M Wt.	6M Wt.	9M Wt.	12M Wt.
mean	3.530.02 (788)	15.970.15 (592)	25.390.25 (509)	29.480.30 (447)	34.850.29 (403)
Sex	**	**	**	**	**
Male	3.630.03 (410)	16.420.20 (302)	27.280.35 (237)	32.410.40 (203)	38.230.39 (183)
Female	3.430.03 (378)	15.510.20 (290)	23.500.34 (272)	26.550.38 (244)	31.470.37 (220)
Year	**	**	NS	**	**
2014	3.44±0.04 (210)	16.92±0.25 (191)	26.09±0.39 (184)	30.12±0.42 (181)	35.57±0.40 (166)
2015	3.48±0.04 (239)	15.85±0.24 (189)	25.15±0.48 (184)	31.10±0.41 (179)	33.80±0.39 (167)
2016	3.40±0.04 (241)	15.13±0.25 (212)	24.93±0.39 (141)	27.22±0.60 (87)	35.18±0.60 (70)
2017	3.79±0.06 (98)	-	-	-	-
Parity	*	NS	NS	NS	NS
I	3.43±0.04 (219)	15.86±0.28 (162)	24.71±0.55 (134)	28.96±0.51 (127)	34.67±0.51 (108)
II	3.56±0.04 (182)	16.27±0.31 (121)	25.15±0.53 (101)	29.32±0.61 (80)	35.33±0.59 (73)
III	3.50±0.05 (118)	16.19±0.35 (89)	25.79±0.55 (79)	30.31±0.65 (69)	34.50±0.62 (65)
IV	3.50±0.06 (101)	15.46±0.37 (76)	25.21±0.55 (68)	28.85±0.70 (59)	34.30±0.67 (55)
>V	3.64±0.05 (168)	16.06±0.27 (144)	26.10±0.46 (127)	29.96±0.53 (112)	35.46±0.51 (102)
Single	3.90±0.03 (554)	17.49±0.17 (425)	26.79±0.29 (362)	30.70±0.33 (318)	35.71±0.32 (282)
Multiple	3.15±0.04 (234)	14.45±0.25 (167)	23.99±0.43 (147)	28.26±0.48 (129)	33.99±0.46 (121)

this year, the annual twinning rate recorded to be 16.4%. The twinning rate showed increasing trend over previous years. The overall replacement rate was calculated as 33.9%. The averages for weight at first service, age at first service, age at first lambing and ewes' weight at lambing were 36.1kg, 488 days, 649 days and 36.4kg, respectively.

Semen collection and Artificial Insemination: The semen was collected by AV in the shed and diluted in the ratio of 1:10 with Tris diluter supplemented with 1% bovine serum albumin. In two major breeding seasons a total of 53 ewes were inseminated only one time with diluted semen. The vaginal AI was performed in standing posture. A total of 54 inseminations at cervical oss were carried out in which 23 ewes became pregnant and lambed. Thus, the overall annual conception rate using liquid semen was 42.6%.

Fig 2 Muzaffarnagari lambs

Adoption of flocks and growth performance in field: During year 2016-17, the data on body weights of lambs of adopted flocks as well as contemporary flocks under field conditions were recorded. The animals covered under adopted flocks were given vaccination of important diseases like PPR, ET etc. and treatment of routine illness. The overall mean of weight at birth, 3, 6 and 12 month age were 3.0, 13.0, 19.5 and 27.3kg, respectively. The body weights recorded from farmers flocks were significantly lower than recorded in Muzaffarnagari Sheep Project, ICAR-CIRG, Makhdoom. The main reason of lower body weights of farmer's flocks is low genetic worth of animals, poor health care and availability of poor feed & fodder to the animals.

Distribution of elite germplasm and revenue generation: A total of 74 elite animals (54 rams and 20 ewes) were supplied to various developmental agencies, Research organizations, Non-Government organizations and progressive farmers for genetic improvement of their flocks under field conditions.

Livelihood Security of Rural Women through Scientific Goat Farming (DST-SoRF)

Principal Investigator
Manali Baghel

Mentor
Saket Bhusan

Two villages viz. Nagla Chandrabhan and Barka Nagla of Farah Block in Mathura, Uttar Pradesh were identified and selected under DST project entitled "livelihood security of rural women through scientific goat farming" in 2015 to improve goat farming system and enhance the income of farm women through upgraded goat farming so that women empowerment and improved goat farming system can be achieved in the area. Rural women being illiterate or less educated have very limited opportunities to make some money for themselves. However, 'goat farming' is one of those areas where women have been playing major role and contributing in sustainable family development in rural India. Since, small unit of goats (5-10) require less investment, less space, less labour and due to their small size, they can be managed well by women. Women along with other home activities also perform major activities of goat farming such as cleaning; milking, feeding, grazing and taking care of sick animals. To help and motivate goat rearing farm women and to increase goat productivity in the area, trainings, meetings, group discussions and health camps were organized in operational areas and critical inputs such as medicines, vaccines, mineral mixtures, concentrated feed and lectures on different aspects of goat farming were provided. Body weights and milk production data were recorded time to time to observe the impact of project interventions.

Management System: Presently the efforts are being made to improve goat farming system and breed for higher body weight and milk production. The area under study had local Barbari type breed goats (72.51%) mostly and others are crosses with other breeds. All the goat keepers had kachcha sheds which were connected with their residence (64.15%), with other livestock (28.30%) and separately (7.55%) and constructed with locally obtainable low priced materials such as bamboo, wood, paddy straw or thatch to reduce the cost of construction. Goats were mostly maintained under extensive grazing system (84.91%) in which they were grazed on available wasteland area on an average of 3.62 hours per day with small quantities of straw and tree leaves are provided at home.

Population Growth: The total goat population of the two villages for the year 2015-16 showed opening balance of the flock was 270 and closing balance was 294. During this period 171 kids were born out of 120 does among which 92kids (53.80%) were females and 79 kids (46.19%) were males. The population growth was 153%. Out of 106 kidding, 43 does (40.56%) gave single birth, 61 does (57.54%) produced twins and 2 does (1.88%) gave triplet births. Over all multiple births were 63 (59.43%). Overall mortality of the total flock of two villages during the year was 7.82%.

Growth Performance: The overall mean and standard error of body weight of kids at birth, 3, 6, 9, and 12 months of ages for the year 2016 were 1.92±0.01, 5.59±0.05, 9.19±0.10, and 12.89±0.12 and 16.72±0.12 kg respectively (table 1). Single born kids were significantly heavier than those born as multiple. Similarly males were significantly heavier than their counterpart's right from birth to 12 months of age. Birth weights of kids were higher

Table 1 Mean and standard errors of body weight growth (Kg) of kids at different age

Factors	Body Weight of Kids				
	Birth	3m	6m	9m	12m
2015-16	1.85±0.04(24)	5.45±0.23(36)	8.95±0.30 (32)	11.61±0.37(7)	15.40±0.48 (12)
2016-17	1.92±0.01 (170)	5.59±0.03 (159)	9.34±0.07 (66)	13.14±0.12 (46)	16.76±0.16 (36)
(Season-I)					
March-April	1.94±0.02 (89)	5.58±0.04(84)	9.34±0.07 (66)	13.14±0.12 (46)	16.76±0.16 (36)
(Season-II)					
Oct.-Nov.	1.90±0.02 (81)	5.62±0.04(75)	-	-	-
Male	2.04±0.02 (78)	5.81±0.04(76)	9.74±0.10 (28)	13.75±0.23 (11)	17.73±0.25 (4)
Female	1.83±0.01 (92)	5.44±0.04(83)	9.29±0.10 (38)	13.16±0.84 (35)	16.79±0.16 (35)
Single	2.04±0.03 (43)	6.12±0.06(41)	10.16±0.14 (16)	14.36±0.25 (9)	17.85±0.32 (6)
Twin	1.88±0.01 (121)	5.62±0.04 (112)	9.34±0.09 (48)	13.15±0.14 (35)	16.78±0.18 (28)
Triplet	1.58±0.03(6)	5.27±0.15(6)	8.85±0.21(2)	12.55±0.21 (2)	15.85±0.21 (2)

in season March-April than in season Oct.-Nov. The average daily weight gain (ADG) of the kids in the area was 45.81 g/day for the year 2016-17 which was 30.66 g/day for the year 2015-16.

Lactation Performance: The overall mean and standard error for 30 days milk yield, 90 days milk, 140 days milk, lactation length, average daily milk yield and total lactation yield and for the does kidded in 2016-17 were 18.22±0.14, 54.45±0.41, 76.79±0.92, 125.04±1.66 days, 0.55±0.01 ml and 68.71±0.95 liters respectively (Table-2). Does kidded during autumn season had higher total milk yield and lactation length than those kidded in spring season. Average daily milk yield and average peak yield of the total goat flock of two villages were 0.55±0.01 ml/d and 0.85±0.01 ml respectively. Type of birth of kids had significant impact on the milk yield as does gave multiple births produced more milk than does gave single births.

Table 2 Lactation performance of goats in villages

Factor	30-d milk yield (Lt)	90-d milk yield (Lt)	140-d milk yield (Lt)	Lactation length (d)	Daily milk yield (ml)	Total milk yield (Lt)
2016-17	18.22±0.14(106)	54.45±0.41(102)	76.79±0.92(29)	125.04±1.66(106)	0.55±0.01(106)	68.71±0.95 (106)
(Season-I) March-April	17.98±0.19 (52)	54.79±0.60 (48)	77.74±1.44(11)	122.71±2.92 (52)	0.54±0.01 (52)	66.73±1.60 (52)
(Season-II) Oct.-Nov.	17.38±0.20 (54)	54.14±0.57(54)	76.91±1.18(17)	127.28±1.67 (54)	0.56±0.01(54)	70.61±1.03 (54)
Single	16.55±0.28 (43)	52.21±0.90 (43)	76.33±1.31 (9)	125.56±1.70 (43)	0.53±0.01 (43)	66.96±1.30 (43)
Multiple	17.70±0.18 (63)	54.58±0.52 (59)	78.94±0.55 (20)	124.68±2.57 (63)	0.64±0.08 (63)	69.63±1.55 (63)

Reproductive Performance: Overall mean for age at first service, age and weight at first kidding, conception rate, gestation period, kidding interval and service period were 341.85±0.73, 470.50±1.99, 19.22±0.25, 1.72±0.06, 144.27±0.73, 226.92±2.25 and 70.63±0.31, respectively. Breeding efficiency on the basis of does available and does tupped was 88.3%. Kidding percentage, kids born as multiple births and kidding rate were 142.5%, 59.43% and 1.43 respectively during the year.

Health Camps, Training Program and meetings organized: A total of four health camps were organized to treat and vaccinate goats in both villages viz. Nagla Chandrabhan and Barka Nagla. A total of 228 goats of above three months of age were vaccinated with PPR vaccines and 171 goats vaccinated for ET vaccines. ET vaccinated goats were vaccinated once again for ET booster injection. One goat was vaccinated with Raksha Rab vaccine for dog bite and recovered. Medicines were provided timely to women farmers for treating their sick goats for common diseases such as diarrhea, ticks, stomach worms, cold & cough, contagious ecthyma, anorexia, and tympany. Training on paneer preparation technique developed in CIRG was organized at Goat Production and Technology Division of CIRG for women farmers involved in project to increase value addition of goat milk. All the women farmers were amused by easy paneer preparation process and decided to make paneer with goat milk at home. A total of 43 goat rearing women participated in this training program. Twelve meetings and group discussions were organized in both villages to promote scientific goat farming and motivate more women farmers to opt goat farming as income source in order to provide farmers with required information, knowledge and advisories on regular basis. Required medicines for sick goats were also provided during meetings and group discussions.

Scientists and goat keepers meeting at village Nagla chandrabhan

Allele mining in caprine KISS 1 and GPR54 genes and its association with prolificacy of Goats

Principal Investigator
M S Dige

Co-Investigators
P K Rout, M K Singh, S D Kharche,
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Improvement of reproductive traits in livestock species has become of increasing interest, especially in goats, where small increase in litter size can equal large gains in profit. Traditional selection for improving litter size is difficult due to the sex-limited nature and low heritability of the trait (5–10%). In addition, the lack of knowledge on the number of the genes controlling this trait and the possible gene interactions are the other limitations for this trait. Molecular genetic scan overcome these limitations offering new opportunities to the improvement of reproductive traits, as it supplies tools to analyze genetic variability directly at the DNA level with the possibility of detecting the individual genes influencing the reproductive capability. The identification of polymorphism and DNA markers associated with reproductive traits can lead to genetic improvement through the implementation of Marker Assisted Selection (MAS) by the breeder to increase litter size and reproduction efficiency.

In the present study we have selected the Jamunapari and Barbari, goats based on the reproduction records for polymorphism analysis. The records on growth production viz. birth weight, 3 M, 6M, 9M and 12 M body weight were collected. Also, the reproduction records viz. parity of doe, number of kidding, type of kidding, kidding season were collected. The blood samples (358) were collected from Jamunapari, Barbari, Ganjam and Black Bengal goats. The genomic DNA was isolated from blood samples. The primers were designed for the Kisspeptin gene i.e. 306 bp fragment spanning promoter region, 235 fragment spanning exon 1 region, 353 and 352 bp fragments spanning intron 1 region of the KISS 1 gene. Similarly, primers were also designed for the GPR 54 gene i.e. 325 bp fragment spanning promotor region and 246 bp fragment spanning exonic region. The PCR (Polymerase Chain Reaction) protocol was standardised for all the fragments of kisspeptin and GPR 54 gene. The High Resolution Melting (HRM) protocol is standardised for Kisspeptin (promotor) gene i.e 306 bp fragment and GPR 54 (promotor) gene i.e 325 bp fragment. The HRM results showed three different genotypes for Kisspeptin 1 promoter and GPR 54 promotor gene.

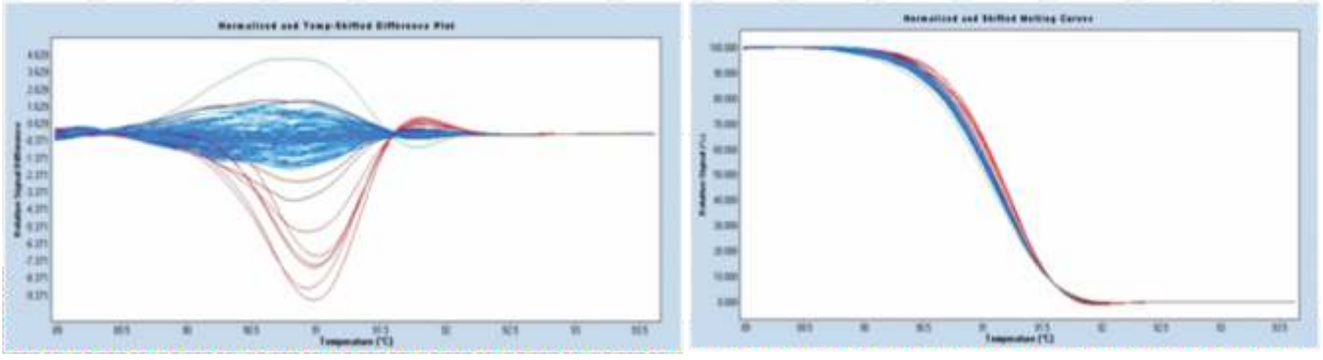

Fig 1The temperature shifted melting peaks showed three different genotypes of Kiss 1 gene (306 bp, Promotor)

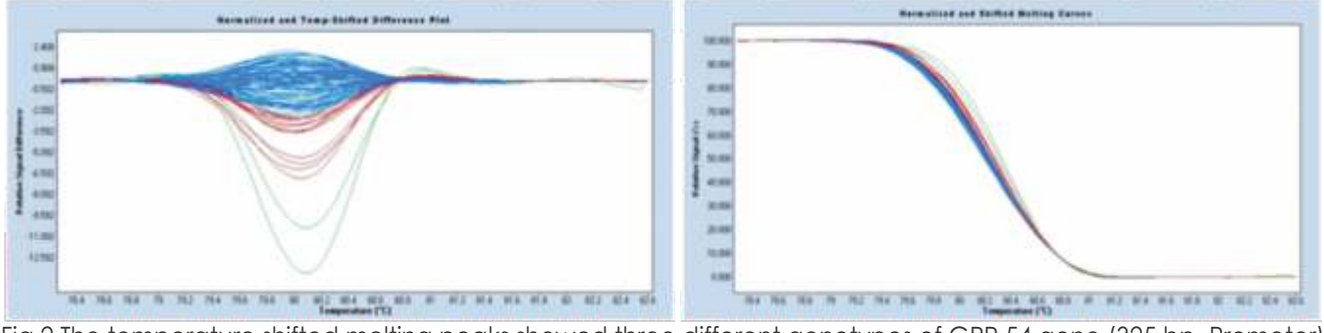

Fig 2 The temperature shifted melting peaks showed three different genotypes of GPR 54 gene (325 bp, Promotor)

CABin Sub-Project 2: Development of Database on SNPs Associated with Economically Important Traits in Indian Goats

Centre PI
RVS Pawaiya
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Co-Investigators
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A total of 350 Jamunapari and Barbari goats were selected based on the production and reproduction records for polymorphism analysis. The records on growth production viz. birth weight, 3 M, 6M, 9M and 12 M body weight were collected. Also the reproduction records viz. parity of doe, number of kidding, type of kidding, kidding season were collected. The genomic DNA was isolated from blood samples. Also the DNA was isolated form 80 animals of Jakhrana and Sirohi breeds. The primers were designed for the Adipose Differentiation Related Protein (ADFP), Leptin, Prolactin Related Peptide (PrRP) genes affecting growth traits and Pituitary specific positive transcriptional factors 1 (POUF1), Thyroid Stimulating Hormone Beta (TSHB), Inhibin Alpha (INHA), Gonadotropin Releasing Hormone (GNRH), Nerve Growth Factor (NGF), GDF-9 (Growth Differentiating Factor) genes affecting reproduction traits. The primers were designed for regions spanning promotor, exonic, intronic, UTR of the genes. The primers for HRM (High Resolution Melting) were also designed for Leptin and Insulin like Growth Factor-1 (IGF 1) genes, MHC (Major Histocompatibility Complex).

A 143 bp fragment of leptin gene was amplified in Jamunapari and Barbari goat breeds by PCR. Subsequently, HRM analysis revealed three genotypes in Jamunapari goat and two genotypes in Barbari goat. The sequencing revealed the SNP (C>T) in the promotor region of leptin (143 bp) at 32th position in both breeds (fig 1). The statistical analysis revealed significant association of this SNP with 9 month body weight in Jamunapri goat ($p<.06$). A 670 bp long fragment of leptin gene containing the 3' UTR region was also amplified and sequenced in four breeds of goats (Barbari, Jamnunapari, Jakhrana and Sirohi). The nucleotide sequence analysis of 670 bp fragment of leptin gene revealed 10 SNPs in 3' UTR region in four breeds of goat. A 285 bp fragment of MHC gene containing the 2 exonic region was also amplified and sequenced in four breeds of goats (Barbari, Jamnunapari, Jakhrana and Sirohi). The nucleotide sequence analysis for MHC gene revealed 132 SNPS in the analysed sequences in the four breeds of goat (i.e.Jamunapari, Barbari, Sirohi and Jakhrana). The sequence pair distance in ClustalW analysis showed the 285 bp fragment (exon 2) of MHC gene showed 85.5-97.2 percent similarity within four breed of goat i.e Jamunapari, Barbari, Jakhrana and Sirohi. The sequence distance showed the similarity A 233 bp fragment of Nerve Growth Factor (NGF) gene containing the exonic region was also amplified by PCR and subsequently HRM analysis revealed three genotypes in different goat breeds.

The SNP database on goat has been developed for the goat which enables users to get the information regarding the SNPs in goat affecting the various economic traits and diseases. It is developed using MySQL, PHP, Java running. It can run on both Windows and Linux operating system. In SNP database users can enter SNPs data of different genes affecting milk production, reproduction, growth, health (fig 2).

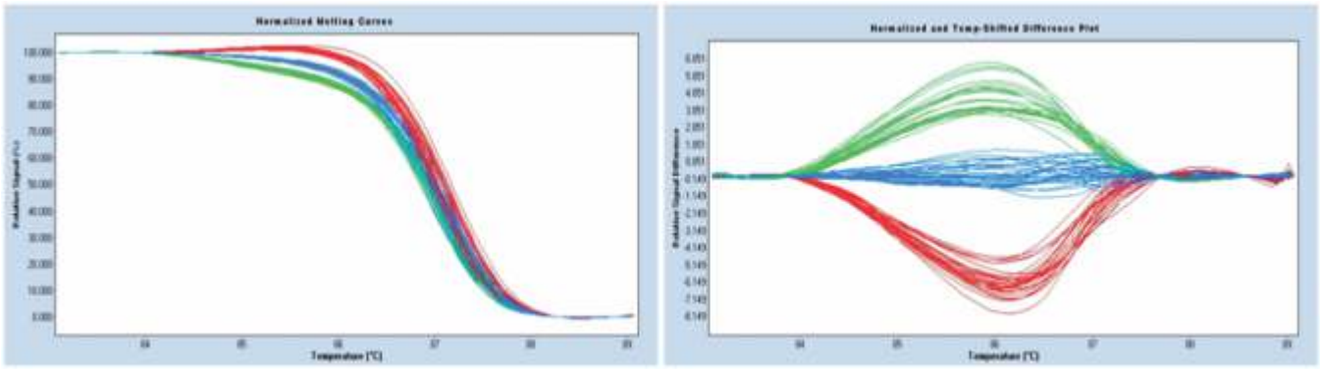
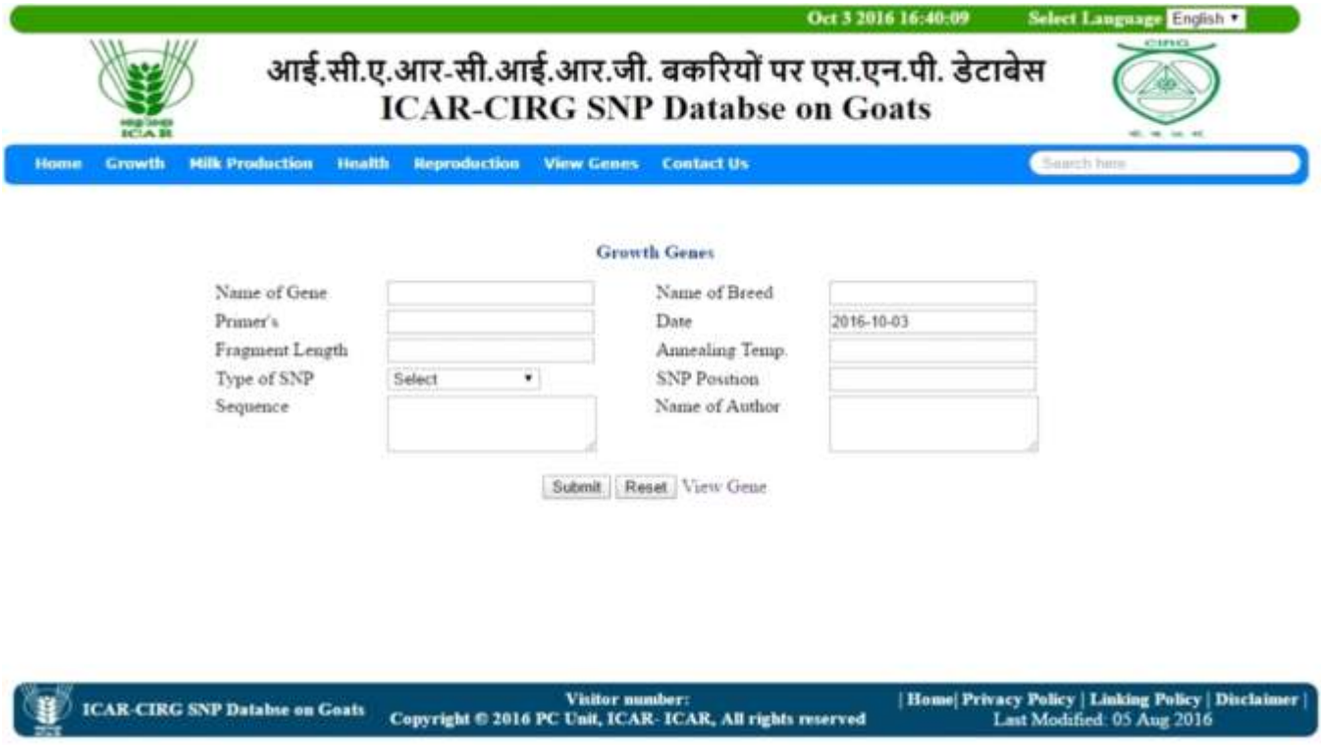


Fig 1The temperature shifted melting peaks showed three different genotypes of Leptin gene (143 bp, 5' UTR) in goats



Home page and Growth module of online database on SNP on goats

ANIMAL PHYSIOLOGY AND REPRODUCTION DIVISION

Flagship Project on Artificial Insemination in Goats

Principal Investigator
Ravi Ranjan

Co-Investigators
S. K. Jindal, Satish Kumar, A. K. Goel, S. D. Kharche, Priyadharsini R.

Effect of THI on Sexual Behavior and Semen Quality in Barbari Buck under Indian Climatic Conditions.

A total of 890 ejaculates from Barbari bucks (2-4 years old) maintained at this Institute under semi-intensive management system were utilized to find out the effect of THI on sexual behavior and semen quality in Barbari buck under Indian climatic conditions. The libido and mounting behavior were observed and ejaculates (n=890) were collected twice a week using artificial vagina. The freezable quality of semen was decided on mass activity having value +4 to +5. Buck mounting per cent during May and June were 93.88% and 90.81% respectively while comparatively lower values (61.64%, 57.93%) were observed in November and December month respectively. Interestingly freezable quality of semen (mass activity >4) was good in November (73.33%) and December (66.33%) month. The poor freezable quality was observed in January and February month. This seems that THI was below the stress level (<72) during the November and December month as compared to moderate stress (>80) during May and June months. The comfortable THI during November and December month have beneficial effect on semen quality in spite of poor libido. The present study suggests that semen freezing should be carried out in November-December months not round the year in Barbari breed of goats.

Triplet in Barbari Goat by Frozen Semen Artificial Insemination Technology.

Artificial Insemination (AI) by using frozen semen straws having post thaw motility 40-50% was carried out. AI has done in 21 Barbari goats and out of them 15 kidded by using Frozen Semen AI Technology. Overall, a success rate of 71.43% was recorded on the basis of actual kidding rate in Barbari breed of goats maintained by

Fig 1 Goat with Triplet kid

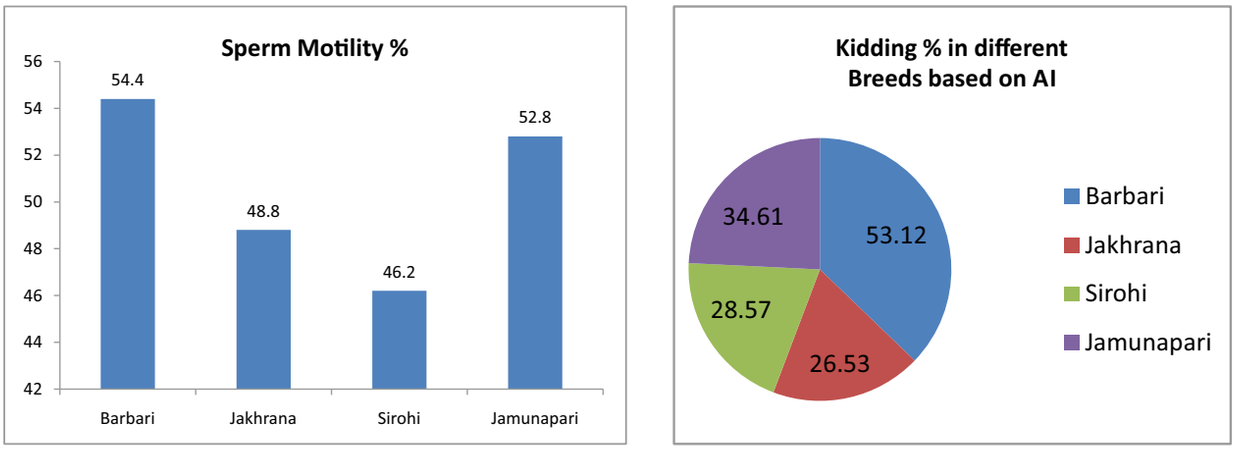


Fig 2 Kidding and Sperm Motility present in different breeds of goats

Experimental Shed of AN&PT Division of this Institute under Intensive Management System. One goat (B-1229) aged more than four years and 35.7 Kg live weight kidded with triplet in her second kidding on 28th November 2016(Fig 1). There were two male, B-1687 (2.4 Kg.) and B-1688 (2.2 Kg.) and one female, B-1689 (2.0 Kg.). The AI was done on 7th July, 2016 with two frozen semen straw doses of B211 breeding buck maintained at Experimental shed of Physiology and Reproduction Division. The total gestation period was 145 days. The health condition of mother and triplet were sound (Fig 2).

During the period under report, a total of 5250 semen doses of different breeds of goat (Jamunapari, Barbari and Jakhrana) were prepared and cryopreserved. Out of the total 5250 doses of frozen semen straws, 1310 straws were used under different experiments, Artificial Insemination under the project and demonstration to different types of visitors.

Transrectal ultrasonography was carried out using 5/7 MHz transducer in inseminated does with frozen semen at or after 28 days post mating.

In two major breeding seasons 181 goats of different breeds (Barbari, Jakhrana, Jamunapari and Sirohi) were inseminated with frozen semen. A total 68 goat conceived by using frozen semen AI technology and total 121 kids (65 female and 56 male) were born through this technology. The kidding percent was 37.57%. This year, we did AI in 35 goats at farmer door step with frozen semen and 12 goats kidded.

Hormone Profile during Different Reproductive Stages in Goats

Principal Investigator
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Co-Investigators
S. K. Jindal, Satish Kumar, S.D. Kharche, Ravi Ranjan, S.P. Singh

Progesterone and testosterone were estimated in different physiological state in goat to imply its influence in improving the reproductive efficiency for higher productivity from tropical goats.

A. Blood Sampling and Storage

1. Jamunapari goats (female, 6) were selected and grouped according to their physiological/ reproductive stages (Age: 12.5-14 months, 14.5-16 months, 16.5 -18 months). 72 Blood samples (4 ml each) from 6 Jamunapari female goats at pre-pubertal, pubertal and sexual maturity were collected at 15 days interval and serum samples after separation were stored at -20°C till assayed for progesterone hormone concentration.

2. Jamunapari goats (male, 6) were selected and grouped according to their physiological/ reproductive stages (Age: 12.5-14 months, 14.5 -16 months, 16.5 -18 months). Accordingly, 72 blood samples (4 ml each) from 6 Jamunapari male goats at pre-pubertal, pubertal and sexual maturity were collected at 15 days interval and serum samples after separation were stored at -20°C till assayed for progesterone hormone concentration.

3. Barbari goats after attainment of sexual maturity were selected and naturally mated by superior Barbari bucks. These goats at 28 days post-mating were monitored for pregnancy status by using B-mode ultrasonography. A total of 6 pregnant does were finally selected for collecting blood during pregnancy and post-partum period. Accordingly, 24 blood samples from six Barbari pregnant does were collected at 30, 60, 90,120 days and serum samples were stored at -20°C till assayed for progesterone hormone concentration.

4. Blood samples (30) from above mentioned 6 Barbari does were collected at day 0,15,30,45 and 60 days post- partum and serum samples were stored at -200C till assayed for progesterone hormone concentration.

B. Ultrasonography of Post-parturient Jakhrana Does to Assess Uterine Involution

Post-parturient Barbari does (6) were subjected to trans-rectal ultrasonographic evaluation using 5/ 7 MHz transducer at day 0,15,30,45 and 60 days post-partum (15 days interval) to assess the uterine horns and associated organs for their relative size for ascertaining post-partum uterine involution.

C. Induction & Synchronization of Oestrus in Post-partum Barbari Goats by Hormonal Treatments

Tropical goats are characterized by longer post-partum oestrus interval than to exotic goats. Present experiment was conducted to augment post-partum reproductive performance in 6 primiparous Barbari goats (> 60 days post-partum) to restore oestrus cyclicity by hormonal treatment. The circulating progesterone concentration (P4) in these goats prior to treatment ranged 0.44 to 0.67 ng/ml indicating the absence of luteal activity. Goats under treatment were implanted with indigenously prepared progestational sponge @ one sponge per goat and kept in situ for 12 days. All goats were checked daily, if the sponges are in position. Each goat, 48 hours prior to sponge removal received a luteolytic dose of synthetic prostaglandin analogue (Estrumate, Cloprostenol Sodium, Intervet India Limited) @ 100 µg per goat intramuscularly.Concurrently, each goat also received 300-400 IU of eCG (previously known as PMSG, Intervet India) intramuscularly to stimulate follicular growth. Sponges were taken out after 12 days. After the completion of treatment, goats were checked for oestrus at 12 hours interval for 96 hours to monitor oestrus response.

Table 1 Serum testosterone concentration during different reproductive stages in Jamunapari male Goats

Reproductive Stage	Serum Progesterone Conc. (ng/ml)	Range (ng/ml)
Pre-pubertal (12.5-14 M)	2.94 ± 0.46 (24)	0.55- 5.99
Pubertal (14.5-16 M)	3.90 ± 0.47 (24)	0.87- 7.83
Sexually Mature (16.5-18M)	6.20 ± 0.67 (24)	0.96-11.16

Table 2 Serum progesterone concentration during different reproductive stages in Jamunapari female Goats

Reproductive Stage	Serum Testosterone Concentration (ng/ml)	Range (ng/ml)
Pre-pubertal (12.5-14 M)	0.72 ± 0.20 (24)	0.14 - 2.97
Pubertal (14.5-16 M)	1.96 ± 0.40 (24)	0.11- 5.42
Sexually Mature (16.5-18M)	1.19 ± 0.36 (24)	0.10- 5.31

Table 3 Serum progesterone concentration during different months of pregnancy in Barbari Goats

Pregnancy in Days	Mean (ng/ml)	SEM	Range(ng/ml)
1. 30	23.44 (6)	2.2	15.993- 32.10
2. 60	18.80 (6)	0.6	17.214 - 21.32
3. 90	17.65 (6)	0.80	14.790 -19.21
4. 120	16.05 (6)	2.0	09.814- 24. 28

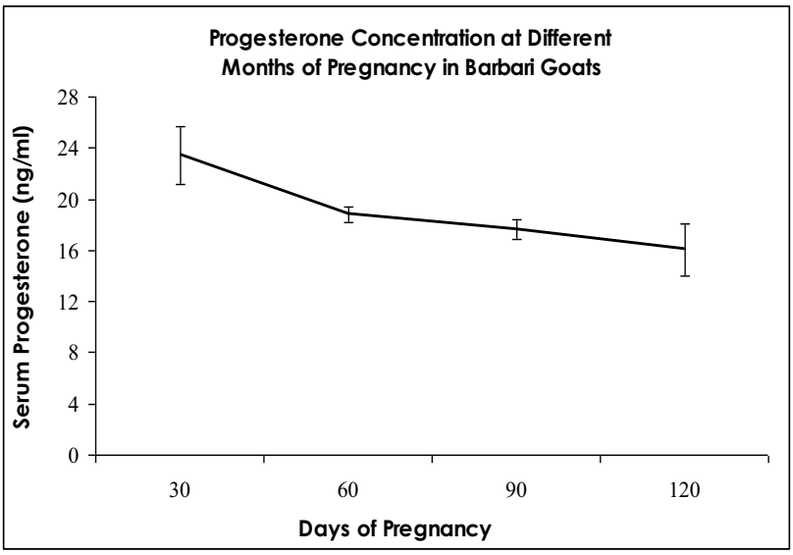
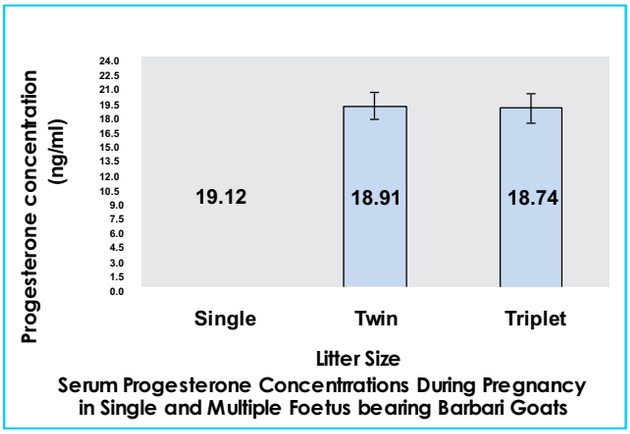


Table 4 Serum progesterone concentration during pregnancy in single & multiple foetus bearing Barbari Goats

Litter Size	Mean (ng/ml)	SEM	Range(ng/ml)
1. Single	19.12 (12)	1.60	9.81-32.10
2. Twin	18.91 (8)	1.40	13.60-26.11
3. Triplet	18.74 (4)	1.60	15.85-23.18
Overall	18.99 (24)	0.93	9.81-32.10

Table 5 Serum progesterone concentration during different days of post -partum in Barbari Goats

Days (Post Partum)	Mean (ng/ml)	SEM	Range (ng/ml)
0	0.67 (6)	0.20	0.34 - 1.36
15	0.38 (6)	0.10	0.221 - 0.80
30	0.41 (6)	0.10	0.235 -0.71
45	0.50 (6)	0.10	0.244- 1.17
60	0.44 (6)	0.10	0.21- 0.81



Serum Progesterone Concentrations During Pregnancy in Single and Multiple Foetus bearing Barbari Goats

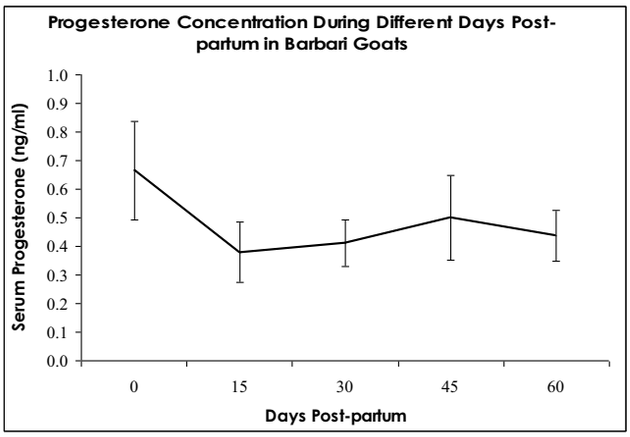


Table 6 Oestrus induction and synchronization response in post-partum anestrus Barbari Goats

S. No.	Attributes	No. of Animals & Response
1	No. of post-partum (>60 days) Barbari goats used.	06
2	No. (%) of goats exhibited oestrus within 96 hours of vaginal sponge removal.	05 (83.33%)
3	Post-treatment oestrus induction cum synchronization interval (Mean ± SEM).	15.60 ± 4.00 hr (6-30)
4	Induced cum synchronized oestrus duration (Mean ± SEM).	28.80 ± 5.50 (12-48)

- Testosterone level in pre-pubertal, pubertal and sexually mature Jamunapari males was 2.94 ± 0.46, 3.90 ± 0.47 and 6.20 ± 0.67ng/ml, respectively (Table No. 1).
- Progesterone level in pre-pubertal, pubertal and sexually mature Jamunapari females was 0.72 ± 0.20, 1.96 ± 0.40 and 1.19 ± 0.36 ng/ml, respectively (Table No. 2).
- Progesterone and Testosterone levels have shown an increasing trend with change of physiological/reproductive stages (pre-pubertal, pubertal and post-pubertal) in Jamunapari goats(male and female).
- Progesterone level during different months of pregnancy was estimated in female Barbari goats. It remained higher and maintained throughout the pregnancy period (Table No.3 and adjoining Graph).
- Progesterone level during pregnancy was not significantly affected due to litter size (single, twin, triplet) in female Barbari goats (Table No. 4 and adjoining Graph).
- Progesterone level during post-parturient period (day 0, 15, 30, 45 and 60 post-partum), was estimated in Barbari does. Progesterone level remained at basal level (≤1.00 ng/ml) indicating that ovarian activity in terms of oestrus cyclicity did not re-occur up to 60 days post-partum (Table No. 5 and adjoining Graph).
- Ultrasonographic evaluation of post-parturient uterus (day 0, 15, 30, 45 and 60 post-partum) was carried in Barbari does for ascertaining uterine involution with the view to correlate uterine size with progesterone level during this period.
- Ultrasonographic evaluation revealed that pregnant uterus regained pre-gravid stage at day 30- 45 post- partum.
- Progesterone level prior to start of hormonal protocol was at basal level (0.44-0.67 ng/ml /ml). Responded does (5/6 goats, 83.33%) expressed behavioral symptoms of oestrus varying from medium to high intensity. Post-treatment oestrus induction cum synchronization period and duration averaged 15.60± 4.00 and 28.80 ± 5.50 hours, respectively (Table 6).
- Oestrus can be efficiently induced and synchronized in post- partum anoestrus Barbari goats (parous) by hormonal intervention (83.33%), thus making it feasible to augment post-partum reproductive performance in tropical goats of Indian origin(Table 6).

Comparative Study on Different Structures of Goat Shelters under Farm Conditions

Principal Investigator
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Co-Investigators
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The milk yield of 20 lactating Jakhrana does was recorded up to 150 days after kidding (Mid Sept. 2016 - Feb.2017) to assess the effect of fibre reimposed plastic (FRP) roof as an alternate roofing materials to asbestos roof on milk production of goats. The does were equally divided in to two groups, housed under FRP and asbestos roofed shed after adjusting for parity and previous lactation milk yield two weeks before expected date of kidding for adaptation and managed on adlib feeding and uniform management conditions. The test day milk yield was recorded at weekly interval for all the does on two roof and milk yield was calculated for 30, 60, 90, 120 and 150 days of lactation.

The mean milk yield of does under FRP roof was lower than the does under asbestos roof (fig.1). The milk yield of does on FRP roof was significantly lower (P=0.025) as compared to asbestos roof at 30 days of lactation. The 60 and 90 days milk yield of does under FRP roof showed 18.79 and 16.82% lower trend than that under asbestos roof.

However, the 120 and 150 days milk production of does under FRP roof was non-significantly lower than that under asbestos roof. Analysis of data on morning and evening milk yield of does also showed similar trend under roof. The morning and evening milk yield of does at 30 days postpartum under FRP roof was 16.33±0.33 and 7.17 ±0.56 lit, respectively. The respective values for asbestos roof was 21.18±1.73 and 9.64±0.94 lit, which were significantly higher (P<0.05) than milk yield under FRP roof. The morning and evening milk yield of does at 60, 90, 120, 150 days postpartum under FRP roof were 37.52 and 15.13, 56.42 and 22.69, 76.92 and 30.71, 98.33 and 38.51 lit, respectively. The respective milk yield of does under asbestos roof was recorded as 45.67 and 19.16, 67.51 and 27.60, 89.84 and 37.40, 112.12 and 46.60 litres. Overview of the results suggest that the provision of FRP roof as an alternate roofing material in goat shelters in semi-arid areas during winter season may not be beneficial in increasing production of lactating does.

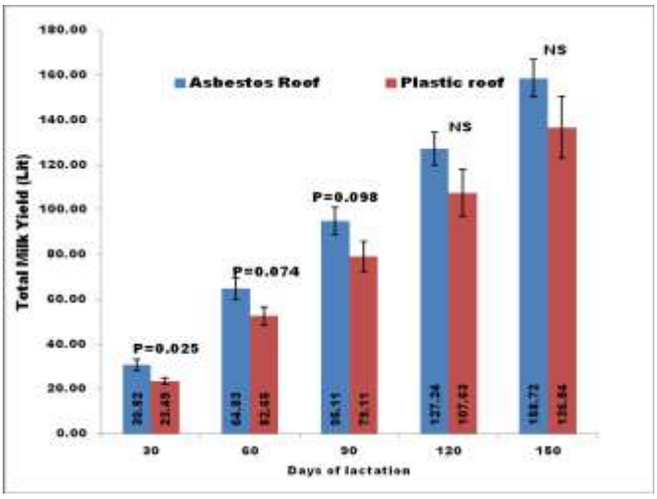


Fig: - 1: Milk yield in goat in different roofing system

Development of Parthenogenetic Goat from Embryonic Stem Cells (NFBSFARA)

Principal Investigator
S.D. Kharche

Co-Investigators
Ravi Ranjan, A K Goel, S K Jindal

1. Parthenogenetic embryo production:

I). **Recovery of oocytes and in vitro maturation (IVM):** The oocytes (5578) were collected from ovary (1448) in a petridish containing oocyte collection media (OCM) (Dulbecco's phosphate-buffered saline with 1mg/ml BSA, 50µg/ml streptomycin and 60µg/ml penicillin) by slicing of the ovaries using 18-G needle. Only grade A and B oocytes were chosen as it has evenly granulated cytoplasm which represents its active physiological state having bunch of compact cumulus cell mass around them. Selected oocytes (5578) were washed two or three times in Oocyte Holding Medium (OHM) containing (TCM-199 with Hepes modification, 10% FBS, Sodium Pyruvate 0.25 mM, Gentamycin 50 µg/ml, Glutamine 100 µg/ml, BSA 3 mg/ml) and subsequently two three times in oocyte maturation media.and allowed for maturation in 50 µl drop of IVM medium in 35mm×10mm Petri dishes for 27 hours in a CO_2 incubator maintained at 38.5° C, 5% CO_2 and 90% humidity.

ii). Activation of oocytes: After maturation for 24–27 h, oocytes were stripped off their cumulus cells by treatment with 0.1% hyaluronidase and gentle pipetting for 5 min in mCR2aa handling medium. The matured oocytes (5222) were activated 5 µM Ca Ionophore in mCR2aa medium for 5 min followed by treatment with 2.0 mM DMAP for 4hr in mCR2aa medium. After 4 hr, the oocytes were washed 6 to 8 times in the culture medium and cultured in 50 µl drop of RVCL medium for 12 days.

iii). In vitro culture of activated oocytes: After 48 hours of parthenogenetic activation treatment, caprine oocytes were examined for cleavage. Development of parthenogenetic embryos was observed at every 48 hr till day 12 post activation under inverted phase contrast microscope (200x, Nikon, Japan). The culture media was replaced with freshly prepared embryo culture media after every 48hr and observations were made for subsequent embryos development. The overall 2-cell, 4-cell, morula, blastocyst and hatched blastocyst production following activation with 5 µM Ca Ionophore in mCR2aa medium for 5 min followed by treatment with 2.0 mM DMAP for 4 hr in mCR2aa medium of in vitro matured oocytes were 24.36±2.02%, 24.71±1.59%, 45.60±2.23%, 9.37±1.70% and 7.75±1.64%, respectively.

Table 1 *In vitro* embryo production through parthenogenetic activation of matured oocytes

No of Oocyte	Matured oocytes (%)	2 Cell embryo (%)	4 Cell embryo (%)	Morula embryos (%)	Blastocyst (%)	Hatched Blastocyst (%)	Cleavage rate (%)
5578	522 (90.55±0.78)	642 (24.36±2.02)	620 (25.01±1.59)	1239 (45.60±2.23)	125 (9.37±1.70)	99 (7.75±1.64)	2626 (57.92±2.96)

2. Embryonic stem cell production:

Development of embryonic stem cell colonies on goat fetal fibroblast monolayer : For the derivation of parthengenetic embryonic stem cells, hatched blastocysts were washed in mCR2aa medium supplemented with 5% FBS and 0.3% BSA. Trophectoderm cells were removed from ICM using micro surgically blade. The inner cell mass of blastocyst was placed in twelve well culture plate on a feeder layer of mitomycin C inactivated goat fibroblast cells. The inner cell mass gets attached to the feeder layer and get spread in the wells. Stem cell culture media was used for the culture of parthenogenetic stem cell. Half of the media of the culture well were replaced with fresh media at every 48 hr interval. The ICM was mechanically isolated and placed on a fresh feeder layer and cultured for next 4-5 days. All the subsequent passages were made after 5-6 days in culture. For early passages, colonies were mechanically divided into clumps and re plated. Further passages of parthenogenetic stem cells were performed with trypsin-EDTA (0.25%) and mechanical dissociation. The propagation of stem cells was performed at 38.5°C, 5% CO_2 in humidified atmosphere. Total five to seven passages were done using the above protocol.

Expanded blastocyst and ICM from partheno-genetic embryos (112) were used for embryonic cell colony formation. The time taken for their attachment on goat fetal fibroblast monolayer was 72-96 hrs. Embryonic cell colonies were further passage up to five passages on goat fetal fibroblast monolayer.

3. *In vitro* embryo production through IVF : In vitro fertilized embryo production

Oocyte collection: The oocytes (3364) were collected from ovaries (991) by

***In vitro* maturation of goat oocytes:** Selected cumulus oocyte complexes (3364) were washed two or three times in Oocyte Holding Medium (OHM) containing (TCM-199 medium, 10% FBS,Sodium Pyruvate 0.25 mM, Gentamicin 50 µg /ml, L-glutamine 100 µg /ml, BSA 3 mg/ml).

Oocytes were matured in 50µl drops of maturation media containing (TCM-199 (Sigma), L-glutamine (100 µg/ml), Sodium pyruvate (0.25 mM), Gentamycin (50µg/ml), FSH (5 µg/ml), LH (10 µg/ml), oestradiol-17β (1µg/ml), EGF (10ng/ml) supplemented with 10% FBS, 10% follicular fluid and 3mg/ml BSA covered with sterile mineral oil for 27 hr in humidified atmosphere of 5% CO_2 at 38.50C in a CO_2 incubator.

***In vitro* fertilization of in vitro matured goat oocytes:** The matured oocytes (3171) were separated from cumulus cells by treating them with PBS containing 0.1% hyaluronidase and by passing through a fine pipette and kept for fertilization in 50µl fertilization drop.

Fresh semen samples were obtained by an artificial vagina from a fertile purebred Sirohi bucks. The capacitation medium for spermatozoa consisted of TALP medium supplemented with heparin, BSA or 10% FBS and antibiotics. First and second ejaculates were virtually examined for volume, colour, consistency and gross motility, then 50µl of neat semen was diluted with 5 ml of sperm TALP medium and wash by centrifugation at 1800 rpm for 5 min. The supernatant was discarded and the pellet again washed with 5ml of medium and the supernatant was discarded. The pellet was diluted with 5ml of medium and kept for incubation at 38.5°C in a CO_2 incubator for 30 minutes. After incubation sperm suspension was centrifuge and 50 µl of sperm pellet was diluted with 750 µl of fertilization medium. Fertilization drop containing oocytes were inseminated with 25 to 50 µl of final diluted semen (1-2x10^6 sperm/ml). The oocytes were washed after 18-24hr of co-incubation with spermatozoa at 38.5°C in an atmosphere of 5%CO_2 in humidified air.

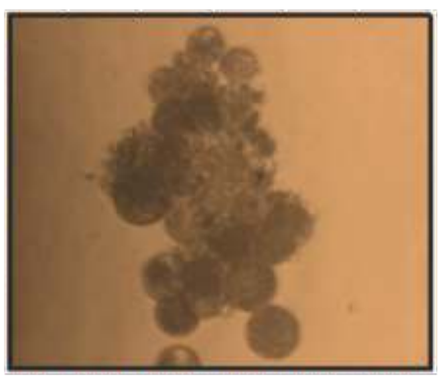
v) *In vitro* culture of In vitro fertilized goat oocytes: Following 18-24 hr of co-incubation with spermatozoa at 38.5°C in an atmosphere of 5% CO_2 in humidified air, oocytes were washed in RVCL culture medium and cultured in RVCL medium for 12 days. A total of 899 oocytes were cleaved. These cleaved oocytes (2 cell embryos) were used for production of tetraploid embryo.

4. Tetraploid embryo production:

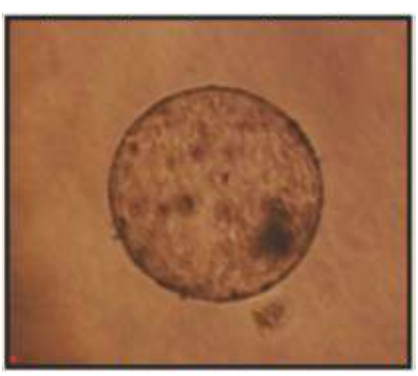
IVF derived embryos were selected at the 2-cell stage between 32 and 48hr post-insemination. Embryos were equilibrated through three washes of mCR2aa medium and three more washing in fusion medium and were placed in groups of five between the electrode wires of a microslide fusion chamber filled with fusion buffer that was connected to a BTX Electro cell Manipulator 2001. Embryos were aligned with a 5.0 V, 5 second alternating current pulse to orient the plane of contact between the blastomeres in parallel with the electrodes. Different direct current pulses for different durations were used to fuse the blastomeres together. Embryos were then washed in mCR2aa medium and incubated for 1 h. Embryos that had only a single cell upon evaluation after 1 h were determined to have fused and were separated.

422 two cell stage embryo were used for tetraploid embryo production. Embryos were aligned with a 5.0 V, 5 second alternating current pulse to orient the plane of contact between the blastomeres in parallel with the electrodes and a DC current with 1.2 kV/cm for 4 µsec was given to the embryos for electrofusion. Out of 422, two cell embryos, 363 (88.74±1.88%) embryos were fused. The overall 2-cell, 4-cell, 8-16-cell and morula

Granulosa cell monolayer



Chimeric Morula



Chimeric blastocyst

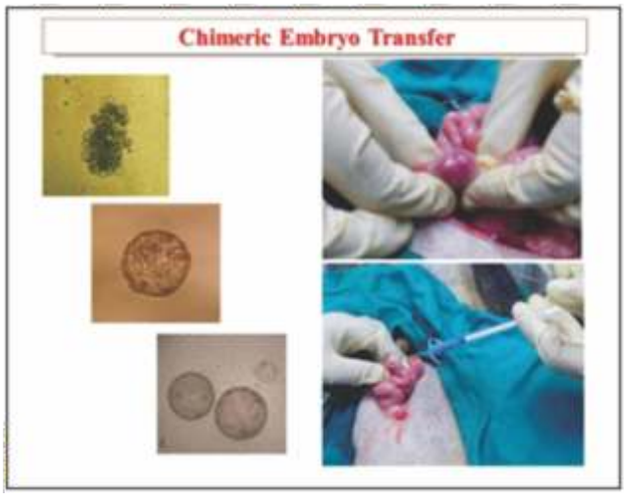
production following electrofusion of fertilized 2 cell embryos were 8.56±2.71%, 21.99±3.33%, 53.67±3.91% and 14.41±2.64%%, respectively.

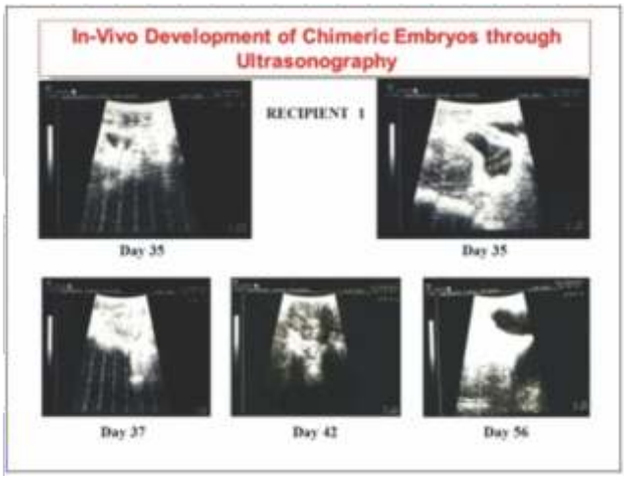
5. Production of chimeric embryo:

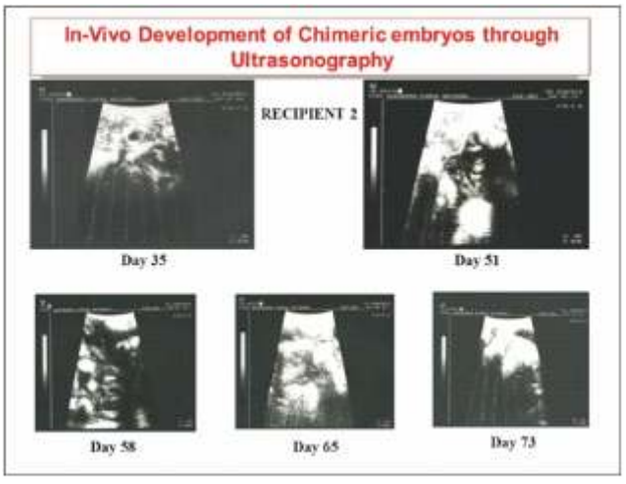
Total 281 tetraploid 2-cell to 8-16 cell stage embryos were aggregated with 90 putative parthenogenetic embryonic stem cells (pESCs) at passage-2 on granulose cell monolayer. They were cultured in mCR2aa containing 10% FBS. Out of 98 aggregates of tetraploid embryo and pESCs, 85 molded into compact structure. The percentage of morula and blastocyst production from the compact structures was 78.82 and 9.41%, respectively.

6. Chimeric Embryo Transfer:

For the transfer of chimeric goat embryos, their developmental stages were synchronized with reproductive stages of naturally occurring oestrus of recipient Sirohi goats (19). Each recipient was deprived of feed and water for 24 hours and put under deep sedation using a preanaesthetic-Xylazine (0.2 mg/kg body weight) and Ketamine (4.4 -6.6 mg/kg body weight). The reproductive tract of recipient goat was exteriorized through a mid-ventral incision to allow visual confirmation of a corpus luteum/lutea on ovaries for ovulation. Chimeric goats embryos (3-4 embryos) at morula and blastocyst stage were transferred surgically at the tip of uterine horn ipsilateral to the ovary containing corpus luteum of 19 naturally synchronized surrogate does. Following transfer, 2 recipients initially diagnosed pregnant on day 35th post-transfer by ultrasonography. In first recipient, the pregnant uterus was having an embryo proper in a fluid filled cavity without amniotic ring. The morphological appearance of the foetus did not resemble to a normal foetus, instead it looked like a solid mass. In another view of ultra sonogram, a very thick and hyperechoic amniotic ring was visible. It indicated that the 2N cell from parthenogenetic embryonic stem cells developed into embryo proper and the 4N cell of tetraploid embryos participated in the formation of foetal membranes. These structures were present till day 49. Thereafter, the fetal membranes started resorption and by the end of day 56 it was completely reabsorbed and the uterus returned to its normal pre-gravid stage. In second recipient, the pregnant uterus was having a fluid filled cavity at day 35 post-transfer in ultrasonographic examination. The foetus and amniotic ring were visible as hypoechoic structure from day 50 onwards. The foetus and fetal membranes started resorption by the end of day 58 and it was completely reabsorbed/ disappeared and the uterus returned to its normal non-pregnant stage on day 73 post-transfer.







"Assessment of Plastic Based Structures of Shelters and Appliances on Goat Production" - Plasticulture Engineering and Technology (PET) Project (AICRP)

Principal Investigator
N. Ramachandran

Co-Investigators
S. K. Jindal, S. P. Singh, B. Rai, Ravi Ranjan

After construction of a small pen (10' x 15' size) using green plastic fiber sheet of 2-3 mm thickness for housing new born goat kids, the micro climatic parameters were recorded at 9 AM, 12 noon, and 5 PM inside the plastic pen during winter along with asbestos roofed shed and at weather station located in the goat farm premises to assess the suitability of plastic based structures for goat kids' pen during winter.

The analysis of recorded weather data indicated that the ambient temperature, dry bulb temperature, wet bulb temperature and Temperature-Humidity Index (THI) was significantly higher ($P<0.05$) under plastic shed as compared to asbestos roofed shed at 12 noon and 5 PM during winter months. Such difference was not observed in the morning at 9.00 AM. The relative humidity was similar in all three sheds during all the three recorded times. Therefore, the use of plastic materials in goat shed may be beneficial to protect kids from winter. However, it is necessary to repeat the trial during peak winter months (December – January) and by using 4-5mm thick plastic sheets as compared to 2-3 mm thick sheets with keeping animals inside the shed.

To investigate the suitability of designed plastic pen during summer months, the recording of weather data inside the weather station, under plastic shed and asbestos shed by removing half side wall of plastic shed for ventilation was continued during summer months.

The plastic pen will be further refined for achieving comfortable micro climate inside the plastic pen by modifying fibre sheet thickness, height of side protection etc before initiating the growth trial on goat kids.

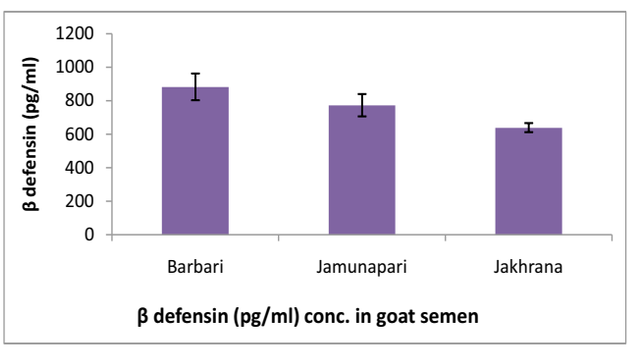
Modulation of immune competence of goat spermatozoa for augmentation of fertility

Principal Investigator
Ravi Ranjan

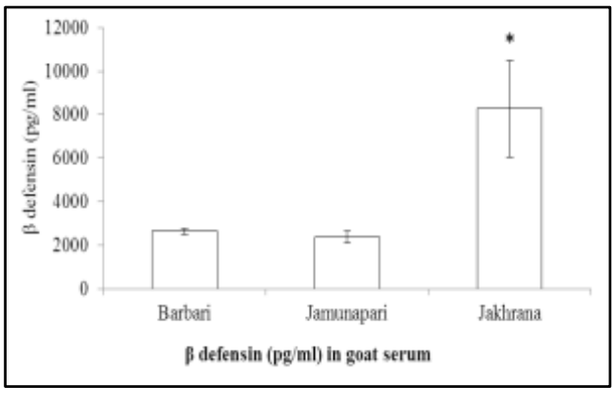
Co-Investigators
Priyadharsini R. (upto 30.6.2016),
S. P. Singh (from 1.7.2016), **S. K. Jindal, K. Gururaj**

Defensins are antimicrobial peptides (AMPs) and two beta-defensins have been identified in goatsGBD1 and GBD2. Beta defensins uniformly spans the entire sperm surface and is not exclusive to a specific domain. GBD1 helps in initiation of motility and capacitation of sperm. It forms a coat on sperm that provides protection from recognition by immune competent cells in in vivo model system as well as when challenged with antisperm antibodies in vitro. The present study was carried out to know the status of Beta Defensin 1 in goat semen and in blood of different breeds of goat (Barbari, Jamunapari and Jakhrana). Goat semen (n=10) from each breed was collected by artificial vagina method and blood samples (n=-30) were also collected from the same animal after semen collection. The samples were stored at -20°C until assayed. Plasma membrane of sperm was broken by freeze thaw followed by ultracentrifugation (20,000 X g for 5 minute) at room temperature before ELISA test. The samples were diluted with Phosphate buffer (1:2) before analysis. The samples were analyzed using goat specific beta defensins 1 commercial kit (EO6D0419) as per the manufacturer`s instruction. We found that beta defensin concentration (pg/ml) was significantly higher (P<0.05) in Barbari (881.72 79.58) followed by Jamunapari (772.18 66.68) and Jakhrana (638.44 27.14) semen. In contrast to that we found very high concentration of beta defensins 1 (pg/ml) in blood of Jakhrana (8267.90 2213.18) followed by Barbari (2640.88 128.44) and Jamunapari (2385.31 267.67) goat breed. As the present results are preliminary, analysis of more number of samples are warranted for clear conclusion concerning greater immune competence of Barbari goats.

Sample collection and storage: Semen samples (30) from Jamunapari, Jakhrana and Barbari bucks vis a vis their blood samples were also collected for the gene expression of some important gene related to sperm motility and their fertility.



CatSper, is a member of the cation channels of sperm family of protein. The four proteins in this family together form a Ca2+-permeant ion channel specific essential for the correct function of sperm cells. Calcium ions play a primary role in the regulation of sperm motility. This gene belongs to a family of putative cation channels that are specific to spermatozoa and localize to the flagellum. CatSper is thus vital to cAMP-mediated Ca2+ influx in sperm, sperm motility and fertilization. The cytochrome P450 aromatase (arom P450) could be used as marker of sperm quality, particularly in the acquisition of its motility. A higher expression of arom P450 transcript was found in spermatozoa obtained from the good quality semen to that in spermatozoa of poor quality semen. Aquaporin7 gene encodes a member of the aquaporin family of water-selective membrane channels. The encoded protein is present in spermatids, as well as in the testicular and epididymal spermatozoa suggesting an important role in late spermatogenesis.



RNA extraction and cDNA preparation: RNA was extracted based on Trizol method. cDNA was synthesized as per manufacture instruction, superscript-III first strand cDNA kit (Life Technology)

Primer design: Beta defensin1, Beta defensin2, GAPDH, Beta actin, CatSper1, CatSper2, AQP7, AroP450

Study the effect of mesenchymal stem cell transplantation on ovarian function and fecundity in goats

Principal Investigator
S D Kharche

Co-Investigators
M. S. Dige, Ravi Ranjan, M. S. Chauhan

1. Bone marrow aspiration from slaughtered goats

Bone marrow aspirates were obtained from 9 slaughtered goats from the tibial ridge (5-9 mL), using a long sterile hypodermic needle (16G), connected to a syringe filled with anticoagulant, ethylenediaminetetra-acetic acid (EDTA, Sigma-Aldrich). The collected bone marrow samples were loaded carefully on histopaque (4:3 ratios) in pre-sterilized 15 ml centrifuge tube and centrifuged at 2000 rpm for 25 min at room temperature. The bone marrow was separated into different phases, plasma, polynuclear cells, and a buffy coat. Buffy coat was our area of interest which contains our target the progenitor cells. The buffy coat was collected carefully and washed with 5 ml of PBS at 1400 rpm for 10 minutes. The supernatant was discarded and the cell pellet was again washed with PBS and re-suspended in 5 ml of complete growth media consisted of Dulbecco Medium Eagle Modified (DMEM) – low glucose, filled with 15% fetal bovine serum, 1% non-essential amino acids, 1% L-glutamine, 1% antibiotic (gentamycin). The re-suspended cells were seeded in to a T-25 culture flask and incubated at 38.5°C in humidified atmosphere with 5% CO2. The non-adherent cells were removed by the 5th day of incubation and the media was changed with fresh growth media in order to propagate the plastic adherent MSCs. The medium was replaced every 3rd day. Passaging of the cells was done on 8th day of primary culture when 70% confluence was attained. This phase of cells was used for 1st passaging. For this cells were detached out from the flask by enzymatic method using 0.25% Trypsin-EDTA, this enhanced number of cells in larger surface area flask.

2. Standardization of bone marrow aspiration from live goats

Adult healthy goats (03) were used for bone marrow collection. Procedure was done under epidural anesthesia using 2% Lignocaine. Site of collection, the iliac crest was prepared for asceptic collection by clipping, shaving, scrubbing and painting with provide iodine. Bone marrow was aspirated with bone marrow biopsy needle of 16 G. A little force was applied to penetrate cortex of the bone. After fixing the needle in marrow cavity stylet was removed and 5 ml of bone marrow aspirate was collected in a 20 ml syringe containing heparin. All the procedures were in compliance with the guidelines of animal ethical committee of the institute. Further processing was done under laminar air flow cabinet to avoid microbial contamination.

The method used for isolation and culture of mesenchymal cells was found suitable. Bone marrow mononuclear cell fraction contains heterogeneous cell population and mesenchymal cells were isolated on the basis of plastic adherence property. The non-adherent cells were removed on 5th day after culture. Adherent cells grew as fibroblast-like cells, which further formed symmetric colonies and attained more than 90% confluency of monolayer on passaging. We maintained the cells up to 2nd passage.

Table 1. Bone marrow aspiration from slaughter and live goats

S.No.	No. of animals	Site of collection	Slaughtered/Live Goats	Date of Passage1	Date of Passage2
1.	1	Tibia ridge	Slaughtered	Discarded	Discarded
2.	1	Tibia ridge	Slaughtered	Discarded	Discarded
3	1	Tibia ridge	Slaughtered	Discarded	Discarded
4	1	Tibia ridge	Slaughtered	Discarded	Discarded
5.	1	Tibia ridge	Slaughtered	3.3.17	Discarded
6.	1	Tibia ridge	Slaughtered	Discarded	Discarded
8.	1	Tibia ridge	Slaughtered	Discarded	Discarded
9.	1	Tibia ridge	Slaughtered	6.3.17	11.3.17
10.	1	Iliac crest (pelvic bone)	Live	Discarded	Discarded
11.	1	Iliac crest (pelvic bone)	Live	25.3.17	31.3.17
12.	1	Iliac crest (pelvic bone)	Live	Coagulation	Discarded

Development and validation of peptide-based immunoassay : application for early pregnancy diagnosis in goats

Principal Investigator
S. P. Singh

Co-Investigator
N. Ramachandran

Early pregnancy diagnosis in goats is a key to shorten inter-kidding interval through early identification of open animals and their timely rebreeding. Several methods of pregnancy diagnosis are being practiced in small ruminants, yet none of the test qualifies as the ideal for pregnancy diagnosis due to their inherent limitations of sensitivity, speed, ease of performing the test and cost. The advancement of molecular techniques and their applications in animal research has provided a new hope to identify early pregnancy biomarker molecules, synthetic peptide generation and antibody production. Pregnancy-associated glycoproteins (PAGs) are abundantly expressed in the outer cell layer of the placenta. Some PAGs are expressed relatively early in gestation, while other PAGs do not appear until later in pregnancy. Therefore, some of these glycoproteins might be good indicators of both pregnancy and feto-placental well-being during early, mid as well as later pregnancy stages. The determination of circulating concentrations of PAGs molecules in goats can provide useful information to develop appropriate feeding strategies for pregnant females and to insure requirements of the mother and fetuses growing in order to avoid metabolic disorders associated to pregnancy. Moreover, sequential measurements of specific PAG in goats allows for the determination of physiological functions of PAGs in goats as well as provide background information of development of diagnostics and therapeutics for farm animals.

Antigen (peptide) prediction, designing and anti-peptide antibody: Potential antigenic determinants tend to be from sequences that are exposed (on the surface of the molecule), hydrophilic and flexible. This is because most proteins have their hydrophobic residues buried in the interior of the molecule. Surface regions or regions of high accessibility often border helical or extended secondary structure regions. In addition, sequence regions with b-turn or amphipathic helix character have been found to be antigenic. Keeping these points in mind, algorithms for predicting protein characteristics such as hydrophilicity/hydrophobicity and secondary structure regions such as a-helix, b-sheet and b-turn aid in selection of a potentially exposed, immunogenic internal sequence for antibody generation was applied in online bioinformatics tools for prediction of suitable peptide sequence which optimum antigenic properties against specific PAG molecule in goats. After finalization of the peptide sequence with careful consideration of all possible points, the peptide was synthesized and was used for generation of polyclonal antisera in rabbits. The anti-peptide polyclonal antisera is being used for development of immunological assay (ELISA) for detection of specific PAG in goat samples.

Ultrasonography, blood sampling and storage: Barbari goats (n=20; pluriparous) were selected and observed regularly for estrous cycle. Once animal came in to estrus, breeding was done by natural mating. Blood sampling was started at d 16 from the day of mating, on alternate day for first month. After confirmation of pregnancy by ultrasonography, blood sampling from 16 Barbari goats were continued weekly until kidding. Blood sampling was continued up to 30 days post-partum. Plasma samples were collected and stored at -20°C for assay optimization and PAG estimation.

ELISA development: Following parameter were tested as an initial step for development of ELISA for caprine PAG. Coating buffer (0.5 M bicarbonate buffer and PBS; composition and pH); Capture Antibody (anti-peptide antibody for specificity, titer, affinity, incubation time and temperature), Blocking Buffer (casein buffer or 2% non-fat dried milk with or without tween 20; composition, concentration); Detection Antibody (Y chain specific anti rabbit antibody was tried for specificity, titer, affinity, incubation time & temperature); Phosphate-citrate buffer with different concentration of TMB and H_2O_2 was tried as substrate buffer; Washing buffer (for composition, volume, duration, frequency).

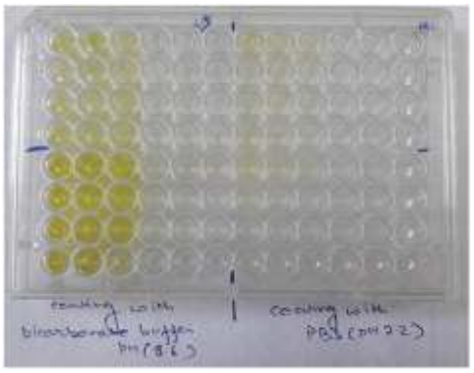


Fig 1 Effect of different coating buffers on ELISA result during optimization of PAG ELISA

Isolation, characterization and development of a culture method for long term preservation of spermatogonial stem cells from Doom pig

Principal Investigator
M.S. Chauhan

Co-Investigators
Priyadharsini. R, S.D. Kharche, S. P. Singh

The productive performance of most of the animals of North-Eastern (NE) states of the country is relatively low. This offers unique opportunity to promote animal husbandry as a means for livelihood and nutritional security through targeted application of recent biotechnological tools in this region. Keeping this in mind, a project entitled "Isolation, characterization and development of a culture method for long term preservation of spermatogonial stem cells from Doom pig" has been given jointly to College of Veterinary Science AAU, Guwahati & ICAR-CIRG, Makhdoom by Department of Biotechnology, under the twinning programme with NEH. The objectives are:

1. To impart training to the researchers/ scientists/faculty from Assam Agriculture University and other NE researchers.
2. Comparative expression of pluripotency and other related genes of spermatogonial stem cell like cells in different culture system.

In order to fulfill the first objective, a 10 days training program on 'Spermatogonial Stem Cell Biology' to the researchers and faculty members of NE region is planned to be organized from 13-22 November, 2017. For this purpose a draft of the training brochure was finalized. Furthermore, advertisement and formal communication will be made for invitation of applications by participants of NE region. Other necessary arrangements to organize this training program and process of purchase of required chemicals, media and other reagents are in progress.

ANIMAL NUTRITION AND PRODUCTS TECHNOLOGY DIVISION

Development of Feed Resources on Poor Lands

Principal Investigator
Prabhat Tripathi

Co-Investigators
Ravindra Kumar, U.B. Chaudhary

Effect of feeding system on milk yield and milk composition of goats in winter: Twelve adult female goats of second lactation after 22-24 days of kidding were divided in two groups, six in each and kept under two feeding systems i.e. intensive fed and extensive fed system. Both the groups were supplemented with 300g of concentrate mixture. Intensively fed animals were offered berseem as green fodder and ad lib gram straw as dry matter source, however, extensive system group was allowed for grazing and browsing in Ber based silvi -pasture system for a period of 5-6 hr daily. Under silvi-pasture system *Cenchrus ciliaris* and seasonal forages were the major grazing materials. This feeding experiment was carried out for 70 days. A metabolism trial of seven days was conducted for intensively fed group with metabolism cages. However, extensive group was evaluated with indicator method. Percent DCP and percent TDN values were higher with intensive or stall fed animals over extensive or grazing animals. Dry matter intake/animal/ day and per 100 kg LBW, CP intake per animal and 100kg LBW were observed with non-significant variation between both the feeding systems. Except ether extract, the digestibility for all other nutritional parameters was recorded with significant variation. Values for digestibility for all nutritional parameters were significantly higher in stall fed group. Milk yield in morning, evening and total yield/day varied significantly in January and February month, but no variation was observed in December month. Milk composition was varied. During January the feeding system observed without any variation however, density, lactose, protein, SNF and salts varied in rest period of experimentation (Table1 and2).

Table 1 Comparison of various nutritional parameters under different feeding systems

Parameters	Intensive system	Extensive system
Metabolic Body weight (W0.75)	10.94±0.52	12.45±0.53
Dry matter intake/animal/day (g)	1165.57±37.83	1315.99±184.07
CPI/ animal/day (g)	160.58±3.73	176.74±23.03
TDNI/animal/day (g)	781.91±21.55	754.02±113.97
DMI/100 Kg LBW	4.84±0.18	4.63±0.70
DMI/W0.75	107.04±2.68	106.79±15.74
CPI/100kg LBW	668.86±30.14	622.24±89.46
CPI/W0.75	14.77±0.43	14.34±1.98
TDNI/100kg LBW	3251.36±130.13	2649.97±424.42
TDNI/W0.75	71.86±1.79	61.10±9.53
DCP/animal/day	110.34±3.92	108.33±12.20
DCP, %	9.47±0.18	8.37±0.31
TDN, %	67.15±0.77	56.81±1.13

Table 2 Milk composition as influenced by feeding system

Parameters	Intensive			Extensive		
	Morning	Evening	Mean±SE	Morning	Evening	Mean±SE
December Fat (%)	4.45±0.44	5.17±0.09	4.81±0.15	4.37±0.41	5.60±0.16	4.98±0.21
Density*(kg/m3)	+27.99±2.12	+27.14±0.14	+27.56±0.85	+26.72±0.65	+25.38±0.62	+26.05±0.46
Lactose (%)	4.57±0.31	4.49±0.02	4.53±0.12	4.37±0.07	4.30±0.04	4.34±0.03
SNF (%)	8.38±0.50	8.12±0.11	8.25±0.21	8.07±0.10	8.04±0.13	8.05±0.08
Protein (%)	2.92±0.21	2.90±0.017	2.91±0.08	2.82±0.05	2.74±0.05	2.78±0.03
Salts (%)	0.68±0.05	0.65±0.003	0.66±0.02	0.64±0.017	0.61±0.01	0.62±0.01
January Fat (%)	4.09±0.16	5.35±0.28	4.72±0.19	3.88±0.19	4.67±0.211	4.28±0.18

Density (kg/m3)	+27.17±0.21	+26.93±1.29	+27.05±0.63	+27.73±0.43	+25.65±1.07	+26.69±0.6
Lactose (%)	4.42±0.02	4.55±0.47	4.48±0.12	4.50±0.05	4.27±0.15	4.39±0.08
SNF (%)	8.12±0.03	8.52±0.47	8.32±0.23	8.22±0.07	7.96±0.29	8.09±0.14
Protein (%)	2.85±0.014	2.76±0.08	2.81±0.04	2.90±0.03	2.75±0.11	2.82±0.05
Salts (%)	0.65±0.005	0.60±0.03	0.63±0.02	0.67±0.01	0.62±0.02	0.64±0.01
February Fat (%)	4.45±0.43	6.89±0.20	5.67±0.27	3.46±0.19	5.97±0.35	4.72±0.16
Density (kg/m3)	+27.04±0.37	+24.75±0.43	+25.89±0.32	+29.15±0.25	+25.87±0.78	+27.51±0.4
Lactose (%)	4.43±0.03	4.28±0.09	4.36±0.05	4.65±0.04	4.45±0.09	4.55±0.06
SNF (%)	8.16±0.01	8.20±0.16	8.18±0.08	8.46±0.07	8.21±0.12	8.34±0.08
Protein (%)	2.86±0.02	2.76±0.06	2.81±0.03	3.01±0.03	2.81±0.06	2.90±0.03
Salts (%)	0.65±0.01	0.60±0.01	0.63±0.01	0.70±0.009	0.62±0.02	0.66±0.01

*Values of density (kg/M^3) added in to 1000

Table 3 Chemical composition of Sorghum, Guinea grass and Concentrate (in percent)

Parameters	Sorghum	Guinea grass	Conc. Mixt.
Dry matter	22.65	17.95	95.6
Crude Protein	8.56±0.23	9.91±0.06	17.13±0.31
Organic matter	92.55±0.19	88.06±0.10	91.71±0.02
Ether extract	2.49±0.02	1.81±0.71	3.44±0.32
NDF	75.38±1.11	76.77±0.12	23.80±1.45
ADF	47.11±0.03	46.05±1.30	11.90±0.86
Cellulose	35.74±0.016	34.77±0.46	10.18±0.18
Hemicellulose	28.27±1.07	30.71±1.18	11.89±0.58
ADL	9.90±0.14	11.28±0.84	2.50±0.26
Total carbohydrate	81.49±0.003	76.33±0.54	71.12±0.66
Na	0.062±0.003	0.021±0.0006	0.577±0.08
Ca	0.057±0.0005	0.075±0.0008	0.064±0.01
K	1.83±0.03	1.90±0.04	0.95±0.065
P	0.005±0.001	0.004±0.001	0.01±0.0003
N	1.37±0.03	1.58±0.009	2.74±0.050

Table 4 Comparison of various nutritional parameters

Parameters	Sorghum	Guinea grass
Body weight (Kg)	16.88±0.66	16.6±0.83
Metabolic Body weight (W0.75)	8.32±0.24	8.21±0.30
Dry matter intake/animal/day (g)	458.52±23.81	478.45±21.20
CPI/ animal/day (g)	55.63±2.03	61.21±2.10
TDNI/animal/day (g)	321.96±23.83	300.95±13.31
DMI/100 Kg. LBW	2.71±0.051	2.89±0.10
DMI/W0.75	54.92±1.42	58.31±1.82
CPI/100kg LBW	329.84±4.00	371.19±12.74
CPI/W0.75	6.67±0.08	7.47±0.20
TDNI/100kg LBW	1893.89±73.43	1822.14±66.87
TDNI/W0.75	38.42±1.82	36.69±1.20
DCP/animal/day	31.03±2.45	32.04±1.55
DCP, %	6.75±0.34	6.72±0.30
TDN, %	69.84±2.20	62.95±1.08
N balance	2.10±0.44	1.56±0.25

Evaluation of Sorghum hybrid and Guinea grass for goats: Twelve barbari growing male kids of average body weight 16.74 kg were divided in two groups and offered chaffed multi cut sorghum in one group and guinea grass in other group for their evaluation during September months. At this stage multicut sorghum was at its 3rd cut of harvesting and guinea grass had its perennial stand. These kids are also supplemented with 200g of concentrate mixture. Both the fodders were evaluated for their chemical composition and nutritional parameters with the help of metabolism trial.

Dry matter content in Guinea grass was 17.95%. Crude protein content was significantly higher in guinea grass. Sodium content was much higher in Sorghum fodder as compared to Guinea grass. However, Ca content was significantly higher in guinea grass. K, and Nitrogen content were recorded with non-significant variation between Sorghum and Guinea grass. Digestibility of various nutritional parameters i.e. DM, CP, EE, OM, NDF, ADF and total carbohydrate was found non-significant between sorghum and guinea grass. Only Cellulose digestibility was observed significantly higher with sorghum fodder. The dry matter intake /100 kg LBW 2.89 percent was significantly higher in guinea grass. In the same manner CPI/100 Kg LBW and CPI/W0.75 were higher with guinea grass. All other nutritional parameters such as % TDN, % DCP, and TDN, DCP Intake were observed with non-significant variation (Table 3 and 4).

Vermi compost preparation from various faecal materials:Four animal's faecal materials were used for this study during winter season. Total five treatments were given with goat faecal as whole pellet and goat pellet (crushed). Initially 75 earth worms were introduced in each treatment. Earth worm sp was Eiseniafetida. To maintain moisture in pot distilled water was used. There was no significant difference in total nitrogen content before and after of vermicomposting. However, there was increase in values of total nitrogen after vermicomposting. There was significant increase in phosphorus content after vermicomposting in all the faecal materials. Potassium content decreased after vermicomposting in goat and sheep faecal materials, however, it had increased values in cow and buffalo.

Network Program on Estimation of Methane Emission under Different Feeding Systems and Development of Mitigation Strategies

Principal Investigator
Ravindra Kumar

Co-Investigators
P. Tripathi, U.B. Chaudhary, P. K. Rout, A. Rahal

Experiment was conducted to study the effect of strategies supplementation on methane production in grazing adult male Barbari goats using Sulfur hexafluoride (SF6) technique. Experiment conducted on sixteen male Barbari goats. All the animals were grazed for 6-7 hour on the pasture of anjana grass (*Cenchrus ciliaris*), doob (*Cynodon dactylon*) grass, neem (*A. indica*) leaves, Safeda (Eucalyptus) leaves, mulberry (Morus spp) leaves to meet their nutrient requirement. Goats of group II were supplemented with 250 gram concentrate pellet/head/day before grazing. The animals were accustomed to carry the canister properly tied with halters and gas collection assembly for 4 weeks during grazing (Fig 2). The concentration of SF6 and CH4 in the canister was determined by gas chromatography. Methane production was calculated on the basis of methane and SF6 concentration in the filled canister and release rate of SF6 from the permeation tube in excess of the background level. Other fermentation metabolites were estimated by standard procedure. Fraction of volatile fatty acids was carried out on gas chromatograph.

The effect of concentrate supplementation on dry matter intake and digestibility of different nutrient is presented in Table 1. No significant effect on dry matter intake on concentrate supplementation was reported though the feed intake was slightly higher on supplementation. Dry matter intake (% BW) was within normal range (3-4% of BW) showing palatability of different grasses in the pasture. There was improvement in the dry matter, organic matter and crude protein digestibility after supplementation of concentrate pellet. There was lower ruminal pH and higher total volatile fatty acids, ammonia nitrogen in supplemented group of goats as compared to control group (Table 2). Total nitrogen and TCA-ppt nitrogen concentration tended to be higher on concentrate supplementation. Lower acetate and higher propionate was reported in supplemented group. Acetate to propionate

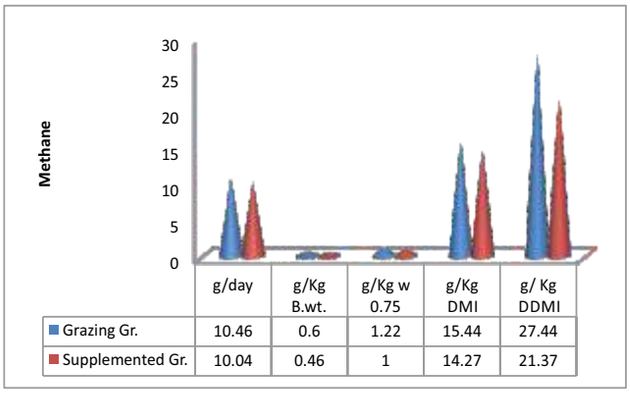


Fig1 Effect of concentrate pellet supplementation on methane production in Barbari goats

Table 1 Effect of supplementation of concentrate pellet on dry matter intake and digestibility of nutrients

Attributes	Gr I	Gr II
B. Wt. (KG)	18.00±1.03	19.66±0.83
W0.75 (Kg)	8.71±0.38	9.32±0.29
DMI (g/d)	677.08±153.83	704.14±33.81
DMI (% Bwt.)	3.59±0.63	3.61±0.20
DMI /W 0.75(g)	74.75±14.12	75.87±3.87
	Nutrient digestibility (%)	
DM*	56.29±1.44	66.77±1.04
OM*	60.88±1.24	69.33±0.95
CP*	56.06±1.93	72.28±1.51
EE	72.10±2.88	67.23±3.85
NDF	48.48±1.75	51.78±2.03
ADF	37.97±2.02	46.47±2.27
Cell	56.00±1.81	53.65±1.85
H cell	64.95±1.94	64.17±2.26
TCHO	61.09±1.26	68.58±0.99

Table 2 Effect of concentrate pellet supplementation on rumen fermentation metabolites

Attributes	Gr I	Gr II
pH	06.80±0.31	06.45±0.07
TVFA (mmol/dl)	11.60±0.60	15.50±0.27
Acetic acid (mmol/dl)	06.80±0.13	08.54±0.23
Propionic acid (mmol/dl)	02.69±0.20	03.87±0.05
Butyric acid (mmol/dl)	02.09±0.31	02.78±0.30
NH3-N(mg/dl)	24.15±1.79	27.30±0.93
NPN (mg/dl)	16.10±1.85	16.80±0.88
Total-N (mg/dl)	89.60±3.54	95.20±3.95
TCA ppt-N (mg/dl)	73.50±5.03	78.40±4.24
	VFA proportion, %	
Acetic acid	59.13±2.32	56.93±1.80
Propionic acid	23.14±0.66	25.12±0.31
Butyric acid	17.70±1.78	17.93±1.75
Ac: Pr ratio	02.57±0.16	02.26±0.09

ratio was lower in supplemented group of goats. Methane emission (g/day) was similar in grazing (10.46) and supplemented group (10.04) of goats. However methane production (g/Kg DMI) and methane production (g/Kg DDMI) reduced by 7.57 and 22.12% in supplemented group in comparison to control group (Fig 1).

Effect of tree leaves containing complete pellet feed on methane emission was studied in male Barbari goats (4-5 months age & 12.10±0.69 Kg mean BW). Three types of complete pellet feed was formulated, Control pellet having Gram straw (60%) and conc. mixture (40%), treatment 1 (T1) and treatment 2 (T2) containing T1 and T2 leaves. All types of pellet were iso nitrogenous. Twelve growing male Barbari goats were divided into three groups (Gr I, Gr II and Gr III).Group I was fed with control pellet while Group II and III was fed with T1 and T2 pellet respectively. After feeding for 6 weeks digestion trial of 6 days duration was conducted to determine the digestibility of different nutrients. There was no difference in the DMI/day between different groups (Gr I, 673.79; Gr II 669.25 and Gr III 564.31). Dry matter digestibility and digestibility of other nutrients were also similar in different group of goats. Rumen pH, ammonia - N and nitrogenous fractions (Total nitrogen, TCA-ppt N, NPN) were statistically similar in all the groups. Total volatile fatty acids (mmol/dl) was significantly ($P<0.05$) higher in Gr III (10.57) and Gr II (9.52) as compared to control group (8.67).Fractions (%) of volatile fatty acids (acetic acid, propionic acid and butyric acid) were similar in different groups. In vivo methane emission in different groups of goats was estimated by SF6 technique as per standardized procedure. Methane production (g/day) was 8.29 in Gr I, 7.47 in Gr II and 6.72 in Gr III. There was 9.89 and 18.93 % lower methane production in Gr II and Gr III as compared to control group of goats fed with complete pellet feed.

Fig 2 Goat fitted with SF6 assembly for methane gas estimation

National Innovations on Climate Resilient Agriculture (NICRA) – Adaptation Strategies in Goats to Environmental Stress through Nutritional Manipulations

Principal Investigator
U. B. Chaudhary

Co-Investigators
P. K. Rout, Ashok Kumar, N. Ramachnadran

Stressol –G an herbal crude powder based tablet to reduce the climatic stress in goats: Institute has formulated an herbal crude powder based tablet to reduce the climatic stress in goats. Three medicinal plants (Coded as CIRG-1, CIRG-2, and CIRG-3) were selected on the basis of their antioxidant activity. The plants were collected after authentication. The chemical standardization was done by analyzing the qualitative chemical constitute and develop chromatogram (GC-MS chemical print) and find out predominate chemical substance. The powder of three plant material was mixed in a definite ratio & crude powder based tablets (5g/tab) were prepared. One tablet daily given (orally) to the goats during stress period (15-30days) shall reduce the stress and improve productivity and immunity in goats. The anti-stress herbal formulation for goats, reduced stress by inhibition of increase SOD and catalase enzymes in blood; and decrease of stress proteins HSP 70, HSP27 and Ubiquitin -related modifier 1 homolog, in stressed animals. The anti-stress herbal formulation can reduce the heat and cold stress and prevent loss of body weight and production performance. The product is in the process of patents and commercialization. This combination can also be given to the goats as extract based herbal formulation (@ rate 10mg/kg body wt.) or as a feed mix (@ 5% in concentrate mixture. This product was released by, secretary, DARE & Director general,ICAR during the inaugural session of annual review meet of NICRA held at New Delhi on 9-10th December, 2016.

Fig 1 Stressol –G, an herbal crude powder based tablets to reduce the climatic stress in goats

Grazing Barbari goats were maintained under semi intensive system of feeding management for a period of 60 days during humid hot period (THI-77.10 - 85.96 and average humidity 83.46) (Table. 1). The results indicated reduced hot humid stress in goats fed with Stressol –G. These findings were based on the observation of physiological responses, and concentration of HSP-70 in plasma. The improve growth rate in the animals given Stressol –G was obtained in comparison to the control goats (Table 2).

In a study conducted for short period, blood samples of Jamunapari female goats collected from, Chakarnagar block of Etawah, UP (home tract of Jamunapari goats), and farm goats during humid period were compared for evaluation of

Table 1 Physiological response of control and treatment (Stressol –G) goats

S. No	Responses	Control	Treatment
1	HR	166.1±2.78 a	154.9±2.29 a
2	RR	66.80±3.10 a	55.05±3.17 a
3	RT(°C)	39.48±0.09 a	39.38±0.07 a

Table 2 Growth rate control and treatment (Stressol –G) goats

Particulars	Control	Treatment
THI	77.10 to 85.96 (Avg.-83.46)	
Growth (g/d)	22	39.33

Table 3 HSP 70 concentration of control and treatment (Stressol –G) goats

S. No	Parameter	Control	Treatment
1	HSP 70(ng/ml)	78.91±1.43a	76.45±2.62b

Table 4 Comparison of stress level between village and farm raised Jamunapari adult goats

S.No	Parameter	Field	Farm
1	Glucose(mg/dl)	58.37±1.80 a	54.39±1.66 a
2	Total protein(g/dl)	05.83±0.23 a	05.91±0.12 b
3	AST(IU/L)	85.46±2.87 a	80.14±3.28 a
4	Urea(mg/dl)	33.10±1.99 a	38.07±2.90 a
5	HSP70(ng/ml)	76.26±1.93 a	71.51±1.69 a

stress level on the basis of concentration of HSP-70 in plasma. The results revealed lower concentration (71.51±1.69 ng/ml) of HSP-70 in the plasma of farm animals in comparison of field goats (76.26±1.93). These findings indicated the lower stress level in the farm goats than the field animals(Table 3 and 4).

Veterinary Type Culture (Rumen Microbes) (Network Program)

Principal Investigator
U. B. Chaudhary

Goat rumen bacteria was cultivated & isolated on anaerobic non defined medium (Tryptose, 9g; Yeast extract, 2.25g; Cellobiose, 0.9g; Microcrystalline cellulose,4.5g; Sodium carbonate, 3.6g; Mineral solution I, 135ml; Mineral solution II, 135ml; Resazurine, 0.9ml; L-Cysteine-HCl 0.45g and Clarified rumen liquor, 360 ml.). Rumen liquor from goats, maintained on basal ration of gram straw was collected and used for isolation & cultivation of rumen Bactria. Isolation and cultivation process was done under anaerobic chamber and roll tubes. Pure cultures of different isolates of rumen bacteria were subjected for extraction of DNA. This DNA was used for amplification of 16S rRNA gene using relevant primers (F-S*-univ-530a-S-16 and R- S*-univ-1392-a-A-15) and amplified products were subjected for sequencing of desired genes. Characterization of rumen bacteria was done on the basis of gene sequence using NCBI data base.

Table 1 Rumen bacteria isolated from the goats fed straw based diet

S.No	Name of Bacteria	Culture ID	Isolate
1	*Enterococcus faecium*	Y-23	BRF12-16
2	*Pseudobutyrivibrio xylanivorans*	Y-24	BRF11-16
3	*Streptococcus lutetiensis*	Y-25	BRF10-16
4	*Slenomonas ruminantium*	Y-26	BRF09-15
5	*Lachnospiraceae bacterium*	Y-27	BRF08-16
6	*Streptococcus parasanguinis*	Y-18	BRF18-15
7	*Acinetobactter baumannii*	Y-20	BRF 20-16
8	*Streptococcus infantarius*	Y-56	BRF36-16
9	*Clostridiales bacterium*	Y-67	BRF44-16
10	*Enterobactor hormaechei*	Y-31	BRF31-16
11	*Pseudobutyrivibrio ruminis*	Y-32	BRF34-16
12	*Prevotella ruminicola*	Y-34	BRF15-16
13	*Clostridium aminovalericum*	Y-37	BRF16-16
14	*Pseudobutyrivibrio xylanivorans*	Y-23	BRM23-16
15	*Butyrivibrio fibrisolvens*	Y-26	BRM26-16
16	*Pseudobutyrivibrio xylanivorans*	Y-29	BRM29-16
17	*Streptococcus bovis*	Y-30	BRM30-16
18	*Butyrivibrio fibrisolvens*	Y-33	BRM33-16
19	*Streptococcus lutetiensis*	Y-51	BRM51-16
20	*Ruminococcus flavefaciens*	Y-38	BRM38-16
21	*Streptococcus infantarius*	Y-43	BRF43-16

Table 2 Enzyme activity of isolated bacterial cultures

S.No	Name of Bacteria	Avicel (µmolglu/min/ml)	CMC (µmolglu/min/ml)
1	*Enterococcus faecium*	1.0130	1.0560
2	*Pseudobutyrivibrio xylanivorans*	6.5737	2.7393
3	*Streptococcus lutetiensis*	7.8446	3.1437
4	*Slenomonas ruminantium*	4.8406	2.1761
5	*Lachnospiraceae bacterium*	0.9341	2.2844
6	*Streptococcus parasanguinis*	0.3469	4.6745
7	*Acinetobactter baumannii*	1.8800	2.2411
8	*Streptococcus infantarius*	0.3469	8.1045
9	*Clostridiales bacterium*	1.6734	3.7936
10	*Enterobactor hormaechei*	0.2697	2.2844
11	*Pseudobutyrivibrio ruminis*	6.4725	5.8804
12	*Prevotella ruminicola*	2.5443	5.9353
13	*Clostridium aminovalericum*	1.0134	7.8734

14	*Pseudobutyrivibrio xylanivorans*	4.1762	6.7252
15	*Butyrivibrio fibrisolvens*	5.4255	3.2664
16	*Pseudobutyrivibrio xylanivorans*	7.3824	2.7393
17	*Streptococcus bovis*	1.6229	3.1437
18	*Butyrivibrio fibrisolvens*	4.7223	4.6745
19	*Streptococcus lutetiensis*	0.9340	6.1873
20	*Ruminococcus flavefaciens*	1.7240	1.1290
21	*Streptococcus infantarius*	0.1975	1.2445

Twenty one isolates of rumen bacteria, (Table. 1) isolated from goat rumen were identified and characterized on the basis of 16S rRNA gene amplification and sequencing of the amplified product. These cultures were screened for carboxy methyl cellulase and avicelase activities in the supernatant of three days old culture. Based on the concentration of carboxy methyl cellulase and avicelase enzymes in the culture supernatant, the cultures on *Pseudobutyrivibrio xylanivorans*, *Streptococcus lutetiensis*, *Pseudobutyrivibrio ruminis*, *Pseudobutyrivibrio xylanivorans* and *Enterobactor xiangfanensis* were found most effective for fiber degradation the efficient cultures shall be submitted to coordinated unit at NIANP Bangalore (Table 2).

Setting up of National Referral Laboratory for Testing of Animal Products (MOFPI)

Principal Investigator
V. Rajkumar

Co-Investigator
Arun K.Verma

Rapid testing of Pathogenic microorganisms in meat and meat products:Goat milk and meat products were screened for the microbiological quality. Goat milk samples were screened for the microbiological quality and they were found to be within the limit (Table 1). Validation plan document was prepared which shall serve as basic requirement for the NABL. This document validates the instrument VIDAS pathogen monitoring system which will be used to screen the pathogens in food products. Document describes in details about the instrument and about its functionality. Periodical Lab training is being organized by M/s Biomerieux.

Analysis milk and meat samples for the microbiological are presented in table 1. All the values are well within the limits. Pathogenic microbiological status reveals no detection of any pathogens (Table 2). Similarly meat products and water samples were found to be having values well within the limits (Table 3).

Table 1 Milk Sample of different goat breeds and their microbiological status (CFU/ml)

S. No.	Tests	Barbari	Jakhrana	Jammunapari	Barbari cross	Mixed milk
1.	TC	4.9	4.9	4.9	1.7	1.7
2.	YM*	10	10	10	10	10
3.	AC	4.9	4.9	4.9	4.9	4.9

*LOQ of the TEMPO for yeast and mold is 10 CFU/g (or) ml. Therefore, the product may have less or equal to 10 colonies per gram or ml of the given product

Table 2 Milk Sample of different goat breeds and their pathogenic microbiological status

S. No.	Tests	Barbari	Jakhrana	Jammunapari	Barbari cross
1.	E Coli	0.00 Negative	0.00 Negative	0.00Negative	0.01 Negative
2.	Salmonella	0.03 Negative	0.07 Negative	0.03 Negative	0.05 Negative
3.	Staph enterotoxin II	0.01 Negative	0.00 Negative	0.01 Negative	0.00 Negative

Table 3 Microbiological status of raw meat vada and processed meat vada sample (CFU/g)

S. No.	Name of Experiment	Raw Vada	Processed Vada
1.	TC	7.4	10
2.	YM*	10	10
3.	AC	4.9	4.7

*LOQ of the TEMPO for yeast and mold is 10 CFU/g (or) ml. Therefore, the product may have less or equal to 10 colonies per gram or ml of the given product

Salmonella detection: A series of 10 random samples were taken. Some of them were spiked; others were normally incubated, by following the Vidas SPT protocol. Along with this a series of three controls were run on Vidas – Positive control, Negative control and Blank. The result obtained from the above run shows that the samples that were spiked with salmonella gave positive results and some samples itself gave positive results were previously reported positive for salmonella by conventional method and the other samples gave a negative result. Positive and negative control results were accurate, which were tested along with the samples. It can be concluded that SPT has an optimum performance when tested with different spice matrix and produced correct results for the samples tested. This can be implemented for further use in routine salmonella detection. The results of using Salmonella VIDAS SPT Strip are presented in table 4.

Staphylococcal enterotoxin detection: The extraction buffer was prepared by diluting the whole R1 extraction buffer with the sterile demineralized water to obtain 1 liter of ready-to-use solution. The R1 buffer can also be diluted in different volumes depending on frequency of use (dilution rate=1/18). Then the 90% TCA solution was dissolved by taking 90gm of TCA in 40 ml of

Table 4 Test values and interpretation of the salmonella VIDAS strip test

Control and samples	Test Value	Interpretation
Control 1	0.88	Positive*
Control 2	0.06	Negative
Barbari	0.04	Negative
Jakharana	0.27	Positive
Jamunapari	0.12	Negative

*Standard value is 4560

demineralized water. Adjusted the final volume to 100ml using demineralized water. The solution can be stored for 1 month at 18-25˚C. pH adjustment of food extracts or milk was carried out by recommended use of a strip paper with 3 color bands and a precision of at least 0.5 pH units was set. Once the assay is completed, results are analyzed automatically by the computer. Fluorescence is measured twice in the Reagent Strips reading cuvette for each sample tested. The first reading is a background reading of the substrate cuvette before the SPR is introduced into the substrate. The second reading is taken after incubating the substrate with enzyme remaining on the indicator of the SPR. The RFV is calculated by subtracting the background reading from the final result. This calculation appears on the result sheet (Table 5). The RFV obtained for each sample is interpreted by the instrument as follows: Test value = sample RFV/ Standard RFV. The calibration values are presented in Table 6. A result with a test value that is less than threshold value indicates that the sample does not contain staphylococcal enterotoxin or contains staphylococcal enterotoxin at a concentration below the detection limit. A result with a test value is greater than or equals to the threshold value indicates a sample contaminated with enterotoxin.

E.coli detection: The presence of *E.coli* in different milk samples was analysed using VIDAS strips. The first reading is a background reading of the substrate cuvette before the SPR is introduced into the substrate. The second reading is taken after

Table 5 Threshold and interpretation values of staphylococcal enterotoxin

Test Value	Interpretation
<0.13	Negative
≥0.13	Positive

Fig. 1 Cultured Colonies of Salmonella Species

Fig 2 Strip before incubation

incubating the substrate with enzyme remaining on the indicator of the SPR. The RFV is calculated by subtracting the background reading from the final result (Table 7). This calculation appears on the result sheet (Fig. 2). The RFV obtained for each sample is interpreted by the instrument as follows:

Test value = sample RFV/ Standard RFV.

A result with a test value that is less than threshold value indicates that the sample does not contain *E.coli* or contains *E.coli* at a concentration below the detection limit (Table 8). A result with a test value is greater than or equals to the threshold value indicates a sample contaminated with *E.coli* O157:H7.

Confirmatory test (API) for the presence of Salmonella species: Carefully emulsified to achieve a homogeneous bacterial suspension. This suspension must be used immediately after preparation. The cultured colonies are presented in Fig 1. The suspension was carefully added in the incubation strip as per the described procedure (Fig. 2)

Table 6 Calibration values of staphylococcal enterotoxin

STRIPS	C1		C2		STANDARD(RFV)	
(LOT NO.)	RFV	TV	RFV	TV	S1	S1
SET2	3810	1.02	13	0.00	3662	3800

After the incubation period of 24 hrs. read the strip (Fig. 3) by referring to the reading table. If 3 or more tests (GLU test + or -) are positive, record all the spontaneous reactions on the result sheet (Fig. 4) and then reveal the tests which require the addition of the reagent.

Table 7 Threshold and interpretation values of *E Coli*

Test Value	Interpretation
<0.04	Negative
≥0.04	Positive

Table 8 Calibration values of *E. Coli*

STRIPS (LOT NO.)	C1		C2		STANDARD(RFV)	
	RFV	TV	RFV	TV	S1	S1
ECPT160922	2500	0.83	-7	-0.00	3005	2980

Fig 3 Strip after incubation

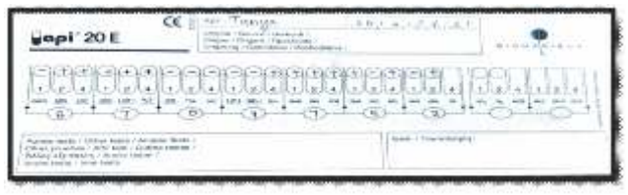


Fig 4 Sheet result of API 20E for salmonella

Table 9 Pesticide contents of by-products of goats of different breeds

S. No.	Breed	Barbari (PPB)		Jakhrana (PPB)	
1.	Goat meat	Chlorpyrifos p,p'-DDD	6.767 0.349	Chlorpyrifos p,p'-DDD	1.605 1.237
2.	Kidney	Chlorpyrifos p,p'-DDD beta-BHC	5.683 8.537 5.000	Chlorpyrifos Nil Nil	5.681 Nil Nil
3.	Liver	Chlorpyrifos p,p'-DDD Ethoprophos	5.473 26.840 5.192	Chlorpyrifos Nil Nil	1.152 Nil Nil
4.	Heart	Chlorpyrifos p,p'-DDD Nil	0.551 2.913 Nil	Chlorpyrifos Metyl Demeton p,p'-DDD	4.754 5.069 4.595
5.	Spleen	Chlorpyrifos Ethoprophos	1.575 7.473	Chlorpyrifos p,p'-DDD	1.152 7.915
6.	Testis	Chlorpyrifos p,p'-DDE	7.811 2.869	Chlorpyrifos Nil	4.754 Nil

TDA Test: add 1 drop of TDA reagent. A reddish brown color indicates a positive reaction to be recorded on the result sheet.

IND Test: add 1 drop of JAMES reagent. A pink color developed in the whole cupule indicates a positive reaction to be recorded in the result sheet.

VP Test: add 1 drop of VP1 and VP2 reagents. Wait at least 10 minutes. A pink or red color indicates a positive reaction to be recorded on the result sheet. If slightly pink color appears, after 10 minutes, the reaction should be consider as negative. If the number of positive tests (including GLU test) before adding the reagent is less than 3, then re-incubate the strip for the further 24 hours without adding any reagent. Reveal the tests requiring the addition of reagents. To complete the identification, it may be necessary to perform supplementary tests before that we can analyse the result by web based application developed by M/s Biomerieux (apiwebTM-API 20E v2.0).

Screening and quanlification of pesticide residues in meat and meat products: Analysis was conducted in Shimadzu GCMS-TQ8030 triple quadrupole GC/MS/MS. GCMS-TQ8030 Pesticides were identified and quantified by comparing their retention times with pesticide standards and were expressed in PPB (Table 9).

Screening and quantification of elements concentration in meat and meat products: Analysis was carried out in Nexion 350X (M/s Perkin Elmer). Different concentrations of elements were

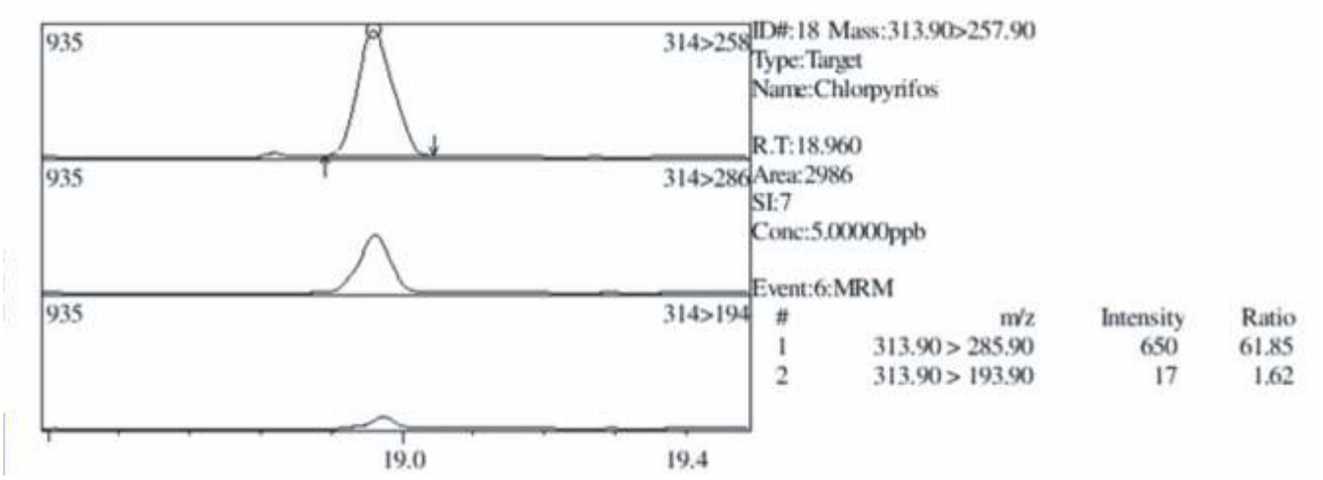


Fig 5 MRM chromatogram of goat meat sample identified for Chlorpyrifos

Table 10 Jakhrana goat meat and by-products mineral analysis (mg/100gm) by ICP MS

S. No.	Elements	Kidney	Liver	Heart	Testis	Spleen	Meat
1	Na	038.39	044.87	041.75	040.89	072.14	045.82
2.	K	336.75	377.07	387.02	447.58	485.44	668.67
3.	Cu	000.14	012.19	000.45	000.47	000.81	000.09
4.	Fe	070.89	077.75	011.00	004.80	149.41	112.14
5.	Ca	128.39	162.19	128.98	100.59	104.56	070.62

prepared and calibrated the equipment and against this calibration unknown sample was tested. Results were presented in Table 10. Instrument detected 200ppb as baseline and the 500 ppb and 1000ppb were slightly lower or higher side. Therefore, the unknown samples were also slightly lower or on higher side were detected. Strict environmental control of the instrument shall provide better and accurate results.

Value Chain for the Development of Goat Products with Healthy Traits

Principal Investigator
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Quality and storage stability of goat meat nuggets added with amla and curry leaves extracts

In this study antioxidant potential, phytochemical profiling of amla and curry leaves extracts and effects of their incorporation on the physico-chemical, colour, textural, sensory characteristics as well as storage stability of goat meat nuggets was evaluated. Both the extracts were added at 1 and 2% (Amla1, Amla2 and CL1, CL2) levels and compared for various quality parameters against product without extract (control) and product with 100ppm BHT (BHT nuggets). Total phenolic (Fig.1) contents in amla was found 176.74 mgGAE/g against 56.63 mgGAE/g in curry leaves while total flavonoids (Fig. 2) in amla was found 60.54 µgCE/g against 420.23 µgCE/g in curry leaves.

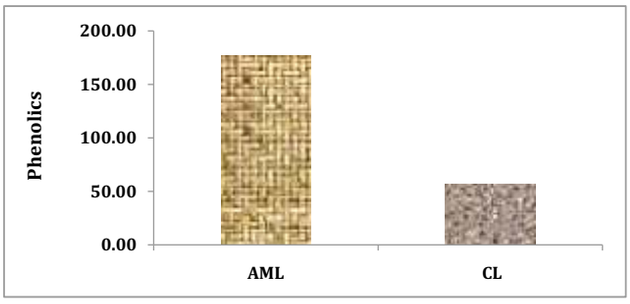

Fig 1 Total phenolics in amla and curry leave aqueous extract

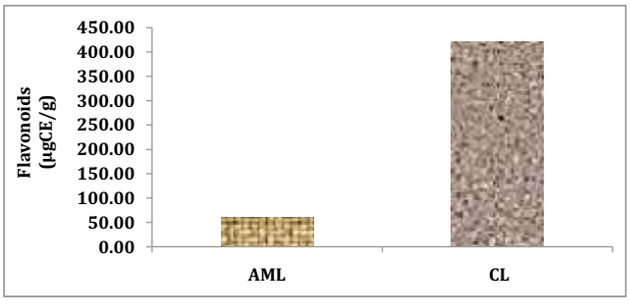

Fig 2 Total flavonoids in amla and curry leave aqueous extract

Both amla and curry leaves extracts showed concentration dependent DPPH radical scavenging activity (Fig 3) though amla activity in amla extract was found quite higher than curry leaves.

Phytochemical profiling of both amla and curry leaves methanolic extracts revealed presence of 18 and 12 compounds, respectively. Many of the

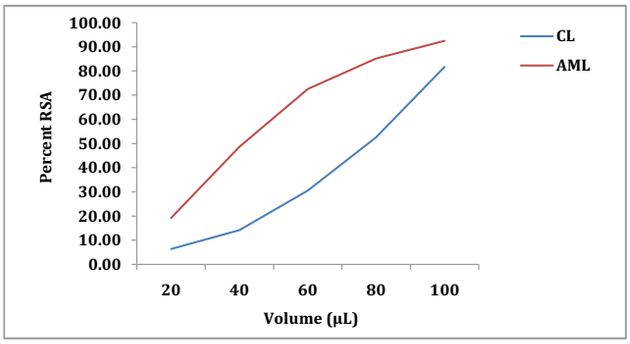

Fig 3 DPPH radical scavenging activity in amla and curry leave aqueous extract

detected components in both the extracts have been found to possess antiseptic, antioxidant, antibacterial, anti-mutagenic antidermatitic and fungicidal properties.

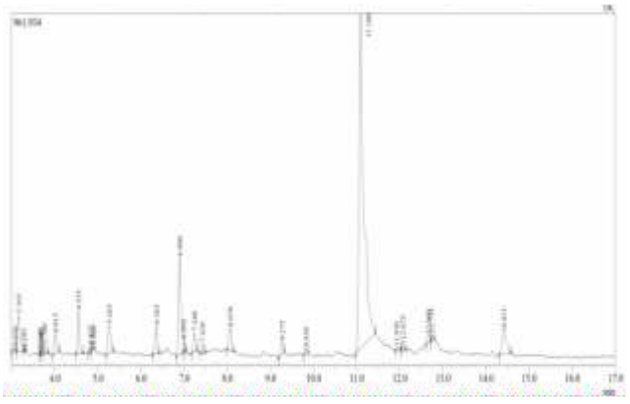

Fig 4 GC-MS/MS chromatogram of methanolic extract of amla powder

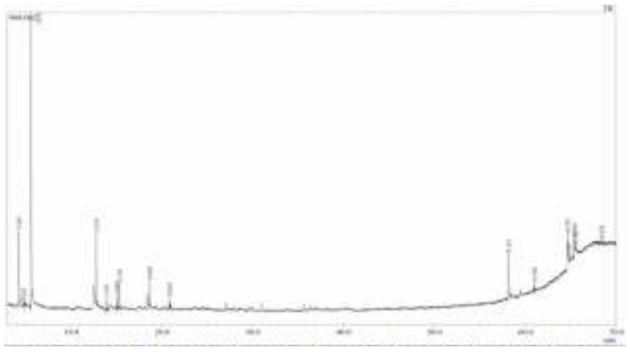

Fig 5 GC-MS/MS chromatogram of methanolic extract of curry leaves powder

The pH values of emulsion and goat meat nuggets among all the treatments did not differ (P>0.05)

significantly (Table 1). Emulsion stability of treatment with 2% amla extract was significantly lower (P<0.05) than the corresponding treatments with 1% amla and 2 % curry leaves extract. However emulsion stability of amla 2 was statistically similar to the values of control, BHT nuggets and curry leaves1. The differences in the proximate composition among all the products were found non-significant (P>0.05). Total phenolic content among all the products differed significantly, and the order of phenolics in the products was amla2>amla1>curry leaves2>curry leaves1>BHT nuggets>control.

Table 1 Effect of amla and curry leave extract on physicochemical quality of goat meat nuggets (n = 6)

Parameter	Control	BHT Nuggets	Amla1	Amla2	Curry Leaves1	Curry Leaves 2
Emulsion pH	06.09±0.02	06.12±0.03	06.10±0.04	06.01±0.04	06.12±0.04	06.10±0.04
Nuggets pH	06.28±0.04	6.30±0.04	06.25±0.04	06.20±0.04	06.28±0.05	06.28±0.04
ES, %	95.12±0.25ab	95.25±0.15ab	95.38±0.09a	94.82±0.06b	95.24±0.12ab	95.65±0.25a
Moisture, %	64.39±0.19	64.68±0.37	64.64±0.16	64.96±0.11	64.20±0.37	64.85±0.30
Protein, %	15.32±0.35	15.16±0.30	15.24±0.30	15.36±0.21	15.37±0.34	15.23±0.39
Fat, %	13.14±0.18	13.03±0.18	13.15±0.26	13.05±0.38	13.18±0.38	12.78±0.47
Ash, %	02.82±0.02	02.79±0.02	02.80±0.03	02.80±0.04	02.83±0.05	02.85±0.02
TP (µgGAE/g)	120.83±5.39f	156.83±3.83e	469.50±3.80b	793.50±6.63a	230.33±4.02d	348.33±4.39c

Control: Nuggets without extract; BHT nuggets: Nuggets with 100ppm BHT; Amla 1: Nuggets with 1 % aqueous amla extract; Amla 2: Nuggets with 2% aqueous amla extract; Curry leaves 1: Nuggets with 1 % aqueous curry leaves extract; Curry leaves 2: Nuggets with 2 % aqueous curry leaves extract
Means bearing different superscripts in a row differ significantly (P<0.05)

Texture profile analysis of all the products revealed significant differences (P<0.05) in the hardness, springiness, gumminess and chewiness values of different products (Table 2). Control product had significantly lower (P<0.05) hardness value as compared to BHT nuggets, amla1, curry leaves1 and curry leaves2. Though control and amla2 as well as amla2, curry leaves1 and curry leaves2 did not differ significantly. Springiness value for control nuggets was significantly lower than the amla2, but the value was comparable to the other treatments. Amla1, curry leaves1 and curry leaves2 had significantly higher gumminess and chewiness values with respect to control.

Table 2 Effect of amla and curry leave extract on texture profile analysis of goat meat nuggets (n = 15)

Parameter	Control	BHT Nuggets	Amla1	Amla2	Curry Leaves1	Curry Leaves2
Hardness	22.35±0.65c	27.19±1.10a	28.27±1.24a	23.89±0.95bc	25.84±0.63ab	26.50±0.80ab
Adhesiveness	-0.04±0.01	-0.07±0.03	-0.10±0.03	-0.07±0.02	-0.09±0.03	-0.12±0.03
Springiness	0.82±0.02b	0.85±0.01ab	0.84±0.01ab	0.86±0.01a	0.85±0.01ab	0.84±0.01ab
Cohesiveness	0.38±0.02	0.37±0.01	0.40±0.01	0.41±0.02	0.41±0.02	0.42±0.01
Gumminess	8.59±0.56b	10.16±0.46ab	11.38±0.65a	9.86±0.82ab	10.47±0.53a	11.02±0.44a
Chewiness	7.06±0.50b	8.65±0.43ab	9.52±0.58a	8.57±0.82ab	8.93±0.51a	9.22±0.35a

Control: Nuggets without extract; BHT nuggets: Nuggets with 100ppm BHT; Amla 1: Nuggets with 1 % aqueous amla extract; Amla 2: Nuggets with 2% aqueous amla extract; Curry leaves 1: Nuggets with 1 % aqueous curry leaves extract; Curry leaves 2: Nuggets with 2 % aqueous curry leaves extract
Means bearing different superscripts in a row differ significantly (P<0.05)

Organoleptic evaluation of all the products showed significant differences in the various parameters. Appearance scores for amla1, amla2, curry leaves1 and curry leaves2 were significantly higher (P<0.05) as compared to control (Table 3). Flavour score of products with curry leaves2 was found significantly higher while amla1 had higher juiciness score. Texture score for amla1 was found significantly higher than the curry leaves1. Amla1 and curry leaves2 products received the highest overall acceptability scores while control product received the lowest score.

All the six products were packed aerobically and stored at refrigeration temperature (4±1°C) and evaluated for Hunter colour parameters, free fatty acid, peroxide value and TBARS number at three days interval for 12 days. Hunter colour lightness value for control product showed significant increase on day 9 of the storage followed by significant decrease on day 12 (Table 4). Lightness

Table 3 Effect of amla and curry leave extract on sensory quality of goat meat nuggets (n = 24)

Parameter	Control	BHT Nuggets	Amla1	Amla2	Curry Leaves 1	Curry Leaves 2
Appearance	7.17±0.11^{b}	7.35±0.09^{ab}	7.58±0.08^{a}	7.44±0.08^{a}	7.44±0.08^{a}	7.54±0.09^{a}
Flavour	7.15±0.08^{b}	7.31±0.09^{ab}	7.19±0.11^{b}	7.13±0.08^{b}	7.27±0.08^{ab}	7.50±0.09^{a}
Juiciness	7.19±0.14^{ab}	7.23±0.11^{ab}	7.38±0.08^{a}	7.29±0.09^{ab}	7.00±0.09^{b}	7.27±0.12^{ab}
Texture	7.15±0.07^{ab}	7.23±0.11^{ab}	7.40±0.09^{a}	7.33±0.12^{ab}	7.04±0.10^{b}	7.33±0.08^{ab}
Overall acceptability	7.06±0.10^{b}	7.31±0.08^{ab}	7.52±0.12^{a}	7.25±0.09^{ab}	7.08±0.08^{b}	7.40±0.08^{a}

Control: Nuggets without extract; BHT nuggets: Nuggets with 100ppm BHT; Amla 1: Nuggets with 1 % aqueous amla extract; Amla 2: Nuggets with 2% aqueous amla extract; Curry leaves 1: Nuggets with 1 % aqueous curry leaves extract; Curry leaves 2: Nuggets with 2 % aqueous curry leaves extract
Means bearing different superscripts in a row differ significantly (P<0.05)

values of other products remained similar throughout the storage period. Among different treatments, lightness values on day 0 were almost similar but on day 12 of storage amla2 product showed significantly lower value. Redness values of control product decreased with the advancement of storage period and on day 6 significant decrease was observed. The redness values of BHT nuggets amla1, amla2 and curry leaves2 showed initial increase up to day 3 and 6 of storage followed by gradual decrease. Product with 1% curry leaves showed gradual decrease in redness value with significant effect on day 9 of storage. As regard the redness values of different treatments control product had significantly higher redness value than the BHT nuggets, amla1, amla2 and curry leaves1. This difference was getting narrower as storage period advanced and on day 12 of storage control product had lower redness value than the BHT nuggets, amla1

Table 4 Effect of amla and curry leave extract on Hunter colour parameters of goat meat nuggets at aerobic refrigerated storage (n = 6)

Treatments	Storage period (days)				
	0	3	6	9	12
Lightness					
Control	46.94±0.62^{b}	47.60±0.34^{bA}	47.49±0.27^{bAB}	48.96±0.47^{aA}	47.59±0.31^{bAB}
BHT	46.96±0.63	46.49±0.40^{BC}	47.76±0.46^{AB}	47.52±0.45^{B}	47.92±0.25^{A}
Amla 1	46.03±0.51	47.02±0.20^{ABC}	47.21±0.47^{AB}	46.98±0.58^{B}	46.90±0.30^{B}
Amla 2	46.12±0.25	46.26±0.38^{C}	46.41±0.49^{B}	47.13±0.33^{B}	45.99±0.29^{C}
Curry leaves 1	47.45±0.40	47.39±0.23^{AB}	47.95±0.25^{A}	47.78±0.39^{AB}	47.62±0.47^{AB}
Curry leaves 2	47.48±0.34	46.71±0.43^{ABC}	47.50±0.60^{AB}	47.76±0.18^{AB}	47.25±0.15^{AB}
Redness					
Control	8.55±0.32^{abA}	9.08±0.13^{aA}	8.12±0.27^{bAB}	7.82±0.38^{b}	7.01±0.19^{b}
BHT	7.66±0.22^{bcB}	8.70±0.20^{aAB}	8.25±0.17^{abAB}	7.32±0.29^{c}	7.32±0.27^{c}
Amla 1	7.76±0.12^{abcB}	8.20±0.22^{abBC}	8.44±0.31^{aA}	7.63±0.27^{bc}	7.34±0.23^{c}
Amla 2	7.84±0.25^{abB}	8.22±0.20^{aBC}	7.65±0.31^{abB}	7.65±0.26^{ab}	7.26±0.30^{c}
Curry leaves 1	8.10±0.19^{aAB}	7.69±0.19^{abC}	7.50±0.21^{abB}	7.25±0.17^{b}	6.99±0.34^{b}
Curry leaves 2	7.88±0.15^{aB}	8.10±0.26^{aC}	7.48±0.17^{abB}	7.30±0.39^{ab}	6.98±0.31^{b}
Yellowness					
Control	13.55±0.23^{A}	12.84±0.43^{AB}	12.94±0.59	12.85±0.31	13.04±0.16^{AB}
BHT	12.80±0.12^{bB}	13.54±0.16^{aA}	13.21±0.14^{ab}	12.83±0.19^{b}	13.14±0.12^{abA}
Amla 1	12.60±0.16^{B}	13.11±0.12^{AB}	13.06±0.28	12.90±0.17	12.66±0.12^{BC}
Amla 2	12.74±0.16^{abB}	13.11±0.12^{aAB}	12.35±0.13^{b}	12.65±0.31^{ab}	12.60±0.15^{abC}
Curry leaves 1	13.07±0.16^{aB}	12.73±0.13^{abB}	12.74±0.11^{ab}	12.41±0.22^{b}	12.74±0.09a^{bABC}
Curry leaves 2	13.60±0.14^{aA}	12.97±0.27^{bAB}	12.49±0.25^{b}	12.89±0.15^{b}	12.61±0.15^{bC}

Control: Nuggets without extract; BHT nuggets: Nuggets with 100ppm BHT; Amla 1: Nuggets with 1 % aqueous amla extract; Amla 2: Nuggets with 2% aqueous amla extract; Curry leaves 1: Nuggets with 1 % aqueous curry leaves extract; Curry leaves 2: Nuggets with 2 % aqueous curry leaves extract
Means bearing different superscripts in a row and column differ significantly (P<0.05)

and amla2 products. Yellowness values for control and amla1 nuggets remained statistically similar throughout the storage period. Yellowness values for BHT nuggets and amla2 did not show clear cut trend throughout the storage period. Yellowness values of curry leaves1 and curry leaves2 decreased significantly on day 9 and day 6 of storage, respectively.

Table 5 Effect of amla and curry leave extract on free fatty acids, peroxide value and TBARS number of goat meat nuggets at aerobic refrigerated storage (n = 6)

Treatments	Storage period (days)				
	0	3	6	9	12
Free fatty acid					
Control	0.13±0.002^{dA}	0.38±0.01^{cA}	0.45±0.01^{bA}	0.45±0.02^{bA}	0.49±0.01^{aA}
BHT nuggets	0.11±0.01^{eB}	0.29±0.01^{dB}	0.34±0.01^{cB}	0.39±0.01^{bB}	0.41±0.01^{aB}
Amla 1	0.09±0.003^{eC}	0.19±0.01^{dC}	0.23±0.01^{cE}	0.25±0.01^{bD}	0.36±0.01^{aC}
Amla 2	0.07±0.01^{eD}	0.12±0.01^{dE}	0.19±0.01^{cF}	0.25±0.01^{bD}	0.30±0.01^{aD}
Curry leaves 1	0.09±0.01^{dC}	0.15±0.01^{cD}	0.29±0.01^{bC}	0.32±0.01^{aC}	0.34±0.01^{aC}
Curry leaves 2	0.10±0.01^{dBC}	0.15±0.01^{cD}	0.26±0.01^{bCD}	0.27±0.01^{bD}	0.31±0.02^{aCD}
Peroxide value					
Control	21.03±0.38^{bA}	20.51±0.38^{bA}	13.59±0.32^{dB}	33.08±0.56^{aA}	15.64±0.51^{cB}
BHT nuggets	16.67±0.51^{bC}	12.31±0.44^{cC}	15.26±0.36^{cB}	21.15±0.33^{aC}	13.46±0.33^{cD}
Amla 1	15.90±0.38^{bC}	12.31±0.44^{dCD}	15.26±0.37^{bA}	21.15±0.33^{aC}	13.46±0.33^{cC}
Amla 2	13.46±0.33^{bD}	11.92±0.33^{cD}	13.21±0.46^{bB}	20.77±0.44^{aC}	11.15±0.33^{cD}
Curry leaves 1	13.08±0.44^{dD}	15.77±0.59^{cB}	15.26±0.46^{cA}	25.77±0.33^{aB}	19.62±0.33^{bA}
Curry leaves 2	19.62±0.33^{bB}	13.33±0.32^{cC}	13.46±0.33^{cB}	21.15±0.33^{aC}	9.36±0.37^{dE}
TBARS number					
Control	0.43±0.01^{eA}	0.45±0.01^{dA}	0.52±0.01^{cA}	0.59±0.01^{bA}	0.76±0.01^{aA}
BHT nuggets	0.33±0.01^{eB}	0.38±0.004^{dB}	0.43±0.004^{cB}	0.52±0.01^{bB}	0.63±0.01^{aB}
Amla 1	0.29±0.01^{eC}	0.33±0.004^{dD}	0.39±0.01^{cC}	0.48±0.01^{bC}	0.57±0.01^{aC}
Amla 2	0.26±0.01^{eD}	0.29±0.01^{dE}	0.35±0.01^{cD}	0.41±0.01^{bE}	0.50±0.003^{aE}
Curry leaves 1	0.31±0.01^{eB}	0.35±0.01^{dC}	0.40±0.01^{cC}	0.47±0.01^{bC}	0.57±0.01^{aC}
Curry leaves 2	0.23±0.01^{eE}	0.26±0.003^{dF}	0.34±0.01^{cD}	0.43±0.01^{bD}	0.53±0.01^{aD}

Control: Nuggets without extract; BHT nuggets: Nuggets with 100ppm BHT; Amla 1: Nuggets with 1 % aqueous amla extract; Amla 2: Nuggets with 2% aqueous amla extract; Curry leaves 1: Nuggets with 1 % aqueous curry leaves extract; Curry leaves 2: Nuggets with 2 % aqueous curry leaves extract
Means bearing different superscripts in a row and column differ significantly (P<0.05)

The various lipid peroxidation indicating parameters such as free fatty acids, peroxide value and TBARS number were evaluated for all the products. Free fatty acid content in all products increased significantly with the storage period. Among different treatments, product with BHT and amla and curry leaves extract had significantly lower free fatty acid contents as compared to control throughout the storage period. Among products with antioxidants, products with amla and curry leaves extract showed the lowest free fatty acid contents than BHT nuggets on day 3 onwards of the storage.

Peroxide values for control, BHT nuggets, amla1, amla2 and curry leaves2 showed fall, rise and fall trend during the storage period. However, goat meat nuggets with 1 % curry leaves extract increased up to day 9 of the storage then decreased significantly on day 12. Among various treatments, except on day 6 of storage, products with BHT and herbal extracts showed significantly lower peroxide value throughout the storage period. On day 12 of the storage curry leaves2 showed the lowest peroxide value followed by amla2 product.

Thiobarbituric acid reactive substance (TBARS) number in all the six products exhibited significant increase on each successive evaluation day. Among different treatments, products with antioxidants had significantly lower TBARS number with respect to control. Goat meat nuggets with herbal extracts had significantly lower TBARS number than BHT nuggets throughout the storage. As regard the products with herbal extracts curry leavs2 had the lowest TBARS number on day 0, however on day 12 of the storage value for amla2 was significantly lower.

Pseudo-cereals in goat meat nuggets effects on quality and acceptability:

In the present study two pseudo-cereals amaranth and quinoa flour were incorporated in goat meat nuggets at 1.5 and 3 % levels by partial or complete replacement of refined wheat flour. The quality and acceptability of the products were evaluated against control. Stability of meat emulsion was significantly decreased (P<0.05) due to amaranth flour (Table 9). Addition of quinoa flour at 1.5% level did not affect emulsion stability, however higher level significantly decreased the value. The differences in the emulsion and product pH values among various treatments were non-significant. Goat meat nuggets with higher level of amaranth flour and lower level of quinoa had significantly lower moisture content with respect to control while amount of fat showed the reverse trend. Protein and ash contents among different products were statistically similar. Addition of amaranth and quinoa by replacing refined wheat flour in goat meat nuggets significantly increased the amount of total dietary fibre. Among the products with amaranth and quinoa, 3% quinoa increased TDF content more significantly as compared to the same level of amaranth.

Table 6 Effect of amaranth and quinoa flour on physicochemical quality of goat meat nuggets (n = 6)

Parameters	Control	Treat I	Treat II	Treat III	Treat IV
ES (%)	96.53±0.21^{a}	95.97±0.10^{b}	95.27±0.24^{c}	96.48±0.03^{a}	95.47±0.11^{c}
Emulsion pH	06.36±0.01	06.36±0.00	06.37±0.02	06.38±0.01	06.37±0.01
Product pH	60.42±0.01	06.42±0.01	06.44±0.01	06.42±0.01	06.43±0.01
Moisture (%)	65.97±0.18^{ab}	66.22±0.17^{a}	65.24±0.22^{cd}	65.06±0.10^{d}	65.63±0.15^{bc}
Protein (%)	15.14±0.17	12.86±2.27	15.97±0.07	15.75±0.10	15.86±0.15
Fat (%)	13.29±0.07^{bc}	13.15±0.11^{b}	13.60±0.08 ^{a}	13.69±0.07^{a}	13.53±0.14^{ab}
Ash (%)	02.69±0.05	02.98±0.27	02.85±0.07	2.64±0.03	02.70±0.01
TDF (%)	0.84±0.01^{e}	01.26±0.02^{d}	01.57±0.02^{b}	1.32±0.01^{c}	1.69±0.02^{a}

Control: Nuggets without refined wheat flour; Treat I: Nuggets with 1.5 % amaranth flour; Treat II Nuggets with 3 % amaranth flour; Treat III: Nuggets with 1.5 % quinoa flour; Treat IV: Nuggets with 3 % quinoa flour
Means bearing different superscripts in a row differ significantly (P<0.05)

Hunter colour lightness value of treatment II was significantly lower as compared to control and treatment I (Table 7). However lightness value for treatment II, treatment III and treatment IV were statistically comparable. Similarly lightness values of control, treatment I, treatment III and treatment IV did not differ significantly. Redness value of treatment IV was significantly higher than the control and treatment III. However redness values of control, treatment I, treatment II and treatment III as well as values of treatment I, treatment II and treatment IV did not differ significantly. Yellowness values for all the products were comparable. Texture profile analysis of the products showed non-significant differences in the hardness and springiness values of all the products. Adhesiveness, gumminess and chewiness values for treatment II was significantly lower when compared with control. Cohesiveness value for control nuggets was significantly higher than the respective treatment I, treatment II and treatment IV.

Table 7 Effect of amaranth and quinoa flour on Hunter colour parameters and texture profile analysis of goat meat nuggets (n = 6)

Parameters	Control	Treat I	Treat II	Treat III	Treat IV
Lightness	46.82±0.32^{a}	46.30±0.25^{a}	45.25±0.20^{b}	45.95±0.41^{ab}	45.86±0.39^{ab}
Redness	7.03±0.20a^{b}	7.56±0.46^{ab}	6.61±0.39^{ab}	6.47±0.40^{b}	7.73±0.32^{a}
Yellowness	12.13±0.20	12.23±0.39	12.37±0.39	12.13±0.26	12.84±0.19
Hardness	32.70±1.50	32.40±2.99	30.02±1.65	34.31±1.36	32.82±1.32
Adhesiveness	-0.05±0.01^{a}	-0.09±0.05^{ab}	-0.20±0.06^{b}	-0.11±0.05^{ab}	-0.07±0.04^{ab}
Springiness	0.85±0.01	0.82±0.01	0.84±0.01	0.85±0.01	0.85±0.01
Cohesiveness	0.45±0.02^{a}	0.40±0.02^{c}	0.37±0.01^{c}	0.45±0.01^{ab}	0.41±0.01^{bc}
Gumminess	14.89±1.11^{a}	13.16±1.57^{ab}	11.27±0.79^{b}	15.32±0.62^{a}	13.40±0.91^{ab}
Chewiness	12.69±0.99^{a}	10.81±1.27^{ab}	9.42±0.57^{b}	13.04±0.48^{a}	11.30±0.67^{ab}

Control: Nuggets without refined wheat flour; Treat I: Nuggets with 1.5 % amaranth flour; Treat II Nuggets with 3 % amaranth flour; Treat III: Nuggets with 1.5 % quinoa flour; Treat IV: Nuggets with 3 % quinoa flour
Means bearing different superscripts in a row differ significantly (P<0.05)

Organoleptic evaluation of the products showed significant differences in the scores of various parameters (Table 8). Treatment II and treatment III had significantly higher appearance scores as compared to control and treatment I. Flavour score for treatment III was significantly higher in relation to the other products. As commented by the panelists amaranth and quinoa masked the saltiness of the products. Products with 1.5 % amaranth had significantly higher texture score. Treatment II, treatment III and treatment IV had significantly higher ($P<0.05$) juiciness scores than the control. Product with 1.5 % amaranth flour had significantly higher texture score as compared to other treatments. Though all the products were very much acceptable, treatment three was found to have significantly higher ($P<0.05$) overall acceptability score.

Table 8 Effect of amaranth and quinoa flour on sensory characteristics of goat meat nuggets (n = 6)

Parameters	Control	Treat I	Treat II	Treat III	Treat IV
Appearance	6.89 ± 0.10^{c}	6.95 ± 0.08^{bc}	7.24 ± 0.10^{a}	7.32 ± 0.08^{a}	7.17 ± 0.10^{ab}
Flavour	7.17 ± 0.05^{b}	7.11 ± 0.06^{b}	7.24 ± 0.08^{b}	7.52 ± 0.07^{a}	7.28 ± 0.11^{b}
Juiciness	7.03 ± 0.10^{b}	7.25 ± 0.08^{ab}	7.29 ± 0.08^{a}	7.49 ± 0.08^{a}	7.44 ± 0.09^{a}
Texture	7.21 ± 0.10^{b}	7.58 ± 0.08^{a}	7.26 ± 0.09^{b}	7.32 ± 0.08^{b}	7.22 ± 0.07^{b}
Overall acceptability	7.35 ± 0.06^{b}	7.47 ± 0.07^{ab}	7.51 ± 0.07^{ab}	7.60 ± 0.07^{a}	7.29 ± 0.11^{b}

Control: Nuggets without refined wheat flour; Treat I: Nuggets with 1.5 % amaranth flour; Treat II Nuggets with 3 % amaranth flour; Treat III: Nuggets with 1.5 % quinoa flour; Treat IV: Nuggets with 3 % quinoa flour
Means bearing different superscripts in a row differ significantly ($P<0.05$)

Antioxidant potential of marigold, hibiscus, gaillardia and sadabahar flower extracts: Methanolic extracts of four flowers namely marigold (*Calendula officinalis*), hibiscus (*Hibiscus rosa-sinensis*), gaillardia (*Gaillardia aristata*) and sadabahar (*Catharanthus roseus*) were evaluated for their antioxidant potential and phytochemical profiling so that these could be

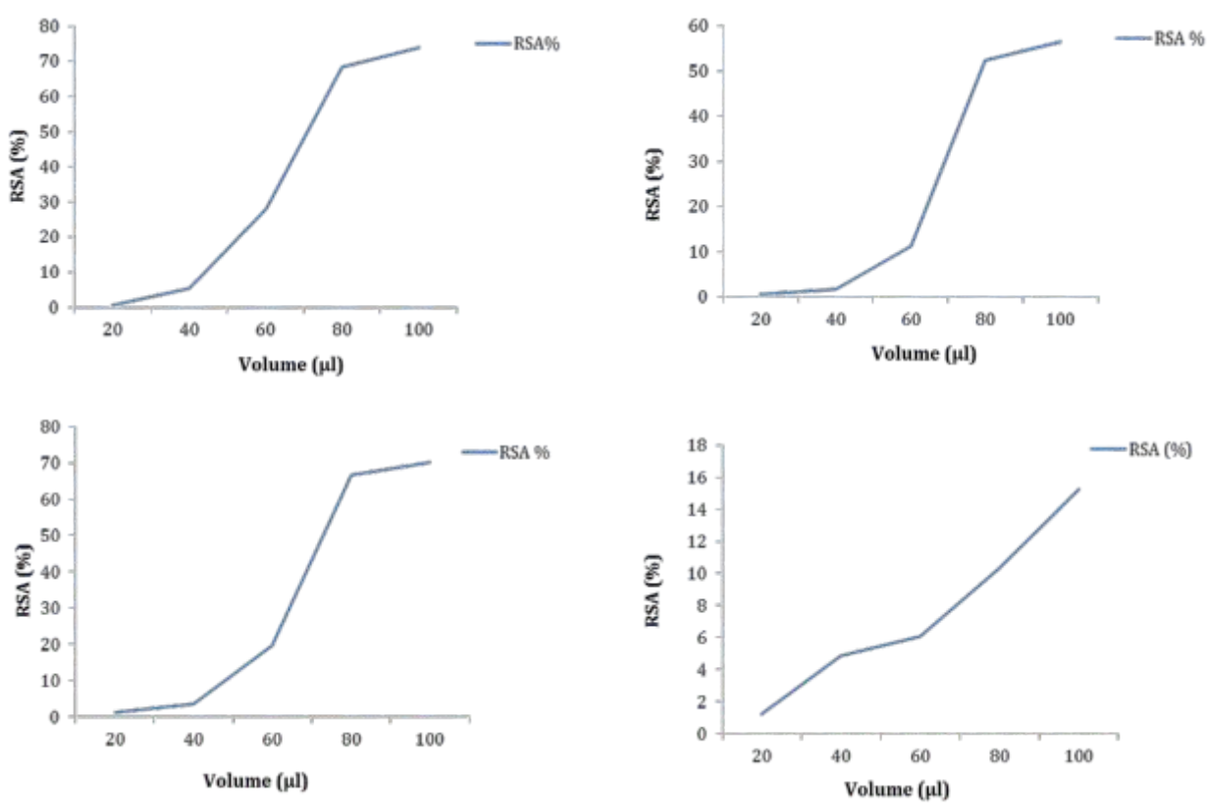

Fig. 6 DPPH radical scavenging activity of methanolic extract of (a) marigold (b) hibiscus (c) gaillardia and (d) sadabahar flowers

Table 9: Total phenolics and flavonoids in marigold, hibiscus, gaillardia and sadabahar flower extracts

Parameters	Marigold	Hibiscus	Gaillardia	Sadabahar
Total phenolics (mgGAE/g)	84.46	85.10	52.61	48.42
Total flavonoids (µgCE/g)	95.56	139.30	129.18	90.30

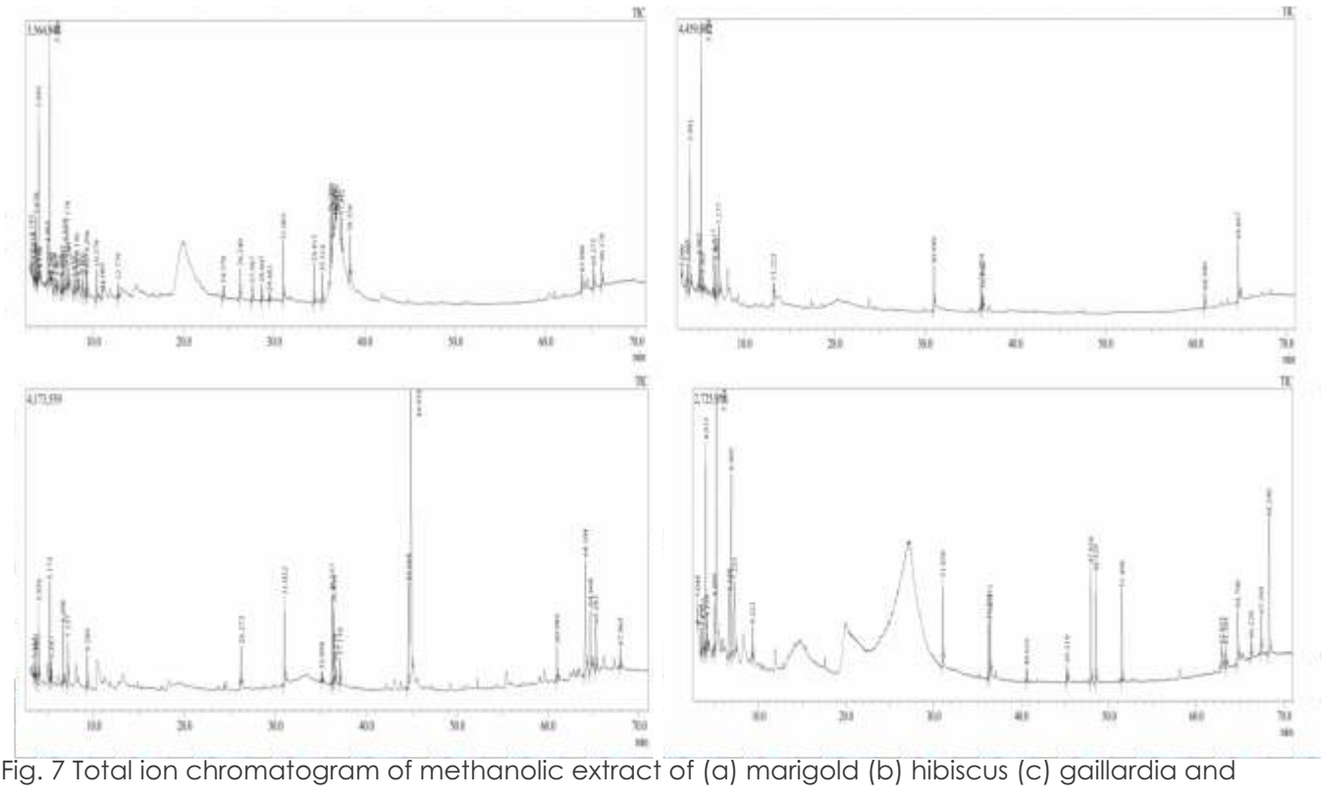

Fig. 7 Total ion chromatogram of methanolic extract of (a) marigold (b) hibiscus (c) gaillardia and (d) sadabahar flowers

used as source of natural antioxidants in meat and meat products. Marigold and hibiscus flower had higher total phenolics as compared to gaillardia and sadabahar flowers. Total flavonoids in hibiscus and gaillardia were found higher with respect to marigold and sadabahar flowers (Table 9). DPPH radical scavenging activity in all four extracts was found concentration dependent (Fig. 6). Phytochemical profiling of methanolic extracts in GC-MS/MS showed presence of 40, 15, 20 and 21 peaks/component in marigold, hibiscus, gaillardia and sadabahar, respectively. Preliminary study with goat minced meat has shown very promising results as application of these flower extracts improved the product redness value, decreased free fatty acid and peroxide value (data not shown).

A Pilot Study on Moringa Oleifera Biomass Based Complete Feed for Goats

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Effect of feeding moringa based complete feed on productivity of goats: PKM-1 varity of Moringa oleifera was used to study in two form (Fig 1 and 2) study was carried out on sixteen female Barbari kids (3 month of age) divided equally in to two groups (Control and treatment), to observe the effect of feeding moringa based complete feed on productivity of these kids. A parallel experiment was also carried out on sixteen male Barbari kids (3 months of age), equally divided in two (Control and treatment). The male and female animals under control groups were maintained at Barbari unit of the institute under semi intensive system and under treatment groups were maintained at exp. shed of AN&PT Division under stall fed condition and were fed moringa based complete feed in the ratio of 80:20 up to age of 9 month of age and 70:30 from 9-12 months. The feeding was continued ill the animals attained the age of 12 months. The observation of in terms of wt. gain, haematology, concentration of stress related enzymes and HSP 70 from both control and treatment groups were collected during experimental goats, however the observation in terms of DM intake could be collected from treatment group only. The body wt. at 6, 9 and 12 months of female goats under treatment group were 16.16±0.61, 18.56±0.73 and 24.29±1.12 kg respectively whereas under control groups these values were 13.16±0.21, 16.92±0.34 and 20.05±1.00 kg at 6, 9 and 12 months respectively. Similarly the body weight of male goats under control at 6, 9 and 12 months of age were recorded 14.01±0.25, 17.82±0.26 and 23.43±0.73 kg and under treatment group were 20.67±0.58, 25.00±0.94

Fig. 1 Fodder crop of PKM-1 variety of Moringa cultivated at CIRG

Fig. 2 Moringa based complete feed

Table 1 Effect of feeding Moringa oleifera biomass based complete feed on body weight of male and female goats

S.No	Months	Average B.wt.(Treatment)	Average B.wt. (Control)	DMI/100kg of B.wt.
1	6	20.67±0.58	14.01±0.25	4.16
2	9	25.00±0.94	17.82±0.26	4.00
3	12	33.99±1.16	23.43±0.73	4.12

Table 2 Physiological response of male goats

Sex	Heart rate		Respiration rate		Rectal temperature	
	Treatment	Control	Treatment	Control	Treatment	Control
Male	137.1±2.5 a	143.8±2.4a	42.43±1.3a	40.64±3.2 a	39.91±0.1 a	39.43±0.1 a
Female	137.5±2.4 a	148.4±3.0a	30.93±2.3a	47.21±3.5a	39.52±0.1a	39.39±0.1a

Table 3 HSP 70 concentration of experimental goats (after 71 days) under humid climate

S.No.	Parameter	Male		Female	
		Control	Treatment	Control	Treatment
1	HSP 70 (ng/ml)	71.98±1.03a	66.92±1.00a	66.94±1.02a	70.57±1.26a

Table4 Lipid profile of experimantal goats after 6 months feeding of moringa oleifera (winter)

S.No.	Parameter	Male		Female	
		Control	Treatment	Control	Treatment
1	Cholesterol (mg/dL)	79.82±1.05a	61.95±1.12a	77.15±1.24a	73.96±1.94a
2	LDL (mg/dL)	39.42±1.19a	34.53±2.19a	39.85±1.65a	35.26±1.52a
3	HDL (mg/dL)	32.22±1.67a	38.32±2.01a	29.82±1.00a	32.97±1.75a
4	Triglycerides (mg/dL)	40.68±0.45a	34.47±2.34a	37.38±1.77a	28.55±2.32a
5	SOD	77.33±0.55a	65.92±1.79a	73.47±0.82a	73.38±1.73a

and 33.99±1.16 kg at 6, 9 and 12 months of age. These observations indicted relatively higher body wt. gain under moringa fed groups of male & female goats. The total DM intake from male and female goats under treatment goats were recorded 4.0-4.9 % of body wt. (Table 1). The values of physiological responses indicated that female and male goats under treatment groups were more comfortable than control (Table 1 and 2). The concentration of HSP 70 in plasma (Table 3) indicates that male goats were less stress under treatment group whereas under female goats the contradictory observation was recorded. The observation of blood lipid profile collected in cold and humid heat period from male and female goats under control and treatment goats (Table 4) Indicated lower values of Cholesterol, LDL and Triglycerides under treatment groups whereas the values of HDL were higher under treatment group. These observations indicated the anti-cholesterol activity of moringa biomass. The observation of haematological parameters revealed almost identical units (Table 6) values under control and treatment group of male and female goats except HCT (%) which was found significantly lower under treatment group of female goats. The moringa feed was found cost effective and productive for goats.

Table.5 Stress related enzymes activities in blood plasma of experimental goats (humidity)

S.No.	Parameter	Male		Female	
		Control	Treatment	Control	Treatment
1	SOD (% inhibition)	37.80±2.65a	41.85±2.98a	36.42±1.88a	42.58±1.90a
2	Cholesterol (mg/dL)	71.70±0.84a	61.95±1.12a	72.03±0.76a	69.41±1.77b
3	LDL (mg/dL)	38.72±3.20a	34.53±2.19a	36.20±1.77a	35.26±1.28a
4	HDL (mg/dL)	36.16±1.35a	38.32±2.01a	32.66±0.86a	39.38±2.06a
5	Triglycerides (mg/dL)	35.18±1.03a	34.47±2.34a	28.09±0.94a	26.40±2.54a

Table 6 Haematological parameters

S.No.	Parameter	Male		Female	
		Control	Treatment	Control	Treatment
1	WBC (M/mm3)	16.58±0.98a	18.02±0.77a	16.76±0.72a	18.24±1.16a
2	RBC (M/mm3)	12.59±0.25a	13.41±0.26a	13.76±0.33a	14.12±0.16a
3	HCT (%)	17.19±0.33a	17.46±0.29a	18.04±0.74a	18.26±0.36b
4	Hb (g/dL)	06.01±0.16a	06.50±0.09a	06.57±0.23a	06.90±0.08a

ANIMAL HEALTH DIVISION

Development of Herbal Anthelmintic and Acaricidal Formulations for Goats

Principal Investigator
Ashok Kumar

Co-Investigators
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Anthelmintic efficacy trial

Based on the in vitro trial, two combinations were prepared as CIRG-A 1 and CIRG-A2 and clinical efficacy evaluated in naturally haemochus infected animals in farmer's flock. Each combination was drenched to haemonchus infected goats (n=6) on two consecutive days and faecal egg count was monitored on regular basis up to 150 days. Albendazole @ of 10mg/kg body weight as single dose rate as positive control and one group negative control was kept. The result indicated that EPG declined on day 3 in positive control significantly and on 30 days onward EPG count has increasing trend, possibly due to infection (Fig. 1). In treatment groups showed consistently declining EPG up to 30 days and interestingly, the infection remained significantly low up to 146 days observation. Comparatively between two combinations, CIRG-A1 was more effective then CIRG-A 2. Both the prototypes were quite efficacious in clearing the infection and maintained it to a minimal level for more than 150 days.

Additionally, in the same samples, the coccidial load was also screened routinely. Interestingly, the treatments were effective in controlling the coccidial load also to some extent.

Acaricidal efficacy: Three potential plants were selected on the basis of in vitro studies. In order to find out the best synergistic combination, three combinations were prepared in a definite ratio and coded as CIRG -P1, CIRG –P2, CIRG –P3. The In vitro adulticidal activity was assessed at

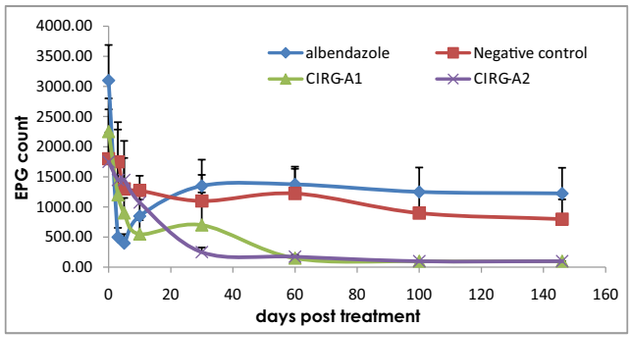

Fig 1 Total hemonchus egg count per gram of goat faeces with respect to days post treatment with CIRG-A1 and CIRG A2

different concentration (40-140mg/ml) on scientifically collected females of Rhipicephalus microplus. The experiment was replicated in three batches with total adult female of 15. The efficacy assessed on the basis of LC 50, LC 90 values, mortality at 24 hrs. estimated reproduction factor and Inhibition reproduction %. Among three combinations, lowest ERF and highest IR percent was exhibited by CIRG-P3 (Table 1). The LC 50 and LC 90 were lowest in CIRG P3 at both 24 hrs.and 15 days post treatment.

In vivo studies: Among three combinations of prototypes, combination CIRG-P3 was selected for in vitro studies on the basis of lowest LC50 and LC90. The three dose levels were selected as 90,120 and 150mg/ml in water base. This concentration was sprayed in heavy infested calf with 40, 64 and 104 female ticks per 100cm square area on body surface. The level of reduction was

Table 1 Comparative Adulticidal bio efficacy of three prototypes

Concentration	Mortality % 24hrs			Estimated Reproduction Factor (ERF)			Inhibition Reproduction (IR %)		
	CIRG-P1	CIRG-P2	CIRG-P3	CIRG-P1	CIRG-P2	CIRG-P3	CIRG-P1	CIRG-P2	CIRG-P3
40	20	0.00	40	52785.31	5998.50	2666.0	89.95	98.64	99.67
60	20	20	60	29090.90	2032.76	635.24	94.57	99.54	99.92
80	40	40	66.67	25000.00	--	--	95.33	--	--
100	60	53.33	80	24222.02	--	--	95.47	--	--
120	66.67	60.00	93.33	17142.86	--	--	96.8	--	--
140	80	86.67	100	--	--	--	--	--	--
Control	0.00	0.00	0.00	535294.11	440540.54	829090.91	--	--	--

80.0, 88.24 and 100 percent respectively in three concentrations in decreasing order respectively.

Sub project: Efficay of polyherbal formulation on Brucella: Twelve brucella positive animals were selected for the study. Two herbal prototypes A and B were prepared on the basis of the pathophysiology of Brucella infection in animals . Prototype A was given 0.5 ml to females and 7.5 ml to male animals while prototpye B was given as 1 gm powder dose for 15 days as a single daily dose. Vaginal swabs and whole blood samples were collected at 0, 7, 14, 36 and 100 days posttreatment. Plasma was used to analyse the inflammatory markers and IgG levels while RBC suspension was used to evaluate the oxidative stress level. The shedding status was assessed by OMP31 taqman Assay. The inflammatory markers (IgG (mg/ml),SAA (mcg/ml), Haptoglobin (ng/ml), CRP (ng/ml) and oxidative stress markers (GSH, LPO,Catalase,SOD) measured in the samples. Both inflammation and oxidative stress showed a downward trend in the treated animals.

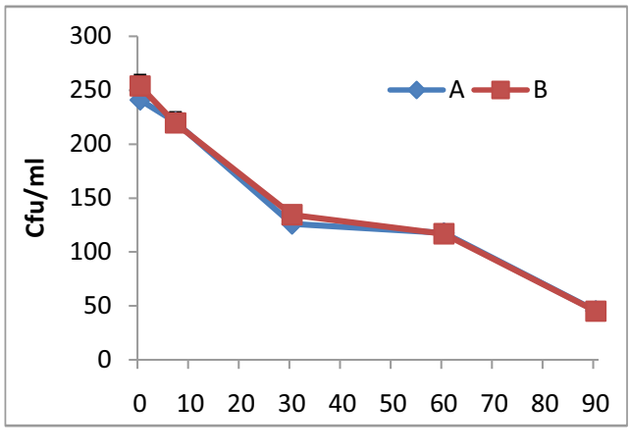

Fig 2 Brucella shedding observed with respect to days post treatment with prototypes A and B

Prototype A showed significant decrease in Brucella shedding up to 40 CFU/ml from 2-3X102 CFU/ml in 90 days post treatment while Prototype B showed moderate decrease in Brucella shedding up to 100 CFU/ml from 2-3X102 CFU/ml in 90 days post treatment (Fig. 2).

All India Network Project on Neonatal Mortality in Farm Animals

Principal Investigator
Ashok Kumar

Co-Investigators
R.V.S. Pawaiya, A.K. Mishra, K. Gururaj

Epidemiological studies: Survey was conducted on kid mortality in different States. For the more precise information, the data of all previous year were added. The details of information and inferences are given in following tables and illustrations. The kid mortality was higher in UP, Rajasthan, Haryana and West Bengal, (36.97-46.79 %) in comparison to southern States (15.73-27.79%). The Season wise mortality revealed that, in Northern States (UP, MP, Rajasthan, Haryana), Mortality was more in winter season, whereas in Southern states, rainy season contributed to higher mortality (Fig 1). Age-wise, the mortality was lower in early neonatal (hebdomadal) age (1-7 days) and higher in 1-3 months age (Fig 2). Diarrhoea was the most common cause of mortality in all climatic zone followed by pneumonia.

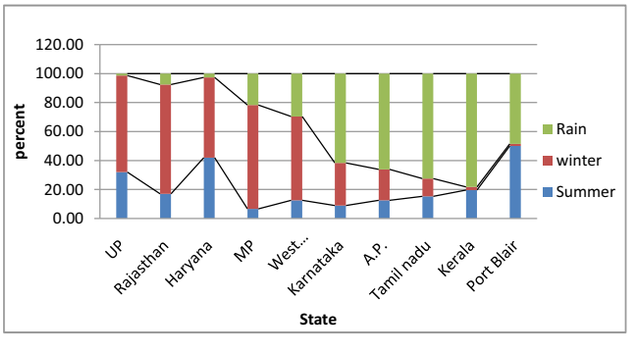

Fig 1 Season wise proportional distribution of kid mortality in different States.

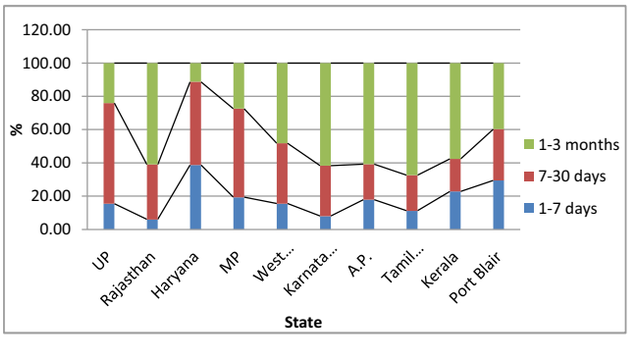

Fig 2 Age wise proportional distribution of kid mortality in different States.

Morbid and fecal sample analysis for Identification and characterization of pathogens:

A. Fecal samples analysis from Diarrheic kids (0-3 Months): A total of 200 faecal samples were aseptically collected from farm and field goat-kids affected with diarrhoea (0-3 months old) from various places of Mathura district. On conventional bacteriological examination, out of 200 faecal samples, 181 samples were found positive for E. coli infections. Total 296 E coli isolates were examined for different pathotypes (Table 1).

Table 1 Different pathotypes of *E coli* isolated from diarrheic kids

No. of Isolates	Different Path types				
	EPEC (bfp A gene)	ETEC (labile toxin)	ETEC (stable toxin)	EIEC (ial gene)	VTEC (Stx 1 gene)
296	76	17	58	14	11
%	25.67	19.59	5.74	4.17	4.6

B. Fecal samples from Diarrheic hebdomadal neonatal kids (0-7 Days): A study was conducted in hebdomadal goat kids which showed acute diarrhea with pasty greenish fecal matter soiling the perianal region. The fecal swabs were cultured for detection of Enteropathogenic Escherichia coli (EPEC) and Shiga-toxin (STX) producing E. coli (STEC) based on the PCR detection using bfpA and stx1 gene respectively. Around 28 kids (87%) showed presence of EPEC by bfpA gene based SYBR green real time PCR. Only one isolate of E.coli was found to be stx1 positive. The amplified stx1 gene was sequenced by Sanger's dideoxy method using big dye terminator kit. The CIRG STEC strain showed 99% homologous with other reference strains. Phylogenetic analysis was conducted using Minimum Evolution method. The optimal tree with the sum of branch length = 0.05187866 was computed. The percentage of replicate trees and the associated taxa clustered together are subjected to bootstrap test (500 replicates). The evolutionary distances were computed using the Maximum Composite Likelihood method and are in the units of the number of base substitutions per site. The ME tree was searched using the Close-Neighbor-Interchange (CNI) algorithm at a search level of 1.

The Neighbor-joining algorithm was used to generate the initial tree. The analysis involved 13 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 520 positions in the final dataset. Based on phylogenetic analysis, the STEC CIRG1:2017 strain was present in one of the two major branches with close association with STEC strains including ONT:H34, 4756/98, O6E01767 reference strains belonging to various sub clades. The strain 4756/98 was present in the same clade where STEC/CIRG: 2017 was placed. However, the DEC 10J strain was present in the other branch along with SWUN 4124 and FD930 strains (Fig 3).

Surprisingly, mixed infection with Bovine corona virus (BCoV) was also found in 16 samples (50%) which showed positive for EPEC and STEC. All the pathogens STEC, EPEC and BCoV were present in a single sample (3.1%). This study showed the close association of BCoV along with EPEC in producing neonatal diarrhea complex in hebdomadal kids. The week old kid that died of mixed infection with EPEC+STEC+BCoV was thoroughly examined by necropsy.

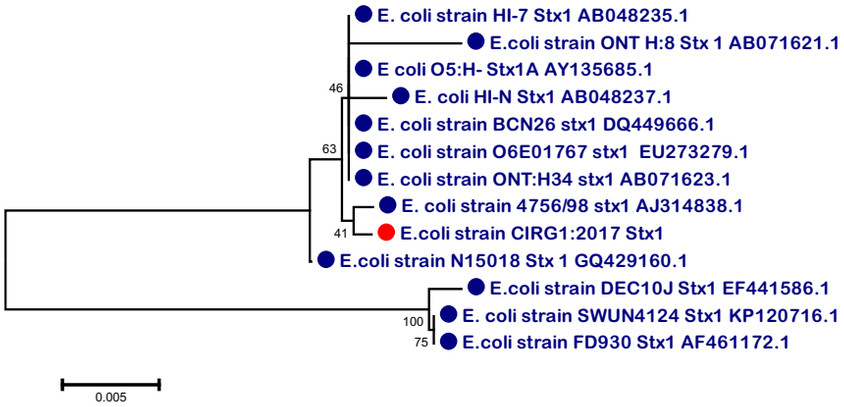

Fig 3 Phylogenetic analysis of Stx1 gene of STEC strain CIRG1: 2017 with other standard reference cultures. The evolutionary history of stx1 gene using the Minimum Evolution method

C. Morbid sample analysis from dead kids: A total of 261 carcasses (240 goats & 21 sheep) from Institute farms were necropsied during 1st April, 2016 to 31st March, 2017. Of these, 77 animals (69 kids and 8 lambs) belonged to 0-3 month's age, with overall mortality rate of 29.50%, comprising of 59.74% males and 40.26% females. The major causes of deaths were diagnosed as enteritis (35.06%), pneumonia (27.27%), anemia/weakness (9.09%) and other diseases (23.76%). Representative tissue specimens from were collected in appropriate preservative pathological, molecular and isolation studies.

Grossly, intestines showed frequently congested and hemorrhagic mucosa or mucoid enteritis with presence of mucoid contents in the lumen. Lungs revealed focal or diffuse lesions of consolidation and congestion involving variably the apical, cardiac and diaphragmatic lobes. Heart, in some cases, showed epicardial congestion and haemorrhages.

Microscopically, intestines showed hemorrhagic and catarrhal enteritis, with severe congestion of mucosal blood vessels, degeneration, necrosis, shortening and detachment of villi from mucosal surface (Fig. 4). In few cases, proliferation of lymphocytes in the lamina propria and infiltration of neutrophils in the villi were evident. The pneumonic cases were diagnosed as acute haemorrhagic pneumonia, serous pneumonia, bronchopneumonia and interstitial pneumonia. In affected lungs, alveolar parenchyma evinced severely congested blood vessels and infiltration of inflammatory cells, comprising of mononuclear cells admixed with neutrophils and erythrocytes in the alveoli and interstitial spaces. At places, the alveolar spaces were obliterated due to accumulation of serous exudate, perivascular edema and emphysematous changes (Fig. 5). A few cases revealed prominent thickening of interstitial tissues due to accumulation of serous inflammatory exudate. Mostly, there was severe congestion of alveolar capillaries with frequent rupture of alveolar wall resulting into emphysema. In case of weakness/anemia, there was depletion of lymphoid tissue in the spleen leading to hindered or retarded hematopoiesis in affected animals.

Intestinal loops were collected from 142 neonatal goat kids died due to enteritis, pneumo-enteritis and neonatal septicaemia for aetiological confirmation by employing various molecular diagnostic techniques. Detection of toxinotypes

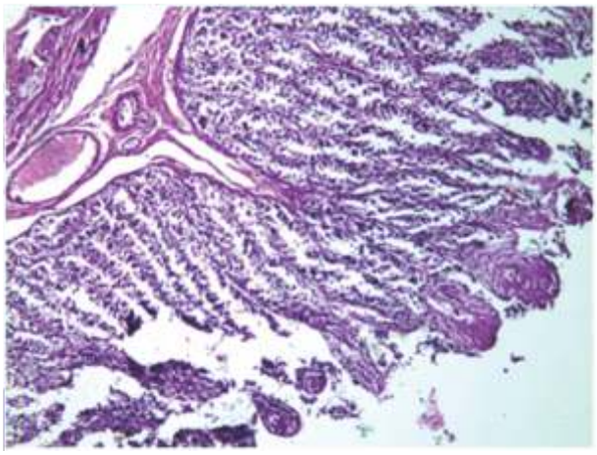

Fig 4 Intestine of goat kid evincing degeneration, necrosis and detachment of villi.H&E x100.

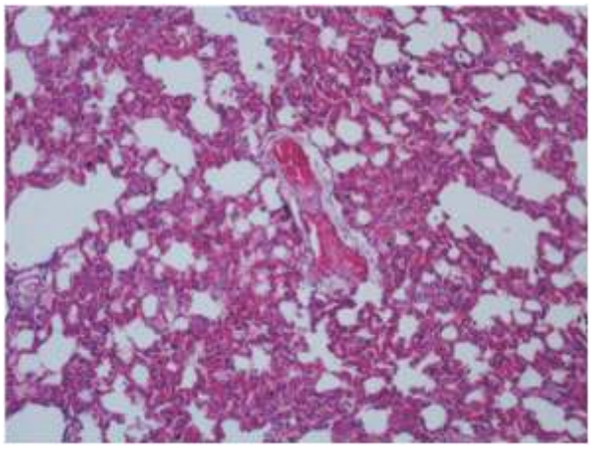

Fig 5 Lung of goat kid showing congested interalveolar septae and blood vessels with perivascular edema and areas of ruptured alveoli (emphysema). H&E x100.

of Clostridium perfringens, enteropathogenic E. coli (EPEC), Group A rotavirus (GARV) and Bovine coronavirus (BCV) were performed in all 142 intestinal tissues using specific primers. Intestinal tissues were used for toxinotyping by multiplex PCR (TmPCR) using primers for cpa, cpb, cpb2, etx and iap gene (Table 2). Same samples were also used for identification of EPEC using BfpA gene and SYBR green based real time PCR assay developed during the study. Detection of GARV and BCV was done by one-step RT-PCR (osRT-PCR). The results are presented in Table 9 and 10. The incidence percentage of C. perfringens was 27.38%, which included 47.83% C. perfringens toxinotype A and 52.17% toxinotype D. Beta2 toxin gene (cpb2) was present in 30.43% of the C. perfringens positive samples. Incidence of EPEC in 0-1 and 1-3 month diarrheic kids was 36.62% and 25.35%, respectively. Based on osRT-PCR, 11.97% were positive for GARV and 9.86% for BCV. Mixed infections detected were C. perfringens + EPEC (12.68%), C. perfringens + GARV (2.11%), C. perfringens + BCV (1.40%), EPEC + GARV (10.56%), EPEC + BCV (7.04%), and EPEC + GARV + BCV (0.70%). On the basis of above findings, it may be concluded that mixed infections are significant in causing mortality in kids which could be detected by combination of molecular diagnostic tools such as TmPCR, osRT-PCR and SYBR green real-time PCR. Besides toxinotyping, there are other virulence factors like beta-2 toxin which produces significant mortality due to ET in kids. The importance of viral enteritis caused by GARV and BCV and their role in the pathogenesis of neonatal diarrhoea complex in goat kids require further investigation.

Evaluation of herbal formulation (prototype 1) on transition in pregnancy and kid Body weight: In first trial, in this experimentation, an herbal formulation consisting of four native medicinal plant powder (Coded AINP CIRG 1) in the dose of 100mg/kg body weight was administered daily. The three times serum samples was collected, as Control (3 week before) without treatment, Treatment BF (1 week before kidding) and Treatment AF (3 week after kidding). The samples were analyzed as per standard methods. The variation in studied parameters due to season, birth type and parity was insignificant. The cortisol level was reduced significantly from 162.361ng/ml to 97.437 ng/ml in treatment group indicating that the herbal powder helped inreducing the pregnancy stress. However, Oxidative stress marker enzyme SOD was not significantly reduced, but showed decline trend in post kidding sample. The pro-inflammatory cytokines IL2 and IL6, which were likely to increase in transition phase of pregnancy, were significantly declined before kidding and after kidding, suggest that herbal powder modulate/optimize the physiological transition. The growth hormone was also remained unchanged in all three stage sampling. The IFNγ (pg/ml) is also has trend to increase in transition, where the animal become more susceptible to infection due to stress , was also reduced from control value of 421.665 pg/ml to 315.119 pg/ml at after kidding significantly. The same decline is also observed in before kidding reading significantly. The immunoglobulin G (IgG mg/ml) also declined significantly from control values of 21.825 mg/ml to 14.640 mg/ml at before kidding and after kidding 15.908 mg/ml, probably due to anti-infective property of herbal prototype. The overall analysis suggests that this herbal formulation modulate the transition of pregnancy by action as antistressor and thus, increase the body weight significantly in treatment group (3.269 kg) as compared to untreated group (3.219 kg) significantly at $P<0.05$.

Table 2 Results of multiplex PCR toxinotypes of *C. perfringens* in neonatal goat kids

S.No	Toxin gene	Toxino types	No. of Isolates from 0-1 month age kids		No. of Isolates from 1-3 months age Kids		Total no. of Isolates
			Male	Female	Male	Female	
1	cpa	A	03	02	02	04	11
2	etx	D	02	02	03	05	12
3	cpb2	A, B, C, D & E	01	01	01	04	07

In second Dam supplementation Trial, the effect of selected prebiotic/herbal interventions in pregnant does on quality of colostrum and immune status, disease susceptibility, birth weight and overall growth and vitality of full term goat kids. 45 healthy pregnant goats of Jamunapari breed of Jamunapari unit of CIRG, Makhdoom, Mathura were randomly divided into 3 groups (Prebiotic – P, Herbal formulation – H and negative control - C) of 15 each. Supplementation was started 06 weeks prior to expected date of parturition until 04 weeks post-partum with (1) Prebiotic mannan oligosaccharide (Agrimos® Lallemand Animal Nutrition, India) @ 100 mg/Kg body weight/day; (2) Herbal formulation , Combination of crude powder of 4 medicinal plants in (Coded formulation as AINP CIRG -2) @ 100 mg/Kg body weight/day, to group H. Good quality dried herbs were procured from local market and powdered in the lab using electric grinder and (3) Group C did not receive any additional supplement.

Assessment of disease susceptibility and innate immunity of goat kids: Twelve goat kids, 04 (02 twin born to different dams and 02 single born) from each of the 3 maternal treatment groups of 2 – 3 weeks of age (4 × 3 = 12) were subjected to experimental sepsis by sub-lethal bolus intravenous injection of purified Escherichia coli O111:B4 lipopolysaccharide (Sigma® L 3024) @ 200 ng/Kg body weight. Clinical (heart rate and rectal temperature) and behavioral (demeanor and suckling) parameters were recorded at 0, 1 and 4 hours of lipopolysaccharide injection.

Effect of supplementation on colostrum: An increase in IgG and IgM concentration was observed in colostrum of both the supplemented groups (Table 3).

Effect of supplementation on protein and immunoglobulin levels of goat kids: Serum total protein, plasma IgG and plasma IgM values in both the supplemented groups were higher than that in control group. However, statistically significant increase in serum total protein and plasma IgG concentration was observed only in prebiotic supplemented group when compared with the control group.

Effect of supplementation on tolerance to induced sepsis: Heart rate of un-supplemented kids was found to be significantly increased when compared to kids of supplemented groups after 1 hour of LPS administration. Contrastingly, rectal temperature of prebiotic supplemented group (P) was significantly higher than both H and C group but the kids of this group were found to be least depressed. While conducting the trial, same unique observation was made that the individuals who have not developed significant fever were persistently more depressed and were not able to suckle their dam after completion of the trial.

Table 3 Concentration of Immunoglobins (IgG & IgM) in different groups

Group	IgG (mg/mL)		IgM (µg/mL)	
	Mean ± SEM	SD	Mean ± SEM	SD
H (n = 7)	80.00 ± 6.34A	16.78	2761 ± 471.56A	1247.63
P (n = 7)	81.49 ± 3.40A	08.99	2441 ± 313.00A	828.12
C (n = 7)	66.86 ± 5.38A	14.22	1917 ± 293.04A	775.31

Values with different alphabets as superscript across the column differ significantly ($P < 0.05$).

Effect of supplementation on goat kid's birth weight and growth rate: Data available of all the kids born to all 37 goats (irrespective of parity) was used to calculate mean birth weight and average daily weight gain. No statistically significant difference was observed either on birth weight or average daily weight gain. It appeared that two supplements have promising immune modulatory effect.

ICAR Network Programme on Veterinary Type Culture–Veterinary Microbes

Principal Investigator
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Isolation and identification of enteropathogenic *Escherichia coli* (epec) from diarrheoa in neonatal goats

Neonatal goats were screened for diarrhea based on the clinical signs including soiling of perianal region with greenish fecal matter, dehydration and reduced growth rate. Fecal swabs were collected and cultured for bacteriological isolation in BHI agar (BHIA) and MacConkey's agar (MCA) and molecular screening of isolates using uspA and EPEC by bfpA gene SYBR green Real time PCR (Fig. 1). The confirmed isolates were submitted to the repository and obtained accession. The molecular identification of E. coli was done by PCR amplification of the uspA gene using the primers uspA-F-5'-CCGATACGCTGCCAATCAGT-3' & uspA-R-5'- ACGCAGACCGTAGGCCAGAT-3'. The size of the amplified product was 884 bp (Fig. 1). The Molecular screening of EPEC using bfpA gene

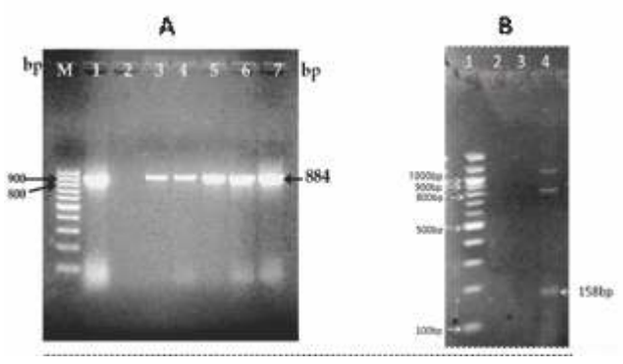

Fig 1 Molecular characterization of EPEC isolates - Gel electrophoresis. A-*usp*A gene PCR for *E.coli*. Wells, M: 100bp DNA ladder, 1, 3-7: 884bp *usp*A gene amplicon, 2: No template control; B-*bfp*A gene conventional PCR for EPEC. Wells, 1: 100bp DNA ladder, 2: No template control, 3: Negative control, 3: 158bp *bfp*A gene amplicon; C-*bfp*A

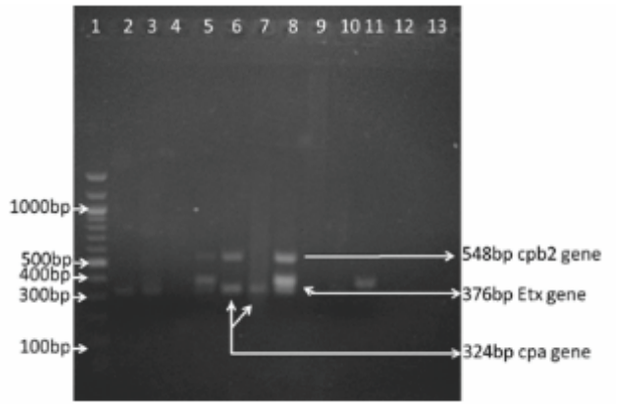

Fig 2 TmPCR-Wells, Gel picture showing the multiplex toxinotyping PCR with various amplicons of genes including cpa, etx and cpb2; Wells, 1 – 100bp DNA ladder, 2-3,7,11- *C. perfringens* typeA, 4,9,10,12-13 – Negative, 5,8- *C. perfringens* type D with cpb2, 6- *C. perfringens* type D.

based SYBR- green Real time PCR by the following primers viz., bfpA F: 5'-ATGGTGCTTGCGCTT-GCTGC-3', bfpA R: 5'-AATCCACTATAACTGG-TCTGC-3'.

Molecular typing of *clostridium perfringens* from various age groups of goat affected due to enterotoxaemia

Clinical outbreaks and mortality suspected due to enterotoxaemia were attended and fecal samples and intestinal loop were collected for bacteriological studies and molecular typing. Ileal portion of intestine showed serosal congestion and mucosal hemorrhages along with emphysematous and edematous lungs. In sheep, the lesions were more prominent with congestion of the whole small and large intestine and major visceral organs.

The intestinal contents were inoculated to the Robertson's cooked meat media (RCM) followed and then incubated overnight at 42˚C. Gas production is an indicator of C. perfringens growth in RCM. The RCM culture supernatant was subsequently inoculated to clostridial supplemented blood agar (CLS-BBA). In CLS-BBA, grayish colored, rounded raised colonies with two zones of hemolysis appeared after overnight incubation in anaerobic jar at 37°C. A single characteristic colony is streaked to Egg yolk agar

(EYA) to confirm the lecithinase activity of alpha toxin (Phospholecithinase).

Molecular typing by TmPCR: Molecular typing was carried out using toxinotyping multiplex PCR (TmPCR) using primers from various toxins including epsilon toxin, enterotoxin, alpha toxin, beta toxin and iota toxin. Based on the combination of the amplicons produced toxinotyping is done (Fig. 2).

Isolation of bacteriophages virulent to *E. coli* associated with neonatal diarrhoea in goat-kids

Collection and processing of samples for phage isolation: The phages isolated from various liquid (water, sewage, etc.) and solid sources (soil, feces etc.) were homogenized in SM buffer followed by centrifugation at 10000 rpm for 30 min, and the supernatant was collected for further analysis, which includes enrichment by BHI broth at 3% (v/v) followed addition of indicator bacterium viz., suspected EPEC. This is followed by filtration using a 0.22 µ (pore size) syringe filter to collect the bacteria-free phage enriched filtrate (BFF). It is then seeded to tubes containing 5 ml of soft nutrient agar (0.7 % agar) heated to 50°C, followed by addition of overnight culture of indicator bacterium and poured to petriplates and incubated overnight at 37°C. The individual plaque is picked and streaked on the newly prepared control plate in form of the parallel lines. After overnight incubation at 37°C, the clear areas around the parallel lines are rich source of phages. The phages are harvested by adding 2 ml of SM diluent to the plate, and kept at 4°C for 4 hr. followed by harvest with help of the sterile glass beads. Gross agar shreds were removed by slow speed centrifugation, and the supernatant (phage suspension) is filtered through 0.22 micron filter and kept at 4°C for future use. The plate lysate generally contains 1010 to1011 pfu per ml. The phage is then assessed for in vitro lytic activity by spot inoculation method. Briefly, the culture of host bacterium was inoculated into sterilized BHI broth and incubated at 37°C. 16 hour old pure broth culture of the organism was spread plated on to the sterile nutrient agar plate, and 3 to 5 µl of the phage suspension was aseptically placed on the dried surface of agar. After incubation at 37°C, the sensitivity of target organism against the phage was observed by formation of clear circular zone (plaque).

Overall, a total of six bacterial isolates were processed and assigned accession numbers by NCVTC repository during 2016-17.

Development of Database Repertoire for *Clostridium Perfringens* Strains Prevalent in Causing Enterotoxaemia in Goats (Network Project for Agricultural Bioinformatics and Computational Biology - Centre for Agricultural Bioinformatics (CABin))

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A total of 406 clinically affected ET animals were examined so far and of which 238 were 0-3month old kids and 168 were post weaned kids. Based on culture and molecular diagnosis a total of 63 isolates were obtained from clinically affected animals. Of these 50 isolates were of *C. perfringens* type A and 13 isolates of *C. perfringens* type D isolated from overall clinical studies.

- A total of 328 necropsies were conducted in suspected ET cases and of which 142 were from 0-3 months old neonatal kids and 186 from post weaned goats. A total of 89 isolates were obtained by bacteriological culture and confirmed by molecular tests. Of the total isolates 45 belonged to C. perfringens type A and 34 belonged to C. perfringens type D based on TmPCR.
- Full gene sequencing analysis of epsilon toxin genes of *Clostridium perfringens* type D strains CIRG-1816, CIRG-2016 and CIRG-3718 were conducted and ORF between reference strains and CIRG-1816 showed point mutations at nucleotide 18th and 762nd positions with codons from GTA→GTG and TCA→ TCG respectively (Fig. 1).
- Complete gene sequences including non-coding regions at 5′ and 3′ were compared between CIRG-1816 and other reference strains. The 5′ NCR of etx gene showed G→C mutation at 157 nucleotides upstream from start codon (ATG).
- Based on the evolutionary distances calculated by the ME (minimum evolution) tree, the CIRG strains were placed in a separate branch along with the NCTC reference cultures compared to IVRI Vac I strain placed as an out group in the same tree. The same sub-clade, where CIRG strains were placed also includes NCTC 8533 whereas Belgium strain, CN409 Iran strains were placed in a different sub-clade on the same branch (Fig2).

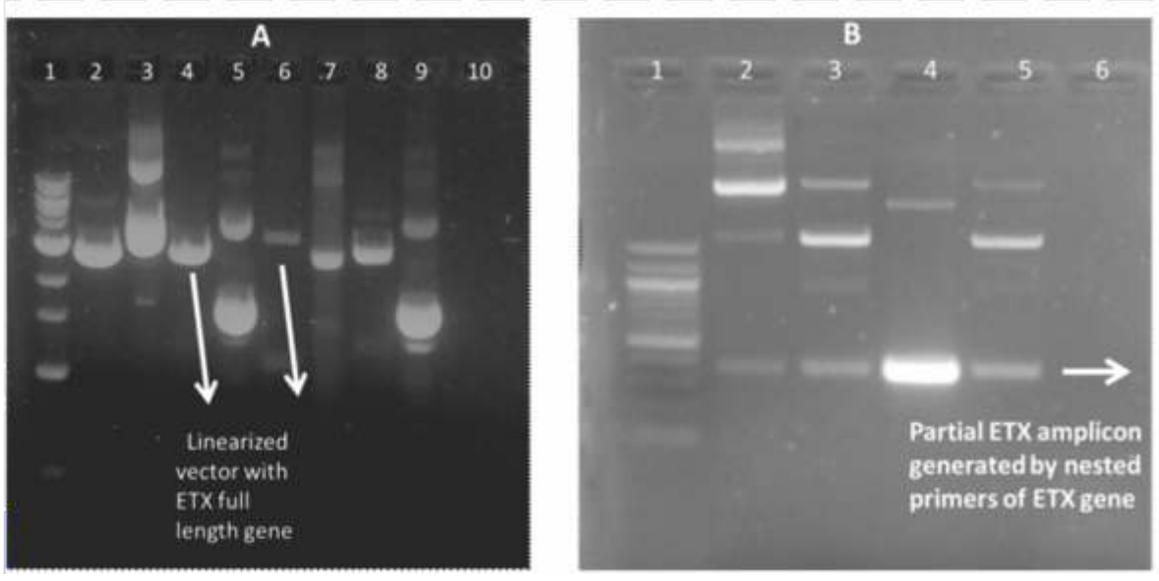

Fig. 1 Sequencing of full gene of epsilon toxin, A- Gel picture showing full length epsilon toxin gene cloned to TAvector, Wells, 1-1 Kb DNA ladder, 3, 5, 7, 9- undigested ETX-TA vector showing nicked and supercoiled patterns, 2, 8 – incompletely HindIII digested ETX-TA vector, 4, 6 – complete Hind III digested ~5Kb ETX-TA vector. B- Gel picture showing nested PCR of partial epsilon gene product using ~5Kb ETX-TA vector as template.

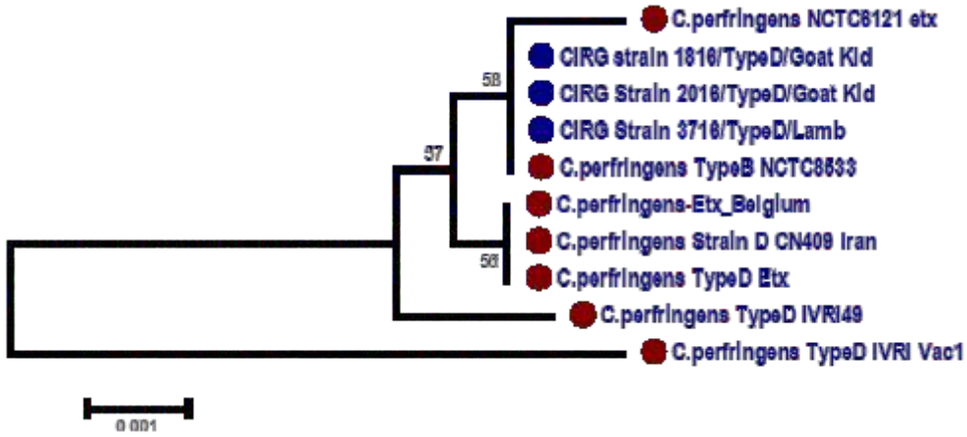

Fig 2 The evolutionary history was inferred using the Minimum Evolution method for epsilon toxin gene of *C. perfringens* type strain CIRG-1816, CIRG-2016 (goat kid) and CIRG-3716 (lamb) with reference isolates from NCBI database. The percentage of replicate trees in which the associated taxa clustered together in the bootstrap test (500 replicates) is shown next to the branches. Evolutionary analyses were conducted in MEGA6.

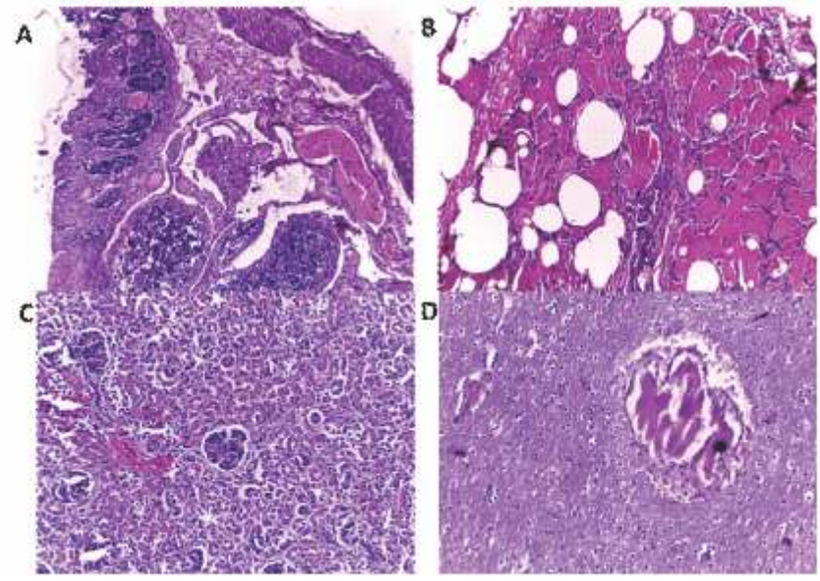

Fig 3 Major microscopic findings of Enterotoxaemia affected goats: A- Intestine: Showing marked congestion and degeneration of mucosal epithelium. H&E, 100x, B- Lung: alveoli showing marked emphysema. H&E, 400x, C- Kidney: Showing congestion and edema in glomeruli, H&E, 100x, D- Brain: Microscopic section of brain showing congestion of blood capillaries with edema, H&E, 100x.

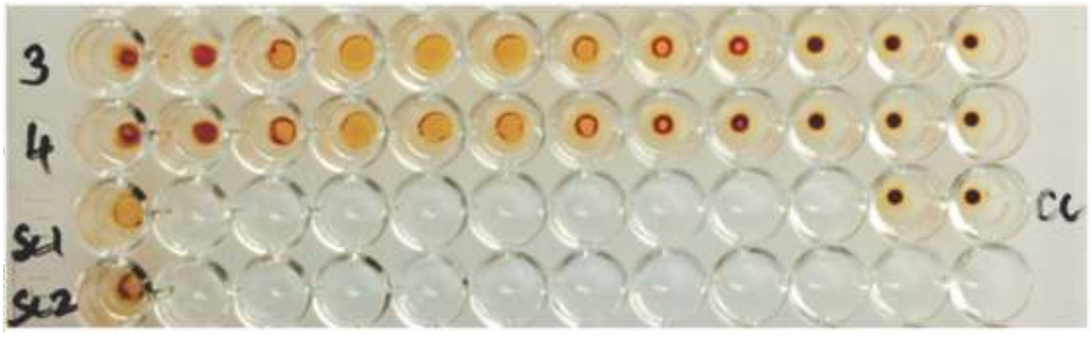

Fig 4 IHT showing visible 'mat' formation for presence anti-epsilon antibodies. 3-whole toxin sensitized sRBC, showing a titre of >1:128, 4- peptide sensitized sRBC showing a titre of 1:128. SC1 and SC2 are serum controls, whereas CC is cell control.

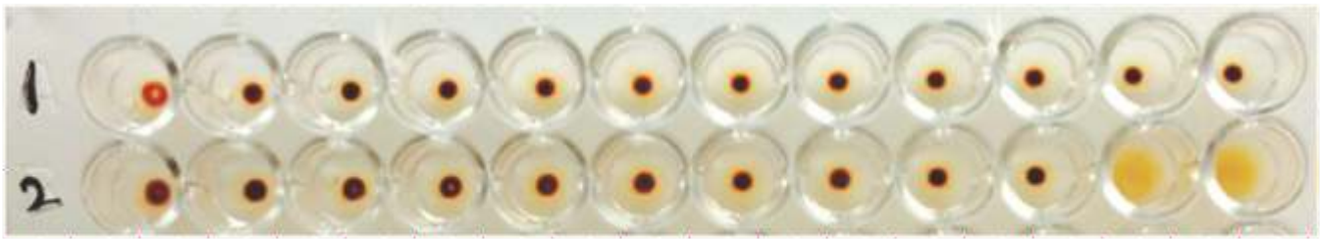

Fig 5 IHIT showing visible 'dot' formation for presence of epsilon toxin collected from (1) culture supernatant and (2) intestinal content of ET suspected animal.

- Experimental enterotoxaemia was induced in neonatal goats to study the pathogenesis of the disease. The microscopic changes observed in various organs are shown in the Fig 3.
- Ileal tissue of the treatment groups and control were collected for transcriptional analysis. The mRNA expression for three genes i.e. IL-1β, IL-2 and TCF-20 were detected by SYBR green based qRT-PCR for experimentally induced ET of neonatal goat kids.
- The highest expression of IL-1β was in spontaneous outbreaks of enterotoxaemia (24.86 folds) and IL-2 gene expression was highest in field outbreaks of enterotoxaemia (0.48folds) followed by WAS (0.012folds). Whereas, TCF-20 gene showed up-regulation in control group (1689.34 folds) followed by WAS (732.41folds).
- Indirect haemagglutination test (IHT) was developed to detect anti-epsilon toxin antibodies in the sera of enterotoxaemia affected animals using glutaraldehyde tannic acid treated Sheep RBCs sensitized with epsilon toxin antigen (Fig 4).
- Indirect haemagglutination inhibition test (IHIT) was developed to confirm the presence of epsilon toxin in the large intestine of animals died of enterotoxemia. By this test, it will be possible to survey the enterotoxaemia in goats and the toxinotype involved based on presence or absence of epsilon toxin as C. perfringens type-D or non-type D (Fig 5).

Patho-epidemiological Studies on Emerging and Existing Diseases of Goats

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Serosurveillance and disease investigation: A total of 2479 samples from goat and sheep comprising of sera, blood, swabs, faeces, tissues etc. were collected from different locations including Delhi, Haryana, Tamil Nadu, Uttar Pradesh and CIRG, Makhdoom. Disease outbreak investigations were carried out in 5 villages of Agra, Mathura and Jhansi Districts of Uttar Pradesh (Khoda (Anvalkheda), Agra; Madaura (Baldev), Mathura; Kharet (Farah), Mathura; Beri (Farah), Mathura; Luhargaon (Baghera), Jhansi) and diseases diagnosed were mainly PPR and suspected bluetongue.

Laboratory investigation of samples revealed Johne's disease in 38.3% (23/60) sera and in 71.2% (240/337) faeces. For Brucella screening, positive animals were 9.0% (15/165). Among goats affected with brucellosis, 7.35% (5/68) were male and 0% (0/0) was female, while among sheep, 15.8% (6/38) were male and 11.1% (1/9) were female. For Chlamydia screening, of 72 animals tested, 22 (30.55%) were positive. Of total collected from abortion cases, 40% (28/70) were positive for brucella melitensis by SAT, whereas 47.22% (17/36) for chlamydophila abortus, 61.29% (19/31) for Campylobacter spp. and 3.23% (1/31) were positive for coxiella burnetii.

From 25 samples (including blood, pus, buccal & nasal swabs, pleural fluid, lung tissues etc.) subjected to microbiological isolation studies, organisms such as *Corynebacterium ovis* (11), *E. coli* (4), *Staphylococcus aureus* (2) and *Actinobacillus Spp.* (1) were isolated. Parasitologically, a total of 1068 (Goat: 736; Sheep: 332) faecal samples were screened for various parasites. The faecal samples were positive for 72.00% (769/1068) coccidial, 33.70% (360/1068) bursate, 5.80% (62/1068) Moniezia and 1.21% (13/1068)) Strongyloid eggs.

Post-mortem examination: A total of 261 animal carcasses (240 goats & 21 sheep) were necropsied during 1st April, 2016 to 31st March, 2017. Of these, 57 (21.83%) were from AH Div. ExperimentalShed, 56 (21.45%) from Jamunapari Unit, 45 (17.24%) from Barbari Unit, 40 (15.32%) from PR&SM Div. Expl. Shed, 23 (8.81%) from Jakhrana Unit, 21 (8.04%) from Sheep Unit, and 19 (7.27%) were from NFR&PT Div. Experimental Shed. The causes of deaths diagnosed were enteritis (22.22%), pneumonia (21.07%), anaemia/debility (20.30%), haemochosis (2.29%), predation (2.29%), septicaemia (1.91%), asphyxiation (1.53%), toxaemia, hepatitis & trauma (1.14% each), and others (24.97%, including urinary impaction, tympany, peritonitis, autolysis, etc.). Age-wise, highest mortality was recorded in Adults (41.37%), followed by 0-3 months (29.50%), 6-12 months (17.62%) and 3-6 months age group (11.49%). Sex-wise, overall mortality was higher in females (60.91%) than males (39.08%). However, sex-wise mortality differed in different age groups, with male mortality dominating in 0-3 months (59.74%) and 3-6 months (60.00%) age groups, the female mortality being 40.26% and 40%, respectively; whereas, female mortality was higher in adult (83.33%) and 6-12 months (56.53%) age groups, with male mortality being (16.66%) and 43.47%, respectively. Representative tissue specimens were collected for laboratory examinations including histopathological and molecular diagnosis studies as well as isolation studies. A total of 112 samples were processed for histopathological studies. Histopathological diagnosis revealed cases of catarrhal enteritis, haemorrhagic enteritis, granulomatous enteritis, acute serous pneumonia, suppurative pneumonia, bronchopneumonia etc.

Among health activities, 6878 deworming, 6187 dipping, 741 coccidiostat, 16093 vaccinations, 5557 treatments were performed in the institute farm animals. Of morbid animals, the highest animals were affected with diarrhoea (59.70%) followed by fever/anorexia (14.27%), wound/abscess (7.14%), pneumonia (4.46%), lameness (3.95%), contagious ecthyma (2.30%), weakness (1.52%), mastitis (1.22%) and others.

Mortality was recorded as 5.4% in Jamunapari, 3.7% in Barbari, 5.25% in Jakhrana and 2.2% in sheep unit. Overall mortality was 4.13%.

Screening of abortion causing agents in breeding flocks of sheep and goats:

1. **Brucellosis**

a) **OMP31 gene based TaqMan® Real-time PCR:** *Brucella melitensis* being the primary pathogen involved in the abortions and still

birth of Sheep and goats in the last trimester was screened using OMP31 gene based TaqMan® Real-time PCR developed and standardized at the Division of Animal Health.

A total of 165 breeding animals have been screened for brucellosis constituting 118 goats and 47 sheep. In Barbari unit, of the total 37 bucks screened, two (5.4%) turned out to be positive, in Jamunapari, 20 bucks screened and 3 (15%) were found positive. Whereas in Jakhrana livestock unit, none of the tested bucks (11) were positive for Brucellosis. In Muzaffarnagari sheep unit, 38 rams and 9 ewes were tested, and of these 6 (15.8%) and 1 (11%) respectively were positive for brucellosis.

Samples from organized farms were tested for brucellosis, as in this case 20 bucks and 7 does were screened from ICAR-IGFRI, Jhansi. Only one breeding doe (3.7%) was found positive for brucellosis.23 samples from unorganized farms were screened and 2 (8.7%) were positive.

b) **Serum agglutination (SAT):** Serum agglutination test also was conducted for 50 animals from Ajeyi (Mathura) and ICAR-IGFRI, with only 4 (8%) animals testing positive for brucellosis.

2. Chlamydia: A total of 72 (29 does and 43 bucks) samples from breeding goats were tested for chlamydiosis caused by *Chlamydophila abortus* using OMP2 gene PCR. Of these, 24 (33.3%) samples were found positive for chlamydia. Modified Ziehl Nielson's staining (Stamp's modification) of smears from aborted placenta showed weak acid fast bodies inside lymphocytes which were suggestive of elementary bodies of Chlamydophila spp. (Fig 1).

Detection of important pathogens involved in abortion cases in small ruminants:

1. Brucellosis

a) **Serum agglutination (SAT):** A total 70 serum samples were collected from cases of abortions from Sheep and goats from various farms of ICAR-CIRG. This includes 49 does and 21 ewes. Out of these, 28 (40%) were positive for brucella. The brucella negative abortion samples were processed for other abortion causing agents like Chlamydia, Campylobacter spp. and Coxiella burnetii.

b) **OMP31 conventional PCR:** 50 vaginal swabs samples were collected from abortion cases from Barbari (25), Muzaffarnagari (21) and field cases of Tamil Nadu (4). Of these 22 samples (44%) were positive for brucella by OMP31 PCR. None of the samples from Tamil Nadu were positive for brucella.

c) **OMP31 gene based TaqMan® Real-time PCR:** 21 vaginal swabs post-abortions were collected and subjected to TaqMan® probe PCR from Barbari (4), Muzaffarnagari (13) and field cases of Tamil Nadu (4). All the goats (8) tested were negative for brucella. Whereas, 5 aborted ewes (23%) tested positive for brucella.

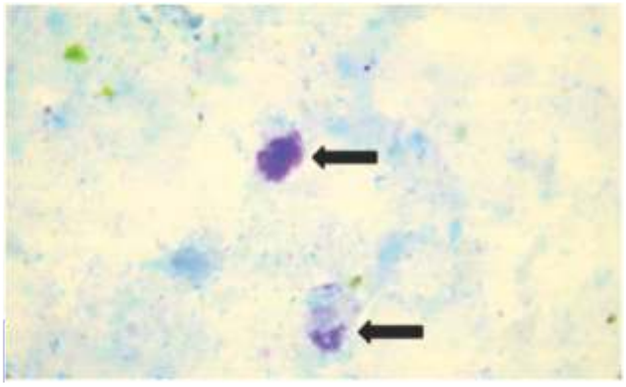


Fig 1 Modified Ziehl Nielson's staining (Stamp's modification) of aborted placenta material showing weak acid fast bodies inside lymphocytes suggestive of elementary bodies of *Chlamydophila spp*.

Culture test: Culture test was conducted to improve the specificity of the indirect assays and molecular assays for detection of brucellosis were total of seven suspected samples from Barbari (3) and Tamil Nadu (4) were cultured by the above technique. One sample from Barbari showed positive for Brucella melitensis from culture test and it was further confirmed by positive MZN reaction and OMP31 PCR.

2. Non-brucella pathogens involved in abortions

a) **Chlamydia:** A total of 36 samples were collected from cases of abortions at various time points to detect the presence of chlamydia in the reproductive tracts of small ruminants from ICAR-CIRG farms as well as field cases. Of the 22 samples tested from Barbari livestock shed, 10 does (45.45%) were positive for C. abortus by OMP2 gene PCR. Similarly, of the 10 samples tested from Muzaffarnagari unit 7 (70%) tested positive. None of the samples tested from TN were positive for chlamydia.

b) **Campylobacter spp.:** Campylobacter causes

abortion and still birth in last trimester along with other complications like endometritis, placentitis including focal necrosis of the uterine caruncles. A total of 31 vaginal swabs were subjected to Campylobacter detection by 16SrRNA gene based PCR. From the samples tested, 19 (61.29%) were positive for Campylobacter spp. This includes 10 positive of 22 samples tested from Barbari, 7 positive of 10 from Muzaffarnagari and 3 positive of 4 from TN. Mixed infections with campylobacter was found in 90 per cent cases that tested positive for chlamydia.

c) ***Coxiella burnetii*:** It is an obligate intracellular parasite and a potent zoonotic agent with worldwide presence causing acute and chronic form of Q fever or abattoir fever in humans. In animals, it is associated with abortion, still birth, metritis and infertility. Infected animals are rich source of this pathogen with its presence in urine, faeces, milk, placenta and aborted contents. In the current study Trans-PCR was conducted to screen coxiella for the aborted samples. The primers used were from the transposon elements of the IS1111 sequence of *Coxiella burnetii*. Of the 88 samples screened from ICAR-CIRG, none of the samples were positive for Coxiella. Interestingly, of the 4 samples screened from TN, one showed positive for Coxiella burnetii. The Coxiella positive case of abortion was found positive for Campylobacter infection.

Overall, the diagnostic testing facility at Division of Animal health has handled 613 samples for various pathogens tested. Of these 22.83% samples were

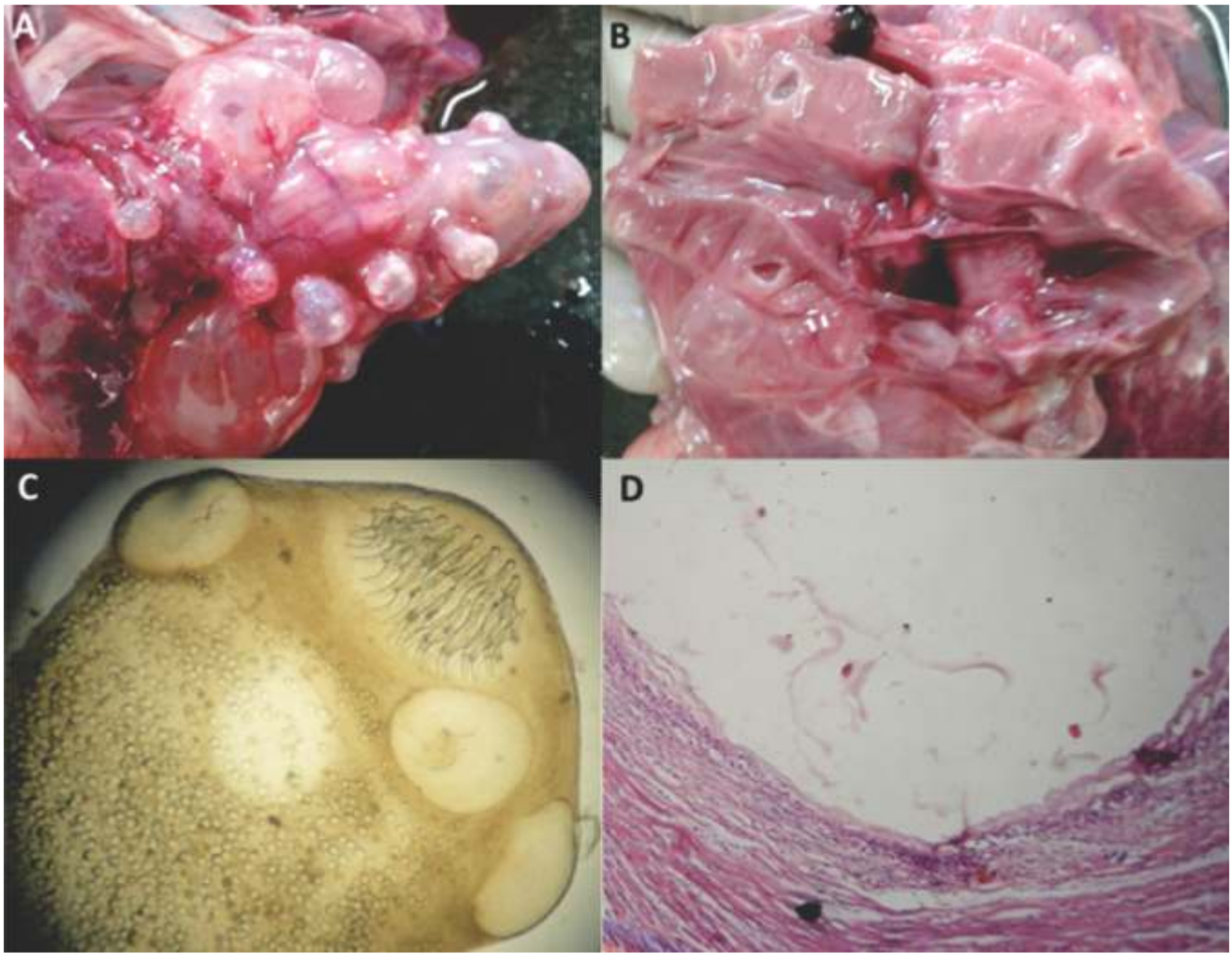


Fig 2 Visceral coenurosis caused by *Coenurus gaigeri* in goats. A- Heart showing numerous attached and embedded parasitic cysts with visible whitish scolices inside them; B- Myocardium of heart showing several parasitic cysts embedded in cut surfaces causing cystic spaces, necrosis and considerable muscular destruction; C- A Single scolice of *C. gaigeri* showing four suckers and a rostellum with a double crown of hooks; D- Cyst in the cardiac muscles showing cellular infiltration.

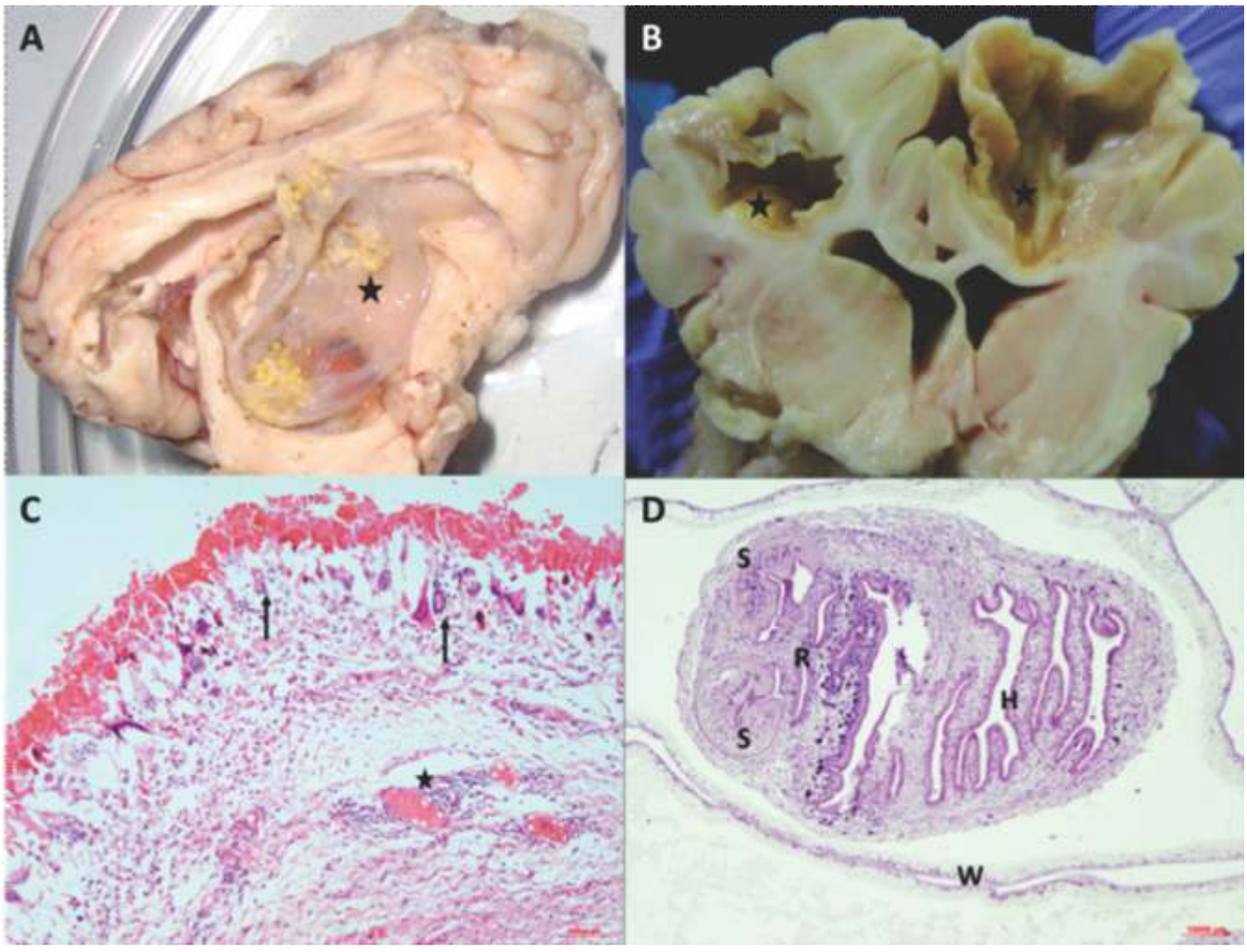


Fig 3 Neurocysticercosis caused by *Coenurus cerebralis*, a metacestode of *Taenia multiceps* in goats. A - The white translucent cyst measuring 1.5×4×2 cm in diameter with bunches of scolices occupying thalamic, hypothalamic and corpus collasum regions in the brain causing dilatation of ventricles and atrophy of surrounding tissue; B- Cerebral hemisphere and cerebellar ventricle region showing *C. cerebralis* cysts with bunches of white scolices (*) in the brain; C- Photomicrograph of cerebral tissue showing cystic wall with numerous giant cells (arrow), vascular congestion surrounded by inflammatory cells such as lymphocytes and macrophages (*) H&E, x100, Bar 1000 µm; D- Photomicrographs of the protoscolices with prominent scolex with one rostellum (R), four suckers (S), rostellar hooklets (H) and thin wall of cyst (W). H&E, x400, Bar 1000 µm.

positive for one or more abortion causing agents. Of 352 samples tested for brucellosis, 120 were screened by SAT, 50 by conventional PCR, 182 by using TaqMan PCR and 4 samples by culture isolation test. For other abortion causing agents, 108 samples were tested for Chlamydia, 54 for *Campylobacter spp.* and 92 for *Coxiella burnetti.*

Taeniamulticeps metacestode infection in neural and visceral forms in goat

1. Necropsy examination and pathological changes :

Visceral form (*Coenurus gaigeri*): from a carcass of five months old Barbari female goat, numerous parasitic cysts (n=56, grossly visible) were present in the visceral cavity including heart, diaphragm, thoracic cavity, abdominal cavity and pelvic inlet. A large number of cysts were also observed in the pericardium and myocardium causing functional damage to the heart. Grossly, the myocardium was found to be embedded with several small variable sized parasitic cysts (Fig. 2). On parasitological examination, the parasitic cysts were identified as Coenurus gaigeri, as the scolices had characteristic four suckers and a rostellum with a double crown of hooks. Further confirmation was done using polymerase chain reaction targeting ND1 and CO1 genes specific for *Coenurus gaigeri.*

Neural form (*Coenurus cerebralis*): Gross lesions included presence of numerous cysts which were translucent, thin walled, and filled with clear fluid which contained up to several hundred scolices that were visible as white plaques on the clear cyst wall; size ranging from 2 to 8 cm with bunches of white coloured protoscolices attached to the walls. In majority of the cases the cysts were located in the right and left cerebral hemispheres occupying the entire portion, which caused atrophy of brain tissue (Fig. 3). Coenuri cysts were also observed thoracic cavity and shoulder muscles in 3 cases which had cerebral cysts, while other 12 cases had only cysts located in cranial cavity and brain. Microscopically, cerebral tissue showed cystic wall with numerous giant cells, vascular congestion surrounded by inflammatory cells such as lymphocytes and macrophages (Fig. 5C). Cellular reaction mainly comprised of numerous multinucleated giant cells along with the cystic border and lymphocytic reaction also evident which suggested chronic encephalitis.

2. Molecular characterization : The coenurus cysts collected from the visceral forms (C.gaigeri) were compared with those obtained from the neural forms (C. cerebralis) through regular cases obtained from necropsy of goats. DNA samples were isolated from scolices excised from the inner wall of the coenurus cysts from both the forms of coenurosis. PCR were performed for two genes viz., ND1 and CO1 to confirm the infection (Fig. 4). Molecular characterization was done to compare the genetic details with respect to the mitochondrial gene sequences of these two distinct manifestations in goats.

PCR targeting NADH dehydrogenase subunit I (NDI) and Cytochrome C oxidase subunit I (COI) gene of Multiceps spp.: DNA isolation was done from separated scolices from the coenurus cysts. The parasite was further confirmed by PCR amplification (Fig. 4) of two species specific genes ND1 with primers, JB11 (5′-AGATTCGTAAGGGG-CCTAATA-3′) and JB12 (5′-ACCACTAACTAATT-CACTTTC-3′), and CO1 with primers JB3 (5′-TTTTTTGGGCATCCTGAGGTTTAT-3′) and JB4.5 (5′-AAAGAAAGAACATAATGAAAATG-3′). Further, thermo cycling was carried out with the initial denaturation of 98°C for 1 min followed by 30 cycles of denaturation with 98°C for 15 sec, annealing at 55°C for 20 sec and extension at 72°C for 30 sec, and the final extension at 72°C for 5 min. The products were purified and sequenced using Sanger's dideoxy method on both the DNA strands.

COI gene phylogenetic analysis: The raw sequences were aligned and subjected to phylogenetic analyses using Maximum Likelihood method based on the Tamura-Nei model. The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. The tree with the highest log likelihood (-961.4151) was computed. The percentage of trees in which the associated taxa clustered together was shown next to the branches. Initial tree(s) for the heuristic search were obtained by applying the Neighbor-Joining methods to a matrix of pairwise distances were estimated using the Maximum Composite Likelihood (MCL) approach. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. The analysis involved 15 nucleotide sequences. All positions

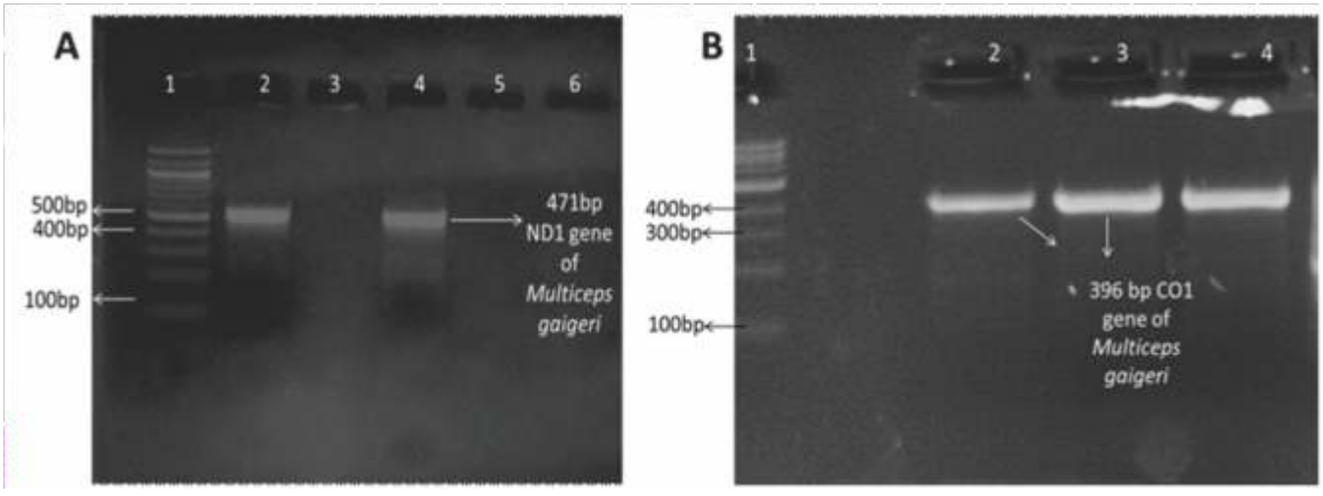


Fig 4A. PCR confirmation of C. gaigeri by ND1 gene. Lane 1: 100bp DNA ladder, Lane 2: Positive control, Lane 3&4: test samples, Lane 5: negative control, Lane 6: no template control. B. PCR confirmation of C. gaigeri by CO1 gene. Lane 1: 100bp DNA ladder, Lane 2: Positive control, Lane 3&4: test samples.

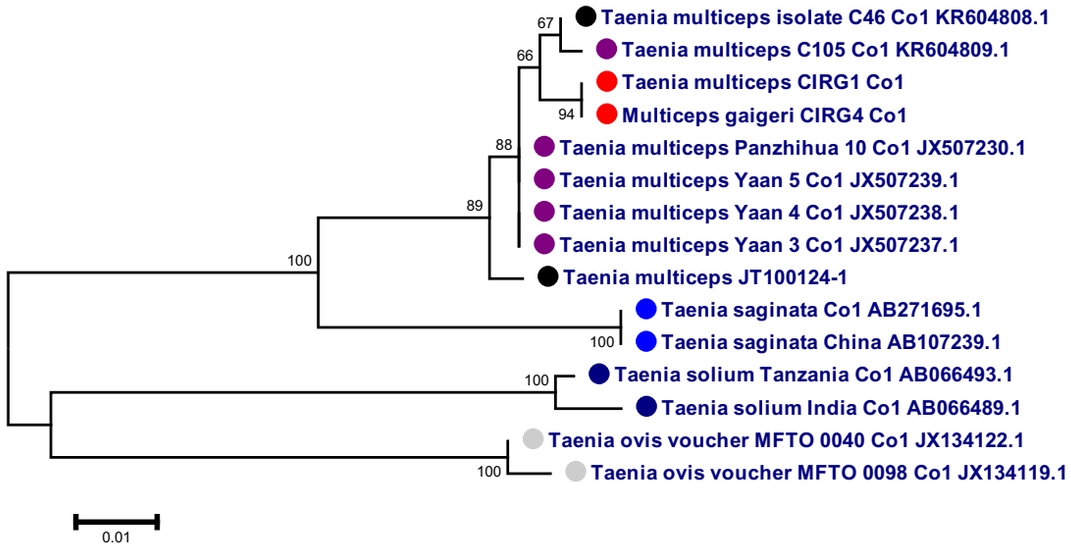


Fig 5 Molecular Phylogenetic analysis of CO1 gene of various Taenia spp. by Maximum Likelihood method.

containing gaps and missing data were eliminated. There were a total of 390 positions in the final dataset. Evolutionary analyses were conducted in MEGA6. The tree information for CO1 gene was compared with various Taenia species affecting the domestic animals including Taenia multiceps Multiceps, T. multiceps Gaigeri, T. saginata, *T. solium* and *T. ovis* (Fig. 5). There were two major branches, with the top branch comprising of *T. multiceps* in one sub-branch and *T. saginata* in another sub-branch; whereas the second major branch consisted of two clades in which T. solium and T. ovis are grouped separately. The first major branch of the CO1 phylogeny has two clades of *T. multiceps* grouped as separate entities. The most striking feature of the first clade of the top sub-branch is that it has T. multiceps Multiceps native CIRG strain was placed in proximity to *T. multiceps* Gaigeri CIRG strain. In contrast, the Chinese strains of *T. multiceps*' COI sequences are phylogenetically distant compared to the CIRG strains. From, this it can be inferred that both the Coenurus cerebralis and Coenurus gaigeri could have diverged from a common ancestor. In another perspective, it can also be construed that the same strain might behave differently due to some unknown reasons causing two different forms of coenurosis viz., neurocysticercosis or visceral cysticercosis in goats.

Nd1 gene phylogenetic analysis: The ND1 sequences from the database were compared with the native strains of *T. multiceps* isolated from cases of neurocysticerosis and visceral cysticercosis and the evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model. The tree with the highest log likelihood (-1469.4801) was constructed during the current analysis. The percentage of trees in which the associated taxa clustered together was shown next to branches. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach, and then selecting the topology with superior log likelihood value. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site. The analysis involved 16 nucleotide sequences. Codon positions included were 1st+2nd+3rd+ Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 338 positions in the final dataset. Evolutionary analyses were conducted in MEGA6. The tree information for ND1 gene was compared with various Taenia species affecting the domestic animals including Taenia multiceps Multiceps, T. multiceps Gaigeri, T. saginata, T. solium, T. ovis, T. asiatica etc., There were two branches, with the top branch comprising of *T. multiceps* and other Taenia spp. except *T. hydatigena*, which was separately placed in another branch (Fig. 6). The major branch consisted of two sub-branches with the first on comprising of various clades and subclades of *T. solium*, T. ovis, *T. saginata*, *T. asiatica*, *T. serialis* and *T. krabbei*. Whereas the second sub-branch included the T. multiceps. There were two clades wherein the first clade consisted of exclusively Chinese strains of *T. multiceps*, and the second clade having the CIRG strains of Taenia multiceps Multiceps and *T. multiceps* Gaigeri arranged together in the same subclade. This phylogeny of the CIRG native strains being placed in close proximity but

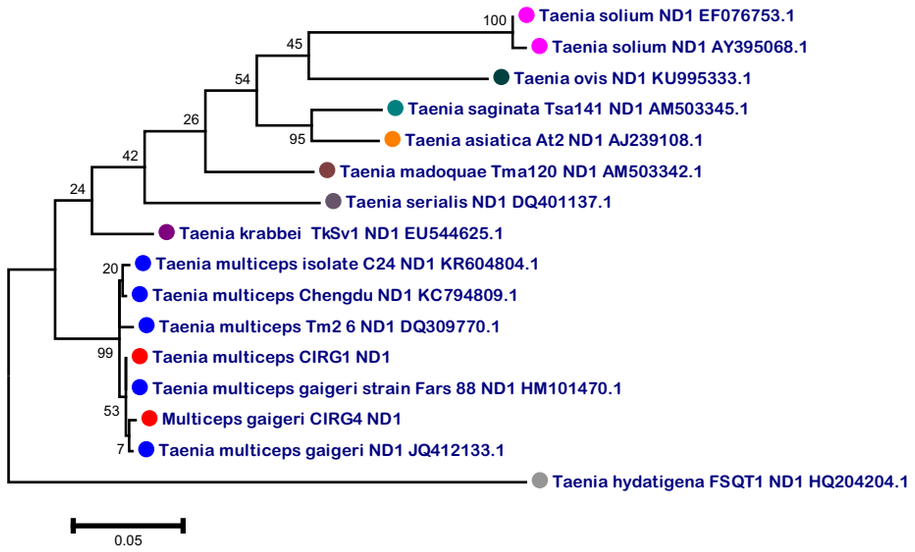


Fig 6 Molecular Phylogenetic analysis of ND1 gene of various Taenia spp. by Maximum Likelihood method.

expressing as two different disease forms (viz., neurocysticercosis and visceral coenurosis) shows that they are very close divergent from a common ancestor.

Microarray analysis of endometritis in goat to study molecular pathogenesis:

The transcriptional profile and pathways related to chronic endometritis in goats was studied using RNA microarray. Endometritic uterus was collected and preserved in RNAlater® from two normal uterus (UN1, UN2) and two endometritis affected uterus (UE1, Ue2). RNA was extracted from Goat uterus using Trizol® method. The RNA quality control was assessed to obtain integrity of RNA samples (RIN) using Bioanalyzer (Agilent; 2100 expert). Based on the Bioanalyser readings, the RNA samples that were passed by the quality control were initially assessed for RNA integrity number (RIN). The RIN for RNA extracted from UE1 was 4.0 and that from normal uterus was 4.3. Based on the RIN value, the RNA was used for downstream processing. The microarray workflow consisted of labelling of sample RNA followed by reverse transcription to cDNA and double stranded DNA.

The dsDNA was further transcribed to cRNA and labelled using Cy3 CTP, which is fragmented, labelled and hybridized to goat microarray 8x60K chip in Agilent's Surehyb Chambers at 65° C for 16 hours and the hybridized slides were washed using Agilent Gene Expression wash buffers. Post hybridization, the system is excited by laser and scanned using the Agilent Microarray Scanner. The microarray image scanner has scanned the hybridized slides and produced the image files for control sample (UN2) and endometritic uterus sample (UE1). Based on these images generated raw data was extracted using the Feature extraction software version 11.5 (Agilent Technologies). Before conducting the microarray analysis, an intra-array quality control was analyzed and normalization was done to reduce the variability within a single array.

Microarray data analysis: The raw data generated during microarray were subjected to various analyses from data extraction of images to assigning functional and pathway analysis. Based on analyzed data from these set of softwares, final data interpretation is done. For data extraction from Images, Feature Extraction software Version 11.5 of Agilent is used. Hierarchical clustering of differential regulated genes is computed using Pearson coefficient correlation algorithm. The major interpretation of microanalysis data and pathway analysis for differentially regulated genes were done using Biointerpreter, Genotypic technology pvt. Ltd., Bangalore. Finally functional and pathway analysis for the differentially regulated genes was assigned using the software Database for Annotation, Visualization and Integrated Discovery (DAVID) version 6.7. Based on microarray analysis study, endometritic uterine tissue (UE1) when compared with normal uterus (UN2) showed upregulation of 4238 genes and a down regulation of 4328 genes. Based on these data, a cluster of differentially regulated genes have been created for endometric uterus in comparison with the normal, and the cluster tree has been shown in the figure below (Fig. 7).

Up regulated pathways in endometritis: Among the pathways studied, a total of 5 pathways have been up regulated viz., higher mRNA expression in

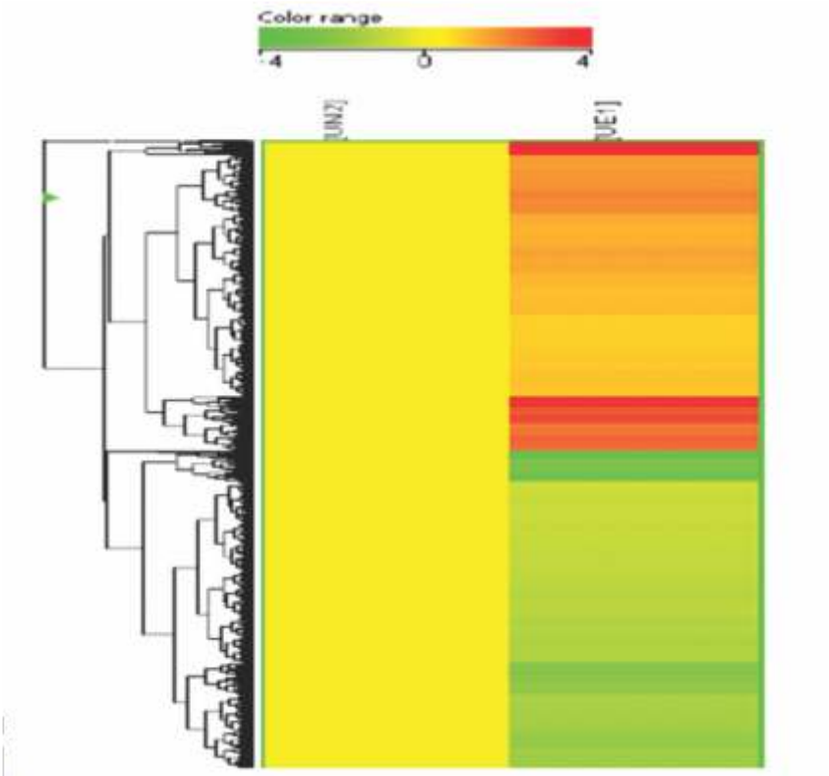


Fig 7 Cluster tree diagram constructed for normal versus endometritic uterine samples after microarray scanning. Red colour in different intensities are directly proportional to up-regulated gene expression, green indicates down regulated gene expression and yellow for normal gene expression.

endometritic uterus when compared to the normal uterus. They were categorised as normal or endometritic based on the gross pathology lesions and the histopathological interpretation. The major pathways that showed statistically significant up regulation were the chemokine and cytokine signalling pathway followed by the interleukin signalling pathways bolstering the findings that inflammatory responses were invariably noticed during histopathology in endometritic uterus. A critical analysis of the genes in the pathways that significantly trended north were IFNAR2, PTGS2, IL8 and CCR3 for inflammation mediated by cytokine/chemokine signalling and IL2RA, IL8 and IL15 for Interleukin signalling pathway. In the present study, the IFNAR2 gene showed a 1.22 fold increase in level of expression in UE1 compared to UN2. This gene belongs to the interferon receptor 2 family, which encodes a Type I membrane protein that forms one of the two chains of a receptor for IFNa and IFNβ. The IFNAR2 gene showed an increase of 2.3 fold in the infected group compared to the control.

This study establishes the potential risk of virulent *C. jejuni* strains in causing abortions facilitated by host candidate genes in the progression of infection. In the current study, the endometritic uterine tissue was collected from random samples of female goat genitalia from slaughter house, and the same sample tested positive for Campylobacter spp. by 16srRNA PCR. Although species specific detection could not be done, still it can be inferred that some of the host responses facilitate the progress of infection. This is due to the fact that the modulation of gene expression has been critical in progressing or curbing the infection, with some minor differences among the domestic animals. The reason behind the surge in CCR3 expression levels may be due to the process of trophoblast migration, without neglecting the fact that the fold change may be higher than normal in the current study. The data can be commensurated with actual change in endometritis only after assaying more number of candidates from clinical as well as experimental studies. The fold change in expression of these up regulated genes was represented graphically (Fig 8).

Down regulated pathways in endometritis: As tabulated above, the genes belonging to 15 major pathways were down regulated with most of the pathways related to inflammation, oxidative stress, innate immunity, metabolism and cell signalling. However, the oxidative stress response pathway, that includes the genes "TXN" and "MYC" was significantly (P<1.00) down

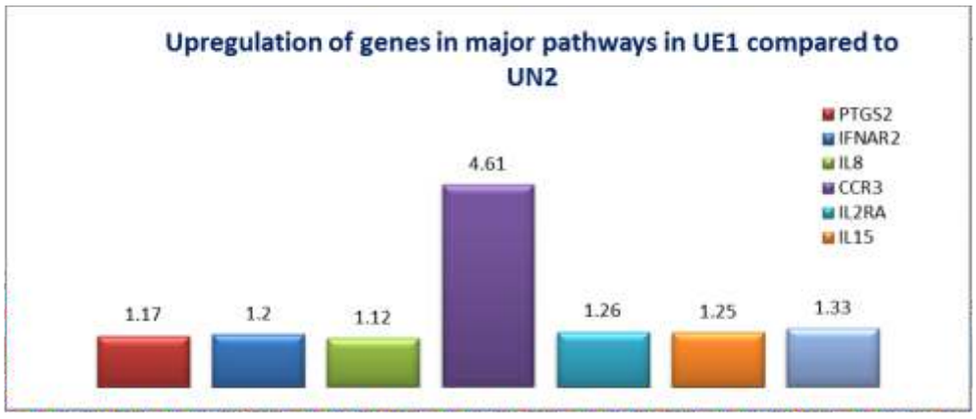


Fig 8 Fold change in gene expression of up regulated genes of major pathways in UN2 versus UE1.

regulated, followed by the interleukin signalling pathway with a different set of genes including "IL18"and "MYC" was as down regulated. There are other pathways like p53 pathway feedback loops2 and Wnt signalling pathway were significantly (P<1.00) down regulated. The fold changes in down regulated genes were represented below (Fig 9).

The major pathways that are down regulated in the present study were belonging to stress related genes either by oxidative stress or other cellular response to stress. This includes the p53 pathway feedback loops2, oxidative stress response pathway, wnt signalling pathway and interleukin signalling pathway. The p53 pathway responds to defective DNA replication and cell division and is the most important pathway that prevents the initiation of cancer. The downstream events of p53 response leads to cell cycle arrest, apoptosis, inhibition of angiogenesis and metastasis and DNA repair. Higher expression of p53 gene leads to activation of p53 protein that acts a transcription factor as an initiation of the above mentioned activities. The p53 pathway is self-regulated by means of positive and negative feedback loops, and the majority of these loops act through MDM-2 ubiquitin ligases, whereas the other feedback loops act through cop-1 and Pirh-2 ubiquitin ligases. The p53-MDM2 loop gets undermined during stressful conditions in positive feedback loop. MDM-2 ubiquitinases and degrades the p53 during a negative feedback mechanism.

The major genes involved in this pathway are TP53 and MYC, which were down regulated by a fold decrease of 1.7 and 2.84 respectively in UE1 when compared with UN2. The gene TP53 has been involved in the production of p53 protein which has been epitomised as the cellular gatekeeper that regulates various stress responses through its multiple pathways. Besides, the TP53 also expresses the p53 isoforms by alternate promoters, splicing sites and translation initiation sites and these p53 isoforms has been reported to combat many bacterial and viral infections. Down regulation of the gene TP53 indicates the system's facilitatory mechanism for progress of any given infection. On the other hand, the down regulation of this gene would reduce the expression of p53 protein and has been reported to induce tumourigenesis. The down regulated TP53 gene which is also associated with the wnt signalling pathway, possibly acts through E-cadherins. E-cadherins are cell adhesion molecules that suppress tumour invasion and any down regulation of the gene or its associated wnt signalling pathway could increase the chances of invasiveness and metastasis. These molecules binds to cellular surface receptors prevents degradation and accumulates β-catenin in cytoplasm, which helps in antagonising tumorigenesis effect along with p53 by transcriptional activation. Another fact that could best explain the phenomena of TP53 gene expression is the stage of oestrus cycle. During prooestrum and metoestrum phases the apoptotic index was detected low, whereas the p53 expression at both mRNA and protein level was found very high.

In the current study, the MYC gene has been down regulated by a fold of 2.84 magnitudes, and involved in all the major pathways that are down regulated in the current study. This is explained by the fact that major genes involved in the tumour suppression including TP53 and MYC were significantly (P<1.00) down regulated. The oxidative stress pathway has been down regulatedof transcription including the Thioredoxin gene (TXN) and MYC gene. The TXN gene has been substantially down regulated to 1.21 fold level in endometric uterine tissue

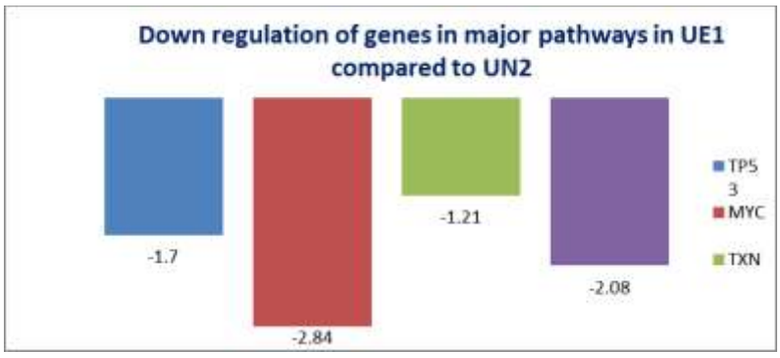


Fig 9 Fold change in gene expression of down regulated genes of major pathways in UE1 compared to UN2.

compared to the normal control. The TXN gene with significant reduction in its transcriptional response in endometrial tissue, in the current study has many connotations owing to its varied activities related to redox homeostasis. In this context, the reproductive tissue that showed lower levels of mRNA due to the fact that no implantation might have occurred during the period of study. However, its involvement as a co-cytokine and chemokine cannot be ruled out. But its major function in the oxidative stress regulation has certainly affected, that has led to involvement of related genes viz., TP53, MYC, IL18 and TXN showing down regulated transcriptional response.

Crohn's Disease in India: A Multicenter Study from a Country Where Intestinal Tuberculosis as well as Johne's Disease is Endemic

Principal Investigator
S V Singh

1. Bio-load of MAP in domestic livestock

A. Bio-load of MAP in clinically suspected and healthy domestic livestock using multiple tests: In total 691 Fecal from farm animals (Goats-493, Sheep-78, Buffaloes-12 and cattle-56), slaughtered Goats (52) and 217 tissues (Mesenteric lymph nodes and intestine) from slaughtered animals (Goats-53, Buffalo-34) and necropsied animals (Goats-21, sheep-1) were collected and screened by ZN-staining. The average bio-load was 62.3% (431/691) and 57.6 (125/217) in fecal and tissues, respectively. The bio-load in farm animals was 60.7% (388/639), in slaughtered animals was 82.6% (43/52) & 55.1% (96/174) in fecal and tissues, respectively and in necropsied animals was 75.0% (6/8) & 67.4% (29/43) in fecal & tissues, respectively. At individual species level bio-load of MAP in farm animals was 58.6% (289/493), 55.1% (43/78), 100.0% (12/12), 78.5% (44/56) in Goats, Sheep, Buffaloes and Cattle, respectively.

B. Fecal culture from farm animals: Of 160 animals were screened by fecal culture where average bio-load of MAP was 22.5% (36/160). At individual species level, bio-incidence of MAP was 18.6% (14/75), 30.0% (9/30) and 23.6% (13/55) in goats, sheep and Cattle, respectively(Table 1).

C. Tissue culture from slaughtered and necropsied animals : Of 225 tissues from slaughtered goats (53) & buffaloes (34) and necropsied goats (21) & sheep (9) were collected and screened by tissue culture. The average bio-load was 31.1% (70/225). The bio-load in slaughtered animals was 29.3% (51/174) and in necropsied animals was 37.2 (19/51). At individual species level bio-load of MAP was 26.4% (28/106), 23.8% (13/68), 38.0 (16/42) and 33.3% (3/9) in slaughtered goats, slaughtered buffaloes, necropsied goats and necropsied sheep, respectively.

D. Findings of the PCR in Fecal samples: Of 260 fecal from farm animals (Goats-83, sheep-70 and cattle-52), slaughtered goats (50) and necropsied sheep (5) were collected and screened by Fecal PCR. The average bio-load was 33.4% (87/260). The bio-load in farm animals was 34.1% (70/205) and in slaughtered animals was 26.8 (17/55). At individual species level bio-load of MAP was 46.9% (39/83), 18.5% (13/68), 34.6% (18/52) in farm goats, sheep and cattle and 24.0 (12/50), 100.0 (5/5) in slaughtered goats and necropsied sheep, respectively.

E. PCR on Tissue samples: Of 217 tissues (Mesenteric lymph nodes and intestine) from slaughtered animals (Goats-53, Buffalo-34) and necropsied animals (Goats-21, sheep-1) were collected and screened by tissue IS900 PCR. The average bio-load was 33.1% (72/217). The bio-load in slaughtered animals was 33.3% (58/174) and in necropsied animals was 32.5 (14/43). At individual species level bio-load of MAP was 30.1% (32/106), 38.2% (26/68), 30.9% (13/42) and 100.0% (1/1) in slaughtered goats & Buffaloes and necropsied Goats & sheep, respectively.

F. ZN staining of Fecal and Tissue Samples: Of 699 Fecal from farm animals (Goats-493, Sheep-78, Buffaloes-12 and cattle-56), slaughtered Goats (52) and necropsied sheep (8) and 217 tissues (Mesenteric lymph nodes and intestine) from slaughtered animals (Goats-53, Buffalo-34) and necropsied animals (Goats-21, sheep-1) were collected and screened by ZN-staining. The average bio-load was 62.5% (437/699) and 57.6 (125/217) in fecal and tissues, respectively. The bio-load in farm animals was 60.7% (388/639), in slaughtered animals was 82.6% (43/52) & 55.1% (96/174) in fecal and tissues, respectively and in necropsied animals was 75.0 %(6/8) & 67.4% (29/43) in fecal & tissues, respectively. At individual species level bio-load of MAP in farm animals was 58.6% (289/493), 55.1% (43/78), 100.0% (12/12), 78.5% (44/56) in Goats, Sheep, Buffaloes and Cattle, respectively. At individual species level bio-load of MAP in slaughtered animals was 82.6% (43/52), 42.4% (45/106) in fecal, tissue goats and 75% (51/68) in tissue of buffaloes. For necropsied animals, individual species level bio-load of MAP was 66.6 (28/42), 75.0 (6/8) and 100 (1/1) in goat tissue, sheep fecal and sheep tissues, respectively.

Comparative Analysis of all diagnostic tests on Farm & Slaughtered: Fecal (52), tissues (53), blood (27) and serum (10) of 53 slaughtered goats from Kosi and Farah and tissues (34) and serum (34) of 34 slaughtered buffaloes from Kosi were screened by microscopy, serum p-ELISA, blood and tissue PCR and fecal and tissue culture.

Animals were selected and sampled based on the

symptoms before slaughter from Farah and Kosi of Mathura District. Serum and tissues were collected from 50 goats and 34 buffaloes for H&E staining. Histopathological examination of H&E stained tissue sections revealed variable grade of lesions of JD in ilea and MLN of 66% (33/50) goats and 82.3% (28/34) buffaloes.

a) **In slaughter goats:** Of 50 goats were screened by H&E staining, Ip-ELISA, C_ELISA and tissue culture where 66.0% (33/50) tissue sections revealed variable grade of lesions of JD in ilea and MLN of goats and 62.0% (31/50), 58.0% (29/50) and 28.0% (28/100) were found positive by Ip-ELISA, C_ELISA and tissue culture, respectively.

b) **In slaughter buffaloes:** Of 34 buffaloes were screened by H & E staining, Ip-ELISA, C_ELISA and tissue culture where 82.3% (28/34) tissue sections revealed variable grade of lesions of JD in ilea and MLN of goats and 76.4% (26/34), 73.5% (25/34) and 33.8% (23/68) were found positive by Ip-ELISA, C_ELISA and tissue culture, respectively.

Table 1 Bio-load of MAP in farm animals by fecal culture

Animal species	Samples screened	Positive by Fecal culture (3 month-16 months incubation)		
		Growth	CWD	Total
Goats	75	2	12	18.6 (14)
Sheep	30	0	9	30.0 (9)
Cattle	55	9	4	23.6 (13)
Total	160	7.3 (11)	15.6 (25)	22.5 (36)

* CWD- Cell wall deficient, Value in parenthesis are percent

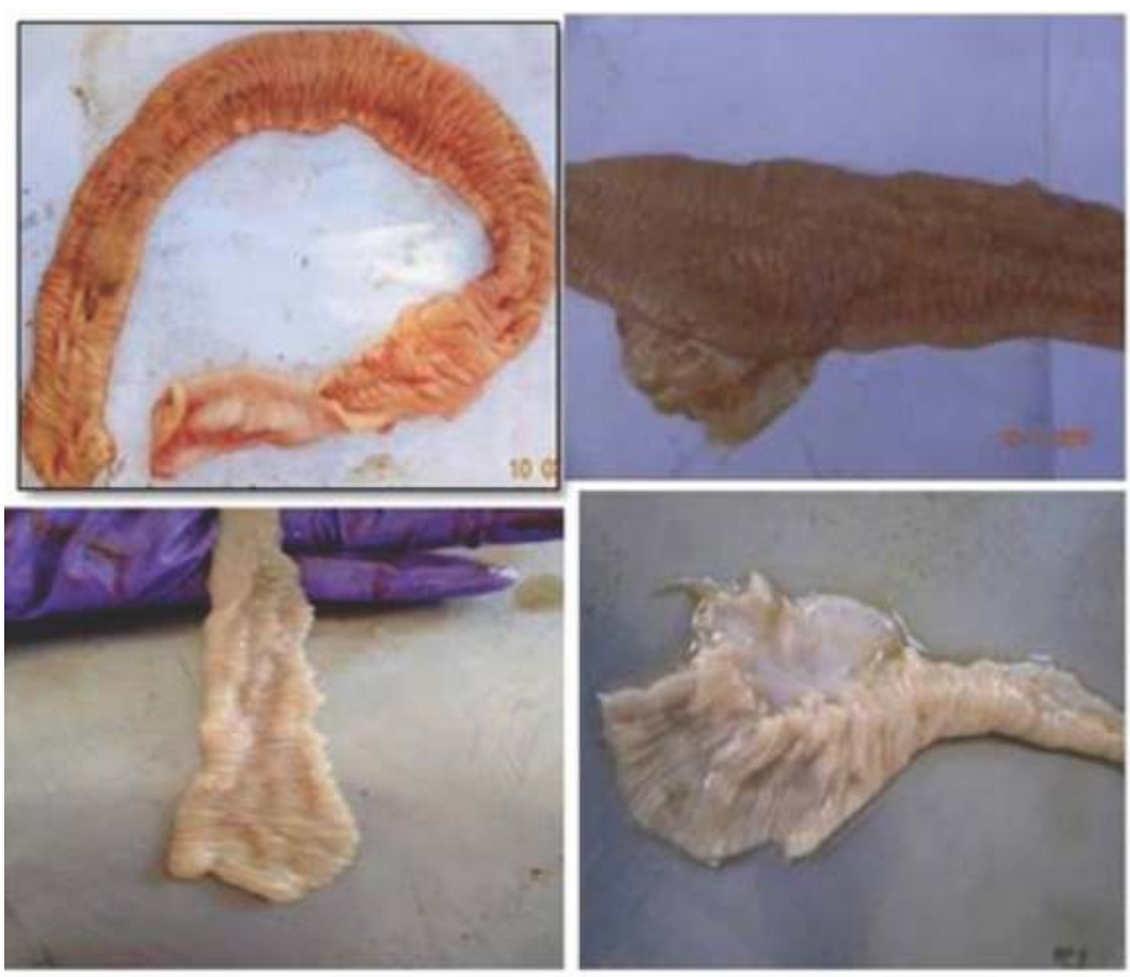


Fig 1 Small intestine showing corrugations, velvety thickening with folded mucosa.

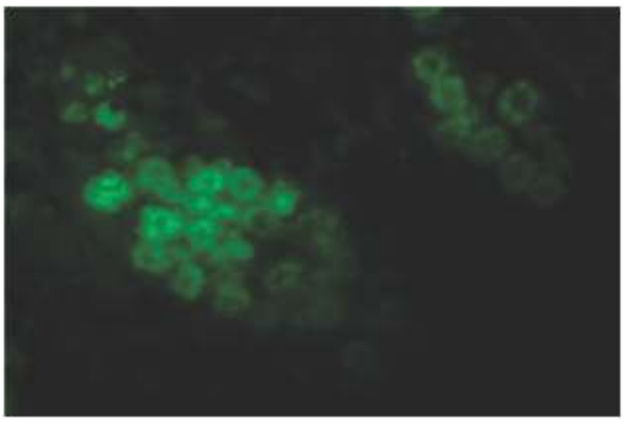


Fig 2Clusters of MAP infected epithelioid cells in lamina propria of villi in terminal ileum showing green fluorescence. (FAT 400X).

Other studies:

Estimation of bio-load of MAP infection in suspected domestic livestock using 'Real Time_PCR' assay: Of the 193 fecal samples screened by Real time IS900 PCR, 40.9% were positive for MAP infection. Use of RT_PCR improved the positivity / detection rate of MAP infection by 50.0%.

Validation of 'Indigenous ELISA Kit':

1. Comparison of Native semi-purified Protoplasmic Antigens (ns_PPA) of goat origin Versus Recombinant secretary proteins (r_PPA) in ELISA test: In the present study, the comparison of native semi-purified protoplasmic antigens' (ns_PPA) with Recombinant antigens' (r_PPA) in Indigenous' and 'Cocktail' ELISA, showed that sensitivity and specificity of recombinant proteins in early stages of infection as compared to native antigens.

2. Comparison of Indigenous ELISA kit, versus EV_ELISA kit, USA: Evaluation of 'Indigenous ELISA kit' with Ethanol Vortex ELISA kit (USA) for the detection of Mycobacterium avium subspecies paratuberculosis infection in cattle

'Indigenous ELISA' was a good diagnostic test to screen the domestic livestock population against MAP infection in Indian conditions.

3. Comparison of Indigenous ELISA kit with Commercial ELISA kit (ID Vet, France) and purified protoplasmic antigen (PPA) of cattle origin (USA): Evaluation of 'Indigenous ELISA' using native semi-purified Protoplasmic Antigen (ns_PPA) of caprine

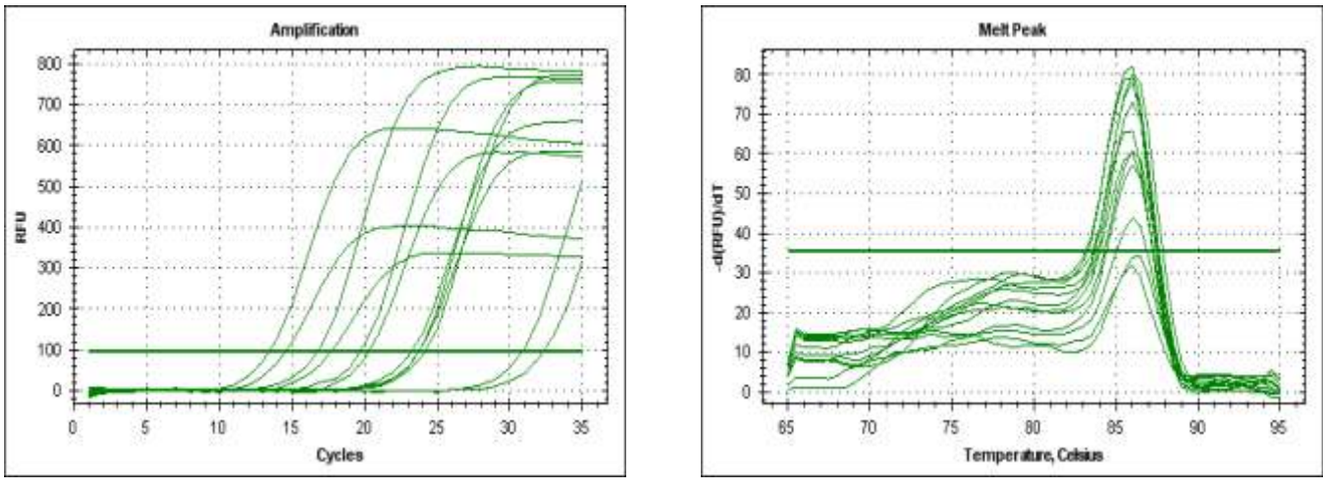


Fig 3 Real Time PCR based assay for the quantitative diagnosis of MAP infection

origin with ID Vet ELISA kit (France) and purified Protoplasmic antigen (PPA) of bovine origin for detection of *Mycobacterium avium*subspecies *paratuberculosis* infecting goats and sheep.

Indigenous ELISA was highly sensitivity in early stages of MAP infections. Allied Monitor antigen based ELISA was less sensitive than Indigenous ELISA. Sensitivity of ID-VET ELISA was lowest. Indigenous ELISA proved superior to commercial ELISA kit and purified PPA, for the diagnosis of MAP infection.

Development of Nano Immuno Rapid Test for the Detection of Mycobactgerium Avium Subspecies Paratuberculosis in Milk Samples - MOFPI

Principal Investigator
S.V. Singh

Antigen detection tests (Direct)

Design of Nano-immuno rapid test: Present test in this project is based on concentration of MAP bacilli from milk using functionalized nano-particles and nano-crystals coated by MAP specific antibodies followed by optical detection and use of metabolic dye to determine the viability hence, this test can easily be used as on spot assay and was initially expected to require about one hour to yield results. Nano-based test is already been standardized as colorimetric detection test but validation with field samples is in continuity. However, In Nano-immuno test, minimum detection limit is 10 MAP cells per mL but minimum milk quantity needed is 10 mL and is taking longer time (minimum 3 days) to complete the detection of viable MAP bacilli instead of 1 hour, as originally hypothesized. Therefore, three new alternate tests (dot_ELISA, Latex Agglutination and Indirect Fluorescent Antibody test were standardized and results were compared with microscopy, IS900 PCR and Indigenous ELISA. Of the 3 new tests, dot-ELISA took 4 hours to test 80 samples and could be developed as 'mass screening' test. While LAT was quickest (1-2 min/sample) screening test and potential to be a 'spot test'. Results of dot-ELISA and LAT were comparable with well standardized 'indigenous plate ELISA test. Of antigen detection tests, iFAT was most sensitive and specific (93.5%) as compared to microscopy and IS900 PCR (100.0%). Good microscope with FAT was minimum requirement of microscopy (1.0 hrs) and iFAT (3.5 hrs) tests.

Table 1 Brief comparison of different diagnostic tests

S. No	Name of test	Type of test	Time required	Specifications	Specificity
1	Nano-immuno rapid test*	Confirmatory	3-5 days	Detect live/viable (antigen) MAP bacilli	100%
2	i_FAT**	Screening	4 hrs / 20 samples	Antigen detection	93.5%
3	LAT*	Screening	2 min / sample	Antibody detection	70%
4	Dot-ELISA*	Screening	4-5 hrs / 80 samples	Antibody detection	70%

* Can be performed in the field, ** require microscope with FAT attachment

Synthesis of Magnetic nanoparticles (MNP's): Fe3O4 nano-particles were synthesized by chemical co-precipitation of Fe (II) and Fe (III) chlorides and NaOH as the reductant (1). Briefly, 2.92g of FeCl3.6H2O and 1.15g FeCl2.4H2O were added to 150 ml of distilled water. The solution was incubated at 60°C for 20 min with vigorous shaking after which 40 ml of (1.5M) NaOH was added to the solution drop wise and allowed to react for 1 hour. A black precipitate will develop immediately (magnetic particles) and was then incubated for 30 minutes at room temperature to cool. The solution was finally sonicated (55% amplitude, 0.5 second) for 30 minutes. After which with the help of the magnet, MNP's were separated and washed with acetone and left to dry.

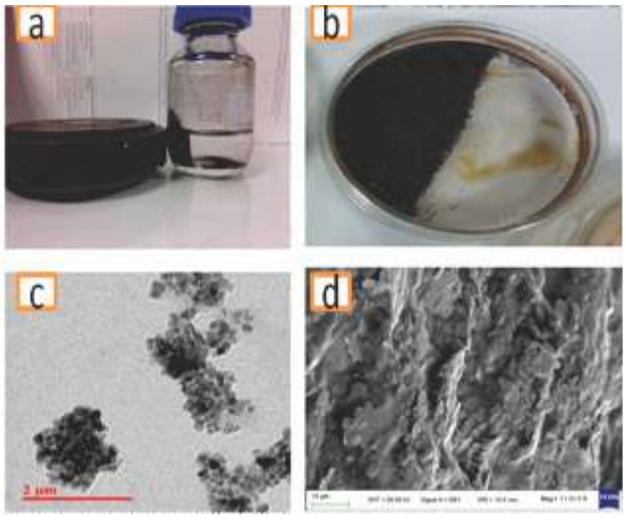


Fig 1 Magnetic separation of MNPs achieved within one minute using a permanent magnet, (b) Drying of MNPs, (c) TEM image of MNP's, (d) A SEM image of MNPs,

Activation of MNP's with cross-linkers:

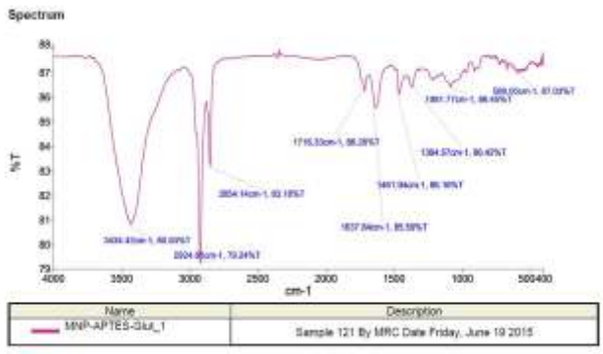


Fig 2 Fe-O bonding, CH2 stretching, Si-O vibration and C-O-O bonding confirms the binding of MNP on APTES while the C=N bond peak confirms the loading of glutaraldehyde onto APTES.

Immobilization of polyclonal antibodies against MAP on activated MNP's: MNP's were functionalized with glutaraldehyde as per Joo et al., (2012). Briefly 0.4 mL of (3-amino) propyltriethoxysilane (APTES) was added to 1 mg of MNP in 40 ml ethanol and incubated at room temperature for 1 h in a shaker. The nano-particles were separated using a magnet, removing the solvent and re-dispersing in ethanol 10 ml (3 times). 100 µL of 5 % glutaraldehyde was added in water at room temperature for 30 min with shaking after which the nano-particles were separated using a magnet, removing the solvent and re-dispersing in water.Finally 10 µL of 1 mg/ml antibody was added at room temperature for 1 hour with shaking after which the MNP's were separated using magnet and dispersed in PBS.

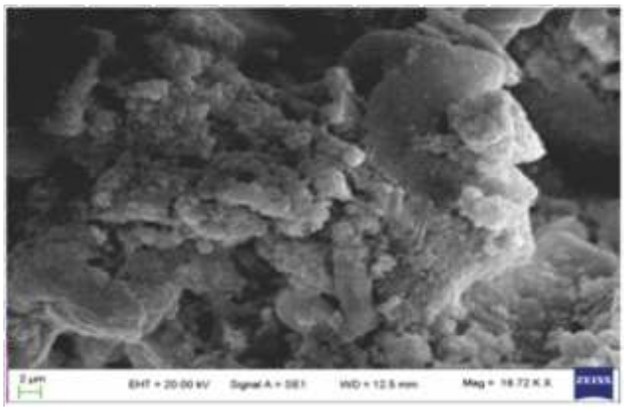
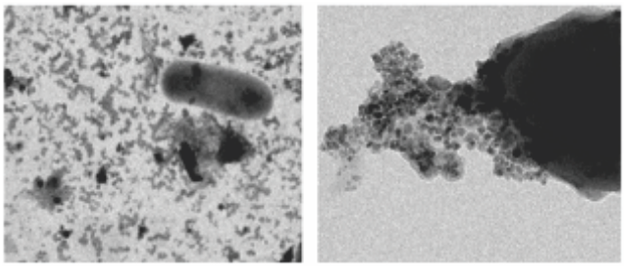


Fig 3 SEM Image-MNP-APTES-Ab

Attachment of MAP antigen (bacilli) on to MNP's: MAP was suspended in 5ml milk equivalent to 1 Mcfarland standard. The MNP's were suspended in the solution, vortexed for 1 hour at room temperature. MNP's were separated with magnet and washed with water two times. 1ml of resazurin dye in 7 ml of water (Dissolve 200mg of resazurin dye in 100ml of hot distilled water in a dark bottle) was prepared to which the MAP-MNP's was added. The solution was then incubated at room temperature in a shaker incubator in dark and observed for the change in color.



(a) (b)

Fig 4 TEM images of MAP bacilli after binding to (a) bare MNPs, (b) Antibody-immobilized MNPs.

Visual colorimetric determination of MAP antigen in milk: Functionalized MNP's were added to 3ml of spiked milk and incubated at room temperature in a shaker for 1 hour. By magnetic decantation the MNP were separated out and washed in PBS. To the MAP-MNP's 7ml of 1XPBS was added followed by the addition of 1ml dye. The suspension was incubated at room temperature for 15 hours in a shaker in dark. Change in Colour from blue to purple indicating the presence of live MAP cells after 15 hours and to purple pink after 3 days followed by pink after 5 days conforming the presence of live MAP cells.

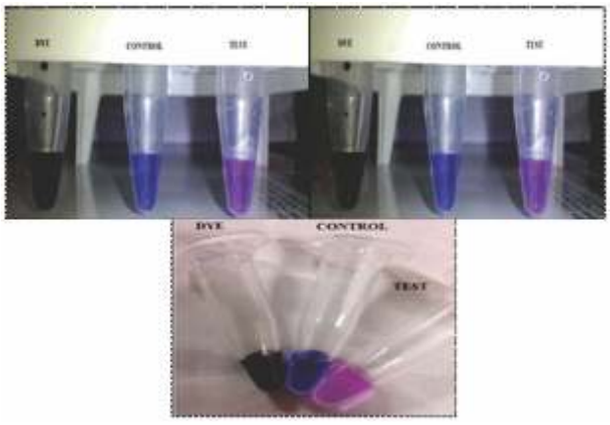


Fig 5 Change in colour observed at Day 0 (a), Day 3 (b) and Day 5 (c)

Zoonotic Potential of *Mycobacterium Avium* Subspecies Paratuberculosis, as the Cause of Inflammatory Bowel Disease (Crohn's Disease) in Human Beings : ICAR Outreach Program on Zoonotic Diseases

Principal Investigator
SV Singh

A total of 1153 clinical samples (biopsies, stool, blood, serum) from patients suffering with chronic ailments (gastero-intestinal / abdominal disorders and general colitis), thyroiditis, Rheumatoid arthritis) were collected from different Pathology labs in Agra and Mathura region to estimate bio-load of Mycobacterium paratuberclosis.

Human patients suffering with thyroid disorder in Agra region of North India screened using 'Indigenous ELISA and Real Time_PCR. Of 84 blood samples screened by RT_IS900 PCR, 15.4% were positive. Positive blood samples in PCR were cultured in HEYM with Mycobactin J. RT_PCR improved detection rate by 50.0%.

Developed Taqman probe based Real-Time qPCR for specific and fast quantitative diagnosis of MAP in human samples. Of 42 blood samples screened, 23.8% were positive for MAP infection. Sensitivity of test was compared with 'Real time PCR' and traditional PCR targeting MAP specific IS900 gene. It was found that both Taqman probe based Real-Time PCR' are superior (sensitive), besides being highly specific as compared to normal PCR for the detection of MAP infection.

Commercial pasteurized milk samples (133) purchased from local markets in Mathura (Farah and Kosi), Agra, Jaipur and Lucknow region were processed for detection of MAP and 41.3 (55), 9.0 (12), 27.0 (36), 49.6 (66), 42.8 (57) and 58.6% (78) were positive in microscopy, IS900 PCR, indigenous ELISA, Dot-ELISA, Latex agglutination test and indirect Fluorescent agglutination tests, respectively.

Of 12 fecal samples collected from Elephant species, Bangalore region and processed for the detection of MAP, 5 (41.6%) were positive in microscopic examination. All the fecal samples (n=12) were processed for culture examination in HEYM medium and isolates were under incubation up to 8-10 weeks. Screening of MAP positive isolates in microscopy were negative by IS900 PCR.

Serum samples (n=91) from Microbiology Dept. of J.N. Medical college, Aligarh were screened for the MAP infection using 'Indigenous ELISA kit'. Of

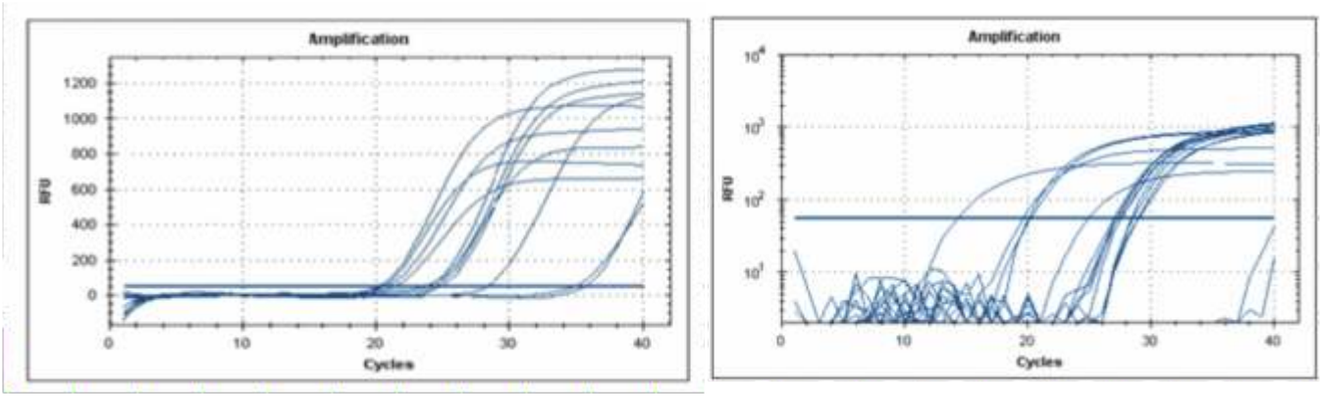


Fig 1 Taqman probe based PCR assay for the fast diagnosis of MAP infection.

Table 1 Comparison of SYBR green RT_PCR, Taqman Probe RT_PCR and traditional PCR targeting MAP specific IS900 gene.

Tests	Combinations				
Taqman Probe RT_ PCR	+	-	+	+	-
SYBR green RT_ PCR	+	-	+	-	+
Traditional PCR	+	-	-	+	-
Total (n- 28)	6 (21.4)	17 (60.7)	2 (7.1)	1 (3.5)	2 (7.1)

*Figures in parentheses are percentage

the 91 serum samples screened, 21 (23.0%) and 2 (2.1%) were in positive and strong positive categories for MAP infection.Screening of biopsies of human patients suffering with chronic ailments (gastero-intestinal / abdominal disorders and general colitis) was collected at the time of surgery for above ailments using microscopy and IS900 tissue PCR. Of the 10 biopsies screened 80.0 and 30.0% biopsies were positive for MAP infection. One human biopsy who suffered with gastero-intestinal problems for long periods exhibited typical corrugations.Screening of goat and sheep serum samples: Screening of goat and sheep serum samples (n=464) from repository of state diagnostic laboratory, Bhopal, MP were screened for the MAP infection using 'Indigenous ELISA kit'. Of the 464 samples screened, 155 (33.4%) were positive for MAP infection.Fecal (n=30) and serum samples (n=39) from IGFRI, Jhansi were collected from Bundelkhand goat breed and screened for the MAP infection. Of the total fecal and serum samples screened, 21 (70.0%) and 31 (79.4%) were positive for MAP infection using microscopy and 'Indigenous ELISA kit', respectively.

Developed 'Dot ELISA' (a rapid 'spot test') for quick detection of MAP in milk samples. Of 60 milk samples screened, 53.3% (32) were positive. Instead of whey, whole milk used for screening by dot-ELISA.

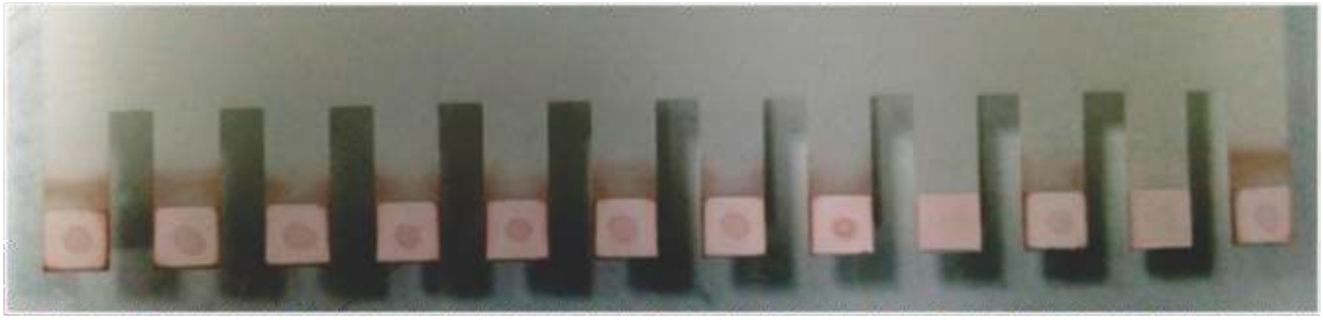


Fig 2 Dot-ELISA showing brown dot for the samples positive for MAP

Three genes (TLR 2, TLR 4 and NOD 2) were identified to study the polymorphism with respect to susceptibility and resistant to MAP infection. Wild-type NOD2 activates nuclear factor NF-kappaB, making it responsive to bacterial lipopolysaccharides; however, this induction was deficient in mutant NOD2. These results implicate NOD2 in susceptibility to Crohn's disease, and suggest a link between an innate immune response to bacterial components and development of disease.

Protocol for C-DNA synthesis: Genomic DNA was isolated from the white blood cell pack. Collect the blood (3.5 ml) in 2.7% EDTA. Blood was mixed with Histopaque (Sigma) and centrifuge at 2500 rpm for 45 min. To the buffy coat 13 ml PBS for washing. Centrifuge at 1000 rpm for 15 min and take the pellet. Add TRI reagent (Trizol, Sigma) to the pellet for RNA extraction. From RNA, then C-DNA synthesis using kit based method (Qiagen). This C-DNA was stored for Q-PCR amplification of 3 susceptibility gene at different annealing temperatures.

Development of Phage Therapeutic Preparation for Neonatal Colibacillosis in Goat-Kids

Principal Investigator
A. K. Mishra

Co-Investigator
K. Gururaj

Isolation and Characterization of Diarrhoeic *E. coli*:

Fecal samples (n=191) from diarrheic neonatal goat-kids of different livestock sheds of the Institute (ICAR-CIRG, Makhdoom), and from the field goats of various places in Mathura were collected, and processed for the isolation of E. coli. Out of 191 fecal samples, 171 isolates of E. coli were identified on the basis of cultural, morphological and biochemical characteristics. A total of 35 isolates of E. coli were sent to National Salmonella and Escherichia Centre, Central Research Institute, Kasauli for the serotyping. Among 35 isolates, the most common serogroups of E. coli responsible for neonatal diarrhoea in kids were identified as O11, O118 and O22. Congo red dye agar test was done to determine the invasiveness (pathogenicity) of the E coli isolates. Out of 171 isolates, 80.12 % (137/171) isolates showed Congo red binding activity i.e. the pathogenicity. For the molecular characterization, the genomic DNAs from all 171 E. coli isolates were extracted by bacterial genomic extraction kit and hot-chill method. The molecular identification of E. coli was done by PCR amplification of the universal stress protein A (uspA) gene using species specific primers (F-5'-CCGATACGCTGCCAATCAGT-3' & R-5-ACGCAGACCGTAGGCCAGAT-3'). The annealing temperature was set at 55 °C for 0.5 min and the size of the amplified product of uspA gene was obtained as 884 bp. The identification of shiga toxin producing E. coli (STEC) or verotoxin producing E. coli (VTEC) was done by the PCR targeting its stx-1 gene. The sequences of the primers used for the PCR amplification were F-5'-CACAATCAGGCGTCGCCAGCGCACTTGCT-3' and R-5'-TGTTGCAGGGATCAGTCGTACGGGG-ATGC-3'. The annealing temperature was kept at 58 °C for 0.5 minute and the amplified stx-1 product was found as 606 bp. Out of 171 isolates of E. coli from the diarrheic neonatal kids, 4.68% (8/171) were identified as STEC by PCR amplification of stx-1 gene. Likewise, pathotype specific primers (F-5'- ATGGTGCTTGCGCTTG-CTGC-3' and R-5'-AATCCACTATAACTGGTCTGC-3') were used to amplify the bfpA gene of enteropathogenic E. coli (EPEC). The annealing temperature was set at 57 °C for 30 seconds, and DNA fragment of 158 bp was observed as the product of the reaction. Out of 171 E. coli isolates, 35.08 % (60/171) isolates were identified as EPEC by the PCR targeting its bfpA gene. Further, a multiplex PCR was used to identify enterotoxigenic E. coli labile toxin producing (ETEC-lt) and enterotoxigenic E. coli stable toxin producing (ETEC-st), and enteroinvasive E. coli (EIEC). The sequences of primers used in the PCR were F-5'-GGC GAC AGA TTA TAC CGT GC-3' and R-5'-CGG TCT CTA TAT TCC CTG TT-3' for ETEC-lt, F-5'- ATT TTT CTT TCT GTA TTG TCT T-3' and R-5'-CAC CCG GTA CAA GCA GGA TT-3' for ETEC-st, and F-5'- GGTATGATGATGATGAGTCCA-3' and R-5'-GGAGGCCAACAATTATTTCC-3' for EIEC. The annealing temperature was set at 50°C for 45 seconds, and DNA fragments of 450, 190 and 650 bp were observed as the products of the reaction

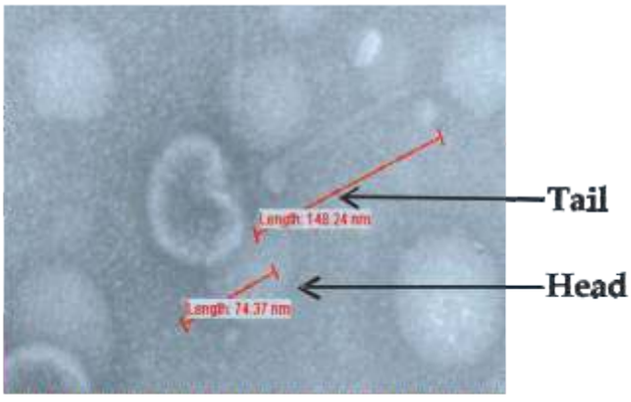


Fig 1 Culturing of *E. coli*phage.

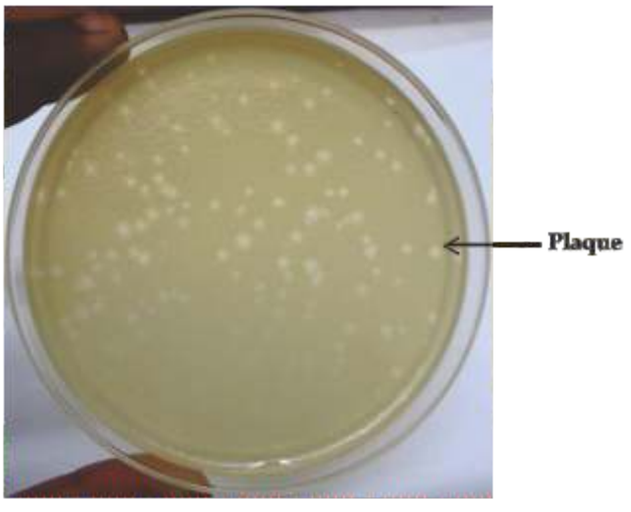


Fig 2 Plaques produced by the phages against the host bacteria (*E. coli*)

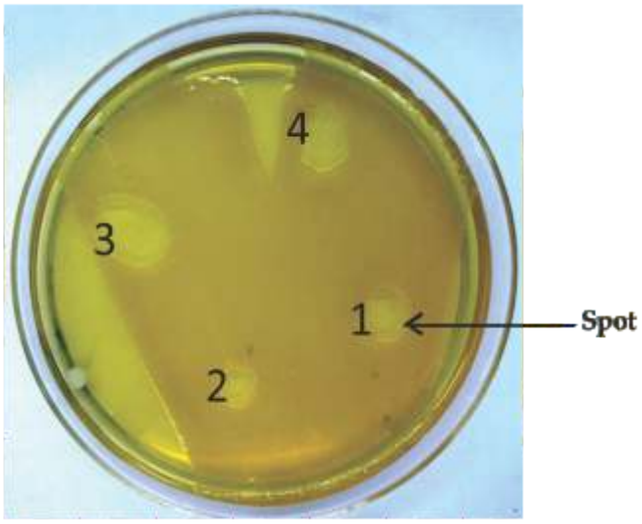


Fig 3 Spots (1,2,3&4) produced by thephages by lysing *E. coli* cells

for ETEC-lt, ETEC-st and EIEC respectively. Out of 171 E. coli isolates; 26.9 % (46/171), 2.92 % (5/171) and 1.75 % (3/171) isolates were identified as ETEC-st, ETEC-lt and EIEC respectively.

Isolation and Identification of *E. coli* Bacteriophages:

A total of 70 solid and liquid sources of bacteriophages (sewage, goat-feces and soil) were collected from different sheds of the Institute and various places of Mathura, and then processed for the isolation of the phages virulent to E. coli associated with neonatal diarrhoea in goat-kids. Out of 70 samples, 38 isolates of the E. coli phages were identified after purification by plaque purification method. Propagation of the phages was done by conventional liquid culture method as well as agar wash method. The sufficient quantity (stock) of the each phage isolate was prepared, and kept at 4oC till further use. The electron microscopy of the phages was done at Plant Pathology Division, ICAR-IARI, New Delhi to classify them. On the basis of the morphological characteristics, they were tentatively classified as members of Myoviridae.

Evaluation of indigenous medicinal herbs for management of peripartum stress and inflammation in goats

Principal Investigator
Anu Rahal

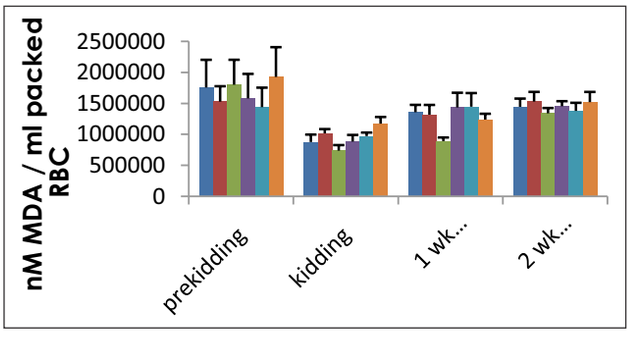
Co-Investigators
Ashok Kumar, Nitika Sharma

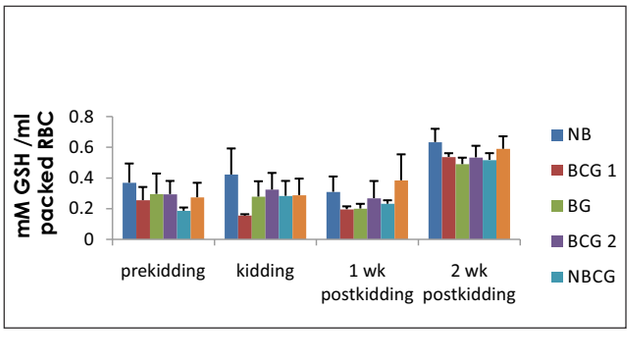
The study was conducted in two phases in pregnant Jakhrana goats. The animals were fed about 5 gm of 5 herbal mixtures taking 6th group as control. Blood samples were collected at the start of feeding, just after kidding, 1 week after kidding and 2 weeks after kidding. The blood samples were centrifuged to collect packed RBC, Buffy coat and plasma for estimating oxidative stress parameters, cytokines and inflammatory markers respectively.

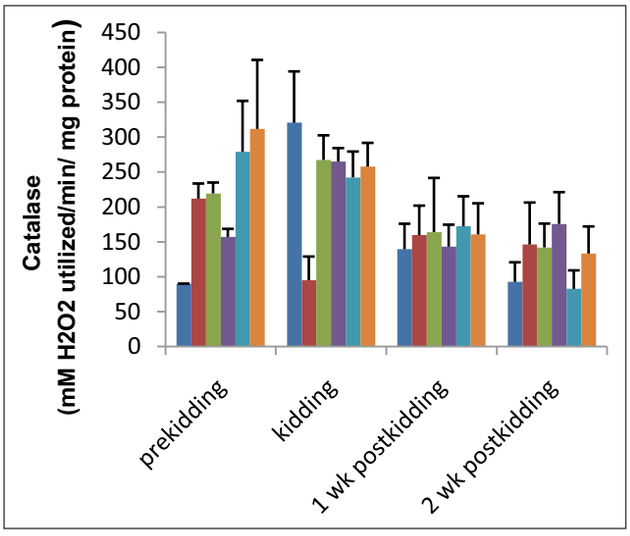
Among oxidative stress parameters, Lipid peroxidation and glutathione levels were estimated as nonenzymic parameters while activities of catalase and superoxide dismutase were analysed (Graph 1-4). In the present study, there was a decline in antioxidant GSH level and a corresponding increase in LPO in the control animals. In the treated groups, both LPO and GSH were reduced in BCG1, BG, BCG2 as well as NBCG. Depressed plasma antioxidant levels were observed at parturition which is a routine phenonmenon where neutrophil function is depressed and excessive lowering of GSH values are usually associated with retained foetal membranes. So increase in GSH along with reduction in LPO was highly desirable results.

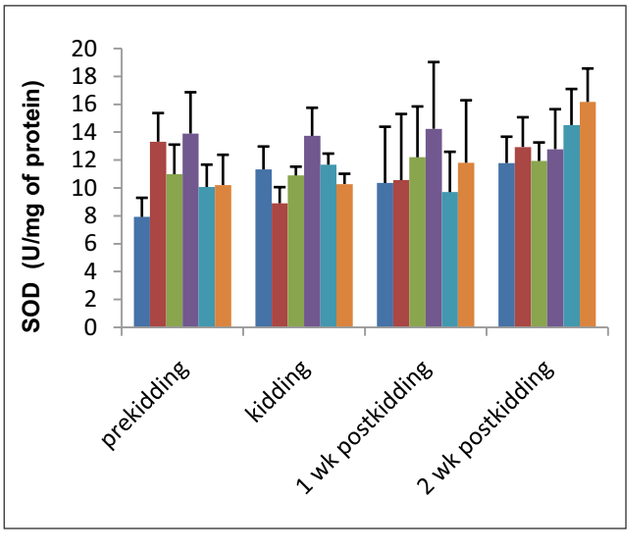
In goats, the acute phase proteins (APPs) have been proposed as sensitive and rapid indicators of inflammatory disturbances. They show a rapid rise and decline in the concentration and so, carry tremendous diagnostic value. The cytokine IgG was well maintained in plasma, along with a significant reduction in inflammatory markers in BCG1, BCG2 and NBCG.

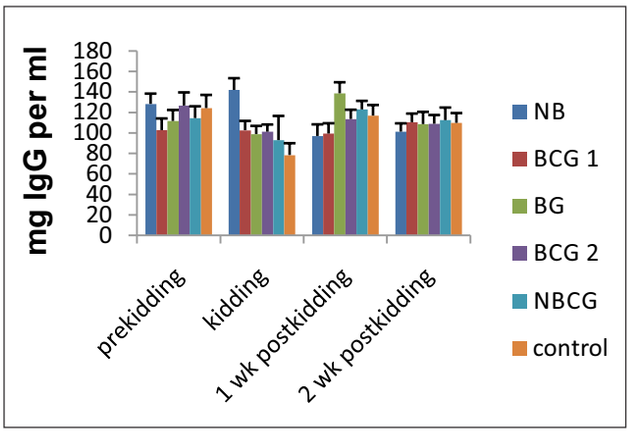
The milk production records were available only from the October trial. The milk yield was maximum for BCG1 and NBCG groups while body growth (as measured on the basis of fortnight body weight) was best for BG and BCG2 groups.

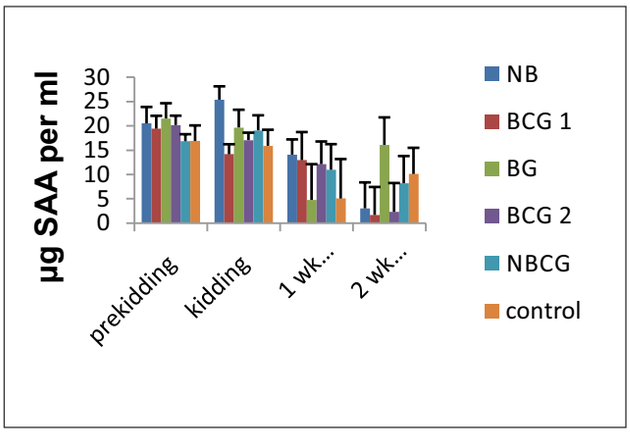









mg IgG per ml
180
160
140
120
100
80
60
40
20
0
prekidding
kidding
1 wk postkidding
2 wk postkidding
NB
BCG 1
BG
BCG 2
NBCG
control


µg SAA per ml
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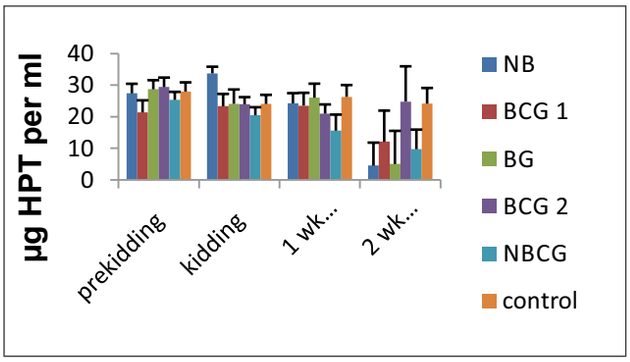
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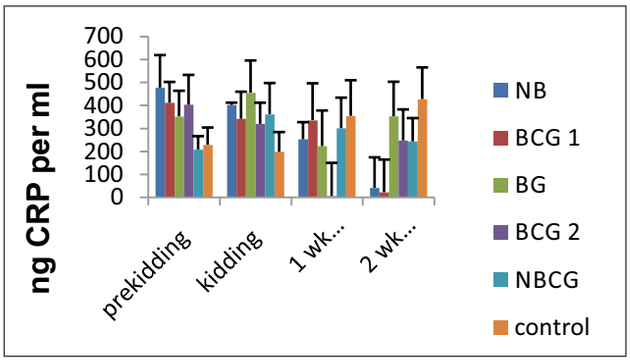
ng CRP per ml
700
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BG
BCG 2
NBCG
control

Development of a sustainable Targeted Selective Treatment (sTST) strategy against haemonchosis in Indian Goats

Principal Investigator
Souvik Paul

Co-Investigators
DK Sharma, Ashok Kumar, Nitika Sharma, MK Singh, V Chaturvedi

The study was conducted during June, 2016 to March 2017 in Barbari goats (n= 475) maintained in AICRP-Barbari Unit, ICAR-CIRG, Mathura, which is a semi-arid region. The goats were reared under semi-intensive system. Each of the goats was subjected to periodic faecal egg count (FEC), faecal oocyst count (FOC) packed cell volume (PCV), eye mucosa score (3 points) and body condition score (BCS) (3 points) as shown in table 1, fig. 1. The scoring points of eye mucosa for anemia was based on clinical experience of vets engaged in treatment and research on goats for last 20-25 years. The scoring points body condition was based on the experience of farm personnels and vets involved in research and management of goats for last 20-25 years; parameters which are used in marketing and pricing of goats were also considered.

Table 1 Eye mucosa and body condition scoring criteria used in the study

EYE MUCOSA SCORING		
Eye Mucosa Score	Description	Inference
1	Red/Reddish/Pinkish Red	Anaemic
2	Pink/Pinkish	Borderline
3	Pale Pink/ White	Non-Anaemic
BODY CONDITION SCORING		
Body Condition Score	Description	Inference
1	Absence of Sternal Fat, Prominent Ribs, Prominent pin bone and transverse process, Rough coat	Bad
2	Visible Sternal Fat, Non-Prominent Ribs, Non-Prominent pin bone and transverse process, Dull coat	Medium
3	Sizeable Sternal Fat, Ribs not visible , Pin bone and transverse process not visible, Shiny coat	Good

The body condition, colour of the conjunctiva was clinically evaluated and simultaneously, faecal samples were directly taken from the rectum and 5 ml sterile EDTA-blood were collected from the jugular vein of each goat and transferred to the laboratory. Scorings were done by 3 different persons in concordance. All scorings were done on the same day along with faecal and blood samplings. The eggs and oocysts were identified based on their morphology. FEC and FOC were performed using a modified McMaster technique with a sensitivity of 200 eggs /g of faeces. The FEC and FOC were log transformed to Geometric faecal egg count (GFEC) and Geometric faecal oocyst count (GFOC) for statistical analysis. Haematological parameters were determined with auto analyzer with goat software. Packed cell volume (PCV) is a measure of the circulating volume of erythrocytes in the blood which serves as a reliable parameter providing a cut-off point

Table 2 Correlation of Eye Mucosa Score with GFEC (Geometric Faecal Egg Count), PCV and Hb% in case of lactating does (N= 148)

Eye Mucosa Score	No. of Ani/Obs	GFEC-Geometric Faecal Egg Count Mean (± SE)*	Packed Cell volume (PCV)	Haemoglobin (Hb %)
1	63	4.71 (± 0.003948)*	15.04*	4.59*
2	79	4.64 (±0.002623)*	17.23*	5.75*
3	6	4.61 (±0.003692)*	20.82*	7.28*

Based on retrospective haematological, clinical and parasitological history
*The values vary significantly (0.05) among the groups

for the definition of anaemia in animals.

It was observed that the eye mucosa scores varied significantly with GFEC, PCV and Hb% among animals under different physiological conditions (Tables 2-6). Which clearly supported the fact that eye mucosa based scoring may be used as a TST parameter for selective treatment of goats.

TST chart developed in the study the treatment against haemonchosis was recommended when FEC values crossed 2000, which is in accordance with the standard in small ruminants. Packed cell volume (PCV) is a measure of the circulating volume of erythrocytes in the blood which serves as a reliable parameter providing a cut-off point for the definition of anaemia in animals. PCV was found to more reliable marker for anemia due to hemonchosis than Hb% due to the fact that the anaemia in hemonchosis is primarily due to blood loss. The normal PCV values in Indian goats varied to great extent among different breeds it has been reported between 20-42. However, based on the clinical observations of scientists, vets and

Table 3 Correlation of Eye Mucosa Score with GFEC (Geometric Faecal Egg Count), PCV and Hb% in case of bucks (N= 71)

Eye Mucosa Score	No. of Ani/Obs	GFEC-Geometric Faecal Egg Count Mean	Packed Cell	Haemoglobin
1	26	4.71	16.83*	4.47*
2	29	4.63	20.03*	5.74*
3	16	4.61	37.64 *	10.63*

Based on retrospective haematological, clinical and parasitological history
*The values vary significantly (0.05) among the groups

Table 4 Correlation of Eye Mucosa Score with GFEC (Geometric Faecal Egg Count), PCV and Hb% in case of non pregnant non lactating does (N= 130)

Eye Mucosa Score	No. of Ani/Obs	GFEC-Geometric Faecal Egg Count Mean	Packed Cell volume (PCV)	Haemoglobin (Hb %)
1	28	4.72	17.89*	4.47*
2	70	4.64	18.89*	5.74*
3	32	4.60	24.32 *	10.63*

based on retrospective haematological, clinical and parasitological history
*The values vary significantly (0.05) among the groups

Table 5 Correlation of Eye Mucosa Score with GFEC (Geometric Faecal Egg Count), PCV and Hb% in case of pregnant does (N= 126)

Eye Mucosa Score	No. of Ani/Obs	GFEC-Geometric Faecal Egg Count Mean	Packed Cell volume (PCV)	Haemoglobin (Hb %)
1	53	4.72	14.76*	3.75*
2	64	4.63	18.48*	5.28*
3	9	4.60	23.62*	8.63*

Based on retrospective haematological, clinical and parasitological history
*The values vary significantly (0.05) among the groups

Table 6 Correlation of Eye Mucosa Score with GFEC (Geometric Faecal Egg Count), PCV and Hb% in case of total animals under study (N= 475)

Eye Mucosa Score	No. of Ani/Obs	GFEC-Geometric Faecal Egg Count Mean	Packed Cell volume (PCV)	Haemoglobin (Hb %)
1	177	4.70	14.36 *	4.85 *
2	178	4.64	17.95*	6.09*
3	54	4.61	27.88 *	9.12*

Based on retrospective haematological, clinical and parasitological history
*The values vary significantly (0.05) among the groups

personnel engaged in treatment and research on goats for last 20-25 years and that of a recent study among Barbari goats the cut off value of PCV for anaemia due to hemonchosis under the present study was fixed as 18. Although, all the group of animals had the PCV values under category 2 at borderline or slightly above 18, still it would be safe not to recommend treatment to pregnant (PCV-18.48) and lactating (PCV- 17.23) does because of several facts like increased physiological demand due to growing foetus or milk production, teratogenecity of some anthelmintics, narrow safety limits during pregnancy, residues in milk, peri-parturient rise of FEC which makes it difficult to infer the correlation between anaemia and increased FEC and to recommend deworming of animals. It is therefore recommended to leave these two physiological groups unless deworming is absolutely necessary.

It was observed that the body condition scores (BCS) varied significantly with GFOC among animals under different physiological conditions (Tables 7-10), which clearly supported the fact that body condition scores may be used as a marker to ascertain the incidence of coccidiosis in the flock by the farmer without any laboratory intervention. The threshold limit for FOC in coccidiosis as encountered in this study was approximately 2000-2500. Although, the vet personnel involved in the treatment of goats describe 4000-5000 FOC as the threshold for treatment of coccidiosis in goats. Body condition based scoring may be used in conjunction with eye mucosa scores for selective treatment of goats. But, again it should be not employed in case of pregnant and lactating goats for obvious reasons. Moreover, Eye mucosa scores and body condition may be used by commercial farmers to categorize their animals for sell in market and also to identify resistant, susceptible and resilient animals. It may be concluded that the eye mucosa based TST chart developed and employed in this study showed good results under farm condition in Barbari Goats. This may be recommended for use in organized (semi-intensive; intensive goat farms). The next phase would be to take the technology to the multiplier flocks and the commercial goat flocks. Taking this directly to field to farmers with small flock size would not be advisable at this point because of the percentage of scientific technology adoption by small scale farmers are very poor as most of the time they are unwilling to adopt modern farming techniques like feed supplementation, housing, vaccination etc. Additionally, they are mostly dependent on albendazole for deworming their animals, which is supplied by govt agencies and NGOs. Albendazole id teratogenic and cannot be used in pregnant animals. Rather the team should try to implement the technology to commercial goat farmers, who are agree readily to adopt modern scientific technologies and deworm their animals 3-4 times a year. Additionally body condition scores will be more acceptable by such entrepreneurs for categorizing their animals for sale.

Under the study we analyzed faecal and blood samples from Barbari goats reared under semi-intensive system. Based on the sample survey we developed a TST chart based on the same principle as of FAMACHA© (i.e., ocular mucous membrane colour as an indication of anaemia due to haemonchosis) for use against haemnchosis in Barbari goats. Implementation of this system and feedback from the farmers will help us to assess the performance and benefits of this TST under existing social and technical context. Our final aim is to empower the farmers to assess and manage the health of their own livestock, thereby increasing resilience, food security and farming sustainability.

Evaluation of herbal immunomodulators for management of weaning stress in goat kids

Principal Investigator
Nitika Sharma

Co-Investigators
Ashok Kumar, Anu Rahal, M.K.Singh, Gopal Dass and Saket Bhushan

Weaning kids from the doe is one of the most stressful events in the kid's life that can contribute to intestinal and immune system dysfunctions that result in reduced kid health, growth and feed intake particularly during the first two weeks after weaning. Therefore, the present study was aimed at investigating the effects of weaning kids abruptly at an average 75 ± 15 days of age on growth, health, behaviour and serum parameters. The study lasted for a total of four weeks; two weeks pre-weaning and two weeks post-weaning. Twenty kids with equal gender were used. Kids were allowed to stay with the doe only during suckling period (30 min/ period) both during the morning and evening during pre-weaning. Grower ration, green fodder, dry fodder and tree leaves were offered ad libitum. The duration of study was divided into two periods for the sampling of growth and bio-chemical parameters; two weeks of pre-weaning period and two weeks of post-weaning period. Blood and serum samples were collected one week prior to weaning and one week after weaning. A gradual decrease in the average daily weight gain of kids was observed as the sampling period progressed. The effect of weaning stress on the biochemical and haematological parameters was evaluated. Weaning significantly reduced the plasma levels of glucose but increased the creatinine levels (78.1±1.35µM). The cortisol level was significantly increased in the weaned kids. Weaning significantly increased the levels of alanine aminotransferase (ALT) (19.2±1.53 U/l) and aspartate aminotransferase (AST) (60.3±2.70 U/l). The changes in the cortisol, alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels may be the result of metabolic alterations that occur during the transition from pre-ruminant to ruminant state. Coccidiosis, pneumonia, GIT parasitism and enterotoxaemia were the major causes of morbidity in weaned kids. Pneumonia was the major cause of mortality in weaned kids.

Immunomodulatory and anti-stress effects of herbal products and bio-response modifier were evaluated in the weaned goat kids. A total of 30 kids included in the study are randomly divided into 6 groups. Group I (control) did not receive any treatment. Group II, III and IV were administered herbal preparations. Group V kids were administered herbal combination. Group VI were administered chemical immuno-modulator. Treatment was initiated 15 days prior to weaning. Blood samples were collected on day -15, 0, 1,7,15 of weaning to assess stress markers (cortisol) and innate immune markers (Neutrophil: Lymphocyte, acute phase proteins, IFN-gamma, catalase). This trial is in progress in weaned kids.

Coenurosis control at CIRG Goat Farms and development of suitable diagnostic test for use

Principal Investigator
Dinesh Kumar Sharma

Co-Investigators
Souvik Paul, K Gururaj

Total of 178 faecal samples from dog population at CIRG campus were collected, processed and examined in laboratory to trace the potential route of Taenia multiceps eggs travel to dog. For this purpose, dog population was divided in 3 sectors i.e. dog population of main residential colony, of type- I colony and field sector No.3 and dogs' population of Post mortem and surrounding area. The highest infection rate of Taenia multiceps was found in dogs mongering around post mortem hall. The whole dog population at CIRG was de-wormed twice in month of October 2016. During the year, 5 coenurus cysts were collected from clinically affected and slaughtered/dead goats. The cestodes parasite was identified as *Taenia multiceps* and confirmed by PCR using a pair of primers of ND1 (NADH dehydrogenase 1) gene, JB11: 5'-AGATTCGTAAGGGGCCTAATA-3' and JB12: 5'-ACCACTAACTAATTCACTTTC-3'were used for specific amplification and confirmation of *Taenia multiceps*.

The tissue materials from cysts like 1. Scoleces and 2. Coenurus membranes were collected and processed through triturating and sonication (80% amplitude, 5 cycles for 30 seconds) and centrifuged (@ 3000 rpm for 10 minutes) under refrigerated conditions for antigen preparation. The supernatant was collected and proteins quantity was estimated through nanodrop. The cyst wall and scoleces antigens respectively had 60 and 100mg protons/ ml. Both these antigens along with synthesized peptide (Tm 16, Taenia multiceps onchoshere proteins) were used for raising hyper immune sera in Barbari goats through three successive subcutaneous injections at 0, 7 and 21th day using 400 ug protein / injection along with adjuvant. The antigenic proteins were also resolved through SDS-PAGE to see the protein profile of antigens. The gel analysis of both antigens is shown here. Gel proteins from SDS-PAGE were transferred to nitrocellulose paper and western blot was conducted to find out the immune dominant proteins using the respective hyper immune sera.

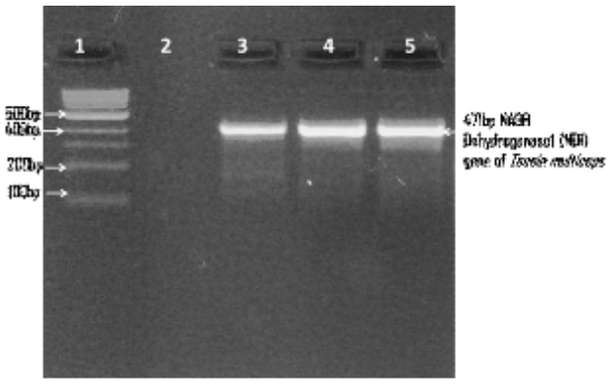


Fig. ND1 gene PCR for *Taenia multiceps*: Wells, 1-100bp DNA ladder; 2- No template control; 3-Positive control; 4-5- Suspected coenurus cyst samples from necropsy

EXTENSION EDUCATION AND SOCIO-ECONOMICS SECTION

Extension Approaches for Dissemination of Goat Production Technologies and Impact Assessment

Principal Investigator
Braj Mohan

Co-Investigators
A.K.Dixit, Khushyal Singh, Vijay Kumar, U.B.Chaudhary and Ashok Kumar

The villages under study during the last year are Daulatpur, Nagla Chandrabhan, Nagla Phunsia, Rawal and other Villages of Mathura District.

Six health camps were organized for different adopted villages covering 295 animals of different age group, in which sick goats were treated for anorexia, diarrhoea, anaemia etc. Four field days were organized in different adopted villages in which 98 goat farmers and 125 women goat were farmer participated.

1. Two demonstrations on AI were carried out in adopted villages on Artificial Insemination at farmer's door.
2. A demonstration was conducted on importance of mineral mixture in Nagla Chandrabhan adopted village, in goat feed which mineral mixture was distributed to 20 goat farmers.
3. Under the transfer of technology programme of Institute for women empowerment and breed improvement in the home tract of Barbari breed, Hon'ble Director ICAR-CIRG, Makhdoom distributed three (03) Barbari breed bucks (free of costs) to three (03) women goat farmers of adopted villages namely, Daulatpur, Nagla Phunsia and Nagal

Interactive meeting with Farmers in adopted Villages.

Chandrabhan. The total number of goats bred were 29 and all were pregnant with these improved breeding bucks given to these adopted villages.

4. A group discussion was arranged in adopted village Rawal with 06 goat farmers.
5. Four Swachchh Bharat Mission camps were conducted in adopted villages.

(a) Transfer of Technologies

Total number of respondents goat farmers : 24

ICAR-CIRG Contribution

1. Advisory.
2. Health care (Deworming and treatment), vaccination in one village only.
3. Mineral mixture.
4. Capacity building.

Impact

1. Attraction of youth towards goat farming by 50% from base population (14 to 20%, below 30 yrs.).
2. Average flock size increased from 5.9 to 7.9 (33.9%).
3. Average family income increased from 78 to 91 thousands per year (16.6%).
4. Mortality was reduced from 20.6 to 11.3% (45.14%).
5. Buck distributed: 3-Crossed: 29; Conceiving 100 % (Twice: 7, Once: 22).
6. AI: 10 (Conceiving 20%).

(b) National Training

Total No. of Respondents opened goat farms 30% of respondents (Maharashtra, Karnataka, West Bengal, Kerala, Odisha, Andhra Pradesh, Tamil Nadu and Uttarakhand).

No. of Goat Farms opened	:	20
Started and Discontinued	:	4 (6%)

Assessment of Economic Losses due to Diseases in Goat Production

Principal Investigator
A.K.Dixit

Co-Investigators
Braj Mohan, AshokKumar, S. K. Singh, Khushyal Singh and Vijay Kumar

A study was conducted in the villages of Dehradun, Haridwar and Tehri districts of Uttarakhand. Where incidence/outbreak of *Peste des petitsruminants* (PPR) disease was reported. Data were collected from 40 goat rearing households on viz. socio-economic status of goat farmer and flock composition. Information on different aspects of goat disease like morbidity,mortality, case fatality rate and economic losses due to goat PPR were recorded on memory recall basis. The status on goat management system particularly goat health management was assessed.

- Majority of the respondents belonged to backward class (40%) social group followed by SC (12.5%), General (20%) and Minority (27.5%). The average age of the respondent was 47 years. The average family size was 5.45 members. Moreover, goat farmers were landless and marginal farmers. Goat husbandry contributes about 27% of total family income. The average flock size of goat was 26.55.
- The overall morbidity, mortality and case fatality rate due to goat PPR was 79.71%, 37.97% and 47.64% respectively. Out of 956 goats in surveyed households, 762 fell ill and 363 goats died.
- The total economic loss per household due to PPR was Rs. 20, 309.
- A disaggregated analysis of economic losses in PPR affected households revealed that mortality loss contribute maximum share (85%) followed by morbidity loss (10.04%) which include weight loss, reduction in market value etc. and milk loss due to reduction in yield.
- The opportunity cost born by the goat farmer share 4.89% which include cost of extra labour to care ill goats and extra feed fed.
- Total economic loss per animal due to PPR was Rs. 765.
- Considering 0.17 as frequency of occurrence of PPR per year, per household per year economic loss was estimated to be Rs.4062 (Rs 153/goat/year).
- Goat farmers' perception about the major constraints in goat production: lack of veterinary service in time, unavailability of vaccine and medicines, high cost and poor knowledge on symptoms of important diseases were major constraints according to their mean scores.

Fig Collection of informations from the farmers on format.

Development of goat milk and meat value chain in Bihar and Uttar Pradesh (ICAR-ILRI)

Principal Investigator
A. K. Dixit

Co-Investigators
M. K. Singh, V. Rajkumar, Vijay Kumar and Souvik Paul

Project was started with the aim to improve the socio-economic condition of goat rearers, traders, butchers and other key actors involved in goat meat/milk value chain in selected districts of Bihar and Uttar Pradesh. In the first year, one of the objectives of the study was to assess goat value chain in the selected sites using value chain assessment tools. The districts of East Champaran and Vaishali in Bihar and Hamirpur and Unnao in Uttar Pradesh were selected mainly based on poverty indicators as well as goat density: 2 districts with high goat and high poverty and 2 districts with high goat and lower poverty densities. Similarly, Blocks were selected according to goat density. It was assumed that the district centre would also represent the biggest and most important consumption centre of goats in the district. (Data collected on goat development, production performance, flock composition, feed fodder supply, breeding services and animal health care, marketing and credit facilities.)

Need assessment of women in Goat farming

Principal Investigator
Khushyal Singh

Co-Investigators
Braj Mohan, A.K.Dixit, Vijay Kumar and Anu Rahal

During the period under report the following activities were performed:

- Collected review of literature
- Developed interview schedule
- Pre-tested the schedule
- Standardization of schedule

Development of Model Goat Village

Principal Investigator
Vijay Kumar

Co-Investigators
K.Singh, A.K.Dixit, Braj Mohan, Ashok Kumar, M.K.Singh, U.B. Chaudhary, Ramachandran N

After conducting PRA, off campus training programme, health camp and advisory services were organised in village. There were 37 goat farmers in the village having 160 goats. Majority of farmers (94.6%) were male, illiterate (37.8%) belong to OBC category (75.7%) of social group and 94.5 per cent belong to APL economic group. 73% farmers fall under marginal category followed by landless (24.3%) and small (2.7%). Due to our intervention 100 per cent farmers feed concentrate to all types of goats and amount varies from 100 to 250gm/goat/day. There was scarcity of feed in winter and drinking water in summer complained by farmers in village. Milk yield varies from 0.5-1.5 lit/day/doe. Majority of animals get sick in winter (75.6%) followed by monsoon (13.5%) and summer (10.8). The mortality was 1.25 per cent. Awareness and adoption about breeding and reproduction was 65.6 and 55; feeding and management was 75.6 and 49.2; hygiene and health was 64.2 and 51.3 and marketing was 43.5 and 39.6, respectively. There were some constraints found in the village as Input supply to goat value chains (32.4%); Support services for goat production (27%) and marketing goats in the value chains (78.3%).

Mera Gaon Mera Gaurav

Coordinator
Braj Mohan

Co-Coordinators
A.K.Dixit, Khushyal Singh, Vijay Kumar and Ramachandran N

As per the guidelines of Mera Gaon Mera Gaurav scheme, ICAR-CIRG formed eight (8) teams of the scientists (4 scientists in each team) and adopted 39 villages in Mathura and Agra districts of Uttar Pradesh and Bharatpur district of Rajasthan.

Baseline survey reports were prepared in adopted villages. The important features of the report are:

- Majority of goat farmers belong to marginal category (<1 ha).
- Classification of goat farmers according to social group indicated that most of the farmers belonged to SC/ST followed by OBC.
- Cropping intensity in surveyed villages varied between 100 to 125%.
- Mustard, Wheat, Barley, Bajra and Sorghum were the major crops in the adopted villages. Potato was that major cash crop in the villages of Etmadpur block of Agra district. Some area was also found under pulses.
- Cattle, buffaloes, goats and sheep were the major livestock species in the villages with the low production levels. Infertility anoestrus & repeat breeding delay in first conception & malnutrition were the major problems reported by livestock owner. Shrinking pastures land was one of the major problems in goat rearing.
- The major problems observed in the villages were: Unemployment, lack of adequate electricity, lack of awareness in adoption of new technologies in crops and animal husbandry. Low productivity of crops due to poor soil and water quality and quantity.

Scientist Interaction with farmers in adopted village

AICRP ON GOAT IMPROVEMENT

P. K. Rout, M.S. Dige

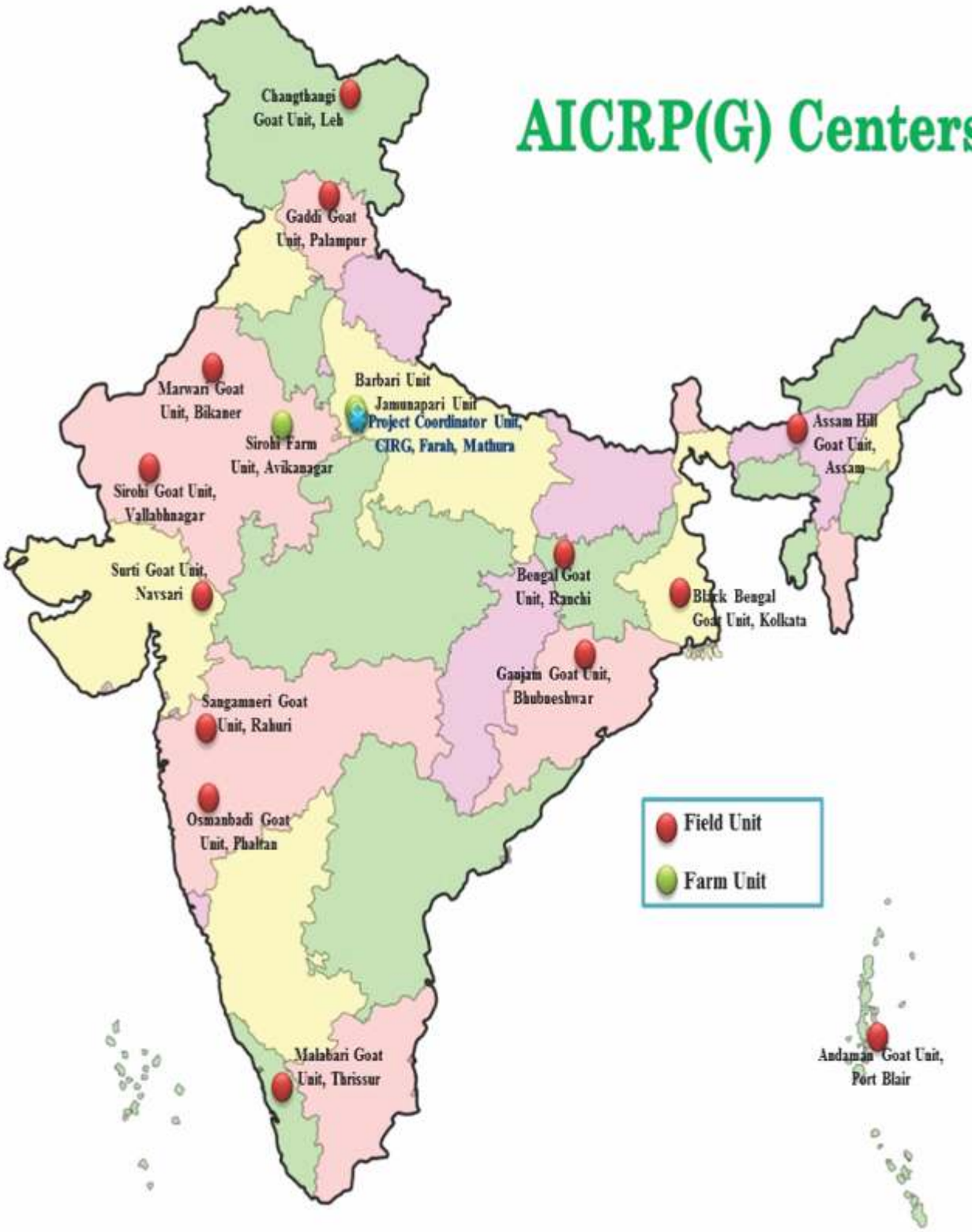
All India Coordinated Research Project (AICRP) on Goat Improvement is designed to enhance the productivity of the goat genetic resources in their natural habitat. The major aim is running a sustainable genetic improvement programme in the natural habitat of genetic resources with farmer's support. The project will enhance the genetic potential of the animal as well as conservation of the germplasm in their natural habitat.

The details of Coordinating Centre of AICRP on Goat Improvement described below.

Table 1: Centers of AICRP on Goat improvement

S. No.	Name of Unit	Location of Centre	Type of Centre
1.	Project Coordinators Unit	ICAR-CIRG, Makhdoom, Farah, Mathura-281122, Uttar Pradesh	Coordinating Unit
2.	Andamani Goat	ICAR-CIARI, Port Blair, Andman & Nicobar Island	Field
3.	Assam Hill Goat Unit (NEH)	ICAR-AAU, Khanpara Guwahati, Assam	Field
4.	Barbari Goat Unit	ICAR-CIRG, Makhdoom, Mathura, Uttar Pradesh	Farm
5.	Bengal Goats (TSP)	BAU, Kanke, Ranchi, Jharkhand	Field
6.	Black Bengal (Partial TSP)	WBUV & FS, Kolkata, West Bengal	Field
7.	Changthangi Goat Unit	SKUAST, Kashmir, Leh-Ladakh, Jammu & Kashmir	Field
8.	Gaddi Goat Unit (TSP)	HPKVV, Palampur, Himachal Pradesh	Field
9.	Ganjam Goat Unit	OUAT, Bhubaneswar, Orissa	Field
10.	Himalayan Local Goat Unit	ICAR-IVRI Campus, Mukteshwar, Uttarakhand	Field
11.	Jamunapari Goat Unit	ICAR-CIRG, Makhdoom, Mathura, Uttar Pradesh	Farm
12.	Malabari Goat Unit	KV&ASU, Mannuthy, Thrissur, Kerala	Field
13.	Marwari Goat Unit	RAJUVAS, Bikaner, Rajasthan	Field
14.	Osmanabadi Goat Unit	NARI, Phaltan, Maharashtra	Field
15.	Sangamneri Goat Unit	MPKV, Rahuri, Maharashtra	Field
16.	Sirohi Goat Unit	ICAR-CSWRI, Avikanagar, Rajasthan	Farm
17.	Sirohi Goat Unit (Partial TSP)	RAJUVAS, Vallabhnagar, Rajasthan	Field
18.	Surti Goat Unit (TSP)	N.A.U., Navsari, Gujarat	Field
19.	Uttarakhand Local Goat Unit	GBPUA&T, Pantnagar, Uttrakhand	Field

The major thrust of the project is to build up long term capacities of goat keepers through introduction of superior breeder goats, technology transfer, creation of knowledge base, application of health management practices for enhancing production potentials on sustainable basis.



SALIENT RESEARCH ACHIEVEMENT 2016-17

Goat production is facing diverse challenges in different agroclimatic condition and it is necessary to carry out research and development activity to increase farmer's income for better livelihood. The project is covering 13 registered breeds and 3 local genotypes(lesser-knowngoats). The project has contributed in increasing population growth, milk production and body growth. Preventive health care measures with farmer's support have reduced morbidity and mortality in field flock. There is significant increase in income of goat farmers and enhanced food security of all stake holders.

i. AICRP on Goat Improvement is operational at 464 villages covering 3010 farmers. The performance recording was carried out in 25622 animals during the year.

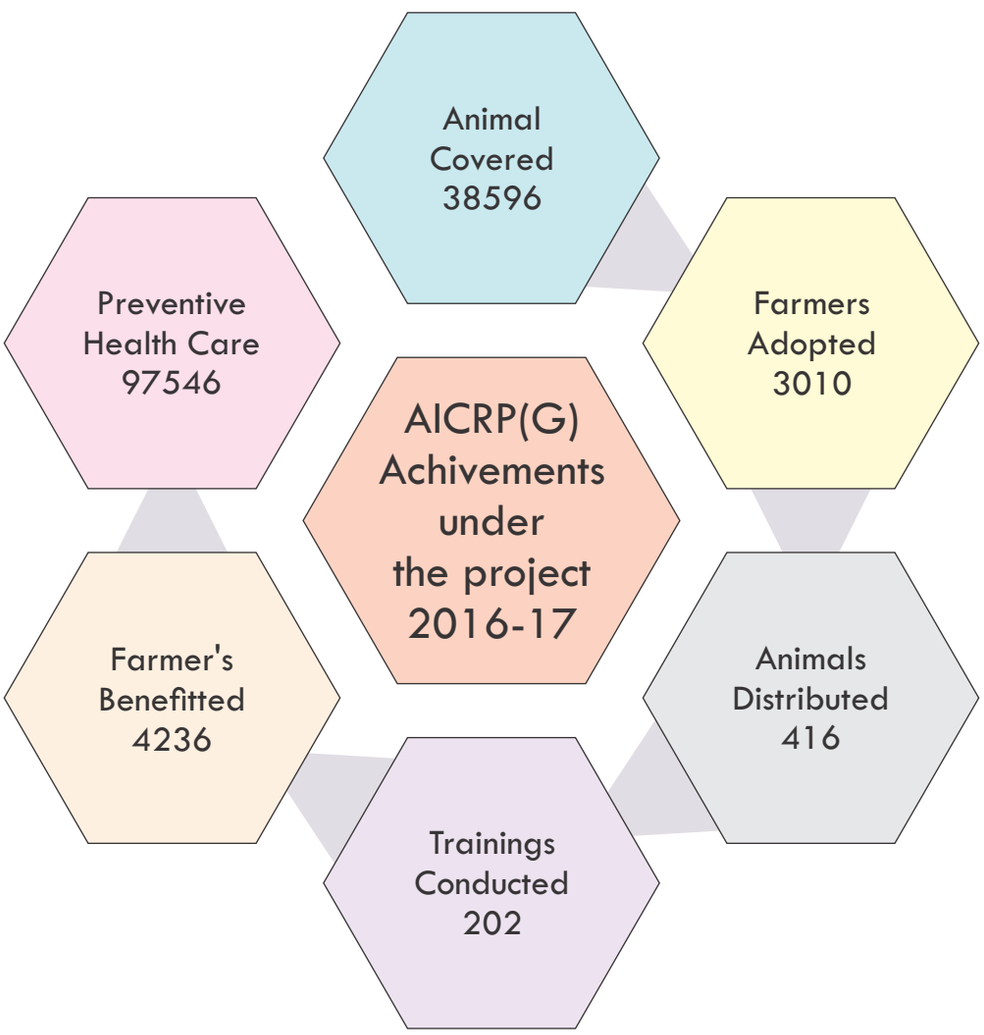
ii. The increase in body weight at 12-month age over the units varied from 0.9 % to 6.2%. Similarly, the increase in milk yield at 90 days varied from 3.4% to 8.8% over the units.

iii. The average pashmina production of Changthangi goats was 269.11gram.

iv. Preventive healthcare was provided to 97546 animals. The healthcare is being taken up sincerely in farmer's flock indicating that the mortality rate varied from 2.78 to 11.15%. This has not only contributed for increasing population growth but also improving the farmer's income by 22% to 35%. A higher population growth amongst breeds resulted into increased selection intensity, thus realized genetic gains could be high.

v. Farm unit have significantly produced and distributed more than 665 improved animals to different agencies for breed improvement as well as up-gradation of local germplasm.

vi. The field units also distributed 416 improved bucks to adopted farmers for genetic improvement.



vii. AICRP units conducted 202 training programme for skill development of goat farmers and about 4236 farmers participated in various training programmes.

viii. Producing technical literature & seasonal advisory for goat farmers to impart better known- how to manage their flocks during the year.

ix. Identification of elite doe producing more than 200 litre of milk in140 days in different units.

x. Different units have produced various technical leaflets /booklets on different managemental practices.

xi. Twenty success stories have been recorded during the period.

xii. AICRP on Goat Improvement has bagged Breed survivor recognition for Malabari, Jamunapari and Surti breeds.

xiii. Working in13 tribal villages and contributing for a better livelihood in the tribal region. Goats as major source of income generation to poor people in Tribal are as and NEH region. The technical inputs have contributed in different aspect of goat production and increasing the income of goat farmers.

RESEARCH FINDINGS FOR THE YEAR 2016-17

1. Andaman Goat Field Unit, ICAR-CIARI, Port Blair, Andaman & Nicobar Island

Three clusters were established in the A & N Islands and base line information on production, reproduction traits, management practices and disease incidence of Andaman local goats and socio-economic status of goat keepers were recorded. Superior bucks and does were selected and tagged in the project area. Biometric dimensions and body weight of the goats at different age groups (birth, 3, 6, 9 & 12 months) were recorded. The opening balance of the Andaman Local Goat in the cluster was 3158 and the closing balance was 2490, which includes 892 adult male and 1598 adult females. During the year a total of 521 kids were born and 252 died. A total of 1231 were sold during the period. The overall population growth was 79.37%. A new cluster at Baratang Tehsil and Nimbudera Tehsil at North & Middle Andaman district were established and a total of 1280 goats were registered. The overall least squares means of body weights (kg) at birth, 3, 6, 9 and 12 months of age are 1.42, 5.86, 9.63, 13.24and 16.10respectively. Age at first mating (days), weight at first mating (kg), age at first kidding (days), weight at first kidding (kg), kidding interval (days), service period (days) and gestation period (days) was 257.24, 11.52, 405.34, 16.05, 281, 98.12 and 146.89 respectively. The kidding percentage was 151.01 per cent on the basis of does kidded and the kidding rate was 1.51. The percentage of singles, twins, triplets were 33.78, 62.10 & 4.0, respectively in the present population under study during the period. A total of 13 superior breeding bucks and 02 adult does were distributed in different villages for up gradation of the Andaman local goats in the adopted villages. During the year, no major disease outbreak was reported from the goats. A total of 2560 goats were provided the mineral mixture, 1679 were treated for different illness and 1768 goats were given deworming. During the year a total of seven awareness programme on scientific goat rearing were also conducted in which 148 farmers were imparted training from different villages of all the clusters. Three extension leaflets on Andaman Local Goat, scientific goat farming & dweepon mein bakiri paalan (in Hindi) was prepared for distribution to the farmers. Based on the socio-economic information net income per animal was found to be 2564/-.

2. Assam Hill Goat Field Unit, AAU, Khanpara, Guwahati, Assam

The project is being operated in 15 villages under four adopted field clusters i.e. a) Batabari, b) Tetelia, c) Nahira and d) Tepesia. Presently, the project encompasses 255 farmer's families rearing 2621 Assam Hill Goats as on 31st March 2017. During the reported period a total of 786 kids were born out of 511 does and recorded an overall population growth of 81.75%. The highest number of births were recorded in the month of January 2017 (20.48%) followed by March 2017 (13.23%). In spite of unusual severe flood in the state in the year 2016-17, a total of 325 goats were sold by the registered farmers with an income of ₹ 617550.00 (average ₹ 1907.00/- per goat) which indicates an annual income of ₹ 2744.67 per house hold. The singlet, twining, triplet and quadruplet percentage has been recorded as 53.08, 40.51, 6.06 and 0.39% respectively, in the four adopted field units. The average body weight of the goats at birth, 3, 6, 9 and 12 months of ages were recorded as 1.27, 5.05, 7.65, 10.62& 13.61kg, respectively. It has been observed that there was an increase of 4.95% in the 12 months body weight over the last year. The average age at first mating, weight at first mating, age at first kidding, weight at first kidding, first kidding interval, service period and gestation period were recorded to be

257.76days, 10.01kg, 404days, 13.98kg, 227.16days, 79.93days and 147.55days respectively. The average mortality rate was 6.79%. A new village has been adopted under the cluster Tepesia, in Kamrup district with 18 beneficiaries. Another 12 new beneficiaries have been registered under the project for the period under report in the remaining three existing clusters. During the year, a total of 10 new selected bucks have been distributed and 23 numbers of existing bucks were exchanged among the clusters to avoid inbreeding. A total of 33 numbers of bucks are being used for selective breeding in the four field units. Twelve Awareness cum training programme was organized to enhance knowledge of goat farmers on the scientific rearing of goats. Twenty five vaccination camps to immunize 6241 animals, 22 deworming camps for 5786 animals and 32 treatment camps to treat 1824 animals including goats of non-adopted villages were organized.

3. Barbari Goat Farm Unit, ICAR-CIRG, Makhdoom, UttarPradesh

Barbari breed of goat has attained special significance now days as meat breed due to higher weight gain, prolificacy and suitability for Intensive rearing. Nucleus flock of these goats was maintained under semi-intensive feeding system from 1983 and from 1993 under AICRP on Goat Improvement. The closing and opening balance of flock was 825 and 716. Three hundred seventy nine kids were born out of 251 does. The population growth of goats was 145% during 2016-17. Three hundred eight goats were provided to farmers and development agencies. The mortality of the flock was 2.9%. The awg. weight at first mating, age at first mating, weight at first kidding and age at first kidding, first kidding interval & gestation period were 19kg, 368 days, 21.7, kg 509 days, 217 days and 145 days, respectively. There were gradual reduction in AFS and AFK over the years however, WFS and WFK shown increasing trend over the years indicating positive improvement in body weight of yearlings. Breeding efficiency on the basis of doe's available and doe's tupped were 72 and 78%, respectively and kidding% on the basis of does available and doe's tupped were 109 and 140%, respectively. Kids born as multiple births for this year were 65.4% of total kids born. The kidding rate (liter size) was 1.51. The least squares means of body weight of kids at birth, 3, 6, 9, and 12 month of ages were 1.91, 7.71, 12.34, 16.47 and 21.94 kg, respectively. The estimates of h^2 for body weight of kids at birth, 3, 6, 9, and 12 month of ages were 0.106, 0.230, 0.210, 0.267 and 0.171. The heritability estimated by animal model also found with similar low to moderate estimates (0.12 for birth weight to 0.19 for 12 month body weight). The highest feed conversion efficiency was obtained during birth to 3 months and thereafter relative decline in ADG during 3-6 followed by 6-9 months growth ages. Overall mean for 90 days milk yield, 140 days milk, total lactation yield, average daily milk yield and lactation length were 52.71, 67.65, 63.02 liters, and 130 days, respectively. The estimates of h^2 for MY 90, LMY and LL were 0.142, 0.109, 0.106 and 0.309 respectively. The selection differential for 9 months body weight was 6.08 kg and that of the dam's 90 days milk yield was 20.3 liters. Total of 32 multiplier flocks of Barbari goats were established for genetic improvement, conservation and promoting scientific goat farming among educated youths and farmers. These flocks were supported by pure-bred Barbari goat unit with 12-16 animals besides technical support from time to time. The net profit per goat was ranged from ₹ 4300 to 9600/year with an average of ₹ 5225. The major contribution of the project has been in sustainable genetic improvement and conservation of the breed at farm and in home tract of the breed.

4. Bengal Goat Field Unit, BAU, Kanke, Ranchi, Jharkhand

Four clusters of AICRP have been established in different zones of Jharkhand having 3165 goats Baseline data on Black Bengal goats and farmers have been completed 40 farmers at different centers have been added having 282 goats data on growth and reproduction parameters have been recorded and analyzed. A total of 7 buck & 28 Does (on the basis of growth and multiple births) were selected from different centers and distributed among 7 farmers under TSP program. Bucks used for three year at a center have been exchanged from one center to others to avoid inbreeding. Selection differential of male at 12 month of age were estimated to be 2.09 kg. The overall means of body weights at birth, 3, 6, 9 and 12th month of age were found to be 1.30, 6.19, 8.71, 11.65 & 13.70 kg, respectively. Age at first mating, body weight at first mating, age at first kidding, weight at first kidding, service period, kidding interval and gestation period were 269.90 days, 11.60 kg, 418.89 days, 12.00 kg, 68.00 days, 215.89 days and 147.89 days, respectively. Kidding rate (litter size) of Black Bengal goat was estimated as 1.69 with 170% kidding. Pro-poor goat based technology developed by the Ranchi Veterinary College, BAU were being used by the

farmers extensively such as dipping and castration of kids at the age of 2 months. All the goats in coverage areas were vaccinated with PPR (2780 goats), dipping (3519 goats) and deworming of 3607 goats have been done. Due to timely intervention mortality has come down to 2.78% Training on 'Scientific Goat Rearing' was organized in which 27 farmers from different centers participated. Two exposure visits and forty 10 days training were organized.

5. Black Bengal Goat Field Unit, WBUV and FS, Kolkata, West Bengal

AICRP on Goat Improvement - Black Bengal Field Unit is now working in four clusters i.e. Ayeshpur and Ganguria (Nadia cluster); Jatirampur and Rangabelia (Sundarban cluster); Bamunia and Beliapukur (Murshidabad cluster); Lodhasuli (Jhargram cluster). There are 913 registered does from 534 farmers (SC-292, General-151, ST-68 and OBC-23), from the 913 registered doe (142, 150, 172, 66, 51, 150 and 182 does in Ayeshpur, Ganguria, Jatirampur, Rangabelia, Bamunia, Beliapukur and Lodhasuli units respectively). A total of 1488 kids were born from 832 kidding during the period. Twenty three bucks were selected based on their 6 months body weight and prolificacy of dams. With the opening flock of 2308 in 2016-17, after selective breeding with superior males the closing flock has been reached to 2538. The population growth rate of Black Bengal for 2016-17 was 253.85%. The average flock strength has been increased to 5.80 in 2016-17 which was 5.65 during 2015-16. Majority of farmers have the flock size of 1 to 4 goats (42.81 %) followed by 5 to 8 (39.54 %), 9 to 12 (14.71 %) and then by above 12 (2.94 %). The average body weight at birth, 3 month, 6 month, 9 month and 12 month were 1.24 kg, 5.11 kg, 7.78 kg, 10.38 kg and 13.05 kg respectively during 2016-17. The mean body length, height at wither and heart girth were 20.29 cm, 21.65 cm and 23.60 cm at birth; 32.64 cm, 34.13 cm and 38.25 cm at 3 months; 37.57 cm, 39.24 cm and 44.54 cm at 6 months; 41.52 cm, 43.24 cm and 49.38 cm at 9 months; 45.30 cm, 47.07 cm and 54.43 cm at 12 months of age. Black Bengal doe produces 3.35 lit, 6.42 lit, 8.40 lit and 9.24lit of milk in 15 days, 30 days, 45 days & 60 days, respectively. The milk yield beyond first lactation was increased up to seventh parity, and then decreases. Higher milk production performance has been observed during monsoon and winter kidding than summer. Significantly higher milk yield has been recorded in Murshidabad cluster, followed by Jhargram, Sundarban and Nadia cluster. The average age at first mating/service and 1st kidding were recorded as 234.55days and 381.37days respectively. The average service period, gestation period and kidding interval was 62.48 days, 147.02 days and 209.52 days, respectively. The kidding rate (litter size) was as 1.79. Twin born kidding is maximum (52.76 %), followed by singlet kidding (34.86 %), triplet kidding (11.66 %) and quadruplet kidding (1.32 %) has been observed in 2016-17. The overall mortality in the total flock has been restricted to 6.77 % in 2016-17. The average annual income from goat rearing per farmer also has been increased from previous year i.e. ₹ 7150.00in 2016-17 which was ₹ 6073.44 in 2015-16. In landless, marginal (upto 20 katha land), small (20 - 40 katha land) and medium (above 40 katha land) farmers, the annual income was ₹ 6850.00, ₹8270.33, ₹5527.37 and ₹ 7063.68, respectively. The income per doe is ₹ 2860.81 which is also increased than that of previous year (₹ 2748.00 in 2015-16). The AICRP on Goat Improvement was successful enough to create awareness among the goat farmers about identification and record keeping, disadvantages of early breeding of young does; regular vaccination and deworming; importance of giving supplementary feeding to does, bucks and kids; optimum age and weight of kids for sale with expected market rate; first aid treatment etc. through organization of several treatment cum vaccination camps along with other extension activities like meeting, interactive sessions, seasonal advisory, training, exposure visit etc.

6. Changthangi Goat Field Unit, SKUAST, Kashmir, Leh-Ladakh, Jammu & Kashmir

The AICRP unit on Changthangi Goats was operational at HMAARI, SKUAST-K, Leh. There are 3 clusters of Zone-I, i.e Kharnak, Samad and Korzok, with a total of 2750 breedable does and 72 breeding bucks. However, in 2015, the total goat population in all the three clusters was to 10032 with a total of 3246 breedable does and 89 breeding bucks. The closing balance in these three clusters was 10285 with a total of 3165 breedable does and 97 breeding bucks during 2016. The overall population growth for this year was 56.19 % as compared to last year 62.96 %. A total of 938 goats were sold to other adjacent breeders, farms and other institutions this year by the adopted breeder of the unit for breed improvement. Five improved bucks were distributed to beneficiaries in the adopted clusters. Tagging of approximately 11000 goats was completed using unique All-flex Tags with farmers and cluster name imprinted on the tags. The overall body weight growth at birth, 3 month, 6

month, 9 month & 12 month was 2.46 Kg, 6.32Kg, 9.45kg, 12.98Kg and 16.08 respectively. The overall average Pashmina production for all the three clusters was 275 gm. This year, the number of does available for breeding was 3246 out of which 2526 does kidded. The overall kidding percentage among the registered goats in all the 3 clusters was 77.81 % compared to last year 66%. This year, the abortion rate has slightly increased to13.30 % from 9.22 during last year, which is attributed to heavy snowfall and starvation. The overall mortality rate irrespective of age groups was 8.76 % with a kid mortality of 22.77%. The main reason for the mortality was inclined weather and availability of less feed and fodder. More than 3746 goats were treated for various ailments during the period and all the goats of the adopted farmers 9267 goats were dewormed. Inventories such as portable weighing balance (10 Nos.) and Burdizzo castrator (4 Nos) were distributed among the beneficiaries. A total of Seven, 2 days and 1 three days training were conducted for the breeders in the Changthang area. The unit developed a 10-hectare land for fodder production with alfalfa, mustard, maize, local pea and Kiker plantation along the border as windbreak. Successful silage and compost making was done this year using locally available ingredients and has been sent for analysis. Hon'ble Governor of J&K released two leaflets one on Pashmina goat health management and another on CCPP management to educate the breeders/farmers during his visit to this unit in Sept 2016. Further, he has given best pashmina grower award to one of AICRP beneficiaries.

7. Gaddi Goat Field Unit, HPKVV, Palampur, Himachal Pradesh

The All India Co-ordinated Research Project on Goat Improvement (Gaddi Field Unit) was operational at HPKVV, Palampur, Himachal Pradesh. During the present report period, the performance of already established four field units belonging to different migratory routes was monitored. The opening balance as on 01.04.2016 was 1123 goats including 723 breedable does. During the year, a total of 592 young kids were added in selected flocks by way of birth, 122 animals of different age groups died and 441 animals pertaining to different age groups were sold by the owners. The closing balance as on 31.03.2017 was 1152 animals under different age groups. The least squares means during the year under report for body weights at birth, 3 months, 6 months, 9 months and 12 months of age were 3.05, 15.09, 19.55, 24.53 and 27.60 Kg., respectively wherein significant effects of sex of kid and years were observed. The overall body length, body height and body girth at birth were 32.01, 33.31 and 35.78 cm, respectively. The corresponding figures at six months of age were 62.83, 62.11 and 65.21 cm and at twelve months 66.24, 63.07 and 74.52 cm, respectively. For breeding inputs, a total of 47 male kids of 4-6 months age group were purchased after primary selection on the basis of morphological characteristics and better/ higher growth rates. These male kids were then transferred to Palampur center for subsequent rearing up to the age of sexual maturity, following all standard management practices. After final selection, a total of 30 males were finally distributed to 30 different farmers as a breeding input. In addition, 40 male kids were also purchased during March, 2017 for the distribution as breeding buck to the farmers during financial year 2017-18 and are being reared at Palampur center. All selected animals were provided health coverage under migratory field conditions viz. vaccination against PPR (1500 doses), de-worming against endo-parasites after fecal sample analysis (1450 animals), periodic health check-ups etc. Strategic supplementary feeding was also provided in the form of mineral mixture (300 Kg) and concentrate feed (25 qtls.) supply. Collaboration with state Animal Husbandry Department was ensured while providing health coverage and other related activities. The overall population growth was observed to be 109.45%. The overall mortality incidence was found to be 7.11%. The incidence of twin birth was recorded 21.56%. The overall abortion incidence in the flocks was observed to be 10.06%. The kidding rate of the flocks was observed to be 1.21%.Maximum kidding was recorded in the month of October (125 kids) and November (166 kids).

8. Ganjam Goat Field Unit, OUAT, Bhubaneswar, Orissa

The All India Coordinated Research Project on Ganjam goats is operational in distribution in four clusters of Ganjam district, the native tract of Ganjam breed of goat, namely Chhatrapur, Rambha and Khallikote with a total of 62 registered farmers and a new cluster i.e. Bhanjanagar has been added this year where a total of 19 farmers have been registered taking the total number of the farmers to 81. Twenty females from each of the three centers at Chhatrapur, Rambha and Khallikote have been identified and milk recording carried out in 260, 140 & 180 observations taken on the milking does. Tagging of the animals is being carried out regularly. The

Area specific mineral mixture developed by them under AICRP- Improvement of Feed Sources & Nutrient Utilization for raising animal production, Bhubaneswar to replenish the critical mineral in Ganjam goats. Preventive health care and vaccination are routinely being carried out with vaccination of 3000 dosages of PPR, 3000 dosages of goat pox, 1200 dosages of Enterotoxaemia vaccines and 670 dosages of FMD. Baseline data, growth data and milk recordings were collected and were uploaded to the GMIS server. Prepared a draft copy of the by-law for the Ganjam Goat Keepers Society. Three training programmes each with fifty goat farmers were conducted at Jirabadi, Khallikote and Chhatrapur on 15th March, 24th March and 30th March 2017 where farmers were made aware about scientific management practices of goats.

9. Himalayan Local Goat Field Unit, ICAR-IVRI Campus, Mukteswar, Uttarakhand

Himalayan goat unit under All India Coordinated Research Project (AICRP) on Goat Improvement was started in the year 2014 with the aim of improvement of local Himalayan goats (Chaugarkha) at Kumaon hills of Uttarakhand. These goats are mainly reared by small and marginal farmers for meat purpose. Villages namely, Khola and Gandhak of Dhauladevi block in have been adopted as cluster-1 and Lamkot-Fatqual dungra of Almora district as cluster-2 after surveying its breeding tract and distribution. Chamdungra-Timta and Duni of Gangolighat block of Pithoragarh district has been identified as third cluster. Total ninety two farmers have been registered and 355 adult breedable does were tagged as well as 63 kids were also tagged from cluster 1 & 2. The morphometric characters from these goats were also recorded. The average body weight, body length, body height and chest girth of male were 22.00 kg, 52.68 cm, 59.07 cm and 61.49 cm, respectively. The average body weight, body length, body height and chest girth of female were 18.08 kg, 50.26 cm, 53.81 cm and 58.00 cm, respectively. The mean body weight of Chaugarkha goat at birth, 3 month, 6 month and 9 month & 12 month were 1.55, 6.31, 10.42, 15.43 and 20.44 kg, respectively. Socio-economic data were collected and major problems for goat husbandry in the region were identified as lack of knowledge on scientific goat farming, scarcity of feed and fodder, parasitic infestation, distress selling. Regular health checkup, sample collection, diagnosis of various diseases at field and at laboratory level were done. Accordingly, prophylactic and curative measures were taken time to time. Five animal health cum awareness camps were organized in field level. Twenty bucks (3 to 6 months) were purchased. At institute farm, five breedable bucks and twenty seven does have been selected initially for breeding purpose on the basis of adult body weight and breed characteristics.

10. Jamunapari Goat Farm Unit, ICAR-CIRG, Makhdoom, Farah, Uttar Pradesh

Jamunapari goat is known for its milk production and selective breeding programme is carried out at CIRG to improve the production performance. The flock strength of nucleus herd of Jamunapari goats at CIRG for the year 2016-2017 was 719. During the period 264 kids were born, in which 128 were males and 136 were females. The population growth of the flocks was 81.5% during the year. The nucleus herd is maintaining about 311 breedable adult does. The overall mortality of the flock during the year 2016-17 was 5.69 % and annual culling rate was 5.79 %. The mean body weights of kids at birth, 3, 6, 9 and 12 months of age were 3.17kg, 10.05kg, 17.81kg, 22.46kg and 27.16kg, respectively during the year. Year and Parity of dam had significant effect (P<0.01) on kid's body weight up to 12 months of age and sex had highly significant effect (P<0.01) on all age group. Season of birth had highly significant effect (P<0.01) on 3 month of age. Males had higher body weight than females at all the ages and the birth type also showed highly significant effect (P<0.01) at all the ages. Year by parity interaction had significant effect (P<0.01) on body weight at the age of 3 Month. Season by sex interaction and Season by birth type interaction had significant (P<0.01) effect on body weight at the age of 6 month, 9 month and 12 month. Year by sex interaction had significant (P<0.01) effect on body weight at 6 month of age. The male had significant higher body weight than female. The Average daily weight gain (ADG) of the kids under intensive management was 107.88, 120.78, 107.86, 133.69 and 107.85 g/day, respectively during 3-6, 3-9, 3-12, 6-9, and 6-12 month age group. The highest value of ADG was 171g/d during 6-9 months of age. Least squares means of part lactation milk yield in 90 days and 140 days were 71.361 and 111.583 liters, respectively during the year 2016-17. Year of kidding had highly significant (P<0.01) influence on both the milk yields. Parity had significant effect on milk yield over the years. The season of kidding had highly significant (P<0.01) on 90 days milk yield. The doe, which had multiple births, produced more milk in comparison to doe having single kid. During this year, a total of 196 does kidded 264 kids, out of which single, twin and triplet born kids were 130, 64 and 02 respectively. Genetic parameter estimates were obtained from

6590 records generated between 1982 to 2013 from 5922 animals in the pedigree over 13 generations. The most parsimonious model for early growth traits included permanent environmental effects due to the dam (pe) and litter effects. Similarly, the most appropriate model for early average daily gain (ADG) between birth and 3 or 6 months also included permanent environment (pe) and litter effects. The estimates of heritability for birth to 12 months ranged from 0.10 to 0.43. The estimates of heritability for ADG varied from 0.04 to 0.41. In general, we had higher estimates of heritability observed when sire was fitted as a random effect. There was no genetic variation observed for survival between birth and 3 months of age. However, we observed heritability estimates of between 0.18 and 0.39 for post-weaning period to 12 months of age. The genetic trend at 9 months of age and 12 months of age was 0.144kg & 0.189 kg per year. The genetic trend at all the ages was positive during the study period. The data comprised of 2217 phenotypic records for milk yield at 90 days (MY90) and 140 days (MY140), total milk yield (TMY) and lactation length (LL) obtained from the progeny of 173 sires and 446 dams during the period 1990-2013. The most appropriate genetic models for milk yield traits were those that included permanent environment effects due to the animal. The direct additive heritability estimates were 0.15, 0.26, 0.25 for MY90, MY140 and TMY, respectively. The additive heritability estimate for LL was low and non-significant at 0.02. The repeatability estimates were moderate to high ranging from 0.68 to 0.73 for milk yield traits. The repeatability for lactation length was 0.20. Maternal variances were low ranging from 0.03 for MY90 to 0.13 for TMY. There was an increase in mean milk yield of 0.25, 0.70 and 0.72 kg/year respectively at 90 and 140 days, and for TMY. Genetic trends and phenotypic trends for MY90, MY140 and TMY were positive and indicated significant improvement in milk yield traits due to selective breeding. Reproductive performance of Jamunapari goats in terms of breeding efficiency and kidding percent on the basis of does selected for breeding were 95.88% and 106.88%, respectively. The kidding rate was 1.35. Improved animals were supplied to various developmental agencies, farmers and state governments, Non-Government Organizations and progressive breeders for genetic improvement in the field conditions. During year, 154 improved animals were distributed to goat breeders for breed improvement programme. Jamunapari unit works with Green Global Farm (Intensive system goat rearing) and with Govt. breeding farm, Shikohabaad, UP. Similarly we are working to analyze the impact of superior males in collaboration with NGO (Hitaishi Sansthan) in the Bharatpur region of Rajasthan. In this direction we have supplied 45 bucks in collaboration with Govt. of Rajasthan and analyzed the impact of distribution in the region.

11. Malabari Goat Field Unit, KV & ASU Mannuthy, Thrissur, Kerala

Project operates in six field centers viz. Thalassery, Badagara, Tanur, Perambra, Thalaiparamba and Kottakkal located in the North Kerala. Baseline information on production, reproduction and management practices were collected. Total of 1557 animals from 214 farmers were registered and all adult females (1086) were provided with insurance coverage under the project. The participation of women was 64.95%. The overall population growth recorded was 67.47% and the average adult flock size was 5.07 goats. Majority of goat keepers (93.30%) in the project area had school education with land holding of below 25 cents. During this year, 26 bucks were distributed to farmers. Periodical deworming and vaccination coverage was provided to 1557 goats. Supplied 2000kg of mineral mixture and 1680kg of vitamin feed supplements to farmers. The kidding rate in Malabari goat population was 1.65. The percentage of singles, twins, triplets and quadruplets were 43.30, 45.60, 10.60 and 0.50, respectively. Mean average daily milk yield recorded was 0.89 litres. Body weight at birth, three, six, nine and twelve months of age was 2.10, 8.45, 15.16, 20.10 and 22.05 kg, respectively. The mean age at first kidding and inter kidding interval were 394.10 and 274.40 days, respectively. The production economics was calculated under field conditions and the main source of income was from sale of kids. Enteritis was the major cause of morbidity (37%) followed by pneumonia. The mortality rate was 4.57% in adopted flocks. As capacity building, trainings on goat rearing were organized to 705 farmers and entrepreneurs. Trainees are linked through ICT - WhatsApp for further follow up and guidance. A monograph on Malabari goat, one training manual, 6 brochures, 2 technical papers, 8 research papers and 12 research abstracts were published. As part of value addition, technology for goat milk products and pseudomonas enriched goat manure were standardized.

12. Marwari Goat Field Unit, RAJUVAS, Bikaner, Rajasthan

The aim of the field unit is to improve the productivity of Marwari goats in the farmers' flock

through selection with in the breeding tract of this breed. At present this field based unit is functioning in the five clusters in Rajasthan at Deshnok, Daiya, Kalayansar, Raisar and Kan Singh Ki Sird villages. In addition to this, the Buck Rearing Center is also functioning at Livestock Research Center, Kodemdesar (RAJUVAS, Bikaner) for rearing of elite breeding bucks for distribution to the farmers. The goat breeders were provided preventive and curative health coverage. The population growth was 124.39% for all the clusters of this unit during this financial year. The overall body weights (2012-16) at different stages of growth were 2.65 kg at birth, 8.95 at 3 month, 13.73 kg at 6 month, 18.07 kg at 9 month, 25.28 at 12 month of age. The biometrical parameters like body length, body height and heart girth were measured from birth to 12 months of age at three month interval. The lactation performance in term of the average milk yield was 32.24 liters in 30 days, 55.44 liters in 60 days, 75.17 liters in 90 days, 127.64 liters in 140 days during 2012-2015. The average lactation length in Marwari goat was observed as 81.89 liters 140 days. The effect of year and season of birth, type of birth and lactation order on locational performance was also evaluated. The kidding percentage and kidding rate was 129.09 and 1.33, respectively during the reporting period. The average age at first mating was 385.41 days with body weight of 23.63 kg. The average age at first kidding ranged from 485.58 to 536.90 days, weight at first kidding 27.01 to 30.86 kg, the first kidding interval from 208.29 to 336.38 days and service period from 138.71 to 186.38 days during 2012 to 2016. Incidence of abortions and stillbirths were 10.33% and twinning percent was 16.74 %. The overall mortality was 3.53 % for the reporting period (2016-17). Out of the total mortality, 24.06% from pneumonia, 18.72% from pneumo-Enteritis, 18.72% Toxaemia/ Acidosis, 10.70% from Colibacillosis, 8.02% from NAD/general weakness, 8.02 % from predation, 6.42% from Coccidiosis and 5.35% from shock were the causes of death. The total numbers of case covered under health coverage were 25,823 which included both prophylactic (59.03 %) and curative (40.96%). Out of total 15,224 prophylactic measures, 5,250 were for endo-parasite, 2752 for ecto-parasite, 3062 for FMD vaccination, 1225 for ET vaccination and 1052 for PPR vaccination for this financial year. The respiratory and digestive system diseases accounted the highest morbidity (22.78%, 20.35%) followed by the nutritional deficiencies (8.55 %), skin diseases (4.06 %), surgical intervention (2.05 %), miscellaneous diseases (1.48 %) and reproductive system diseases (1.45 %). Ten bucks and 16 females' elite animals were sold in addition to 17 bucks distributed to our own cluster. Fifty out of 66 goat kepeers were provided daily required items such as water bottle. This improvement is due to distribution of selected elite sires in farmers' flocks and effective health coverage.

13. Osmanabadi Goat Field Unit, NARI, Phaltan, Maharashtra

An Osmanabadi goat field unit was established at NARI in April 2009 under the AICRP on Goat Improvement. During the period 1 April 2016 to 31 March 2017, the production performance of goats in farmer's flocks was assessed in three districts in western Maharashtra State. viz. Solapur, Ahmednagar and Sangli districts. The Osmanabadi unit MS Access database of goat records is now also on a web-based platform called AniCloud for ease of data retrieval. This has been done in collaboration with a New Zealand based firm called AbacusBio. Seven hundred sixty eight adult does (325, 224 and 219 adult does in Solapur, Ahmednagar and Sangli districts respectively) are being recorded. These belong to 192 goat keepers, indicating that about four goats are reared per household on average. Detailed periodic recording has been done of their body weight, milk yield, reproduction, kid weights, mortality, morbidity, cost incurred for goat rearing and income earned. 1094 kids were born in 644 kiddings during April 2016 to March 2017, making the average litter size 1.70. Mortality across all age groups and sexes was 4.5%. This has reduced from 6 to 7.5% in the last few years. During the period April 2016 to March 2017, with six months weights of 16 to 19 kg and dam's milk yield 1 to 1.8 litres per day. The total number of bucks purchased since 2009 is 53. About 34,000 straws (0.25 ml French mini straws) of frozen semen of 46 Osmanabadi bucks have been produced so far in NARI's Frozen Semen Laboratory from January 2012 to 31 March 2017. During 2016-17, total 2,348 Osmanabadi buck straws were supplied to A.I. technicians, farmers and entrepreneurs for breeding Osmanabadi goats including 225 straws supplied to The Goat Trust, Lucknow, Uttar Pradesh and 69 straws supplied to Quidditas Farms Pvt. Ltd., Gulbarga, Karnataka. More than 50 A.I. technicians have started using Osmanabadi buck frozen semen from NARI for inseminating Osmanabadi and local does in the field. Conception rates of 50 to 55% have been reported by field technicians. Additionally, 20,482 straws of Osmanabadi buck semen were procured from NARI in September 2016 by the Karnataka Animal Husbandry Dept. for use in different areas of Karnataka State. The

Osmanabadi unit provided training in goat cervical A.I. using frozen semen, to about 100 officers of the Animal Husbandry Department in Karnataka. Nine information booklets in Marathi language have been distributed to participating and other goat keepers to promote better goat management practices. Regular preventive health care of all 768 goats and their kids was carried out in all villages including vaccinations, deworming and spraying against ecto-parasites. 71 goat keepers were trained in 6 programs in preventive health care of goats and first-aid treatment so that they can care for their goats themselves instead of having to rely on others. Six Goshthi/meetings and two exposure visits of women were conducted. The quality of the Osmanabadi breed in the project and other areas including other states is being improved continuously through dissemination of the genetics of elite bucks.

14. Sangamneri Goat Field Unit, MPKV, Rahuri, Maharashtra

The Sangamneri field unit is working in two dimensions being it a threatened breed i.e. upgradation alike Sangamneri goat and genetic improvement in existing Sangamneri population. During the year 2016-17, 2023 does were registered in 29 villages under 4 clusters and 3 districts. Total 43 bucks were rotated in 4 clusters for breeding. The total progeny generated was1851. The overall least squares means for birth, 3, 6, 9 and 12 month of age were 2.12, 9.42, 15.05, 19.23 and 22.84 kg, respectively. The corresponding least squares means noticed during the period were 2.16, 10.30, 16.10, 19.66 and 23.17 kg, respectively. The village cluster, year of birth and season of birth exerted significance influence ($p<0.01$) on body weights upto six month of age, while sex and sire influenced the body weights significantly ($p<0.01$) up to 12 months of age. The overall age at first kidding was 418.70 days and kidding interval was 257.91 days. The overall 90 days milk yield was 95.21 L which was significantly affected by Village cluster, year and season of kidding and kidding interval. The seasonal advisory has been provided to goat keepers through Gramin Krishi Mosum Seva (GKMS) of Mahatma Phule Krushi vidyapeeth, Rahuri. During the period 7 farmers trainings, 3 health camps, 4 exposure visits and 13 group meetings were organised. One training manual for goat keeper is published. The process standardisation for Quarg Cheese by using goat milk has been carried out with the help of PG student of Dairy science. The major impact of this unit is increase the population of Sangamneri goat with improvement in growth and prolificacy.

15. Sirohi Goat Farm Unit, ICAR-CSWRI, Avikanagar, Rajasthan

The opening balance of flock strength on 01.04.2016 was 663 animals. The closing balance as on 31.03.2017 was 595 animals. The overall least squares means for live weights of kids born during 2012-13 to 2016-17 at birth, 3, 6, 9 and 12 months of age were 3.09, 12.27, 19.93, 26.56 and 31.32 kg, respectively. Males were heavier than the females at all stages of growth. The effect of year, sex and type of birth was significant on almost all the traits, except type of birth on PDG3-12 month. The LS means of growth rate in terms of per day average gain was 101.76 and 68.15 g from 0 to 3 months (PDG 0-3) and 3 to 12 months (PDG 3-12) of age, respectively. The overall least squares means for milk yield of does kidded during 2011-12 to 2015-16 at 90 days, 150 days, total lactation milk yield and lactation length were 66.06, 93.13 and 106.85 kg, and 192.78 days, respectively. The effects of year of kidding and lactation order were significant on almost all the traits except lactation order on 90DMY and 150DMY. Out of 306 does available for breeding, 288 were tupped and 242 kidded with 32 giving birth to twins during the year. The tupping percentage was 94.12. The breeding efficiency was 88.30% and 94.32%, on the basis of does available and does tupped. The kidding percentage was 97.16 and 103.79% on the basis of does available and does tupped, respectively. The litter size was 1.13. The mortality rates in 0-3, 3-6, 6-12 month age group and in adults were 9.46, 1.43, 0.42 and 0.33 percent, respectively. The overall mortality rate based on animals available and exposed at different stages of growth was 2.81 percent. A total of 201 animals comprising of 88 males and 113 females were sold to the progressive farmers, Government and non-government agencies for improvement of their livestock. In addition to these, two superior Sirohi bucks were distributed free of cost to registered goat farmers under MoU for breeding and improvement of their livestock. Four KVKs located at Bundi, Chomu, Sangaria (Hanumangarh) and Khedbrahma (Gujarat) were provided with breeding males and females for establishment of Sirohi goat units.

16. Sirohi Goat Field Unit, College of veterinary sciences & AH, Vallabhnagar, Rajasthan

Baseline information on production and reproduction traits, managemental practices,

production trend and disease pattern were recorded and analyzed. The registration of farmer's flock and the identification of animals were carried out in four clusters. The data on growth, lactation and reproductive performance of Sirohi goats under field conditions have been analyzed. The closing balance of the registered flock was 1997 animals including 1189 adult females. During report period, 869 kids were born out of which 442 were males. During report period population growth was 72.62%. Total 310 males were sold out of which maximum 157 males were sold at adult age group. The least square means for body weight at birth, 3, 6, 9 and 12 months of ages were 2.43, 13.14, 17.63, 20.99 and 25.98 kg, respectively. The birth weight increased over the years. Year, sex of kid and type of birth had significantly affected the body weights. Single born kids were significantly heavier than the multiple born kids at all the ages. The overall least squares means for milk yield over 30 days, 60days, 90 days, 150 days, lactation yield and lactation length were 21.74, 47.54, 69.13, 100.01, 100.31 lit. and 151.11 days, respectively. Season of kidding, type of birth had significant effect on milk yield. The lactation order played a significant role in milk yield. The overall least square means for age at first mating, weight at first mating, age at first kidding, weight at first kidding, service period, kidding interval and gestation period of test progenies were 474.03 days, 27.12 kg, 624.58 days, 30.23 kg, 247.97, 398.05 and 150.10 days, respectively. The kidding rate (litter size) was 1.17. During report period 4980 animals were dewormed, ecto-parasiticide was used in 4228 animals. Further, 1542 and 700 animals were vaccinated for ET & PPR, respectively. The overall mortality was 3.61%.

17. Surti Goat Field Unit, N.A.U., Navsari, Gujarat

Base line information on production and reproduction traits, managemental practices, production trend and disease pattern were recorded and analyzed. The registration of farmer's flock and the identification of animals were carried out in 18 villages under six clusters. The data on growth, lactation and reproductive performance of Surti goats under field conditions have been analyzed using least square techniques for the year 2016-17. The closing balance of the registered flock was 966 animals including 732 females. Out of 732 females 640 females were white coloured that includes 512 adult white coloured females. During the year, 34 new white coloured goats had kidded for the first time in different clusters. During current year, 564 kids were born out of which 289 were males. White coloured kids born during the year were 172 males and 166 females respectively. Major constraint faced during the year again remained non availability good quality white coloured Surti bucks. Farmers raise white Surti type buck for sacrificial purpose on Id-ul-Fitar festival. This imparts high selection coefficient against this breed leading to genetic death of almost entire elite Surti germplasm from male side in natural breeding tract of this breed. Closing balance for born and brought up male Surti bucks in field clusters remained only 9 due to sale of white coloured Surti bucks during Id-ul-Fitar festival as preferred by Muslims of South Gujarat region. Total 166 males were sold out of which maximum 135 males were sold between 6-12 months age. Overall population growth of 98.46% was recorded with the addition of 564 live kids. A marginal increase in the population growth had been observed during current year. Continuously increasing white: non-white ratios of kids have been obtained in farmers flock as a result of selective breeding for economically important trait of white colour. The white: non-white kid ratio had significantly increased from 1.02 to 1.49 in last five years. The least square means for body weight (2011-2016) at birth, 3, 6, 9 and 12 months of ages was 2.035 (2671), 8.199(1740), 13.138 (1351), 18.288 (1111), 21.435 (500) kg, respectively. Significantly higher body weight had been observed among all the age groups during report period as compared to year 2012-13. Season of birth, sex of kid, colour and type of birth had also significantly affected the body weights. Kids born between November and February months had higher birth weights at all age groups. The least square mean weight of single born kids was found to be significantly higher than the twins and triplet kids at all the age groups. The overall least square means for milk yield over 90 days, 150 days, lactational yield and lactation length was 76.63 (765), 116.92 (594), 122.85 (765) Kg and 168.53 (765) days, respectively. Significant increase in 90 and 150 day milk yield had been observed during report period as compared to 2012-13. Season of kidding has significant effect on milk yield and goat kidded during the July to October remained low producer throughout. Surti goats with higher litter size were found to be better producer compared to their counter parts. This phenotypic variation in milk yield among Surti goats gives possible scope for improvement in Surti Flock for total lactation yield using selection tools. Age at first mating, weight at first mating, age at first kidding, weight at first kidding, service period, kidding interval and gestation period was 463.62 (34) days 22.38 (34)

Kg, 608.53 (34) days, 24.47 (34) Kg, 171.71 (346), 321.00 (346), 149.29 (346) days, respectively. The kidding rate (litter size) was 1.50 justifying higher prolificacy in Surti Goats. Continuous significant improvement in reproductive traits had been observed over last five years in study area. Total 46 breeding bucks were provided to goat farmers of adopted villages and those have taken training from our center to minimize the problem of non-availability of Surti bucks. During last five years 111 breeding bucks had been provided from the center. During 2016-17 thirteen (13) breeding females had also been supplied. Additionally surplus stock of 29 males and 43 females had also been distributed to farmers and Jeevdaya trust. In total 140 males and 77 females had been supplied by Surti field unit during last five years. During current year 2275 animals were dewormed, Mineral mixture and antibiotics were distributed for use in 1650 animals. Around 175 doses of FMD, PPR and HS vaccine had been given to the goats maintained at Surti farm unit. Overall mortality in Surti flocks was 5.94%. Visits to the tribal villages of Surat and Tapi district have been undertaken during the current year. Sensitization about benefits of AICRP on Goat scheme was made through field visits and on farm one day training programs. Eighteen (18) key persons have been identified from 14 villages that voluntarily came forward for the implementation of scheme in their villages after understanding the objectives of scheme. With continuous bilateral efforts from farmers and Surti field unit, around10-20 village level goat cooperatives had been started in these tribal villages. One (1) five day training programs entitled "Profitable goat farming through scientific methodologies" was organized by Surti unit in which 37 farmers participated. Additionally, four (4) one day on campus trainings benefiting 210 farmers in collaboration with ATMA project were conducted. Additionally, one success story entitled "Packaged Goat Milk: An innovation for social cause among tribal" had been documented.

18. Uttarakhand Local Goat Field Unit, GBPUA&T, Pantnagar, Uttrakhand

Four clusters names Bara, Tilpuri, Bhimtal and Kunda were established. A total of 1178 kids using 40 bucks and 661 doe have been produced during the period.The average values for body weight were observed as 1.89, 9.75, 13.09, 16.69and 20.05kg, respectively at birth, 3, 6, 9 and 12 months of age. Corresponding values for body height were 28.31, 47.25, 51.30, 56.02 and 59.91 cm, for body length 26.68, 44.10, 47.84, 51.68and 55.19cm and for chest girth 29.01, 48.52, 52.70, 57.26and 60.53cm, respectively at birth, 3, 6, 9 and 12 months of age.The overall milk yield in 30, 60, 90 and 120 days were 14.81, 35.98, 54.05and 71.77liter, respectively.Overall lactation length and lactation yield were 114.21days and 66.66liter, respectively. The overall age at first mating and weight at first mating were recorded as 281.76days and 17.33kg, respectively. The mortality in the total flock was 11.15%. The kidding rate has been recorded as 1.53 %. Twining and triplet kidding was observed as 48.41 and 2.27% respectively. A nucleus flock of Pantja goats has been established at Pantnagar, where in 41 females and 34 males are being maintained (as on March 31, 2017). During the report period 31 Pantja bucks (total 61) were supplied, out of these 13 bucks (total 17) were died and 39 scrub bucks (total 97) were castrated in the field. To record relevant information in the breeding tract, a detailed questionnaire was prepared and surveys were made on 132 households, rearing 1178 goats (with 35.74% Pantja population) in 19 villages of 4 clusters of U.S. Nagar and Nainital districts. Pantja buckling was castrated at an early age for delicious meat of withers. Goat keepers maintained their flocks within shed (76.52%) with kaccha floor (81.82%) and temporary roof (89.39%) during night and allowed grazing from morning to evening (78.03%) on community land. They did not provide manger (48.48%) but provided concentrate (30.30%) from home available ingredients.

PRIORIZATION, MONITORING AND EVALUATION CELL

Ashok Kumar and P.K. Rout

A. Research management and coordination: This is major activity relate to manage research projects (Institute and out funded project and coordination of IRC, RAC and other related meetings). This year institute running 18 Institute and 25 out funding project.

B. **HRD and training:** This unit provides opportunity for training and capacity building of all class of employee considering their skill deficiency areas for best performance in the institute. Annual training plan (ATP) was prepared as per the guideline of ICAR and executed it.

C. **Institute Technical Management Unit (IPR):** This unit assigned to Intellectual Property Management and transfer / commercialization of Agricultural Technology under "National Agriculture Innovation Foundation(NAIF)" project of ICAR. It manages the innovation, showcase the intellectual assets and pursue matter related to IP management and transfer/ commercialization of technologies.

D. **ISO (9001:2008) management activities:** Institute awarded ISO Certification in April 2015 to 31 March, 2018. In annual process 1st Internal Audit was held Month of July, 2016 and 2nd Internal Audit conducted in Month of December, 2016. The External Audit conducted by TUV Nord in February (16.02.2016).

E. **Academic and collaboration:** This unit assigned the student admission for training and dissertation for different degree/ programme (M.Sc., M.VSc. and Ph.D) AND academic / training collaboration with institute, universities, NGOs and progressive farmers.

METHODOLOGY/TECHNOLOGIES DEVELOPED

Development/Standardisation of Methodology for Non-Surgical Saliva Collection in Goats

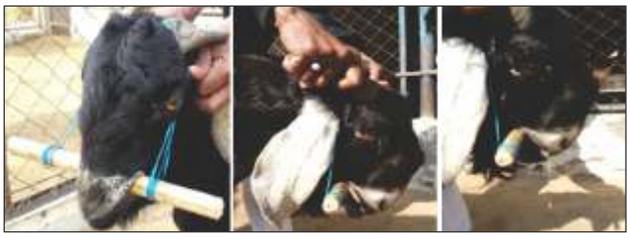
N. Ramachandran and S. P. Singh

The non-surgical steps using low cost device for collection of clear whole saliva samples has standardised.

In this method, the swab holder was prepared inserting 5 ml micro tip in 15 ml dry and clean graduated centrifuge tubes having neck (Borosil, code 8084). Tie the cotton rope/plastic sutli (length: 25-30" for kids, 45-50" for adults) at one end of wooden stick (Length: 6" for kids and 12" for adults; Diameter: about 1 cm for kids and 2 cm for adults) preferably of neem or any other edible stem of perennial tree fodders/PVC pipe of same size, very tightly in such way that stick is 2" out on both side of buccal cavity after tying. The time of saliva collection should be preferably before feeding in the morning (minimum 10 h feed restrictions) and ad lib watering 24 h.

The stick should be inserted between the jaws above tongue and fasten as shown in picture below. After 1-2 minutes accumulation of saliva in buccal cavity and/or drooling of saliva started.

The saliva swabs should be taken using forceps (length: 5" for kids, 10"for adult goats) from the base between the base of the tongue and lower mandible ensuring regurgitated feed materials or blood are not contaminating the swab. At least 2-3 swabs should be taken to have minimum of 1ml saliva. Then the tubes with cotton swab should be kept inside the ice box till they are centrifuged at 2000 x g for 5 minutes at room temperature or refrigerated temperature (4°C) as per the requirement.



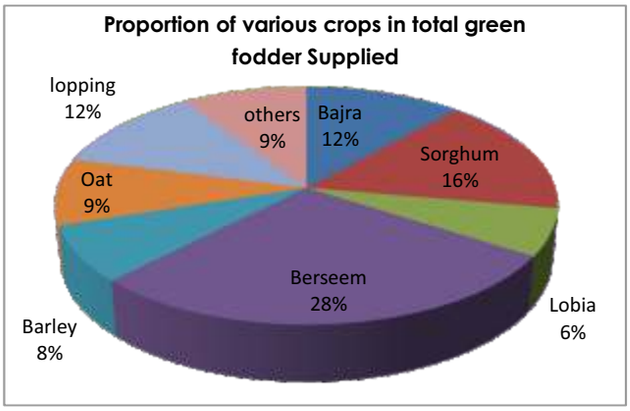
After centrifugation, the tip should be removed from centrifuge tubes and the clear saliva should be aspirated with the help of micropipette by leaving debris at the bottom and stored at -20°C till further analysis.

AGRICULTURE FARM AND AGROFORESTRY SECTION

Prabhat Tripathi

Agriculture farm section is working with main objectives to produce nutritionally sound fodder for goats and sheep through cultivated fodder crops and agro-forestry systems During the year 2016-17 farm section supplied 9000 quintals of green fodder to different livestock units and produced approximately 230 quintals barley& oat grains. A nursery of about 2000 seedlings of various fodder trees were raised and maintained.

Apart from its main objectives this section also supports horticulture, maintenance section and staff welfare club for various daily routine activities.



METEOROLOGICAL OBSERVATIONS (2016-17)

N.Ramachandran & S. P. Singh

Months	Mean Max Temp. (°C)	Mean Min Temp. (°C)	Mean Daily Temp. (°C)	Mean Vapor Pressure (mmHg)	Mean RH (%)	Mean RainFall (mm)/ Wet Days	Sun Shine (hrs)
April, 2016	43.00	22.63	32.82	10.12	21.71	0.00	284.60
May, 2016	44.53	26.23	35.38	16.42	33.18	13.60	275.90
June, 2016	43.67	28.80	36.23	21.94	45.20	14.20	258.60
July, 2016	36.65	27.10	31.87	27.14	78.65	195.60	107.10
August, 2016	35.61	26.19	30.90	27.19	79.33	136.10	184.70
September, 2016	38.08	25.20	31.64	24.09	64.68	38.00	255.40
October, 2016	38.39	19.53	28.96	26.64	46.99	2.00	262.00
November, 2016	33.02	12.00	22.51	11.59	50.07	0.00	212.90
December, 2016	25.61	8.39	17.00	10.68	70.00	0.00	167.00
January, 2017	22.73	7.11	14.92	10.27	72.84	27.20	177.50
February, 2017	28.02	9.98	19.00	10.68	55.88	0.00	242.20
March, 2017	33.37	14.89	24.13	11.61	42.38	10.90	278.10

Maximum temperature: 49.0 °C on 05.06.2016.
Minimum temperature: 0 °C on 22.01.2016.
Annual Rain Fall: 437.6 mm in 50 Days.
High sunshine: 11.5 hrs on 21.04.16.

CONSULTANCY, PATENTS AND COMMERCIALIZATION OF TECHNOLOGIES

Commercialized

- Alquit - a green drug technology for control of ecto-parasites has been commercialized to M/S Natural Remedies Pvt. Ltd, Bengaluru.
- Areamix- An area specific mineral mixture, commercialized to M/S Girraj Industries, Sirsaganj, U.P.
- Diarrionex-HS - an anti-diarrhoeal formulation commercialized to M/S Girraj Industries, Sirsaganj, U. P.
- HEALEX-FR - a skin gel commercialized to M/S Girraj Industries, Sirsaganj, U. P.
- Goat milk based soap (Ajas) – three variants of soap i.e. Ajas beauty, Ajas green and Ajas antiseptic soaps have been commercialized to M/S BVG Life sciences, Pune (M.S.).
- J.D. Vaccine – (Mycobacterium avium subspecies paratuberculosis) transferred to commercialization Bio JD commercialized to M/S Girraj Industries, Sirsaganj, U. P.

Under Commercialization

- BRUCHEK-Dot ELISA Kit for diagnostics for brucellosis in goats transferred to NRDC for commercialization.
- ELISA KIT for JD transferred to NRDC for commercialization.
- Intra vaginal pessaries for oestrus synchronization.
- Low cost complete feed pellet.
- Cost-effective milk replacers for kids.
- Goat meat Murukku: A crispy food product.
- Goat meat Nimkee: A snack food.
- Goat flavoured milk and whey drink.
- Cereal pop.

Patent Filed

S.No.	Title	Name of First Inventor	Patent Application No.	Date of filling
1.	Moringa oleifera complete feed for goats: Chemical composition, production protocol & goat productivity thereof	Dr. U.B. Chaudhary	E101/56426/2016-DEL	20.06.16

SKILL DEVELOPMENT PROGRAMME

A.National Training Programme

S. No.	Name of Training	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
1	66th National Training Programme on Scientific Goat Farming	Self-financed	Farmers, Entrepreneur etc.	53 (UP-20, MP-6, Uttarakhand-4, Haryana -4, Rajasthan-3, Karnataka - 3, Bihar-4, Chhattisgarh -2, Maharashtra – 1, Andhra Pradesh -1, Tamil Nadu-1, Bengal-1, Punjab-1, Odisha-1, Delhi-1)	21st – 30th April 2016 (10 days)
2	67th National Training Programme on Scientific Goat Farming	Self-financed	Farmers, Entrepreneur etc.	92 (UP-52, MP-5, Uttarakhand -4, Haryana -6, Rajasthan-3, Bihar-4, Chhattisgarh -2, Maharashtra – 1, Andhra Pradesh -2, Bengal-2, Punjab-1, Odisha-1, Delhi-4, Jharkhand -1, Telangana- 2, Himachal Pradesh- 2)	30th August to 8th Sept. 2016 (10 days)
3	68th National Training Programme on Scientific Goat Farming	Self-financed	Farmers, Entrepreneur etc.	72 (UP-37, MP-11, Haryana -6, Rajasthan-2, Bihar-8, Chhattisgarh -1, Maharashtra – 1, Delhi-3, Jharkhand -3)	2-11 Nov. 2016 (10 days)
4	69th National Training Programme on Scientific Goat Farming	Self-financed	Farmers, Entrepreneur etc.	107 (UP-42, MP-15, Uttarakhand -1, Haryana -7, Rajasthan-9, Bihar-5, Chhattisgarh -4, Maharashtra – 1, Andhra Pradesh -2, Bengal-2, Punjab-4, Odisha-3, Delhi-5, Jharkhand -1, Telangana- 1, Himachal Pradesh- 2, Chandigarh -2, Sikkim-1, Jharkhand -1, Gujarat-1, Karnataka -1)	16-25, March 2017 (10 days)

B. Sponsored Training programme for Farmers

S. No.	Name of Training	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
1	Scientific Goat Farming	Irrigation and Water Resources Department, Bahjoi, UP	Farmers	20	2-6 February, 2017 (5 days)
2	Scientific Goat Production	Animal Husbandry Department, Odisha	Farmers	10	20-23 February, 2017 (4 days)

C. Sponsored Training Programme for Officers/Staff (Trainers)

S. No.	Name of Training	Sponsoring Agency	Nature of Participants	Number of Participants	Duration
1	Scientific Goat Production	Directorate of Animal Husbandry, Government of Uttar Pradesh	Veterinary Officers	14	14-18 June, 2016 (5 days)
2	Scientific Goat Farming	Veterinary Officers Training Institute (VOTI), Odisha	Veterinary Officers	10	18-20 October, 2016 (3 days)
3	Scientific Goat Farming	Veterinary Officers Training Institute (VOTI), Odisha	Veterinary Officers	10	16-18 Nov., 2016 (3 days)
4	Advances in Goat Rearing	JEEVIKA, Bihar	Officers and Other staff of organization	15	24-30 Nov., 2016 (7 days)
5	Scientific Goat Production	Directorate of Animal Husbandry, Government of Punjab	Veterinary Officers	13	19-25, January 2017 (7 days)
6	Scientific Goat Farming	Veterinary Officers Training Institute (VOTI), Odisha	Veterinary Officers	10	31 Jan. - 2 Feb., 2017 (3 days)
7	Scientific Goat Farming	Veterinary Officers Training Institute (VOTI), Odisha	Veterinary Officers	10	7-9 February, 2017 (3 days)
8	Scientific Goat Farming	Chhattisgarh Kamdhenu Vishwavidalya, Durg	Veterinary Officers	15	1-7 March, 2017 (7 days)

LINKAGES AND COLLABORATIONS

The institute has developed effective linkages with GLA University Mathura, DUVASU Mathura, IVRI Izatnagar, Kamdhenu University, Gujarat; and Banda University of Agriculture & Technology, Banda during this year.

Teaching

During this year 13 Ph.D. (05DUVASU, 04 GLA, 01 NDRI and 03 IVRI) students are conducting research under different scientists of the Institute. The final year B. V.Sc. & AH students of college of veterinary science & AH, Mathura successfully completed internship programme during May, 2016. Students of different academic colleges and veterinary colleges visited the institute laboratory and livestock Units.

RADIO TALK / TV PROGRAMME

1. Ashok Kumar (2016). Delivered Radio Talk on AIR Mathura on Goat diseases and vaccination on 8th September, 2016.
2. Ashok Kumar (2016). Participated in live programme under "HELLO KISAN" on 29th September, 2016 from 06:00 to 07:00 PM on DD Kisan, New Delhi.
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6. M.K. Singh (2016) Coordinated programme on breeding management of goats, package of goat management practices at organized farm, Kids management, Goat management under inclement weather etc. Such programmes were recorded in May, August, December, February and March 2017 which were telecasted by Krishi Darsan (Delhi-Doordarsan) from time to time.
7. M K Singh (2017) Coordinated and delivered talk for preparation of documentary film on Doubling of Farmer's Income on 3rd March, 2017with the NFDC.

AWARDS AND RECOGNITIONS

1. **Vividhlaxi Audyogik Samshodhan Vikas Kendra (VASVIK) AWARD:** Dr. M.S. Chauhan, Director, was awarded VASVIK Award for Outstanding Research in Agricultural Sciences-2015. He has developed several potential Assisted Reproductive Technologies for enhancing the reproductive efficiency in livestock and significantly contributed towards the development of simple method for in vitro Production (IVF) of embryos in cattle, buffalo, yak and goats, production of embryonic stem cell lines in buffalo, ovum pick up (OPU)-IVF technology in cattle and yak and cloning technology in buffalo using a modified and cost effective hand guided cloning technology.

2. **ICAR TEAM AWARD:** Dr. M.S. Chauhan was awarded ICAR team award (as team member) for his contribution in outstanding research in Animal and Fisheries Science. The team led by Dr. S.K. Singla, was involved in standardization and optimization of Zone-free Embryo Cloning (hand guided cloning) of buffaloes of high generic merit-Garima-II, Mahima, Shresht, Swarn, Lalima, Rajat, Apurva. The production involved several types of somatic cells such as fetal, new-born and adult skin fibroblasts, embryonic stem cells, seminal plasma-derived cells, trophoblast cells, blood lymphocytes, etc. and birth of live progeny from cloned embryos using newborn fibroblasts as donor cells-fist in the world in buffalo.

3. **Rafi Ahmed Kidwai Award for outstanding research in agricultural** sciences Dr. M.S. Chauhan, Director, CIRG was awarded Rafi Ahmed Kidwai Award for outstanding research in agricultural sciences for his contribution in outstanding research in Animal and Fisheries Science. He has developed several potential Assisted Reproductive Technologies for enhancing the reproductive efficiency in livestock. He has significantly contributed towards the development of simple method for in vitro Production (IVF) of embryos in cattle, buffalo, yak and goats, production of embryonic stem cell lines in buffalo, ovum pick up (OPU)-IVF technology in cattle and yak and cloning technology in buffalo using a modified and cost effective hand guided cloning technology. He has published a large number of research papers in the high impact journals. His research achievements are well recognized both within and outside the country.

4. **The SEE Fellow Award**of Society of Extension Education in the field of Teaching, Research and Extension Management-2017 has been conferred to Dr. M.S. Chauhan, Director, CIRG.

5. **Best Extension Professional Award**during 8th National Extension Education Congress-2017 has been conferred to Dr. M.K. Singh, P.S., GGB.

6. **Rajbhasha Gaurav Award** (2015) was conferred to Dr. Dinesh Kumar Sharma to his book Bakri-Bhed Rog: Chikitsa Avam Prabandhan.

7. Singh SV. 2017.**NRDC Societal Innovation award- 2014**for innovation entitled 'Indigenous vaccine against Johne's Disease in domestic livestock'.

8. Pawaiya RVS. 2016. **Award of Fellow (FIAVP)**of the Indian Association of Veterinary Pathologists (IAVP) at Durg, Chhattisgarh at Veterinary Pathology Congress-2016 held during 9-11 November, 2016.

9. Pawaiya RVS. 2016.**Awarded Diplomate of the Indian College of Veterinary Pathologists (ICVP)** at Durg, Chhattisgarh at Veterinary Pathology Congress-2016 held during 9-11 November, 2016.

10. Nitika Sharma. 2016.**Second Prize in Shrutlekh Competition**held at CIRG during Hindi Pakwada.

11. Kumar V, Mohan B, Singh K and Dixit A K. (2016). Kendriya Bakri Anusandhan Sansthan Ke Prodhogikiyon Ka Angikrat Ganv Par Prabhav.**Hindi Shodh Patra Pratiyogita**at ICAR-CIRG, Makhdoom on 24.09.2016 (Won 3rd Prize).

12. Received **An Appreciation Award**from the organizers for the participation and showcasing goat technologies in Krishi Unnati Mela-2017 at ICAR-IARI, PUSA, New Delhi on 14-17 March 2017 by putting stall, goat show and showcasing technologies in thematic pendal. Team- A.K.Dixit, S.P.Singh, Khushyal Singh and Vijay Kishore.

13. **S. C. Sud Memorial Best Doctoral Thesis Award-2015:** Dr. Ravi Ranjan, Scientist, Animal Physiology & Reproduction Division of Institute was awarded S. C. Sud Memorial Best Doctoral Thesis Award-2015 during XXV Annual Conference of Society of Animal Physiologists of India (SAPI) held at Department of Veterinary Physiology, College of Veterinary Science & Animal Husbandry, Nanaji Deshmukh Veterinary Science University, Mhow- 453446, Indore, M.P., India on 21st December, 2016.

14. **ISSGPU Fellowship award:** Dr S K Jindal, PS & Head AP&R Division, ICAR-CIRG Makhdoom bestowed with ISSGPU fellowship during Annual Conference of Indian Society for Sheep and Goat Production & Utilization (ISSGPU) and National Seminar on " Improvement of Small Ruminant Production System for Livelihood Security", ICAR-CSWRI, Avikanagar, (Malpura),District Tonk Via Jaipur, Rajasthan (India)-304 501, March 9 -10, 2017.

15. Dr. M.K. Singh,**"Best Extension Professional Award"** for outstanding contribution in the field of extension by the Society of Extension Education in 2017 for promoting scientific goat farming and development of goat based agri-business models.

16. Received First prize in **Hindi Shodh Patra Pratiyogita** during Hindi Pakhwada at CIRG, Makhdoom from 14-28 September, 2016.

17. Awarded with prestigious **"ANA-Dr. UB Singh Memorial Young Scientist Award"** from Animal Nutrition Association, India for outstanding work in the field of Animal Nutrition.

18. संस्थान के डा. दिनेश कुमार शर्मा, प्रधान वैज्ञानिक द्वारा हिन्दी में लिखित पुस्तक 'बकरी–भेड़ रोगः चिकित्सा एवं प्रबन्धन' बकरी एवं भेड़ रोगों के सम्बन्ध में महत्वपूर्ण जानकारी प्रदान करती है। इस पुस्तक में कुल 13 अध्याय, 27 चित्र एवं 7 तालिकाओं के रूप में बकरी–भेड़ रोगों की गहन चर्चा की गई है। पुस्तक में हिन्दी भाषा का प्रयोग सरल

सुपाच्य और प्रभावी है जो विषय की निरन्तरता को बनाये रखता है। यह पुस्तक पशुपालन के क्षेत्र में किया गया एक सफल प्रयास है। इस पुस्तक के लेखक डा. दिनेश कुमार शर्मा, प्रधान वैज्ञानिक को दिनांक 14 सितम्बर, 2016 को माननीय राष्ट्रपति द्वारा तृतीय पुरस्कार से सम्मानित किया गया।

19. केन्द्रीय गृह मंत्रालय भारत सरकार के आधीन कार्यरत नगर राजभाषा कार्यान्वयन समिति (नराकास), मथुरा द्वारा वर्ष 2015–16 के दौरान राजभाषा हिन्दी में उत्कृष्ट कार्य हेतु मथुरा जनपद के अन्तर्गत कार्यरत केन्द्रीय कार्यालयों में संस्थान को प्रथम पुरस्कार व प्रशस्ति–पत्र प्रदान कर सम्मानित किया गया।

EXHIBITION/TECHNOLOGY/KISAN MELA

Exhibitions/ Technology/Kisan Mela

- Participated in Kisan Summelan and Krishi Pradarshani Under the Prime Minister Crop Insurance Scheme at ICAR-IVRI, Izzatnagar, Bareilly, U.P., on 16.04.2016.
- Participated in Kisan Summelan and Krishi Pradarshani Under the Prime Minister Crop Insurance Scheme at K.V.K. DUVASU, Mathura, U.P., on 30.04.2016.
- Participated in District Kisan Mela at K.V.K., Mathura, U.P., on 08.07.2016
- Participated in Krishi Evam Gramya Vikas Pradarshani at Pt. Deen Dayal Dham, Nagla Chandrabhan, Farah, Mathura, U.P., on 25-29 September, 2016.
- Participated in Purvanchal Krishi Pradarshini Evam Kisan Sangosthi at Mahant Digvijaynath Inter College, Chaukimaphi, Vikaskhand-Janglekoria, Gorakhpur, U.P. on 23-24 October, 2016.
- Participated in Janpad Istriya Kisan Mela (Jila Adhikari Ki Adhayksha Mei) at Jawahar Bagh Parisar, Mathura, U.P., on 27.10.2016.
- Participated in Global Rajasthan Agritech Meet (GRAM) in Conference at Jaipur Exhibition & Convention Center (JECC), Sitapura, Jaipur, Rajasthan on 09-11 November, 2016.
- Participated in Northern Regional Farmers/Agriculture Fair (RAF), Krishi Kumbh-2016 at GIC Ground, Muzaffarnagar, U.P., on 28-30 November, 2016.
- Participated in National Sheep and Wool Fair at ICAR-CSWRI, Avikanagar (Rajasthan) on 04.01.2017.
- Participated in Gramoday Mela at Chitrakoot, Satna, M.P., on 24-27 February, 2017.
- Participated in Krishi Unnati Mela – 2017 along with animal Show at ICAR-IARI, Pusa, New Delhi on 15-17 March, 2017.

Exhibited Goat Technologies

- Displayed ICAR-CIRG technologies on the occasion of Institute Foundation Day.
- Displayed ICAR-CIRG, Makhdoom technologies on the occasion of visit of Hon'ble DDG (AS), ICAR, New Delhi Prof. (Dr.) H. Rahman to ICAR-CIRG, Makhdoom on 06.01.2017 to 07.01.2017.

Technical Correspondence

In all 166 technical letters of which 146 in Hindi and 20 in English were received from different categories of aspirants covering different of parts of country on various aspects of goat production and replied suitably.

Visit Arrangement and Solutions provided through Farmer Single Window

In all 3380 visitors were entertained and apprised them with research, extension and development activities of the Institute.

Helpline Calls

In all 1262 calls were received regarding various aspects of commercial goat farming, improved goat production technologies, elite germ plasm andtraining programmes and replied suitably.

RADIO TALK / TV PROGRAMME

1. Ashok Kumar (2016). Delivered Radio Talk on AIR Mathura on Goat diseases and vaccination on 8th September, 2016.
2. Ashok Kumar (2016). Participated in live programme under "HELLO KISAN" on 29th September, 2016 from 06:00 to 07:00 PM on DD Kisan, New Delhi.
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7. M K Singh (2017) Coordinated and delivered talk for preparation of documentary film on Doubling of Farmer's Income on 3rd March, 2017with the NFDC.

SUCCESS STORIES

Build Possibilities in Friendship with Goats

Vijay Kumar, Braj Mohan,
A K Dixit and Khushyal Singh

Four friends lead by Mohd. Mujassim of Muzaffarnagar (Nansurpur) Uttar Pradesh decided to go for big goat farm inspired by another farm in middle-east country. After visiting ICAR-CIRG in December 2015, their motivation level gets higher and found more possibilities in the sector. After proper training at CIRG, they invested about 25 lakh in INDIAN GREEN FARMS (goat farm) with equal sharing basis. Pucca shed with all necessary facilities was constructed keeping in mind of CIRG shed. 146 goats (Sirohi, Jamunapari and Barbari) were purchased in three phases from Kanpur, Ajmer and Nagaur. Due to transportation stress and lack of experience, some animals died but they learned lesson. Up to March 2017, 200 kids born (80% twins, 5 % triplet and 15% single) at farm. Kid mortality (1-2 week of age) was higher in early days but CIRG intervention leads to satisfactory level whereas adult mortality was normal below 5%. Animals are reared under semi-intensive condition with 3 full-time and 2 part-time labours. All essential vaccination and deworming are normal practices at farm. Manure is used in agriculture farm and milk is not taken out. Bakri Id was target market and 50 animals were sold and average price was Rs. 12,000/goat (Range: Rs.8, 500-26,000). Weight of the animals varies from 32 kg to 57 kg. Net benefit per goat was calculated Rs. 7,500. Major constraints they find are: vaccine unavailability, local doctor and trained labor. Trust among friends play big role in management of farm. Works are distributed among them on their capacities and available time. They are planning for expending the farm for 500 goat capacity within 2 years and play a big role in secondary goat farming sector. They thank CIRG for all type of supports.

Adoption of goat technologies and its impact on farm income: A success story of young goat farmer

A K Dixit, M.K.Singh, Braj Mohan,
Khushyal Singh and Vijay Kumar

Mr. Rashid a young educated entrepreneur obtained training on Scientific Goat farming from ICAR-CIRG in the year 2013. He started a multiplier flock of Barbari breed in Vrindavan, Mathura district, Uttar Pradesh in the year January 2016. A flock of 17 goats was provided by ICAR-CIRG to study production performance of Barbari breed goats in field level. Flock was maintained under intensive management system. Out of total 17 goats, 3 were adult females, 3 young females with 1 breeding buck, 5 were male kids and 5 female kids. In total 23kids were born out of which 4 died and 5 sold/gifted at the age of 3m. The mortality among kids was 40% in the beginning. No further mortality was reported in the flock. Thebody weight of kids was recorded as: 2.4 kg at birth, 12-13 kg at 3 month of age, 18-20 kg at 6 month, about25-26 kg at the age of 9 months and 32-35

kg at 12 month of age. Lactation length was recorded as of 95-100 days with an average milk yield 1-1.5 lit (1.5 lit/day for 60 days).Feed fed to the goats were recorded as at the rate of 200-300 gram concentrate (grinded) per goat per day. Goats were also provided chopped green fodder mixed with legumes straw/crop resides (home grown/purchased). Total cost of feed and fodder was estimated about Rs.10-12 per goat per day. Theother expenses which include labour (@Rs. 2 per goat/day) and vet care (Rs. 250/animal/day). Expected income to be generated through sale of kids (14 kids- @Rs.12000-15000/animal) is Rs. 1,82,000. Total expenditure on feed, labour and others was Rs. 70,000. Expected annual net income was estimated to be Rs. 1,17,000 and net income per goat per year would be Rs. 8000. He thanksICAR-CIRG for all type of technical supports.

राजभाषा कार्यक्रम

संस्थान में वर्ष 2016 के दौरान हिन्दी पखवाड़ा के अन्तर्गत होने वाली गतिविधियां

हिन्दी पखवाड़ा : संस्थान में दिनांक 14.09.2016 (हिन्दी दिवस) के अन्तर्गत हिन्दी पखवाड़ा के कार्यक्रमों का आयोजन दिनांक 14.09.2016 से 28.09.2016 तक निम्नवत विवरण के अनुसार किया गया –

- दिनांक 14.09.2016 को एक विचार संगो ठी का आयोजन किया गया जिसमें संस्थान के विभिन्न वैज्ञानिकों, अधिकारियों, कर्मचारियों व आमंत्रित अतिथियों द्वारा 'राष्ट्र विकास में हिन्दी का महत्व एवं संस्थान में राजभाषा हिन्दी के प्रगामी प्रयोग व बढ़ते कदम एवं सुधार हेतु सुझाव' पर अपने विचार प्रकट किये गये तथा अन्त में संस्थान के निदेशक द्वारा अपने उद्‌बोधन में हिन्दी को अपने देश की एकता को जोड़ने वाली एक कड़ी तथा पहचान बताते हुए संस्थान के सभी कर्मियों को शत–प्रतिशत हिन्दी में कार्य करने हेतु आह्‌वान किया गया।
- दिनांक 15.09.2016 को हिन्दी श्रुतलेख प्रतियोगिता का आयोजन किया गया, जिसमें संस्थान के अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं ने सहभागिता की तथा डा. अनिल कुमार गोयल, डा. नितिका शर्मा एवं डा. विजय किशोर गेट क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व पुरस्कृत किये गये।
- दिनांक 16–17 सितम्बर, 2016 को हिन्दी हस्ताक्षर प्रतियोगिता का आयोजन किया गया जिसमें संस्थान के वैज्ञानिकों, अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं द्वारा हिन्दी में अपने हस्ताक्षर किये गये तथा मूल्यांकन के पश्चात् सर्वश्रेष्ठ तीन हस्ताक्षर करने वाले डा. विजय किशोर, डा. अनिल कुमार गोयल एवं श्री गंगादत्त क्रमशः प्रथम, द्वितीय व तृतीय स्थान पर रहे व पुरस्कृत किये गये।
- दिनांक 19.09.2016 को हिन्दी निबन्ध प्रतियोगिता विषय : 'स्वच्छ भारत–स्वस्थ भारत' का आयोजन किया गया, जिसमें संस्थान के वैज्ञानिकों, अधिकारियों, कर्मचारियों एवं बच्चों द्वारा सहभागिता की जिसमें डा. साकेत भूषण, कु. नीतू सिंह एवं श्री सुगड़ सिंह क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व पुरस्कृत किये गये।
- दिनांक 20.09.2016 को राजभाषा कार्यशाला का आयोजन किया गया जिसमें संस्थान के समस्त वैज्ञानिकों, तकनीकी अधिकारी व कर्मचारी, प्रशासनिक अधिकारी व कर्मचारियों ने सहभागिता निभायी, जिसमें डा. रघुवीर शरण तिवारी, प्राध्यापक एवं सहसचिव, नगर राजभाषा कार्यान्वयन समिति, (नराकास) छटवां तल, आयकर भवन, आगरा द्वारा 'राजभाषा अधिनियम' पर एक व्याख्यान दिया गया।
- दिनांक 21.09.2016 को आओ बताओ ईनाम पाओ प्रतियोगिता का आयोजन किया गया जिसमें 112 वैज्ञानिकों, अधिकारियों, कर्मचारियों, बच्चों एवं महिलाओं ने सहभागिता की। इस प्रतियोगिता में सहभागिओं से राजभाषा एवं सामान्य ज्ञान से सम्बन्धित 100 प्रश्न पूछे गये तथा सही उत्तर देने वाले 100 सफल प्रतियोगिओं को पुरस्कृत किया गया।
- दिनांक 22.09.2016 को बच्चों की श्रुतलेख प्रतियोगिता का आयोजन बच्चों के प्रौढ़ वर्ग एवं बाल वर्ग के लिए अलग–अलग किया गया। प्रौढ़ वर्ग में कु. नीतू सिंह, श्री ज्ञानेन्द्र एवं मा. राबा महाराज क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे एवं बाल वर्ग में मि. उत्कर्ष चन्द्रा, मि. अनुज कुमार एवं कु. सेव्या सिंह क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व पुरस्कृत किये गये।
- दिनांक 23.09.2016 को संस्थान के अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं के लिए हिन्दी अनुवाद प्रतियोगिता का आयोजन किया गया जिसमें डा. अनिल कुमार गोयल, डा. रवीन्द्र कुमार एवं श्री जितेन्द्र सिंह गेट क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व पुरस्कृत किये गये।
- दिनांक 24.09.2016 को अपराह्न 2.00 बजे से संस्थान के वैज्ञानिकों के लिए एक हिन्दी शोध पत्र प्रतियोगिता का आयोजन किया गया। वैज्ञानिक वर्ग में डा. गोपाल दास, डा. के. गुरूराज, डा. विजय कुमार एवं डा. रवीन्द्र कुमार क्रमशः प्रथम, द्वितीय एवं

तृतीय–तृतीय स्थान पर रहे व पुरस्कृत किये गये।

- दिनांक 26.09.2016 को राजभाषा से सम्बन्धित वृत्तचित्र, सेतु व हिन्दी गांधी और गुलामी का चलचित्र प्रदर्शन समस्त कर्मचारियों के लिए संस्थान में किया गया।
- दिनांक 27.09.2016 को हिन्दी अनुप्रयोग प्रतियोगिता का आयोजन किया गया जिसमें संस्थान के वैज्ञानिकों, अधिकारियों, कर्मचारियों एवं छात्र/छात्राओं ने भाग लिया। श्री राजकुमार सिंह, श्री जितेन्द्र सिंह गेट एवं डा. रवीन्द्र कुमार क्रमशः प्रथम, द्वितीय एवं तृतीय स्थान पर रहे व पुरस्कृत किये गये।
- दिनांक 14.10.2016 को हिन्दी पखवाड़ा समापान समारोह का आयोजन किया गया जिसमें संस्थान के समस्त वैज्ञानिकों, तकनीकी अधिकारी व कर्मचारी, प्रशासनिक अधिकारी व कर्मचारियों ने सहभागिता निभायी एवं दिनांक 14 सितम्बर, 2016 से प्रारम्भ हुए इस हिन्दी पखवाड़े के दौरान समस्त सफल प्रतिभागियों को संस्थान निदेशक एवं अध्यक्ष राजभाषा कार्यान्वयन समिति डा. मनमोहन सिंह चौहान द्वारा धनराशि रू. 1000.00, 800.00 एवं 600.00 नगद प्रदान करते हुये पुरस्कृत किया गया। इस अवसर पर निदेशक महोदय ने अपने उद्‌बोधन में कहा कि किसी भी देश की एकता एवं विकास के लिए उस देश की राष्ट्रभाषा का समृद्ध होना अति आवश्यक है। अतः हम सभी का कर्तव्य है कि हिन्दी को राष्ट्रभाषा के पद पर आसीन करने के लिए हर सम्भव प्रयास करें तथा संस्थान मे निर्धारित लक्ष्यों के अनुरूप हिन्दी में कार्य करते हुए हिन्दी के कार्यान्वयन को आगे बढ़ाना सुनिश्चित करें। हमेशा याद रखें कि दैनिक व्यवहार में हिन्दी भाषा का प्रयोग हीनता नहीं बल्कि गौरव का प्रतीक है।

हिन्दी पखवाड़े के अन्तर्गत आयोजित विभिन्न प्रतियोगिताओं में सफल प्रतिभागियों को पुरस्कार वितरण करते हुये संस्थान के निदेशक, डा. मनमोहन सिंह चौहान

01 अप्रैल, 2016 से 31 मार्च, 2017 तक आयोजित राजभाषा हिन्दी से सम्बन्धित त्रैमासिक बैठक

राजभाषा अधिनियम के अन्तर्गत संस्थान की राजभाषा कार्यान्वयन समिति की बैठकों का आयोजन क्रमशः दिनांक 25 मई, 2016, दिनांक 09 सितम्बर, 2016, दिनांक 15 दिसम्बर, 2016 एवं दिनांक 03 मार्च, 2017 को संस्थान निदेशक एवं अध्यक्ष संस्थान राजभाषा कार्यान्वयन समिति की अध्यक्षता में सम्पन्न हुयी। इन बैठकों में संस्थान के समस्त विभागाध्यक्ष, अनुभाग प्रभारी व संस्थान राजभाषा कार्यान्वयन समिति के सदस्यों ने सहभागिता की। बैठकों के दौरान संस्थान में हिन्दी के प्रगामी प्रयोग को बढ़ावा देने हेतु किये गये कार्य कलापों पर गहन विचार-विमर्श किया गया तथा संस्थान निदेशक द्वारा समस्त वैज्ञानिकों, अधिकारियों व कर्मचारियों को संस्थान के 'क' क्षेत्र में स्थित होने के कारण अपना शत-प्रतिशत कार्य हिन्दी में करने हेतु निर्देशित किया गया तथा प्रशासनिक अधिकारी व प्रशासन के अन्य अधिकारियों एवं कर्मचारियों को प्रत्येक

दशा में धारा 3(3) का अनुपालन करने के लिये निर्देशित किया गया। इसी दौरान राजभाषा अनुभाग को समस्त कर्मचारियों में राजभाषा हिन्दी के प्रति जागरूकता व रूचि जागृत करने के उद्देश्य से हिन्दी में उत्कृष्ट कार्य करने के लिये कर्मचारियों को नियमानुसार नगद पुरस्कार प्रदान करने हेतु निर्देश जारी किया गया।

हिन्दी कार्यशाला

01 अप्रैल, 2016 से 31 मार्च, 2017 तक आयोजित त्रैमासिक हिन्दी कार्यशाला

1. दिनांक 29 जून, 2016 को प्रथम त्रैमासिक एक दिवसीय कार्यशाला का आयोजन किया गया, जिसमें संस्थान के समस्त वैज्ञानिकों, तकनीकी अधिकारी व कर्मचारी, प्रशासनिक अधिकारी व कर्मचारियों ने सहभागिता निभायी जिसमें डा. शीलेन्द्र वशिष्ठ, पूर्व वरिष्ठ प्रबन्धक (राजभाषा),पंजाब नेशनल बैंक, क्षेत्रीय कार्यालय, आगरा द्वारा 'प्रशासनिक शब्दावली एवं अनुवाद' पर एक व्याख्यान दिया गया।
2. दिनांक 20.09.2016 को द्वितीय त्रैमासिक एक दिवसीय कार्यशाला का आयोजन संस्थान के केन्द्रीय सभागार में किया गया। इस कार्यशाला में डा. रघुवीर शरण तिवारी, प्राध्यापक एवं सह–सचिव, नराकास, आगरा संघ की राजभाषा नीति, नियम एवं प्रावधान पर व्याख्यान दिया गया। इस कार्यशाला में संस्थान के समस्त वैज्ञानिक, तकनीकी अधिकारी, प्रशासनिक अधिकारी व कर्मचारियों ने सहभागिता की।
3. दिनांक 16.12.2016 को तृतीय त्रैमासिक एक दिवसीय कार्यशाला का आयोजन संस्थान में किया गया। इस कार्यशाला में संस्थान के समस्त वैज्ञानिक, तकनीकी अधिकारी, प्रशासनिक अधिकारी, व कर्मचारियों एवं हाईस्कूल उत्तीर्ण कुशल सहा. कर्मचारियों ने सहभागिता की। इस कार्यशाला में प्रभारी, राजभाषा द्वारा संस्थान में राजभाषा के प्रगामी प्रयोग को बढ़ावा देने हेतु एक व्याख्यान प्रस्तुत किया गया।
4. दिनांक 25 मार्च, 2017 को चतुर्थ एक दिवसीय कार्यशाला का आयोजन संस्थान में किया गया। यह कार्यशाला बकरी पालन पर 69वें वैज्ञानिक राष्ट्रीय प्रशिक्षण कार्यक्रम के दिनांक 25 मार्च, 2017 को समापन कार्यक्रम में डा. हरिऔध तिवारी, प्रभारी राजभाषा अनुभाग द्वारा 'हिन्दी शब्दों का सरल उपयोग' विषय पर व्याख्यान दिया गया। इस प्रशिक्षण कार्यक्रम में देश के विभिन्न राज्यों से 102 प्रशिक्षणार्थियों तथा संस्थान के समस्त वैज्ञानिकों एवं अधिकारी द्वारा सहभागिता की गयी।

TECHNOLOGY SERVICES

Goat Germplasm supplied

Institute supplied 482 goats and 82 sheep to the progressive farmers and various government agencies for breed improvement programmes.

Superior Germplasm Supplied

Breed	Total
Jamunapari	154
Barbari	308
Jakhrana	126
Muzaffarnagri	74
Total	662

WOMEN'S COMPLAINT COMMITTEE

Women's Complaint Committee is meant to redress the grievances of the women employee of the institute and to provide them a congenial environment at their workplace. The Women's Complaint Committee' was reconstituted with the following members:

1. **Dr Anu Rahal:** Chair person
2. **Dr Nitika Sharma:** Member
3. **Dr Priyadarshini Raju:** Member
4. **Dr Madhu Tiwari:** 3rd Party Member
5. **Senior Administrative Officer:** Member
6. **Smt. Rajesh Tomar:** Member Secretary

No complaint was received during the Academic year 2016-17. Four meeting cum awareness programmes regarding their rights at their workplace were conducted on 25th July, 2016, 29th Sept., 2016, 10th Feb., 2017 and 22nd March, 2017.

IMPORTANT MEETINGS RESEARCH ADVISORY COMMITTEE (RAC)

The meeting of Research Advisory Committee (RAC) of CIRG was held on 29th July, 2016 under the chairmanship of Dr A.K.Mishra, members of RAC, Dr M.S. Chauhan, Director, CIRG, Dr. D.V. Rangnekar, Dr. R.K. Tanwar, Dr. S.A. Asokan were present. Dr. P.K. Rout, Member Secretary RAC invited Director, CIRG for the welcome address. Dr. M.S. Chauhan, Director, CIRG in his welcome address highlighted the mission, vision, mandate and the activities of CIRG for the development of goat husbandry and prosperity of rural goat farmers. He presented progress of the institute during 2015-16 and highlighting the brief description of land resources, farms, different divisions, sections, scientific strength, manpower status, revenue generation, milk production, and supply of elite animals to different Govt. and Non-Govt. agencies, standardization and cryopreservation of semen and A.I in goats and interventions for better housing and management of goats. He also highlighted the research achievements, patents filed, research papers published, collaboration and MoU with different universities for education and research, financial outlays of the institute, awards and recognition to the institute. A brief description of AICRP on Goats and its different centers were also made. The committee gave several recommendations on various projects being undertaken by scientists at this institute. This was followed by opening address by the chairman and members of RAC. They appreciated the achievements of CIRG made during 2015-16 and emphasized that A.I. in goat should be taken on priority and organize a Brain Storming Session to discuss strategies on implement in the country.

Institute Management Committee (IMC)

The Institute Management Committee meeting was held on 29th March, 2017. Director, CIRG Dr. M.S. Chauhan chaired the meeting. The meeting was attended by Dr. S.P. Dixit, Principal Scientist, NBAGR, Karnal and member IMC, Dr. S.K. Jindal, PS & Head AP&R Division, CIRG, IMC Member, Dr. Ashok Kumar, PS & Incharge, SAO, CIRG and Sh. P.K. Singh, FAO, CIRG, Makhdoom. The agenda of the meeting was placed before the House and each agenda was discussed. All the members of the House appreciated the progress and achievements made by the CIRG during recent past.

Institute Research Committee (IRC)

The Annual Institute Research Committee meeting of CIRG was held on 3-5 May 2016 in the Committee room of CIRG under the chairmanship of Dr. M.S. Chauhan, Director, CIRG, Makhdoom. Dr. Ashok Kumar, I/c PME Cell of the Institute extended formal welcome to the Director, Dr. Neelam Gupta and scientists of the Institute. Dr. Neelam Gupta, P.S., ICAR, New Delhi has represented council in the IRC 2015-16. Dr. Gupta emphasized that IRC is essentially about exposure, discussion, sharing information and finding solution to problem rather than evaluation and criticism. She commented that women training programme may be taken through Institute activity in general and AICRP in particular. The Director in his introductory address highlighted the importance of institute IRC and he said that it is mandatory for every scientist to attend the IRC as it provides an opportunity to interact with the scientists of other divisions, to know about their work, projects running in different divisions and overall research achievements of the institute. This also helps to develop good projects and to avoid repetition of work.

RESEARCH ADVISORY COMMITTEE

Composition of the Research Advisory Committee

Chairman

Dr. A.K. Mishra
Vice Chancellor
Maharashtra Animal and Fishery Sciences University
Seminary Hills, Nagpur – 440 001, Maharashtra

Members

- Prof. S.A. Asokan, Ph.D., Dean, Madras Veterinary College, Chennai – 600 007
- Prof. (Dr.) R.K. Tanwar, Ex-Director Clinics, CVAS, A-202, Karni Nagar, (Lalgarh), P.O. Bikaner – 334001, Rajasthan
- Dr. Mohamed Nadeem Fairoze, Professor & Head, Deptt. of LPT, Veterinary College, Hebbal, Bangalore - 560024
- Dr. D.V. Rangnekar, Former Programme Coordinator, BAIF 4, Shobhana Apts., Nehru Park, Vastrapur, Ahmedabad – 380015
- Sh. Ashok Rangnath Kale, 21, Kisan Kranti, Station Road, Ahmedanagar (Maharashtra)
- Sh. K. Venkatesh, Villupuram, Tamil Nadu
- Dr. S.K. Agarwal, Director, CIRG, Makhdoom
- Dr .B.S. Prakash, ADG (AN&P), ICAR, New Delhi

- **Member Secretary:** Dr. P.K. Rout, Principal Scientist, CIRG

Composition of the Institute Management Committee

Chairman

Dr. M.S. Chauhan,
Director, CIRG, Makhdoom

Members

- Dr. S.K. Dixit, PS, NBAGR, Karnal
- Dr. R.P. Singh, Head Division of Biological Products, IVRI, Izatnagar
- Dr. A.K. Sahoo, PS & Head, Animal Nutrition, CSWRI, Avikanagar
- ADG (AN&B), ICAR, ICAR, Krishi Bhavan, New Delhi
- Dr. Ashok Kumar, Incharge PME Cell, CIRG, Member Secretary

EVENTS

37th Foundation Day

The institute foundation day (37) was celebrated on 12th July 2016. The foundation day started with plantation of trees by the Director, Dr. M S Chauhan with participation of all the staff of the institute. The Director highlighted the scientific achievements of the institute during the year.

15th August Celebration

Institute celebrated 70th Independenceday with devotion and joy on 15th August, 2016. Dr. M. S. Chauhan, Director of the institute in his address congratulated the scientific staff and supporting for their contribution in uplifting goat farmers of the country on this great occasion.

Single Window System for Goat Farmers inaugurated at ICAR-CIRG, Makhdoom

Dr Trilochan Mohapatra, Secretary, DARE and Director General, ICAR inaugurated the Single Window System for the goat farmers at ICAR-Central Institute of Research on Goats (CIRG), Makhdoom on 26.09.2016 to provide all kinds of technical information and assistance regarding goat production from a single place. He enthusiastically interacted with the local goat farmers gathered during the occasion and queried them about their problems related to the goat farming. Dr Mohapatra visited different Livestock Units, Agroforestry Section, and Laboratories and discussed about research projects being carried out with the scientists and suggested to incorporate cutting edge research in respective fields to provide a better solution of the goat farmers of the nation. He suggested CIRG should keep all recognized goat breeds in the institute for showcasing to the farmers of the country, and develop breeding strategies for faster growth, new generation diagnostics and

multivalent vaccines, research on cloning aspect for multiplication of elite germplasm. He appreciated the work and contribution of the Institute.

Vigilance Awareness week-2016, Public participation in promoting integrity and eradicating corruption

The Central Vigilance Commission issued a directive to observe Vigilance Awareness Week during the period of Oct. 31 – Nov. 5, 2016 with the theme on **"Public Participation in Promoting integrity and eradicating Corruption"**. In pursuance of the said directive issued by the

Central Vigilance Commission, New Delhi vide circular no. 16/VGL/030 dated 19.09.2016, 23.09.16, 26.09.16 and 27.09.16 and the directive issued by the Council vide file no. 51-2/2016-Vig.-1 dated 17.10.16, Vigilance Awareness Week was observed in ICAR-CIRG, Makhdoom from October 31 to November 5, 2016. On this occasion display of banner at prominent locations/places in laboratory building/offices and main gate of the institute were done to make awareness about vigilance awareness week-2016 on the theme **"Public Participation in Promoting integrity and eradicating Corruption"**.

Swach Bharat Abhiyan

Retirement

DISTINGUISHED VISITORS

Visite of Hon'ble Sh Purushotam Rupala, Union State Agriculture and Farmers Welfare Minister, on 28th September, 2016

Hon'ble Sh Sudarshan Bhagat, Union State Agriculture and Farmers Welfare Minister, on 29th September, 2016.

Dr T Mohapatra, Secretary DARE and Director General ICAR on 25 -26th September, 2016.


Shri R P Singh, Governing body and General body member on 16-17 Sept, 2016

Dr. A. K. Srivastava Member, ASRB, New Delhi and Former Director NDRI, Karnal on 11-12 November, 2016.

Distinguished Visitors List

i. Mr. S K Singh, Additional Secretary and FA (DARE/ICAR), New Delhi on April 16, 2016.

ii. Hon'ble Shri Giriraj Singh, Union Minister of States for MSME, GOI on 23rd April, 2016.

iii. Dr T Mohapatra, Secretary DARE and Director General ICAR on 25 -26th September, 2016.

iv. Hon'ble Sh Purushotam Rupala, Union State Agriculture and Farmers Welfare Minister, on 28th September, 2016.

v. Hon'ble Sh Sudarshan Bhagat, Union State Agriculture and Farmers Welfare Minister, on 29th September, 2016.

vi. Shri R P Singh, Governing body and General body member on 16-17 Sept, 2016

vii. Dr. H R Rahman Deputy Director General (AS), ICAR on 6-7 January, 2017.

viii. Former Deputy Director General (AS) (Dr M L Madan) on 1-2 January, 2017.

ix. Dr N. S. Rathore, Deputy Director General (Education) on 24-25 March, 2017.

x. Dr. A. K. Srivastava, Member, ASRB, New Delhi and Former Director NDRI, Karnal on 11-12 November, 2016.

PUBLICATIONS

Research Articles

1. Agarwal S, Sharma J R, Kharche S D, Goel A K, and Jindal S K.(2016). Effect of polyvinyl pyrrolidon (PVP) on in vitro maturation and cleavage rate of caprine oocytes. Indian Journal of Animal Reproduction 36(1): 37-41.
2. Agrawal JK, Kharche SD, Saxena A, Patel A, Pathak J, Sikarwar AKS (2016). Tetraploidy Induced by Electrofusion - A Review Adv. Anim. Vet. Sci. 4(5): 266-270.
3. A Kumar, VK Gupta, AK Verma, SK Yadav and A Rahal (2016). Vaccines for caprine bruellosis: status and prospectives. Int J Vaccines Vaccin, 2(3): 0030.
4. A Rahal and A Kumar (2016). Cardiovascular Diseases: Can Herb-Based Antioxidant and Anti-Inflammatory Functional Products Be a Solution? Reactive Oxygen Species. 10.20455/ros.2016.877
5. Arun K Das, Rajkumar, V., Nanda, P.K., Chauhan, P., S, R. Pradhan, S Biswas and 2016. Antioxidant efficacy of litchi (*litchi chinensis* sonn.) pericarp extract in sheep meat nuggets. Antioxidants. 5 (16): 1-10.
6. P. K. Rout, R Kaushik, N. Ramachandran (2016). Differential expression pattern of heat shock protein70 gene in tissues and heat stress phenotypes in goats during peak heat stress period. Cell Stress and Chaperones. 21(4):645-651(Impact: 3.163)
7. B.K. Prajapati, K P Singh, Ajoy Mandal, P K Raut and R Roy (2017) Genetic and phenotypic parameters of milk composition traits in Jamunapari goats. Accepted for publication in Indian Journal of dairy science on 23-12-12016 for May-June 2017 Vol.70 No. 3, (NAAS Score: 5.26)
8. Baqir M, Bhusan, S, Kumar A, Sonawane A, Singh R, Chauhan A, Yaday R, Prakash O, renjoth R, Baladhare A and Sharma D. 2016. Association of polymorphism in SLC11A1 gene with bovine tuberculosis trait among Indian cattle. Journal of Applied Animal research 44 (1): 380-383.
9. Beena V, Pawaiya RVS, Gururaj K, Shivasharanappa N, Karikalan M and Singh R. (2016). Application of microarray in animal disease pathogenesis and diagnosis. J Vet Sci Technol 7(6): 402. doi: 10.4172/2157-7579.1000402
10. Beena V, Pawaiya RVS, Singh DD, Gangwar NK, Shivasharanappa N and Gururaj K. (2016). A case of composite neoplasm of ovary in a goat having histological features of thecoma and metastatic adenocarcinoma. Indian J Vet Pathol 40(2): 177-180.
11. Chaubey KK, Gupta RD, Gupta S, Singh SV, Bhatia AK, Jayaraman S, Kumar N, Goel A, Rathore AS, Sahzad, Sohal JS, BJ, Singh M, Goyal M, Dhama K & Derakhshandeh A 2016. Trends and advances in the diagnosis and control of paratuberculosis in domestic livestock. Veterinary Quarterly, DOI: 10.1080/01652176.2016.1196508.
12. Dinesh Kumar Sharma, Souvik Pal, Promod Kumar Rout, Ajay Mandal, Saket Bhusan, Nitika Sharma and Yogendra Kumar Kushwah. 2017. Caprine coccidiosis in semi-arid India: Dynamics and factors affecting fecal oocytes count. Journal of Advance Veterinary and Animal Research 4 (1): 52-57.
13. Dixit, A.K., Kumar Vijay, Kumar Ashok, Mohan Braj and Rai B. (2016). Economic losses due to peste des petits ruminants (PPR) disease in goats: a post outbreak sample study in Auraiya district of Uttar Pradesh. India Veterinary Practitioner Vol. 17 No. 2 December 2016.
14. Dixit, A.K. and Birthal, P.S. (2016). Greenhouse gases emission from livestock production system of India: An actual consumption approach. Indian Journal of Animal Sciences 86 (11): 1331–1336.
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Lead / Invited Papers

1. 1. A K Dixit, M K Singh, Narendra Singh and B S Reddy. 2017. Goat Production in India: Technological and Marketing strategies for improving goat farmer's income: International Conference of Maharashtra Society of Agricultural Economics held from 10-11 Feb, 2017 at MPKV, Rahuri.

2. A K Dixit and M K Singh. 2017. Role of goat farming in sustainable livelihood security and doubling farmer's income. Souvenir on National Seminar on Improvement of Small Ruminant Production System for Livelihood Security. In Compendium: Annual Conference of ISSGPU and National Seminar on "Improvement of Small Ruminant Production System for Livelihood Security" at ICAR-CSWRI Avikanagar, Malpura (Tonk) Jaipur, Rajasthan (India),March 9-10, 2017

3. Arun K.Verma and Rajkumar, V. 2016. Recent approaches to reduce sodium in meat. Short course on Strategies in development of functional livestock products. Nov 21 to Nov 30th 2016, Department of LPT, DUVASU, Mathura. Pp- 48-58.

4. Arun Kumar Verma and V Rajkumar. 2017. Effect of freeze-dried strawberry on the quality of goat meat nuggets. Compendium of National Seminar on "Improvement of Small Ruminant Production System for Livelihood Security" at ICAR-CSWRI, Avikanagar on 09-10 March, 2017. Pp -225. (Oral presentation)

5. Bhusan, S. 2017. Biodynamic Farming: a concept of traditional, organic and alternative farming. Compendium of national symposium on, "Biodynamic animal farming for the management for livestock diversity under changing global scenario" held at Mannuthy, Thrissur, Kerala on February 08-10, 2017, p. 208-212.

6. Bhusan, S. 2017. Goat genetic resources in North Western Region of India and their conservation for sustainability. Compendium of national symposium on, "Farmers' centric agri-innovation for sustainable development" held at CSA Univ. of Ag & Tech, Kanpur on 24-25 March, 2017.

7. Goel A K and Singh S P. 2017. Status and Prospects of Reproductive Technologies in Small Ruminants. In Compendium: Annual Conference of ISSGPU and National Seminar on "Improvement of Small Ruminant Production System for Livelihood Security" at ICAR-CSWRI Avikanagar, Malpura (Tonk) Jaipur, Rajasthan (India),March 9-10, 2017 pp. 93 (SS2-LP1).

8. K. Dixit, M K Singh, Narendra Singh and B S Reddy. 2017. Goat Production in India: Technological and Marketing strategies for improving goat farmer's income: International Conference of Maharashtra Society of Agricultural Economics held from 10-11 Feb, 2017 at MPKV, Rahuri.

9. Khushyal Singh and V. Rajkumar. 2016. Goat meat preference in Indian conditions. Short course on Strategies in development of functional livestock products. Nov 21 to Nov 30, 2016, Department of LPT, DUVASU, Mathura. PP- 42-47.

10. M K Singh, A K Dixit and M S Chauhan. Presented lead paper on Importance of Goat Farming in improvement of rural households income and probable gains through technological and marketing interventions in VIIIth National Extension Education Congress-2017 at NAARM, Hyderabad held from 28-31 January, 2017

11. Rajkumar, V., Arun Kumar Verma and A Vanathi. 2016. Recent advances in analysis of meat and meat products by modern tools. Compendium of Winter School on a

contemporary theme entitled, "Advances in Value Addition and Quality Evaluation of Meat and Poultry Products" from 20th September- 10th October 2016., IVRI, Izatnagar. No. 25. Pp. 156-163.

12. Rajkumar, V., Arun Kumar Verma and Khushyal Singh. 2017. Advances in Goat meat processing. Lead paper. Compendium of National Seminar on "Improvement of Small Ruminant Production System for Livelihood Security" at ICAR-CSWRI, Avikanagar on 09-10 March, 2017. No. LP5, Pp -220.
13. Rajkumar, V. and Arun K. Verma. 2016. Hygienic meat production. Compendium on Scientific goat production. Eds (Kharche, S.D., Dige, M S., Khushyal Singh). ICR- CIRG Publications, June 2016 (Total pages 214). Pp-93-97.
14. Rajkumar, V. and Arun K. Verma. 2017. Hygienic Goat Meat Production. Compendium on Scientific goat Production (1-7th March 2017). Eds (M S Chauhan, M K Singh, A K Dixit, M S Dige, S Pal and N D Agarwal). Pp- 86-90.
15. Rajkumar, V and Arun K.Verma. 2016. Research advances in functional goat meat and milk products. Short course on Strategies in development of functional livestock products. Nov 21 to Nov 30th 2016, Department of LPT, DUVASU, Mathura. Pp- 36-41.
16. Rajkumar V. and Arun K. Verma. 2016. Hygiene in meat production and processing. Compendium on Advances in goat rearing. Eds. (Anu Rahal, Nitika Sharma, M S Dige, M S Chauhan; Total pages 113). Pp-86-89.
17. Kharche SD and Jha BK. (2016). Parthenogenesis. Regenerative medicine-from protocol to patient, Editor Gustav Steinhoff. Third Edition, Springer.

Popular Articles

1. Dass G, Kushwaha YK, Sharma N and Rout PK (2017). Muzzaffarnagri bhedo ke utpadan evam janan guno ya vibhin karko ka prabhav. Bhartiya Krishi Anusandhan Patrika, Vol. 32(1) Issue March 2017.
2. Dass G and Sharma N (2016). Bhed bakri mein chatni ka mahatav. Ajamukh CIRG Newsletter (Hindi), Vol. 33, Jan-June 2016, Page 5.
3. Gopal Dass, M. S. Dige and Nitika Sharma (2016). Common practices at organized goat farm. A Training manual on "Scientific Goat Production", ICAR-CIRG, Makhdoom, page: 16-20.
4. Gopal Dass, Nitika Sharma and Saket Bhusan(2016).Bhed-Bakari mein chhatani ka mahatwa. Ajamukh (Hindi magazine) of CIRG, 33rd issue, January-June, 2016, Page 5.
5. Gopal Dass (2016). Triplet lambs in Muzaffarnagari sheep. Goat News (English magazine) of CIRG, Vol. XIV , Issue January-June, 2016, page: 3.
6. Kumar Vijay and Kumar Ashok. 2016. Management of goats in rainy season. CIRG News Volume XIV by Central Institute for Research on Goats, Makhdoom, Mathura, Uttar Pradesh, India - 281 122. pp-5.
7. M. S. Dige, M. K. Singh, S. Paul & P. K. Rout (2017) Record keeping in goat farm management. Advances in Goat Rearing. Pg 26
8. Mishra AK Gururaj K, Sharma N and Abhishek. 2016. (Jan-June) Caseous lymphadenitis in Goats. CIRG News. Vol. XIV.
9. M K Singh,M S Dige and A K Dixit 2016. Goat Resources of Uttar Pradesh: Strategy for their Improvement and Development. CIRG-Goat News, Vol-13, Page No 7.
10. M K Singh and Manali Baghail. 2017. Rural Livelihood development through goat farming in India: Approaches and Models. Chapter for ***E-Training Manual*** published by CIRG for Training of Veterinary Officers on **Scientific Goat Farming** from 1-7th March, 2017, sponsored by Directorate of Research, Chhattisgarh Kamdhenu Viswavidylya- Durg. Page: 1-10
11. M K Singhand M S Dige. 2016. Rural Livelihood Development through Goat Farming in India. Published in Manual in Training Programme sponsored by JEEVIKA-Bihar held from 24-30 November, 2016 at CIRG, Makhdoom, Mathura. Page:
12. M K Singh and M S Dige 2016. Goat Genetic Resources of Uttar Pradesh and Road Map for their Improvement. A book on "Scientific Goat Production" Published by Director-CIRG). Page 1-6
13. Mohan, B., Dixit, A.K., Singh, K., Kumar, V. and Gautam, S.C.L. (2016). Bakari Palan Duwara Mahila Sashaktikaran. Ajamukh, Ank-33, January- June, 2016, PP: 02.

14. M S Dige, ***M K Singh***, Gopal Dass and P K Rout. 2016. Record keeping in goat farm management. A book on "Scientific Goat Production" Published by Director-CIRG. Page 21-27

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35. सतेन्द्र कुमार सिंह एवं मनोज कुमार सिंह 2016 उत्तर प्रदेश की बकरी संपदा एवं विकास पशुधन प्रकाश,अंक 7 पृष्ठ संख्या : 40–43

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37. **गोपाल दास, युगेन्द्र कुशवाह, नितिका शर्मा एवं प्रमोद कुमार राउत (2017)। मुजफ्फरनगरी भेड़ों के उत्पादन एवं जनन गुणों पर विभिन्न कारकों का प्रभाव।** Bhartiya Krishi Anusandhan Patrika (Research Journal of Agriculture and Animal Sciences), Vol. 32(1) Issue March 2017.

RESEARCH PROJECTS

Institute Funded Projects (2016-17)

S. No.	Projects Title	P. I
1.	Flagship Programme on A.I.	Dr. Ravi Ranjan
2.	Hormone profile during different reproductive stages in goats	Dr. A.K. Goel
3.	Comparative study on different structures of goat shelters under farm conditions	Dr. N. Ramachandran
4.	Modulation of immunocompetence of goat spermatozoa for augmentation of fertility	Dr. Ravi Ranjan
5.	Development of feed resources on poor land for goats	Dr. Prabhat Tripathi
6.	Value Chain for the Development of Goat Products with Healthy Traits	Dr. A. K. Verma
7.	Moringa olifera biomass based complete feed for goats	Dr. U.B. Chaudhary
8.	Extension approaches for dissemination of goat production technologies and impact assessment	Dr. Braj Mohan
9.	Economic losses due to important diseases in goat production	Dr. A.K. Dixit
10.	Development of model goat village	Dr. Vijay Kumar
11.	Need assessment of women in goat farming	Dr. Khusyal Singh
12.	Development of herbal anti-helminthic and acaricidal formulation for Goats	Dr. Ashok Kumar
13.	Patho-epidemiological studies on emerging and existing diseases of goats	Dr. R.V.S. Pawaiya
14.	Development of a sustainable Targeted Selective Treatment (sTST) strategy against haemonchosis in Indian Goats	Dr. Souvik Paul
15.	Evaluation of herbal immunomodulators for management of weaning stress in goat kids	Dr. Nitika Sharma
16.	Coenurosis control at CIRG goat farms and development of suitable diagnostic test for use	Dr. D.K.Sharma
17.	Genetic evaluation and improvement of Jakhrana breed for milk and growth traits	Dr. Saket Bhusan
18.	Allele mining in caprine Kisspeptin and GPRSG genes in association with fecundity in Indian goats	Dr. Mahesh S Dige

S. No.	Projects Title	P. I
AICRP Projects		
1.	AICRP – Genetic improvement of Barbari goats for milk and meat production	Dr. M. K. Singh
2.	AICRP – Improvement of Sire evaluation of Jamunapari goats for milk & meat production AICRP Jamunapari Unit	Dr. P. K. Rout
3.	AICRP – Network Project on Sheep Improvement – Muzaffarnagri Unit	Dr. Gopal Dass
4.	AICRP – Plasticulture Engineering & Technology (PET)	Dr. N Ramachandran
5.	AICRP – Outreach Project "Estimation of methane emission under different feeding system and development of mitigation strategies	Dr. Ravindar Kumar
External Funded Projects		
6.	NFBSFRA- Development of parthenogenetic goat embryos from embryonic stem cells	Dr. S.D. Kharche
7.	Development and Validation of a Peptide-based Immunoassay: Application for Early Pregnancy Diagnosis in Goats	Dr. S. P. Singh
8.	Isolation, Characterization and Development of a culture method for long term preservation of spermatogonial stem cells from doom pig	Dr. M.S. Chauhan
9.	Study the effect of Mesenchymal Stem Cell Transplantation on Ovarian Function and Fecundity in Goats	Dr. S. D. Kharche
10.	MOFPI – National Referral Laboratory for Testing of Animal Products	Dr. V. Rajkumar
11.	Veterinary Type Culture-Microbes (NAINP Bangalore, CIRG Makhdoom Collaboration)	Dr. U.B. Chaudhary
12.	"NICRA Project – Assessing resilience of small ruminant production under changing climatic conditions in semi-arid zone"	Dr. U.B. Chaudhary
13.	Goat Milk and Meat Value Chain	Dr. Anupam Krishna Dixit
14.	Outreach Programme on Zoonotic Diseases	Dr. S.V. Singh
15.	Veterinary Type Culture-Microbes (NRC on Equines, Hisar: CIRG Makhdoom Collaboration)	Dr. K. Gururaj
16.	ICMR – Crohn's disease in India: A multicenter study from a country where intestinal tuberculosis as well as Johne's Disease in endemic	Dr. S.V. Singh
17.	MOFPI – Development of Nano Immuno rapid test for the detection of Mycobactgerium avium subspecies paratuberculosis in milk samples	Dr. S.V. Singh
18.	AINP-NM – Neonatal Mortality in Farm Animals	Dr. Ashok Kumar
19.	CABin – Development of database repertoire for Clostridium perfringens strains prevalent in causing Enterotoxaemia in goats	Dr. R.V.S. Pawaiya
20.	Development of database on SNPs associated with economic traits production and reproduction in Indian goats	Dr. R.V.S. Pawaiya
21.	DST – Development of phage therapeutic preparation for neonatal colibacillosis in goat-kids	Dr. A.K. Mishra
22.	ICAR – Evaluation of Indigenous Medicinal of Peripartum Stress and Inflammation in Goats	Dr. Anu Rahal
23.	DST- Development of Phytopharmaceutical product for Bovine Mastitis	Dr. S.V. Singh
24.	NASF- Identification of bio-markers for early diagnosis of Mycobacterium avium subspecies paratuberculosis (MAP) infection and development of test to differentiate between Johne's Disease Infected and Vaccinatted Animals (DIVA)	Dr. S.V. Singh
25.	Enhancing livelihood Security of farming Community through livestock and crop integration using proven technologies	Dr. Manoj Kumar Singh

TRAINING AND CAPACITY BUILDINGS

S.No.	Name of employee	Designation	Name of Training / Programme attended	Duration (days)	Organizing / Institution
1	Dr. R.V.S. Pawaiya	Principal Scientist	Big Data Analytics in Agriculture	10 days	NAARM, Hyderabad
2	Dr A K Dixit	Sr. Scientist	Impact Assessment	05 days	NAARM, Hyderabad
3	Dr. Vijay Kumar	Scientist	IPR	3 days	NBAGR, Karnal
4	Dr. S.P. Singh	Scientist	Cell Culture	7 days	ICSCCB, Pune
5	Dr. Vijay Kumar	Scientist	Right to Information Act-2005	3 days	ISTM, New Delhi
6	Dr. M.S. Dige	Scientist	Recent Models and methods for analysis of Farm animal Data for during suitable Breeding and Management Strategies	10 days	CSWRI, Avikanagar
7	Mr. Satis Chandra	Technical Officers (T-5)	Training Programme on Implementation of Nicc- procurement cpp portal	02 days	IVRI, Izatnagar
8	Dr. Vijay Kishore Nimesh	Technical Officers (T-5)	Competence Enhancement Programme on Motivation and Positive Thinking for Technical Officers of ICAR	10 days	NAARM, Hyderabad
9	Mr. Shyam Singh	Technical Officers (T-5)	Competence Enhancement Programme on Motivation and Positive Thinking for Technical Officers of ICAR	10 days	NAARM, Hyderabad
10	Mr. V.K. Gautam	Technical Officers (T-5)	Competence Enhancement Programme on Motivation and Positive Thinking for Technical Officers of ICAR	10 days	NAARM, Hyderabad
11	Dr Nitika Sharma	Scientist	Advance techniques in pharmaco-toxicodynamic studies	20 days	DUVASU, Mathura

STAFF POSITION

Category	No. of Post Sanctioned	No. of Post Filled
Director	1	1
Scientific	51	35
Administrative Staff	33	34
Technical	72	55
Supporting	119	85
Temporary Status		96
Total	276	306

FINANCIAL STATEMENT (2016-17)

	Plan (Rest Lakh)		Non Plan (Rs Lakh)	
	Allocation	Expenditure	Allocation	Expenditure
A. Recurring				
Establishment charges	0.00	0.00	1600.74	1590.91
Wages	0.00	0.00	345.00	341.81
Pension	0.00	0.00	212.00	181.59
OTA	0.00	0.00	2.00	1.11
TA	7.50	6.95	5.00	3.79
Other charges	191.10	191.06	205.72	204.70
HRD	1.40	1.37	2.00	2.00
Total	200.00	199.38	2372.46	2325.91
B. Non–recurring				
Equipments	22.00	21.46	8.00	6.21
Furniture & Fixture	5.00	4.33	1.00	0.00
Library books & Journals	5.00	2.61	1.00	0.00
Livestock	0.00	0.00	0.00	0.00
Work	48.50	48.31	0.00	0.00
Others	0.00	0.00	0.00	0.00
Total	80.50	76.71	10.00	6.21
Grand Total (A+B)	280.50	276.09	2382.46	2331.12

REVENUE GENERATION(2016-17)

Particulars	Amount (in Rs)
Sale of Farm Produce	4753660.00
Sale of Meat/Meat Products	586493.00
Income from royalty/Sale of Publications and Advertisement	191166.00
License Fee	841748.00
Application fee from candidates	495230.00
Interest Earned from short term deposits	1778871.00
Income generated from Internal Resource Generation	1010721.00
Miscellaneous Receipts	1788048.00
Grand Total	11445937.00
Revenue Generation as per new guidelines	
Income from sale & Services	6561343.00
Income from fee/subscription	495000.00
Income from royalty/ Publications	191166.00
Grand Total	7247509.00

PERSONNEL

Administration and Managements

Dr. M. S. Chauhan	Director
Dr. S. D. Kharche	Vigilance Officer
Mr. Ashok Mallick	Sr. Administrative Officer
Mr. P. K. Singh	Finance & Accounts Officer
Mr. C. S. Sagar	Asstt. Admn. Officer
Mr. A. K. Sharma	Asstt. Admn. Officer
Mr. Roney Alfred	Private Secretary
Mr. Rajeev Kulshrestha	Jr. Accounts Officer

Animal Genetics and Breeding Division

Dr. Saket Bhushan	Principal Scientist & Head
Dr. P. K. Rout	Principal Scientist
Dr. Gopal Dass	Principal Scientist
Dr. M. K. Singh	Principal Scientist
Dr. M. S. Dige	Scientist
Mr. Rajendra Kumar	Technical Officer T-5
Mr. Badan Singh	Technical Officer T-5
Mr. V. K. Sharma	Technical Officer T-5
Mr. A. S. Prajapati	Technical Officer T-5
Mr. M. P. Agrawal	Technical Officer T-5

Animal Physiology and Reproduction Division

Dr. S. K. Jindal	Principal Scientist & Head
Dr. Satish Kumar	Principal Scientist
Dr. A. K. Goel	Principal Scientist
Dr. B. Rai	Principal Scientist
Dr. S. D. Kharche	Principal Scientist
Dr. N. Ramachandran	Sr. Scientist
Dr. Ravi Ranjan	Scientist
Dr. S. P. Singh	Scientist
Dr. R. Priyadharsini	Scientist
Dr. Chetna Gangwar	Scientist (on study leave)
Mr. H. K. Himkar	Technical Officer T-5

Animal Nutrition & Product Technology Division

Dr. U. B.Chaudhary	Principal Scientist & Head
Dr. Prabhat Tripathi	Principal Scientist
Dr. Ravindra Kumar	Sr. Scientist
Dr. V. Raj Kumar	Sr. Scientist
Dr. A. K. Das	Scientist (Transferred for 2 Year)
Dr. A. K. Verma	Scientist
Mr. Dori Lal Gupta	Sr. Technical Officer T-6
Mr. Raj Kumar Singh	Sr. Technical Officer T-6
Mr. Suraj Pal	Sr. Technical Officer T-6
Mr. Ram Kumar	Technical Officer T-5
Mr. Radhey Shyam	Technical Officer T-5

Animal Health Division

Dr. S. V. Singh	Principal Scientist & Head
Dr. D. K. Sharma	Principal Scientist
Dr. Ashok Kumar	Principal Scientist
Dr. R. V. S. Pawaiya	Principal Scientist
Dr. Anu Rahal	Sr. Scientist
Dr. K. Gururaj	Scientist
Dr. A. K. Mishra	Scientist
Dr. Souvik Pal	Scientist
Dr. Nitika Sharma	Scientist
Dr. H. A. Tewari	Chief Technical Officer T-9
Dr. Vinay Chaturvedi	Sr. Technical Officer T-6
Mr. V. K. Gautam	Technical Officer T-5
Mr. Vijay Kishore	Technical Officer T-5
Mr. D. V. Sharma	Technical Officer T-5
Mr. T. K. Gautam	Technical Officer T-5

Extension Education and Socio-Economics Section

Dr. Braj Mohan	Principal Scientist & I/c
Dr. A. K. Dixit	Senior Scientist
Dr. Khushyal Singh	Sr. Scientist
Dr. Vijay Kumar	Scientist
Mr. Suresh Tiwari	Technical Officer T-7

AICRP on Goat Improvement

Dr. P. K. Rout	Principal Scientist & PC
Dr. M. S. Dige	Scientist
Mr. C. S. Sagar	Asstt. Admn. Officer

Network Project on Sheep

Dr. Gopal Dass	Principal Scientist
Mr. Rajendra Kumar	Technical Officer T-5

Prioritization, Monitoring and Evaluation Cell

Dr. Ashok Kumar	Principal Scientist & I/c
Dr. P. K. Rout	Principal Scientist
Dr. M. K. Singh	Principal Scientist
Dr. Souvik Paul	Scientist
Dr. Nitika Sharma	Scientist
Dr. Vijay Kumar	Scientist

ITMU

Dr. Ashok Kumar	Principal Scientist & I/c

RTI Cell

Dr. A. K. Dixit	Sr. Scientist & Transparency Officer
Dr. H. A. Tewari	Chief Technical Officer (T-9) and Chief PIO
Dr. Vijay Kumar	Scientist and APIO

Agriculture Knowledge Management Unit (AKMU)

Dr. R. V. S. Pawaiya	Principal Scientist & I/c
Mr. Satish Chandra	Technical Officer T-5

Maintenance

Dr. M. K. Singh	Principal Scientist & I/c
Mr. Ishwari Saran	Technical Officer T-5
Mr. Shyam Singh	Technical Officer T-5
Mr. I. P. Sharma	Technical Officer T-5

Security Section

Dr. Raj Kumar	Sr. Scientist & I/c
Mr.P. K. Sharma	Security Officer

Medical Section

Dr. Ashok Kumar	Principal Scientist & I/c
Mr. MohanLal	Technical Officer T-5

APAR Section

Mr. A. Mallick	Sr. Administrative Officer

Library

Dr. K. Gururaj	Scientist & I/c
Dr. Balraj Singh	Sr. Technical Officer T-6

Agriculture Farm

Dr. Prabhat Tripathi	Principal Scientist & I/c
Mr. Lal Singh	Technical Officer T-5
Mr. Hukam Singh	Technical Officer T-5
Mr. Sugad Singh	Technical Officer T-5

Horticulture Section

Dr. A.K. Verma	Scientist & I/c
Mr. Suraj	Technical Officer T-5

Retirement

Mr. S. S. Gautam	Asstt. Admn. Officer
Mr. Hari Om	Technical Officer T-5
Mr. D. K. Bhat	Technical Officer T-5
Mr. U. C. Yadav	Technical Officer T-5
Mr. S. C. L. Gautam	Technical Officer T-5

Death

Mr. Khajan Sungh	05/01/2017

Research Scholars and Young Professionals

Manali Baghel	Women Scientist
Rakesh Kaushik	Research Associate
Kundan Kumar Chobey	Research Assistant
Anuj Kumar	Research Associate
Dimple Anadani	Young Professional-II
Nikhil Mishra	Young Professional-II
Aman Kumar	Young Professional-I
Tanuja Kushwah	Young Professional-I
Yogendra Kushwah	Senior Research Fellow
Juhi Pathak	Senior Research Fellow
Kamendra Sawrup	Senior Research Fellow
Geetika Gupta	Senior Research Fellow
Shantnu Singh	Senior Research Fellow
Madhumita Singh	Senior Research Fellow
Deendayal	Senior Research Fellow
Khushboo Seth	Senior Research Fellow

CERTIFICATE

TÜV NORD

Management system as per
ISO 9001 : 2008

In accordance with TÜV INDIA procedures, it is hereby certified that

ICAR - Central Institute for Research on Goats
Makhdoom, Farah - 281 122, Mathura,
India

applies a quality management system in line with the above standard for the following scope

Research & Development and Capacity Building for improving Goat productivity

Certificate Registration No. **QM 04 00356**
Audit Report No. **Q 6752/2015**

Valid until **31.03.2018**

S.K.Kulkta

Certification Body
at TÜV INDIA PVT. LTD.

Issue **01.04.2015**
Place : **Mumbai**

This certification was conducted in accordance with the TÜV INDIA auditing and certification procedures and is subject to regular surveillance audits.

TUV India Pvt. Ltd., 801, Raheja Plaza – 1, L.B.S. Marg, Ghatkopar (W), Mumbai - 400 086, India www.tuvindia.co.in

TÜV INDIA NABCB

IAF


C.I.R.G.
मेरा गांव
मेरा गौरव

भा.कृ.अ.प.–केन्द्रीय बकरी अनुसंधान संस्थान

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